

## Selection Panel Review Summary

**Proposal No.:** 024

**Proposal Title:** Assessing Contaminant and Pathogen Susceptibility in Steelhead Trout

**Principal Investigator:** Richard E. Connon

**Amount Requested:** \$649,340

**Recommended Amount:** \$0

**Summary:** The focus of the proposed three-year research project is to perform a physiological assessment of the effect of naturally occurring pathogens and contaminants on steelhead trout, which will be conducted throughout life-cycle assessments.

**Assessment:** The proposed project builds on previous work from these researchers linking the genomic response to the population response which is difficult to do. The immune function aspects of the proposal are very well developed and the investigators have already done significant work in this area and have promising and interesting preliminary results showing that these techniques provide very useful information. This includes exciting evidence that visual inspection of a fish is well-correlated with gene transcription. Based on the impressive past work by the proposal authors linking genomic endpoints to endpoints of concern, there is "incredible promise" for carrying this through to a management issue and to identifying impacts of combined stressors and subpopulation differences. The proposal would add solid basic knowledge and sophisticated new methods that may find important applications in steelhead management and monitoring.

However, the proposal has many deficiencies. It lacks an action/implementation plan. Portions of the approach (and supporting information in the introduction section) were unsubstantiated, not applied in the methods, and poorly described. The chemical exposure portion of the proposal is not as well developed in the proposal as the immune function work and it seems like it was hastily added. The experimental design and application of methods to the chemical exposures seem like an add-on that is not very well developed. Temperature is noted as an important variable that can predispose juvenile steelhead to disease, yet the proposed approach does not describe this variable, nor justify why it is not included. The field methods are not described in detail. Chemical data is not mentioned in monitoring or data goals. Initial studies with condition rank were described, but it was not clear what exactly "condition rank" was or what metrics were used to objectively discern that endpoint. The proposed exposure-related assessments do not include descriptions of clinically-relevant endpoints that can link to the molecular endpoints, SNP analyses, and genomic signatures (which is really the overarching goal of the project). The histopathology of gill and anterior kidney, a critical portion of the effort to link biological/physiological outcomes with other endpoints, has no metrics associated with it. There are no power analyses described to discern sample sizes. The literature support is used in vague terms, and there is a lack of relevant fish health literature. The existing salmonid literature on family-specific survival rates should have been cited. The specific roles and expertise of the investigators are not clearly described and there are no fish pathologists on the team. Permitting is not discussed and there were multiple typos and grammatical errors throughout the document suggesting either a close submission deadline or carelessness. Additionally, the proposal did not make the case for the value of the information to policy and management decisions nor did they convincingly establish that pathogens were a problem for Sacramento River steelhead.

# CALFED Ecosystem Restoration Program

## External Scientific Review Form

**Proposal Number:** 024

**Proposal Title:** Assessing Contaminant and Pathogen Susceptibility in Steelhead Trout

**Reviewer:** #1

### Conflict of Interest Statements:

I have no financial interest in this proposal (please mark correct response).

- Correct

### General Review Questions:

Along with your written observations in response to the questions below, please rate each using the following criteria:

Excellent: Outstanding in all respects

Very Good: High quality in nearly all aspects

Good: Quality work, but with some deficiencies

Fair: Lacking in one or more critical aspects

Poor: Serious deficiencies

1. **Problem/Goals.** Is the problem that the project is designed to address adequately described? Are the goals, objectives, and hypotheses clearly stated and internally consistent? Does the proposal describe the ecosystem goals it is designed to address (link to ERP goals)?

Comments:

The proposal makes a good case that the steelhead of the Sacramento River system are exposed to a wide variety of chemical contaminants, pesticides, and pathogens. It is not entirely clear where along their migratory pathway or in what habitats wild fish might be exposed. I am a bit puzzled by the statement that 70% of the smolts seem to be hatchery-produced but 90% of the adults caught were hatchery fish. This seems to imply lower survival of wild fish, which would be a bit of a surprise. In any case, there is no follow-up so I am not sure what to make of it. The rest of the proposal does not provide information on the survival rates from the two hatcheries, comparisons to wild fish, etc. Thus the case that pathogens and contaminants are a major problem is not fully established. It is also not clear why determination of family-specific vulnerability is needed, other than the basic statistical premise that if you want to compare two populations then you should sample families within populations. The existing salmonid literature on family-specific survival rates should have been cited.

Rating: **Good**

2. **Approach.** Does the proposal clearly describe its approach (including study design and methods, if appropriate)? Is the approach well designed and appropriate for meeting the

objectives of the project as described in the proposal? Will the proposal contribute to our knowledge base?

