Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal Form

Section 1. General administrative information

Assessing Summer and Fall Chinook Salmon Restoration in the Snake River Basin

Bonneville project number, if an ongoing project 9403400

Business name of agency, institution or organization requesting funding
Nez Perce Tribe Department of Fisheries Resources Management

Business acronym (if appropriate) NPT-DFRM

Proposal contact person or principal investigator:

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Subcontractors. List one subcontractor per row; to add more rows, press Alt-Insert from within this table

Organization	Mailing Address	City, ST Zip	Contact Name
Valley Helicopter Service	P.O. Box 54	Clarkston, WA 99403	Jim Pope
Steward Consulting	P.O. Box 206	Bothell, WA 98041-0206	Cleveland Steward
Washington Dept. Of Fish & Wildlife	600 Capital Way N.	Olympia, WA 98501-1090	Lee Blankenship

NPPC Program Measure Number(s) which this project addresses.
7.3B.2, 7.4B.1, 7.5B.1, 7.5B.3

NMFS Biological Opinion Number(s) which this project addresses.

Other planning document references.

If the project type is "Watershed" (see Section 2), reference any demonstrable support from affected agencies, tribes, local watershed groups, and public and/or private landowners, and cite available documentation.

National Marine Fisheries Service Proposed Recovery Plan for Snake River Salmon (March, 1995), Chapter V, Section 4, p V-4-15 Monitoring and Evaluation Strategy; Chapter V, Section 4, p V-4-40 4.7 Biological Objective and p V-4-42 4.7.d; and Chapter V, Section 4, p V-4-43 4.8 Biological Objective. In relation to the Draft Tribal Recovery Plan WY-KAN-USH-MI WA-KISH-WIT (June 15, 1995) p 3-20, the plan states that "fish utilized in supplementation and reintroduction efforts will be selected to best match the natural population of the stream in question" and "the increase in survival and reproduction capacity gained through the use of artificial propagation in supplementation and reintroduction programs is necessary to recover stocks in a timely fashion" and p.5B-25 recommends to: develop experimental and monitoring programs in association with these projects to study the relationships between natural and supplemented components of the populations.

Subbasin.

Clearwater, Grande Ronde, Salmon, Imnaha

Short description.

Assess current summer and fall chinook salmon spawning habitat and use, juvenile growth rates, emigration timing and travel times to dams, juvenile and smolt-to-adult survival for evaluating the recovery and restoration potential in the Clearwater and major tributaries, lower Grande Ronde, Salmon, and Imnaha Rivers.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
X	Anadromous fish		Construction		Watershed
	Resident fish		O & M	+	Biodiversity/genetics
	Wildlife		Production		Population dynamics
	Oceans/estuaries	X	Research		Ecosystems
	Climate	+	Monitoring/eval.	X	Flow/survival
	Other	+	Resource mgmt		Fish disease
			Planning/admin.	+	Supplementation
			Enforcement		Wildlife habitat en-
			Acquisitions		hancement/restoration

Other keywords.

Life history characteristics, hatchery-wild survival comparisons, ecological interactions

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
9801004	Monitoring & Evaluation of Yearling Snake River Fall Chinook	Depends on this project for conducting fall chinook aerial redd surveys and carcass recovery to determine hatchery fish spawning contribution; for fall chinook adult telemetry in Snake River tributaries; and use of jet boat and personnel for juvenile telemetry studies.

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Determine optimal spawning times based on current incubation temperatures for mainstem spawning chinook salmon in the upper mainstem Clearwater (from the North Fork Clearwater River upstream), Middle Fork Clearwater, and lower sections of the South Fork Clearwater, Selway, Lochsa, Salmon, Grande Ronde, and Imnaha Rivers.	a	Collect and analyze all available temperature data for all study streams and identified areas lacking existing temperature data and deploy thermographs where supplement data is needed.
1		b	Describe the spawning and emergence timing window based on average daily thermal temperature units which will allow for successful incubation of summer and fall chinook salmon in all study streams. This task will also describe critical habitat areas for summer and fall spawning chinook salmon.
1		c	Using results of Task 1a and 1b, and available growth information in the literature, model subyearling

			chinook salmon growth necessary to reach a size for successful subyearling emigration survival to the lower Snake and Columbia River dams.
2	Quantitatively and qualitatively evaluate summer and fall chinook salmon spawning habitat at representative or critical spawning index sites in the upper mainstem Clearwater (from the North Fork Clearwater River upstream), Middle Fork Clearwater, and lower sections of the South Fork Clearwater, Selway, and Lochsa, Salmon, Grande Ronde, and Imnaha Rivers.	a	Quantify the existing spawning habitat through physical measurements by boat, snorkeling and direct underwater observation techniques and delineate potential spawning reaches on aerial photographs.
2		b	Qualitatively evaluate the spawning substrate particle sizes with substrate depth at critical, representative, and potential spawning sites for all study streams using the tri-tube freeze-core technique.
2		c	Obtain 9,000 Lyons Ferry Hatchery fall chinook eggs to test incubation survival in the upper Clearwater spawning habitat.
2		d	Investigate the use of infrared technology to locate potential warm water upwelling areas in spawning areas identified in the upper Clearwater River drainage and deploy thermographs in the spawning substrate in reaches where upwelling is identified.
3	Develop a summer and fall chinook salmon broodstock management plan which identifies appropriate brood sources for restoration, potential genetic risks, and a risk containment analysis for the upper mainstem Clearwater	a	Review the Nez Perce Tribe Hatchery Master Plan and coordinate with hatchery managers on appropriate chinook salmon brood sources and risk assessments.

