Narrative Preamble:

The Columbia Basin Fish Accords (Accords) are ten-year agreements between the federal action agencies and states and tribes. The Accords supplement the Columbia Basin Fish and Wildlife Program and are intended to assist the action agencies in meeting obligations under the Endangered Species Act by producing substantial biological benefits for Columbia Basin fish. The Accords also acknowledge the tribes' and states' substantive role as fish resource managers, and provide greater long-term certainty for fish restoration funding and biological benefits for fish. Ongoing projects supported and new projects developed under these agreements are designed to contribute to hydro, habitat, hatchery and predation management activities required under the 2008 FCRPS Biological Opinion. In addition, projects within the agreement assist BPA in meeting its mitigation obligations under the Northwest Power Act.

Project Title:

Table 1. Proposal Metadata:

Project Number	2008-607-00
Title	Idaho Nutrient Enhancement Project
Proposer	Idaho Office of Species Conservation
Brief Description	This is a pilot habitat improvement project with monitoring and evaluation. The objective is to introduce selected nutrient sources to Idaho streams with the goal of providing benefits to Idaho steelhead populations. A paired treatment/control approach will be utilized to evaluate the effectiveness of the nutrient enhancements.
Province(s)	Mountain Snake
Subbasin(s)	Clearwater
Contact Name	Mike Edmondson, Program Manager
Contact email	Mike.edmondson@osc.idaho.gov
Projected Start Date	January 1, 2011

A. Abstract

The State of Idaho, through the Idaho Department of Fish and Game (IDFG), will conduct this pilot project in the Clearwater subbasin. This habitat improvement project will involve the addition of nutrient sources to Idaho streams with the goal of providing benefits to Idaho steelhead populations. The project will use a paired treatment/control approach. Two streams will receive nutrients and two will serve as controls. IDFG will conduct monitoring and evaluation of juvenile steelhead to determine the effectiveness of the nutrient treatment and application techniques. The primary parameters to be estimated are density in natal streams, length at age, and survival from study streams to Lower Granite Dam. The focus of this project is development of logistical expertise for nutrient enhancements. As such, our emphasis is on the step-wise process necessary to implement and adaptively manage nutrient enhancements as a management tool. Accordingly, collection of fish data will be simplified and require no infrastructure.

B. Problem statement: technical and/or scientific background

Recent studies in the Pacific Northwest have highlighted the importance of marine-derived nutrients (MDN) to stream productivity (Willson et al. 1998; Naiman et al. 2002). The chief natural vector of MDN to inland streams are spawning salmon (Gende et al. 2002; Schindler et al. 2003). Historically, the effects of salmon-borne MDN in the Pacific Northwest were apparent as far inland as Idaho (Koyama et al. 2005). In recent decades, most populations of salmon in the continental United States are extremely depressed (Good et al. 2005). Loss of regular MDN inputs can greatly reduce aquatic productivity and further contribute to depression of salmonid abundance (Larkin and Slaney 1997; Gresh et al. 2000).

Conceptually, benefits of MDN to freshwater fish come indirectly from increased productivity in the aquatic environment and directly from feeding on the nutrient source. Many studies have shown a boost in basic productivity and macroinvertebrate density (e.g., Wipfli et al. 1998; Wipfli et al. 1999; Claeson et al. 2006). Many studies also have shown benefits to fish. Nutrient additions have increased fish growth (Wipfli et al. 2003; Mesa et al. 2007) and density (Bilby et al. 1998). If these increases are accompanied by increased or maintained survival rates, nutrient additions have the potential to increase the number of recruits to the spawning population.

There is great interest in using nutrient additions for management of salmonid populations (Stockner 2003). Nutrient addition programs have been developed in several states and provinces (Ashley and Stockner 2003), including some fairly extensive efforts. For example, many steelhead streams in British Columbia are receiving nutrients to enhance their productivity (see project reports at www.bccf.com/steelhead and www.bchydro.com/bcrp). There is interest in conducting similar work in Idaho to enhance productivity of B-run steelhead populations. Although occurrences of such implementation-scale efforts are rising, few thorough evaluations have been conducted and actual estimates of fish survival increases are sparse.

Actual benefits from nutrient additions in terms of fish population abundance or productivity are uncertain. Most studies have been small-scale, e.g. applications are limited to 500-m reaches (Mesa et al. 2007). There are some studies showing increases in population productivity in British Columbia (Slaney et al. 2003; Ward et al. 2008). Other investigations have shown the effects of nutrient additions are not uniform among systems or application methods (Chaloner et al. 2004, 2007; Wilzbach et al. 2005; Giannico and Hinch 2007; Shaff and Compton 2009). However, in the British Columbia model, nutrient additions are only used to help shorten recovery times after other elements of stream habitat have been rehabilitated (Slaney and Zaldokas 1997; Ward et al. 2008). It is thought that use of nutrient additions without addressing underlying problems is not likely to be successful at restoring salmonid populations (Ashley and Stockner 2003). Clearly, more study is needed to fully understand how and to what extent nutrient additions can boost fish population productivity.

There are several ways to accomplish nutrient enhancements. Salmon carcasses are thought to be most beneficial but are logistically unwieldy, may not be in steady supply, and carry disease transfer risks (Pearsons et al. 2007). Servicing liquid nutrient delivery systems is logistically intensive and would add considerably to the Clean Water

Act/National Environmental Policy Act (NEPA) regulatory burden and cost (R.S. Hardy, Kootenai River Ecosystem Rehabilitation Project, Idaho Department of Fish & Game, personal communication). Carcass analogs are desirable (Pearsons et al. 2007) but commercial availability can be difficult for small projects. The use of inorganic fertilizers is also of interest (Ashley and Slaney 1997) but this technique obviates the direct benefit of feeding on salmon carcasses or organic analogs by target fish species. Slow-release pellets are logistically desirable for remote locations (Sterling and Ashley 2003). However, most work with inorganic pellets has been done on streams in which biological production is limited by phosphorus. Most streams in central Idaho are limited or co-limited by nitrogen concentrations (Snyder et al. 2002; Thomas et al. 2003; Marcarelli and Wurtsbaugh 2007; Kohler et al. 2008; Sanderson et al. 2009); therefore, we expect treatments will emphasize nitrogen but nutrient prescriptions must be determined in the field, case by case. Commercially available nitrogen pellet fertilizers have not been tested for this kind of work.

We propose to test the feasibility of commercially available fertilizers for use as a nutrient mitigation technique in Idaho. As a pilot study, this proposal will feature the step-wise process necessary to implement nutrient enhancements as a management tool: identifying streams suitable for enhancement; development of the appropriate nutrient prescriptions; and monitoring and adaptive management of the project. Much previous work has demonstrated that primary production is nutrient limited in many central Idaho streams (Snyder et al. 2002; Thomas et al. 2003; Marcarelli and Wurtsbaugh 2007; Kohler et al. 2008; Sanderson et al. 2009); hence, there is a reasonable expectation of a positive treatment effect. Carcass analogs or other processed fish meal products will be used if available and if pretreatment testing finds that they are appropriate for the study streams. Inorganic pellets will also be tested, but preference will be given to organic alternatives. Implementation will be on a large enough scale to test for a population level effect. We predict that length at age and survival to emigration will be greater in treatment streams compared to control streams.

Habitat

Nutrient losses were mentioned in the Clearwater Subbasin Assessment and Management Plan (NPCC 2003 a, b) as general limiting factors. Resident and anadromous fish may be limited by reductions in available forage, aquatic macroinvertebrate biomass and taxonomic richness, and reduced growth rates due to loss of anadromous fish production and the nutrients that carcasses provide (NPCC 2003a, p. 342). Reductions of anadromous fish runs throughout the subbasin have resulted in reduced nutrient cycling, with impacts to both plant and animal species (NPCC 2003b, p. 12). One of the objectives of the Clearwater Subbasin Management Plan (NPCC 2003b, p. 18) is to increase anadromous fish productivity and production, and life stage specific survival through habitat improvement. In relatively unimpacted watersheds, nutrient additions are a logical alternative to physical habitat alterations. The management plan further states: by 2010, develop a nutrient allocation plan for the subbasin which investigates the potential benefits to fish and wildlife of nutrient additions or reductions (NPCC 2003b, p. 36). Nutrient enhancement efforts are to be monitored and evaluated, with new information integrated to adaptively manage such efforts. One of the recommended research initiatives in the Management Plan is to investigate effects of potential loss or lack of nutrients due to declines in anadromous salmonid populations, with the goal of assessing where nutrient reductions/additions would be beneficial to focal salmonid species (NPCC 2003b, p. 63). However, a specific priority was not given for any of these objectives.

