Bonneville Power Administration
FY 2003 Provincial Project Review

PART 2. Narrative

Project ID: 35020

Title: **Regional Project Effectiveness Monitoring Program for Columbia River Basin Listed Anadromous Salmonids.**

Section 9 of 10. Project description

This project proposal is directly tied to four other proposals submitted for re-review (35019, 35016, 35024, 35048). Together these five proposals form a pilot program approach to a comprehensive status and effectiveness monitoring program for Columbia River basin salmonids and their habitat. This suite of proposals aims to implement the critical missing components (status monitoring, effectiveness monitoring and data management) of a regional RME program as called for in the 2000 NMFS FCRPS BO (RPA Action Items 180, 181, 183, and 198). While all attempts to make each proposal a stand-alone project have been made, the five projects have been developed in concert to meet independent, yet closely related, RME needs of the FCRPS BO implementation plan.

a. Abstract

Without knowledge of the effect of actions on salmon survival and abundance, our ability to plan effectively, or to evaluate the cumulative impact of management actions is seriously compromised. Monitoring the actual impact of projects designed to affect the recovery of federally listed anadromous salmonids is a keystone of the mandated recovery process in the Columbia River Basin. Indeed, RPA 183 of the Federal Columbia River Power System Biological Opinion (FCRPS BO) makes an explicit call for effectiveness monitoring to be in place by 2003. Recognizing this need, a variety of agencies and groups (e.g. ISRP, NMFS, Federal Action Agencies) have called for rigorous effectiveness monitoring program to assess the progress of off-site mitigation actions designed to contribute to salmon recovery. To date, however, few projects aimed at determining changes in salmonid survival associated with habitat improvement actions have been proposed or implemented.

In this proposal, we provide a mechanism to: 1) take available monitoring guidelines and provide specific designs and coordination for individual monitoring projects; and 2) oversee the technical implementation of three pilot monitoring projects as a critical first steps in a complete effectiveness monitoring program. In fact, the current proposal is intended to use available guidance on effectiveness

research to adapt a specific research monitoring plan for several categories of habitat actions as pilots, as well as generate a handbook or toolbox that will serve as a vehicle for taking non-specific guidance and creating specific study designs. To evaluate the utility of the available designs, three pilot programs that are identified within this proposal will have different study designs. When combined with two additional projects, these five projects will form the initial pilot implementation for FY03 – FY07. Results from these pilot experiments can be used to support "check-ins" mandated by the 2000 FCRPS BO, to refine regional modeling efforts, and to develop new, rigorous planning tools.

b. Technical and/or scientific background

Currently, a wide variety of habitat restoration and improvement activities aimed at anadromous salmonids are being conducted across the Columbia River Basin. Because these efforts are manipulations of the environment, they provide the opportunity to evaluate, as an explicit experiment, the effect of specific actions on both habitat and salmon population characteristics. However, few habitat projects include any assessment of their impact on salmon survival or fitness as a component of their design. This leaves a tremendous gap in our knowledge, and limits the region's ability to plan recovery efforts effectively, both biologically and economically.

Project sponsors currently face at least two challenges in developing monitoring that would fill this gap. First, due to the potential temporal variability in likely response variables (both biological and habitat), experiments based on individual projects may lack power to detect change in a timely fashion. Second, developing appropriate protocols and experimental design, particularly for experiments that may (and should) be used in a larger framework, will require some knowledge of other experiments and consistency across them. Thus, sponsors face a great need for coordination of multiple effectiveness monitoring projects within a study, as well as development of statistically rigorous design within each of those experiments.

As will be seen below, there is a general call for effectiveness monitoring in the FCRPS BO. However, there are components to this call for effectiveness research that requires a multi-component solution. Separate from the detailed questions asked of individual projects by their sponsors, there are overarching programmatic questions that must be addressed. For Action Effectiveness Research these include:

Q1) Is THIS one project effective?
Q2) Did projects within a subpopulation or sub watershed on aggregate effect the larger demographic unit?
Q3) Are classes of projects effective, and if not why not?

Here the word *effective* refers to having the anticipated impact on the habitat and also a correlated fish demographic response.

While all of these questions are raised in the BO in the context of Effectiveness Research, answering them places quite different expectations on the monitoring program. Among these, question Q1 is largely of interest to individual project sponsors. While question Q2 operates on a spatial scale that is defined by the characteristics of the demographic unit of study—usually a larger scale than individual projects and within a framework established by status monitoring programs. Question Q3, on the other hand, is not defined by a spatial scale as such. Rather, it addresses characteristics of project categories – wherever they may be implemented. This proposal is designed to address question Q3, and where appropriate Q1. A high-resolution monitoring program to address question Q2 has been made a component of proposal 35019, which is being coordinated within the current set of pilot proposals for monitoring. In fact, the current proposal is intended to use available guidance on effectiveness research to adapt a specific research monitoring plan for several categories of habitat actions as pilots, as well as generate a toolbox that will serve as a model for effectiveness monitoring and research of other project types.

Consistent, coordinated action-effectiveness experiments will contribute to technical aspects of regional recovery efforts in a variety of ways. First, they determine the effect of individual actions, allowing the region to ensure that its resources are well-allocated. Second, they can provide the basis for "check-ins" mandated by the 2000 FCRPS BO. These check-ins require evidence that off-site mitigation actions are having their intended effects. Without experimental monitoring, this will be difficult, if not impossible, to achieve. In addition, results from action-effectiveness experiments can be used to refine (or alter) currently used models, such as EDT, which currently over-rely on expert opinion. Finally, the real data acquired from such experiments may provide the opportunity to develop new, more rigorous planning tools.

c. Rationale and significance to Regional Programs

This proposal addresses several tasks defined by the RME RPA Action Items in the 2000 FCRPS BO. Among them is the directive to develop a multi-component monitoring program to assess the impacts of actions called for under the RPA section of the BO. A specific mandate for the monitoring program—both for status and effectiveness components of monitoring--is provided in section 9.4.2.8 of the BO

Action 9: The Action Agencies, with assistance from NMFS and USFWS, shall annually develop 1- and 5- year plans for research, monitoring, and evaluation to further develop and to determine the effectiveness of the suite of actions in this RPA.

Importantly, this section sets a timetable for the development of a monitoring program as well as defining the scope to include effectiveness monitoring.

> Research, monitoring, and evaluation will provide data for resolving a wide range of uncertainties, including determining population status, establishing causal relationships between habitat (or other) attributes and population response, and assessing the effectiveness of management actions. Progress on resolving these uncertainties will be a primary consideration in the 1- and 5-year planning process as well as in the 5- and 8-year check-ins. (FCRPS BO page 9-31)

Within this overarching mandate for monitoring, research on the usefulness of off-site mitigation efforts intended to improve salmon population health through improvements in habitat quality are specifically identified in RPA 183:

Action 183: Initiate at least three tier 3 studies (each necessarily comprising several sites) within each ESU (a single action may affect more than one ESU). In addition, at least two studies focusing on each major management action must take place within the Columbia River basin. The Action Agencies shall work with NMFS and the Technical Recovery Teams to identify key studies in the 1-year plan. Those studies will be implemented no later than 2003.

In addition, section 9.6.5.3.3 of the FCRPS BO states that

> Each major habitat or hatchery management action should be assessed immediately to obtain enough information for a complete evaluation at the 5- and 8-year check-in points. (FCRPS BO page 9-170)

Action 183 is focused on scientifically rigorous studies that determine the effectiveness of recovery actions, as well as the mechanistic basis of action effectiveness to empower strategic planning of future recovery efforts.

The programmatic scope of work under this request is defined by RPA 183, which calls for 16 complete studies (two examples each of eight project categories). Specifically, two examples of each of the following project categories will be executed as experimental studies:

1. In-stream Flow
2. Nutrient Enhancement
3. Barrier Removal
4. Diversion Screen
5. Sediment Reduction
6. Riparian Buffer
7. In-stream Structure
8. Water Quality Improvement

Action 183 also specifies that at least three of these research projects will be performed within each ESU.

This proposal outlines a strategic plan for implementing a series of pilot effectiveness monitoring projects that will satisfy, in part, components of RPAs 9 and 183 as well as other regional effectiveness monitoring needs, and will guide the development of a complete effectiveness monitoring program.