	(from the North Fork Clearwater River upstream), Middle Fork Clearwater, and lower sections of the South Fork Clearwater, Selway, and Lochsa, Salmon, Grande Ronde, and Imnaha Rivers.		
3		b	Subcontract with a genetic consultant to prepare a broodstock management plan which will contain a genetic risk assessment and a risk containment analysis for all study streams.
3		c	Coordinate development of the summer and fall chinook salmon broodstock management plan with appropriate State and Federal agencies.
4	Describe the movement patterns, growth rates, life history characteristics, and emigration survival of hatchery and wild fall chinook salmon in major Snake River tributaries.	a	Obtain 24,000 Lyons Ferry Hatchery fall chinook salmon subyearlings to PIT tag, acclimate a week, and release in the Clearwater River at the Big Canyon Creek Acclimation Facility.
4		b	Work in cooperation with the NMFS in obtaining and PIT tagging 7,500 Lyons Ferry Hatchery subyearling fall chinook for direct stream release in the Clearwater River at Big Canyon Creek.
4		c	Capture (by beach seines, fyke nets and screw traps) and PIT tag up to 4,000 wild fall chinook subyearlings in each the lower Clearwater and Grande Ronde Rivers, and in the lower Salmon and Imnaha Rivers if enough fall chinook redds were present the previous fall.
4		d	Recapture (through task c) wild and Lyons Ferry Hatchery subyearling fall chinook released in tasks a, b, and c to obtain

			movement patterns, habitat use, and growth rates.
4		e	Obtain a subsample of up to 120 wild chinook salmon from the PIT tag groups in each study stream for chinook stock identification i.e. either spring/summer or fall chinook.
4		f	Analyze PIT tag detection information from the mainstem dams, use the Survival Under Proportional Hazards (SURPH) model to estimate juvenile survival of hatchery and wild fall chinook salmon to the Snake River dams, and relate this information to life history characteristics observed in each study stream i.e. percent subyearling versus yearling emigration pattern.
4		g	Obtain a subsample of PIT tagged fish (up to 25 fish/day hatchery and wild) at Lower Granite Dam (through the separation by code system) for growth measurements.
4		h	Assist the Fall Chinook M & E staff (Project 9801004) in collecting locations of radio tagged Lyons Ferry Hatchery yearling fall chinook released at the three acclimation facilities above Lower Granite Dam.
5	Relate wild and hatchery fall chinook survival in study streams to current environmental variables.	a	Correlate wild and hatchery juvenile fall chinook growth and survival information with flow, temperature, Dworshak and Snake River dam operations and compare to previous years data.
5		b	Calculate and compare smolt-to-adult survival versus various release strategies based on PIT tagged adult returns.
6	Determine the extent of current	a	Conduct weekly aerial spawning

	fall chinook spawning activity and hatchery fish contributions in the Clearwater and major tributaries, Grande Ronde, and Salmon Rivers and coordinate redd locations on the Imnaha River with the USFWS and Idaho Power.		ground surveys from mid-October to the first week in December by helicopter to determine fall chinook salmon spawning timing, total number of redds and spawning distribution in the Clearwater and major tributaries, Salmon, and Grande Ronde Rivers.
6		b	Obtain locations of radio tagged hatchery fall chinook salmon adults by helicopter during aerial redd surveys to further determine hatchery fish spawning contributions (in cooperation with Project 9801004).
6		c	Conduct fall chinook deep water redd surveys using underwater video in systematic sampling locations in the Clearwater River to determine the extent of deep water spawning.
6		d	Collect fall chinook carcasses in all study streams for biological information (length, weight, percent spawned, and scales for age determination) and to determine hatchery contributions (through coded wire and elastomer tags), and coordinate with the USFWS and Idaho Power Company on redd counts and locations in the Imnaha River.
7	Provide reports on technical findings, project status, and budget status, including inventory of equipment purchased for the study.	a	Provide project status reports on a quarterly basis to BPA.
7		b	Provide an draft annual report and/or a scientific journal paper on the technical findings for peer review by regional scientists with expertise in this type of research.
7		c	Provide a final annual report and or scientific journal paper for

			publication and distribution that incorporates any necessary changes resulting from peer review comments.

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	02/1994	09/1994	5
2	08/1994	05/1999	25
3	05/1994	03/1998	5
4	06/1994	12/2001	35
5	10/1994	12/2001	1
6	10/1994	12/2001	20
7	05/1994	04/2002	9

Schedule constraints.

Availability of Lyons Ferry Hatchery subyearling fall chinook salmon to continue supplementation survival research for at least five consecutive years. If enough fall chinook adults return to Lyons Ferry Hatchery, we would have five complete years of subyearling fall chinook survival information under a range of environmental conditions by the year 2001.

Completion date.
2002

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel		115,500
Fringe benefits		24,750
Supplies, materials, non-expendable property		800
Operations & maintenance		8,600
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		0
PIT tags	# of tags: 32,000	92,800
Travel		6,700
Indirect costs		45,650
Subcontracts	Helicopter service for aerial redd surveys	10,000

Other		0
TOTAL		304,800

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	313,944	323,362	45,000	
O&M as % of total	96	96	100	

Section 6. Abstract

The goal of this project is to identify currently assessable mainstem habitats, document wild chinook salmon spawning escapement and life history characteristics, and evaluate supplementation strategies that would be favorable for the recovery and restoration of summer and fall chinook in the upper Clearwater River and principal tributaries, lower Grande Ronde, Salmon and Imnaha Rivers.

The 1994 Columbia River Basin Fish and Wildlife Program, Section 7.3B.2, called on Fishery Managers to: "...implement the high priority supplementation projects including design, construction, operation, maintenance, monitoring and evaluation." And Section 7.5B.1 states: "...as quickly as possible and in consultation with the National Marine Fisheries Service, develop an experimental design for implementing, monitoring and evaluating supplementation of and, if appropriate, a captive broodstock program for Snake River fall chinook."

We assessed water temperatures for chinook salmon egg incubation and juvenile rearing which may be limiting factors for recovery of stocks in the upper Clearwater River and major tributaries, lower Grande Ronde, Salmon, and Imnaha Rivers. We are assessing spawning habitat quality and quantity. We are conducting fall chinook salmon aerial redd surveys to document adult escapement and hatchery contributions.

We are investigating life history characteristics of naturally produced Snake River fall chinook in the lower Clearwater and Grande Ronde and monitoring and evaluating supplementation strategies from Lyons Ferry Hatchery. Results will be completed by 2001 and will provide fishery managers with supplementation recommendations that will return the greatest number of spawning adults and contribute to ESA Snake River fall chinook salmon delisting.

Section 7. Project description

a. Technical and/or scientific background.

We are studying summer and fall chinook salmon enhancement and restoration potential because these stocks were historically present in most major tributaries of the Snake River and are currently extinct or on the brink of extinction. The Snake River spring/summer and fall chinook stocks were listed as threatened in 1992 under the Endangered Species Act (ESA). Chinook salmon runs were virtually eliminated in the Clearwater River subbasin by the construction of the Washington Water Power Diversion Dam in the lower river in 1927 (Parkhurst 1950). The dam was removed in 1972 and chinook supplementation began primarily as spring chinook releases in headwater tributaries of the Clearwater subbasin. Dworshak Dam was built on the North Fork Clearwater and under operation in 1972. This project mitigates loses of summer and fall chinook salmon stocks in the Clearwater subbasin as the result of the Clearwater dams and mitigates for summer and fall chinook losses in other major tributaries to the Snake River affected by the lower Snake and Columbia River dams.