Research/Monitoring/Evaluation

The emphasis of this project is on the step-wise process necessary to implement and adaptively manage nutrient enhancements as a management tool. Again, as noted above, based on an extensive literature, there is a reasonable expectation of a positive treatment effect. The primary question of interest is *not* if there will be an effect, but can a nutrient enhancement program be implemented on a broad enough scale to provide an effective tool for enhancing steelhead *populations*. Adaptive management requires monitoring and evaluation as the feedback loop whereby management is evaluated (Kershner 1997; Bisbal 2001). This proposed project will use a paired treatment/control approach for monitoring and evaluation. Two streams will receive nutrients and two will serve as controls. IDFG will monitor and evaluate the effectiveness of the nutrient sources and application techniques. Water quality and the physical state of the nutrient source will be monitored to address treatment effectiveness. Several parameters of the fish populations in the study streams will be monitored also so that the intended biological effect may be estimated. These parameters include juvenile density, length at age, and survival to Lower Granite Dam. The focal species will be steelhead but data from other salmonids will be collected, also.

C. Rationale and significance to regional programs

Implementation of the Idaho Nutrient Enhancement Project will address the goals and objectives in the following regional programs:

1) Biological Opinion
    - RPA 35 - Achieving habitat quality and survival improvement targets.
    - RPA 57 - Evaluate the effectiveness of tributary habitat actions.

2) Clearwater Subbasin Management Plan (NPCC 2003b)
    - Objective B: Increase anadromous fish productivity and production, and life stage specific survival through habitat improvement.
    - Objective T: By 2010, develop a nutrient allocation plan for the subbasin which investigates the potential benefits to fish and wildlife of nutrient additions or reductions.

3) 2000 Fish and Wildlife Program
    - Biological objective 4: Increase energy and nutrient connections within the system to increase productivity and expand biological communities.

Columbia River Basin Accords

The Columbia River Basin Accord agreements were established with action agencies, four tribes and one state for 10-year commitments to benefit Columbia

River Basin salmon and steelhead stocks. Key components of the Accord Agreements which are addressed with this project include:

- Northwest ratepayer's litigation risk will be reduced as fish populations respond to improved habitat quantity and quality in the watershed
- Implementation of NOAA Fisheries BiOp actions will insure that key components of the biological opinions are incorporated into on-the-ground salmon and steelhead recovery efforts
- Partnerships with key landowners and action agencies will promote collaborative approaches towards the conservation of fish and wildlife resources in the watershed
- Establish a mechanism whereby interested parties can work together on species recovery before statutory obligations become contentious issues in the court system

Bonneville Power Administration Habitat Improvement Program (HIP II)

The National Marine Fisheries Service (NMFS) and BPA added new activity subcategories to the HIP II Section 7 Programmatic Consultation Biological Opinion(NMFS 2008). A subcategory was added for the supplementation of streams with nutrients (p. 2). BPA proposed funding projects designed to improve biological productivity through the use of nutrient additions in the form of carcasses, carcass analogs, or inorganic fertilizers (p. 21). This project will abide by all HIP II guidelines provided by NMFS.

D. Relationships to other projects

During development of this project, we have consulted with biologists associated with four existing nutrient-related projects funded by BPA (Table 2). These projects are more research-oriented and are developing information on the movement of nutrients and energy through stream ecosystems. The Idaho Nutrient Enhancement project will build on this information but project focus is on developing the logistical expertise to conduct management-scale nutrient enhancement projects. Additionally, this project will focus on steelhead, which were not the primary species addressed by the other projects. For logistical support and planning purposes, this project will interact with two of IDFG's anadromous salmonid monitoring projects, Idaho Steelhead Monitoring & Evaluation Studies and Idaho Natural Production Monitoring & Evaluation Project (Table 2).

Table 2. Relationship to existing projects

Funding Source	Project #	Project Title	Relationship (brief)
BPA	200733200	Mitigation of marine-derived nutrient loss in the Boise-Payette-Weiser subbasin	Consulting for planning purposes, interact apply recent findings

Funding Source	Project #	Project Title	Relationship (brief)
BPA	199404900	Kootenai River Ecosystem Improvements Project	Consulting for planning purposes, interact apply recent findings
BPA	200890400	Salmon River basin nutrient enhancement	Consulting for planning purposes, interact apply recent findings
BPA	200105500	Assessment of three alternative methods of nutrient enhancement	Consulting for planning purposes
BPA	199005500	Idaho Steelhead Monitoring & Evaluation Studies	Logistical support
BPA	199107300	Idaho Natural Production Monitoring & Evaluation Project	Logistical support

E. Project history (for ongoing projects; this includes projects that have been funded with non-BPA funds).

This is a new project.

F. Proposal biological/physical objectives, methods, work elements and metrics.

Objectives

The ultimate goal is to increase freshwater productivity of Idaho's steelhead populations by the use of nutrient enhancements. Research elsewhere has documented such effects; we propose to start using these techniques as habitat mitigation at a management scale. This is a pilot project intended to pave the way for larger-scale efforts.

The objectives of the proposed project are 1) to develop the expertise and experience with commercially available products to conduct large-scale nutrient enhancement projects in Idaho, and 2) to confirm that the addition of such nutrients can measurably increase steelhead population productivity in central Idaho streams. Biological response variables include juvenile density, length at age, and survival (natal stream to Lower Granite Dam). The approach proposed will focus on project development and release logistics rather than biological monitoring. However, examination of a reduced set of fish parameters will enable an evaluation of project effects and lead the way for the more substantive assessments of larger efforts. In this section, general methodology will be discussed; more specific details will be given in the Monitoring and Evaluation section.

Two general treatment options will be considered: organic materials (carcass analogs or other processed fish meal products) and inorganic slow-release pellets. Carcasses have been rejected as a management-scale option due to logistical issues (Pearsons et al. 2007). Samples should be obtained of each of the viable options and tested during the pre-treatment phase. The plan is to be flexible and research the most appropriate options before finalizing the treatment plan. Actual use should be as a part of an integrated adaptive management plan to be developed during the project.

Project permitting begins in 2011 (Figures 1 and 2). We will work with the Idaho Department of Environmental Quality (IDEQ) Lewiston Regional Office to initially identify a population of CWA non-nutrient impaired streams that are suitable, from a regulatory standpoint, to enhance with nutrients. BPA HIP II Bi-Op minimization measures (NMFS 2008) will also be considered in developing this list of streams. We will avoid treatment of any nutrient impaired streams or their upstream tributaries.

The major activities during 2011-2013 will lead to a treatment plan that will be adaptively managed during the project life, with final evaluation after the last treatment (Figure 1). The first two years will focus on permitting, product testing, and developing a list of candidate streams, which will enable the collection of pretreatment data (Figure 2). In years 3 and 4, the initial treatment plan will be developed and the list of study streams finalized (Figure 3). The statement of work, located in Pisces, provides a more in-depth schedule of projected work during the first three years of the project. Treatments will commence in 2014 and tasks in subsequent years will follow the template for 2014 (Figure 3) as modified based on the monitoring results of the previous year.

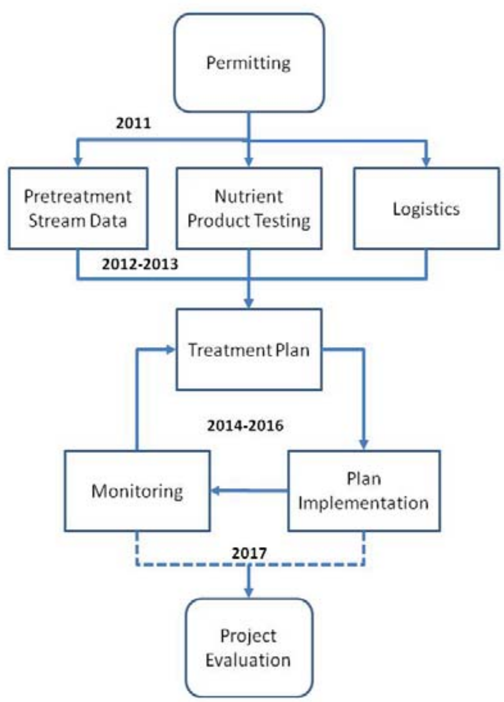

Figure 1 - Nutrient Enhancement Project Flow Chart

Idaho Nutrient Enhancement Project (2008-607-00) timeline

Work element/task outline for 2 yrs of project set-up and an example implementation year.

		2011 Permitting Phase												2012 Year 1: project start-up, begin pretreatment data collection.											
Work Element	Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A. Administration		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
B. Status Reports					X			X			X						X			X			X		
C. Permitting																									
	IDEQ variance	X	X	X	X	X	X	X	X	X	X	X	X												
	NPDES Permit - Determine Need/Apply	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	404 Permit - Determine Need/Apply	X	X	X	X	X	X	X	X	X	X	X	X												
	ESA Take Permits										X	X	X										X	X	X
	Special Use Permit	X	X	X	X	X	X	X	X	X	X	X	X												
D. Biological Assessment		X	X	X	X	X	X	X	X	X	X	X	X												
E. Project Study Design																									
	List streams													X	X	X									
	Evaluate streams															X	X	X	X	X	X	X			
	Pre-test nutrients																	X	X	X	X	X			
	Select study streams																						X	X	X
F. Water Quality Sampling																									
	WQ sampling															X	X	X	X	X	X	X			
	Install/maintain equipment															X	X								
	Observe nutrient samples																	X	X	X	X	X			
G. Nutrient Additions																									
	Develop/adapt plan																								
	Treatment regime																								
	Select locations																								
	Nutrient logistics																								
	Add nutrients																								
H. Fish Surveys																									
	Select sites																	X							
	Complete surveys																			X	X	X			
I. PIT Tagging																									
	Forecast & Dist Request																					X	X	X	
	Tagging																								
J. Manage PIT Files																									
K. Maintain Databases														X	X	X	X	X	X	X	X	X	X	X	X
L. Analyze Data																							X	X	X
M. Disseminate Data														X	X	X	X	X	X	X	X	X	X	X	X
N. Progress Report																									

Figure 2 - Work Element/Task Outline - Years One and Two (2011 -

Idaho Nutrient Enhancement Project (2008-607-00) timeline

Work element/task outline for 2 yrs of project set-up and an example implementation year.