In addition to the language cited above for RPA 9, there is the following:

> The Federal Action Agencies, working with CRI and EDT analysts, have established preliminary hypotheses linking habitat strategies and measures to key habitat attributes. The next steps will be as follows:
>
> - Establish an initial set of performance standards and measures—ecological and management indicators—expressed as desired habitat trends.
>
> - Implement pilot studies designed to test and confirm key assumptions that relate habitat improvements to life-stage survival improvements for listed fish species.
>
> The studies needed to assess the specific ecological and management targets will be integrated into tier 3 of the research, monitoring, and evaluation program described in Section 9.6.5. … They will enable policymakers to evaluate and refine hypotheses, adjust habitat measures, and reach further decisions on the contribution to recovery of habitat protection and restoration. They are high priority projects for early implementation in fiscal year 2001. (FCRPS BO page 9-18)

Therefore, there is a need to establish cause-and-effect relationships between tributary actions and physical/environmental effects—and that need is immediate. The information developed through our studies will be integrated with status monitoring, other types of action effectiveness research, and critical uncertainties research as part of the broader comprehensive RME Program that is called for by the BO, the Federal Caucus Basinwide Strategy, and the Columbia River Basin Fish and Wildlife Program, and outlined in the Action Agencies Implementation Plans.

d. Relationships to other projects

As mentioned at the outset, this project proposal is directly tied to four other proposals submitted for re-review (35019, 35016, 35024, 35048). Together these five proposals form a pilot program approach to a comprehensive status and effectiveness monitoring program for Columbia River basin salmonids and their habitat. We have tried to ensure that this proposal can stand on its own, however it should be evaluated as a component of the larger program
Other than this set of proposals there are no individual projects in place to meet all of the specific needs of RPA 183. However, there are several other projects that are

addressing closely related needs, and with which we will coordinate to maximize the value of this program.

As mentioned above, project 35024, currently in the CBFWA Maninstem/Systemwide provincial review, identified as a critical need, and a component of the RME pilot program proposals is designed to evaluate the potential performance of water quality improvement projects in both agricultural and urbanized watersheds. This project is designed as an evaluation of current water quality conditions and related fish survival. With few opportunities for replication in the field, this project is designed to combine field monitoring compatible with the those in this proposal with targeted laboratory evaluations of fish physiology in order to improve the power of cause and effect inferences. Since this proposal was currently in review by the ISRP, rather than already funded it was inappropriate to subsume it into this proposal explicitly. Like the other programs described in this proposal, however, cooperative agreements are engaged to ensure that the design and implementation of this water quality project will be compatible with and service the effectiveness monitoring call in RPA 183.

In project sponsorship, there are several programs currently in place to fund recovery actions. In particular, numerous projects are funded through the NWPPC/CBFWA sub-basin planning process. In addition, the states of Washington, Oregon and Idaho, along with numerous municipalities and tribal entities, fund individual recovery projects all over the region. In particular, the Washington State Governor's Comprehensive Monitoring Strategy calls for and the Oregon Watershed Enhancement Board currently funds an organized program that includes effectiveness monitoring. As described in task 2C below, we are looking to these programs as sources of projects that can be accumulated into an optimal study design.

For example, the Bureau of Reclamation and Army Corps of Engineers are executing a large-scale program to remove numerous passage barriers in the John Day basin, collaboration with which may prove to be an additional, important pilot platform for the tasks outlined in this proposal. That program will evaluate passage barrier removal effectiveness as well as the effectiveness of alternative water control structures for agricultural use. Cooperative agreements are engaged to ensure that the design and implementation of the John Day passage removal project will be compatible with and service this effectiveness monitoring program.

Currently, project 34008, awarded to ESSA Technologies Ltd., has been undertaken to identify the opportunities to address RPA 183 questions with existing monitoring data. That effort will involve the organization of working groups of local experts to identify existing monitoring programs that may in part address RPA 183 needs. That project will be critical for identifying not only where opportunities to resolve effectiveness monitoring questions exist, but also where gaps remain, and therefore, will contribute the necessary data for prioritizing projects. Currently, there is an agreement in place that commits the author of the current proposal and ESSA technologies Ltd. to work cooperatively to ensure that both projects target the needs and priorities established by RPA 183. Indeed, the author of this proposal worked with BPA to draft the statement of work for project 34008.

As pointed out below, one of the critical determinants of success in this enterprise, is the free and rapid exchange and sharing of data. Successful coordination of these diverse actions requires it. Currently, there are four programs of which we are aware that should interact with the effectiveness monitoring program: The Data Management Work group of the BPA RME program, StreamNet, the Federal Habitat Team Project Tracking Program, and the Salmon Data Center of the NWFSC of NMFS.

Specific data management programs with which this proposal is coordinated include proposal 35048 in the Mainstem/Systemwide provincial review. That proposal is to implement a coordinated database to support all of the components of the RME program which are being set up as pilot programs this year. The author of this proposal is a participant in the design of that program as part of the coordination of these collective pilot proposals.

e. Project history (for ongoing projects)

This is a proposal for a new program.

f. Proposal objectives, tasks and methods

This proposal aims to 1) develop a technical monitoring plan for effectiveness monitoring and evaluation of projects that are implemented across the basin; and 2) apply those plans with the implementation of three pilot studies as a first step toward a comprehensive set of effectiveness monitoring projects.

Task 1: Develop implementable handbook for actual effectiveness monitoring
NMFS and the Federal Action Agencies workgroup focusing on AER developed guidelines for AER (Paulsen et al., 2002). As mentioned previously, this set of guidelines, previously reviewed by the ISRP, describes how features of a monitoring program should look for the entire region. However, the effectiveness monitoring guidelines were written to meet the simultaneous regional needs for a "one-size-fits-all" document and a diverse set of project, each with a diversity of eccentricities. As will be seen in the description of Task 2, there is a diversity of potential study designs and there may be requirements that significantly tailor the monitoring guidelines to the eccentricities of those designs. Therefore, this proposal's first task is to take the available generic guidance and use them to produce actual effectiveness monitoring plans--a handbook for monitoring -- that can then be used in a series of pilot implementations of the sixteen RPA 183 research elements. We are requesting funds in FY03 to fund release time for the PI's to develop these monitoring plans.

AER project design has two conceptual components that should be recognized. The first component is the ***Study design*** and the second is the ***Response design***. ***Study design*** is that component that involves the planning and execution of the experiment; how treatment and control sites are chosen, choice of indicators and sample sizes, etc. ***Response desig***n, on the other hand, involves the framework for analysis; the model chosen for hypothesis testing, the statistical approach to data analysis. Although related and interdependent, these components make separate demands on the project sponsor and need to be described as separate tasks.

The common strategy for all implementations of effectiveness monitoring, as described in the existing "one-size-fits-all" guidelines, is as follows:

Study Design:

1) Identify the action category to be studied
2) Identify suitable treatment sites based on standardized criteria and opportunities that occur consequent to existing project implementation and planning
3) Identify suitably matched control sites based on an evaluation of appropriate classification variables
4) Use consistant protocols to monitor an ambitiously diverse set of habitat and biological indicators in treatment and control locations

Response Design:

5) Evaluate correlated changes in habitat and biological responses in treatment versus control areas.
6) Infer causative role of offsite mitigation activities in fish responses.

There is also a commitment that inferences drawn within this program will service the decision support structures developed in the region in parallel with this program as they both mature. However, absent those structures currently, it is difficult to be explicit about how this strategy will interface with those decision support structures.

<u>Task 1a: Identify features of Study Design common to all component programs and incorporate into monitoring plan for pilot programs.</u>

Step 1, 2 & 3: Site Selection. Our approach manifests an "Observational Studies" approach to project effectiveness. Techniques for observational studies are commonly applied to tests of drug effectiveness or tests of environmental toxicology and correlated human response. As such, there already are tools for the design and analysis of experiments of this type (see Rosenbaum, 1995).

Unfortunately, it is uncommon for the details and limitation of observational studies to be incorporated explicitly into work plans for field studies of the type we are describing. For example, it is common for people to monitor a couple of indicators in populations of treatments and controls and simply perform a t-test or ANOVA to identify differences between those populations. This is inadequate for our purposes.