The National Marine Fisheries Service Proposed Recovery Plan for Snake River Salmon (March, 1995), Chapter V, Section 4, p V-4-40 4.7 Biological Objective states: "Restore listed chinook salmon by reintroducing them into historic habitat" and Chapter V, Section 4, p V-4-43 4.8 Biological Objective states: "Conduct research to facilitate management that optimizes hatchery production and conserves natural populations." The Mainstem Clearwater River Study: Assessment for Salmonid Spawning, Incubation and Rearing (Arnsberg et al. 1992) described adequate habitat for the recovery and restoration of the ESA listed Snake River fall chinook in the lower Clearwater River and recommended flow and temperature releases from Dworshak Reservoir that would promote recovery. This study also recommended supplementation studies using Lyons Ferry Hatchery fall chinook (Snake River stock) to enhance the natural fall chinook population in the lower Clearwater River.
The current study is a follow-up study for information needed on juvenile fall chinook life history characteristics and survival in the lower Clearwater River in relation to flow and water temperature releases from Dworshak Reservoir and to evaluate potential and vacant habitat in the upper Clearwater River, its major tributaries (Middle Fork Clearwater, South Fork Clearwater, Lochsa, and Selway), and the lower Grande Ronde, Imnaha, and Salmon Rivers for assessing summer and fall chinook recovery and restoration potential. The National Marine Fisheries Service Proposed Recovery Plan for Snake River Salmon (March, 1995) Chapter V, Section 4 p V-4-42 4.7.d states: "Reintroduce spring/summer chinook salmon in the Lochsa and Selway River once an appropriate stock is identified" As part of the current project, we are developing a Broodstock Management Plan for the upper Clearwater subbasin, Grande Ronde, Salmon, and Imnaha Rivers. The Broodstock Management Plan will be coordinated with appropriate Fishery Agencies and will be included in the 1995-96 Report (3/98 draft).

During the start of this project (1994), we investigated the movement patterns, growth rates, and relative survival of naturally produced (wild) subyearling chinook salmon in the lower Clearwater River to the lower Snake River dams through the use of passive integrated transponder (PIT) tags. Wild juvenile fall chinook survival studies will continue and supplementation will begin in other study streams as fish become available.

During 1996-1998, we are quantitatively and qualitatively evaluating potential chinook salmon spawning habitat in the lower Grande Ronde, Salmon, and Imnaha Rivers. We began collecting and will continue to collect life history and survival information on wild fall chinook salmon in the Grande Ronde during 1997 and will do the same on the lower Salmon and Imnaha Rivers if adult spawning escapement increases.

The National Marine Fisheries Service Proposed Recovery Plan for Snake River Salmon Chapter V, Section 4, p V-4-15 Monitoring and Evaluation Strategy states: "supplementation studies are long-term and may extend for 15 years and preliminary information should be available after five years" and "The fisheries agencies and the Tribes should also conduct spawning ground surveys and initiate genetic monitoring programs for natural populations that may be affected by stray fish." The current study began supplementation studies using Lyons Ferry Hatchery fall chinook (Snake River stock) in the lower Clearwater River in 1996 as enough fish were not available in 1994 and 1995 because of low adult returns to the hatchery. We would like to have at least five years of supplementation research under different environmental conditions to assess survival and to recommend supplementation strategies that will return the greatest number of spawning adults. The Nez Perce Tribe initiated fall chinook redd surveys in the lower Clearwater River in 1988 (Arnsberg et al. 1992). The current project continued to assess fall chinook spawning escapement to the lower Clearwater and began redd surveys in the lower Salmon River in 1994. We are now working in cooperation with the U.S. Fish and Wildlife Service and Idaho Power on conducting fall chinook redd surveys in the Grande Ronde and Imnaha Rivers. All fall chinook carcasses observed from redd surveys were collected and biological information, hatchery contributions, and stray fish assessed each year since redd surveys began in 1988.

The Goals of the 1994 Fish and Wildlife Program also calls on Fishery Managers "...as quickly as possible and in consultation with the National Marine Fisheries Service, develop an experimental design for implementing, monitoring and evaluating supplementation of and, if appropriate, a captive broodstock program for Snake River fall chinook." We included in the first annual report a supplementation experimental study design to investigate the survival of Lyons Ferry Hatchery fall chinook salmon (Snake River stock) to Lower Granite Dam following releases in the lower Clearwater River (Arnsberg and Steward in Arnsberg and Statler, 1995). The first two years of this project (1994-95) addressed current summer and fall chinook salmon use and spawning habitat evaluations in the upper Clearwater River (above the North Fork Clearwater River confluence) and major tributaries. We believe limiting factors for successful restoration of summer and fall chinook salmon in the upper Clearwater and principal tributaries may be cold water temperatures during the early egg incubation period and warm temperatures during summer juvenile rearing (Arnsberg and Statler, 1995). Arnsberg and Statler (1995) also reports that current Dworshak Reservoir cold water releases (primarily to cool the Snake River) in the summer may be negatively affecting rearing ESA listed fall chinook in the lower Clearwater River. However, emigration survival of fall chinook salmon juveniles to the ocean, as with all anadromous species, may be the most prominent single factor limiting recovery and restoration of ESA listed stocks under the

current lower Snake and Columbia Rivers dam configuration.

b. Proposal objectives.

Objective 1: Determine optimal spawning times based on current incubation temperatures for mainstem spawning chinook salmon in the upper mainstem Clearwater (from the North Fork Clearwater River upstream), Middle Fork Clearwater, and lower sections of the South Fork Clearwater, Selway, Lochsa, Salmon, Grande Ronde, and Imnaha Rivers. This modeling exercise was used in the Broodstock Management Plan which identifies potential summer and fall chinook salmon stocks suitable for recovery and restoration in the Snake River Basin. Results for the Clearwater River subbasin are reported in Arnsberg and Statler (1995). Results for the lower Grande Ronde, Salmon, and Imnaha Rivers and the Broodstock Management Plan will be reported in the combined 1995-96 report (3/98 draft).

