PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Lower Columbia River Adult Study

BPA project number: 9204101
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
U.S. Army Corps of Engineers

Business acronym (if appropriate) COE

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
6.1A.2, 6.1A.3, 6.1A.4, 6.1B.8, 6.1D7, 6.1E.1

FWS/NMFS Biological Opinion Number(s) which this project addresses
Biological Opinion for the Operation of the Federal Columbia River Power System, 1995 - RPA items 5 and 7; CR items 2 and 3

Other planning document references
Snake River Salmon Recovery Plan - 2.6.a.3, 2.6.b.3, 2.6.c.3

Short description
Assess the success of adult salmon, steelhead and lamprey passage through the Lower Columbia River hydropower system and into tributaries. Evaluate the effects on adult passage of specific flow and spill conditions and various adult passage improvements.

Target species
Chinook Salmon (Onchorhynchus tshawytscha), steelhead trout (O. mykiss) and Pacific lamprey (Lempetra tridentata)

Section 2. Sorting and evaluation

Subbasin
Systemwide

Evaluation Process Sort

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

Section 3. Relationships to other Bonneville projects

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

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
	Lower Columbia River Adult Study	Co-Sponsor

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
1995	Install equipment and prepare protocol for collecting and processing fish movement data.	

1995	Develop adult Pacific lamprey tagging method.	Yes. A surigical implant was deemed the most suitable method.
1998	Monitor fish movement at dams and into tributaries.	Yes. Fish movement data were collected from 1996-98. The data are currently being analyzed. Progress and preliminary results have been presented at annual AFEP reviews.

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Determine the proportion of fish passing Bonneville Dam that ultimately pass the upstream dams, enter tributaries, enter hatcheries, are taken in fisheries, and are "losses" between dams.	a	Tag fish
		b	Monitor recievers
		c	Mobile track
		d	Process data
		e	Analyze data
		f	Compile report
2	Assess the time for fish to pass each dam and migrate through reservoirs, evaluate entrance use and passage through fishways at the dams, evaluate the effects of spill and powerhouse discharge patterns on fish passage, assess the amount of fallback of fis	a	Tag fish
		b	Monitor recievers
		c	Mobile track
		d	Process data
		e	Analyze data
		f	Compile report
3	Evaluate specific measures to improve passage at Lower Columbia River projects based on results of 1996-98 study. Results of study are due in FY99.	a	Identify measures to evaluate for FY00 based on 1996-98 telemetry data.
		b	Prepare proposals.

		c	Tag fish
		d	Track fish
		e	Process data
		f	Analyze data
		g	Compile report(s)
4	Evaluate the effects of operation of the new Bonneville Navigation Lock on upstream migration of adult fall chinook salmon, and lamprey	a	Tag fish
		b	Monitor recievers
		c	Mobile track
		d	Process data
		e	Analyze data
		f	Compile report
5	Assess the passage of adult lamprey at Bonneville Dam and test different passage facilities	a	Same as a-f above.
		b	Continue to test experimental facilities developed in 1999.
6	Monitor the migrations of PIT tagged salmon and steelhead outfitted with transmitters at Bonneville Dam to evaluate homing and the effect of mode of seaward migration.	a	Implant radio transmitters in PIT tagged fish captured at Bonneville
		b	Monitor recievers
		c	Track fish
		d	Process data
		e	Analyze data
		f	Compile report

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	3/2000	12/2002			33.34%
2	3/2000	12/2002			33.33%
3	3/2000	12/2002			0.00%
4	3/2000	12/2002			0.00%
5	3/2000	12/2002			0.00%
6	3/2000	12/2002			33.33%
				Total	100.00%

Schedule constraints
This is a multi-year project that uses an adaptive approach. Our schedule may depend on how the region prioritizes 1999 LCARS report measures identified for further study, for example.

Completion date
12/2002

Section 5. Budget

FY99 project budget (BPA obligated): $200,000

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	$80,000 of the $175,570 total	%40	80000
Fringe benefits		%0	
Supplies, materials, non-expendable property		%0	
Operations & maintenance		%0	
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		%0	
NEPA costs		%0	
Construction-related support		%0	
PIT tags	# of tags:	%0	
Travel		%0	
Indirect costs		%0	
Subcontractor		%0	
Other	600 of the 2000 radio transmitter tags	%60	120,000
TOTAL BPA FY2000 BUDGET REQUEST			$200,000

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
Corps of Engineers	Dollars for 1400 tags (70%), personnel (54%), fringe benefits, supplies, travel, indirect costs, subcontractor	%87	1,300,904

	costs.		
		%0	
		%0	
		%0	
		Total project cost (including BPA portion)	$1,500,904

