PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project Evaluate a Modified Feeding Strategy to Reduce Residualism and Promote Smolting of Dworshak Juvenile Steelhead in the Clearwater River in Idaho	
BPA project number	**20080**
Contract renewal date (mm/yyyy)	
Multiple actions? (indicate Yes or No)	
Business name of agency, institution or organization requesting funding Idaho Fishery Resource Office, U.S. Fish and Wildlife Service	
Business acronym (if appropriate)	**IFRO-USFWS**
Proposal contact person or principal investigator:	
Name **Mailing address** **City, ST Zip** **Phone** **Fax** **Email address**	**Ray N. Jones** **P.O. Box 18** **Ahsahka, Idaho 83521** **(208) 476-7242** **208-476-7228** **Ray_Jones@fws.gov**
NPPC Program Measure Number(s) which this project addresses ***5.7A.4, 5.7B.17, 7.2D.1, and 7.2D.3***	
FWS/NMFS Biological Opinion Number(s) which this project addresses Endangered Species Act Section 7 Biological Opinion on 1995-1998 Hatchery Operations in the Columbia River Basin, Consultation Number 383, April 5, 1995. Section VIII, Number 1 (page 66).	
Other planning document references This proposal addresses the following action items in the National Marine Fisheries Services recommendations in their **Proposed Plan for Snake River Salmon**: Task 4.4.a, develop an index of measures to evaluate smolt quality and improve adult returns"; Task 4.4.c, "...design and carry out production-scale experiments at appropriate Columbia River Basin hatcheries to test individual release strategies and evaluate smolt quality indices believed to improve smolt quality", and Task 4.5.b, "...release steelhead smolts that are 170 to 220 mm in total length". This type of research has also been called for by **IHOT** and the **Artificial Production Review.**	
Short description Reduce residualism and improve smoltification of steelhead using a modified feeding strategy designed to stimulate smoltification, reduce residualism, increase emigration success, reduce interactions with wild fish, and increase adult returns.	
Target species **Summer Steelhead (***Oncorhynchus mykiss***)**	

Section 2. Sorting and evaluation

Subbasin
Lower Snake River - Clearwater River Subbasin

Evaluation Process Sort

CBFWA caucus		CBFWA eval. process		ISRP project type	
X one or more caucus		If your project fits either of these processes, X one or both		X one or more categories	
X	Anadromous fish	X	Multi-year (milestone-based evaluation)		Watershed councils/model watersheds
	Resident Fish		Watershed project eval.		Information dissemination
	Wildlife				Operation & maintenance
					New construction
				X	Research & monitoring
					Implementation & mgmt
					Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description
20542	Biological Monitoring of Columbia Basin Salmonids
8740100	Assessment of Smolt Condition: Biological and Environmental Interactions

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
99-018-00	Characterize and Quantify Residual Steelhead in the Clearwater River, Idaho	Not dependent but very closely related in that both projects are attempting to address the issue of residualism of juvenile steelhead at Dworshak NFH.

		Fish released by this project can contribute additional data to Project 99-018-00. Collections of our fish by Project 99-018-00 will provide additional information for our project as well.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
FY98	Completed unfunded pilot study*	Completed all objectives

*Preliminary unfunded pilot work was completed during FY 98. The project was successful in altering the growth rate of steelhead and compensatory growth occurred. Performance of treatment group equaled or exceeded the control group in most measures.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Increase the proportion of juvenile steelhead that exhibit characteristics of smoltification prior to release from the hatchery.	1a	Manipulate growth rate of selected groups of steelhead using a feeding schedule designed to decrease growth over winter and increase growth during spring.
		1b	Calculate monthly growth rates for treatment and control groups and determine the relationship between growth rate and smoltification.
		1c	Evaluate smolt condition of steelhead on altered feeding schedule during rearing and at release: monitor condition factor, mucus lysozyme, gill sodium, potassium ATPase, skin