The ISRP said as much in its recent review of the Clearwater Subbasin Plan (ISRP, 2003) when they distinguished randomized treatments and controls from the non-random selection in observational studies:

> *Large scale observational studies that involve "treatment-control", "before-after" or "before-after-control-impact (BACI)" designs fall under Tier 1 or 2 trend monitoring and do not establish cause and effect relationships as in Tier 3 research monitoring.* (ISRP, 2002)

This clearly points to the statistical challenges presented by non-randomization of treatments. It may be too conservative to treat observational studies as inadequate for our purposes. In fact, Cochran defines observational studies as empirical studies where:

> *"...the objective is to elucidate cause-and-effect relationships..."* where *"it is not feasible to use controlled experimentation, in the sense of being able to impose the procedures or treatments ... or to assign subjects at random to different procedures."* (Cochran, 1965)

So the potential to infer cause and effect from properly designed and analyzed observational studies exists. Having said that, however, the word "properly" places a heavy responsibility squarely on us to design these studies incorporating design features adequate to allow the inferences we are called to make in RPA 183.

Luckily, there are strategies for dealing with these design issues. For example, the challenge of non-random assignment of treatments is that some feature of the treated area will be responsible for differences from the control areas having nothing to do with the treatment itself–the problem of hidden bias. A familiar example is the correlation of smoking and heart attacks. If we were to look at 500 smokers and 500 non-smokers and evaluate the number of heart attack sufferers in those two populations we might see a significant correlation between smoking and heart disease. However, on that data alone we cannot exclude other correlated hypotheses. For example, it is possible that the smokers were on average more obese, in which case heart disease may be correlated strongly with obesity, but poorly with smoking, independent of body condition; obesity is biasing the correlation.

It turns out that if we can establish that treatments in our studies are free from hidden bias we can still apply statistical approaches that are familiar to randomized experiments and draw similar quality inferences (Rosenbaum, 1995). One of the strategies for eliminating hidden bias is to stratify treatment and control comparisons with a long vector of correlated variables ($\mathbf{x}_{[j]}$). If one can show that $\mathbf{x}_{[j]}$ is the same in treatment and control groups, or indeed even that the likelihood of elements in $\mathbf{x}_{[j]}$ being the same ($\lambda(\mathbf{x}_{[j]})$) is itself the same in treatments and controls, then one is able to employ standard statistical approaches to evaluating the consequences of treatments (Rosenbaum, 1995). In fact, even if $\mathbf{x}_{[j]}$ is of high dimension with continuous variables, and so is unlikely to be exactly equivalent in treatments and controls, there are approaches to determine confidence intervals on $\mathbf{x}_{[j]}$ and rules for when one can and cannot apply standard analytical approaches for randomized treatments to observational studies (Rosenbaum, 1995).

These features of observational studies will be incorporated into the study designs for effectiveness research in this program. Indeed, the utility of $\mathbf{x}_{[j]}$ in validating inferences has, in part, motivated the long list of indicators that are required components for projects in this program. It is hoped that these indictors can serve in steps 3 & 5 in the strategy above. In the study design, we will use common values of $\mathbf{x}_{[j]}$ to identify suitable controls for treatment sites. In the response design we will capitalize on changes in other indicators to discriminate the differences between treatments and controls.

Step 4: Identify an ambitious list of habitat and biological indicators and establish standard protocols. Indicators were actually specified in the guidance document and are listed in Table 1. Indicators fall into several large categories, but all are designated in an effort to get a balanced cross-section of all potential indicators that give a description of the result of actions. In the study design two classes of indicators are identified:

- *Direct Indicators* - which are reasonable to measure, tractable, show direct response
- *Stratification Indicators* - which allow evaluation to characterize when and when not to implement actions.

Some of the variables in Table 1 are direct indicators principally because they are expected to change as a direct result of the action and so need to be monitored to gauge the progress of the individual action. For example, it is *prima facia* reasonable to monitor sediment quality in projects that are designed to reduce sediment input to streams. But there are other regional needs that require monitoring of additional indicators. We have already addressed the role correlated variables play in establishing the appropriateness of specific study designs and analytical approaches above. As will be pointed out below, these additional indicators provide information that may allow stratification and discrimination in analysis and so are referred to as classification, or stratification variables. If a specific indicator is desired from the monitoring program for a specific action category, it is identified with an "I" in Table 1 whether it is a direct indicator or not.

In the case where indicators are neither classification variables nor indicator variables for a specific class of action, the variables are listed as optional (O). Collecting this type of data is not required, but may be collected if the project

	Table 2.	**Actions identified in NMFS (2000) BIOP**							
	Specific indicators	**Instream flows**	**Nutrient enrichment**	**Barrier removal**	**Diversion Screens**	**Sediment Reduction**	**Riparian Buffers**	**In Stream Structure**	**Water Quality Improvement**
Geo-morph.	Bailey Ecoregion	I	I	I	I	I	I	I	I
	Omernic Ecoregion	I	I	I	I	I	I	I	I
	Physiographic Province	I	I	I	I	I	I	I	I
	Basin Area	I	I	I	I	I	I	I	I
	Basin Relief	I	I	I	I	I	I	I	I
	Drainage density	I	I	I	I	I	I	I	I
	Valley Bottom Type	I	I	I	I	I	I	I	I
	Valley Bottom Width	I	I	I	I	I	I	I	I
	Valley Bottom Gradient	I	I	I	I	I	I	I	I
	Valley Containment	I	I	I	I	I	I	I	I
	Elevation	I	I	I	I	I	I	I	I
	Rosgen Channel Type	I	I	I	I	I	I	I	I
	Bed-Form Type	I	I	I	I	I	I	I	I
	Channel Gradient	I	I	I	I	I	I	I	I
	Riparian Cover Group	I	I	I	I	I	I	I	I
	Riparian Community Type	I	I	I	I	I	I	I	I
	Stream Order	I	I	I	I	I	I	I	I
	Linkage of Order/Adjacent Order	I	I	I	I	I	I	I	I
Access spp. Indicators	Culvert gradient	O	O	I	O	O	O	O	O
	Culvert roughness	O	O	I	O	O	O	O	O
Temp.	MDMT	I	O	I	O	O	I	O	O
	MWMT	I	I	I	I	I	I	I	I
Water Quality	Metals and pollutants	I	I	O	O	O	O	O	O
	PH	O	I	O	O	O	O	O	O
	DO	I	I	I	I	I	I	I	I
	Nitrogen	I	I	I	I	I	I	I	I
	Phosphorus	O	I	O	O	I	O	O	O
	Conductivity	O	I	O	O	I	O	O	O
Water/ sediment	Turbidity	I	I	I	I	I	I	I	I
	Depth fines	I	I	I	I	I	I	I	I
Sediment	Dominant substrate	I	I	I	I	I	I	I	I
	Embeddedness	O	O	O	O	O	O	I	I
Bariers	Road crossings	I	I	I	I	I	I	I	I
	Number of Obstructions and Dams	I	I	I	I	I	I	I	I
	Fishways	O	O	I	O	O	O	O	O
Channel Structure	LWD	I	I	I	I	I	I	I	I
	Pool frequency	I	I	I	I	I	I	I	I
	Pool quality	I	I	I	I	I	I	I	I
	Off-channel habitat	I	I	I	I	I	I	I	I
	Width/depth	O	O	O	O	O	I	I	I
	Stream Wet Width	I	I	I	I	I	I	I	I
	Bank Full Width	I	I	I	I	I	I	I	I
	Bank stability	O	O	O	O	I	I	I	I
Flow	Change in peak Q	I	O	I	I	O	O	I	I
	Change in base Q	I	O	I	I	O	O	I	I
	Change in Q timing	I	O	I	I	O	O	I	I
Riparian Character	Road density	O	O	O	O	O	I	O	O
	Riparian-road index	I	I	I	I	I	I	I	I
	Number of Bears	O	I	O	O	O	I	O	O
	Equivalent clearcut	O	I	O	O	O	I	O	O
	Percent veg. altered	O	I	O	I	I	I	O	O
	Vegitative cover	I	O	O	I	I	I	O	O
	Vegitative structure	I	O	O	I	I	I	O	O
Biologicals	Periphyton	I	I	I	I	I	I	I	I
	Invertebrate Diversity	I	I	I	I	I	I	I	I
	Vertebrate Diversity (fish&amphib)	I	I	I	I	I	I	I	I
	Juvenile Salmon Abundance	I	I	I	I	I	I	I	I
	Adult Salmon Abundance	I	I	I	I	I	I	I	I

Table 1. List of indicators sampled at each treatment and control reach associated with each action category.

sponsor is prepared and willing to do so. The benefit of collecting these data is that they can contribute to the status (Tier II) monitoring needs of a larger RME program (proposal 35019), and efficiencies in monitoring protocols can be increased. The responsibility for taking that extra step is left up to those sponsors of individual projects.