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$1,575,949	$1,654,746		

Section 6. References

Watershed?	Reference
☐	Bjornn, T.C., R.R. Ringe, K.R. Tolotti, P.J. Keniry, J.P. Hunt, C.J. Knutsen, and S.M. Knapp. 1992. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into the tributaries - 1991. Technical Rep
☐	Bjornn, T.C., J.P. Hunt, K.R. Tolotti, P.J. Keniry, R.R. Ringe. 1994. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into the tributaries - 1992. Technical Report 94-1, Idaho Cooperative Fi
☐	Bjornn, T.C., J.P. Hunt, K.R. Tolotti, P.J. Keniry, R.R. Ringe. 1995. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into the tributaries - 1993. Technical Report 95-1, Idaho Cooperative Fi
☐	Junge, C.O., and B.E. Carnegie. 1976. Dam operations and adult fish passage, 1975. Completion Report, Contract DACW68-75-C-0129, Oregon Department of Fish and Wildlife, Portland.
☐	Schiavone, Albert Jr., and R. D. Adams. 1994. Movement of Sea Lamprey Past The Dexter Dam Complex on the Black River, New York. Unpublished. New York State Department of Environmental Conservation, 317 Washington Street, New York, 13601.
☐	Stier, Kathleen, and B. Kynard. 1986. Movement of Sea-Run Sea Lamprey, Petromyzon Marinus, During the Spawning Migration in the Connecticut River. Fishery Bulletin 84(3): 749-753.
☐	Tibbles, James J. , S. M. Dustin, R. A. Braem, and H. H. Moore. 1983. Annual Report 1981, Great Lakes Fishery Commission. 1451 Green Road, Ann Arbor, Michigan.
☐	Turner, A.R., J.R. Kuskie, and K.E. Kostow. 1983. Evaluation of adult fish passage at Little Goose and Lower Granite dams, 1981. U.S. Army Corps of Engineers, Portland District, Oregon.
☐	Turner, A.R., J.R. Kuskie, and K.E. Kostow. 1984. Evaluation of adult fish passage at Ice Harbor and Lower Monumental dams, 1982. U.S. Army Corps

	of Engineers, Portland District, Oregon.

PART II - NARRATIVE

Section 7. Abstract

The goals of this project are to assess the passage of adult salmon, steelhead, and lamprey at the four lower Columbia River dams, through their reservoirs, into tributaries, to evaluate fish responses to flow and spill conditions, and to evaluate measures to improve passage.

Objectives are: 1.) determine the proportion of fish passing Bonneville Dam that ultimately pass the upstream dams, enter tributaries, enter hatcheries, are taken in fisheries, and are "losses" between dams.for all fish released, 2.) assess the time for fish to pass each dam and migrate through reservoirs, evaluate entrance use and passage through fishways at the dams, evaluate the effects of spill and powerhouse discharge patterns on fish passage, assess the amount of fallback of fish at each dam, 3.) evaluate specific measures to improve passage at Lower Columbia River projects based on results of 1996-98 study. Results of study are due in FY99, 4.) evaluate the effects of operation of the new Bonneville Navigation Lock on upstream migration of adult fall chinook salmon, and lamprey, 5.) assess the passage of adult lamprey at Bonneville Dam and test different passage facilities, 6.) monitor the migrations of PIT tagged salmon and steelhead outfitted with transmitters at Bonneville Dam to evaluate homing and the effect of mode of seaward migration.

We propose to put radio transmitters in PIT tagged spring and summer chinook salmon and steelhead detected as they return to Bonneville Dam, and in a random sample of fall chinook salmon. Studies of lamprey passage at Bonneville Dam will continue with testing of alternative passage facilities and guidance devices. Movements of all fish released with transmitters would be monitored and recorded at each dam and in several upstream tributaries with radio receivers. Information collected on movements will be related to flow, spill, turbidity, temperature, conditions in rivers and at dams during periods of migration, and origin of PIT tagged fish.

This project will address priority research areas related to passage of adult salmonids identified in the Corps of Engineers former Fish Passage Development and Evaluation Program, in the Northwest Power Planning Council's 1994 Fish and Wildlife Program (items 6.1B.1, 6.1B.8, 6.1E.1), in the Proposed Recovery Plan for Snake River Salmon (National Marine Fisheries Service 1995, items 2.6.a.3, 2.6.b.3, 2.6.c.3), and in the Biological Opinions (NMFS 1995, RPA items 5 and 7, and CR items 2 and 3, and 1998, XII, 2.b, 2.e, 2.f, 2.g, 2.h) related to recovery of endangered Snake River salmon.