Obj 1,2,3	Objective	Task a,b,c	Task
			reflectance, and total body fat.
		1d	Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.
2	Increase the proportion of steelhead smolts that successfully emigrate to downriver dams on the Snake and Columbia Rivers.	2a	Mark representative groups of treatment and control steelhead smolts with PIT tags prior to release.
		2b	Interrogate PIT-tagged emigrants using the PTAGIS database system .
		2c	Analyze relationship between modified feeding strategy, physiological development, and emigration success.
		2d	Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.
3	Increase the proportion of steelhead smolts that successfully rear during extended seawater rearing .	3a	Transfer individuals from treatment and control groups to seawater rearing tanks to monitor extended seawater survival.
		3b	Monitor health and smolt condition of fish held in seawater using gill ATPase, total body fat analysis, and necropsy-based fish health assessment.
		3c	Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.
4	Increase the proportion of smolts that survive to return as adults to the hatchery.	4a	Mark 20,000 fish in each treatment and control pond with coded-wire tags prior to release.
		4b	Scan all returning adult steelhead at the hatchery for coded-wire tags for tag extraction and decoding.
		4c	Analyze coded-wire tag returns for statistical differences between treatment and control groups.
		4d	Prepare annual progress reports that summarize data and prepare a final

Obj 1,2,3	Objective	Task a,b,c	Task
			project report summarizing results and findings.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	10/2003			40%
2	10/1999	10/2003			30%
3	10/1999	10/2003			10%
4	5/2002	10/2007			20%
				Total	100%

Schedule constraints
Flow conditions in the spring may have an effect on PIT-tag detection rates at Lower Snake and Columbia River dams.
Completion date
2003 for production research 2007 for adult return monitoring and final report completion.

Section 5. Budget

FY99 project budget (BPA obligated):	$

FY2000 budget by line item

Item	Note	% of total	FY2000 ($)
Personnel		23.1	38,800
Fringe benefits		4.6	7,900
Supplies, materials, non-expendable property	Field equipment, lab and office supplies	6.0	10,000
Operations & maintenance	Coded-wire and PIT tagging	9.5	16,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Laptop computer and software, digital camera	2.1	3,500
NEPA costs			
Construction-related support			
PIT tags	# of tags: 4000	6.9	11,600

Travel		4.5	7,500
Indirect costs		12.5	21,000
Subcontractor	USGS-BRD Salaries, Benefits, etc.	30.8	51,750
Other			
		TOTAL BPA REQUESTED BUDGET	168,050

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		Total project cost (including BPA portion)	

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	168,050	168,050	138,000	138,000

Section 6. References

Watershed?	Reference
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	Ban, M., H. Hasegawa, and K. Abe. 1995. Relationship between feeding rate and physiological quality in hatchery-reared juvenile chum salmon, Oncorhynchus keta. Sci. Rep. Hokkaido Salm. Hatch. Hokkaido Sake Masu Fukajo Kenpo 49:27-33.
	Bigelow, P.E. 1995. Migration to Lower Granite Dam of Dworshak National Fish Hatchery Steelhead. Pages 42-58 *in* Interactions of hatchery and wild steelhead in the Clearwater River of Idaho. United States Fish and Wildlife Service and Nez Perce Tribe. United States Fish and Wildlife Report. Fisheries Stewardship Project. 1994 Progress Report. Ahsahka, Idaho.
	Bigelow, P.E. 1997. Emigration of Dworshak National Fish Hatchery steelhead. Pages III-1 to III-22 *in* Interactions of hatchery and wild steelhead in the Clearwater River of Idaho. United States Fish and Wildlife Service and Nez Perce Tribe. United States Fish and Wildlife Report. Fisheries Stewardship Project. 1995 Progress Report. Ahsahka, Idaho.
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PART II - NARRATIVE

Section 7. Abstract

Reducing residualism for summer steelhead at Dworshak NFH will be addressed in a production level research project conducted jointly by the USFWS and the USGS-BRD. The project

addresses key components of the 1994 Columbia Basin Fish and Wildlife plan with regard to steelhead populations, specifically measures ***5.7A.4***, ***5.7B.17, 7.2D.1, and 7.2D.3.*** .

The project is intended to evaluate a modified feeding strategy designed to stimulate smoltification over a wider range of fish sizes, thereby reducing residualism and precocity. Manipulation of growth rates and smolt physiology will be effected by changing the feeding rate on a seasonal basis. The modified feeding schedule will be evaluated at the production level by monitoring growth, survival, emigration success, and adult returns of treatment groups compared to regular production control groups. Physiological development, smolt condition and health will be monitored during rearing, emigration, and extended seawater holding. Improved physiological condition, enhanced smoltification, increased emigration success, prolonged seawater survival, and increased adult returns will determine the effectiveness of the experimental treatment.