Comments:

I am neither an expert in genomics nor in pathology. However, I am reasonably familiar with the basic concepts and methods described here, which is part of a rapidly emerging set of tools and approaches. The lab techniques are sound, to the best of my ability to critique them, and this is indeed a very exciting new field, linking genetics, physiology, life history, and other aspects of the basic biology of organisms. The field methods are much less clear, and there is no detail on the sampling location, how it was chosen, the consequences of that for the study, etc. The contrast between the very detailed and well-referenced lab methods and the sketchy field methods is notable.

Rating: Very good (excellent for the lab, which is most of the study, and fair for the field)

3. **Feasibility.** Is the proposed project's approach fully documented and technically feasible? Can the project be completed within reasonably foreseeable constraints (e.g., acquiring permits, construction, weather, etc...)? Does the proposal thoroughly address requirements such as environmental compliance and permitting? Is the scale of the project consistent with the objectives?

Comments:

The field methods are not described in detail but there seems to be protocols in place to catch steelhead smolts so I assume this can be accomplished. The lab work is described in considerably more detail and I base my rating on the reputations of the personnel and especially Dr. May. It is regrettable that there are no c.v.s to examine.

Rating: Excellent

4. **Conceptual Model.** Does the proposal provide a conceptual model that describes the interconnections among the key ecosystem components relevant to the action(s) being proposed? Does the conceptual model clearly explain the hypotheses it is testing?

Comments:

The proposal does a really good job describing the ways in which past, non-lethal exposure to contaminants and pathogens can be discerned, and the responses of fish from different hatchery populations. The evidence the visual inspection of a fish is well-correlated with gene transcription is indeed exciting. The conceptual model draws the connections among the technical components of the study. However, it stops short as it approaches the final and most important connection, to an action plan. If we learn all the things this proposal promises (and I do not doubt that good science would be done), what would the application be? What would we do differently from what we are doing now? Would we close one hatchery, or keep both open and start using the alternative broodstock, etc.? I doubt it, as there are probably pretty entrenched reasons for doing what is being done now (people like catching big fish, etc.). If there were family-level differences (as seems very likely, given everything we know about salmonids), how would the information be put to use? Frankly, I do not find the "Relevance to CALFED" very convincing and it has not been thought through enough.

Rating: Very good (excellent for the lab work but at best fair for the real links to action)

5. **Performance Evaluation Plan (Monitoring Plan and Performance Measures).** Does the proposal include a plan for project performance evaluation (monitoring to assess results and evaluate assumptions and hypotheses)? Does the project include appropriate performance measures to measure success relative to the project's goals and objectives? Will future studies or restoration projects be able to incorporate the information from this project?

Comments:

There is every indication that the lab work has been carefully planned and should go pretty much as expected, assuming the field collections are accomplished.

Rating: Excellent

6. **Expected Products/Outcomes.** Are products of value likely from the project? Are products of value also likely from the individual components of the project? Will the results of this study be readily accessible?

Comments:

As with many of the questions, I am of two minds on this one. It is likely that the team will produce results that can be published in journals read by scientists, and that is fine. I am, after all, one such scientist so I cannot knock the profession too much. How valuable the contributions will be is a more difficult question to address. At the end of the day it is not clear to me how much we will know that we do not know now about survival, and what (if anything) can be done about it.

Rating: Very good

7. **Previous Related Work.** Does the proposed project continue past work or include any work that could be considered a duplication of work previously done or currently being done by others?

Comments:

This project seems to build on but not duplicate past work.

Rating: Excellent

8. **Qualifications.** What is the track record of applicants in terms of past projects? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project? Do they have working knowledge of California streams and rivers?

Comments:

My ability to assess the qualifications was limited because I only had short self-assessments and no c.v.s for the team members. However, they seem qualified for the lab work and certainly

Dr. May is a very prominent geneticist. The lack of expertise with salmonid ecology (which shows in the rather weak coverage of the literature, especially that outside the Sacramento River system) is part and parcel of the tendency to see this as a lab study.

Rating: Very good

9. **Cost/Benefit Comments.** Is the budget reasonable and adequate for the work proposed? If the budget is considered to be excessive or inadequate for the work proposed, please highlight areas of the budget that may be of concern.