		2013 Year 2: collect pretreatment data, finalize detailed plan.												2014 Year 3 (2014): Begin implementation.											
Work Element	Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A. Administration		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
B. Status Reports		X			X			X			X			X			X			X			X		
C. Permitting																									
	IDEQ variance																								
	NPDES Permit - Determine Need/Apply																								
	404 Permit - Determine Need/Apply																								
	ESA Take Permits										X	X	X										X	X	X
	Special Use Permit																								
D. Biological Assessment																									
E. Project Study Design																									
	List streams																								
	Evaluate streams																								
	Pre-test nutrients																								
	Select study streams																								
F. Water Quality Sampling																									
	WQ sampling			X	X	X	X	X	X	X						X	X	X	X	X	X	X			
	Install/maintain equipment			X	X											X	X								
	Observe nutrient samples					X	X	X	X	X								X	X	X	X	X			
G. Nutrient Additions																									
	Develop/adapt plan							X	X	X	X	X	X							X	X	X	X	X	X
	Treatment regime								X	X	X	X	X												
	Select locations									X	X	X	X												
	Nutrient logistics										X	X	X					X	X				X	X	X
	Add nutrients																		X						
H. Fish Surveys																									
	Select sites					X																			
	Complete surveys							X	X	X										X	X	X			
I. PIT Tagging																									
	Forecast & Dist Request									X	X	X										X	X	X	
	Tagging							X	X	X										X	X	X			
J. Manage PIT Files								X	X	X										X	X	X			
K. Maintain Databases		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
L. Analyze Data		X	X								X	X	X	X	X								X	X	X
M. Disseminate Data		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
N. Progress Report										X	X	X	X												

2012)

Figure 3 - Work Element/Task Outline - Years Three and Four (2013 - 2014)

Water quality permitting will be addressed during the first two project years (2011 – 2012). The Idaho Office of Species Conservation (IOSC) contacted IDEQ in November 2009 regarding Idaho Water Quality Standards. The response letter from IDEQ is included as Attachment 1. This project will require IDEQ to issue either a short term activity exemption (in the event a National Pollutant Discharge Elimination System (NPDES) permit is not needed) or a Section 401 water quality certification (in the event an NPDES permit is required). Although the nutrient enhancement activities could result in a violation of the Idaho Water Quality Standards, IDEQ was generally supportive of the project (see Attachment 1). We will conduct water quality sampling in the main stem reach below the treatment streams to verify minimal impact outside the treatment reaches.

A final subset of those steams will be chosen during 2012 as the treatment/control streams. During the permitting phase, we will also contact the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers regarding applicability of NPDES and 404 permits. We will apply for those permits if required.

Work elements (tasks), methods, and metrics

Objective 1. Develop the expertise and experience with commercially available products to conduct nutrient enhancement projects in Idaho.

Work Element A. Annual Project Planning and Administration

Project management and planning activities for the year. Construct statements of work, budgets, inventories, and other administrative duties. Obtain appropriate training for project personnel. Coordinate with land management agencies (United States Forest Service(USFS), Bureau of Land Management (BLM)) and secure agreement that the project is desirable. Notify local landowners, interested parties, etc, and obtain support for the project.

Work Element B. Periodic Status Reports

Reporting on the status of milestones and deliverables in Pisces. Done quarterly.

Work Element C. Project Permitting

Obtain all necessary permits for project activities. Securing the necessary permits is a time-consuming affair requiring at least a year's effort. The Environmental Assessment will be completed by the funding agency (BPA).

Milestones:

A. Identify a population of streams in the Clearwater Subbasin: work with the IDEQ Regional Office to initially identify a population of CWA non-nutrient impaired streams that are suitable, from a regulatory standpoint, to enhance with nutrients. BPA HIP II Bi-Op minimization measures (NMFS 2008) will also be considered. We will avoid treatment of any nutrient impaired streams or their upstream tributaries.
B. Stay of Water Quality Standards: obtain permission to deviate from Idaho state standards from IDEQ. In the event an NPDES permit is not needed, either IOSC or IDFG will enter into a voluntary consent order authorizing the project under the short term activity exemption provisions of Idaho's Water Quality Standards. In

the event an NPDES permit is needed, IDEQ will not issue an authorization; IDEQ would instead provide a Section 401 water quality certification of the NPDES permit (see Attachment 1).

C. NPDES Permit: IOSC will contact EPA to obtain determination of NPDES applicability. IOSC or IDFG will apply for an NPDES permit for the project if one is required.
D. 404 Permit: IOSC will contact U.S. Army Corps of Engineers to obtain determination of 404 permit applicability. In the event a permit is needed, application will be made.
E. Endangered Species Act Take Permits: permission to handle endangered fishes, required by NOAA. Handling/sampling coverage under Section 4d of the ESA from NOAA must be completed annually. Permit application period is October prior to field work, with reporting due by the end of each calendar year.
F. Special Use Permit: placement of material on federal property, required by USFS/BLM; to be completed by project sponsor (IOSC).

Deliverables: project permits as needed.

<u>Work Element D.</u> Produce Biological Assessment (BA)

Any impacts to threatened/endangered species in the project area must be addressed in a formal document as required by NOAA Fisheries and U.S. Fish and Wildlife Service (USFWS). Any federally funded activities must be covered by a Biological Assessment. The minimum is an informal consultation with NOAA Fisheries and USFWS. If no adverse effects are likely, a Memorandum of No Effect will be issued. This may take longer than a year.

Milestones:

A. Initial Coordination: contact NOAA, USFWS, and local USFS/BLM biologists to determine likely BA requirements.
B. Draft Biological Assessment: gather materials and write draft.
C. Informal ESA Consultation: consultation with NOAA & USFWS on likely project impacts to threatened and endangered species.

Deliverable: Completed and approved BA.

<u>Work Element E.</u> Project Study Design

In the first year of the project, we will work with the IDEQ Lewiston Regional Office to initially identify a population of CWA non-nutrient impaired streams that are suitable, from a regulatory standpoint, to enhance with nutrients. A final subset of those steams will be chosen during 2012 as the treatment/control streams. Milestones for this work element lead to final project stream selection. IDFG will define stream criteria, pre-test nutrients, prioritize and make final decisions on streams. See Section G below for the template for this process.

Milestones:

A. Define set of potential project streams during 2011: define criteria and develop list of candidate streams from population of streams identified in Work Element C, Milestone A. Criteria will include gradient, flow, drainage size, geology, and land cover. Develop a refined list of candidate streams from these criteria. Check for pre-existing data in sources such as the Assessment, TMDL Tracking and Implementation System (ATTAINS) database or Pacific Northwest Water Quality Data Exchange (PNWQDE). We will also contact local IDEQ and EPA personnel for input and data.

B. Evaluate candidate streams during summer 2012: prioritize list, make site visits, and conduct initial water quality sampling. Screen candidate streams for nutrient limitations. Check water quality at base flow during the growing season (July-August). Describe light availability, flow/temperature regime, and physical habitat.
C. Pre-test nutrient products: test nutrient types. Evaluate commercially available alternatives (carcass analogs, slow-release inorganic pellets, fish meal). Obtain samples, verify composition. Product samples will be tested for dissolution rates under field conditions. Chemical content should be verified to prevent introduction of toxins. Work should commence in 2012.
D. Select treatment/control streams during fall 2012: select appropriate stream pairs and randomly assign treatment/control status. Base selections on physical, chemical, and logistical criteria. Attempt to keep nutrient limitations, drainage area, hydrograph, temperature, and stream widths similar within each pair.

Deliverables: list of potential streams, initial project design, final list of treatment/control streams, methods and protocols for implementation of data collection and generation.

Work Element F. Conduct Water Quality Sampling

Water quality sampling is necessary to develop nutrient addition prescriptions specific to each treatment stream, provide baseline/control data, and satisfy permit requirements. Set up study reaches within each stream. Measure total phosphorus, total nitrogen and chlorophyll-a, as well as other parameters, on a monthly basis. Sample above and below each treatment site as well as at the mouth. Spread chlorophyll-a samples evenly through the treatment reach to measure effective treatment length. For treatment streams this will be from the upper-most fertilization site to the mouth. For control streams, define a similar length within each stream pair. Nutrient limitations will be confirmed using nutrient diffusing substrate (NDS) experiments (e.g., Marcarelli and Wurtsbaugh 2007; Kohler et al. 2008; Sanderson et al. 2009) conducted near the bottom of the study reaches.