The resubmitted proposal 35016 is a project whose tasks include the assembling of a library of GIS-layer data for large parts of the Columbia River Basin. It is a design feature of that proposal that data extractable form these layers will be freely available to the sponsors of pilot studies in this program. Consequently, project sponsors will not need to invest their own resources in acquiring those indicators in table 1 that are available in GIS-based data sources. Indeed, it is hoped that in those cases where new sample sites are being identified, access to the database produced in project 35016 will facilitate identification and comparison of $\mathbf{x}_{[j]}$ for each potential site.

Field protocols for the collection of the physical and environmental indicators will use the techniques described in Kauffman et al. (1999), Peck et al. (2001), and Hillman and Giorgi (2002). These documents describe field methodologies for defining study site characteristics as well as study site location. Measurement of the invertebrate community will adopt protocols described in Hafele and Mulvey (1998). Standard snorkeling and trapping protocols will be used for monitoring adult and juvenile fish (ODFW, 1998 & 2000). Experience indicates that the exclusive use of single methods in any field protocol is commonly questioned on the basis of data quality/data control. Within this program, it will be a continuing task to perform data quality checks by use of multiple techniques (e.g. snorkel surveys, seining, and electro-fishing) within a subset of sampled locations. In addition, subsets of samples will be chosen within each project for repeated visits with in a single sampling visit in order to evaluate the consequences for data reliability resulting from inter- and intra-investigator/field crew components of variance. Indeed, in task 2A & B below funds are requested funds to increase sampling in existing programs to allow for these data quality checks.

The Action Effectiveness Research workgroup of the Federal Caucus RME program has identified field protocols for use on BO AER Projects (Hillman and Giorgi, 2003). In addition to addressing other programmatic goals, study designs in this program will test the usefulness of this set of indicators and protocols as part of each participating research project. Considering factors such as sampling error associated with the protocol, we will be able to recommend protocols that should be used in effectiveness monitoring studies to ensure consistency and compatibility across datasets throughout the region. It has been suggested that comparisons between projects can be made with fairly sparse metadata or reduced data, such as mean and variance estimators and sample sizes (Gurevitch & Hedges, 2001). However, recent work suggests that results from separate projects can only be made if rigid adherence to the same protocols is kept (Don Stevens, pers. com.). A specific coordinating task for FY 03 is to organize participating project sponsors on the use of a single, standardized set of field protocols for all studies. Our budget includes funds for education meetings for project sponsors and field training programs for training contracted field crews.

Task 1b: Develop Response Design: analysis tools for evaluation of project effectiveness. We have pointed out the challenges of designing an observational study. We have also suggested a strategy for dealing with these challenges that results in an ambitious program of data collection. When it comes time to collate the data produced in this monitoring program and apply our response design, there will also be some significant demands placed on the technical products.

Effectiveness of actions in the FCRPS BO and elsewhere is defined as projects having the intended effect on the habitat and some positive impact on fish life-stage survivorship or abundance. It is possible that actions will have immediate and apparent impacts on fish populations such that a test of differences between means in the population of treatment and control data will reveal a difference. Given the state of temporal and spatial variability, this is a low probability. Far more likely is that differences between treatment and control areas will be far too subtle to detect with such a simple response design. We are requesting funding to support the PI and a Post-Doctoral fellow to be named to work on the development of more sophisticated response designs. This work will continue as a part of the general strategy outlined above.

Step 5 & 6: Application of evaluation tools as components of a coordinated response design. It is a tired expression that one must have a proper question before applying the proper analytical tool. Indeed, this program takes as a guiding principle the statement of Green (1979):

> *"Do not get the cart before the horse and hunt around for cookbook statistics which then determine what hypothesis is being tested. Let your purpose generate the question, and let the null hypothesis be the simplest possible answer to that question, stated in a way that is testable and falsifiable."*

In each case the null hypothesis is:

> **H_0**: *the relevant management action* **will not** *have any effect on the habitat, with correlated, observable increases in fish survivorship or abundance, as appropriate.*

Therefore, falsification of that hypothesis supports the alternative hypothesis:

> **H_1**: *the relevant management action (grazing control, barrier removal, irrigation diversion screen)* **will** *affect the habitat within the area of impact of the aggregate management project, with the consequence being correlated, observable increases in fish survivorship or abundance as appropriate.*

In both cases the stated hypothesis is inadequate. To be adequate they need to more specifically address the spatial and temporal scale of the project as well as the current understanding of the mechanistic connection between the management action and the correlated variables. Unfortunately, these specific details will only be available once the response designs for the specific projects have matured. We are asking for funds in FY03 to cover work with project sponsors to develop specific study and response designs that clearly identify testable hypothesis statements. Our strategy is to use these trivial hypotheses as kernels upon which to build a more sophisticated, testable questions for each specific project.

The key will be craft the monitoring plan so as to ask the testable question we really want answered. Once accomplished and then implemented in FY 04-08 in the course of consistent monitoring, we anticipate being able to apply relatively straight forward statistical analysis to demonstrate the effectiveness of classes of projects. The design process for relating the study to the response design will follow a strategy outlined by Green (1979), where the evaluation design reflects the study design:

1) Has the impact already occurred?
2) Is the "where and when" known *a priori*?
3) Is there a Control area?

The answers to these questions canalize the choices for study design and consequently the response design. Currently, there are several common experimental models in use including BACI (or modified BACI), Staircase, paired treatment control and other post-treatment observational study. While all have consequences that may make us want *a priori* to choose one above others (e.g. Roni *et al.*, 2003; Walters *et al.*, 1988, 1989; Rosenbaum, 1995), the final choice is dependant on the opportunities that present themselves in the course of tasks 1 & 2 of the proposal. For Task 2 we have chosen to evaluate studies of three different designs types.

Although it remains to be seen if standard methods for discriminant analysis will work for observational studies (see below), it still seems appropriate to evaluate the reasonableness of our hypothesis testing ability at the outset. The currency for evaluating the quality of our response design is statistical power. Our expectation for resolving power in the monitoring program is based on a power analysis performed within the following: *what change in signal over time (difference between regressions of indicator values over time in the treatment vs. control populations) should the monitoring program be able to detect?* This does not place the expectation that the variable "will" change by some amount as a consequence of the management action. Rather it is a way of characterizing the monitoring program performance independent of the management action's performance. Therefore, the effect size of the management action is not specified *a priori*. What this strategy does mean, however, is that we acknowledge up front that the management action may have a small effect, smaller than we can detect with our monitoring program, and if so we may fail to detect it.