Comments:

I do not know what the ordinary budgets are for CALFED projects, and this budget is probably reasonable, given the nature of the work (lots of salaries for highly-paid people, lab costs, etc.). Whether, in the big picture, this is the best use of the money is a harder call. If the purpose is to advance basic science that may, at some point in the future, be applied to fish conservation, then this is probably pretty reasonable. On the other hand, if the purpose is to provide information that can guide policies, then this is a lot of money for a very uncertain outcome.

Rating: Very good

**Additional comments:**

None.

## **Overall Evaluation Summary Rating**

In the space below, please provide an overall rating of the proposal using one of the following categories:

- **Superior:** Outstanding in all respects with superior technical and scientific value and no significant concerns. Expected to add substantial new thinking/concepts to our knowledge/understanding of the topic proposed.
- **Above Average:** A very good proposal with at least high technical and scientific value and no significant concerns. Will add solid basic knowledge/understanding of the topic proposed.
- **Adequate:** A reasonable proposal without serious technical deficiencies and at least adequate value scientifically. Will add some useful knowledge to the topic proposed.
- **Inadequate:** A technically deficient proposal and/or one with low value, serious impediments or concerns. Will not likely change our basic knowledge/understanding of the topic proposed.

Rating: Above average.

Please provide a brief explanation of your summary rating:

As noted throughout this review, I have very mixed feelings. On the one hand I am cognizant of the exciting discoveries in the field of genomics, and the team here is likely to

complete the studies as proposed. In that sense the proposal would be in the “above average to excellent” range. On the other hand, I wonder if this proposal is appropriate for this funding source. This is really not for me to decide; however, I wonder if this is the best use of this considerable amount of money. After the study is over, what will be done differently in the system? The lack of implementation plan (i.e., out of the lab and into the policy arena or the river itself) concerns me. Seen in this light the proposal would merit a ranking in the “barely adequate to inadequate” range.

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## **CALFED Ecosystem Restoration Program External Scientific Review Form**

**Proposal Number:** 024

**Proposal Title:** Assessing Contaminant and Pathogen Susceptibility in Steelhead Trout

**Reviewer:** #2

### **Conflict of Interest Statements:**

I have no financial interest in this proposal (please mark correct response).

- XX Correct
- Incorrect

### **General Review Questions:**

Along with your written observations in response to the questions below, please rate each using the following criteria:

- Excellent: Outstanding in all respects
- Very Good: High quality in nearly all aspects
- Good: Quality work, but with some deficiencies
- Fair: Lacking in one or more critical aspects
- Poor: Serious deficiencies

1. **Problem/Goals.** Is the problem that the project is designed to address adequately described? Are the goals, objectives, and hypotheses clearly stated and internally consistent? Does the proposal describe the ecosystem goals it is designed to address (link to ERP goals)?

Comments:

The overall goals of the project are a little confusing when looking at the whole proposal. Is the goal to see how disease susceptibility impacts how an organism survives an additional stressor OR is the goal to determine if the additional stressor (chemical) impacts the immune response of the organism? It seems to be the second from the methods, but the hypothesis is stated the opposite. The specific objectives do not answer this question and actually do not mention the chemical stressor. Why would one expect that subpopulations that are less

susceptible would be compromised as far as chemical susceptibility? This is not necessarily clear from the literature review.

Rating: Good

2. **Approach.** Does the proposal clearly describe its approach (including study design and methods, if appropriate)? Is the approach well designed and appropriate for meeting the objectives of the project as described in the proposal? Will the proposal contribute to our knowledge base?

Comments:

The proposal clearly describes the study design and will meet the objectives listed in the proposal. My only issues are with matching the methods to the issues with the objectives I list in #1. The authors have done an impressive job with their research in the past linking genomic endpoints to endpoints of concern which shown incredible promise in this particular experiment carrying this through to a management issue and to identifying impacts of combined stressors and subpopulation differences.

Rating: Very good

3. **Feasibility.** Is the proposed project's approach fully documented and technically feasible? Can the project be completed within reasonably foreseeable constraints (e.g., acquiring permits, construction, weather, etc...)? Does the proposal thoroughly address requirements such as environmental compliance and permitting? Is the scale of the project consistent with the objectives?

Comments:

The approach of the investigators is technically feasible and as mentioned above their past studies using these techniques are impressive in linking the genomic response to the population response which is difficult to do. The proposal can be completed given potential constraints and the scale of the project is entirely appropriate for this proposal.

Rating: Excellent

4. **Conceptual Model.** Does the proposal provide a conceptual model that describes the interconnections among the key ecosystem components relevant to the action(s) being proposed? Does the conceptual model clearly explain the hypotheses it is testing?