Conduct pretreatment sampling in 2013 to determine appropriate doses. Sampling should be throughout the growing season (June-October). Identify treatment sites. Initially, we will assume an effective treatment length of 5 km. Install temperature monitors near the downstream end of the study reaches before snow melt. Conduct pretreatment water quality sampling. Sampling during the pretreatment phase will be at least bi-monthly in order to establish nutrient uptake during the growing season. Establish a staff gage to measure flow. Flow and temperature will be monitored year-round on at least a monthly basis.

After treatment begins (June 2014), conduct monthly routine water quality monitoring to satisfy permit requirements, verify nutrient releases, and allow adaptive management of the treatment plan. Sample above and below each treatment site as well as at the mouth. If possible, an NDS experiment will be run upstream of the treatment reach for comparison to that within the treatment reach. Some limited water quality sampling will occur in main stem reaches downstream of treatment streams to verify minimal impacts there.

Milestones:

A. Environmental compliance requirements complete.
B. Conduct water quality sampling: conduct water quality sampling necessary for permits and to verify increases in stream productivity. Take samples for analysis and measure stream flow.
C. Install/maintain monitoring equipment: install temperature monitors and staff gauges. Perform annual maintenance as necessary.
D. Verify nutrient retention/absorption: observe/measure physical retention and weight loss of nutrient additions within small-scale plots. Conduct some testing in 2012 (if possible). Follow up with further testing in chosen study streams in 2013.

Deliverables: Water quality data - measurements of total phosphorus, total nitrogen and chlorophyll-a; temperature and flow data. Preliminary data on performance of nutrient sources.

<u>*Work Element G.*</u> Enhance Nutrients Instream

The appropriate nutrient source (slow-release fertilizer pellets, fish meal, or carcass analogs) will be dispensed into streams to increase productivity. Two streams will receive treatment. Develop a nutrient enhancement plan for each stream. Determine locations for additions. Annually, order the amount of nutrients required. Develop a logistics plan to receive and distribute materials to each stream. Apply fertilizer during the growing season, after peak run-off (June). Evaluate fertilizer performance. Determine nutrient uptake rate and effective treatment distance. Estimate rate of pellet dissolution. Obtain samples of other products to test for future use.

Milestones:

A. Environmental compliance requirements complete.
B. Develop nutrient/fertilizer enhancement management plan. Adaptive management of initial project design.
C. Determine method(s) to add nutrients/fertilizer to system (by human or automated). Develop a treatment regime specific to each stream. Treatment is based on flow characteristics and watershed fertility. Identify treatment sites. Develop appropriate and feasible means to add nutrients in remote areas.
D. Determine location(s) where nutrients/fertilizer should be added to system. Select nutrient addition sites based on measured water quality.
E. Obtain nutrients/fertilizer annually. Determine amount needed for both treatment streams by analysis of the previous year's data and place order with vendor.

Deliverables: nutrient source(s) identified and implementation plan drafted. Dispense nutrient sources in the Clearwater Subbasin.

Objective 2. Confirm that the addition of nutrients can measurably increase steelhead population productivity in central Idaho streams.

<u>*Work Element H.*</u> Fish Population Surveys

Monitor salmonid abundance in study streams. Set up study reaches within each stream. For treatment streams this will be from the upper-most fertilization site to the mouth. For control streams, define a similar length within each stream pair. Attempt to keep drainage area and stream widths similar within each pair. Choose 10 sites per stream using EMAP protocol for subsequent field work. Hire snorkel crew (1 senior technician & 4 bio-aides) and conduct training in late June. Conduct snorkel surveys for fish densities during July. Use IDFG general parr monitoring protocol to estimate densities. Conduct at least 2 mark-resight efforts per stream to estimate crew efficiency (a modification of Thurow et al. 2006, see Copeland et al. 2008). Use these data to estimate standing stock. See Section G below for more specifics.

Milestones:

A. Environmental compliance requirements complete.
B. Select survey sites: use EMAP protocol to choose a minimum of ten survey sites within each project stream. Sites will be fixed after first year.
C. Complete surveys: Use IDFG general parr monitoring protocol to complete surveys. Do mark-resight studies in at least two sites per stream.

Deliverables: estimated steelhead parr abundance. Data files in IDFG Standard Stream Survey database.

<u>Work Element I.</u> Place PIT Tags

Place PIT tags in young steelhead in each stream. PIT tags are used to estimate survival rates. Conduct fish collection efforts to place tags, measure lengths and gather scales during August. Place 500-1,000 PIT tags in juvenile steelhead per stream. Use angling gear and minnow traps to collect steelhead. Attempt to place tags evenly throughout the study reaches. See Section G below for more specifics.

Milestones:

A. Environmental compliance requirements complete.
B. PIT tag forecast: complete and submit PIT tag needs forecast annual to Pacific States Marine Fisheries Commission and BPA to facilitate purchases (tagging needs).
C. Collect and PIT-tag juvenile steelhead: PIT-tag juvenile steelhead. Collect scale samples from tagged fish.

Deliverables: conduct fish collection efforts to place tags, measure lengths, and gather scales. Place 500-1,000 PIT tags in young steelhead per stream.

<u>Work Element J.</u> Manage PIT Tag Files

All PIT tag efforts must be reported in the PTAGIS database. Records of detections of project-tagged fish will be retrieved to provide survival estimates from tagging to emigration at Lower Granite Dam each spring.

Milestones:

A. Upload PIT tag files to PTAGIS database.

Deliverables: uploaded PIT tag files.

Work Element K. Maintain Databases

Store, update, and maintain data collected by this project. Construct and maintain databases/spreadsheets for water quality and nutrient status data, as appropriate. Store and maintain age data (from scales) in the IDFG Biological Samples database (project 199107300). Maintain salmonid parr data in the IDFG Standard Stream Survey database (project 199107300). IDFG will work with IDEQ's data management contact for the PNWQDE and with the IDFG StreamNet Coordinator to agree on a format and archive for project data. If an appropriate data storage option does not exist, water quality and macro data will be uploaded to the StreamNet Data Store (with the metadata form).

Milestones:

A. Water quality database: construct and maintain Access database for water quality and nutrient status data.
B. Juvenile steelhead ages: store and maintain steelhead age data in IDFG Biological Samples database.
C. Maintain parr abundance data in IDFG Standard Stream Survey database: maintain parr abundance data.

Deliverables: maintain databases.

Work Element L. Evaluate Fish Population and Water Quality Parameters

Describe fish performance in study streams. Conduct laboratory work during September and October. Technicians will determine the number of annuli on each scale. Use age data to estimate length at age. Each spring, obtain PIT tag detections from the lower Snake River dams. Compute survival from natal stream to emigration using SURPH software (Lady et al. 2010). Conduct analysis. Compare conductivity, water temperatures, and other water quality parameters among streams. Compare natal stream densities, length at age, and survival from natal stream to Lower Granite Dam within each stream pair. See Section G below for more specifics.

Milestones:

A. Conduct scale analysis: determine the number of annuli on scales collected.
B. Compare length at age among treatment and control streams. Estimate ages from scale analysis. Conduct statistical comparisons.

Deliverables: data on fish performance. Compare densities, length at age, and survival within each stream pair.

Work Element M. Provide Data to Regional Managers

Provide information and data from the project. This includes reporting of water quality data as required by IDEQ to be included in the State's 303(d) assessment of impaired waters. Provide reports and analysis as requested by IDFG staff or other regional entities, including IDEQ. This may include attendance in regional workshops or professional meetings.

Milestones:

A. Provide data and analysis: as requested by IDFG managers and Bureau staff, provide data and analysis that can be used in management decisions. This includes reporting of water quality data as required by IDEQ.

Deliverables: submit data, reports and analysis to IDFG and other regional entities, including IDEQ.

Work Element N. Produce Annual Progress Reports

Annual reports to BPA will be the primary vehicle for dissemination of results. Reports will be submitted for each contract period. Reports will be vetted by IDFG's internal review process.

Milestones:

A. Review progress report format requirements.
B. Draft report.

Deliverables: progress report in Pisces.

G. Monitoring and evaluation

The focus of this project is development of logistical expertise for nutrient enhancements. As such, our emphasis is on the step-wise process necessary to implement and adaptively manage nutrient enhancements as a management tool. Accordingly, collection of fish data will be simplified and require no infrastructure. We will rely on cooperating nutrient research projects to supply information regarding nutrient and energy flow at other trophic levels. If necessary, we will cooperate with other entities to do such research but funding will have to come from outside this project's Accord funding.

Decision Protocol

Adaptive management is a key feature of this project. Stream selection will involve preliminary measurement of stream chemistry to identify stream pairs with similarities in nutrient limitations and other factors that influence fish production. For this pilot project, we will target 5-15 km reaches in streams with average summer base flow of <10 m^3/s. There are seven key questions for each stream (Ashley and Stockner 2003), some answerable now, some to be determined during the project.