Ho1: Water temperatures will not be favorable for summer or fall chinook egg incubation survival. Corollary: Water temperatures will be favorable for summer and/or fall chinook survival during egg incubation.

Objective 2: Quantitatively and qualitatively evaluate summer and fall chinook salmon spawning habitat at representative or critical spawning index sites in the upper mainstem Clearwater (from the North Fork Clearwater River upstream), Middle Fork Clearwater, and lower sections of the South Fork Clearwater, Selway, and Lochsa, Salmon, Grande Ronde, and Imnaha Rivers.

Ho2: Spawning habitat quality and quantity will not be adequate to sustain summer and/or fall chinook natural production. Corollary: Sufficient spawning habitat will be available in study streams and sedimentation levels will be favorable for natural production.

Objective 3: Develop a summer and fall chinook salmon broodstock management plan which identifies appropriate brood sources for restoration, potential genetic risks, and a risk containment analysis for the upper mainstem Clearwater (from the North Fork Clearwater River upstream), Middle Fork Clearwater, and lower sections of the South Fork Clearwater, Selway, and Lochsa, Salmon, Grande Ronde, and Imnaha Rivers. The Broodstock Management Plan will be reported in the combined 1995-96 report (3/98 draft).

Objective 4: Describe the movement patterns, growth rates, life history characteristics, and emigration survival of hatchery and wild fall chinook salmon in major Snake River tributaries.
Survival research of Lyons Ferry Hatchery fall chinook subyearlings began in the lower Clearwater River during 1996 in cooperation with the NMFS (a draft 1996 annual report is completed). These were direct steams releases and research continued in 1997. We

began supplementation survival research in 1997 and acclimated release groups at the Big Canyon Creek Acclimation Facility prior to release. Generally, fishery managers believe that acclimation is essential prior to release of supplemented fish for the highest return of adults to the stream of supplementation.

Ho4a: No difference in emigration survival and travel times occurs between Lyons Ferry Hatchery subyearling fall chinook and wild fall chinook regardless of size and time of release. Corollary: A detectable difference in the emigration survival and travel times will be observed between hatchery and wild fall chinook released at different sizes and times .

Ho4b: Acclimation of hatchery fall chinook subyearlings does not improve emigration survival to the mainstem dams. Corollary: A detectable difference in emigration survival will be observed in acclimated hatchery versus direct stream released fall chinook.

Objective 5: Relate wild and hatchery fall chinook survival in study streams to current environmental variables.

Ho5: There will be no relationship between juvenile emigration survival and water temperature and flows. Corollary: A correlation between juvenile survival and dam discharges and water release temperatures will be observed.

Objective 6: Determine the extent of current fall chinook spawning activity and hatchery fish contributions in the Clearwater and major tributaries, Grande Ronde, and Salmon Rivers and coordinate redd locations on the Imnaha River with the USFWS and Idaho Power.
We continued conducting fall chinook redd surveys in the Clearwater subbasin since this project began. The lower Salmon River was included in redd surveys in 1994. We reported on redd locations and hatchery contributions in our 1994 Annual Report (Arnsberg and Statler 1995). We are working in cooperation with the U.S. Fish and Wildlife Service and Idaho Power Company on fall chinook redd surveys and carcass collections in the Grande Ronde and Imnaha Rivers.

Objective 7: Provide reports on technical findings, project status, and budget status, including inventory of equipment purchased for the study.
Quarterly progress reports have been provided and will be provided to BPA. A 1994 Annual Report has been published by BPA (Arnsberg and Statler 1995). A draft combined 1995-96 Report will be out for review in 3/98. A 1997-98 Report will be provided to BPA by 3/99. Annual reports will be provided to BPA for 1999 and 2000 results and a final report of project results and recommendations will be provided by 4/2002. Papers on applicable results will be submitted for scientific journal publication where appropriate and presented orally in scientific forums.

c. Rationale and significance to Regional Programs.

This research and monitoring and monitoring study may direct future supplementation strategies (i.e. release location, release timing, release fish size, acclimation versus direct stream release) for Lyons Ferry Hatchery fall chinook supplementation above Lower Granite Dam. Supplementation of fall chinook above Lower Granite Dam was initiated for immediate conservation and future recovery of fall chinook in their native habitat. This study will provide a broodstock management plan for supplementation to recover stocks of summer and/or fall chinook salmon in the upper Clearwater and major tributaries, Grande Ronde, Imnaha, and Salmon Rivers. Our 1994 BPA Annual Report (Arnsberg and Statler 1995) recommended discharge and water temperature releases from Dworshak Dam that may provide benefits to the ESA listed fall chinook and all anadromous stocks in the lower Clearwater River which enforced earlier recommendations by Arnsberg et al. (1992). Spawning habitat quality assessments may result in greater habitat protection measures in critical and potential summer and fall chinook spawning reaches.

During 1996, our recommendations on Dworshak Reservoir discharges and water temperature releases were taken into account by the Technical Management Team for Snake River salmon recovery. Flow releases in the last few years were not as drastic as in 1994 (Arnsberg and Statler 1995) and flows were increased later in the summer (August instead of July). In the long term, we recommended that water shortages for anadromous fish during the summer come out of conservation measures in the upper Snake River Basin instead of a disproportionate amount from the North Fork Clearwater River (Arnsberg and Statler 1995).

The FWP calls for an adaptive management approach which involves monitoring and evaluation of implemented programs. This project will evaluate the success of subyearling fall chinook supplementation above Lower Granite Dam and facilitate management decisions for the future conservation and perpetuation of naturally spawning populations of fall chinook salmon in the Clearwater, Grande Ronde, Salmon, and Imnaha River subbasins.

Project 9102900 is assessing fall chinook spawning habitat availability and quality, juvenile life history characteristics and emigration survival in the mainstem Snake River and we are doing the same in the major Snake River tributaries where fall chinook exist but in low numbers. Project cooperation includes: describing juvenile life history characteristics of wild and Lyons Ferry Hatchery supplemented fall chinook, emigration survival as it relates to environmental conditions, and conducting fall chinook aerial redd surveys and documenting hatchery fish contributions in all remaining production streams above Lower Granite Dam.

Project 9302900 evaluated the emigration survival of supplemented fall chinook (non-Snake River stock) in the Snake River above Lower Granite Dam during 1995. During 1996, we worked cooperatively with NMFS and USFWS to evaluate emigration survival of supplemented Lyons Ferry fall chinook (Snake River stock) subyearlings in the Snake

and Clearwater Rivers. We are also cooperating with these entities and the WDFW on similar and expanded studies in which extra Lyons Ferry Hatchery production subyearlings were released in the Clearwater River at the Big Canyon Creek Acclimation Facility during 1997.

d. Project history

This current project is a follow-up study from the Mainstem Clearwater Study (Arnsberg et al. 1992) to evaluate potential and vacant habitat in the upper Clearwater River, its major tributaries (Middle Fork Clearwater, South Fork Clearwater, Lochsa, and Selway), and the lower Grande Ronde, Imnaha, and Salmon Rivers for assessing summer and fall chinook salmon recovery and restoration. During the start of this project (1994), we investigated the movement patterns, growth rates, and relative survival of naturally produced (wild) subyearling chinook salmon in the lower Clearwater River to Lower Granite Dam through the use of passive integrated transponder (PIT) tags. Wild juvenile fall chinook survival studies will continue and supplementation will begin in other study streams as fish become available. During 1996-1998, we are quantitatively and qualitatively evaluating potential chinook salmon spawning habitat in the lower Grande Ronde, Salmon, and Imnaha Rivers. We began collecting life history and survival information on wild fall chinook salmon in the Grande Ronde during 1997 and will do the same on the lower Salmon and Imnaha Rivers if adult spawning escapement increases. This project promotes adaptive management by evaluating fall chinook survival and life history characteristics during varying environmental conditions and management regimes of controlled flows and water temperature releases.

Quarterly Progress Reports have been submitted to BPA since this project's inception. A 1994 Annual Report has been published by BPA (Arnsberg and Statler 1995). A combined 1995-96 Annual Report draft will be completed by 3/98. A cooperative BPA Annual Report is drafted for the direct stream releases of Lyons Ferry Hatchery subyearling fall chinook: Muir, W.D., S.G. Smith, E.E. Hockersmith, M.B. Eppard, W.P. Connor, and B.D. Arnsberg. REVIEW DRAFT. 1998. Passage survival of hatchery subyearling fall chinook salmon to Lower Granite, Little Goose, and Lower Monumental Dams, 1996.

The project costs for four years since its inception in February 1994 have been $978,283.

e. Methods.

Objective 1:

Temperatures will be continuously monitored to assess early egg incubation and juvenile rearing conditions in all study streams. Thermographs were placed in the water column and in the spawning substrate to determine habitat conditions. Thermal temperature units will be calculated for the summer and fall chinook egg incubation period to assess egg-to-

fry survival and to predict emergence timing of potential stocks. Summer juvenile rearing conditions will be assessed by describing average daily and maximum water temperatures. Tasks associated with Objective 1 are: Task 1a, Task 1b, and Task 1c as described earlier in table format in Section 4. A critical assumption in all study streams is that water temperature monitoring will be representative of the entire stream. Thermal warm water upwellings may exist in some study streams which may enhance egg incubation survival, promote earlier fry emergence and emigration timing which may improve juvenile survival. Conversely, late juvenile rearing conditions may be expose fish to extreme warm water during the summer which may be tempered by cold water refuges or deep pools in some study streams. Preliminary results indicate that a summer chinook exhibiting a subyearling emigration life history pattern or an early spawning fall chinook may be better suited for reintroduction in the upper Clearwater River and major tributaries (Arnsberg and Statler 1995).

Objective 2:

Spawning habitat quality and quality will be assessed to determine the natural production potential of summer and/or fall chinook. A tri-tube freeze-core sampler will be used to obtain ten spawning substrate samples from each representative spawning site and a subsampler will be used to assess substrate quality with depth. Sample size was based on past studies and variability of the substrate in the Mainstem Clearwater River Study (Arnsberg et al. 1992). ANOVA will be used to test for differences within and between spawning substrate quality indices of percent fines, geometric mean diameter, and the Fredle Index. Expected results may be that some study stream reaches will have poor quality spawning substrate and a high percent fines or sedimentation may be a limiting factor to restoration.

Potential spawning areas will be mapped and spawning availability will be assessed by direct observation and instream flow measurements as described in Arnsberg et al. 1992. Tasks associated with Objective 2 are outlined in Task 2a and Task 2b in Section 4. There is a slight human risk associated with free-coring that includes working with CO2 tanks under pressure, pressure release valves, gauges, etc., however, safety goggles and gloves will minimize these risks.

To test critical egg incubation survival as outlined in Objective 1, we will conduct Task 2c: Obtain 9,000 Lyons Ferry Hatchery fall chinook eggs to test incubation survival in the upper Clearwater spawning habitat. Methods for this experiment will follow those outlined in Arnsberg et al. 1992. We will also Investigate the use of infrared technology to locate potential warm water upwelling areas in spawning areas identified in the upper Clearwater River drainage and deploy thermographs in the spawning substrate in reaches where upwelling is identified (Task 2d). This methodology has been successfully used in the John Day River Basin (Torgersen 1997). Expect results may be that spawning quantity will not be a limiting factor as much as substrate quality in most study streams.

Objective 3:

We will review the Nez Perce Tribe Hatchery Master Plan and coordinate with hatchery managers on appropriate chinook salmon brood sources and risk assessments.
We subcontract with a consultant to prepare a broodstock management plan which will contain a genetic risk assessment and a risk containment analysis for all study streams. A Selway River genetic resource assessment has been prepared (Cramer 1995) has been reviewed and incorporated into the Broodstock Management Plan. This plan will be reviewed by and coordinated with appropriate State and Federal agencies. Tasks 3a, 3b, and 3c outlined in Section 4 relates to this objective. Expected results of chinook stock recommendations within the Broodstock Management Plan may be limited more by ESA considerations and out of basin transfers than by the suitability of the recommended stock to the habitat.

Objective 4:

Snake River fall chinook subyearlings will be requested from Lyons Ferry Hatchery to assess emigration timing, travel times, growth rates, and survival from the lower Clearwater River to the mainstem dams. A total of 24,000 PIT tagged hatchery subyearlings at two sizes (75 and 95 mm) will be acclimated for a week at the Big Canyon Creek Acclimation Facility and released into the Clearwater River over a six week period (4 replicates of 500 fish of each size). Sample sizes were based on an experimental study design by Arnsberg and Steward as reported in Arnsberg and Statler (1995). In cooperation with NMFS, another 1,250 PIT tagged hatchery subyearlings will be direct stream released on each date as the acclimated fish groups for a total of 7,500 fish. Sample sizes were based on sample means and variances obtained for the 1996 survival studies on the Snake and Clearwater Rivers (Muir et al. 1998, draft 1996 Annual Report in review). Survival rates will be compared to wild fall chinook subyearlings captured and PIT tagged (up to 4,000) in the lower Clearwater River as described in Arnsberg and Statler 1995. Recapture information of wild and Lyons Ferry Hatchery subyearling fall chinook will be important to obtain movement patterns, habitat use, and growth rates. We will obtain a subsample of up to 120 wild chinook salmon from the PIT tag groups in each study stream for chinook stock identification i.e. either spring/summer or fall chinook. It is important in describing life history characteristics that the stock of wild subyearlings that are tagged are indeed fall chinook and not spring chinook which rear in lower mainstem reaches. Subyearling fall chinook samples will be sent to the Olympia, WA Laboratory of the Washington Department of Fish and Wildlife for genetic analysis using electrophoretic techniques. Expected results are that a high percentage of juvenile chinook collected will be the fall chinook stock. A subsample of PIT tagged fish (up to 25 fish/day hatchery and wild) at Lower Granite Dam (through the separation by code system, if operable) will be obtained for further growth measurements of emigrating smolts.

The Survival Under Proportional Hazards (SURPH) model (Skalski et al. 1994) will be used to estimate juvenile emigration survival to the mainstem dams. ANOVA will be used to measure statistical survival differences between hatchery and wild fall chinook

releases. We will also compare subyearling to yearling survival as estimated by Project 9801004 and relate this information to smolt-to-adult survival from different supplementation strategies in the Snake River Basin. Preliminary results have indicated that the larger fish released earlier in the year survive better at least to the downstream dams than smaller fish released later in the summer. Tasks outlined in Section 4 that relate to Objective 4 and the methods describe above are Task 4a through Task 4g.

Objective 5:

We will correlate wild and hatchery juvenile fall chinook growth and survival information as described in Objective 4 with flow and water temperatures releases from Dworshak Reservoir and in the Snake River during emigration and compare to previous years data. If enough adults return, we will calculate the smolt-to-adult survival for all subyearling and yearling fall chinook release groups in the Snake River Basin. We will calculate and compare smolt-to-adult survival versus various release strategies based on PIT tagged adult returns to Lower Granite Dam and through carcass collections as described in Objective 6 below. Expected survival of subyearling and yearling fall chinook releases from Lyons Ferry Hatchery has been higher than expected because of a couple good water years in a row. Therefore, adult returns are expected to be higher than normal in the future which will enhance our ability to predict smolt-to-adult survival from various supplementation strategies. Tasks outlined in Section 4 that relate to Objective 5 and the methods describe above are Task 5a and Task 5b.

Objective 6:

We will continue to conduct aerial fall chinook spawning ground surveys by helicopter to determine adult escapement and spawning locations in the Clearwater, Grande Ronde, and Salmon Rivers and coordinate with the USFWS and Idaho Power Company on redd numbers, location, and carcass collection on the Imnaha River. Redds will be mapped on each survey and verified from the ground to document spawning escapement and locations. Spawned-out fish will be collected and biological measurements made to determine sex, size, age (from scale analysis), percent spawned, and the percent hatchery contributions to natural production. Hatchery fish contributions will be made by identifying an adipose clip, other fin clip, or elastomer tag on adults, and through the collection of snouts for coded wire tag (CWT) information. Snouts will be sent to the Washington Department of Fish and Wildlife for CWT extraction and tag reading. An increase in adult escapement and successful contribution to the natural spawning population by hatchery fish is expected in the near future from fall chinook supplementation in the basin.

We will conduct fall chinook deep water redd surveys using underwater video in systematic sampling locations in the Clearwater River to determine the extent of deep water spawning. An underwater video camera mounted on a weighted sled will be lowered to just off the stream bottom by an instream flow cable setup mounted in front of a jet boat. We will search deep water areas where fall chinook spawning substrate is

expected and where redds have been seen from the air when visibility was excellent, however, not common on surveys. Tasks outlined in Section 4 that relate to Objective 6 and methods describe above are Task 6a and Task 6d.

f. Facilities and equipment.

This project is based out of the Nez Perce Tribe Orofino Fisheries Field office in which office space is shared with other BPA funded projects and is adequate for the research and monitoring and evaluation studies.

One jet boat capable of negotiating whitewater has been purchased for the project for juvenile collections, habitat assessments, and chinook salmon redd truthing and carcass collections. An underwater video camera is being purchased to assist in searching for deep water fall chinook redds in study streams. Two seines have been purchased for collecting juveniles along beaches by jet boat. This boat is also used in another BPA project (9801004) for radio telemetry studies of yearling fall chinook supplemented upstream of Lower Granite.

The project currently has one personal computer and one laptop computer for field use such as PIT tagging and downloading thermographs in which eight Hobos have been purchased. The project currently has one backpack PIT tag station suitable for field applications. All standard PIT tagging equipment (syringes, needles, MS-222, aeration systems, etc.) has been purchased by the project. A total of 24,000 PIT tags were used for fall chinook supplementation survival research in 1997 and another 10,000 tags were used for production subyearlings to assess juvenile survival released from the Big Canyon Creek Acclimation Facility on the Clearwater River.

The project has one leased GSA fleet pickup truck capable of pulling a jet boat and transporting a crew of four which is required for seining juveniles. A leased GSA fleet mini-van is used for smaller general project transportation, however is not in the FY 1999 Budget.

g. References.

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Arnsberg, B.D and D.P. Statler. 1995. Assessing summer and fall chinook salmon restoration in the upper Clearwater River and principal tributaries. Nez Perce Tribe Department of Fisheries Annual Report to the U.S. Department of Energy, Bonneville Power Administration, Contract No. DE-BI79-87BI12872, Project No.

94-034.

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Torgersen, C.E. 1997. Multiscale assessment of thermal patterns and the distribution of chinook salmon in

Section 8. Relationships to other projects

Project 9102900 is assessing fall chinook spawning habitat availability and quality, juvenile life history characteristics and emigration survival in the mainstem Snake River and we are doing the same in the major Snake River tributaries where fall chinook exist but in low numbers. Project cooperation includes: describing juvenile life history characteristics of wild and Lyons Ferry Hatchery supplemented fall chinook, emigration survival as it relates to environmental conditions, and conducting fall chinook aerial redd surveys and documenting hatchery fish contributions in all remaining production streams above Lower Granite Dam.

Project 9302900 evaluated the emigration survival of supplemented fall chinook (non-Snake River stock) in the Snake River above Lower Granite Dam during 1995. During 1996, we worked cooperatively with these the NMFS and USFWS to evaluate emigration survival of supplemented Lyons Ferry Hatchery fall chinook (Snake River stock) subyearlings in the Snake and Clearwater Rivers. We are also cooperating with these entities and the WDFW on similar and expanded studies in which extra production subyearlings were released in the Clearwater during 1997.

We are also working closely with NPT Project 9801004: Monitoring and Evaluation of Yearling Snake River Fall Chinook Outplanted Upstream of Lower Granite Dam. We share equipment and personnel on this project. Project goals are basically the same which is to restore fall chinook salmon in the Snake River Basin above Lower Granite Dam. We will also be working closely with NPT Project 9801005 at the portable acclimation facilities operated by the Tribe. Research subyearling fall chinook salmon from Lyons Ferry Hatchery will be acclimated at the Big Canyon Creek Acclimation Facility on the Clearwater River during a six week period following the release of yearling fall chinook.

Section 9. Key personnel

Billy D. Arnsberg, Project Leader, full time (1 FTE). Under the direction of the Director of Biological Services (Paul Kucera) and the Research Coordinator (Jay Hesse), the Project Leader is responsible for: assessing summer and fall chinook salmon spawning, incubation, outmigration timing, and survival in the Clearwater and upper tributaries, lower Salmon, Grande Ronde, and Imnaha rivers. The Project Leader shall coordinate summer and fall chinook salmon research with the Bonneville Power Administration, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Forest Service, Washington Department of Fisheries, Oregon Department of Fish and Wildlife, Idaho Department of Fish and Game and other agencies as required. The Project Leader will work closely with the Nez Perce Tribal Hatchery Monitoring and Evaluation studies and oversee Project 9801004 Monitoring and Evaluation of Lyons Ferry Hatchery Fall Chinook released upstream of Lower Granite Dam. The Project Leader is responsible for administrating Bonneville Power Administration contracts and conducting evaluation studies for the Nez Perce Tribe including development of budgets, plan of operation, monitoring expenditures, statements of work, reporting and coordinating office and field work with management staff. The Project Leader is also responsible for maintaining written records of interactions with funding agencies, reviewing agencies and co-management agencies, write and publish meeting, progress and annual reports, maintain a data base, correspond orally and in writing with supervisory staff and co-management agencies. The Project Leader provides management, training and supervision of full time and temporary personnel for conducting an evaluation of summer and/or fall chinook salmon restoration potential in mainstem rivers, and yearling fall chinook monitoring and evaluation studies. The Project Leader will act as a technical representative of the Nez Perce Tribe on multi-agency committees for coordination and planning of chinook salmon assessment and restoration in mainstem rivers, including hatchery management, supplementation and natural production.

Qualifications of Billy D. Arnsberg for this project includes over eight years of working as a Fisheries Research Project Leader for the Nez Perce Tribe, one year experience working at Dworshak National Fish Hatchery and the McCall Fish Hatchery, over 2 years working as a Fisheries Research Technician for the Idaho Department of Fish and Game, and 2 years working as a Fisheries Research Technician at the University of Missouri. Mr. Arnsberg was the Project Leader and primary author on The Mainstem Clearwater River Study: Assessment for Salmonid Spawning, Incubation, and Rearing. BPA Project 88-15.

RESUME: Billy D. Arnsberg

EDUCATION:

UNIVERSITY OF IDAHO, MOSCOW, ID. 1987-1990. M.S. coursework in Fisheries Science. Thesis entitled: Food Availability and Diet of Fish in Little Payette Lake Before and After Rotenone Treatment.

UNIVERSITY OF MISSOURI, COLUMBIA, MO. 1982-1984. B.S. Degree in Fisheries and Wildlife Management.

SOUTHEAST MISSOURI STATE UNIVERSITY, CAPE GIRARDEAU, MO. 1980-1982.

EXPERIENCE:

NEZ PERCE TRIBE, LAPWAI, ID. 1989-Present. Fisheries Research Project Leader. Researcher and primary author of the Mainstem Clearwater River Study: Assessment for Salmonid Spawning, Incubation, and Rearing, BPA Project 88-15. Project Leader for two years on Salmon Supplementation Studies in Idaho Rivers, BPA Project 8909802. Currently Project Leader for Assessing Summer and Fall Chinook Salmon Restoration in the Snake River Basin (BPA Project 9403400).

IDAHO DEPARTMENT OF FISH AND GAME, McCALL, ID. 4/86-9/88. Fisheries Research Technician.

DWORSHAK NATIONAL FISH HATCHERY, AHSAHKA, ID. 12/86-4/87. Fisheries Biological Aid.

McCALL FISH HATCHERY, McCALL, ID. 10/86-12/86. Fisheries Biological Aid.
MISSOURI DEPARTMENT OF CONSERVATION, COLUMBIA, MO. 1/85-12/85 and 9/85-12/85. Wildlife Research Technician.

U.S. FISH AND WILDLIFE SERVICE, SASKATCHEWAN, CANADA. 4/85-9/85. Wildlife Research Technician.

MISSOURI DEPARTMENT OF NATURAL RESOURCES, COLUMBIA, MO. 5/84-10/84. State Park Ranger.

UNIVERSITY OF MISSOURI, COLUMBIA, MO. 5/82-5/84. Fisheries Research Technician.

PUBLICATIONS:

Muir, W.D., S.G. Smith, E.E. Hockersmith, M.B. Eppard, W.P. Connor, and B.D. Arnsberg. REVIEW DRAFT. 1998. Passage survival of hatchery subyearling fall chinook salmon to Lower Granite, Little Goose, and Lower Monumental Dams, 1996. Prepared for Bonneville Power Administration.

Arnsberg, B.D and D.P. Statler. 1995. Assessing summer and fall chinook salmon restoration in the upper Clearwater River and principal tributaries. 1994 Annual Report prepared for the U.S. Department of Energy, Bonneville Power Administration, Contract No. DE-BI79-87BI12872, Project No. 94-034.).

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Anderson, D., D. Scully, J.H. Griswold, and B. Arnsberg. 1987. Idaho Department of Fish and Game Federal Aid in Fish Restoration, Job Performance Report, Project F-71-R-11.

RESUME:

Research Director: Paul Kucrea, Director of Biological Services, 160 hrs
Nez Perce Tribe Department of Fisheries Resources Management

EDUCATION:

Bachelor of Science. 1975.
Utah State University.
Major: Fisheries Management.

Completed MS studies at the University of Idaho 1990
Major: Fisheries Management.

PROFESSIONAL EXPERIENCE:

1991-present Director of Biological Services with the Nez Perce Tribe Department of Fisheries Resources Management. Responsible for technical program direction and administration of the Fisheries Research Division.

1988-1991 Senior Fisheries Biologist with the Nez Perce Tribe Fisheries Department.

1987-1988 Acting Fisheries Program Manager with the Nez Perce Tribe Fisheries Department. Responsible for fisheries program management and direction.

1984-1986	Senior Fisheries Biologist with the Nez Perce Tribe Fisheries Department. Conducted research on juvenile steelhead trout life history characteristics and abundance in relation to physical habitat parameters on five streams.
1982-1983	Project fisheries biologist with the Nez Perce Tribe Fisheries Department. Responsible for conduct of a physical and biological inventory of streams on the reservation proper with emphasis on anadromous salmonids.
1978-1980	Fisheries biologist with the Colville Confederated Tribes Fish and Wildlife Department. Developed fishery management programs for the Colville Tribe on their 1.3 million acre reservation and the 1.7 million acre ceded area.
1975-1978	Fisheries research biologist with W.F. Sigler and Associates, Environmental Consulting Firm. Ecological and fish life history research on 110,000 acre Pyramid Lake, Nevada.

Unique Abilities:

Certified Fisheries Scientist - AFS
Experienced with Endangered Species Act and management of listed fish species.
Experience in program development and procuring project funding.
Research and management experience with resident and anadromous species.
Familiar with Tribal government and management approaches.
Trained in CPR and First Aid.
Certified SCUBA diver - NAUI

Publications

Kucera, P.A. and J.L. Kennedy. 1977. Evaluation of a sphere volume method for estimating fish fecundity. The Progressive Fish Culturist. 39(3)115-117.

Kucera, P.A. 1978. Reproductive biology of the tui chub, Gila bicolor, in Pyramid Lake, Nevada. Great Basin Naturalist. 38(2): 203-207.

Kennedy, J.L. and P.A. Kucera. 1978. The reproductive ecology of the Tahoe sucker, Catostomus tahoensis, in Pyramid Lake, Nevada. Great Basin Naturalist 38(2): 181-186.

Vigg, S., P. A. Kucera. 1981. Contributions to the life history of Sacramento perch,
Archoplites interruptus, in Pyramid Lake, Nevada.Great Basin Naturalist 41(3): 278-289.

Sigler, W.F., W.T. Helm, P. A. Kucera, S. Vigg and G. W. Workman. 1983. Life history of the Lahontan cutthroat trout, Salmo clarki henshawi, in Pyramid Lake, Nevada. Great Basin Naturalist 43(1): 1-29.

Kucera, P.A., D.L. Koch and G.F. Marco. 1985. Introductions of Lahontan cutthroat trout into Omak Lake, Washington. North Amer. Jrnl. Of Fish. Mngt. 5(2): 296-301.

Johnson, J.H. and P.A. Kucera. 1985. Summer-autumn habitat utilization of subyearling steelhead trout in tributaries of the Clearwater River, Idaho. Can. Jrnl. Zool. Vol, 63:2283-2290.

Kucera, P.A. 1989. Nez Perce Tribal review of the Imnaha River Lower Snake River Compensation Plan. AFF1/LSR-89-08, Tech. Rep. 89-7. Annual project report to the U.S. Fish and Wildlife Service. Nez Perce Tribe Fisheries Dept., Lapwai, ID. 49 pp.

Kucera, P.A. and M.L. Blenden. 1996. Summary report of 1996 project activities relating to endangered chinook salmon populations listed under the Endangered Species Act. Nez Perce Tribe Department of Fisheries Resources Management, Lapwai, Idaho. 60 pp.

RESUME:

Technical Advisor: Jay A. Hesse, Research Coordinator, no funding associated
Nez Perce Tribe Department of Fisheries Resources Management

Education: M.S. in Fisheries, Michigan State University, 1994
B.S. in Fisheries and Wildlife, Michigan State University, 1992

Duties: Technical direction and supervision of fisheries research projects, research coordination, Nez Perce Tribe LSRCP project implementation, report writing, monitoring and evaluation plan and proposal development, tribal fisheries research representation at federal and state meetings, budget preparation, personnel supervision.

Experience: Project Leader, Idaho Salmon Supplementation Study. Nez Perce Tribe. July 1994 - October 1997.

Publications: Hesse, J. 1997. A-run steelhead status in tributaries of the lower Clearwater River, Idaho. In Interactions of hatchery and wild

steelhead in the Clearwater River of Idaho. 1995 Progress Report, Fisheries Stewardship Project, USFWS Report. November 1997.

Hesse, J.A., P.J. Cleary, and B.D. Arnsberg. 1995. Salmon Supplementation Studies in Idaho Rivers. Annual Report - 1994. U.S. Department of Energy - Bonneville Power Administration. Portland, Oregon.

Hesse, J.A. and B.D. Arnsberg 1994. Salmon Supplementation Studies in Idaho Rivers. Annual Report - 1993. U.S. Department of Energy - Bonneville Power Administration. Portland, Oregon.

Hesse, J.A. 1994. Contribution of hatchery and natural chinook salmon to the eastern Lake Michigan fishery, 1992-1993. Masters Thesis, Michigan State University.

Section 10. Information/technology transfer

Annual reports will be written on the results of all objectives and tasks outlined above and scientific journal publications will be submitted on the most contributing results to restore chinook salmon stocks in the Snake River Basin. The Final Project Report will include updated flow and temperature release recommendations which will support the recovery of fall chinook salmon in the lower Clearwater River. Oral presentations of study results will be made in regional forums and at the American Fisheries Society meetings.