Section 8. Project description

a. Technical and/or scientific background

Background

Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass eight or nine dams and reservoirs, four each in the lower Columbia and Snake rivers and five in the mid Columbia River. Losses and delays in migration at each hydroelectric project must be minimized to succeed in maintaining the native runs of fish and achieve the Northwest Power Planning Council's goal of doubling the abundance of fish in the future.

This proposal addresses concerns of the COE, the Council in section 6 of the 1994 Columbia River Basin Fish and Wildlife Program, and NMFS in the Proposed Recovery Plan for Snake River Salmon, and Biological Opinions issued in 1995 and 1998. The proposals have been developed in response to the high priority assigned to adult passage research in the Columbia and Snake rivers by the former Fish Research Needs and Priorities subcommittee of the Fish Passage Development and Evaluation Program.

Research has been conducted in the past by COE, Idaho Cooperative Foishand Wildlife Research Unit, National Marine Fisheries Service, and Oregon Department of Fish and Wildlife to evaluate passage rates, entrance and fallout in the passage facilities, fallback over the dams, and migration rates with reduced nightime flows at the Columbia and Snake river dams. Facilities and operating procedures were or will be midified as a result of earlier studies, and studies are needed to determine if the changes will reslt in the disired improvements. The studies by Turner et al. (1983, 1984) were conducted during only a part of the migration season and with an incomplete range of flow conditons and they recommended further study.

Additional studies are needed to better define: the use of fishway entrances and passage through the fishways; the effect of spill and powerhouse discharge patterns on the entry of fish into the fishways and on passage rates; the effect of the new Bonneville navigation lock on fish passage at the dam and movement into the hatchery; the rate of fallback over the dams with various conditions; the effects of various in –water activities (dredging, disposal, and construction of barge mooring facilities, etc.) on the distribution and migration rates of adults, and; the distribution, migration rates, and survival of fish after they are tagged and released at Bonneville Dam.

Field work began in 1995, with trial trapping of fish in the river downstream from Bonneville Dam, and installation of radio telemetry gear at the dams. Adult salmon, steelhead, and lamprey were captured at Bonneville Dam in 1996, 1997, and 1998, outfitted with radio transmitters and released downstream from the dam to better define: (1) the use of fishway entrances and passage through the fishways, (2) the effect of spill and powerhouse discharge patterns on the entry of fish into the fishways and on passage rates, (3) the effect of the new Bonneville navigation lock on fish passage at the dam and movement into Bonneville Hatchery, (4) the rate of fallback over the dams with various flow conditions, and (5) the distribution, migration rates, and survival of fish after they are tagged and released near Bonneville Dam.

During the first three years of the project, we selected fish at random from the spring and summer chinook runs, from the steelhead runs in 1996 and 1997, from the sockeye run in 1997, and from the fall chinook run in 1998. Flows during the spring and summer migration periods were high in 1996 and 1997, and closer to average in 1998. We do not anticipate a need to tag a random sample of spring and summer chinook salmon at Bonneville Dam in 1999 to evaluate passage at the various dams; the data we have should be sufficient.

The incidence of salmon falling back over Bonneville and The Dalles dams was high each year, but not as high as that reported in earlier studies, and there was a period of no spill in 1998 to compare with periods with spill. Based on tracking of salmon in the Bonneville forebay, we know that fish that use the Bradford Island fishway are more likely to fallback through the spillway than fish using the Washinton shore fishway. Somewhat surprising has been the fallback of some salmon at Bonneville Dam after having migrated upstream considerable distances (into Snake River). By radio-tagging salmon and steelhead with PIT tags we should be able to determine the origin and early history of the fish and better understand their movements.

We have a wealth of information now on passage of salmon at the dams, especially spring and summer chinook salmon. During the next year we will have reports out for most of the groups of fish we studied. We have presented some of the information we have in annual reviews and to groups needing information such as the group studying straying into the Deschutes River, and on fallback issues.

b. Rationale and significance to Regional Programs

This project will provide critical information to ensure that passage conditions at dams are adequate for safe and timely passage of adult fishes. The project specifically addresses measures 6.1A.2, 6.1A.3, 6.1B.8, 6.1D7 of the 1994 Fish and Wildlife Program. Objective 2 evaluates facility and dam operation improvements (6.1A.2, 6.1A.3, 6.1A.4) identified during 1996-98 study years. Objective 1 addresses interdam losses (6.1B.8) as well as fallback, straying, timing, movement and other behavioral characteristics (6.1D.7). This project addresses Conservation Recommendations 2 and 3 of the 1995 Biological Opinion on the Operation of the Federal Columbia River Hydropower System. Tasks 2.6.a.3, 2.6.b.3 and 2.6.c.3 also call for adult fish migration evaluation.