Section 8. Project description

a. Technical and/or scientific background

Dworshak National Fish Hatchery (NFH) is located at the confluence of the North Fork and the main stem of the Clearwater River near Ahsahka, Idaho. Construction of the hatchery was included in the authorization for Dworshak Dam and Reservoir (Public Law 87-847, October 23, 1962) to mitigate for losses of summer steelhead (*Oncorhynchus mykiss*) in the North Fork of the Clearwater River as a result of the construction of the dam and reservoir. The mitigation program calls for the release of about 2.3 million summer steelhead smolts into the Clearwater River each year.

Wide length frequency distributions are a common characteristic of juvenile steelhead at Dworshak NFH. Lengths often range from 80 to 240 mm (total length) by the time they are released as smolts. Research conducted by the Idaho Fishery Resource Office and Dworshak NFH indicates that a high proportion, as many as 25%, of the steelhead that are less than 170 mm at the time of release may not be migrating downriver to the ocean (Bigelow 1995, 1997). This does not conform to the Biological Opinion from the National Marine Fisheries Service (NMFS) on Hatchery Operations for 1996-1999 that calls for hatchery steelhead to be released at sizes between 170-220 mm (TL) in order to minimize residualization. The Draft Snake River Salmon Recovery Plan (SRSRP) recognizes that “Steelhead larger than 170 mm experience more complete parr-smolt transformation and are therefore more likely to actively migrate”. Fish larger than 220 mm are more prone to residualize (Partridge 1985, 1986; Cannamela 1992) and steelhead greater than 250 mm may be more capable of predation (Cannamela 1993).

Of particular concern is the potential interaction of residual steelhead with sensitive species such as the threatened Snake River fall chinook, spring and summer chinook, the threatened wild Snake River steelhead, or the threatened bull trout. Interactions include displacement, competition for food, and behavioral effects (Viola and Schuck 1995; McMichael *et al.* 1997). The primary objective of this project is to manipulate growth and smoltification to minimize the number of non-migrating hatchery summer steelhead released into the Snake River basin.

Hatchery managers may develop production strategies that produce steelhead that meet the SRSRP guidelines for size at release, but that does not necessarily insure an increase in the proportion of actively migrating steelhead smolts released. Hatchery practices can have a significant influence on the parr-smolt transformation process (Folmar and Dickoff 1980; Shrimpton *et al*. 1994), and need to be developed based on a knowledge of how they directly influence the growth, physiology, and behavior of steelhead leading up to and during smoltification. Previous studies to reduce growth in steelhead did not address the effects of changes in growth rate on smolt condition (Smith 1987; Klontz *et al.* 1991). Research with chinook salmon found that both the size of ration and feeding schedule may influence the peak of gill sodium, potassium-activated adenosine triphosphatase activity (ATPase)(Ewing *et al.* 1980).

We address the residualism issue from a completely different perspective, promoting the idea that the real need is to produce healthy, high quality, actively migrating steelhead smolts, regardless of size. Wild steelhead smolts outmigrating from the Snake River basin are generally smaller on the average than their hatchery counterparts. Many wild salmon stocks exhibit osmoregulatory competence at sizes much smaller than hatchery stocks (Zaporozhec and Zaporozhec 1993; Shrimpton *et al.* 1994). Naturally spawning stocks outmigrating from Columbia River tributaries exhibit a wide range of lengths and ages due to the harsh environment (Peven *et al.* 1994), providing further evidence that size alone does not control smoltification. At Dworshak NFH, a high proportion (about 25%) of steelhead less than 170 mm apparently fail to outmigrate. However, the remaining proportion <170 mm do outmigrate, strong evidence that size alone does not determine whether a particular juvenile steelhead will smolt. A review of the literature indicates that high variability in size (length) within a juvenile steelhead population is in part a product of social interactions, and the establishment of dominant and subordinate individuals, where dominants grow significantly faster than subordinates (Abbott and Dill 1989). This same phenomenon has been observed in Atlantic salmon populations (Symons 1970; Thorpe *et al.* 1992). Subordinate individuals in a population generally experience slower growth rates and higher levels of stress than dominant individuals. It is our contention that this situation leads to arrested development of subordinate individuals, and a failure to make the successful transformation from parr to smolt. Further literature review indicates that growth rate at the time of smoltification may be more critical in the parr-smolt transformation process than the absolute amount of growth that occurs (Whitesel 1991).

