Draft Individual Review Form

Proposal number: #2001-K205-1 **Title: Hyporheic Zone and Salmon Spawning**

1a) Are the objectives and hypotheses clearly stated? No, the objectives and hypotheses are not clearly stated.

The principal objective of this research "… is to provide information regarding the influence of discharge, temperature, and fine sediments on anadromous egg survival in the intragravel region known as the hyporheic zone … (executive summary)". A thorough review of the literature would show that, in general, the principal objective has been well studied (see comments under 1b1 below).

Hypotheses are listed on page 3, and include:

1. Hyporheic flow direction and magnitude differ with different discharge regimes and fine sediment load.
2. Hyporheic flow direction and magnitude influence salmonid egg survival.
3. Sacramento River hyporheic temperatures produce higher egg survival than Deer Creek temperatures in early-arriving fall chinook salmon redds. Early arriving fall chinook are defined as those fall-run spawning between October 1 and October 15.
4. Sacramento River fine sediment deposition is lower in anadromous salmonids redds and produces higher egg survival than fine sediment loads in Deer Creek redds.

H1: Perhaps the only hypothesis worthy of testing, but I would rewrite the null hypothesis as: "Hyporheic flow direction and magnitude does not change with changes in the magnitude of river discharge." What specific aspect would the applicant focus on and how does it relate to the system the applicant is studying?
H2: What specifically does "influence salmonid egg survival" mean?
H3 and H4: These are extremely awkward sentences. How can Sacramento River hyporheic temperatures/sediment produce higher egg survival in early arriving redds? Based on Figure 2 from the proposal, the temperatures during the egg incubation period (~10/15-3/15) in either system are 50-55 F so I don't understand what the applicant's point is. How will the applicant separate out the relative effects between H3 and H4, or from other factors besides sediment and temperature?

1b1) Does the conceptual model clearly explain the underlying basis for the proposed work? No, the entire proposal, including the conceptual model, does not clearly explain the underlying basis for the proposed work.

One serious and fatal flaw of this proposal is the missing linkage between how the proposed work will reduce the uncertainty regarding the factors that are limiting salmon recovery in the San Francisco Bay/Sacramento-San Joaquin watershed. Although I did not read the Ecosystem Restoration Program (ERP), the ERP Strategic Plan, or the Multi Species Conservation Strategy, one can assume that there are a suite of factors that are thought to limit recovery of the salmonid species targeted in this proposal (spring and fall chinook salmon). What are these and how does this work relate to these factors? If the proposal was to mention the specific limiting factor(s) the research was attempting to address, it would be easier to place the work in context of the problem. However, the proposal vaguely refers to issues that affect salmonid survival in general, leaving the reader wondering how the conceptual model relates to the issue of salmon survival in the Sacramento River Basin.

Specific comments in the problem statement and conceptual model sections:

- "The problem is the relationship between discharge and egg survival is poorly understood, …". Not true! The authors are referred to the literature where they will find numerous papers that describe how egg survival is affected by discharge, temperature, water percolation (hyporheic flow), sediment, etc. They should start with "Pacific Salmon Life Histories", edited by Groot and Margolis.

- The hyporheic zone should be defined relative to the objectives of the study. Ground water and surface water mix within the hyporheic zone at spatial distances of centimeters to meters to even kilometers from the river channel. Presumably for this study, the hyporheic zone of interest is at the spatial scale of a salmon redd. The issue of spatial scale needs to be recognized by the authors and more specific and extensive definitions of the hyporheic zone should be used.
- The proposed objectives have been largely tested in the literature. For example, flow and fine sediment do influence hyporheic flow and direction. This is well studied in the hydrogeology discipline (e.g., Carl Palmer's work on hydraulic conductivities; David Lee's work on groundwater – surface water interfaces; Ken Bencala's work on hyporheic zones; and many others).
- Before concluding that the female salmon controls conditions in the egg pocket to the degree the proposal suggest, the authors should look at recent work by Phil Peterson and Tom Quinn (Environmental Biology of Fishes 46:243-253) where they showed fines migrate back into the redd to levels comparable to what they were before spawning.
- I don't understand Figure 1 in the proposal so I can't follow how the figure supports the statement that changes in river discharge affects hyporheic flow direction and magnitude. What exactly does this figure show? VHG doesn't mean flow. VHG is an indicator of a potential energy gradient. Flow direction and magnitude can only be known if VHG and hydraulic conductivity/permeability are known. Look at Freeze and Cherry (Groundwater, published in 1979) for a complete discussion of the Darcy flow equations, etc.
- I don't understand how high temperatures, egg mortality, and hyporheic conditions are related. As stated above, Figure 2 shows that the temperatures during the incubation period are around 50-55 F in both systems. High temperatures occur during the pre-spawning period when the eggs are still retained in the female. If this is the mortality mechanism (this is what the applicant is implying), then why not sample the eggs before they are put in the gravel? It really isn't a hyporheic issue if that is the mortality mechanism, but rather surface water temperature issue. Waiting until eggs are in the gravel will only complicate the issue.