c. Relationships to other projects

This project is co-sponsored by the COE. Also related is a Mid-Columbia PUD adult passage evaluation which utilizes fish marked under the COE/BPA program. Information is then pooled in the same data base. U.S.G.S. Biological Resource Division will be evaluating the effects of swimming and exhaustive stress in Pacific lamprey and its implications for upstream migration past dams. This work will be complimentary to past and proposed telemetry work.

d. Project history (for ongoing projects)

The BPA and COE are cost sharing throughout this six year program. Costs incurred in 1995 for program planning were approximately $255,000. Efforts included finalization of the study design; the determination, purchase, and installation of necessary equipment; and preliminary trapping and tag implantation evaluations. Physiological evaluations of adult lamprey tagging procedures were also conducted. In 1996, BPA and COE contributions totaled $350,000, and approximately $1,000,000 respectively. Program implementation, data collection and analysis began in 1996. In 1996-98 data collection and analysis continued although BPA support was reduced to $200,000. The bulk of 1999 efforts involve final data analysis and reporting: only lamprey passage will be evaluated during the field season.

An adaptive approach to our project was demonstrated with program change for 1998 which involved monitoring adult fish movements rather than taking a field season off to analyze data. The program change was brought about because of flow differences between seasons: 1996 and 1997 were high flow years while 1998 was projected to be an average year. In 1999, information collected from 1996-98 will be analyzed to identify problem areas and develop measures to prioritize, improve and study for 2000.

e. Proposal objectives

The project's objectives are to : 1.) determine the proportion of fish passing Bonneville Dam that ultimately pass the upstream dams, enter tributaries, enter hatcheries, are taken in fisheries, and are "losses" between dams, 2.) assess the time for fish to pass each dam and migrate through reservoirs, evaluate entrance use and passage through fishways at the dams, evaluate the effects of spill and powerhouse discharge patterns on fish passage, assess the amount of fallback of fish at each dam, 3.) evaluate specific measures to improve passage at Lower Columbia River projects based on results of 1996-98 study. Results of study are due in FY99, 4.) evaluate the effects of operation of the new Bonneville Navigation Lock on upstream migration of adult fall chinook salmon, and lamprey, 5.) assess the passage of adult lamprey at Bonneville Dam and test different passage facilities, 6.) monitor the migrations of PIT tagged salmon and steelhead outfitted with transmitters at Bonneville Dam to evaluate homing and the effect of mode of seaward migration.

f. Methods

Approximately 1000 fall chinook salmon, 300 spring/summer chinook salmon, 300 steelhead trout, and 200 Pacific lamprey would be trapped at Bonneville Dam, outfitted with radio transmitters and a visible external tag, released downstream from the dam, and their movements monitored and recorded at each dam and in several upstream tributaries with radio receivers. Information collected on movements will be related to flow, spill, turbidity, temperature, and conditions in rivers and at dams during periods of migration.

Fish will be tagged throughout each of the runs in proportion to their abundance. Sample sizes are based on the proportion of fish counted at Bonneville dam that are counted at upstream dams. These proportions were initially estimated from adult fish counts at dams and refined during the first three years of this project.

Protocols for radio tracking, downloading of data from receivers, recovery of information of recaptured fish, and processing of the data will be similar to those developed for 1996-98. Computer programs prepared and tested in 1996 –98 for processing the data and getting it into summary form for analysis and report preparation will be used.

Fish tagged in 2000 will be monitored at the lower Columbia River dams in a manner similar to 1996-98, with specific sub-studies yet to be determined. We will coordinate with all research groups using radio telemetry for both adult and juvenile salmon and steelhead and other fishes to insure efficient use of the equipment and resources available. As we did in 1996-98, we will coordinate use of transmitter frequencies and codes by all groups using radio telemetry in the main stem study areas to prevent duplicate use of frequencies and codes that would lead to confounded data.

Maintenance and repairs for the more than 120 receiver sites at the dams and in tributaries will be accomplished during fall-winter of 1999-00 when flows and tailrace elevations are low and when fishways are normally dewatered for maintenance.

Proportion of fish passing dams, entering tributaries, and losses.