Question	Answer
Nutrient additive	Inorganic or organic fertilizer
Application technique	Slow-release inorganic pellets or carcass analogs
Seasonal timing	June - September
Addition frequency	Once annually
Desired concentration	Specific to stream, depends on stream chemistry
Nitrogen:phosphorus ratio	Specific to stream, depends on stream chemistry
Application locations	Specific to stream; depends on effective treatment length

Most streams in central Idaho are limited by nitrogen concentrations. Servicing liquid nitrogen delivery systems is logistically intensive and would add considerably to the Clean Water Act/NEPA regulatory burden. Slow-release pellets are logistically desirable for remote locations, as are fish meal packets or carcass analogs. We will test feasibility of likely products but preference will be given to organic alternatives.

A list of candidate study streams will be generated and evaluated in several sequential steps (Figure 4). We will start from a list of all steelhead-bearing streams in the Clearwater drainage. This list will be reduced, based on presence of potentially confounding factors (e.g., hatchery influence and habitat problems). The list will be further reduced by other factors, such as appropriate size and accessibility. Then, the list will be prioritized based on existing data relevant to steelhead production. The foregoing steps can be done in the office during project set-up, field evaluations. Field evaluations during summer 2012 will focus on collecting more specific confirmatory data. Field visits will consist of grab samples for water quality parameters, flow estimation, preliminary assessment of fish densities and age structure (if no previous data exist). From the preliminary assessments, candidates will be retained or discarded according to nutrient limitation, flow and stream length. Potential nutrient limitation will be assessed according to Table 3. Lastly, the most appropriate study pairs will be determined according to proximity and similarities in fish production, chemical parameters and habitat.

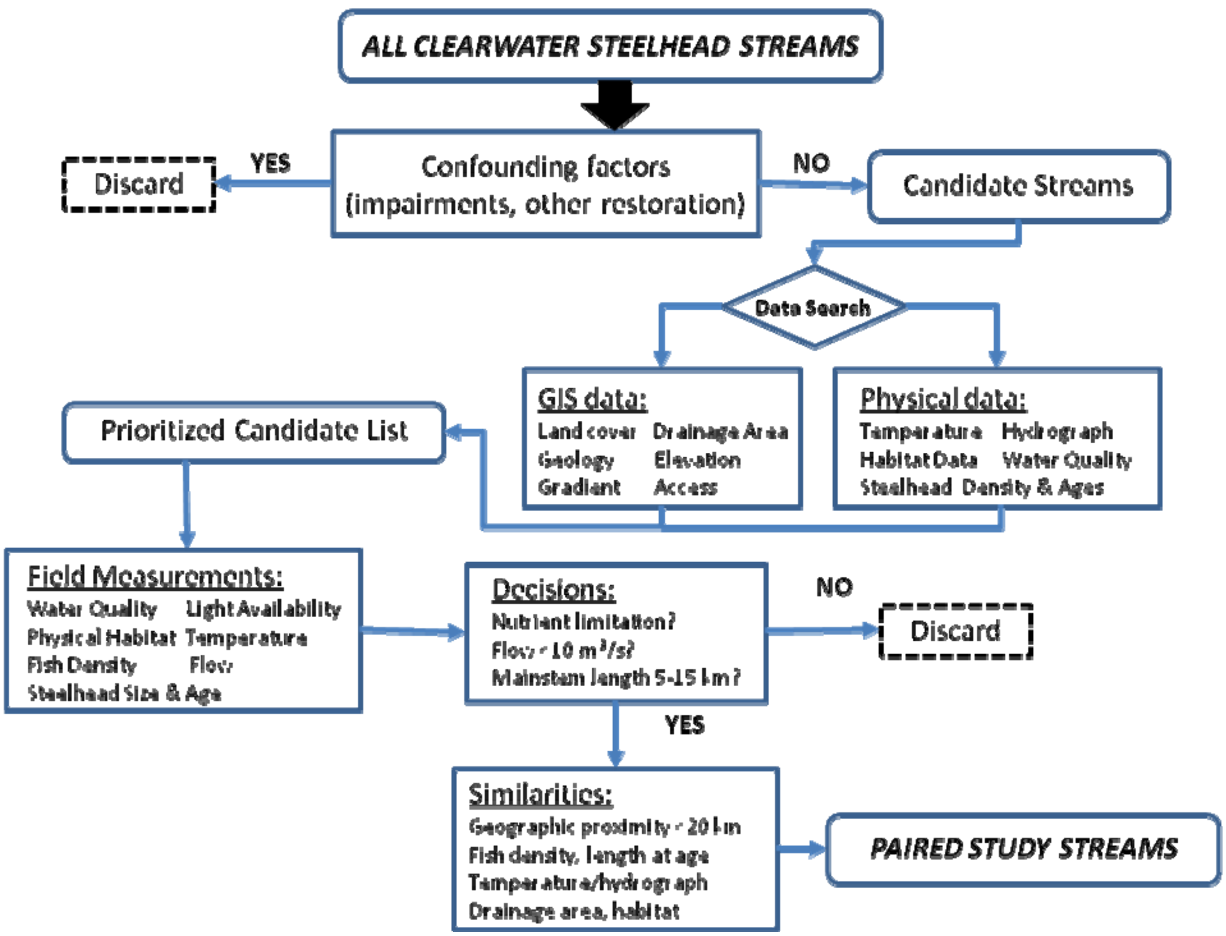

Figure 4. Pathway for developing appropriate pairs of study streams.

Table 3. Preliminary rules for assessing stream nutrient limitations (based on Snyder et al. 2002, Ashley and Stockner 2003, and Thomas et al. 2003). DIN = dissolved inorganic nitrogen, SRP = soluble reactive phosphorus.

Limitation type	Nutrient concentration	Molar N:P ratio
N limitation	DIN <20 µg/l	<10
P limitation	SRP <1 µg/l	>20
N+P co-limitation	DIN <20 µg/l, SRP <1 µg/l	10-20

Once candidate streams are chosen, we will develop a fertilizer application program appropriate for each stream. Natural fertility often changes between watersheds. Too much or an inappropriate fertilizer formula can lead to toxic conditions and the growth of harmful algae. Ashley and Stockner (2003) recommend 1-2 seasons of pretreatment water quality sampling to develop a treatment regime. Preliminary data will be collected during 2012 and more focused work will take place in 2013 to develop the stream-specific prescriptions. Nutrient limitations determined as per Table 3 will be confirmed by nutrient diffusing substrate experiments (Tank et al. 2007 as modified by Marcarelli et al. 2009 and Sanderson et al. 2009). Target nutrient levels will be 30-50 µg/l of dissolved inorganic nitrogen and 3-5 µg/l of soluble reactive phosphorus (see Ashley and Stockner 2003); nutrient additions are a function of the desired increase in nutrient concentration, treatment time period, and volume of flow during the treatment period. Corrections will need to be applied for actual concentration of nutrients in fertilizer and dissolution/uptake rates in the stream. Target treatment levels will remain constant for the life of the project; note that the target is nutrient concentration in the stream, not the amount of fertilizer added. After treatment starts, effective treatment length must be measured as this parameter determines the number and location of treatment sites within a stream. This information allows adaptive management of the treatment program. Initially, we will assume an effective treatment length of 5 km (so there will be 1-3 treatment sites) but this parameter depends on stream size and flow (Ashley and Slaney 1997) and should be measured. Additionally, treatment length monitoring will show the likelihood of exporting excess nutrients from treatment streams. These and the above concerns are addressed by Work Elements E through G. IDFG will work with the IDEQ Lewiston Regional Office to recruit IDEQ staff to assist in sampling and laboratory analysis.

Routine water quality monitoring and tracking pellet dissolution and retention rates will provide important information for planned large-scale efforts. Fertilizer performance must be verified as has been done rigorously in British Columbia waters prior to widespread application (e.g, Sterling et al. 2000; Sterling and Ashley 2003). This will occur during 2012 with any follow-up work in 2013. Several types of fertilizer should be tested in small-scale experiments to identify the most suitable product for future use. Samples should be checked for harmful metals, especially inorganic fertilizers (Ashley and Stockner 2003). Some of this work is currently underway by project 200733200 (Table 2; Scott Collins, Idaho State University, personal communication). During treatment, physical fertilizer performance will be followed by observations of treatment reaches to track dissolution rates and movement.

Water Quality and Nutrient Limitation Measurements

Permit requirements usually include regular monitoring of water quality. Samples will be sent to the IDEQ laboratory for analysis by standard methods. Values to be measured include total alkalinity, nitrite, nitrate, soluble reactive phosphorus, total nitrogen, and total phosphorus. Ammonia is usually undetectable in well oxygenated streams (Thomas et al. 2003), so we will not test for it. Detection levels need to be sensitive: <1 µg/l for phosphorus and 2 µg/l for nitrogen. Water samples will be taken from the thalweg in a run or riffle to ensure the sample is well-oxygenated and mixed. A non-reactive plastic or glass bottle will be rinsed three times, filled, then stored on ice until analysis using standard methods. If analysis will not occur within 48 hours, samples will be frozen.