We propose to reduce wide length frequency distributions in steelhead at Dworshak NFH by changing growth and smoltification patterns by manipulation of growth rates prior to and during smoltification using a modified feeding strategy. The underlying assumption of this project is that manipulation of the feeding schedule during rearing will result in changes in growth during the parr-smolt transformation that will prompt more fish to migrate by promoting smoltification in a larger proportion of the production. Present guidelines assume that fish length is the primary variable responsible for successful smoltification. Evidence does indeed suggests that there is a critical size threshold that is important in the timing of seaward migration (Folmar and Dickoff 1980; Whitesel 1991). For steelhead, research indicates that salinity preference can be size and age dependent (Folmar and Dickoff 1980). Conte and Wagner (1965) concluded that steelhead less than 120 mm had not reached the critical or optimal size to have developed an effective osmotic and ionic regulating system. Their data suggests that the critical size for seaward migration in steelhead is about 140 to 150 mm.

Rearing practices within the hatchery can affect the onset of smoltification as well as the process of smoltification itself, and can have dramatic effects on the success of the parr-smolt transformation (Folmar and Dickoff 1980; Hansen *et al.* 1988). Therefore, to focus attention primarily on fish size alone disregards the complex interaction between growth and smoltification, and the need to develop a physiological approach for insuring a higher parr-smolt transformation rate for hatchery steelhead.

Accelerated growth and smoltification may be induced by photoperiod and temperature manipulation during experiments (see Hansen *et al*. 1989), but managing these variables at a large production hatchery is difficult. Altering the hatchery feeding regime may offer a management alternative for improving production. Low levels of ration have been found to alter feeding behavior (Dill 1983) and may provide a strategy to influence the social hierarchy in a hatchery population. Smaller daily rations have been shown to produce growth rates equal to rates with higher daily rations by improving feeding efficiency (Farmer *et al.* 1983). Ration levels have a pronounced effect on growth rates, but the rate of increase of growth rate and gross feed conversion efficiency decreases with increased rations (McCormick *et al.* 1989). Feeding rates ranging from 1 to 5 % body weight did not affect the physiological quality of hatchery reared chum salmon (Ban *et al.* 1995). We propose to stimulate the onset of smoltification over a wider range of the population by sustaining a lower growth rate prior to the time the fish are known to smolt.

Smolt condition will be evaluated using physiological indices that have characterized Dworshak NFH steelhead in earlier studies to allow comparison among past years. The methods include condition factor; gill sodium, potassium ATPase (Schrock *et al.* 1994); reflectance Haner *et al.* 1995); and mucus lysozyme (Schrock 1994). The methods will allow for comparison of physiological development in the experimental groups with that of production steelhead from Dworshak, and elsewhere, under different rearing regimes.

Extended seawater survival will be monitored at Marrowstone Marine Station (USGS-BRD). Fish will be transported at the time of release, acclimated to seawater over 4 days, and inventoried on a monthly basis for growth, survival, and health status by necropsy based assessment.

b. Rationale and significance to Regional Programs

The Dworshak National Fish Hatchery stock is characterized by a wide length frequency distribution at the time of release. This does not conform to the Biological Opinion from the National Marine Fisheries Service (NMFS) on Hatchery Operations for 1996-1999 that calls for hatchery steelhead to be released between 170-220 mm (TL) in order to minimize residualization. The Draft Snake River Salmon Recovery Plan (SRSRP) recognizes that "Steelhead larger than 170 mm experience more complete parr-smolt transformation and are therefore more likely to actively migrate". Fish larger than 220 mm are more prone to residualize (Partridge 1985, 1986; Cannamela 1992), and steelhead greater than 250 mm may be more capable of predation (Cannamela 1993). If successful, this project would provide steelhead hatchery managers a tool with which to address problems of wide length frequencies and residualism in both larger and smaller fish.