This segment of the study of upstream migration of adult salmon, steelhead and lamprey is designed to assess the success of fish with transmitters in passing each of the dams, the distribution of fish to tributaries, hatcheries, and fisheries, and the number of fish that cannot be accounted for (potential losses) within the study area. Fish trapped at Bonneville Dam, outfitted with transmitters, and released downstream from the dam were monitored as they migrated upstream past the dams, into major tributaries, and to spawning areas or hatcheries. Records of fish movements obtained at fixed-site receivers was supplemented with mobile tracking in areas upstream from the dams, and by recaptures of tagged fish at various weirs, traps, and hatcheries.

Success of passage and distribution will be assessed for each species of fish studied (spring/summer chinook salmon, sockeye salmon, steelhead, and lamprey). The number of salmon recorded at receivers in the tailrace (1-2 km downstream from dams) of each dam and at mouths of tributaries will be used to determine the percentage of tagged fish that successfully migrate upstream. This data in combination with recaptures at weirs, traps, hatcheries, in fisheries, and mobile track information will be used to determine the distribution of fish in the Columbia and Snake River basins in relation to tag-date at Bonneville Dam. Estimates of loss between dams and tributaries will be based on fish that can not be accounted for from the above listed sources of information.

Special efforts would be made to put transmitters in all fish trapped that have distinctive fin clips (such as those with adipose-right ventral clips from Lookingglass Hatchery in

1996) and PIT tags so that we might determine if fish returned to their stream or hatchery of origin.

Time to pass dams and through reservoirs.
Time to pass each of the dams and through each reservoir is a key measure of the success of salmon and steelhead migrating upstream through the lower Columbia River. Data needed to determine time to pass dams and through reservoirs will be available from records stored and processed as described in the previous section. Time to pass a dam is calculated as the difference in time between the last record at the tailrace site and last record at the top of the ladders. Time to pass through a reservoir is calculated as the difference in time between last record for a fish passing out the top of a ladder to the first record at the tailrace receiver at the next dam upstream.

Median values will be used to describe passage times because of the tendency of the data to be skewed to the right (a few fish will have high passage times). Time to pass dams will be compared between the four lower Columbia River dams, and with data collected at Snake River dams, to identify potential problem areas. Time to pass through reservoirs will be converted to rates of travel (km per day) to allow comparisons between different river stretches. A rank analysis will be used to test for statistical differences in comparisons between years and between conditions at time of passage.

Entrance use and passage through fishways.
In addition to receivers installed in the tailraces and tops of ladders at each dam, SRX/DSP receivers have been installed with antennae that are used to monitor fishway entrances and inside fishways of Bonneville and McNary dams to assess fishway entrance use and movements in the fishways. Installation of antennas at the two dams selected for fishway studies was completed during the summer and fall of 1995 and receivers were installed and used in 1996. Separate databases for each dam and species/stock of fish studied will be created from the records downloaded from the receivers set up in the fishways plus the receivers in the tailraces and tops of the ladders.

Fishway entrance use and passage through the fishways will be assessed in the same ways used in recent Snake and mid Columbia river studies. Fish will be recorded as they enter tailraces of the dams, approach fishway entrances (first record at antenna at a fishway entrance), enter fishways (record of a fish inside fishway following record of a fish at a fishway entrance), move within fishways (progression of records at various antennae inside fishway), leave fishways (record of a fish outside fishway following a record of the fish inside the fishway), reenter fishways, ascend ladders, and pass over the dams (last record of a fish at top of ladder possibly followed by record of the fish at upstream dam or other upstream receiver site).

Entrance use will be described as the total number of entries and exits made by fish at each fishway opening and will be related to flow, spill, and powerhouse discharges at the dams. Emphasis will be placed on the locations fish first approach a dam and first enter a fishway.

Time to pass through fishways will be based on time of last record at tailrace sites to: time of first approach to the dam, time of first entry to fishway, time to pass through transition areas, and time of last record at tops of ladders. Median values will be used to describe passage rates. Passage through the fishways will be related to conditions within fishways, particularly the transition areas leading to the ladders.

Effects of spill and powerhouse discharge on fish passage.
The effects of flow and spill on passage of adult salmon and steelhead will be assessed in a general way (number passing and time to pass) at all dams with a minimum receiver configuration, but more detailed evaluations will be conducted at dams with receivers installed at fishway entrances (Bonneville and McNary dams). Data collected in 1996 and 1997, years with above average flows, extended periods of spill, and delayed fish runs, will provide a base of comparison with passage data in subsequent years with average or below flows. We do not anticipate controlling river flow for studies of adult fish passage, but we should be able to gain some insight into the effects of flow, spill, and location of powerhouse discharge by monitoring fish passage throughout the runs as flows change. As we learn more of what fish are doing at the dams, we may consider testing various spill and powerhouse discharge configurations if there is evidence that passage is affected by those discharges.

