Response to ISRP review comments on Project # 32011 – Mitigation of marine-derived nutrient loss in the Boise-Payette-Weiser subbasins.

- ISRP - This is a research project.

The purpose of the project is a management action to mitigate of nutrient loss related to anadromous fish loss in these subbasins. As ISRP has noted, the actual management action of applying either fish carcasses or salmon analogs to streams is a relatively simple and inexpensive action. This is especially so in our proposal because carcasses will be free and relatively accessible through IDFG hatchery programs and because the manufacturer of the salmon analogs, Bio-Oregon, has agreed to provide custom made analogs to the project free of charge.

The management actions we propose will have unknown and varying effects. Therefore, we have proposed the management action be statistically rigorous to provide information for subsequent nutrient mitigation actions at the completion of the project.

Because of its adaptive management design, the expense of the proposed management is in monitoring the effects of the management action. This includes replication of treatments, comparison of analogs and carcass applications, and monitoring control or untreated areas. We believe this design will provide conclusive information at the end of 3 years of the management action.

Economics, team expertise, and conscious design affected the funding and staffing requested in this project. We believe one of the outstanding characteristics of the proposal is the background and expertise of the project proponents. Dr. Wipfli has extensive background and experience in determining the effect of marine-derived nutrients at all levels of aquatic ecology. Dr. Robbins is an international expert on wild animal nutrition with experience in the quantifying the effects of marine-derived nutrients in terrestrial animals. Dr. Kavanagh has extensive and ongoing work in measuring the effects of marine-derived nitrogen in riparian and forest vegetation. We sought to use graduate students is association expertise of the project team to provide an economical way for accomplishing 3 years of monitoring while maintaining a high level of scientific rigor. Using graduate students through universities also allowed us to avoid the need for IDFG to request FTE's as part of the project. The major difference between our budget request and the other studies cited below is the use of graduate students instead of requesting FTE's for technicians and PI's.

-ISRP - Better describe how the project fits with other ongoing nutrient supplementation studies. What does the proposal offer beyond projects #200105500 and 200101300? Is there some attribute of this project that makes it very fundable? Why should this project move forward before other ongoing innovative pilot studies testing the efficacy of nutrient supplementation are completed?

We reviewed the projects identified by the ISRP.

Briefly, the Kootenai mesocosm research study (Evaluate the effects of nutrient supplementation on benthic periphyton, macroinvertebrates, and juvenile sturgeon in the Kootenai River) is using a direct application of inorganic nutrients using mesocosm for control of application/response along several reaches of a major river system using continual inorganic nutrient release over one growing season and the research also looks at nutrient effects through captive fish experiments.

The salmonid response study (Salmonid response to fertilization: an experimental evaluation of alternative methods of fertilization) looks at an aquatic mesocosm study in artificial stream channels on the Green river over just 6 weeks and evaluates 3 different types of fertilization (analogs, carcasses, inorganic pellets) on fish growth in several tributaries in the Salmon basin over 1 year. Predicted responses from fertilization efforts will be modeled and a cost: benefit analysis done.

Based on our review of the above projects, we submit our project adds to the above ongoing work and should proceed for the following reasons.

1) Our study measures not only the effects of carcass and analog treatments on several ecosystem components (e.g. terrestrial wildlife, vegetation, and aquatic ecology); but also compares analogs to carcasses in these same respects. This is extremely important if we desire to understand the full ecological effects of nutrient treatments rather than just fertilization to get a direct aquatic effect.

2) Our study examines replicate treatment effects over 3 years. This provides time to measure for ecological response and we feel is more statistically robust than the above studies. The pathways through which treatments may have an effect may be both direct and indirect and therefore require longer to manifest themselves. Our treatment replications, 3 treatments over 3 years, and positive and negative controls compare favorably to the above studies that rely on a single season or year to measure only the direct effects of treatments.

3) Our project is implemented and monitored within the ecosystem we wish to affect. It is a management action and is designed as adaptive management. Different than the other studies, we do not propose to use artificial channels, planted fish, or confined feeding experiments.

4) Our project will be conducted in an area previously accessible to anadromous fish but that is now blocked. The effect of this loss is unknown but is hypothesized to have ecosystem wide effects including on listed bull trout, resident fish and wildlife, and watershed vegetation. We will be able to quantify and compare these ecosystem and mesocosm effects and pathways and use this information to amend treatments based on feedback. We are not treating areas currently open to and used by anadromous fish.

5) Our study looks at terrestrial and vegetative response to marine-derived nutrient treatments. Neither of the above studies do this. We believe if we were to

eliminate the aquatic portion of our project to avoid overlap with the above projects, it would eliminate the important comparison of responses between analogs and carcass treatments within the aquatic system.

6) N from terrestrial sources (i.e. leaves) can be 90% of the N inputs into aquatic systems and as N becomes more limiting, N cycles within vegetation tighten and potentially release less N to aquatic system. The C:N ratio of conifer foliage measured in two watersheds in South Idaho on the North Fork of the Payette, were 46.9 $\pm$ 1.19 (unpublished data, J. Marshall) compared to sites without salmon in Alaska of 39.21 + 2.01 and with salmon 32.73+32.73 (Helfield and Naiman 2001). The relatively high C:N ratios in conifer foliage indicate N is more limiting in the drier conifer forests of central Idaho.

   With addition of N from salmon carcasses, nutrients may cycle through the terrestrial system quicker and be deposited more readily into the aquatic system (i.e. the C:N ratio of the foliage may decline, making the foliage more readily decomposed). Therefore, our project's replications and inclusion of the terrestrial system allows us to examine the entire ecosystem including interactions, thereby increasing the interpretative power of our management results and monitoring. It is important that our project is proposed in areas that are relatively nutrient poor because addition of historical deposition rates of N over 3 years are more likely to be detected increase the overall effect of nutrient treatments.

7) In both of the above studies, there is no attempt to track nutrient pathways using stable isotopes. While the studies may obtain some correlations based on nutrient additions, they will not understand nutrient pathways and it would appear that attempts to apply results to other systems would be hampered by lack of understanding of this response. This is especially true given the short time the projects are being conducted. Our project recognizes the complex interaction of the N cycle and by measuring many of the pools and fluxes of N within and between the aquatic system (invertebrates, bio film, and fish) and terrestrial (birds, small mammals, plants etc.) over 3 years, we can use a budgeting or mass-balance approach in interrupting our results.

8) Our study design proposes to treat streams with carcasses based on an historic estimate of salmon abundance. This provides a level of analog/carcass and nutrient input. Different to the above studies, this measure of relative abundance, replicates, and subsequent monitoring provides better potential to evaluate nutrient management.

9) Our study design accounts for the potential nutrient mitigating effect of land use (e.g. livestock grazing). By choosing both positive (grazing) and negative (no grazing) controls, we will compare responses to nutrient treatments while accounting for a widespread land use that may have potentially significant

nitrogen and phosphorus inputs effecting watershed ecosystems in the Columbia basin.

Helfield J. and RJ Naiman,. 2001. Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity. Ecology 82(9). 2043-2409.