Our preliminary target for power to detect 5%/year change or trend (63% change after 10 yrs) in the indicators with an intra-annual CV (Variance/Mean) of 0.35 with an $\alpha = 0.25$ and a confidence of $(1-\beta)$ of 0.75. A CV of 0.35 was selected as an intermediate or "average" behavior for habitat indicators (Kauffman et al., 1999). The combination of 5% /year change and confidence of 0.75 result in the potential to eliminate the null hypothesis after 7 years with 30 replicates. Figure 1 is a graphical description of the consequences of these design choices for a variety of replicate numbers. These two example indicators (Large Woody Debris = LWD, and Substrate type) were chosen to express the range of possible indicator behavior around

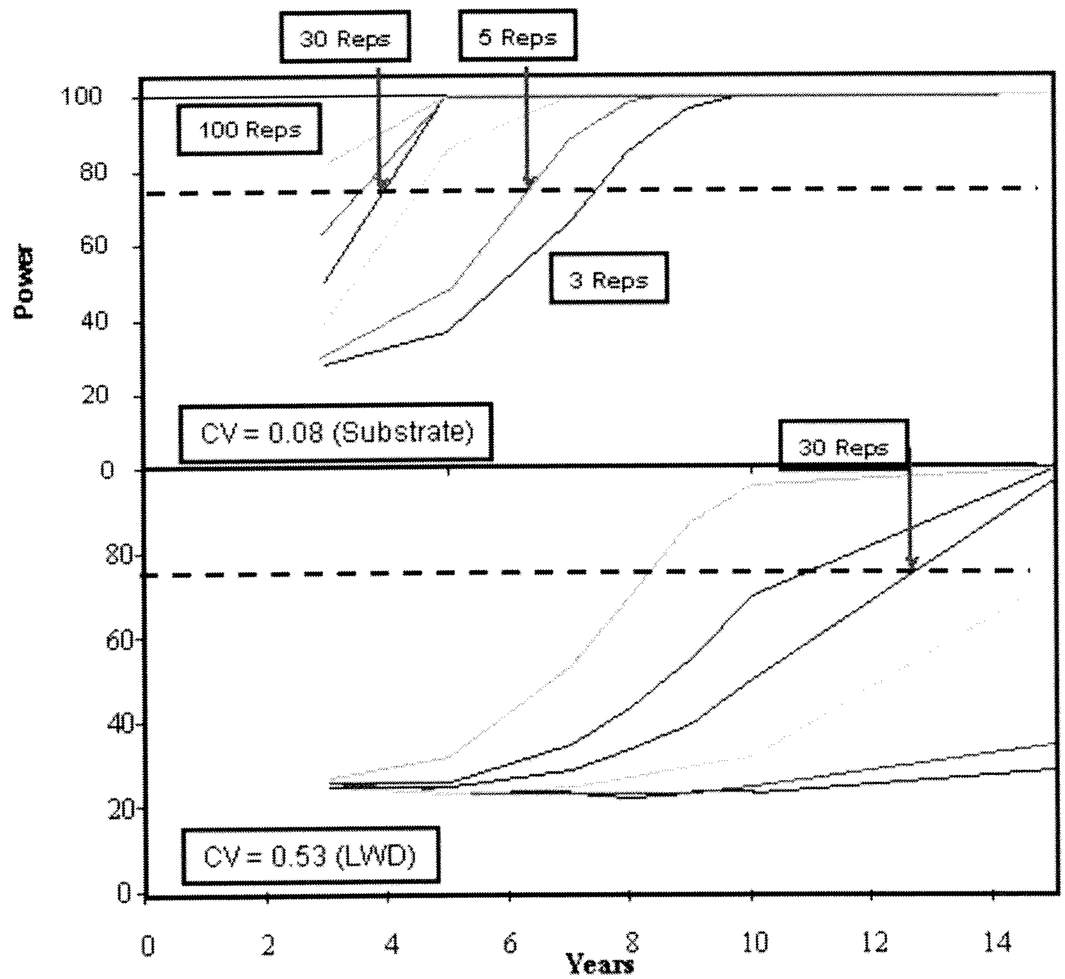

Figure 1. Results of Power Analysis of habitat indicators to produce preliminary targets for replicate numbers in pilot projects. Curves represent the power to detect 5%/year change (63% change after 10 years) with an $\alpha = 0.25$.

this average of 0.35. We are anticipating an iterative process of review to evaluate the performance of the monitoring program and if these design choices require modification we can implement them as necessary. Indeed, as we shall see, there is a high probability that we will employ multivariate techniques to improve our ability to discriminate treatments from controls. In that event, our resolving power should increase, but exact solutions will remain unknown until the response designs are more completely specified. Specification of these designs will be a major component of Task 1b.

We are also likely to benefit here from our plan for ambitious stratification. As mentioned above, differentiating treatments from controls (i.e. falsifying $\mathbf{H}_1$) will require some form of discriminant analysis, and it is likely that simple comparisons between treatments and controls described in this power analysis will be inadequate. Given the diversity of indicators we anticipate some form of multivariate discriminant statistics. Examples that have been fruitfully applied to studies of environmental impacts and project effectiveness are Principal Components Analysis (PCA) and Principal Coordinate Analysis (Green, 1979), Gradient Analysis (McGarigal *et al.,* 2000) and Canonical Correspondence Analysis (ter Braak and Verdonschot, 1995). All of these multivariate techniques rely on an estimation of the covariance or correlation matrix and subsequent evaluation of the differences between populations based on the derived properties of those matricies. Each of these approaches has benefits and limitations relative to the others. We are anticipating that as the AER program proceeds, the development of these analytical tools and the methods of their application to our studies will mature greatly. It will be a continuing task for this proposal to develop and adapt the necessary tools for the eccentricities of the projects we are undertaking. For this reason we are requesting funds, starting in FY03 and continuing in out years, for a full-time post-doctoral fellow in statistics, as well as part-time salary recovery for the principal investigator to help with the development of targeted multivariate statistical evaluation tools.

Indeed, the use of multivariate discriminant analysis assumes that we can satisfy the conditions described above, which allow an observational study to rely on statistics relevant to randomized designs. If these conditions are not met, we will require the adaptation of other statistical approaches, including non-parametric comparisons. Development of both non-parametric statistical tools, as well as tools for response design choice will be additional work products of our group, and additional chapters of the handbook.

Task 2: Oversee the technical design and implementation of 3 of 5 pilot studies of effectiveness monitoring

This task will occur concurrently with Task 1, and is anticipated to provide the raw material with which the products of Task 1 can be validated. As mentioned above, the FCRPS BO identifies eight high priority areas for habitat actions: In-stream Flow, Nutrient Enhancement, Barrier Removal, Diversion Screen, Sediment Reduction, Riparian Buffer, In-stream Structure, and Water Quality Improvement. This task has two goals: The first is to perform the necessary research to resolve a sample of the effectiveness of the eight categories of action; The second is to resolve the usefulness of the AER guidelines. Our strategy for this task is to develop a set of three pilot projects, each addressing one of these action categories. When coordinated with the BOR Passage Barrier project and project 35024 from the mainstem province, these will form five of the 16 required elements of RPA 183. This initial set of pilot studies will be expanded in out years, with three added in year-two and three more the next for a total of 11 projects in progress from years three to six. BPA has presented an initial allocation estimate of $1.5 Million for the first year and $3.0 Million for the second year for effectiveness monitoring design. Task 2 will include working with BPA to coordinate the allocation of these funds to these pilot programs for a sufficient duration to produce the quality of inferences called for in the FCRPS BO.

Task 2's programmatic goals include:

1) coordinate the technical monitoring plan for those projects and ensure that the data is of sufficient quality that when evaluated these projects will successfully resolve the BO needs for project-based effectiveness monitoring;
2) test the research management and coordination structure put in place with the Federal Action Agencies' RME Plan;
3) test the utility of the various study and response designs adopted in the pilot studies.

If we were to design research monitoring and evaluation projects from scratch, we would create them with an optimal impact design that included randomization of treatments and controls, high replication, and intense stratification of data. This is only possible in the rarest of cases. What we actually find in the field is a diversity of study design opportunities. Therefore, we have to work with the projects that are available, and consequently, adapt our study designs to the available projects. In identifying the three pilot projects in this proposal, we have chosen three different designs. The hope is that we can evaluate to research guidelines' ability to serve users who are confronted with diverse implementation opportunities. The projects identified are:

1) Nutrient Enhancement (project 2001-055-0)
2) Sediment Control (proposal 28045)
3) Project incorporating randomized treatment design (to be identified)

Each project addresses a different action category and represents a different approach to study design. The studies identified in Tasks 2A & 2B constitute "observational studies" in the sense that treatments are not assigned randomly. Consequently, there is the potential for hidden bias to limit the representativeness of any findings to other potential locations. One of the first year tasks will be to identify a third project opportunity (identified in Task 2C) where an optimal impact study design can be applied.