At the present time, high flows and spill and dissolved gas concentrations in the river appear to be important factors that adult salmon, steelhead, and lamprey must deal with during their upstream migration.

Effect of new navigation lock on passage at Bonneville Dam.
The effects, if any, of the new navigation lock at Bonneville Dam on fish passage at the dam and adults entering Bonneville Hatchery will be investigated by placing receivers and antennas in locations that will allow monitoring of fish movements in the vicinity of the lock and the entrance to the hatchery. Fish outfitted with transmitters will be monitored as described above, and mobile tracking will be undertaken to get a complete record of fish movements. In 1996, many spring chinook salmon hesitated at the mouth of Tanner Creek and then entered the navigation lock channel before proceeding upstream. In 1997, some sockeye salmon have been recorded as they passed the antennas at the upstream end of the navigation lock.

The primary question to answer is whether the new lock entrance affects the movements of fish entering Tanner Creek (access to Bonneville Hatchery) and those passing the dam. The number of fish entering the lock entrance, time spent in the lock, and ultimate entry into Tanner Creek or passage at the dam will be assessed to determine if the lock delays or affects fish moving up the south shore of the Columbia River. Movements into and out of the lock will be related to activities and flows in the lock channel.

Fallback of fish at the dams.
Flows were above average in 1996 and 1997 and there was an extended period of spill at all dams. Fish passage data from Bonneville Dam was processed during the migration

period to provide managers with a preliminary estimate of fallback (15-20% in 1996 and up to 20% in 1997). Estimates for the other dams have not been completed, and the estimates at Bonneville Dam will be refined when the general migration analysis is completed. The extent of fallback will be determined at each of the dams with receivers located in tailraces and top of ladders. Fish that exit the top of the ladders and are then recorded downstream in the tailrace or reascending and passing through the top of a ladder will be noted as a fallback, even though the route of fallback will be unknown. At Bonneville Dam antennas and receivers were set up to monitor movements in the spillway channel of the forebay and in the ice and trash sluiceways to help determine the route of fallback. A comprehensive assessment of fallback at the lower Columbia River dams will be available when migrations files for each fish outfitted with a transmitter have been assembled.

Passage of lamprey at the dams and through reservoirs.
In 1996, several lamprey were trapped and 100 were released with transmitters, most downstream from Bonneville Dam and a few upstream near Cascade Locks, to evaluate their movements past the dam, through the reservoir, and to evaluate the use of transmitters in lamprey. The lamprey population in the Columbia River has declined in the last 25 years, and the cause of the decline is unknown. Radio telemetry is a potential tool to provide unbiased data on the migrational behavior of lamprey at the dams. Stier and Kynard (1986) tagged lamprey with external (dorsal mount) radio transmitters while Tibble et al. (1981) and Schiavone et al. (1994) placed transmitters in the body cavity (surgical implants) for lamprey behavior studies. However, little has been done to evaluate migrations of lamprey at large hydroelectric facilities, and the effect of the transmitters on migration and maturation.

Information to be collected on lamprey migrations is similar to that on salmonids, including time to return to Bonneville Dam from the release site, time to pass each of the lower Columbia River dams, migration rates and behavior in reservoirs, routes of passage at dams and in reservoirs, and distribution of lamprey upstream from Bonneville Dam. Lamprey were trapped in the north-shore ladder during June through August 1996-98. . In 1998, three studies are underway: detailed monitoring of lamprey with transmitters to determine where lamprey fail in their migration past Bonneville Dam, laboratory studies to define the swimming capabilities and willingness of lamprey to move through tubes, and evaluations of lamprey maturation and its relation to migrations. Studies in 1999-00 involve testing of structures to guide lamprey into passage conduits, testing of alternate means of passing lamprey over the dams, and perhaps testing of some modifications in present fishways at identified bottlenecks. Migration data will be collected using the same receivers and antennas, mobile tracking procedures, and data processing previously described for adult salmonids.

Migration of salmon and steelhead to tributaries and hatcheries and survival to spawning.
To determine if salmon and steelhead with transmitters successfully migrate to tributaries used for spawning, fixed-site receivers and Yagi antennas will be installed near the mouths of major tributaries to record the number and timing of fish entering the

tributaries. Distribution of fish within major tributaries will be assessed by periodic mobile tracking by truck or aircraft.

Arrival of fish with transmitters at hatcheries will be assessed by hatchery personnel when the fish are first handled at the hatchery and by periodic mobile tracking in the vicinity of each hatchery.

