Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Assess Impacts Of Hydro Operations On Mainstem Habitats For Fish

Bonneville project number, if an ongoing project 9135

Business name of agency, institution or organization requesting funding
U.S. Geological Survey, Biological Resources Division, Columbia River Research Laboratory

Business acronym (if appropriate) USGS - CRRL

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name

NPPC Program Measure Number(s) which this project addresses.
5.5A.2, 6.1A.1, 6.1C.2, 7.1A, 7.1C.3, 7.6A

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

Other planning document references.

Subbasin.

Lower Columbia River Mainstem, Lower Snake River Mainstem

Short description.
Assess present day nearshore, littoral, and deepwater habitats in mainstem reservoirs and make comparisons to historical river conditions.

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		Research	X	Ecosystems
	Climate	X	Monitoring/eval.		Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat enhancement/restoration
			Acquisitions		

Other keywords.
physical habitat, substrate, depths, river bed elevations, carrying capacity, GIS, remote sensing,

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Use existing data to characterize habitats in impounded areas of the Columbia River downstream from the confluence of the Snake River.	a	Compile existing spatial data describing river bed elevations or other measures of channel morphology

		b	Compile existing spatial data describing river and floodplain substrates.
2	Characterize the physical channel morphometry present prior to impoundment in selected reservoirs	a	Use existing information (War Department maps, pre-impoundment air photos, etc.) to characterize the pre-impoundment habitat in selected river reaches
3	Compare pre and post-impoundment habitat conditions	a	Incorporate data into a Geographic Information System for storage, analysis, manipulation, and display.
		b	Incorporate water surface profiles from backwater curves and other sources to model changes in habitat due to changes in water surface elevation and discharge.
		c	Use existing data on habitat used by anadromous and resident fishes to define critical habitats for pre- and post-impoundment comparisons.
4	If necessary, characterize the physical channel morphometry in selected reservoirs.	a	Use remote sensing tools to obtain nearshore, littoral, and deepwater river bed elevations
		b	Use remote sensing tools with ground-truthing to characterize river bed substrates.

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	10/1998	9/1999	20.00%
2	10/1998	9/2000	20.00%
3	10/1999	9/2000	20.00%
4	10/2000	9/2001	40.00%
			TOTAL 100.00%

Schedule constraints.

Spatial data currently available may not be adequate; the data may have poor resolution, be the wrong scale, or be poor quality. Weather and water conditions on the Columbia river may delay collection of remotely sensed data necessary for Objective 4

Completion date.
2001

Section 5. Budget

FY99 budget by line item

Item	**Note**	**FY99**
Personnel		$60,000
Fringe benefits		$17,400
Supplies, materials, non-expendable property		$10,000
Operations & maintenance		$10,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		$3,000
Indirect costs	38% of 100,400	$38,152
Subcontracts		
Other		
TOTAL		$138,552

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	$250,000	$250,000		
O&M as % of total	20.00%	30.00%		

Section 6. Abstract

Spatial data analyses will be done to quantify the changes to mainstem habitats for anadromous and resident fishes that have occurred from hydroelectric development and current operations of the hydroelectric system. Analyses will also be done to predict the effects of water level manipulations (i.e. reservoir drawdowns, flood control, ramping rates) on those habitats. Several measures in the Fish and Wildlife Program, including sections 5.5A, 6.1A, 6.1C, 7.1A, 7.1C, and 7.6A, state the need to investigate the effects of operations of hydroelectric facilities on habitats, investigate the effects of proposed mitigation activities on resident fish and wildlife, or maintain or improve the existing habitat conditions. Habitat assessments of this type are commonly done in terrestrial systems, and in large river systems such as the Mississippi River. The quality of the analyses are dependent on the quality of data available to use. Generally, there is a paucity of spatial data available for aquatic habitats compared to that available for use in

analyses of terrestrial habitat. However, there are remote sensing tools available that can enable the rapid and efficient collection of data from large rivers and reservoirs.

The results from this work can be monitored by the production of spatial data products including digital elevation models for each impounded reach and digital terrain models that characterize river and floodplain substrates.

Section 7. Project description

a. **Technical and/or scientific background**.