Task 2A: Coordinate a pilot study on nutrient supplementation using matched pairs design. Project 2001-055-0 is a collaborative effort between the Shoshone-Bannock tribe, Washington Dept. of Fish and Wildlife (WDFW), the Yakima Nation and NMFS scientists looking at the importance of nutrient supplementation for the growth and survival of juvenile salmonids. The Shoshone-Bannock, Yakima and NMFS scientists have been collecting "Before" data at several sites for the last two years and are preparing to introduce several different nutrient supplementation treatments in the upcoming field season in the Salmon River basin. The WDFW scientists have been performing a parallel study on anadromous and non-anadromous salmonids as a 1-year pilot project. The study design used in this project has been a before-after-impact-control (BACI) design utilizing matched pairs of treatments and controls. Matched pairs are treatment sites that have been identified and then matched to suitable control sites that have been located based on some initial survey criteria as per the description in Task 1.

This project has encountered numerous logistical and coordination challenges, and has also suffered from very limited replication. Challenges have included lack of success by individual project sponsors in anticipating permitting, organizational and staffing support difficulties. To date, neither the Shoshone-Bannock nor the NMFS scientists have been able to apply any nutrient treatments. Instead, they have been collecting habitat data at potential treatment sites. The Yakima Nation project was not able to sample as intensively as anticipated as a consequence of staffing shortages. The WDFW project was only funded as a pilot study. While they seem to have the most success in implementing their project, they now don't have continuing funding to monitor the project this summer and fall. In speaking with project sponsors and their BPA COTR, this collaborative program's lack of success in generating a coordinated study has resulted from an absence of a single coordinating entity. We are proposing to use the pilot project as that coordinating entity. We are requesting funds in FY03 and out years to amend the monitoring plans of these groups to increase replication and increase the characterization of sample sites by sponsors. The amendment process will include increasing the scope of the monitoring plan and an increase in manpower to cover the field monitoring in the fall of 2003. Together we are requesting a total allocation of $270,000 for the amendment to this contract to be subdivided in the course of coordination efforts of this project. We are asking that these funds be allocated to these projects as amendments to their current contracts with BPA subject to their continued willingness to execute these projects within the coordination mechanism we are proposing in this proposal.

Early in FY03 we are proposing to initiate coordinating workshops to more tightly focus the activities of the participating entities. These groups have had a year of work within the framework of this innovative proposal to learn from mistakes, determine the value of program components and discover unanticipated problems. They are now in a position to come together and share their accomplishments and frustrations. As the coordinating entity, it will be an opportunity to define more clearly the connection between the funding provided and the expectation for high quality, cooperative scientific investigation of the tested hypotheses. In addition, there is a need to more clearly define the separation of labor on this project. Not all participants are using the same treatment techniques nor are they investing the same effort in field monitoring. Consequently, efficiencies in implementation are not being achieved. As a coordinator for this project, we can help recover these opportunities. Project sponsors have been contacted and there is a provisional agreement among them and the author of this proposal to work together to achieve the goals of this pilot program in effectiveness monitoring contingent on success of this proposal.

Task 2B: Coordinate a pilot study on sediment control through road obliteration using a stair case design. Project 28045 is a large-scale study undertaken by the Nez Pierce Tribe that is designed to address, in part, a series of sediment control actions that arises from road closures they are currently doing and are planning for the future. So far, there have been five road closing projects in the Clearwater basin with nine planned for the near future. Figure 2 is a GIS-based map of the Clearwater basin showing the location of the current road closing projects as red triangles and the planned projects as green triangles. Superimposed on the stream layer in this map are the stream segments that are known steelhead spawning areas. That there are 14 projects, with nine not yet implemented, gives us our best hope yet of generating sufficient replication to achieve the sort of answers the FCRPS BO has called for.

This study design includes the progressive recruitment of treatments, referred to as a "staircase" design (Walters *et al.*, 1988, 1989). A staircase design is a modification of a BACI design where treatments are initiated at different times within the duration of the study. This design was in response to criticism of simple BACI design, where all sites are monitored to collect "before" data and then some fraction were treated simultantiously and subsequently monitored. This was criticized for not accounting for correlated temporal variation at all sites.

Currently, the Nez Pierce have been notified that their contract with BPA to monitor these Clearwater projects will eventually be funded. They are anticipating $270,000 in FY03. We are proposing to attach an amendment to this contract of $230,000 in FY03 to cover additional study elements. In particular, we will work with the Nez Pierce tribal biologists to modify their monitoring plan such that they increase the number of indicators monitored and increase the number of control sites monitored. In addition, funds are requested to increase the available staffing needed for the increased field monitoring. Given the current date, it is unlikely we will be able to implement juvenile fish sampling in the spring of 2003. If successful, we are anticipating FY03 expenses for resolving the new monitoring plan, some habitat monitoring and adult fish monitoring in the fall of 2003.

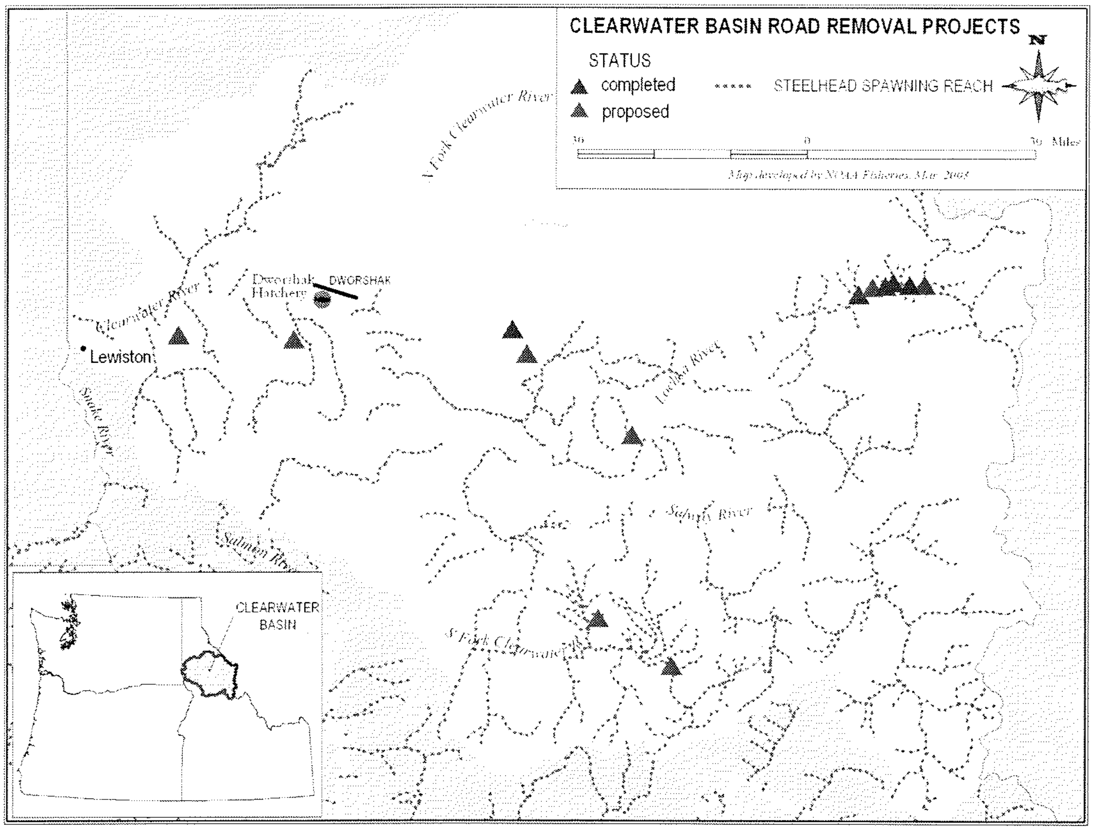

Figure 2. Location of road closing projects in the Clearwater basin available for effectiveness monitoring of sediment control projects.

A critical coordinating requirement is that should this proposal be funded and the Nez Pierce monitoring plan be amended to include these additional components, in no way must this process endanger or delay the current monitoring activities of the Nez Pierce Tribe in the Clearwater. Currently, the authors of this proposal and the Nez Pierce have an understanding that, if funded, they would be willing to work with us, unless such activity delays the contracts that are in place now. Therefore, it is imperative that it be stated explicitly that additional monitoring requirements must not be seen (even inadvertently) as a mechanism to delay current activities.