The project directly addresses the Fish and Wildlife Programs objective 5.7A.4, which describes the need to evaluate hatchery steelhead residualism, the causes, and the need to identify solutions. Similarly, the project addresses the Fish and Wildlife Program objective 5.7B.17 which calls for hatchery steelhead to be released in a physiological condition conducive to rapid emigration. This project is designed specifically to address physiological development. Objective 2 directly addresses the issue of migration success. The Fish and Wildlife Program objective 7.2D.1 calls for research and development for improved husbandry practices at hatcheries which lead to improved survival and adult returns. This project is designed to improve the physiological condition of steelhead smolts at the time of release, leading to increased survival of smolts (Objective 3) and adult returns (Objective 4).

c. Relationships to other projects

BPA project 99-018-00, Characterize and Quantify Residual Steelhead in the Clearwater River, Idaho, has already been funded and will start this year. That project is designed to provide more detailed data on the extent of residualism of Dworshak steelhead and the relationship to ongoing hatchery operations. Our project is not dependent but very closely related in that both projects are attempting to address the issue of residualism of juvenile steelhead at Dworshak NFH. Fish released by our project will contribute additional data to Project 99-018-00. Collections of our fish by Project 99-018-00 will provide additional information for our project as well.

d. **Project history** (for ongoing projects)

(Replace this text with your response in paragraph form)

e. Proposal objectives

1. Increase the proportion of juvenile steelhead that exhibit characteristics of smoltification prior to release from the hatchery.

    a. Manipulate growth rate of selected groups of steelhead using a feeding schedule designed to decrease growth overwinter and increase growth during spring.

    b. Calculate monthly growth rates for treatment and control groups and determine the relationship between growth rate and smoltification.

    c. Evaluate smolt condition of steelhead on altered feeding schedule during rearing and at release: monitor condition factor, mucus lysozyme, gill ATPase, and skin reflectance.

    d. Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.

2. Increase the proportion of steelhead smolts that successfully emigrate to downriver dams on the Snake and Columbia Rivers.

    a. Mark representative groups of treatment and control steelhead smolts with PIT tags prior to release.

    b. Interrogate PIT-tagged emigrants using the PTAGIS database system.

    c. Analyze relationship between modfied feeding strategy, physiological development, and emigration success.

    d. Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.

3. Increase the proportion of steelhead smolts that successfully rear during extended seawater rearing.

a. Transfer individuals from treatment and control groups to seawater rearing tanks to monitor extended seawater survival.

b. Monitor health and condition of fish held in seawater using necropsy-based fish health assessment.

c. Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.

4. Increase the proportion of smolts that survive to return as adults to the hatchery.

a. Mark 20,000 fish in each treatment and control pond with coded-wire tags prior to release.

b. Scan all returning adult steelhead at the hatchery for coded-wire tags for tag extraction and decoding.

c. Analyze coded-wire tag returns for statistical differences between treatment and control groups.

d. Prepare annual progress reports that summarize data and prepare a final project report summarizing results and findings.

f. Methods

Objective 1: Increase the proportion of juvenile steelhead that exhibit characteristics of smoltification prior to release from the hatchery.

Tasks: Groups of summer steelhead at Dworshak NFH will be set up in outside rearing ponds so that each of three treatment and control groups have at least three replicate ponds. Feed, growth, and adult return records from the past ten years have been analyzed to determine the reduction in feed needed to attain minimum growth rates comparable to those in years of high adult returns when small individuals were released. The growth rate will then be accelerated during a critical period from February to the time of release to induce smoltification. Monitoring of growth rates of control and treatment groups will occur during rearing and before release by collecting monthly samples of about 100 fish per rearing container and measuring them for length and weight. Smoltification will be monitored using health assessment by the Columbia River Research Laboratory for gill sodium, potassium ATPase (Schrock *et al.*1994); reflectance (Haner *et al.* 1995), and mucus lysozyme (Litwack 1955; Muona and Soivio 1992). Sample size has been established for the physiological measurements by statistical analysis of test group results to determine the minimum sample size necessary to distinguish among treatment groups. A minimum of 40 fish must be sampled per group to detect difference among test groups for skin mucus lysozyme, while power analysis of other indices suggests smaller samples sizes.

Data Analysis: Multivariate analysis will be applied to all smolt condition data collected to determine differences among the treatment groups.

Expected Results: All fish will be raised in standard production ponds at Dworshak NFH. The critical assumptions are that feeding methods affect growth rate, that growth rate affects smolt condition, and that smolt condition determines migration numbers and rates. It is expected that there will be differences in growth rate, smolt condition, and migration success among the treatment groups.