Effective treatment length will be determined from analysis of chlorophyll a on artificial substrates placed systematically just above and at regular intervals below a treatment site (modified from Pringle and Triska 2007). Clean closed-cell sheets of foam will be attached to bricks and deployed in riffles. Time series samples will be taken by punching out a core weekly during the first month after treatment. Samples will be placed on ice in the field and frozen upon return to the office until cores can be analyzed at the IDEQ laboratory. As a low-cost alternative, algal growth can be determined by visual comparison of core samples, using a core from a non-treated area and clean foam as standards.

Nutrient diffusing substrate experiments will be run to confirm nutrient limitations. Fabrication and methods will follow Tank et al (2007), as modified by Marcarelli et al. (2009) and Sanderson et al (2009). Briefly, racks are constructed holding replicate vials containing silica discs and agar amended with nitrate and phosphate. Treatments will be nitrate-amended, phosphate-amended, combined treatment, and un-amended control. There should be at least 5 replicates of each treatment per rack. Racks will be deployed in run habitats in each stream within 1 km of a treatment site. After treatment begins, a rack will be deployed above the upper-most treatment site to act as another control. Vials will be analyzed for chlorophyll a (or alternatively ash-free dry mass of periphyton) as a measure of algal biomass (Steinman et al. 2007). Significant differences among treatments in algal biomass will determine limitation status as per Tank et al. (2007): N-limited, P-limited, N+P limited, primary N-limited with secondary P-limitation, primary P-limited with secondary N-limitation, or not limited. Depending on costs, experiments may be run monthly during the treatment season (June-September).

Steelhead Population Monitoring

The ultimate goal of this project is to increase freshwater productivity of Idaho's steelhead populations; therefore, the primary measures of project success will be variables known to influence population production of steelhead smolts: length at age, natal stream density, and survival to Lower Granite Dam. These will be measured by cohort during the study period. Ancillary data collected will include densities of other salmonids inhabiting the study streams. Most emigrating juvenile steelhead in Idaho leave their natal streams after temperatures cool in the fall or during high flows in the spring. To enhance data collection efficiency and for safety, fish sampling will be conducted during the late summer and early fall months. Collection and interpretation of fish data are covered by Work Elements H through L.

Snorkel surveys will be used to measure densities of all salmonids in the study streams during July and August. Survey protocol is based on the established methods employed by INPMEP since the 1980s (Petrosky and Holubetz 1985). All salmonid species observed will be enumerated by length group. Site selection will be based on the generalized random-tessellation stratification (GRTS) design (Stevens and Olsen 2004). A list of all potential sites in the Clearwater and Salmon basins was obtained from personnel in the Environmental Protection Agency office in Corvallis, Oregon. These sites were plotted on a 1:100,000 stream layer and their order randomized by EPA. The desired average site length is 100 m. Actual site bounds may be adjusted to fit within hydraulic controls. The percentage of each habitat type (pool, pocket water, riffle, or run) within the site is visually estimated and recorded. One to five snorkelers count fish in each site, depending on the stream size and visibility. All salmonids observed are counted and individual size is estimated to the nearest inch while moving slowly upstream. Chinook salmon parr are assigned an age based on length. Nonsalmonid species observed are noted as present. After each site is snorkeled, site length and up to ten widths are measured to calculate surface area. Gross habitat characteristics are also evaluated. The efficiency of the crews at detecting juvenile steelhead will be evaluated at a subset of sites. A protocol modified from Thurow et al. (2006) was designed to allow us to estimate efficiency through observation of marked individuals. Briefly, juvenile steelhead are caught (by angling), measured, marked (caudal notch), and released within the selected site. The next day, snorkeling will begin approximately 50 m downstream of the main transect and number of marked fish will be recorded. Then, the main section will be snorkeled and all salmonids counted by length group. Finally, a section approximately 50 m in length upstream of the main section will be snorkeled and number of marked fish recorded. The habitat variables described by Thurow et al. (2006) are measured in the target section. A minimum of 20% of the sites sampled will be assessed for crew efficiency and steelhead densities will be corrected for average efficiency. An alternative to GRTS site selection is to use Hankin and Reeves' (1988) habitat-based approach within the study reaches.

Individual fish data will be collected and PIT tags placed during September in order to capture the bulk of the growing season and before juvenile emigration occurs. Wild steelhead trout juveniles will be captured by angling with artificial flies throughout the study reach. Each angler will carry a five-gallon bucket half filled with water to store captured fish temporarily. Fish will be transferred from buckets to submerged perforated plastic live-boxes placed at approximately 1 km intervals throughout the stream. Captured fish will be held in live-boxes overnight and tagged the following morning. The delay allows the fish to recover from collection stress and provides the coolest water temperatures for tagging. We will anesthetize the fish and inject PIT tags into the body cavity using a 12-gauge hypodermic needle and modified syringe. Needles and PIT tags are sterilized by soaking in a 70% alcohol solution for at least 10 min before tagging. During tagging, fish will be measured to fork length (nearest mm) and a scale sample taken from the area above the lateral line and just posterior to the dorsal fin. After tagging, fish will be returned to a live-box and allowed to recover at least 1 h before release. At the completion of fieldwork, project personnel will upload PIT tag data to the Columbia River Basin PIT Tag Information System (PTAGIS; www.ptagis.org). Additional fish may be collected using minnow traps but fish <80 mm will not be tagged.

Data Analyses

For each study population, we will estimate the primary measures of project success: length at age, natal stream density, and survival to Lower Granite Dam. Natal stream density will be expressed as average number per 100 m^2. Mean length at age for each stream will be based on ages assigned from scales collected during tagging activities. Survival from natal stream to Lower Granite Dam will be estimated using a Cormack-Jolly-Seber model implemented by SURPH software (Lady et al. 2010). Model inputs are records of tagged fish released and detections of these fish in the Columbia River hydrosystem. Model outputs are probabilities of detection at and survival to Lower Granite Dam.

The basic study design is Before-After Control-Impact in which study sites are paired. Given that one site is a good replicate for another, the parameter of interest for statistical analysis is the difference between values measured at a treatment site versus its control ($x_i - x_c$) or the log of their ratios if the error structure is multiplicative ($\ln(x_i/x_c)$; Smith 2002). A treatment effect is found when there is a significant change in site differences between the Before and After periods, i.e., the null hypothesis is that differences remain constant. Given enough degrees of freedom, site differences can be modeled with covariates to account for external variables influencing parameter estimates, e.g., parental abundance, flow, and temperature. Temperature and flow are important because they determine the realized treatment effect and parental abundance determines whether the stream is fully seeded with progeny or not. There are several weirs that collect wild adult steelhead in the Clearwater River drainage (Potlatch River in the lower basin, Fish Creek in the Lochsa watershed and Crooked River in the South Fork Clearwater drainage). Adult abundance at the nearest weir will be used as an index to actual number of spawners for each study stream pair. Temperature and flow will be measured in each study stream. Adult abundance index, temperature, and flow will be evaluated as covariates.

To guide project planning, we conducted rough *a priori* power analyses for each of the primary measures. The objective was to determine likely detectable effect sizes and sample sizes needed; desired power was defined as 80% and acceptable risk of a Type I error was set at 10% (Peterman 1990).

Length at age was the most sensitive parameter, based on lengths of age-1 steelhead collected in Fish Creek in September 2009. Mean length was 122.4 mm with a standard deviation of 14.1 mm. To detect a significant change of 2%, approximately 300 samples are required. We intend to collect 500-1,000 fish per stream for PIT tagging, so there should be excellent power for evaluating this parameter.

Densities computed from snorkel data are more variable and only much larger effect sizes will be detectable. We used data from GRTS sites snorkeled in five streams in the Lochsa and South Fork Clearwater basins during 2007-2009. Standard deviations were negatively correlated to observed densities. We used this relationship to predict standard deviation over a range of likely densities and computed number of sites needed at a particular density to detect an effect (Figure 5). Typically, 30-40 sites can be completed in a week, so it is likely we could detect effects >50%. This prediction is conservative because densities in this power calculation were not corrected for probability of detection and included more variable headwater sites that would be excluded from this study.

Lastly, we used Hinrichsen's (2010) on-line power calculator for survival experiments (www.onefishtwofish.net/baci) to examine the ability of the proposed study design to find survival differences between treatments and controls. To look at correlations between populations in survival and variances from time series, we used data on young Chinook salmon tagged at Marsh Creek and Sawtooth, 35 km apart (no comparable adjacent data series exist for steelhead in Idaho). The correlation coefficient was approximately 0.70 and variance ranged from 0.04 to 0.29 depending on life stage and time period. Measurement errors are usually low for releases >500 (D. Venditti, Idaho Supplementation Studies, unpublished data), so we assumed an error of 0.03, one year of pretreatment data and four years of post-treatment data. For the range of variances observed, power is adequate for an effect size of ≥35% (Figure 6A). Because the selection criteria for stream pairs specify a maximum distance of 20 km (Figure 4), correlations among study streams likely will be greater than that between Marsh Creek and Sawtooth. As the correlation among study streams increases, it is likely we will be able to detect effects as small as 20% (Figure 6B).