Survival to natural spawning will be assessed by examining fish with transmitters found in selected spawning areas to determine if they had spawned. Each spawning area selected for intensive study would be mobile tracked prior to surveys by crews counting redds and examining carcasses to determine if fish with transmitters are present and their approximate location. This information will be passed to spawning ground survey crews to increase the chances of recovering tagged fish.

Survival to time of spawning in hatcheries will be assessed by examination of fish that die before spawning and those spawned to find and record the number on VI tags placed near the eye at time of tagging. Both VI tags and transmitters will be used to identify fish that enter hatcheries, but transmitters will be removed when fish are first handled at hatcheries. Hatchery personnel will be requested to examine fish that die before spawning for transmitters and VI tags.

Success of migration and survival to spawning related to migration history.
The migration history of each salmon and steelhead released with a transmitter will be related to the last location recorded and information on survival to spawning, if available. Migration history will include date of release with transmitter, time to pass the dams and through free-flowing rivers enroute to their natal stream or hatchery, number of fall backs, route of migration, injuries noted at time of tagging, and migration conditions they faced; i.e. flows, spill, and turbidity.

Route of migration of chinook and sockeye salmon in forebay of Bonneville Dam in relation to fallback at the dam.
Columbia River flows at Bonneville Dam in 1997 were above average with high flows and spill through July. Three groups of salmon (spring and summer chinook, and sockeye salmon) that pass Bonneville Dam in spring and summer were subject to conditions that are associated with high fallback rates.

We tracked salmon with transmitters in the forebay of the dam starting in April as soon as signigicant numbers of fish were available. Two people in a boat tracked fish when they exited the Bradford Island fishway into the forebay of powerhouse I. Fish were tracked through the forebay and to a point upstream from the dam from which fish were unlikely to return to the dam. The route of migration of each fish tracked will be plotted on maps of the forebay and then grouped to determine the predominant patterns.

The extent of fallback will be determined at the dam with receivers located in tailraces and top of ladders. Fish that exit the top of the ladders and are then recorded downstream in the tailrace or reascending and passing through the top of a ladder will be noted as a

fallback, even though the route of fallback will be unknown. At Bonneville Dam antennas and receivers have been set up to monitor movements in the spillway channel of the forebay and in the ice and trash sluiceways to help determine the route of fallback. A comprehensive assessment of fallback will be available when migration files for each fish outfitted with a tranmitter have been assembled.

During 1997, we released more than 800 spring and summer chinook salmon and 600 sockeye salmon with transmitters. About half of those fish would pass over Bonneville Dam via the Bradford Island fishway. With two people tracking fish 8 h/d, 5 d/wk, during April through July, we anticipate tracking at least 100 each of chinook and sockeye salmon.

g. Facilities and equipment

Radio telemetry equipment used in 1998 would be available for studies in 2000. Coordination and planning will be necessary to distribute the equipment as needed. Transmitters for use in 2000 will need to be ordered in late 1999. Computers, vehicles, and boats will be supplied by the researchers as needed on a rental basis.

h. Budget

Total project budget for FY 2000 is $1,500,904. Based on last years agreement, BPA's portion of the budget is 200,000. This is approximately 13% of total expected expenses for FY00. Objectives 1, 2, and 6 relate to system wide effects and so portions of these objectives are appropriate for BPA funding. We are requesting BPA fund 30% of the cost for tags and 46% of personnel costs.

Section 9. Key personnel

Project planning, administration, reporting:
Project leader, T.C. Bjornn,
Work plan preparation, protocols, computer programs, permits:
T. Bjornn, NBS
L. Stuehrenberg, NMFS
C. Peery, U of I
Equipment specifications and purchase:
K. Tolotti, U of I
Tagging of fish
R. Ringe, tagging crew
Monitoring of receivers at dams and downloading data
K. Tolotti, P. Kinery, R. Ringe, J. Vela
Mobile tracking and gathering of recapture information
C.Peery, R. Ringe, NMFS people, Bio aides
Processing of data
L. Stuehrenberg, C. Peery

NAME: BJORNN, Theodore C.

POSITION: Professor of Fish Resources and Assistant Leader, Idaho Cooperative Fish and Wildlife Research Unit, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow 83843.
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EDUCATION

Degree	Date	Institution	Location	Major
B.S.	1956	Utah State U.	Logan, UT	Fish Biology
M.S.	1957	U. of Idaho	Moscow, ID	Fishery Mgt.
Ph.D.	1966	Utah State U.	Logan, UT	Fish Biology

RECENT EXPERIENCE

1985 - Present: Professor of Fish Management and Assistant Leader of Idaho Cooperative, Fish and Wildlife Research Unit, Department of Fish and Wildlife Resources, University of Idaho.