Objective 2. Increase the proportion of steelhead smolts that successfully emigrate to downriver dams on the Snake and Columbia rivers.

Tasks: Two weeks prior to release, 400 fish above and below 170 mm (TL) from each pond will be PIT-tagged. After smolts are released, PIT-tag interrogation data from Lower Snake and Columbia river dams will be downloaded from the PTAGIS database for each of the treatment and control groups. PIT-tag data will be compiled into standard databases for statistical summary and analysis. Migration rates will be compared between treatments and controls using a standard t-Test. Survival will be calculated using a Jolly-Seber estimate.

Expected Results: We expect to determine whether enhanced feeds and altered feeding regimes significantly increase the proportion of steelhead smolts that successfully emigrate downriver to the ocean. Replication of the experiment will involve three production years.

Objective 3: Increase the proportion of steelhead smolts that successfully rear during extended seawater rearing.

Tasks: About 70 fish from each rearing container at Dworshak NFH will be collected and transferred to Marrowstone Marine Station for extended seawater rearing. Performance of treatment and control groups will be monitored for about 3 months. Periodic inventory will compare survival, condition factor, and health by necropsy based fish health assessment among the treatment groups.

Data Analysis: Multivariate analysis will determine the significance of differences among treatment groups during seawater rearing.

Expected Results: A critical assumption is that different feeding strategies result in differences in smolt condition and seawater adaptability that will be detected as differences in seawater survival among the treatment groups.

Objective 4: Increase the proportion of smolts that survive to return as adults.

Tasks: In the fall prior to release, we will mark 20,000 fish in each of the treatment and control ponds with code-wire tags to determine treatment effects on adult returns. Prior to release, estimates of coded-wire tag retention will be made by taking random samples from each pond.

All adults returning to the hatchery will be scanned for tags, which will be extracted and read.

Data Analysis: Mean rates of adult returns will be calculated for each treatment and control group. Means will be tested for significant differences using a standard t-Test.

Expected Results: We expect to determine whether feeding enhanced feeds or using altered feeding schedules significantly increases the number of adults that return.

g. Facilities and equipment

Dworshak Fishery Complex (USFWS)
The fish rearing and treatment application will be conducted at the Dworshak Fishery Complex at Ahsahka, Idaho, which includes the Dworshak NFH, the Idaho Fishery Resource Office, and the Idaho Fish Health Center. Currently, Dworshak NFH raises and releases about 2.3 million summer steelhead annually, and has 85 Burrows ponds for steelhead rearing. The Fishery Resource Office has conducted research and evaluation studies for chinook salmon and steelhead at this facility for nearly 12 years. Sufficient facilities and equipment are presently available to accommodate the project. Office and laboratory space is available for conducting all necessary activities.

Columbia River Research Laboratory (USGS-BRD, CRRL)
The facility offers 1600 sq. ft. of analytical laboratory space including biochemistry, physiology, and immunology labs. A 1500 sq. ft. wet lab with 64 tanks is serviced with river and well water. Field technology capabilities employee 25 vessels geared for radio telemetry, hydroacoustics, electroshocking, diving, and in-river sampling.

Marrowstone Marine Station (USGS-BRD, MMS)
Located on Marrowstone Island on northern Puget Sound, the newly remodeled and expanded marine facility has 9456 sq. ft. of wet lab space equipped for fish holding, and a fully equipped analytical laboratory. High quality seawater is available for seawater holding. The station provides cooperators with support for projects examining seawater survival of anadromous salmon, disease and stress in salmon, contamination in marine species, and marine species rearing technology.

h. Budget

Personnel - Budget is for .25 FTE for a GS-11 biologist, one GS 5/6 administrative person for .25 FTE, and one GS 5 Fishery Technician for 1 FTE.
Fringe Benefits - Budget if for the above personnel.
Supplies, Materials, non-expendable property - Budget for field equipment (waders, gloves, dip nets, crowders, buckets, tubs, MS-222, etc.), lab supplies (liquid nitrogen, vials for gill filaments, perservatives, etc.), and office supplies (desk, chair, computer station, file cabinet, bookcase, and various other office supplies).
Operations and Maintenance - Cost of about $90.00/1000 for purchase and application of about 160,000 coded wire tags (8 groups at 20,000 tags per group). Cost of about $.40/tag for application of 4000 PIT tags.

Capital Aquisitions and major equipment - Purchase of laptop computer, software and digital camera.
PIT-tags - Project will use about 4000 PIT tags for the first year (8 treatment and control groups at 500 tags per group).
Travel - Budget includes travel between Dworshak NFH, Columbia river Research Laboratory, and Marrowstone Field Station for sampling and transfer of experimental groups; daily travel of biologist and technician between Dworshak NFH and Little Goose Dam over a 3 to 4 week period to collect PIT-tagged smolts for estimating smolt development after release; travel and per diem for the fisheries technician during 8-10 weeks of relocation to Marrowstone Field Station to assist in extended seawater rearing.
Indirect Costs - Cost for new projects is 22% of our portion of the project (12.5% as listed in section 5).
Subcontractors - Cost is for personnel, travel, equipment, and supplies for two GS 11 biologists with the USGS-BRD (CRRL and MMS) at .25 FTE.

Section 9. Key personnel

Principal Investigator: Ray N. Jones, Fishery Biologist
Idaho Fishery Resource Office, U.S. Fish and Wildlife Service

Jones will be working as the principal investigator and coordinator of all project activities. Jones will supervise experimental operations and data collection on the hatchery during rearing, PIT-tagging of smolts prior to release, collection and analysis of PIT-tag data, and will coordinate the compilation and completion of all interim and final reports. These activities will require about .25 FTE.

EDUCATION
Master of Science, Zoology - Oklahoma State University **1981**
Major: Fisheries Ecology Stillwater, Oklahoma
Bachelor of Science, Fisheries Resources - University of Idaho **1977**
Major: Fisheries Management Moscow, Idaho

EMPLOYMENT
Fishery Biologist **1991 to Present**
U.S. Fish and Wildlife Service, Ahsahka, Idaho

Responsible for conducting hatchery evaluations at Dworshak and Kooskia NFHs; Identifies contraints in hatchery production and designs and conducts research projects to improve production practices; Team Leader for both the Dworshak and Kooskia Hatchery Evaluation Teams.

Fishery Biologist **1986 to 1991**
U.S. Fish and Wildlife Service, Kenai, Alaska

Developed and conducted fishery resource investigation projects on National Wildlife Refuges. Developed Refuge fishery management plans.

Fishery Biologist **1983 to 1986**
Nez Perce Tribe Department of Fishery Resources, Lapwai, Idaho

As the Departments Harvest Manager, Jones was responsible for planning and developing harvest management plans and collecting fishery harvest information. Jones participated on various interagency groups to prepare comprehensive enhancement plans for the Columbia River.

EXPERTISE
Jones has worked nearly 15 years as a fishery biologist. The past 7 years has been at the Idaho FRO assisting the staffs at Dworshak and Kooskia NFHs in conducting evaluation projects to improve steelhead and spring chinook production. Jones provides the leadership for the Hatchery Evaluation Teams at both of these hatcheries. This experience well qualifies Jones for coordinating the activities of the of this proposal.

SELECTED REPORTS
Jones, R. N. 1996. An evaluation of rearing density in relation to rearing performance, post-release performance, and adult returns of spring chinook salmon at Dworshak NFH, Idaho. Final Report. Idaho Fishery Resource Office, Ahsahka, Idaho.
Jones, R.N., P. Hayduk, M.A. Bouchard, G.S. Green, and A. Izbicki. 1996. Effects of fish cultural techniques on size variation of summer steelhead populations at Dworshak NFH. Final Report. Idaho Fishery Resource Office, Ahsahka, Idaho.
Jones, R. N. and H.L. Burge . 1995. An evaluation of the effects of release time on the post-release performance and adult returns of spring chinook salmon at Dworshak and Kooskia NFHs in Idaho. Progress report, Idaho Fishery Resource Office, Ahsahka, Idaho.
Jones, R.N., R.B. Roseberg, and R. Bottomley. 1997. An evaluation of adipose fin clip versus left ventral fin clip as mass marks for hatchery spring chinook salmon at Kooskia NFH. Final Report. Idaho Fishery Resource Office, Ahsahka, Idaho.