In the course of human development of the Columbia River Basin, important mainstem spawning and rearing habitat was degraded as a consequence of the construction of dams and associated large water storage reservoirs and various land use activities (ISG 1996). Analyses can be undertaken that use spatial data, spatial statistical approaches, and remote sensing techniques to characterize the impacts to aquatic habitats due to human development (Meaden and Kapetsky 1991, Welch et al. 1988, Parson et al. 1996). We propose to investigate the changes associated with hydroelectric development and operations to the mainstem Columbia River downstream from the confluence with the Snake River at river mile 325. Several sections within the Fish and Wildlife Program call for data that would be developed through this work. Section 7.6 (Habitat Goals, Policies, and Objectives) calls for the protection and improvement of mainstem habitat; however, those habitats must first be identified and quantified prior to meeting this goal.

We do not propose a mitigative measure, instead, we propose to provide a tool and techniques to enable the prediction of the effects of mitigative measures (i.e. reservoir drawdown) on mainstem habitats for spawning and rearing salmonids, white sturgeons and other native or introduced fishes. The principal investigators are familiar with the lower mainstem Columbia River and with the techniques proposed here.

b. **Proposal objectives**.

1. Compare and contrast current aquatic and floodplain habitats within Bonneville, The Dalles, John Day, and McNary reservoirs using the best available information that describes the historic riverine conditions in these areas. This will provide an assessment of how hydroelectric development has altered the physical environment. Products from this work will be a report detailing the pre and post impoundment habitats, and metadata describing the spatial data used in the analysis.

2. Incorporate water surface profiles from backwater curves or use 2-dimensional hydraulic modeling to characterize habitats available under different water level management strategies. This will provide an analysis of how water level fluctuations, either through reservoir drawdowns, flood control, or due to power peaking activities, affect the availability and continuity of habitats for aquatic biota. Products from this work will be a report detailing the findings and a decision support system that graphically details the effects of water level manipulations.

c. Rationale and significance to Regional Programs.

The effects of hydroelectric development and operation on mainstem habitats has largely been ignored. We know of only one published study (Parsley and Beckman 1993) that has looked at the availability of microhabitats for aquatic biota in the large mainstem reservoirs. In that study, (done under the auspices of BPA project 860500) the authors showed that river discharges affect the availability of habitat for spawning sturgeons downstream from the four lowermost dams on the Columbia River, and that impoundment of the river has increased the physical habitat suitable for rearing sturgeons.

The document ***Return to the River*** (ISG 1996) details the need to consider the availability of complex and connected habitats in all environments, not just tributaries. This document states that the most abundant salmon spawning populations likely occurred in river segments with well-developed floodplains and gravel bars, where habitat complexity was high, and concluded that salmon populations spawning in large alluvial mainstem reaches of the Columbia may have served as core populations critical to sustaining salmonid populations in the basin. The recovery of prime mainstem spawning habitat by lowering water levels in several impoundments has been proposed. The work proposed here will provide the capabilities to assess the resulting river conditions from water level manipulations.

Initially, the work will use existing data to craft the analyses. However, additional information on river bed and flood plain elevations and substrates will need to be collected. We propose to use remote sensing tools to quickly collect this information. The large-scale data collected during this effort could be used as a benchmark to gauge changes to the mainstem environment over time.

d. Project history

e. Methods.

Existing spatial data that can be used to describe present-day and historic microhabitats in the mainstem Columbia River will be used to populate a geographic information system database. Information on river bed elevations, substrates, and water surface profiles can be found in a variety of hardcopy and electronic formats. All data will be converted to Arc\Info coverages or grids.

When it becomes necessary to collect additional data on the physical habitats in the impoundments, remote sensing technologies can be used to acquire data more efficiently than traditional survey techniques. Light Detection And Ranging (LIDAR) technology can be used to collect bathymetric data in some aquatic environments. With this technology, a laser beam originating from a fixed-wing aircraft or helicopter is directed down through the water column, where part of the beam energy is reflected off the surface and the remainder, unless absorbed by particles in the water, is transmitted through the column and reflected by the substrate. A computer calculates the depth from the time interval between the two reflected energy readings. As the beam travels through the water column and reflects off the substrate, scattering, absorption, and refraction all combine to limit the strength of the bottom return and therefore the system's maximum detectable depth. This depth is a function of water clarity, and is generally about three times the Secchi depth.

The Army Corps of Engineers Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS) system is a state-of-the-art LIDAR system currently used for surveying. The helicopter-mounted system can rapidly perform hydrographic and topographic surveys over large areas, and can obtain data from areas where traditional water-borne surveying methods cannot be used (Lillycrop et al. 1996, Parson et al. 1996). The product is generally a digital elevation model (DEM) which can encompass the inundated portion of a water body as well as the flood plain.

The images produced by side scan sonar can be used to characterize substrates. Side scan sonar offers the ability to work in zero visibility water, at great depths, and over extensive areas. Side scan sonar has been used to characterize and map lake trout (*Salvelinus namaycush*) spawning habitat in Lake Michigan (Edsall et al. 1989) and Lake Huron (Edsall et al. 1992). With this technology, differences in substrates are apparent, and ground-truthing can be done to verify the results. Some systems can georeference each pixel, which allows digital images to be draped over a digital surface of bed elevations (a DEM) to create a digital terrain model (DTM) for enhanced analyses.

f. **Facilities and equipment**.

Work would be done at the Columbia River Research Laboratory (CRRL), located in Cook, WA. The CRRL's GIS operates on a 300 mHz pentium II microcomputer running the NT operating system. The system has 27 gigabytes of storage configured at RAID level V to maintain data integrity. Metadata meeting USGS National Biological Information Infrastructure standards would be provided for all spatial data.

The facility has adequate office space, and an extensive fleet of research boats to 30 ft in length to carry out this work. The acquisition of additional spatial data, including river bed elevations and substrates, would require the purchase of a side-scan sonar system.

g. **References**.

Edsall, T.A., T.P. Poe, R.T. Nestler, and C.L. Brown. 1989. Side-scan sonar mapping of lake trout spawning habitat in Northern Lake Michigan. North American Journal of Fisheries Management. 9: 269-279.

Edsall, T.A., C.L. Brown, G.W. Kennedy, and T.P. Poe. 1992. Lake trout spawning habitat in the Six Fathom Bank-Yankee Reef lake trout sanctuary, Lake Huron. Journal of Great Lakes Research. 18: (1) 70-90.

ISG. 1996. Return to the River: Restoration of salmonid fishes in the Columbia River ecosystem. Report of the Independent Scientific Group. Northwest Power Planning Council. Portland, OR.

Lillycrop, W.J., L.E. Parson, and J.L. Irish. 1996. "Development and Operation of the SHOALS Airborne Lidar Hydrographic System," SPIE: Laser Remote Sensing of Natural Waters, from Theory to Practice. 2964: 26-37.

Meaden, G.J. and J.M. Kapetsky. 1991. Geographical Information Systems and remote sensing in inland fisheries and aquaculture. FAO Fisheries Technical Paper 318. Rome, Italy. 262p.

Parson, L.E., W.J. Lillycrop, C.J. Klein, R.C. Ives, and S.P. Orlando. 1996. Use of Lidar Technology for Collecting Shallow Bathymetry of Florida Bay. Journal of Coastal Research. 13:(4).

Parsley, M.J. and L.G. Beckman. 1993. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management. 14:812-827.

Section 8. Relationships to other projects

This work would benefit the PATH workgroup and other resource managers by providing information on the potential changes to aquatic habitats if reservoir drawdowns are implemented.

Section 9. Key personnel

Michael J. Parsley
Research Fishery Biologist - Project Leader FTE 0.25

School	Degree	Date
Iowa State University	B.S. Fisheries & Wildlife Biology	1982
University of Wisconsin at Stevens Point	M. S. Fisheries	1984

Certified by the American Fisheries Society as a Fisheries Scientist in 1990

Current Employer: U.S. Geological Survey - Biological Resources Division

Current Responsibilities: I serve as the geospatial technology coordinator for the Western Fisheries Research Center. I also serve as project leader for studies done by staff at our facility on the early life history and habitat use of white sturgeons in the Columbia River. The studies have included the use of biotelemetry to ascertain habitat use by juvenile and adult white sturgeons, laboratory experiments to determine the effects of gas supersaturation on developing embryos, and the use of trawls to estimate recruitment to young of the year. My role is to coordinate our research activities on white sturgeons with the activities and needs of the tribes, states, and other governmental agencies. I oversee the work of several biologists and technicians who collect and analyze data pertaining to our studies to ensure that our work is of the highest quality and that it is done in accordance with established standards and protocols, such as the Good Laboratory Practices Act.