The sampling and analytic strategies proposed give this study design power to detect effect sizes adequate for making informed management decisions. There is good power to detect increases in length at age and survival to Lower Granite Dam; power to detect changes in densities is not as good but we believe the analysis was conservative and actual power will be greater. Monitoring several variables and employing a flexible analytic approach will have a synergistic effect on power (Hewitt et al. 2001), which is not reflected in the separate analyses above. Additionally, data from nearby indicator populations, such as Fish Creek and Crooked River, may also be used as supplemental references, which will increase power (Underwood and Chapman 2003) beyond that for the design used in these analyses.

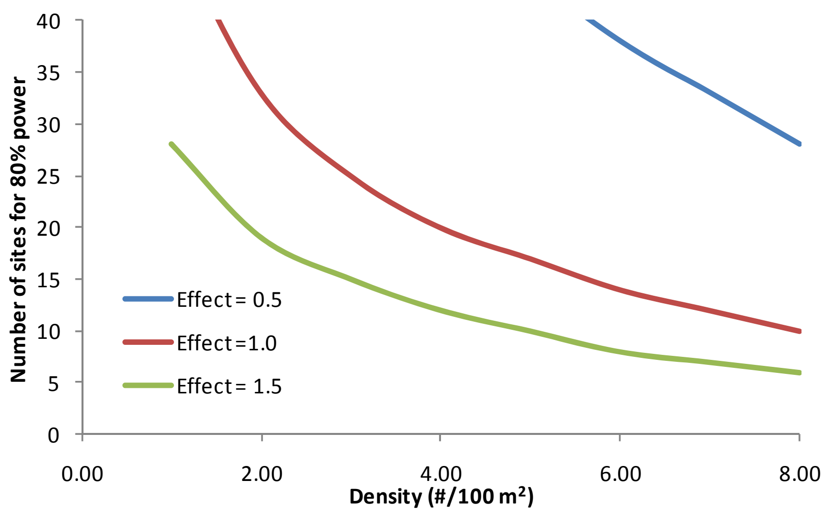

Figure 5. Number of snorkel sites at a range of densities for 80% power at three effect sizes.

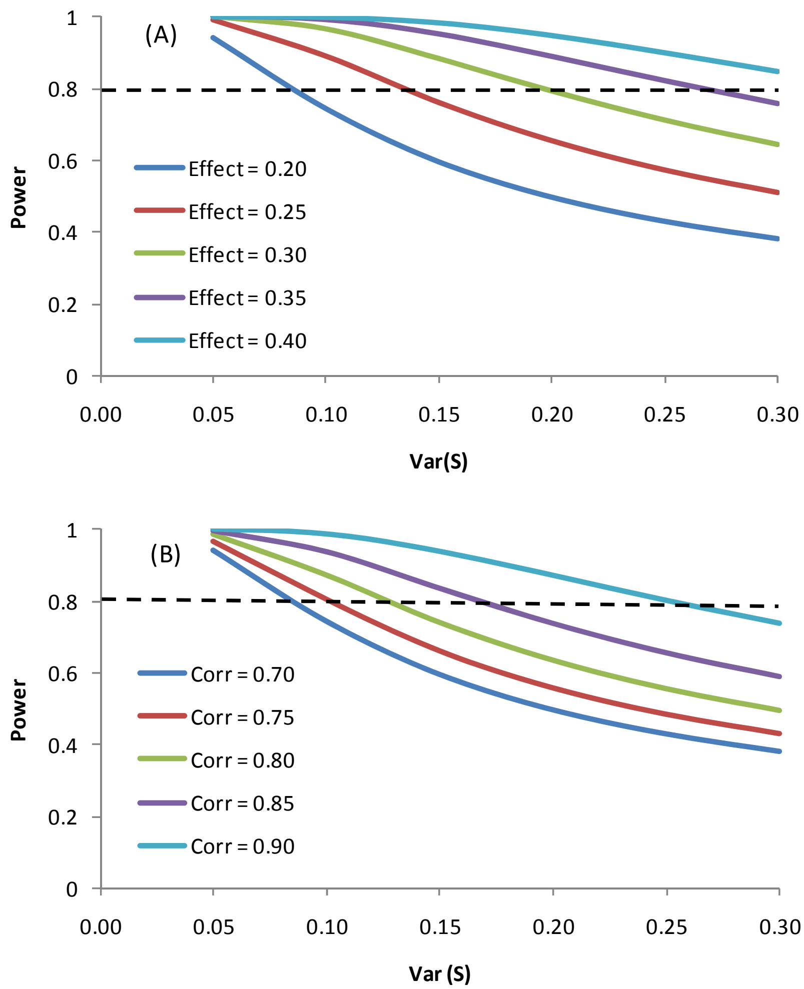

Figure 6. Power to detect differences in juvenile steelhead survival (based on surrogate Chinook data) over the observed range of variances. (A) Power to detect effect sizes, given a population correlation of 0.70. (B) Power to detect an effect of 20%, assuming a range of correlations. In both panels, 80% power is shown by the dashed line.

H. Facilities and equipment

The personnel, equipment, and infrastructure of IDFG will be used to do this research. Project field personnel will live in existing IDFG structures, trailers, or camping equipment. Items that need to be replaced due to wear or use will be included in the yearly Operations & Maintenance or Capitol Outlay budget. Water quality analyses will have to be contracted out. IDFG has enough existing office space for the personnel of this project.

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Wipfli, M. S., J. P. Hudson, and J. P. Caouette. 1998. Influence of salmon carcasses on stream productivity: response of biofilm and benthic macroinvertebrates in southeastern Alaska, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences 55:1503-1511.

Wipfli, M. S., J. P. Hudson, D. T. Chaloner, and J. P. Caouette. 1999. Influence of salmon spawner densities on stream productivity in Southeast Alaska. Canadian Journal of Fisheries and Aquatic Sciences 56:1600-1611.

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J. Key personnel

Idaho Governor's Office of Species Conservation

The IOSC is an agency within the Executive Office of the Governor charged with the responsibility to coordinate all state departments and divisions with duties and responsibilities affecting petitioned and listed species under the federal Endangered Species Act (ESA). IOSC has been tasked by Idaho's Governor with coordinating the state's salmon and steelhead projects, including all of Idaho's Accord Projects. IOSC works in cooperation with all of Idaho's natural resource agencies. IOSC provides oversight to all Accord projects, whether or not those projects are contracted directly through IOSC. This includes budgetary review and technical support as needed.

Funding for IOSC's salmon and steelhead recovery projects is provided by BPA, Pacific Coast Salmon Recovery Fund (PCSRF) and the Snake River Basin Adjudication (SRBA). IOSC's Anadromous Fish Program Manager, Mike Edmondson, provides oversight to all three of these programs. IOSC employs a project manager for each of the three funding programs. These individuals report directly to the Anadromous Fish Program Manager. Amy Hines is the Project Manager assigned to BPA programs. Information for both Mike Edmondson and Amy Hines follows.

Mike Edmondson

For this proposed work, Mike Edmondson's role will be technical contact for IOSC in the permitting phase. FTE = .15.

Since August 2008, Mike Edmondson has served as the Anadromous Fish Program Manager for the Idaho Office of Species Conservation (OSC). Mike brings more than a decade of experience administering federal programs. Mike came to OSC with a background of 14 years with the Idaho Department of Environmental Quality working on surface water quality and forestry issues. Mike has co-authored Total Maximum Daily Loads; served on the Idaho Forest Practices Act Advisory committee (the rule making committee for forestry rules); authored the 1998, 2002, and 2008 Clean Water Act §303(d) Impaired Waters Reports and the 2002 and 2008 §305(b) Reports collectively known as the Integrated Reports. Mike lead Idaho's stream monitoring program from 1996 through 1998 overseeing ambient biological data collection on 2,552 stream data collection sites. Mike has held scientific collection permits for electrofishing and collected fish abundance and fish tissue data from streams, lakes, and rivers.

Professional Experience

Anadromous Fish Program Manager, Idaho Office of Species Conservation, 2008-Present
Scientist 3: 303(d)/305(b) Program Manager, Idaho Department of Environmental Quality (DEQ), Boise, Idaho, 2001-2008
Water Quality Science Officer: 303(d)/305(b) Program Manager, Idaho DEQ, Boise, Idaho, 1998-2001

Water Quality Science Officer: Beneficial Use Reconnaissance Program (BURP) Manager, Idaho DEQ, Boise, Idaho, 1996-1998
Environmental Sciences Specialist: Cascade Reservoir Project Idaho DEQ, Boise, Idaho, 1995-1996
Environmental Sciences Specialist: Tri-State Mining Project, Idaho DEQ, Boise, Idaho, 1994-1995

Education

California Polytechnic State University, San Luis Obispo
Degree: Bachelor of Science (Conferred June 1994)
Major: Ecology and Systematic Biology with concentration in Ecology (aquatic)

Publications

- 2008 Integrated Report. DEQ 2009
- Idaho Forest Practices Act Quadrennial Audit Work Plan. DEQ 2008.
- Policies and Procedures Document. DEQ 2008
- 2002 Integrated Report. DEQ 2005
- Policies and Procedures Document. DEQ 2002.
- New Mayfly (Ephemeroptera) Records from Idaho. Lester, G.T., McCafferty, W.P., and Edmondson, M.R., Entomology News 113 (2): 131-136, March & April, 2002.
- Level IV Ecoregions of Idaho. McGrath C.L., Woods A.J., Omernik, J.M., Bryce, S.A., Edmondson, M., Nesser, J.A., Shelden, J., Crawford, R.C., Comstock, J.A., and Plocher, M.D., 2002, Ecoregions of Idaho (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey
- 1998 303(d) List. DEQ 2000
- Tri-State Field Sampling Manual. Edmondson, M.R., DEQ 1995

Amy Hines

For this proposed work, Amy Hines' role will be administrative oversight. FTE = .15.