***Task 2C: Coordinate a pilot study using an optimal impact design*.**

We are requesting funds in FY03 to identify and coordinate a third pilot project based on an optimal impact study design that has not been explicitly identified yet. As noted in many places, picking from available projects to find an opportunistic study for effectiveness research precludes randomization of treatments and controls. As pointed out, the problem of overt bias in opportunistic restoration projects arise from them generally only being put in places that have a problem already. There is a potential that results from such studies will always give a biased picture of those restoration actions. Indeed, the basic format is problematic since the treatments are generally identified and the study design has to be applied after the fact.

We are proposing to use the remainder of FY03 to identify and begin monitoring candidate projects as replicates in a third pilot project subject to them meeting inclusion criteria. These criteria for optimal impact study design include:

1) The impact has not occurred yet
2) The type of impact and time and place of occurrence must be specified by the monitoring program
3) All samples will have identical monitoring protocols
4) All samples will have non-treated controls that are equally representative.

These criteria are the essentially the same as applied in the other tasks. However, in this case treatment locations will be made on the basis of monitoring priorities rather than the monitoring being attached after the fact. This allows us to introduce representativeness into the inferences drawn from the monitoring, and to test the relative performance of the alternative study designs. Our strategy for this program is to work with the planning authorities at BPA to target specific projects as candidates for participation in this pilot project.

We are currently attempting to coordinate with the development of the Federal Habitat Team's (FHT) Project Tracking Database as a strategy for identifying candidate projects. The FHT is an umbrella group of Federal Action Agencies that has a programmatic need to track implementation of and compliance with the FCRPS BO. Currently, they are organizing a Project Tracking Database to facilitate their compliance monitoring obligation. This database identifies planned as well as existing projects and is therefore a useful database for identifying projects for our third pilot study. The FHT has a September 2003 deadline for the database to be operational. A commitment is in place to work cooperatively with the FHT and with the efforts of the attached database proposal (35048) to coordinate in the development of the Project Tracking Database so that it addresses our programmatic needs. We are requesting funds in FY03 to cover half of an intern through the Oak Ridge Science and Education (ORISE) program to monitor the coordination of our pilot program and the FHT.

We have performed a worked example that models what we are planning for this pilot project. Working with the Oregon Watershed Enhancement Board OWEB database, two assistants in our office extracted all the data for Riparian enhancement projects in the John Day basin that met a set of simple criteria. All projects would be publicly sponsored (State, Federal or Non-Profit) and would be the terminal project on a wadeable tributary in the basin. We identified the riparian projects because a survey of the OWEB data indicated there were numerous riparian enhancement projects, increasing the odds of identifying several that met our criteria. We specified projects that were the last project on a tributary to maximize the likelihood that study results would be uncorrupted with the impacts of nearby projects.

This simple set of criteria identified 11projects. Figure 3 is a GIS-based map of the John Day Basin showing the locations of the 11 riparian projects (At this scale one point obscured two locations in the North Fork John Day). The sponsors of these projects include Oregon Department of Fish and Wildlife, Wheeler County Soil and Water Conservation District, and Pioneer Resources LLC.

We are not yet proposing to work with these sponsors to coordinate these riparian projects into a single RPA 183 study. The worked example is provided merely to indicate that even a modest effort produced a reasonable initial set of projects. We expect that a more concerted effort, coordinated with the more complete Project Tracking Database of the FHT, will produce a set of planned projects where we can coordinate an implementable effectiveness monitoring project. Indeed, as part of its implementation of RPA 150 BPA has been acquiring large pieces of land as conservation easements. It is very likely that these easements will be fruitful locations for optimal impact studies for this third pilot program as we can be more specific in choosing project locations to meet monitoring needs.

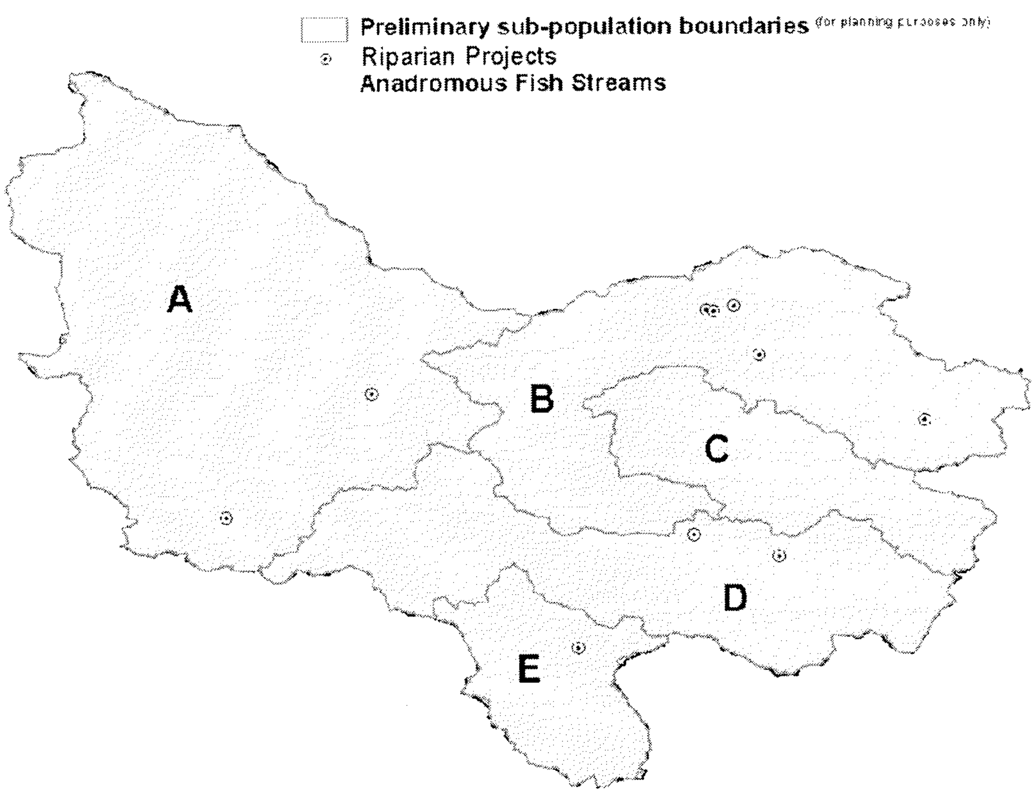

Figure 3. Map of John Day Basin in Oregon showing provisional population segment boundaries and locations of riparian enhancement projects that satisfy preliminary criteria.

We are proposing to work through FY03 to identify an action category, treatment and control locations and develop a study and response design for this pilot program. We are also requesting funds in FY03 for a first summer of habitat monitoring and adult fish surveys in the fall.

The estimated monitoring costs for this pilot project are calculated for monitoring only. If habitat actions must be undertaken to have something to monitor, those costs will be additional. We are requesting $120,000 in FY03 to cover light construction costs for new projects in areas identified in the first phase of this task. It is likely that each project will require a unique design and so the detailed monitoring costs are likely to be distributed differently. Thus, the following cost estimate is a rough guide and it is possible that significant economy will be achieved in the actual implementation. Until that time, however, we need to be ensure an adequate allocation to guarantee success in meeting FCRPS BO requirements.

Analysis of the intrinsic variability of habitat data (Kaufmann et al. 1999) indicates that statistical power described above can be obtained with 30 replicates per action category within the boundaries of a single study. If each replicate has a single paired control reach, that defines 60 sites per study as an initial estimate. If actions impact life stages in different seasons then one would need to repeat sampling within a single year to assess the impacts of actions in both spring and fall. If half of the studies fall into this category 90 site visits would be needed. Indeed, it is unlikely that 30 treatment sites will be found that all meet the minimum criteria for inclusion. It may be necessary in this case to increase discriminating power of the study by sampling those participating studies more frequently within the year to improve the data quality produced by each one.

Rough costs per mile appear to be about $2K to $4K, including habitat variables and snorkel surveys. Hughes *et al.* (2002) suggest that as much as 85 wetted widths may be required to estimate 95 percent of present species richness. Given a value of 25m for wadable streams in this program, this suggests a minimum sample of 2.13 km or 1.36 miles. Since abundance sampling is a statistical estimate, it is likely that the minimum dimension required for estimating abundance can be smaller than for diversity. Thus, we round down and use 1-mile sample reaches. If all studies required approximately 90 samples, $2K to $4K gives a range of costs of $180K to $360K for field expenses for this pilot study.