1973-1985: Professor of Fish Management and Leader, Idaho Cooperative Fishery Research Unit, Department of Fish and Wildlife Resources, University of Idaho.

1966-1973: Associate Professor of Fish Management and Assistant Leader, Idaho Cooperative Fishery, Research Unit, Department of Fish and Wildlife Resources, University of Idaho.

RELEVANT PUBLICATIONS

Stabler, D. F., R. R. Ringe, R. G. White, and T. C. Bjornn. 1975. The effects of altered flow regimes, temperatures and river impoundment on adult steelhead trout and chinook salmon. Idaho Cooperative Fishery Research Unit, University of Idaho, Progress Report, Moscow.

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– 1996. Technical Report 97-1, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho.

Bjornn, T.C., K.R. Tolotti, J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 1998. Passage of chinook salmon through the lower Snake River and distribution in the tributaries, 1991-1993. Part I of final report for Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries. U.S Army Corps of Engineers, Walla Walla, Washington.

Bjornn, T.C., J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 1998. Entrances used and passage through fishways for salmon and steelhead at Snake River dams. Part III of final report for Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries. U.S Army Corps of Engineers, Walla Walla, Washington.

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Bjornn, T.C., J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 1998. Movements of steelhead in fishways in relation to transition pools. Part V of final report for Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries. U.S Army Corps of Engineers, Walla Walla, Washington.

Bjornn, T.C., J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 1998. Effect of zero versus normal flow at night on passage of steelhead in summer and fall. Part VII of final report for Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries. U.S Army Corps of Engineers, Walla Walla, Washington.

Peery, C.A, T.C. Bjornn, and K.R. Tolotti. 1998. Evaluation of adult chinook and sockeye salmon passage at Priest Rapids and Wanapum dams with orifice gates open and closed and with a fishway fence – 1997. Technical Report 98-2, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho.

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Curriculum Vitae

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EDUCATION

January 1991 – December 1995
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Major Professor: Dr. Theodore C. Bjornn.

September 1986 – August 1989
Virginia Institute of Marine Science, College of William and Mary, School of Marine Science, Gloucester Point, Virginia 23062. M.A., Biological Oceanography.
Major Professor: Dr. Robert J. Orth.

September 1982 – May 1986
Linfield College, McMinnville, Oregon. B.A., Biology.

September 1978 – May 1982
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RESEARCH EXPERIENCE

August 1996 – Present
Research Associate, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, Idaho 83844.

August 1995 – August 1996
Postdoctoral fellow, Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho, 83844.

January 1991 – December 1995

Ph.D. candidate, Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho 83844.

March 1990 – December 1990
Research associate, Department of Fish and Wildlife Resources, University of Idaho, Moscow, Idaho 83844.

June 1989 – August 1989
Laboratory technician (summer position), Department of Chemistry and Toxicology, Virginia Institute of Marine Science, Gloucester Point, Virginia.

September 1989 – June 1989
M.A. candidate, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

September 1986 – June 1989
Research assistant, Virginia Institute of Marine Science, Gloucester Point, Virginia.

PUBLICATIONS

Papers

Peery, C.A., and T.C. Bjornn. Summer dispersal and growth of hatchery chinook salmon parr following release into four Idaho streams. Submitted to North American Journal of Fisheries Management.

Peery, C.A., and T.C. Bjornn. Interactions between hatchery and naturally reared chinook salmon in a laboratory stream channel. In preparation.

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Bjornn, T.C., K.R. Tolotti, J.P. Hunt, P.J. Keniry, R.R. Ringe, and C.A. Peery. 1998. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and tributaries; Part 1, Passage of chinook salmon through the lower Snake River and distribution into the tributaries, 1991-1993. U.S. Army Corps of Engineers, Walla, Walla District. Final Report.

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Peery, C.A., and Bjornn. 1992. Examination of the extent and factors affecting downstream emigration of chinook salmon from spawning grounds in the upper

Salmon River. Idaho Cooperative Fish and Wildlife Research unit, University of Idaho, Moscow. Final Report.

Dissertation

Peery, C.A. 1995. Investigation into chinook salmon supplementation strategies and techniques. University of Idaho, Moscow.

Thesis

Peery, C.A. 1989. Cannibalism experiments with blue crab (*Callinectes sapidus* Rathbun): potential effects of size and abundance. College of William and Mary, Williamsburg, Virginia.

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Section 10. Information/technology transfer

Information and analyses from this study will be provided regularly to managers via reports and verbal presentations. Information that is appropriate will be published in technical journals. Special efforts will be made to provide information for managers as needed.

Congratulations!