Recent Previous Employment: Research Fisheries Biologist, U.S. Geological Survey, Biological Resources Division, Columbia River Research Laboratory, 1984 - present.

Expertise: My area of expertise is Fisheries Research, and I'm considered an expert on the ecology and biology of white sturgeons. I'm also knowledgeable in methods to quantify habitat in large rivers using remote sensing and geographic information systems.

Recent Relevant Publications:

Parsley, M. J. 1992. Use of a raster structured GIS in fisheries research activities on the Columbia River. in F. D'erchia, editor, Proceedings of the Third National U.S. Fish and Wildlife Service Geographic Information Systems Workshop. May 1992, LaCrosse, Wisconsin.

Parsley, M. J., D. W. Rondorf, and M.W. Hanks. In press. Remote Sensing of Fish and Their Habitats. Proceedings of the "Instream and Environmental Flows Symposium" held in conjunction with the Annual Meeting of the North American Lake Management Society, December 1997, Houston, Texas.

Parsley, M. J., and L. G. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.

Parsley, M. J., L. G. Beckman, and G. T. McCabe. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia River downstream from McNary Dam. Transactions of the American Fisheries Society 122:217-227.

Thomas P. Poe

Supervisory Fishery Biologist, Co-Project Manager, FTE= 0.25

School	Degree	Date
Carroll College	B.S. Biology	1966
Northern Illinois University	M.S. Zoology	1972

Current Employer: U.S. Geological Survey - Biological Resources Division

Current Responsibilities: I serve as project leader for several fisheries research projects in the lower Columbia River. Studies focus on: (1) juvenile salmonid passage behavior at John Day, The Dalles, and Bonneville dams, (2) habitat use by larval and juvenile anadromous and resident fishes in lower Columbia River reservoirs, and (3) a graduate student research project comparing pre and post-impoundment river features in upper John Day Reservoir using a GIS to manipulate and analyze spatial and biological data.

Recent Previous Employment: Supervisory Fishery Biologist/Project Leader, U.S. Geological Survey, Biological Resources Division, Great Lakes Research Center, Ann Arbor, Michigan, 1979-1986.

Expertise: Applied behavioral ecology of fishes, specializing in predator-prey interactions, and on early life history studies, particularly focused on spawning and rearing habitat requirements . I am also trained in the use of side scan sonar and have used this tool to map spawning and rearing habitats of lake trout.

Recent Relevant Publications:

Poe, T.P., R.S. Shively, and R.A.Tabor. 1994. Ecological consequences of introduced piscivorous fishes in the lower Columbia and Snake rivers. Pages 347-360, in D.J. Stouder, K. Fresh, and R.J. Feller (eds.), Theory and Application in Fish Feeding Ecology. Bell W. Baruch Library and Marine Sciences, No. 18, University of South Carolina Press, Columbia, South Carolina.

Edsall, T.A., C.L. Brown, G.W. Kennedy, and T. P. Poe. 1992. Lake trout spawning habitat in the Six Fathom Bank-Yankee Reef lake trout sanctuary, Lake Huron. Journal of Great Lakes Research 18: 70-90.

Poe, T.P., H.C. Hansel, S. Vigg, D.E. Palmer, and L. A. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120: 405-420.

Edsall, T.A., T.P. Poe, R.T. Nester, and C.L. Brown. 1989. Side scan sonar mapping of lake trout spawning habitat in the Great Lakes. North American Journal of Fisheries Management
9: 269-279.

Poe, T.P., C.O. Hatcher, C.L. Brown, and D.W. Schlosser. 1986. Comparison of species composition and richness of fish assemblages in altered and unaltered littoral habitats. Journal of Freshwater Ecology 3: 525-536.

Section 10. Information/technology transfer

Analyses will be presented in annual reports. Spatial data used in the analyses will be made available via anonymous ftp server.