Comments:

The proposal does clearly describe the fact that viruses and waste chemicals may be interacting to impact populations of steelhead. The conceptual model does explain hypotheses but it was a little unclear regarding what is said in the beginning versus the specific objectives. See #1. Never the less this research would provide results relevant to current ecological problems.

Rating: Very good

5. **Performance Evaluation Plan (Monitoring Plan and Performance Measures).** Does the proposal include a plan for project performance evaluation (monitoring to assess results and evaluate assumptions and hypotheses)? Does the project include appropriate performance measures to measure success relative to the project's goals and objectives? Will future studies or restoration projects be able to incorporate the information from this project?

Comments:

It seems like most of the deliverables are items that have already been completed such as the identification of biomarkers etc. These previous deliverable make this project strong but new deliverables need to be developed for this specific project. It seems the deliverables here should move into QTL markers associated with immune functions and data on chemical tolerance in relation to immune status. Again chemical data not mentioned in monitoring or data goals.

Rating: Good

6. **Expected Products/Outcomes.** Are products of value likely from the project? Are products of value also likely from the individual components of the project? Will the results of this study be readily accessible?

Comments:

This project will help to determine which subpopulations of steelhead may be more robust for stocking waterways, in addition it will assess the potential impacts of multiple stressors on the health of steelhead populations which would also be important to managers. Researchers in the past have been good about publishing and making data available results of their research. It is anticipated this would continue under this project.

Rating: Excellent

7. **Previous Related Work.** Does the proposed project continue past work or include any work that could be considered a duplication of work previously done or currently being done by others?

Comments:

The proposed project builds on previous work from these researchers tying genomic and specifically immune related genomic endpoints of a population with standard immune endpoints. This work is not currently being done by this group or others and is unique to this proposal.

Rating: Excellent

8. **Qualifications.** What is the track record of applicants in terms of past projects? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project? Do they have working knowledge of California streams and rivers?

Comments:



Researchers named in the proposal have significant experience in the techniques described and the species named in the proposal. The researchers also have a significant publication record in this field indicating they are successfully able to complete such projects. They have conducted many projects on California streams and rivers.

Rating: Excellent

9. **Cost/Benefit Comments.** Is the budget reasonable and adequate for the work proposed? If the budget is considered to be excessive or inadequate for the work proposed, please highlight areas of the budget that may be of concern.

Comments: The budget appears to be reasonable for the work mentioned in the proposal.

Rating: Excellent

**Additional comments:**

None.

**Overall Evaluation Summary Rating**

In the space below, please provide an overall rating of the proposal using one of the following categories:

- **Superior:** Outstanding in all respects with superior technical and scientific value and no significant concerns. Expected to add substantial new thinking/concepts to our knowledge/understanding of the topic proposed.
- **Above Average:** A very good proposal with at least high technical and scientific value and no significant concerns. Will add solid basic knowledge/understanding of the topic proposed.
- **Adequate:** A reasonable proposal without serious technical deficiencies and at least adequate value scientifically. Will add some useful knowledge to the topic proposed.
- **Inadequate:** A technically deficient proposal and/or one with low value, serious impediments or concerns. Will not likely change our basic knowledge/understanding of the topic proposed.

Rating: Above Average

Please provide a brief explanation of your summary rating:

This is a very interesting proposal to examine the influence of both pathogens and toxins on the health of steelhead populations and to identify if subpopulations from different fisheries have different susceptibilities. There is a little confusion as to the specific objectives and deliverables and why one would expect individuals with a stronger immune response to respond more negatively to chemicals. The immune function aspects of the proposal seem to be very well developed and the investigators have already done significant work in this area and have preliminary information that these techniques provide very useful information. The chemical exposure portion of the proposal by comparison is not as well developed in the proposal and

seems like it was hastily added. The experimental design and application of methods to the chemical insults seem like an add on that is not very well developed.

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**CALFED Ecosystem Restoration Program  
External Scientific Review Form**

**Proposal Number:** 024

**Proposal Title:** Assessing Contaminant and Pathogen Susceptibility in Steelhead Trout

**Reviewer:** #3

**Conflict of Interest Statements:**

I have no financial interest in this proposal (please mark correct response).

- **Correct**
- ~~Incorrect~~

**General Review Questions:**

Along with your written observations in response to the questions below, please rate each using the following criteria:

- Excellent: Outstanding in all respects
- Very Good: High quality in nearly all aspects
- Good: Quality work, but with some deficiencies
- Fair: Lacking in one or more critical aspects
- Poor: Serious deficiencies

1. **Problem/Goals.** Is the problem that the project is designed to address adequately described? Are the goals, objectives, and hypotheses clearly stated and internally consistent? Does the proposal describe the ecosystem goals it is designed to address (link to ERP goals)?