1b2) Is the approach well designed and appropriate for meeting the objectives of the project? No, the approach is not well designed nor appropriate for meeting the objectives of the project.

Methods/approaches were presented by the applicant in the section following the hypotheses and in the proposed scope of work section. Neither section provides sufficient detail describing the selected methods, so it is almost impossible to fully evaluate whether the applicant can meet the objectives of the project. Worse, there is no rationale as to how the proposed methods/approaches relate to the issues limiting salmon production.

I confined my review to the scope of work section since it simply reiterates the methods described under the hypotheses section.

- Why were two drainages in Washington state all of a sudden tossed in? The rationale for selecting them is not clear. For example, is the geomorphology, hydrology, species composition, etc. the similar between the watersheds in California and Washington? The geomorphology, hydrology, and physiography of the basin will have a much larger impact on the hyporheic conditions than the presence of a reservoir. The inclusion of the watersheds in Washington should be based on the value added to the science, not simply because the applicant has funding to conduct work in those drainages.
- How will the applicant measure hyporheic flow? Once again, flow is a function of sediment permeability/hydraulic conductivity and VHG. I don't see where the applicant is measuring sediment permeability.
- How will the applicant measure VHG in locations where it is not possible to place a steel piezometer (i.e., middle of a navigable river, deep water, high surface water velocities, etc.)?

- How frequently will measurements be made? If the river fluctuates daily because of power peaking or irrigation withdrawal, then continuous measurements of hyporheic conditions may be necessary.
- Why did the applicant select 18" for a driving distance? What if a low permeability lens is present between the river bed surface and 18" deep?
- What is hyporheic availability? Hyporheic flux across a redd can't be measured the way the applicant has proposed. The applicant needs to know the hydraulic conductivity of the sediments. And what will flux through the redd tell the applicant? The redd changes conditions in the stream so measurements of flux can't be used to assess habitat use.
- Hypothesis H1 implies something about fine sediment load. There is nothing in the approach that addresses this. At the very least the applicant would need to conduct some bulk sampling and better still would be freeze cores of the redd pocket (see Peterson and Quinn's work as well as Chapman's).
- I don't understand the sentence "The hyporheic pots allow us to determine egg survival immediately adjacent to a redd." If, as the applicant suggests, the female modifies the sediment to improve survival of the eggs, how can a measure of egg survival adjacent to the redd be representative of the redd environment? I am lost.
- How will the applicant measure egg survival? Will they cap the redds and then look at emergence success? If eggs will placed in the pot, how many? How will the applicant know if the hyporheic pot is simulating the egg pocket (i.e., similar hydrogeology, abiotic parameters, etc.)?
- I would be hesitant to put much faith in a physical model that measures 4 x 5 feet (roughly). Anadromous salmon respond to geomorphic features of river channels that are linked across spatial scales of several orders of magnitude. In reality the applicant may be able to replicate the immediate environment of an egg pocket using the physical model, but I seriously doubt they will be able to "independently vary both surface and groundwater flow features to simulate wide ranging hyporheic flow conditions (p. 6)." If the applicant has already done this, they should cite some peer reviewed articles that give me some confidence in the approach they have proposed.
- The applicant's reliance on the physical model before an adequate understanding of the river environment is dangerous. Their proposal doesn't demonstrate to me that they are close to being able to construct a laboratory model to simulate river conditions. The schedule suggest the two occurring at the same time.