In addition to field expenses, data and project management as well as logistical support for field crews must be accounted for. If the study is assumed to be composed of several independent entities, four in the riparian enhancement worked example, the costs for managing these projects will need to be attached to all implementations. This additional cost is estimated at $100K for project and personnel management total. This puts the estimated cost at roughly $500K for the entire project fully implemented.

It is very likely that economies can be achieved if multiple projects are managed by the same entities or if activities can be combined with those of other programs, but for now we have no way to guarantee this. In FY03 we are proposing to work with BPA to coordinate the allocation of $380,000 for FY03 to identify the project, define a monitoring plan and perform the first season of habitat and environmental monitoring in the summer and fall of 2003. We anticipate increasing the Monitoring and Evaluation budget for this project in out years to cover additional juvenile monitoring.

Given that this pilot project is as yet undefined, we would also propose that when the study design for this project is complete it be reviewed by the ISRP to maintain the highest standards of scientific integrity and accountability for this program.

g. Facilities and equipment

For the Action Effectiveness Monitoring Team efforts, little additional equipment is needed. Necessary equipment for pilot projects will be acquired during the pilot project funding.

h. References

Reference (include web address if available online)	Submitted w/form (y/n)
Cochran, W. G. (1965). The planning of observational studies of human populations. J. Royal Statistical Soc., Series A, 128:134-155.	N

Green, R. H., (1979). Sampling Design and Statstical Methods for Environmental Biologists. Wiley-Interscience. N.Y.:N.Y. 257 pp.

Gurevitch, J. and Hedges, L. V., (2001). Meta-analysis: combining the results of independent experiments. pp 347-369. In: Design and Analysis of Ecological Experiments. 2nd Ed. Jessica Gurevitch and Samuel M. Scheiner Editors. Oxford Press, New York. 415 pp.

Hafele, R. & M. Mulvey. 1998. Stream Macroinvertebrate Protocol. Oregon Plan for Salmon and Watersheds. Draft report - Oregon DEQ.

Hillman, T. & Giorgi, A., (2002). Monitoring Protocols: Effectiveness Monitoring of Physical/Environmental Indicators In Tributary Habitats. A. Available at: **http://www.efw.bpa.gov/EW/FishandWildlifeDocs_Post/RME/effect_mon_rpt_02_0725.pdf**

ISRP (2002). Review of Draft Clearwater Subbasin Plan. Available at: **http://www.nwcouncil.org/library/isrp/isrp2003-3.pdf**

McGarigal, K., S. A. Cushman, and S. G. Stafford. 2000. Multivariate Statistics for Wildlife and Ecology Research. Springer-Verlag, New York.

Kaufmann, P.R., P. Levine, E.G. Robison, C. Seeliger, and D.V. Peck. (1999). Quantifying Physical Habitat in Wadeable Streams. EPA 620/R-99/003. Environmental Monitoring and Assessment Program, US EPA, Washington, D.C.

ODFW (2000). Habitat Restoration Guide. Natural Production Program: Oregon Department of Fish and Wildlife, Corvallis, OR. Available at: http://www.oregon-plan.org/guidelines/habitat_restoration_guide1999/index.html

Oregon Department of Fish and Wildlife. (1998). Methods for Stream Habitat Surveys. Corvallis Research Station, Corvallis, OR.

Reference (include web address if available online)	Submitted w/form (y/n)
Paulsen, C., Katz, S. L., Hillman, T., Giorgi, A., Jordon, C., Newsom, M. and Geiselman, J., (2002). Guidelines for Action Effectiveness Research Proposals for FCRPS Offsite Mitigation Habitat Measures. Available at: http://www.cbfwf.org/reviewforms/systemwide/habitatrmerpa183.pdf	
Roni, P., M. Liermann, and A. Steel. 2003. Monitoring and evaluating responses of salmonids and other fishes to in-stream restoration. in D.R. Montgomery, S. Bolton, D. B. Booth, and L. Wall (editors), Restoration of Puget Sound Rivers, University of Washington Press, Seattle. Pages 318 to 339.	N
Research, Monitoring & Evaluation For the NMFS 2000 FCRPS Biological Opinion, available at: http://www.efw.bpa.gov/EW/FishandWildlifeDocs_Post/RME/rme_plan_draft_03_0203.pdf)	
Ter Braak, C. J. F. and Verdonschot, P. F. M., (1995). Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aquatic sciences **57(3)**:255-289.	
Walters, C.J.; Collie, J.S.; Webb, T., (1988). Experimental designs for estimating transient responses to management disturbances. Canadian Journal of Fisheries and Aquatic Sciences. **45(3)**:530-538.	
Walters, C.J.; Collie, J.S.; Webb, T., (1989). Experimental designs for estimating transient responses to habitat alteration: Is it practical to control for environmental interactions? Proc. Of the National Workshop on Effects of Habitat Alteration on Salmonid Stocks. pp. 13-20, Can. Spec. Publ. Fish. Aquat. Sci., no. 105	

Section 10 of 10. Key personnel

We anticipate a large coordination effort in FY03 as we work with project sponsors to modify their study designs – adding components in one case and adding replicates in another. We are also anticipating that our first priority will be to identify the third pilot study for task 2C. Therefore we are requesting funds for three administrative assistants to coordinate the various agents so we can develop appropriate study designs for each project (2A, B & C). Accordingly, we will hire two new interns via the Oak Ridge Science and Education (ORISE) program to contact various agencies and collect existing project and monitoring data. In addition, a Bio-Statistical Science Postdoctoral level researcher will work full time for the remainder of FY03 with Dr. Katz and Dr. Courbois to establish appropriate statistical tools for the response designs.

Stephen L. Katz, Principal Investigator (0.45 FTE for FY03)

Education and Experience

B.A.	Occidental College	1981
Ph.D.	University of British Columbia, Vancouver	1994
Monitoring and Evaluation Coordinator, NWFSC		2001-present

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Environmental Conservation Division, Montlake Facility. Previous employment: Mellon Council Postdoctoral Associate, Scripps Institution of Oceanography (1993-1998); Research Assoc. Duke University/DARPA (1998-2000).

Position: Research Fisheries Biologist/Systems Analyst, Coordinator for Monitoring and Evaluation, Conservation Biology Division, NWFSC. NMFS employee since 2001.

Present assignment: Dr. Katz co-supervises the Monitoring and Evaluation program at the NWFSC that is currently working with regional entities to develop a coordinated, comprehensive monitoring program for fish with an emphasis on species that are listed as threatened or endangered under the ESA.

Previous research/expertise: Dr. Katz's expertise is in the areas of Mathematical Biology, Bioengineering and Systems Engineering. His background in laboratory science, biomathematics and systems engineering provides a specific set of skills that are tailored to the solution of the effectiveness monitoring problem.

Selected Relevant Publications:

Paulsen, C., Katz, S. L., Hillman, T., Giorgi, A., Jordon, C., Newsom, M. and Geiselman, J., (2002). Guidelines for Action Effectiveness Research Proposals for FCRPS Offsite Mitigation Habitat Measures. Available at: http://www.cbfwf.org/reviewforms/systemwide/habitatrmerpa183.pdf

Jordan, C. E. et al. (including S. L. Katz). (2002). Mainstem/Systemwide Province Stock Status Program Summary: *Guidelines for Conducting Population and Environmental Status Monitoring.* Available from: www.cbfwa.org/files/province/systemwide/subsum/stock_status_consensus.pdf

Zabel, R.W., Harvey, C., Katz, S. L., Good, T. and Levin, P. S., (2003). Sustaining Marine Ecosystems. **American Scientist**. **91**:150-157.

Katz, S. L. (2002). Design of heterothermic muscle in fish **Journal of Experimental Biology**. 205 (15): 2251-2266

Katz, S. L., Syme, D. A., and Shadwick, R. E., (2001). Enhanced power in yellowfin tuna. **Nature** 410 (6830): 770-771.

Pip Courbois, Principal Investigator

Education and Experience
B.A.
Ph.D.

Employer: National Marine Fisheries Service, Northwest Fisheries Science Center, Environmental Conservation Division, Montlake Facility.

Position:

Present assignment:

Previous research/expertise:

Selected Relevant Publications: