Selection Panel Review Summary

Proposal No.: 015
Proposal Title: Salinity effects on native and introduced SAV of Suisun Bay and the Delta
Principal Investigator: Katharyn Boyer
Amount Requested: $412,410.00
Recommended Amount: $412,410.00

Summary: The purpose of this project is to evaluate the role of increased salinity on native versus introduced submerged aquatic vegetation (SAV) beds in an effort to predict how native *Stuckenia pectinata* beds might contribute to restoration of native communities and functions in the Delta region. S*tuckenia pectinata* occurs mainly in the western Delta and Suisun Bay. The proposed project is a companion to recently funded projects (NOAA and Delta Science) mapping *Stuckenia* distribution and characterizing *Stuckenia* beds as habitat for epifaunal invertebrates and fish.

Assessment: The proposal is of high quality; it is clearly written and has a clear goal supported by appropriate hypotheses and objectives. The conceptual model is described with a clear narrative, and the proposal is straightforward with its approach. The Project Team is highly qualified and experienced. This project builds on work currently underway by the Project Team. The 3-year project will build on work done in the first years of the project. Project results will be useful for restoration in the important western Delta. The Selection Panel found minor weaknesses including: white light penetration (PAR), turbidity, or suspended solids could be measured, issues with pseudo-replicates (statistics), lack of inclusion of detailed information on which invertebrates will be examined and why, and lack of clarity on how information would be provided to people with a non-scientific background. Conditions for funding are: 1) inclusion of turbidity measurement component, 2) addition of a better plan to communicate findings to people with a non-science background (e.g., managers), and 3) addressing the issue of pseudo-replication.

CALFED Ecosystem Restoration Program

External Scientific Review Form

Proposal Number: 015

Proposal Title: Salinity effects on native and introduced SAV of Suisun Bay and the Delta

Reviewer: #1

Conflict of Interest Statements:

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

x 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 research goal described here is part of a larger effort by this applicant and others to understand and describe the distribution, ecology and physical determinants of a poorly studied ecosystem: subtidal shoals of submerged rooted vegetation (SAV) occurring in low salinity reaches of the Bay and Delta. The work proposed will examine the effects of salinity on plant growth and invertebrate assemblages of native and non-native SAV beds in order to better understand and predict the effects of changing salinity on these habitats and the invertebrates and fish that use them. As such the work is well connected to ERP goals and is forward-thinking in that the results will help decision makers understand some of the consequences of choices that will affect Delta hydrology (and therefore salinity average and range). The project description has a clear goal, supported by appropriate objectives and hypotheses.

   Rating: **Excellent**

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 approach is clearly established as a one-year descriptive study of two types of SAV shoal habitats, dominated by one native and one invasive species. In year two and three, an experimental study using 15 mesocosms dominated by each plant species will examine plant and invertebrate responses to different salinities, based on increases of 5 ppt above levels determined from the field evaluation in year one. The distribution of these two species with respect to salinity conditions and their influence on the salinity within the beds will be an important contribution to understanding their physical distributions (mapped prior to this project). Much will be learned about these two species of plant (sago pondweed and Brazilian waterweed) and well as their ecological interactions with invertebrates from this ambitious and carefully described/designed project.

Rating: **Excellent**

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 project is described clearly. It is relatively straightforward and should be completed without any problems. Mesocosms can be difficult to control, but the microcosm work with aquaria performed in advance should help identify and overcome unforeseen issues with herbivory, light, etc. The environmental impacts from the field study and collections will be minor and all fieldwork conducted on state lands. Replication at the habitat level (4 beds of each) and experimental level (5 replicates for each salinity level for each species) appears appropriate and on a scale consistent with project objectives.

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 overall goal of the project and underlying conceptual model is simple and clear, though there are no figures to illustrate the model. The results will inform the model so potential actions (including no action) that may result in increased or decreased salinity may be evaluated with respect to recovery and restoration of native species and communities.

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:

The proposed work is largely basic research to improve understanding of native and non-native SAV response to changing salinity. As such, evaluation and testing will use standard statistical techniques (e.g., ANOVA, post-hoc tests) as described in the proposal to evaluate outcomes. Future actions, including projects that influence the hydrology and salinity of the Delta, will benefit from information generated by the research. The research results will help us understand impacts of actions on native and non-native habitats and together using the collaborative work with Dr. Peter Moyle, the impacts on native fish.

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:

The project proposer will have useful information after year one concerning the current salinity environment of the native and non-native SAV beds. After the mesocosm experiments in years two and three, much useful information about the native and non-native SAV beds will be developed, including general ecology, invertebrate interactions and especially salinity tolerance. Results will be made available through local and regional presentations, peer reviewed articles and a final report. As an aside, I would like to see a mechanism for grantees to incorporate information from their project results into the CALFED conceptual models of the Delta habitats, if possible. Also, the proposal could have included plans to distribute results, such as distribution maps, on the WWW.

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:

The proposal is crafted to build upon ongoing work on this little studied SAV habitat. Physical distribution in the estuary is scheduled to be mapped prior to the start of the proposed work, which would add a salinity distribution layer to the GIS product after year one. The experiments will help explain the limits of distribution in the system. I do not believe there is any duplication of work done by others.

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:

Dr. Boyer has been studying tidal and subtidal habitats for many years and has an excellent publication record (7 peer-reviewed research reports since 2008) that includes a management document and a scientific contribution for eelgrass in 2010 and 2011 for the estuarine system. Her team appears well qualified to conduct all phases of the research and the work appears to be well supported by the facilities of the Tiburon Center. I assume the mesocosm facilities are available at Tiburon with fresh and saline running water, but this is not made clear in the proposal.

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 appropriate for the type of work and level of attention required by mesocosm research.

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: **Superior**

Please provide a brief explanation of your summary rating:

It is refreshing to see a forward-thinking proposal that builds upon ongoing research to investigate a little-known habitat type (SAV beds in the low salinity and oligohaline Delta) and provides a clear set of experiments to help guide decisions that might affect salinity in the Delta. The proposal is well thought out and affords reasonable effort and time to accomplish its objectives. I have no concerns regarding permitting, logistics or successful completion of the work proposed. The scientific value of the work will be high and very valuable as integrated into the collaborative effort to understand native and non-native SAV beds and support of invertebrates as well as Bay-Delta fish.

CALFED Ecosystem Restoration Program
External Scientific Review Form

Proposal Number: 015

Proposal Title: Salinity effects on native and introduced SAV of Suisun Bay and the Delta

Reviewer: #2

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 does an excellent job of explicitly addressing how the proposed research aligns with the ERP goals. The information generated from this proposed research would build on a very limited dataset about this habitat and increase the information about how these particular species will respond to increasing salinity conditions (likely under current climate change predictions) (Goal 2, Obj. 1). By elucidating the role of both native and non-native species in

these habitats, the proposed work will potentially provide information relevant to goal 5 (nonnative species).

Rating: Excellent

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:

Overall, the proposal describes their two-pronged approach to evaluating thoroughly. I think the in-situ and off site experiments are a good pairing. I would suggest running the in-situ experiments for a longer time period than 1 year to get a longer view of the temporal variability within the system.

In addition to testing impacts of increasing salinity on native and non-native SAV species, I would also suggest that the authors include treatments to look at the suspended sediment supply and turbidity impacts on SAV in the estuary (see Ganju and Schoelhammer 2009). I recognize that this adds replicates and may not be possible within the scope of the grant (available funding), the authors should acknowledge that salinity alone will not predict the distribution.

Finally, I am concerned about the low number of replicates as well as the pseudo-replication (many fronds in same tank) in the laboratory experimental design. This can be addressed in a simple revision of the experimental design.

Rating: Good (As discussed above).

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:

I think the project's proposed two-pronged approach is documented and completely feasible. Permits are already in place or easily obtained.

Rating: Very 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:

As indicated in another section, I think the conceptual model that the authors propose is missing some ecosystem components, such as sedimentation, that also influence the distribution of both SAV species.

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:

   The proposal does not include a plan for project performance evaluation in great detail; the monitoring Is implied throughout the document as experimental data collection. Proposed performance measures will assess how well the project is functioning. I would suggest extending the in-situ abiotic monitoring to provide additional feedback to the microcosm experiments. One of the best parts of this proposal is the ability of data generated from this project to inform future restoration projects.

   Rating: Very 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:

   See above comments about planning for future restoration.

   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:

   I do not see any issues with duplication of work previously conducted. In addition, it appears to build nicely on work previously (or simultaneously) funded by CALFED and NOAA Fisheries with knowledgeable local collaborators (Moyle).

   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:

The proposed research team seems highly qualified to implement the proposed project. In addition, the facilities (water table, laboratory space) and field equipment (boat, SCUBA) seem more than adequate to support the research.

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:

Budget seems in line with work proposed and will support the required personnel and needed equipment.

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:

Overall, I think this proposal will contribute important and timely information about the SAV habitat in the low salinity zone of the estuary. These are clearly of potential value to native fish (including endangered fish species) and the Delta/Bay ecosystem itself yet not much is known about the system. The project combines in-situ abiotic measurements with laboratory (tank) experiments to generate important information that can be applied to restoration projects throughout the Suisun Bay and Delta. My main concern revolves around certain details of replication and mechanistic explanations for observed patterns. However, if the authors keep

those critiques in mind, I think the project will be an important contribution and should be funded.

CALFED Ecosystem Restoration Program
External Scientific Review Form

Proposal Number: 015

Proposal Title: Salinity effects on native and introduced SAV of Suisun Bay and the Delta

Reviewer: #3

Conflict of Interest Statements:

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

- X 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 problem, goals and hypotheses for this project are clearly stated and described. The overall objective is to examine how increases in salinity affect the growth of two species of submersed aquatic vegetation (SAV). One of the species, *Egeria densa*, is non-native and supports primarily non-native species of fish. The other, *Stuckenia pectinata*, is native and supports primarily native species of fish. Almost nothing is known about the ecology of these SAV beds, in contrast with eelgrass beds in more saline parts of the estuary. Since *Stuckenia* is found in slight more saline waters than *Egeria*, the author speculates that increases in salinity (e.g, due to sea level rise, levee failure, watershed management changes) will foster that spread of the native species at the extent of the non-native, thus improving conditions for native invertebrate and fish species. This general hypothesis would be tested using field monitoring to describe existing conditions in the beds followed up by mesocosm studies examining salinity

effects on the two species. This projects is explicitly linked with Priority 2 in the RFP, which identified research to test hypotheses on factors related to conservation measures. The project also addresses the goal statement of the ERP that deals with rehabilitating natural processes.

The objectives and goals of the project are important to understanding what is controlling the distribution of these SAV beds, which are clearly critical to trophic support of native species. The argument for only studying increases in salinity needs stronger justification, however. In some estuaries, particularly in arid regions, salinity can decrease due to changes in watershed land use or hydrologic modification, facilitating the spread on invasive species. Certainly sea level rise can be expected to increase saltwater intrusion, but increases in precipitation may reduce salinity; results of climate prediction for the Bay-Delta area would help justify. This is a minor concern, but should be considered.

Rating: Excellent

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 approach would involve three primary tasks: 1. Characterize salinity and other variables in and outside the Egeria and Stuckenia beds; 2. Evaluate effects of salinity on growth of the two species separately in mesocosm experiments; and 3. Evaluate salinity effects on common invertebrates in separate mesocosm experiments. Environmental data from Task 1 would be used to fine-tune salinity levels for tasks 2 and 3. A number of variables will be examined, including nutrients, element ration, photosynthesis, and biomass.

This is a strong experimental approach that will provide valuable information on the response of these two species and the invertebrates they support to salinity. The results are likely to be conclusive. One concern I have is that the outcome of the experiments seems predetermined in that Stuckenia is exposed to a higher range of salinity values (5, 10 and 15 ppt) than Egeria, the strictly freshwater species (0, 5, and 10). Since a broader goal of the project is to forecast how salinity changes might change the distribution of the two species, with Egeria possibly supplanted by Stuckenia, I suggest that both species be exposed to the same levels of salinity. This will also provide information on what may happen if salinity decreases instead of increases. Furthermore, it would be interesting to see if competitive outcomes between the two species growing together would differ depending on salinity. Higher salinity may allow Stuckenia to persist in the presence of Egeria but under freshwater condition Egeria may be competitively superior. One other suggestion: the light environment and nutrient supply rates, which are not described in the proposal, should be carefully considered in setting up and operating the mesocosm experiment, as they will have a profound effect on outcomes. Regarding invertebrates: is it possible that invertebrates will respond differently to salinity than the plants? If different invertebrates are used for the different species it will not be possible to determine this. These suggestions are made in the spirit of improving the proposed research, not to point out flaws in the approach.

This approach would provide information about the environmental variable controlling the distribution of two important SAV species in the low-salinity regions of the Bay-Delta that have received almost no attention. Given the demonstrated effects of these species on fish and invertebrates, the results are likely to be important in understanding how sea level, climate change, and human activities may influence their distribution and ecological function.

Rating: Excellent

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 project team appears fully capable of carrying out the research. Permitting requirements are minor and should not hinder research. Weather will not constrain the mesocosm experiments and should not pose a constraint for the field measurements, since they will be conducted over an extended period. The scale of the project is consistent with the objectives.

   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:

   There is no diagram of a conceptual model (I am not sure if this is required by CALFED) but the second and third paragraphs on p. 10 explicitly describe the conceptual model that will be tested. This model is that 1. salinity increases will favor the growth and expansion of Stuckenia but hinder that of Egeria; and 2. That salinity will also influence the invertebrate communities present.

   Rating: Excellent

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:

   Since this is not a restoration project, a performance evaluation plan is not applicable. The assessment of success will be determined by the quality and dissemination of the project and their influence on management decisions.

   Rating: not applicable

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:

The results of the research will be submitted for publication in refereed scientific journals and presented at regional and national meetings. It is not clear how the findings will be conveyed to managers, stakeholders, and the general public other than via presentation. The proposal states that predictions of changes in invertebrates and GIS maps will be generated, but does not describe how these will be made available to groups other than researchers.

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 will benefit from two related projects the PI is currently working on. These are a survey of the distribution of Stuckenia beds and another study characterizing fish and invertebrates in the beds. The results of these two studies will be directly applicable to the proposed research. The project does not appear to duplicate any other 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:

The PI has extensive experience in the ecology of emergent and submergent communities, and is specifically recognized for her expertise on eelgrass SAV beds of San Francisco Bay. The team also includes a graduate student, a technician, and other support staff who seem well-qualified to implement the proposed projects. The roles and responsibilities of the team members are clearly spelled out.

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 seems reasonable and adequate for the work proposed. I didn't notice any benefits for the graduate student, which is not the case at my institution. The request for salaries seems appropriate and the equipment, travel, and supplies well-justified. Overhead costs are considerable but typical of rates for universities. For matching funds, is it possible that the PI commit some academic-year salary as matching funds? The other two projects are beneficial but

not qualified as matching. Overall I think the research findings from this work will be valuable and the amount requested will be a worthwhile investment of CALFED resources.

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: Superior

Please provide a brief explanation of your summary rating:

This is a carefully thought-through, well-defined research proposal that is likely to yield useful information on SAV species that are little known in the Bay-Delta. This information will be important in understanding how these species will respond to changes in salinity due to sea level or climate change and may lead to management decisions affecting freshwater to the Bay.