1c1) Has the applicant justified the selection of research, pilot or demonstration project, or a full-scale implementation project? No, the applicant has not justified why this research project is needed. This was thoroughly discussed in 1b1 above.

1c2) Is the project likely to generate information that can be used to inform future decision making? No, the project is not likely to generate information that can be used to inform future decision making.

The basis for this answer stems from the fact that attributes of hypotheses 1 and 2 have been answered already. The proposal is not described in sufficient detail to know whether there are nuances of these hypotheses that will be tested in order to generate new information, or more importantly, how the information will be used for decision making. With regards to hypotheses 3 and 4, there is no justification, facts, data, etc. that show egg to emergent fry survival is limiting in either system, what those survival rates are, or whether there is any reason to think that they are a function of hyporheic conditions.

Thus, there does not appear to be additional information the project will generate that can be used to inform decision makers.

2a) Are the monitoring and information assessment plans adequate to assess the outcome of the project? No, the monitoring and information assessment plans are not adequate to assess the outcome of the project.

The applicant's monitoring and assessment section is one paragraph (5 sentences). There is no mention of a sampling strategy or experimental design; frequency of sampling; number of sample points; how piezometers will be sampled and how quality assurance will be implemented to ensure high quality data, etc. There is no mention about how salmon utilization of various study areas will be completed or whether data will be collected in non-spawning areas.

2b) Are data collection, data management, data analysis, and reporting plans well-described, scientifically sound and adequate to meet the proposed objectives? No, the data collection, data management, data analysis, and reporting plans are not well described enough to meet the proposed objectives.

Why is the applicant proposing to use ANOVA when regression analysis is more powerful and likely to show relationships better? They mention that they are attempting to establish the relationship between egg survival and hyporheic conditions. The applicant has not adequately described the measurement of egg survival or the collection of hyporheic conditions. Thus, it is impossible to evaluate how data analysis will be conducted on this data.

3) Is the proposed work likely to be technically feasible?
It is not possible to evaluate whether the proposed work is technically feasible as the proposal lacks detail in describing the methods that will be used. Specific questions have previously been identified (see section 1b2).

4) Is the proposed project team qualified to efficiently and effectively implement the proposed project?
It is not clear whether the project team is qualified to efficiently and effectively implement a study of hyporheic conditions and salmon spawning. Dr. Bowen's and Ms. Borthwick's resumes/vitas were not included in the proposal package. Selected publications listed for each of the principal investigators showed no publications in peer reviewed journals, nor any publications (reports or otherwise) on the subject of the proposed study. The roles of the other team members is not clear. Mr. Nelson appears to have some experience with hyporheic pots and has published in the peer reviewed literature. Dr. Duffy has an impressive resume and a number of peer reviewed publications, but I could not find any that related to hyporheic zone investigations. The other team members also did not show any hyporheic zone related publications.

Miscellaneous comments

This proposal misses the mark in its ability to convince the reader that money should be spent studying the hyporheic zone and salmon egg survival in the Sacramento River Basin. A good salmon research proposal starts out by explaining the factors that limit salmon recovery in a particular basin, reviewing the uncertainty associated with this information, and proposing objectives/hypotheses that would reduce this uncertainty, thereby providing information that managers can use to recover salmon populations. Associated with each of the hypotheses should be a detailed description of the approach that will be taken to carry out the stated objectives. Only in this way can funding agencies feel comfortable that they are not simply tossing money toward projects that won't meet the stated objectives.

This is not a good proposal. Although additional information on the topic of hyporheic zones and salmon survival may be needed, the applicant has not done a suitable job of describing how this project would reduce the uncertainty of the factors limiting the recovery of salmon survival. Consequently, I can not in good faith recommend that this proposal be funded by the CALFED Ecosystem Restoration Program.

Overall Evaluation Summary Rating	**Provide a brief explanation of your summary rating**
☐ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor	