Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal Form

Section 1. General administrative information

Evaluate strobe lights as a juvenile salmonid guidance behavioral tool

Bonneville project number, if an ongoing project 9108

Business name of agency, institution or organization requesting funding
Washington State Department of Fish and Wildlife

Business acronym (if appropriate) WDFW

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
Flash Technology Corporation of America	P.O. Box 1549	Brentwood, TN 37024	Ron Brown
HARZA	2353 130th Avenue N. E. , Suite200	Bellevue, WA 98005	Dave Thompson
Columbia River Research Lab, Biological Resources Division, USGS	5501 A Cook-Underwood Road	Cook, WA 98605	Dennis Rondorf
Lewis County PUD/BPA	1379 Falls Road	Randle WA 98377	Mike Kohn and Paul Foster
Fishery Research	3700 East Union	Seattle WA 98122	James Anderson

Consultant			

NPPC Program Measure Number(s) which this project addresses.

Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program (December 1994)

> 5.6A.13. Corps of Engineers and Other Parties. Explore promising new approaches to fish bypass technologies, including development and prototype testing of surface bypass systems, surface spill and behavioral guidance devices, such as the use of sound to guide fish.

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

National Marine Fisheries Service Biological Opinion (March 1995)

> Immediate Measure 15. "The NMFS and other fishery agencies should explore the feasibility and conduct, where appropriate, laboratory and field research to develop new means to collect and/or bypass juvenile migrants so as to avoid turbine related mortality at dams. Studies shall include but not be limited to the following: ...
>
> 3. ...behavioral modifying guidance of smolts into bypass routes..."

Other planning document references.

National Marine Fisheries Service Proposed Recovery Plan (March 1995)

> 2.3.b. Modify facilities to improve survival of listed Snake River salmon past dams.
>
> 2.3.b.10. Evaluate all modifications to fish bypass and collection facilities to ensure that they work as designed and cause minimal adverse effects to fish passing through them.
>
> 2.3.d.1. Evaluate methods to improve bypass systems.

Columbia River Inter-Tribal Fish Commission's Wy-Kan-Ush-Mi Wa-Kish Wit (Spitit of the Salmon) (June 1995)

> Page 5B-41: "Expedite prototype development of surface flow bypass systems(SBC)..."

Subbasin.

Cowlitz Basin above Cowlitz Falls Dam located at RM 88.5.

Short description.

Test strobe lights as tools to guide juvenile salmonids away from turbine intakes and induction slots and into the surface collector at Cowlitz Falls Dam. Hydroaccoustics, radio tagging, fyke and flume nets will be used to evaluate fish responses.

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.

Strobe lights, smolts, presmolts , juvenile salmonids, juvenile spring chinook, juvenile steelhead, juvenile coho, juvenile cutthroat trout, fish guidance efficiency, surface bypass collection (SBC), surface collector, dams, hydroaccoustics, radio telemetry, directed attraction flows

Section 3. Relationships to other Bonneville projects

If you need more rows, press Alt-Insert from within this table.

Project #	Project title/description	Nature of relationship
DE-MS79-91BP93212	Cowlitz Falls Project Anadromous Fish Reintroduction Program DE-MS79-91BP93212	Funded under Power Generation Division of BPA

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Determine the efficacy of strobe lights as a behavioral guidance tool to guide juvenile steelhead, spring chinook, and coho upwards away from the turbine intakes and increase the >opportunity for discovery= to the Surface Bypass Collection System (SBC) at the Cowlitz Falls Dam	a.	Review estimates of Fish Guidance Efficiencies obtained in 1998 as baseline for study objectives
		b.	Use radio telemetry data obtained from pilot study in 1998 for steelhead approach, passage and FGE to refine and finalize study design
		c.	Install and test radio telemetry and hydroaccoustic systems
		d.	Set up and test fyke net frames, installation and removal in the selected turbine intake slot
		e.	Tag, release and monitor approach, passage and collection of radio tagged juvenile salmonids with strobe lights on/off
		f.	Use split beam hydroaccoustics to monitor approach of juvenile salmonids with strobe lights on/off
		g.	Fyke net the selected turbine intake and induction slot to monitor juvenile salmonid passage via the turbine intake and induction slot with strobe lights on/off
		h.	Compile, synthesize and summarize data on passage routes chosen by the juvenile salmonids and estimate Fish Guidance Efficiencies (FGE). Write up results in Annual Project report
2	Determine the efficacy of strobe lights as a behavioral barrier to block juvenile salmonids use of the induction slot thus increasing FGE	a.	Finalize design and install strobe lights at the entrance to turbine unit number 3 induction slot. Test and verify correct operation
		b.	Monitor approach/passage and collection of radio tagged juvenile salmonids with strobe lights on/off

			at the entrance to induction slot number 3
		c.	Fyke net the selected induction slot to monitor juvenile salmonid passage via the turbine intake and/or induction slot with strobe lights on/off
		d.	Collect and enumerate the numbers and species of juvenile salmonids that enter the surface collection/bypass flume in nets placed in the collection flumes
		e.	Compile, synthesize and summarize data on passage routes chosen by the juvenile salmonids and estimate Fish Guidance Efficiencies (FGE). Write up results in Annual Project report
3	Determine how environmental conditions effect strobe light guidance; ie diel patterns, turbidity and temperature	a.	Measure reservoir turbidity and correlate to stobe light effectiveness
		b.	Stratify sampling to evaluate day vs night strobe light effectiveness using data from tasks 1e,1f,1g,2b,2c and 2d
4	Determine the efficacy of inducing a directed flow of water into and through the vertical slots in the baffle panel and entrance to the collection flumes along with the strobe lights to maximize Fish Guidance Efficiencies for the SBC at Cowlitz Falls Dam (FY2001-FY2002)	a.	Finalize design and location of attraction flow devices relative to SBC. Install and test operation
		b.	Finalize study experimental design
		c.	Monitor approach and passage of radio tagged juvenile salmonids with strobe lights and directed attraction flow on/off
		d.	Use split beam hydroaccoustics to monitor movement of juvenile salmonids with strobe lights and directed attraction flow on/off
		e.	Fyke net a turbine intake and induction slot to monitor juvenile salmonid passage via the turbine intake and/or induction slot with strobe lights and directed attraction flow on/off
		f.	Collect and enumerate the numbers and species of juvenile

			salmonids that enter the surface collection/bypass flume in nets placed in the collection flumes with strobe lights and directed attraction flow on/off
		g.	Compile, synthesize and summarize data on passage routes chosen by the juvenile salmonids and estimate Fish Guidance Efficiencies (FGE). Write up results in Annual Project report
5	Complete reports and identify effective ways to utilize this technology to enhance FGE at other hydroprojects throughout the Columbia Basin	a.	Complete compilation and analysis of all data collected for the application of strobe lights and directed attraction flow to enhance FGE in Annual reports and a final Project completion report (FY2003)
		b.	Present results at workshops and/or seminars related to fish passage/collection in the basin
		c.	Host workshops/tours on site to demonstrate application of technology

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	10/1998	12/2003	30 %
2	10/1998	12/2003	20 %
3	10/1998	12/2003	20 %
4	10/2001	12/2003	25 %
5	04/1999	12/2003	5 %

Schedule constraints.

The Cowlitz Falls Dam is a run of the river hydroproject and high flows that require the project to draw the reservoir down more than two feet during the spring-summer migration periods could result in schedule changes. However, the fifty year historical discharge records indicate that it is highly unlikely flows would be high enough to require a drawdown during the spring- summer migration. It is possible that project operation and/or maintenance might require a drawdown that may result in a schedule change.

The 1998-99 proposal assumes that ongoing funding under the current contract will continue and that normal environmental conditions will exist during the evaluation. The

risks are similar to those found at other hydro projects and therefore, a set of safety procedures have been developed.

Completion date.
2003

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel		
WDFW	Temporary fte=s for on-site field work	$41,600
USGS	Telemetry Components	$67,300
USGS	Hydroaccoustic Components	$43,400
Fringe benefits		
WDFW	Temporary fte=s for on-site field work	$12,900
USGS	Telemetry Components	$17,700
USGS	Hydroaccoustic Components	$10,400
Supplies, materials, non-expendable property		
WDFW	Sampling equipment	$2,000
USGS	Telemetry equipment	$66,000
USGS	Hydroaccoustic equipment	$104,900
Operations & maintenance		
USGS	Telemetry	$8,700
USGS	Hydroaccoustics - Vehicles	$2,300
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
USGS	Telemetry Equipment - Receivers, DSP;s	$144,000
USGS	Hydroaccoustic Equipment	$104,900
PIT tags	# of tags:	
Travel		
USGS	Telemetry	$11,200
USGS	Hydroaccoustic	$5,600
Indirect costs		
WDFW	On-site evaluation work	$10,700
USGS	Telemetry	$73,400
USGS	Hydroaccoustic	$39,000
Subcontracts		
Flash Technology Corp.	Costs for lights, set-up, testing, & repairs	$350,000
Harza N.W.	Costs for structural design and construction of support framework for lights	$67,000

James Anderson	Consultant Fishery Research Scientist	$4,700
Other		
WDFW		$67,200
USGS-Telemetry		$388,300
USGS-Hydroaccoustics		$310,500
Flash Technology		$350,000
Harza N.W.		$67,000
James Anderson		$4,700
TOTAL		$1,187,700

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
WDFW	$70,400	$72,500	$74,700	$30,000
USGS-Telemetry	$291,500	$306,100	$321,400	$100,800
USGS-Hydroaccoustics	$214,800	$225,500	$236,700	$72,700
Flash Technology	$400,000	$85,000	$85,000	
Harza N.W.	$33,000	$35,000		
James Anderson	$4,700	$5,100	$5,300	$5,500
Total budget	$1,014,000	$729,200	$723,100	$209,000
O&M as % of total	5 %	5 %	5 %	2 %

Section 6. Abstract

We propose to use strobe lights to guide juvenile spring chinook, steelhead, and coho upwards, and away from turbine intake(s) and induction slot(s) towards the Surface Bypass Collection (SBC) at Cowlitz Falls Dam. This should increase the "opportunity for discovery" (Rainey, 1997) and use of the SBC. In conjunction with the strobe lights we will induce directed attraction flow into the SBC to attract/guide fish into the SBC over the later three years of the project. Past and current research indicate that this approach offers the potential to significantly enhance FGE for migrant juvenile salmonids. This technology may offer managers a cost effective tool to use at hydroprojects within the Columbia Basin to meet juvenile passage and FGE goals. Hydroaccoustics, radio tagging, fyke and flume netting will provide the tools to measure and evaluate the response and behavior of the juvenile salmonids. The experimental study design will utilize on/off blocks of time on a weekly basis throughout primary migration periods for each species. The results could serve as a model for enhancing the FGE of other bypass and SBC systems in operation in the Columbia Basin.

Section 7. Project description

a. Technical and/or scientific background.

Technical and/or scientific background:

7.a.1. The Cowlitz Falls Hydroelectric Project began operation in the spring of 1994. In conjunction with this project Bonneville Power Administration (BPA) contracted an independent consulting firm (GAIA) to develop a plan to restore anadromous fish runs into the upper Cowlitz Watershed and formed a Technical Advisory Committee (TAC) comprised of representatives from state and federal natural resource agencies, public utilities, consultants and citizen groups to help develop and implement the plan. A sub-committee of this group worked specifically with issues related to the Fish Facility and Fish Passage. The result was the completion of a state of the art surface collector and facility which includes attraction, collection, dewatering, bypass, and handling/transport facilities. The site's SBC was modeled on an existing hydro-combine system at the Wells Hydroelectric Project on the Columbia River where the spillways are situated directly over the turbine intakes. This concept creates an attraction flow field with a relatively large amount of water near the surface of the forebay immediately upstream of the dam, which the fish can sense and follow through to the bypass. In addition, the concept called "Opportunity for Discovery" postulates that juvenile fish must pass near the entrance (within 10 feet) of the SBC system if they are to perceive its presence and enter. (Rainey, 1997).

7.a.3 During the spring and summer of 1996, split-beam hydroacoustics were used to monitor directional approach and passage vectors of juvenile salmonids as they approached the Cowlitz Falls Dam. The objective of the study was to determine FGE for migrating juvenile salmonids. The results of the study indicated that almost all fish initially approach the face of the dam in a trajectory which is relatively flat and generally parallel to the surface of the water and were located at a depth of less than 30 feet. However, at a point starting about 25 feet from the entrance of the SBC the trajectory vectors show that the majority of the fish were diving below the entrance to the SBC and towards the facility's turbine intakes. (Adeniyi et al., 1997). As part of the evaluation of the Cowlitz Falls fish facility (Cfff), WDFW released groups of marked fish into the Cowlitz Falls reservoir. The proportion of these fish recovered at the Cfff estimate project Fish Guidance Efficiency (FGE). Preliminary test results indicated the following average recoveries; 45% for steelhead; 17% for subyearling chinook ; and 21% for coho (Serl, *pers. com*). The fish trajectories observed at Cowlitz Falls Dam are not unique. The 1996 hydroacoustic studies by the Corps of Engineers at Lower Granite Dam also indicated that migrating juvenile salmonids were diving at a point approximately 25 to 30 feet in front of the entrance of Lower Granite's SBC. The downward trajectory of the fish eliminated their "opportunity for discovery" of the SBC entrance and resulted in this system's low FGE. However if those fish came within 10 feet of the entrance, 59 to 79% entered the SBC. (Rainey, 1997).

7.a.4 As presently written, the Endangered Species Act (ESA) measures for protecting listed species in the Snake River call for a decision by 1999 on the best manner of bypassing juvenile migrants through non-turbine routes. The present targets are 80% passage through non-turbine routes and a minimum of 95% survival at each dam. These measures will probably be the target model for the Columbia Basin in the future. It is believed that SBC systems can accomplish this rate of FGE if fish can be guided to within 10 feet of the system's entrance.

Strobe Lights as a Behavioral Guidance Barrier for Smolts:

7.a.5 For over forty years, the testing of strobe lighting as a potential protection

technology to guide fish to areas of safe bypass has been conducted in the laboratory, modified field tests and in full site applications. Only in the last several years have the technical advancements in underwater strobe lighting been developed which allow for the full exploitation of this application. Many of the early efforts in evaluating strobe lighting as a potential protection technology for fish were encouraging. Oher laboratory or field tests may have been adversely impacted by the limited capabilities of the equipment utilized. Testing prior to late 1991 was based on the usage of strobe lighting equipment purchased "off the retail shelf," and while at the time it might have represented the best available, these "standard" systems were primarily designed for above water usage. During the last seven years, a number of advances in strobe lighting technology have been made that allow for prolonged and effective usage underwater. In 1995, FTCA introduced the AGL 4100 Aquatic Guidance Lighting System. This system is multi-functional, highly flexible, remote controlled and provides real-time responses to site-specific variables. A portable computer allows the operator to monitor the system and make real time adjustments to flash rates, intensity levels, the sequence of flashing lights and the sequential flash rate. This strobe lighting unit was specifically designed to be used as a behavioral barrier for fish.

7.a.6. When evaluating a candidate application for the usage of strobe lighting as a behavioral barrier for fish, a number of factors must be reviewed. They include the species and life stage of the target fish; the characteristics of the site including the structural configuration, velocity, and turbidity of the water; and the desired bypass option for the fish. The fish subjected to the strobe light behavioral diversion must have adequate time and distance to respond to the lights.

7.a.7. In 1987-1988, research was conducted at the University of Washington's School of Fisheries with juvenile atlantic salmon, coho, chinook and steelhead to determine their response to strobe lights under both day and night conditions . All species showed a consistent avoidance to the strobe light at night, and the coho and chinook avoided the strobe lights during the day. The study concluded that strobe lights were effective in repelling the juveniles during the day and night, and that the salmon did not acclimate to the strobe lighting (Nemeth, 1989). Subsequent testing of juvenile coho and chinook salmon concluded that exposure to strobe lighting usually startled both species. After the initial startle response, the coho and chinook moved to the darkest area . It was theorized that when juvenile coho and chinook were exposed to strobe lighting that they might seek the area of a darkened bypass system (Nemeth et al., 1992). These favorable results lead to the full site testing of this theory at Great Northern Paper's Weldon Dam located in northern Maine on the Penobscot River.

7.a.8. In early 1995, Great Northern Paper and FTCA entered into a five-year testing agreement to evaluate the capability of an AGL 4100 Strobe Lighting System to enhance the direction of downstream migrating *smolts* toward the surface bypass inlets at Weldon Dam. One of the reasons for selecting this site for testing was that the traditional passage routes of the *smolts* at the dam had been recorded for seven years prior to 1995, including the tracking of radio tagged smolts in 1993 and 1994. Strategic positioning of the strobe lights was designed to produce a "wall of light" barrier completely covering turbine forebays number 1 and 2. Additional positioning of strobe lights at turbine forebays nubmer 3 and 4 duplicate the "wall of light" on the lower half of those turbines intakes. The conceptual intention was to prevent fish entrainment through turbine forebays

Number 1 and 2, and to prevent the *smolts from diving* to the lower depths of all four turbine forebays, and therefore, direct the *smolts* to the "dark option" of the downstream passage systems surface inlets located in the upper half of forebays Nos. 3 and 4 . The AGL 4100 System *was* operated during the spring of 1995 and 1997. Due to heavy flooding in the spring of *1996, the system was not operated and the fish went over the dam*.

7.a.9. The comparison of 1995 and 1997 downstream passage route data for radio tagged smolts to data collected prior to the installation of the AGL 4100 Strobe Lighting System (1993 and 1994) continues to provide encouraging results on the effectiveness of the system in guiding smolts from turbine forebays number 1 and 2 to turbine forebays number 3 and 4. The combined 1995/1997 *test* results with the AGL 4100 Strobe Lighting system in operation revealed a 50 % reduction in radio tagged smolt passage *passage* through turbines Nos, 1 and 2 when compared to the 1993/1994 results. Since the AGL 4100 Strobe Lighting System was installed in 1995, 85% of the of radio tagged smolts that have passed the project went through turbine forebays number 3 and 4 . This is a 22% increase over 1993/1994 results. (Bernier, 1998)

7.a.10. During the spring and summer of 1997, the Idaho Department of Fish and Game initiated testing to determine if strobe lights could be used to keep kokanee salmon away from the turbine intakes at Dworshak Dam. The previous year, 1.3 million kokanee salmon were spilled over Dworshak Dam, almost collapsing the entire stock of this reservoir. Extensive testing was conducted at Spirit Lake and Lake Pend Oreille. Monitoring with a Simrad split-beam echosounder confirmed that fish of all size classes quickly moved away from strobe lights once they were turned on. Within minutes the area around the strobe lights was almost completely devoid of fish. The testing concluded that the kokanee were repelled away from the strobe lights for an average distance of 100 feet. A subsequent test for 5 hours demonstrated that the kokanee did not become acclimated to the strobe lights, continuing to remain at a distance in excess of 100 feet from the light source. The Idaho Department of Fish and Game has scheduled extensive continued testing of strobe lights and kokanee throughout 1998 and is seeking funding for the installation of strobe lighting at Dworshak Dam in 1999 (Mariolie, *pers. comm*.).

7.a.11. In the spring and summer of 1997, the United States Army Corps of Engineers' Waterways Experimental Station Fisheries Engineering Team conducted tests to evaluate the vertical and horizontal displacement of juvenile salmonids in response to strobe light stimuli. The tests were conducted near the Hirman M. Chittenden Locks in Seattle. A cylindrical net pen (4 meters long, 1.5 meters diameter) was used as a test enclosure. Four underwater video cameras were mounted at 1 meter intervals on the perimeter of the net, thereby, subdividing the length of the net pen into four zones. The use of the video cameras allowed the fisheries biologists to observe on a "real time" basis and to document the response of the juvenile salmonids to the strobe lights. The test species consisted of yearling coho, sub-yearling chinook and coho smolts. Monospecific groups of approximately 15 fish were used in an on/off testing protocol during each of the 190 trials, with each trial having five replicates. Testing results concluded that strobe lights elicited consistent displacement of juvenile salmonids both vertically and horizontally. Avoidance up to 7 meters horizontally was observed on a sunny day. Depths of only 6 meters at the test site prevented the evaluation of the maximum extent of the vertical

responses. Night testing was not conducted because of video capability limitations. The range of effectiveness of strobe lights presumably would have been greater at night than during the day (Ploskey et al, 1998).

b. Proposal objectives.

Proposal objectives:

7.b.1. 1. Determine the efficacy of strobe lights as a behavioral guidance tool to guide juvenile steelhead, spring chinook, and coho upwards away from the turbine intakes and increase the >opportunity for discovery= to the Surface Bypass Collection System (SBC) at the Cowlitz Falls Dam(CFD).

2. Determine the efficacy of strobe lights as a behavioral barrier to guide juvenile salmonids upwards and away from the induction slot behind the baffle panel in front of the fish flap gates of the SBC to increase FGE. The induction slot at CFD is commonly identified as gatewell slots in mainstem Columbia and Snake River dams. However at CFD the induction slot is designed to draw water through the vertical slots in the baffle panel to create attraction flow to the SBC.

3. Determine how environmental conditions effect strobe light guidance; ie diel patterns, turbidity and temperature.

4. Determine the efficacy of inducing a directed flow of water into and through the vertical slots in the baffle panel and entrance to the collection flumes along with the strobe lights to maximize Fish Guidance Efficiencies for the SBC at Cowlitz Falls Dam (FY2001-FY2002).

4. Complete annual reports, quarterly updates and a final project completion report and identify effective ways to utilize this technology to enhance FGE and/or meet other fish guidance needs at other hydroprojects throughout the Columbia Basin.

7.b.3.a Fish deflected from diving to the turbines by a strobe-light system still do not necessarily have sufficient hydraulic cues to orient to the surface bypass entrances, which are small relative to the entire dam forebay. Coutant (1998 in review) summarized the natural ability of migrating salmonids to recognize higher velocities in turbulent river water and to orient downstream with typical riverine hydraulic features such as turbulent eddies. Non-turbulent flow fields (Aflownets≅ of Johnson et al., 1997) based solely on differences in hydraulic head between the forebay and bypass portal do not supply sufficient cues to attract migrants except close to the entrance (Rainey, 1997). Numerous surface bypass prototypes based on attraction by non-turbulent hydraulic head differences have failed to yield desired high guidance efficiencies (e.g., Stockley, 1959; Wayne, 1961; Johnson et al., 1997; Pevan et al., 1996). Provision of a Atrail of turbulence≅ in the quiescent surface waters of the forebay has been hypothesized to enlarge the Aopportunity for discovery≅ of the bypass entrance and to minimize migration delay (Coutant 1998 in review). The hypothesis would be tested by installing propotype arrays of water jets pointing toward the bypass entrances and testing fish passage with experimental designs similar to those used for strobe lights.

7.b.3. The Cowlitz Falls Dam is an excellent candidate site to demonstrate the use of strobe lighting as a behavioral guidance tool to increase the FGE of the SBC due to the low velocity at the dam face and expected turbidity levels during the spring-summer migration will allow the juveniles adequate time and distance to respond to the strobe

lights. The low FGE recorded to date likely reflects the inability of the juvenile migrants to locate the entrance of the SBC. A "shelf " of upward directed strobe lights constructed and positioned at a depth of about 40 feet below the entrance to the SBC and extending out a distance of about 40 feet from the face of the dam would prevent the approaching fish from "diving,≅ keeping them in the upper portion of the water column and/or guide them upwards to near the entrance of SBC, thereby, increasing their "opportunity for discovery' of the bypass entrance. The effectiveness of this behavioral guidance tool would be evaluated with hydroacoustics, radio tagging, and fyke netting under an on/off testing protocol.

Project Objectives by Year:

7.b.6 Fiscal Year 2000: A second " shelf" of upwardly pointed strobe lights will be installed to complete the Ashelf≅ of light across the entire intake of the site=s number 2 turbine to test fish guidance by strobe lights in two of four intake bays. System tests and evaluation will incorporate on/off testing. Fyke nets, flume nets, hydroaccoustics, and radio telemetry will be used to measure the FGE and directional movement of migrants throughout the tests.

7.b.7 Fiscal Year 2001: Testing of the strobe lights systems will continue with the addition of induced directed flow into and through the SBC entrance and collection flume. Current literature and research indicate that additional guidance may be needed to achieve desired FGE=s. Again, system tests and evaluation will incorporate on/off testing. Fyke nets, flume nets, hydroacoustics, and radio telemetry will be used to measure the responce variables.

7.b.8. Fiscal Year 2002 : Testing of both strobe lights and directed flow will continue to further refine the techniques and improve FGE. The objective is continued testing of the integrated system, preparation of completion reports, and technology transfer to other sites.

7.b.9. Fiscal Year 2003 : The objective is continue operation of the integrated system, preparation of completion reports, and technology transfer to other sites.

c. Rationale and significance to Regional Programs.

7.c.1. The Cowlitz Falls Project, Anadromous Fish Reintroduction Program was initiated by BPA in 1992. This program developed from an agreement between BPA and Friends of the Cowlitz as a result of the Power Purchase Agreement with Lewis County PUD. The program calls for the reintroduction of three species of anadromous fish: spring chinook, coho and late winter steelhead. Searun cutthroat were added to the plan due to their presence at the fish collection facility. The program reopens approximately 200 miles of river and tributaries to these anadromous species. This program is consistent with the State of Washingtons= Wild Salmonid Policy (WDFW, 1997) and the ALower Columbia Steelhead Conservation Initiative≅ (WDFW, pre-draft, 1997). It is also directly applicable to the regional programs in the Columbia Basin.

7.c.2. The ACowlitz Falls Project Fisheries Management Plan: Anadromous Fish Reintroduction Program≅ (GAIA, 1994) provided the original goals and objectives for the reintroduction of anadromous fish to the upper watershed. Two subsequent documents were prepared by WDFW for program implementation, ACowlitz Falls Fishery

Management Plan≅ (WDFW, 1994) and ACowlitz Falls Anadromous Reintroduction Plan (WDFW, 1996). The long-range goal of the plans and program still are Ato restore anadromous fish runs while at the same time protecting naturally producing resident fish, to allow for a balance of wild, native and hatchery fish populations.≅ The Cowlitz Falls Project Fish Collection Facility and SBC were designed and constructed as the cornerstone for a Atrap and haul≅ operation that could successfully attract and collect a high percentage of downstream migrants. The preliminary estimates of FGE indicated a high probability of success for attracting and collecting steelhead. The placement of strobe lights horizontally above the turbine units aimed upwards to guide fish upwards away from the turbine intakes and towards the SBC offers the potential to significantly improve the attraction and collection efficiencies for all juvenile salmonids.

Regional Rationale and Significance

7.c.3. The successful use of strobe lights as an effective fish behavioral guidance tool for juvenile salmonids at the Cowlitz Falls Project would be applicable to regional juvenile fish passage programs. As is amply discussed and documented in regional salmonid reviews and recovery plans (NPPC, 1994; BPA, 1994; CRITFC, 1995; NMFS, 1995a, 1995b; OTA, 1995; NRC, 1996; ISG, 1996), the passage of juvenile salmonids downstream at dams is a major obstacle to population survival. The System Operation Review (BPA 1994, Appendix C-1, p. 4-25) notes that downstream juvenile survival is essentially the only measure that directly relates hydrosystem operation to relative health of salmonid populations, because this is the only life-cycle activity that plays itself out exclusively within the waters of the hydrosystem. Because juvenile salmonids above Bonneville Dam have no alternative to passing mainstem (and often tributary) dams in the Columbia River basin, all plans recognize the urgent obligation to develop safe passage mechanisms.

7.c.4. Passage through turbines is hazardous. The bulk of river flow is usually directed through turbines for generation of electricity. Because juvenile migrants are adapted to follow river flow, they are drawn through the turbines creating mortality rates ranging from 2 to 20 percent (Whitney et al., 1997). There are various causes for mortality in turbines and more Afish-friendly≅ turbine designs are under development (Cada et al., 1997). However, guidance of fish away from turbine intakes has been the most consistent engineering approach to promote safer fish passage (Mighetto and Ebel, 1995; OTA 1995). The most extensively deployed fish-guidance system in the Columbia-Snake mainstem is the submersible traveling screen in turbine intakes, which screens the upper layers of water entering the turbine intake and directs them to the gatewell and a transportation channel in the dam (Mighetto and Ebel, 1995). Such screens are expensive, they cause physical damage to many migrants (descaling is most common), and they counteract (rather than use) the natural migration tendencies of the fish. Thus, more cost-effective and less damaging passage methods are sought.

7.c.5. Spill is recognized as a management tool that can provide a safer alternative migration route (CRITFC 1995; NMFS, 1995a). Because juvenile migrants are generally surface oriented, they preferentially follow large surface currents toward spillways rather than diving deep to follow turbine flows. Deaths from spillway passage are usually less than 2% (Whitney et al. 1997). Spill, however, requires large amounts of water to be passed that cannot be used for power generation, creating an economic cost.

Uncontrolled, excessive spill can cause gas supersaturation and result in potentially lethal gas bubble disease in juvenile salmonids exposed to high (120% and greater) dissolved gas levels for extended periods of time.

7.c.6 Surface-flow bypass systems have recently been developed, which capitalize on the natural surface-migrating tendencies of juvenile salmonids but require less water than spill (Johnson et al., 1997). However, surface bypass systems have had difficulty in attracting and capturing juveniles with their small flows wherever the bypass is not directly above the main attracting turbine flow, as was the initial prototype hydrocombine at Wells Dam.

7.c.7. This project would test the hypothesis that strobe lights can provide an effective guidance behavioral tool for juvenile salmonids at the Cowlitz Falls Dam. More importantly, this project would demonstrate the feasibility of applying this technique to mainstem Columbia and Snake River dams. Successful testing at Cowlitz Falls is expected to lead to testing at other facilities and eventually at major mainstem projects such as at Lower Granite Dam (Corps of Engineers) and Wanapum Dam (Grant County PUD). Compared with mainstem dams on the Snake and Columbia, the Cowlitz Falls Dam has a relatively simple surface flow bypass/collection system located above deep turbine intakes. Spring chinook, steelhead and coho, species of concern throughout the basin, are part of the Cowlitz Falls Reintroduction Program.

7.c.8. Currently several other projects using strobe lights as a fish guidance behavioral tool are underway in the region. Idaho Department of Fish and Game is testing the potential use of strobe lights to repel kokanee away from the face of Dworkshak Dam to prevent the kokanee from approaching the face of the dam, becoming entrained into the penstock intakes and reservoir outlets and flushed out during periods of spill and drawdowns. At Roza Dam on the Yakima River, BOR and WDFW are scheduled to conduct tests starting in April, 1998 using strobe lights to guide wild salmonid smolts horizontally from the main river channel to the entrance of juvenile collection system. This work is part of the Yakima KK and is funded by BPA. On the Columbia River near Burbank, WDFW and BOR are scheduled to test strobe lights to prevent salmonid smolts from entering a irigation diversion canal starting March 15, 1998.

d. Project history

e. Methods.

7.e.1. The scope of this study is to determine the efficacy of strobe lights and surface attraction flows as a behavioral guidance tool, guiding juvenile salmonids away from the turbine intakes. Radio telemetry, hydroacoustics, fyke and flume netting will provide the tools to evaluate these objectives. Fyke netting at the turbine intakes will provide specific emperical data, but is lethal to the fish captured. However, it is unlikely that any juvenile salmonids that pass the project will successfully negotiate the two reservoirs and dams downstream. Nets placed in the SBC flumes cause infrequent injury to steelhead, coho and cutthroat, however, spring chinook are often descaled (Serl, *pers. comm*.). Efforts to modify the flume collection system continue. Biotelemetry allows investigators to obtain specific behavioral information on individual fish, (e.g., location at time of day,

movement since last detection) sample size is relatively small because only a limited number of radio-tagged fish can be tracked concurrently. In contrast, hydroacoustic fish stock assessment can substantially increase sample size, since numerous fish can be tracked simultaneously, however species composition is difficult to determine. Also information about individual fish is limited. Utilizing both radio telemetry and hydroacoustic stock assessment in conjunction will overcome the limitations of each method and a better understanding of the migration behavior of juvenile steelhead, chinook, and coho salmon will result.

7.e.3. The tests would begin on or after April 20 and run for 12 consecutive weeks. This time frame brackets the steelhead and coho emigration. In addition, three to four weeks of testing would occur when the spring chinook emigration begins (anticipate late July - August). Two on/off tests would be scheduled each week, one set of day and one set of night on/off tests. The daylight hours would run from 9:00 a.m. through 5:00 p.m. (8 hr.). Night tests would run from 6:00 p.m. through 8:00 a.m. (14 hr.) Although this creates some dichotomy, it alleviates many scheduling difficulties. A statistician experienced with fish passage studies and projects will guide final study design.

Telemetry Methods: Tasks; 1b, 1c, 1e, 2b, 4c.

7.e.5. ACoded≅ radio transmitters supplied by Lotek Engineering will be surgically implanted in juvenile steelhead, chinook salmon, and coho salmon. Releases will occur 5-10 day blocks during the middle 80% of the spring out migration for steelhead, chinook salmon, and coho salmon. Tagging related mortality will probably range between 1% and 3%. Mortality rates from previous studies conducted at Lower Granite Dam was about 3% in 1996 and less than 1% in 1997 (Adams et.al., 1996) Laboratory experiments conducted at our facility during 1994 and 1995 have shown that surgical implantation may have less of an effect on growth and swimming performance than gastric implantation (Adams et.al. 1997). Furthermore, results of our 1996 and 1997 study at Lower Granite Dam demonstrated the feasibility of surgically implanting radio tags in juvenile salmonids. We propose to surgically implant coded radio transmitters in all test fish during the 1999 season.

7.e.6. Coded tags offer several features which make them ideal for studying juvenile fish movements at Cowlitz Falls Dam. Because each tag is uniquely coded, as many as 100 tags can be broadcast on the same frequency without losing the ability to identify distinct individuals. As a result, the scan cycle of the receiver is relatively short and the probability of not detecting a fish is fairly low. Additionally, a Digital Spectrum Processor (DSP) can be used in conjunction with a receiver to scan multiple frequencies and codes simultaneously. The DSP eliminates any need for a scan cycle and allows for instantaneous detection of all fish within range of the antennas. A disadvantage of the DSP, however, is that excess electrical noise from the dam can interfere with the detection of valid signals from radio-tagged fish. Electrical interference underwater is not a significant problem, so DSP technology will be used extensively in underwater applications. During 1997 at Lower Granite Dam we successfully installed a DSP system in an aerial application immediately downstream of the spillway. We propose to use DSP technology at Cowlitz Falls in other aerial applications if the level of ambient electrical noise is low.

7.e.7. The proposed antenna array at Cowlitz Falls Dam will consist of about 25 aerial antennas and 50 underwater antennas. The antennas will be linked to about 14

automated data collecting receivers used in conjunction with 7 DSPs and will provide continuous information on fish movements at the dam. Aerial arrays will be located both upstream and downstream from the dam, around the collection facility raceways, on the downstream face of the dam, on the upstream face of the dam, and along the debris barrier. The underwater antenna arrays will be located on the debris barrier, on the fyke net frame in the draft tubes, around the vertical slot surface collection area, in the induction channel, in front of the spillbays, and on and around the strobe light structure.
7.e.10. To address sample size concerns to adequately analyze dam passage and the effect of the strobe lights and attraction flows, we used power analysis to determine the minimum detectable difference between two proportions for a given sample size with an alpha level of .05 and power = .80. The two proportions are the fish collection efficiency (FCE) with the strobe lights off and the FCE with the strobe lights on. A rough estimate of FCE = .50 (strobe lights off) was used for the analysis. During the first year the sample size will be limited to 100 tagged fish per species. Based on this analysis, we will be able to detect a minimum difference of .27 between FCE with the strobe lights on and FCE with the strobe lights off.
7.e.11. It is unknown how much the strobe lights will affect FCE, especially during the first year the strobe lights are in place. During the first year strobe lights will be installed in only one turbine intake. Fish may be guided away from this turbine intake and into the SBC, but they may also be guided laterally into the other turbine intake. It is anticipated that strobe lights installed in front of both turbine intakes would have a greater effect than strobe lights in front of one intake. It would therefore be advantageous to have a high sample size during FY99 in order to detect a small difference between FCE with the strobe lights on and FCE with the strobe lights off, but due to capital investments and budgetary constraints the sample size must be limited to 100 fish per species. This minimum detectable difference (.27) therefore may not be realized until the second year of study when strobe lights will be installed in front of both turbine units.

This analysis assumes a Abest case≅ scenario and provides only a basis for estimating the effect of a given sample size. Even though the proposed sample size may not be adequate to detect a small difference in FCE, descriptive statistics will be adequate to determine the effects of the strobe lights on smolt behavior. Additionally, actual sample size for this analysis would be reduced if fish pass via the spillway and 5-10% of the tagged fish may never be detected due to predation, tag loss, or tagging related mortality. Also, this analysis assumes equal sample size for each test condition.
7.e.12. Two sources of fish for radio telemetry are run-of-the-river fish and collection facility fish. Run-of-the-river or Anaive≅ fish are fish that have never been exposed to dam passage. Collection facility fish have already passed through Cowlitz Falls Dam being guided away from the turbines and into the collection facility by the surface collection system. Run-of-the-river fish would be the best source for radio-tagging because collection facility fish could have a learned response to dam passage. In addition, bias may be introduced since only fish that were guided would be used for radio-tagging. Perhaps fish that pass the dam via the turbines or spillway have a different behavioral response. Efforts will be made to collect and utilize run of the river fish, otherwise fish from the collection facility will be used for radio-tracking.
Hydroacoustic Methods: Tasks; 1c, 1f, 4d.

7.e.13. Fixed-aspect split-beam hydroacoustic transducers will be used to monitor the approach and use of passage routs to evaluate the efficacy of strobe lights to guide fish away from the turbine intakes. The hydroacoustic system will include a split-beam transducer, a high frequency echo sounder, a digital echo processor, a multiplexer,equalizer, a chart recorder, an oscilloscope, and associated cables.
7.e.14. Hydroacoustic split-beam transducers will be deployed in the spill bays, turbines, in front of the surface collection system, and on and around the strobe light platform. During the study period sampling will occur 24 hours a day, 7 days a week. The digital echo processor will use a predetermined set of detection criteria such as echo pulse widths, amplitude, and position to select only echoes from single targets, such as fish. The raw data files will be processed with a manual data entry fish tracking program. Manual data entry using this program will provide the most accurate summary of individual fish in the sampling area because it relies on human selection of each observed fish target, and is not subject to potential automatic tracking of potential non-fish targets due to acoustic noise. Each fish detection will be weighted to compensate for beam spreading (increasing sample volume with range).
7.e.15. Fish trajectories will be calculated by location from the series of 3-dimensional echo returns from each tracked fish. For the cross-sectional trajectory plots, the angles will be plotted as a function of 5 ft range bins from the transducer. The cross-sectional trajectories will be plotted on a standard Cartesian coordinate system. Cross-section trajectories will be the average of the tracked fish targets in the Y-Z plane. The plan view trajectories will be plotted on a standard Cartesian coordinate system. Plan view trajectories are based on the mean positions of the tracked fish targets in the X-Y plane. The target velocity of downstream migrants was calculated for each transducer.
Fyke and Flume Netting: Tasks; 1d, 1g, 2c, 4e.
7.e.4. Fyke netting will be done in conjunction with hydroaccoustics, radio telemetry and operation of the collection facility to provide an accurate measure of the numbers of fish passing into the turbine intake slot, the induction slot and the fish flap gate of the SBC. A catch net will also be set in the surface collection flumes to monitor the number and species entering the SBC throughout the tests in conjunction with the fyke netting of the turbine intake and induction slot. These nets will be installed a short distance downstream of the fish flap gates. This will provide numbers and species composition as needed for the ongoing evaluation. The area fyke netted corresponds to one half of a turbine.

f. Facilities and equipment.

7.f.1. The Cowlitz Falls Project Fish Collection Facility was designed and constructed as the cornerstone for the upper Cowlitz River Reintroduction Program. The facilities were completed in 1996 and are considered to be state of the art. Facilities include: fish flap gates, a flume transport system, juvenile and adult separation, PIT tag detection system, work-up areas and holding facilities for juveniles and adult fish. In addition, the Cowlitz Falls Dam provides a 200 ton crane and jib crane (capable of moving and installing baffle panels, fyke nets etc.). The facilities and program have all of the necessary equipment for the current program.

7.f.5. The AGL 4100 Aquatic Guidance Lighting System is specifically designed for underwater usage as a behavioral barrier for fish. This system is multi-functional, highly flexible and remote controlled to providing real time responses to site-specific variables. A portable computer allows the operator to monitor the system and make real time adjustments to flash rates, intensity levels, the sequence of flashing lights and sequential flash rates.

Equipment for FY 1999: Twenty-two (22) tri packs consisting a total of sixty-six(66) 901 Flash Heads will be used to cover the platform positioned at a depth of 40 feet in front the north intake of the No. 2 turbine. The platform will be approximately 30 feet wide and will extend out from the dam face a distance of approximately 40 feet. Two tri packs consisting of a total of six 901 Flash Heads will used to cover the entrance to the induction slot behind the baffle panel at north intake of the No.2 turbine, an area of approximately 20 feet X 6 feet. Additional equipment will include a trailer(portable equipment room), a Power Center installed in the trailer, a Computer System installed in the trailer and a 6340 Interconnect Cable and twenty-four (24) Mounting Brackets.

Equipment for FY 2000: Twenty-two (22) tri packs consisting of a total of sixty-six (66) 901 Flash Heads for the south intake of the No. 2 turbine. Two tri packs consisting of a total of six 901 Flash Heads will be used to cover the entrance to the induction slot behind the baffle panel. Additional Power Converters, 6340 Interconnect Cable and twenty-four (24) Mounting Brackets will also be installed.

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Section 8. Relationships to other projects

8.a. Lewis County PUD provides assistance and maintenance for the reintroduction program and ongoing research. The PUD is responsible for all operations associated with the 200 ton crane and associated jib crane. The PUD installs the fish baffle panels, lowers fyke nets and controls all aspects associated with the use of the cranes and related maintenance. The Project Biologist coordinates the ongoing reintroduction efforts between the PUD and WDFW as well as any other agencies requiring use at the Project.
7.b.5. Fiscal Year 1999: A "shelf " of upwardly pointed strobe lights will be installed to test vertical fish guidance by strobe lights in one of four intake bays of the Cowlitz Falls Dam. This "shelf " will be positioned in front of the site=s north intake at the No. 2

turbine at a depth of about 40 feet below the entrance of the site=s SBC . The light output will cover an area about 30 feet wide, and extend out about 40 feet from the face of the dam . Upwardly pointing strobe lights will also cover the entrance to the adjacent induction slot. Fyke nets, flume nets, hydroacoustics and radio telemetry will be used to measure the effectiveness of the strobe lights in preventing the approaching migrants from "diving" toward the turbines intakes below the entrance of the SBC. Current research and literature indicate that strobe lights will maintain the migrants in the upper portion of the water column and/ or move them upwards closer to the entrance of the SBC , thereby , increasing their "opportunity for discovery" of the bypass . An on/off testing protocol would be used.

8.b. In addition to Lewis County PUDs= work, Tacoma City Light provides all fish transport for the reintroduction effort.

Section 9. Key personnel

Here=s a list for discusssion:
Charles Morrill, WDFW - lead project coordinator/manager
Mike Kohn, BPA/LCPUD - co-project coordinator/manager
Dennis Rondorf, BRD, USGS - lead investigator with radio telemetry and hydroaccoustics
Ron Brown, Flash Technology - lead investigator with Strobe lights and technology
John Serl, WDFW - lead on-site field biologist
- does this seem appropriate?

James Jay Anderson, Associate Professor (WOT) Fisheries Research Institute and Center for Quantitative Science in Forestry, Fisheries and Wildlife College of Ocean and Fisheries Sciences University of Washington, Seattle,Washington 98195

Associate Professor James Anderson has been very active in the fisheries related issues throughout the Columbia Basin for many years. The project facilitator (Charles Morrill) condensed his resume to focus primarily on his experience and expertise relative to this proposed project.

Research Associate Professor, College of Ocean and Fishery Sciences, UW (1987-91)
Research Assistant Professor, College of Ocean and Fishery Sciences, UW (1983-87)
Research Associate, College of Ocean and Fishery Sciences, UW (1981-1982)
RESEARCH INTEREST
Biomathematics, ecology, fisheries, oceanography, toxicology, fish protection at power plants, fish passage and life cycle modeling, animal and human behavior, decision processes, ecosystem modeling, fisheries decision support models for fish/hydropower interaction.
CRiSP Project: Developing computer for management of Columbia River hydroelectric and fisheries agencies. The work involves building models and analyzing data on the

migration and survival of salmon through the Columbia River system (CRiSP1) and the harvest of fish in
the ocean and rivers (CRiSP2). The projects maintains computer models and database information accessible through the World Wide Web. The model are being used to assess management strategies for hydrosystem operations and fisheries management. Model development has involved original work on fish migration and survival. The model will incorporate upstream adult migration, nearshore and estuary affects on juvenile salmon survival, and improved modeling of the impact of supersaturation on fish survival.
U.S. Army Corps of Engineers Project: Developing analysis and computer models for the impact of gas bubble disease on migrating salmon.
Analyzing the impact of reservoir drawdown on passage and survival of adult and juvenile salmon.

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Ron Brown, Director of Marketing
Flash Technology Corporation America

Vendor of the Strobe Lighting Behavioral Barrier System

Flash Technology Corporation of America is a privately held corporation which is headquartered in a suburb of Nashville, Tennessee. Having been in business for over 27 years, Flash Technology is recognized as the world=s leading manufacturer of strobe aviation obstruction lighting and airport runway lighting. The corporation is international in scope, presently conducting business in over 40 countries . Our account base includes many major corporations and governmental agencies, to include NASA, for whom we designed and built the landing lights for the Space Shuttle Program (these landing lights can be seen at a distance of 90 miles above the earth). In 1993, Flash Technology introduced the AGL 901 Aquatic Guidance flashhead . This strobe lighting unit was the first flashhead specifically designed for underwater usage as a behavioral barrier for fish . In 1995, Flash Technology introduced the AGL 4100 Aquatic Guidance Lighting System . This system is multi-functional, highly flexible, remotely controlled, providing real time responses to site specific variables. A portable computer allows the operator to monitor the system and make real time adjustments to flash rates, intensity levels, the sequence of flashing lights, and the sequential flash rate . For large projects, the power center and computer systems are assembled into trailers at our plant and driven to the project site, thereby , avoiding costly on site set up.

Ron Brown received a Bachelor of Arts degree from the University of Kentucky, and a Masters of International Business Management from The American Graduate School of International Management, Glendale, Arizona . With over 20 years of marketing managerial experience in new technology introduction and holding five United States patents, Ron joined Flash Technology in 1993 as the Director of Marketing. During this period of time his primary responsibility has been dedicated to the scientific research and development of the usage of strobe lighting as a cost effective behavioral barrier for fish. In 1995, Flash Technology and Great Northern Paper entered into a five testing agreement to evaluate the capability of an AGL 4100 Strobe Lighting System to enhance the direction of downstream migrating smolts toward the surface bypass inlets at the client=s Weldon Dam, located in northern Maine on the Penobscot River . This successful application continues . Other projects have included working directly with the U.S. Army Corps of Engineers , Bureau of Reclamation , Washington Department of Fish & Wildlife , Idaho Department of Fish & Game , and the U. S. Fish & Wildlife Service . By invitation, Ron has published and made presentations on the usage of strobe lighting as a behavioral barrier for fish to the Electric Power Research Institute=s Fish Passage Workshop and the American Fisheries Society 1997 Annual Meeting.

MICHAEL S. KOHN
Lewis Co PUD biologist on loan to BPA

QUALIFICATIONS

Experience coordinating with multiagency technical committees involving

the anadromous fish reintroduction in the upper Cowlitz River and previously on fish passage issues in the Yakima Basin. Responsibilities include chairing the Cowlitz Falls Technical Advisory Committee and overseeing research and monitoring programs.

Experience performing a variety of activities for the Bonneville Power Administration, including: facility design review, permitting, budget development and review, as well as participating in many biological studies. Responsibilities also include informing county officials, sportsmen groups, landowners and the general public regarding the various fish and wildlife programs.

Experience overseeing the design, implementation, maintenance and monitoring of the Cowlitz Falls Wildlife Mitigation Plan. Previously a member of the Fish and Wildlife Committee overseeing the implementation of the Wildlife Plan and currently a member of the Habitat Evaluation Procedure (HEP) team responsible for evaluating the project habitat baseline.

Experience monitoring and evaluating the various life stages and migrations of anadromous fish. Experience includes training and supervising entry level biologist and up to 12 fisheries technicians. Responsibilities included managing large quantities of data, data analysis and report writing.

EDUCATION

BS General Science, Portland State University; 1982. Major course work in Biology and Geography.

Previously attended Hope College in Holland Michigan. Major course work in Biology.

Work Experience

Feb 1993 - Present — Lewis County PUD (hired in cooperation with BPA)

Aug. 1987 - Feb. 1993 — Yakima Indian Nation - Fisheries Resource Management, Toppenish, WA. Supervisor at the Chandler Juvenile Fish Facility in Prosser (smolt monitoring and evaluation). Previously the Project Leader the final year of the Spring Chinook Enhancement Project. Field Supervisor for spawning surveys in Methow and Okanogan Basins for three seasons.

Charles Morrill, Fish Biologist, Washington State Department of Fish and Wildlife
Education:

M.S. in Fisheries, University of Idaho, 1972
B.S. in Wildlife Management, University of Maine, 1969

Current Employment and Responsibilities:

Mr Morrill has over 20 years of professional experience working with Anadromous Salmonids in Washington for the Washington Departments of Fisheries, Wildlife, and now Fish and Wildlife. Since the early 1980's he has worked on and led a variety of projects within the Columbia Basin including Coded-Wire tag recovery programs, Smolt Monitoring Programs at Lower Monumental and Lower Granite Dam, and for the last three years, the Fish Passage/Facility component of the Cowlitz Falls Anadromous Fish Reintroduction Program.
Currently Mr. Morrill:

Leads and supervises WDFW work at the Cowlitz Falls Fish Facility as part of the Cowlitz Falls Anadromous Fish Reintroduction Program

Supervises WDFW Smolt Monitoring work at Lower Granite Dam (LGR) under the Northwest Power Planning Councils Fish and Wildlife Water Budge Measures Program under the oversight of the Fish Passage Center (FPC).

Supervises WDFW work at Lower Granite Dam as part of the Corps Walla Walla District annual Juvenile Fish Facility Operation Program.

Represents the agency as a technical member on the PIT Tag Steering Committee (PTSC), serves as a co-chair, provides technical direction and guidance for the continued development and use of PIT tags and the PIT tag data base (PTAGIS) within the Columbia Basin. The PTSC is a standing subcommittee under the Fish Passage Advisory Commission (FPAC) and Columbia Fish and Wildlife Authority (CBFWA). The Pacific States Marine Fisheries Commission's (PSMFC) Pit Tag Operations Center (PTOC) handles the day to day management and system operation for system hardware and software.

Represents the agency as technical Co-chair of the PIT Tag Transition Team that is overseeing BPA's project to replace the current 400 KHz PIT Tag system in the Columbia River Basin with a new standard ISO system in time for the year 2000 smolt migration.

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Dennis W. Rondorf, Fishery Research Biologist
Education:
M.S. Oceanography and Limnology, University of Wisconsin, Madison, 1981
B.S. Wildlife Management, University of Minnesota, St. Paul, 1972

Current Employment and Responsibilities::
D.W. Rondorf serves as a Fishery Research Biologist and Section Leader for the Anadromous Fish Ecology section at the Columbia River Research Laboratory, Biological Resources Division, U.S. Geological Survey, Cook, Washington. Current areas of research include the behavior and ecology of Snake River wild and hathery fall chinook salmon, the distribution of smolts and relation to gas supersaturation in the main stem Columbia River, and behavior of smolts to evaluate a prototype surface collector at Lower Granite Dam, Washington. In recent years, D.W. Rondorf has lead research teams using radio telemetry, geographic information systems (GIS), global positioning systems (GPS), remotely operated underwater vehicles (ROV), hydroacoustic fish stock assessment systems, and acoustic Doppler current profilers (ADCP) as research tools. Between 1979 and 1997, D.W. Rondorf was employed by the research division of the U.S. Fish and Wildlife Service and the National Biological Service to conduct research on juvenile salmon in the Columbia River basin.

Adams, N.S., D.W. Rondorf, S.D. Evans, J.E. Kelley, and R.W. Perry. 1998. Effects of surgically and gastrically implanted radio transmitters on swimming performance and predator avoidance of juvenile chinook salmon. (*In Press*) Canadian Journal of Fisheries and Aquatic Sciences.

Adams, N.S., D.W. Rondorf, S.D. Evans, and J. E. Kelley. 1998. Effects of surgically and gastrically implanted radio transmitters on growth and feeding behavior of juvenile chinook salmon. Transactions of the American Fisheries Society 127:128-136.

Parsley, M.J., D.W. Rondorf, and M.E. Hanks. 1998. Remote sensing of fish and their habitats. Proceedings of instream and environmental flows symposium-technology and policy issues. (*In Press*) North American Lake Management Society and others, Denver, Colorado.

Adams, N.S., D.W. Rondorf, E.E. Kofoot, M.J. Banach, and M.A. Tuell. 1997. Migrational characteristics of juvenile chinook salmon and steelhead in the forebay of Lower Granite Dam relative to the 1996 surface bypass collector tests. U. S. Army Corps of Engineers, Walla Walla, Washington.

David P. Thompson, P.E. Principle Structural Engineer: Mr. Thompson is employed by Harza Engineering Company in Bellevue, Washington. He will lead the effort to design the structural features necessary to support the strobe lights in the project forebay.

Education: University of Washington, B.S., Civil Engineering, 1976
Certifications: Registered Professional Engineer: WA, OR., CA and AK
Current Employer: Harza Engineering Company, Western Division, 1984 to present
Current Responsibilities:

Department Head of HARZA=s Northwest Engineering Group

Engineering Project Manager for the design and construction of BPA=s Cowlitz Falls Fish Passage Facility

Design Project Manager for BPA=s Bonneville Captive Brood Facility

Project Manager and Project Engineer for other projects

Expertise: Mr Thompson has over 20 years of experience, working on a variety of engineering porjects with emphasis on hydroelectric power and water resource development, fish protection and structural engineering. He has been the principle civil/structural designer for many new hydroelectric projects and fisheries facilities. He has worked extensively on the Cowlitz Falls Dam over the last three years and is thoroughly familiar with the project features and operation.
Publications:

Development of a Surface Collection System for Juvenile Salmonids at the Cowlitz Falls Hydroelectric Project, Waterpower 1995.

Bonneville First Powerhouse Prototype Surface Collector, Alden Labs Fish Passage Workshop, 1997.

Cowlitz Falls Fish Passage Design and Construction, Waterpower 1997.

Relevant Project Experience:

Cowlitz Falls Fish Passage Facility, WA., Bonneville Power Administration

Bonneville First Powerhouse Prototype Surface Fish Collector, OR., Army Corps. Of Engineers, Portland District

Gunnuk Creek Fish Hatchery Expansion, AK., Kake Nonprofit Fisheries Corporation

Wynoochee Hydroelectric Project,WA., City of Aberdeen/City of Tacoma

Elwha Eicher Screen Project, WA., James River Corporation

Owyhee Tunnel No.1 Hydroelectric Project, OR., Owyhee Irrigation District

Mitchell Butte Project, OR., Owyhee Irrigation District

Weeks Falls Project, OR., City of Tacoma

Sunnyside Canal Fish Screening Facility, WA., Sunnyside Valley Irrigation District

Summer Falls Project, WA., South Columbia Basin Irrigation District

John David Serl
On Site Cowitz Falls Fish Facility Lead Biologist

EDUCATION

University of Washington, Seattle, Wa. Master of Science in Fisheries, Spring 1998 (Expected).
University of Washington, Seattle, Wa. Bachelor of Science in Fisheries, *cum laude*, June 1991.

EMPLOYMENT

FISH BIOLOGIST II, April 1996-Present.
Cowlitz Falls Anadromous Fish Reintroduction project, Washinton Department of Fish andWildlife, Randle, Washington

- Assisted with final construction and start up of the Cowlitz Falls Fish Facility.
- Evaluated Fish collection efficiency of the Facility.
- Supervised, trained and directed a crew of 3 to 13 technicians.
- Provided on-site direction for capture, marking, identification and transportation of juvenile salmonids at the fish collection facility and Lake Merwin trap.
- Provided coordination for project activities between Contractors, PUD, consultants and WDFW groups.
- Collected, entered and summarized project data.
- Assisted in preparation of reports, memos, letters and budgets.

RESEARCH ASSISTANT, September 1992-June 1995.
Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, Wa.

- Designed a study of the effects of urbanization on stream fishes within a watershed.
- Sampled fish populations and habitat use by electrofishing.
- Determined trout ages from collected scales.
- Analyzed collected data via personal computer.
- Produced a written thesis.

FISH AND WILDLIFE HELPER, March 1992-September 1992.
Public Utility District No.1 of Chelan County, Wenatchee, Washington.

- Assisted with studies of juvenile salmonid passage at hydro-electric projects.
- Monitored numbers and condition of downstream migrating juvenile salmon.
- Participated in wildlife habitat improvement projects.

Section 10. Information/technology transfer

The results will be presented at appropriate regional workshops, professional meetings and public meetings within the basin that relate to Fish Guidance/Collection needs and issues (i.e. NWPPC, CBFWA, NMFS, COE, USFWS, State Agencies and Tribes). An annual report will be completed within 90 days at the end of years field tests for regional distribution. If warranted the results will be written up for publication in a professional journal. Brief quarterly updates will be provided for distribution throughout the region.

If testing at Cowlitz Falls is successful, it will then be possible to use this technology as a means to assist juvenile migrants at Columbia River Hydroelectric Projects. Specifically, the strobe light system would be used to:

1) Increase the fish guidance efficiency of existing turbine screens. Currently, the FGE of screening systems at mainstem Columbia and Snake River

dams range from about 30-80%, dependent on the species being examined. As a rule of thumb, for each 10 percentage point increase in FGE results in a 1% increase in juvenile survival past a given project. Multiply this effect by eight mainstem dams and it is obvious that the potential of the strobe system to dramatically increase juvenile survival in the Columbia River is dramatic.

2) Increase the FGE of prototype surface collectors. The FGE of the prototype surface collectors tested to date (Wanapum, Cowlitz Falls, Lower Granite) have been disappointing (< 50%). Based on the FGE results obtained at Wells Dam, researchers anticipated that the FGE=s of the prototype systems would approach 95%. The major problem with each of these systems has been that although fish are surface oriented, they tend to follow the stronger turbine flow lines which direct them away from surface collector openings. Strobe lights may prevent these fish from sounding by acting as a behavioral barrier and thereby increasing surface collector FGE.

3) Separate juvenile migrants from bypass flows. Strobe lights may substitute for the screen based juvenile dewatering systems currently used at Columbia River projects equipped with turbine screens. These screening systems cause physical injury to bypassed fish and are expensive to build and maintain. As a behavioral barrier, strobe lights would be much more Afish friendly≅, as fish never come in physical contact with the system. In addition, surface collectors will require that even larger volumes of water (>6,000 cfs) be screened to separate juveniles for transport in barges or to discharge areas with low predator abundance. Either way, it will be difficult with current screen technology to handle large volumes of water in a manner that protects juvenile migrants. Thus, the need for an alternative dewatering system.