Comments:

This project will investigate the effects contaminant and pathogen exposure to Californian steelhead trout, based on field experiments, and laboratory contaminant and pathogen exposures, in order to develop a multivariate model to predict life cycle success in the wild in association to multiple stressors. The efforts are proposed in response to the “DRERIP Evaluation of the Bay Delta Conservation Plan: Conservation Measures and National Research Council Operations Criteria and Plan, Biological Opinion Review to Address Uncertainties.” The overall goal would be to assess the contribution of life stage, hatchery origin, and multiple exposures on the population success of the delta-bay steelhead populations.

Rating: Very Good

Overall this proposal is “very good” with regard to description of problems and goals. In general the goals reflect the RFP as well as relevant ecological questions. General descriptions of diseases that affect bay salmonids was drafted in a generic sense, and could have been more specific to Bay-Delta steelhead populations.

2. **Approach.** Does the proposal clearly describe its approach (including study design and methods, if appropriate)? Is the approach well designed and appropriate for meeting the objectives of the project as described in the proposal? Will the proposal contribute to our knowledge base?

Comments:

The overall approach is worthwhile. There are, however, areas that lack sufficient description, do not have literature support, or remain vague. For example, it is certainly in line to suggest that “determining the sublethal effects of environmental stressors in field-collected fish is a major challenge, yet these effects likely have a significant population-level effect.” Indeed, that is exactly what needs to be addressed. The fact that there is “likely a significant population-level effect” is unsubstantiated in the proposal, however. The next statement then leads the reviewer to look at biomarkers as increasingly powerful and informative tools to assess disease and exposure... This leap of faith is disquieting in light of the essential need to make direct linkages between functional biological effects and functional biomarkers.

Temperature is noted as an important variable that can predispose juvenile steelhead to disease, yet the proposed approach does not describe this variable, nor justify why it is not included.

Initial studies with condition rank were described, but it was not clear what “condition rank” was or what metrics were used to objectively discern that endpoint. Were data from combined gill and kidney profiles?

The authors stated: “Clusters are seemingly representative of disease types, with mycotic dermatitis (Md) highlighted in the “bad” condition, and genomic profiles of fish affected by IHNV clustered together regardless of condition classification, suggesting supporting our hypothesis that different infection types yield specific genomic response patterns (Indicated as viral or fungal in Fig 2).” It might make better sense to support the hypothesis that there are differences in transcription signatures with different stressors (and not that profiles are altered with some stressors but not other stressors). The tenet, as described, would imply that this type of profiling has limitations depending on the stress/disease agent.

Preliminary data were used to lay the foundation for the proposed efforts: “We contend that by increasing the number of genes measured (in previous studies), profiles will be more specific to each pathogen and/or pathogen interaction effects, and thus be more accurate in determining the health status of sampled individuals.” This reviewer’s translation of this statement is: widening the bore of the shotgun, using a shotgun approach.

The relevance of presence/absence data has not been made clear, nor how it will be integrated with “degree of infection” as described in this study. The investigators suggest that fish physiological responses integrate the sum of “unknown” stress exposures... and that the focus of the project will be placed on the physiological assessments. This could be a matter of semantics in this reviewer’s understanding, but physiological assessments to be conducted or

used in this study as endpoints in definitive experiments with fish are absent (with the exception of swimming performance as described in preliminary experiments). Exposure-related assessments described do not include descriptions of clinically-relevant endpoints that can link to the molecular endpoints, SNP analyses, and genomic signatures (which is really the overarching goal of the project). The histopathology of gill and anterior kidney, a critical portion of the effort to link biological/physiological outcomes with other endpoints, has no metrics associated with it.

Power analyses not described to discern sample sizes.

Portions of the approach (and supporting information in the introduction section) were unsubstantiated, not applied in the methods, and poorly described. There were multiple typos and grammatical errors throughout the document suggesting either a close submission deadline or carelessness.

Rating: Fair

The approach ranked “fair,” based on weak descriptive integration of the multiple endpoints at different levels of biological organization and relevance.

3. **Feasibility.** Is the proposed project’s approach fully documented and technically feasible? Can the project be completed within reasonably foreseeable constraints (e.g., acquiring permits, construction, weather, etc...)? Does the proposal thoroughly address requirements such as environmental compliance and permitting? Is the scale of the project consistent with the objectives?

Comments: The approach as described is feasible, although the supporting documentation is too conceptual for this reviewer. Further, literature support is used in vague terms, and there is a lack of relevant fish health literature (consistent with absence of physiological assessments in the proposal).

Compliance nor permitting is discussed. Scale of project is reasonable.

**Rating:** Good. Overall feasibility ranked as “good.”

4. **Conceptual Model.** Does the proposal provide a conceptual model that describes the interconnections among the key ecosystem components relevant to the action(s) being proposed? Does the conceptual model clearly explain the hypotheses it is testing?

Comments:

There is a conceptual model contained within the proposal, based on a combination of “a schematic diagram of the hatchery and field sampling capacity of this project, indicating stages at which monitoring could take place (Figure 5),” and a series of equations to integrate the different assessment endpoints. There is not, however, a reasonable integration of ecological considerations or interconnections relevant to susceptibility of the fish to the different exposures, nor to potential morbidity or decline in population strength.

Also lacking are individual exposures of pathogen or contaminant, in order to discern comparative differences with combined pathogen/contaminant exposure. It was not clear what was meant by IHNV-bifenthrin versus bifenthrin-IHNV exposures.

Rating: Good.

5. **Performance Evaluation Plan (Monitoring Plan and Performance Measures)**. Does the proposal include a plan for project performance evaluation (monitoring to assess results and evaluate assumptions and hypotheses)? Does the project include appropriate performance measures to measure success relative to the project's goals and objectives? Will future studies or restoration projects be able to incorporate the information from this project?

Comments:

This was not made clear in the proposal.

Rating: not rated since not included.

6. **Expected Products/Outcomes**. Are products of value likely from the project? Are products of value also likely from the individual components of the project? Will the results of this study be readily accessible?

Comments:

Indeed there would be benefits from this study as it would contribute to the knowledge of regulatory mechanisms associated with multiple stressors.

Rating: Good.

7. **Previous Related Work**. Does the proposed project continue past work or include any work that could be considered a duplication of work previously done or currently being done by others?

Comments:

No.

Rating: Very good.

8. **Qualifications**. What is the track record of applicants in terms of past projects? Is the project team qualified to efficiently and effectively implement the proposed project? Do they have available the infrastructure and other aspects of support necessary to accomplish the project? Do they have working knowledge of California streams and rivers?

Comments:

Not clear which investigator is doing what in the proposed effort. Background of the PI and the team in general have experience in environmental toxicology and molecular assessment of stress exposures. None, however, are fish pathologists or have specific experience with the fish species of interest. Dr. Israel (Co-PI) is *expected* to join the UC team in the spring, but not clear if this can be counted upon. Much of the literature authored by the PI that supports the proposed efforts is in review or in preparation (and not included with the proposal for review). Overall qualifications are good, nevertheless. Infrastructure appears reasonable.

Rating: Good.

9. **Cost/Benefit Comments.** Is the budget reasonable and adequate for the work proposed? If the budget is considered to be excessive or inadequate for the work proposed, please highlight areas of the budget that may be of concern.

Comments:

No major concerns.

Rating: Very good.

**Additional comments:**

None.

**Overall Evaluation Summary Rating**

In the space below, please provide an overall rating of the proposal using one of the following categories:

- **Superior:** Outstanding in all respects with superior technical and scientific value and no significant concerns. Expected to add substantial new thinking/concepts to our knowledge/understanding of the topic proposed.
- **Above Average:** A very good proposal with at least high technical and scientific value and no significant concerns. Will add solid basic knowledge/understanding of the topic proposed.
- **Adequate:** A reasonable proposal without serious technical deficiencies and at least adequate value scientifically. Will add some useful knowledge to the topic proposed.
- **Inadequate:** A technically deficient proposal and/or one with low value, serious impediments or concerns. Will not likely change our basic knowledge/understanding of the topic proposed.

**Rating: Adequate.**

Please provide a brief explanation of your summary rating:

The proposed efforts represent an ambitious undertaking to integrate multiple endpoints of effect as they relate to a model for biological (IHNV) and chemical (bifenthrin) exposures on steelhead trout. The proposed assessments lack an integration of clinically-relevant endpoints to functionally validate the molecular and genomic determinations. Excellent description of needs assessment in the introductory section, but not well-integrated in the approach. The proposal was sloppy with respect to flow, grammar and typos. Specific roles and expertise of the investigators not clearly described.