Smolt Physiologist: Robin Schrock, Research Fishery Biologist
Columbia River Research Laboratory, USGS - Biological Resources Division.

Schrock will be responsible for collecting and analyzing all the fish physiology data. This will require about .25 FTE.

Education
M.S., University of Wisconsin, Stevens Point, WI (Natural Resource Management - Fisheries) 1986

B.A., Portland State University, Portland, OR (Biology and German) 1982
Diploma, School for Medical Technologists, Bern, Switzerland 1975

Experience
Research Fishery Biologist, USGS-Biological Resources Division,

Columbia River Research Laboratory 1991 to present

Fishery Biologist, USFWS-National Fishery Research Center
Marrowstone Field Station 1987-1991

Publications and Reports

Schrock, R.M., J.W. Beeman, P.V. Haner, K.M. Hans, J.D. Hotchkiss, S.T. Sauter, S.P. VanderKooi, W.L. Gale, P.A. Petrusso, and A.G. Maule. 1998. Assessment of Smolt Condition for Travel Time Analysis: Project Review 1987-1997. Bonneville Power Administration Homepage Publication. 68 p.

Schrock, R.M., J.W. Beeman, D.W. Rondorf, and P.V. Haner. 1994. A microassay for gill sodium, potassium-activated ATPase in juvenile Pacific salmonids. Transactions of the American Fisheries Society. 123:223-229.

Haner, P.V., J.C. Faler, R.M. Schrock, D.W. Rondorf, and A.G. Maule. 1995. Skin reflectance as a non-lethal measure of smoltification for juvenile salmonids. North American Journal of Fisheries Management 15:814-822.

Maule, A.G., R.M. Schrock, C. Slater, M.S. Fitzpatrick, and C.B. Schreck. 1996. Immune and endocrine responses of adult spring chinook salmon during freshwater migration and sexual maturation. Fish and Shellfish Immunology 6:221-233.

Schrock, R.M. 1994. Quantifying non-specific disease response in adult and juvenile salmon. Proceedings of International Fish Physiology Symposium, University of British Columbia, Victoria, Canada. July 1994:476-480.

Maule, A.G., J.W. Beeman, R.M. Schrock, and P.V. Haner. 1994. Assessment of smolt condition for travel time analysis. Annual report 1991 - 1992. Prepared for the Bonneville Power Administration. Portland, Or.

Schrock, R.M. and J.W. Beeman. 1993. Microassay for sodium, potassium-activated ATPase in juvenile salmon. Research Information Bulletin No. 67. U.S. Fish and Wildlife Service.

Palmisano, A.N., R.M. Schrock, W.T. Yasutake, and G.A. Wedemeyer. 1990. Tolerance of juvenile fall chinook salmon to selenium exposure from water and the food chain: impacts on smoltification and early marine survival. Report by the U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service.

Zaugg, W.S., W.W. Dickhoff, B.R. Beckman, C.V.W. Mahnken, G.A. Winans, T.W. Newcomb, C.B. Schreck, A.N. Palmisano, R.M. Schrock, G.A. Wedemeyer, R.D. Ewing, and C.W. Hopley, 1991. Smolt quality assessment of spring chinook salmon. Annual report to Bonneville Power Administration.

Marine facility, Acting Director: Nancy Elder, Fishery Biologist
Marrowstone Marine Station, USGS - Biological Resources Division

Elder will be responsible for maintaining the extended seawater rearing environment for treatment and control groups. Elder will assist in the collection of data. This will require about .25 FTE.

Education
B.S., Purdue University, West Lafayette, IN (Animal Science) 1980

Experience

USGS-BRD, Marrowstone Marine Station, Acting Director	1995 to present
NBS (formerly USFWS), Marrowstone Field Station, Fishery Biologist	1987-present
University of Idaho, Research Associate - Fisheries Dept.	1985-1987

Section 10. Information/technology transfer

Results of the project will be published in an acceptable peer reviewed scientific journal. Data from PIT tagging will become incorporated into the PTAGIS database. Coded-wire tag data will be incorporated into U.S. Fish and Wildlife Service databases. Physiological data will be incorporated into the Assessment of Smolt Condition: Biological and Environmental Interactions comprehensive database. Presentations will be made at regional and national workshops, conferences, and symposiums.

Congratulations!