Since December 2008, Amy Hines has worked as a Project Manager for the Idaho Office of Species Conservation. Amy provides administrative and technical support to federal, state and private partners pertaining to BPA assistance programs. This role requires Amy to provide oversight of BPA-funded contracts and any associated subcontracts.

Amy has duties that include coordination of the ISRP process and narrative submission, contracting, completing statements of work within BPA's Pisces software, tracking funding for OSC's BPA-funded projects, as well as subcontracting duties required for all BPA-funded projects at OSC. Amy does the BPA-related invoicing, payments, and reporting.

Professional Experience

Project Manager, Idaho Office of Species Conservation, Boise, Idaho, 2008-present.
Grants/Contracts Program Specialist, Idaho State Department of Agriculture, Boise, Idaho, 2007 – 2008.
Technical Writer, Idaho State Department of Agriculture, Boise, Idaho, 2004-2007.
Grants Coordinator, Idaho State Department of Agriculture, Boise, Idaho, 2003-2004.
Consultant, Boise, Idaho, 1998-2003.
Research Assistant Internship, Idaho Council on Industry and the Environment, Boise, Idaho, 1998.
Research Assistant, Idaho Geological Survey, Moscow, Idaho, 1996-1997.

Education

University of Idaho
Degree: Bachelor of Science (December 2009)
Major: Environmental Science, Physical Science Option.

Relevant Professional/Technical Courses completed:
Subawarding for Pass-Through Entities, Management Concepts, 2008.
Managing Federal Grants and Cooperative Agreements for Recipients, Management Concepts, 2008.
Project Management I & II, Executrain, 2004.

Idaho Department of Fish and Game

Timothy Copeland

For this proposed work, Tim Copeland's role will be study design, data analysis, and co-authoring reports. FTE = 0.08

Tim Copeland is the Project Leader for the Idaho Natural Production Monitoring and Evaluation Project and the Idaho Steelhead Monitoring and Evaluation Studies. He has the primary responsibility for data analysis, report writing and oversees the operations of both projects. Tim has spent most of his career conducting fish population assessments for management purposes. Beyond the publications listed below, he has written over 50 technical management reports and outlined a fisheries management program for Fort A.P. Hill in Virginia. His graduate research has emphasized the population-level implications of fish physiology.

Professional Experience

<u>Senior Fisheries Research Biologist</u>, Idaho Dept of Fish & Game, Nampa ID, 2004-present.
<u>Fishery Ecologist</u>, Conservation Management Institute, Blacksburg VA, 2003-2004.
<u>Graduate Research Assistant</u>, Dept of Fisheries & Wildlife Sciences, Virginia Tech, Blacksburg VA, 1997-2003.
<u>Fisheries Technician</u>, Pennsylvania Fish & Boat Commission, Sweet Valley PA, 1989-1997.

Education

Ph.D., Fisheries & Wildlife Science, Virginia Polytechnic Institute & State University (2004).
M.S., Wildlife & Fisheries Science, The Pennsylvania State University (1996).
B.S., Wildlife Science, The Pennsylvania State University (1987).
B.S., Environmental Resource Management, The Pennsylvania State University (1987).

Certification

Certified Fisheries Professional, American Fisheries Society (2003).

Selected Publications

Copeland, T., and D.A. Venditti. 2009. Contributions of three life history types to smolt production in a Chinook salmon population. Canadian Journal of Fisheries and Aquatic Sciences 66:1658-1665.

Copeland, T., C.C. Kozfkay, J. Johnson, and M.R. Campbell. 2009. Do dead fish tell tales? DNA degradation in Chinook salmon (*Oncorhynchus tshawytscha*) carcasses. Northwest Science 83:140-147.

Copeland, T., B.R. Murphy, and J.J. Ney. 2008. A comparison of relative weight and nutritional status among four fish species in two impoundments. Journal of Freshwater Ecology 23:373-386.

Copeland, T., B.R. Murphy, and J.J. Ney. 2008. Interpretation of relative weight in three populations of wild bluegills: a cautionary tale. North American Journal of Fisheries Management 28:368-377.

Copeland, T., M.W. Hyatt, and J. Johnson. 2007. Comparison of methods used to age spring-summer Chinook salmon in Idaho: validation and simulated effects on estimated age composition. North American Journal of Fisheries Management 27:1393-1401.

Other IDFG Personnel:

As the project start dates approaches, IDFG will identify a fisheries biologist to provide oversight of daily operations. FTE = 1.0.

Idaho Department of Environmental Quality

John Cardwell

For this proposed work, John Cardwell's role will be to coordinate water quality permitting and to assist in determining suitable waters for the project. FTE = 0.25

As a Regional Water Quality Program Manager for the IDEQ, John Cardwell supervises professional and seasonal staff conducting water quality monitoring, analyses, and management plan development with public advisory groups. He plans and implements program work, scheduling and budgeting.

Professional Experience
Regional Water Quality Program Manager, Idaho Department of Environmental Quality, 1991 - present.

Groundwater Quality Specialist, Oregon Department of Environmental Quality, 1988 – 1991. Developed and implemented area wide ground water management programs.

Geologist, Riedel Environmental Services, Portland, Oregon, 1985 – 1988. Emergency response contractor for mitigation of hazardous material and wastes.

Geologic Engineer, Pittsburgh Testing Laboratory, Oregon and Utah, 1982 – 1985. Geologic Engineer, structural building inspector, technical analyses and site inspection of building materials.

Bureau of Reclamation, Columbia Basin Irrigation Project, Ephrata, Washington, 1979 – 1981. Conducted subsurface and ground water investigations projects.

Education
Washington State University, Pullman, Washington
Bachelor of Science, Geology, 1982

Spokane Falls Community College, Spokane, Washington
Associate of Arts, Liberal Arts, 1978

Continuing Education Credits: Supervisory and public management; environmental remediation, hydrology, monitoring; software – word, excel, access, powerpoint.

Other personnel will be determined as the project date nears.

ATTACHMENT 1

STATE OF IDAHO
DEPARTMENT OF
ENVIRONMENTAL QUALITY

1410 North Hilton • Boise, Idaho 83706 • (208) 373-0502

C.L. "Butch" Otter, Governor
Toni Hardesty, Director

November 13, 2009

Michael Edmondson
Idaho Office of Species Conservation
P.O. Box 83720
Boise, ID 83720-0195

RE: Idaho Department of Fish and Game Nutrient Enhancement Project – Application of the Idaho Water Quality Standards

Dear Mr. Edmondson:

The Idaho Office of Species Conservation, through the Idaho Department of Fish and Game, is proposing to conduct a nutrient enhancement project in the Clearwater subbasin. The Idaho Department of Environmental Quality (DEQ) understands that nutrients (in the form of slow-release fertilizer pellets or carcass analogs) will be added to various streams during the growing season. DEQ has previously worked with the Idaho Department of Fish and Game on a similar proposal for Dworshak Reservoir.

This activity could result in a violation o the Idaho Water Quality Standards (WQS), including without limitations, IDAPA 5801.02.080.01. However, nutrient addition projects conducted specifically for providing ecological benefits to the receiving water bodies are likely to promote the public interest and unlikely to result in any permanent or long-term injury of the beneficial uses. As such, DEQ and either Idaho Department of Fish and Game or the Office of Species Conservation may enter into a voluntary consent order authorizing this project under the short term activity exemption provisions (IDAPA 58.01.02.080.02) of Idaho's WQS. Because the WQS define "short term activity" as being no more than one year, it would be necessary to seek authorization pursuant to IDAPA 58.01.02.080.02 annually.

Idaho does not have primacy for the National Pollutant Discharge Elimination System (NDPES) program. Therefore, we recommend that you contact the Environmental Protection Agency regarding potential Clean Water Act Section 402 permitting requirements for your project. If EPA determines that an NPDES permit is required, DEQ will not issue an authorization pursuant to IDAPA 58.01.02.080.02. Rather, DEQ will provide a Section 401 water quality certification of the NPDES permit.

If you have additional questions or concerns, please contact Johnna Sandow via telephone (208.373.0163) or email (Johnna.Sandow@deq.idaho.gov).

Sincerely,

Barry M. Burnell

Barry N. Burnell
Water Quality Division Administrator

BNB:JS:bmm

c. Doug Conde, Idaho Office of Attorney General
John Cardwell, Lewiston Regional Office

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