PRELIMINARY PROPOSAL FOR FY 2005 FUNDING

Title: Behavior of White Sturgeon Near Hydroprojects and Fishways

Study Code: ADS-04-NEW

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PROJECT SUMMARY

Goal: The goal of this effort is to provide information on how Corps of Engineers operated dams influence white sturgeon *Acipenser transmontanus*. These investigations will increase the understanding of how dam operations influence behavior related to upstream and downstream passage as well as behavior in areas proximal to the dams. Behavior of white sturgeon in fishways and in dam tailraces and forebays will be investigated to determine ways to enhance access to and use of fishways and reduce entrainment during maintenance activities or downstream migrations. A better understanding of white sturgeon behavior in the vicinity of dams will facilitate management of this fishery.

Study Objectives:
1. Describe the distribution, movements, and behavior of white sturgeon immediately downstream from dams including fish ladder entrances and exits, in fishways, navigation locks, and immediate tailrace areas.

2. Determine routes of passage taken by downstream migrants and if fallback occurs for fish that ascend fishways.

A telemetry study begun in 2004 at The Dalles Dam will continue in 2005. Additional hydrophones will be added in the forebay and tailrace to increase coverage of key areas around the dam. Additional sampling with setlines will be done to achieve goals of releasing 100 tagged white sturgeon downstream from the dam and 50 white sturgeon upstream.

Relevance: The Reasonable and Prudent Alternative section in the 2000 Biological Opinion (BIOP) lists several measures to avoid jeopardy in Section 9.6. Though mostly intended to improve juvenile and adult salmonid survival, these measures will affect resident fishes including white sturgeon, and the BIOP calls for minimizing negative impacts on, or providing benefits to, resident fish and wildlife. Sections 9.6.1.6 (Adult Passage and Research) and 9.6.1.8 (Strategy to Improve Fish Facility Operations and Maintenance) describe several actions that will modify fishway entrances and exits and operations which will have unknown effects on white sturgeon passage.

Section 10.4 of the Northwest Power Planning Council's Fish and Wildlife Program calls for studies on the migration potential of white sturgeon and to investigate additional passage opportunities for these fish.

White sturgeon can become entrained in turbine draft tubes and other areas during maintenance activities. The Washington Department of Fish and Wildlife has pursued and received compensation from the Army Corps of Engineers for losses of white sturgeon that have occurred during maintenance activities at the dams.

PROJECT DESCRIPTION

Background

The Army Corps of Engineers began funding research in fiscal year 2004 to meet the multiyear objectives described below.

Description and literature review. White sturgeon *Acipenser transmontanus* are an important recreational, commercial, and cultural resource in the Columbia River Basin. However, white sturgeon populations vary considerably in abundance and age structure throughout the Columbia River Basin (Beamesderfer et al. 1995). The abundance and density of fish is greatest in the unimpounded river downstream from Bonneville Dam and this area supports one of the largest and most productive sturgeon populations in the world (Devore et al. 1995). Conversely, the white sturgeon population from the Kootenai River in northern Idaho has been listed as endangered since 1994. Populations in the Snake River downstream from Hells Canyon Dam appear to be persisting but at a lower abundance than prior to impoundment.

This variation in population status can be attributed to a number of factors including differences in exploitation rates and recruitment success, access to marine food resources, and suitability of hydrologic conditions and available habitats (Beamesderfer et al. 1995; DeVore et al. 1995). In particular, construction and operation of hydroelectric dams on the Columbia and Snake rivers has directly affected white sturgeon populations in several ways. Spawning habitats are reduced (Parsley and Beckman 1994), upstream and downstream passage is limited (Warren and Beckman 1992), and substantial numbers of juvenile and adult fish can be entrained and killed during dam maintenance activities (Brad James, Washington Department of Fish and Wildlife, personal communication).

White sturgeon seldom ascend the existing fishways at the hydroelectric projects probably because the fish passage facilities for upstream migrating fish at Columbia River Basin dams were designed primarily for anadromous salmonids. Although little is known about white sturgeon swimming performance, research conducted with lake sturgeon (Peake et al. 1997) demonstrated that the swimming abilities of sturgeons are substantially different from those of salmonids. In particular, Peake et al. (1997) found that lake sturgeon are poor swimmers compared with salmonids, particularly at burst swimming speeds. Sturgeons also generate greater drag than salmonids while swimming (Webb 1986) and have a less efficient tail, resulting in greater energy expenditure while swimming in higher velocity areas. Wilga and Lauder (1999) showed that small white sturgeon (<32 cm TL) exhibited undulatory swimming in current velocities of 0.5 – 2.0 body lengths/sec, and that the transition to burst-and-glide swimming occurred when velocities reached 2.5 body lengths/sec. The large body size of sturgeon may also impede progress through submerged orifices designed for salmonids. Unlike teleosts, sturgeon generate rapid swim speeds via increased body curvature (Long 1995). They therefore may be hindered by submerged orifices that were dimensioned to accommodate salmonids.

An exception to limited upstream movement is the east fishway at The Dalles Dam. Warren and Beckman (1993) reported that during 1986 through 1991, 3,181 white sturgeon (range = 187-791 fish per year) were counted at the fishways at The Dalles Dam. The majority of these fish were counted in the east fishway. In comparison, during the same period, only 215 fish

(range = 19-60) were counted at Bonneville Dam fishways, with even fewer (N = 68, range = 4-29) observed at John Day Dam. White sturgeon upstream passage at all of the dams was generally highest during the months of July and August. Similar late summer and early fall upstream movement patterns have been identified in reservoirs and unimpounded river reaches (Haynes et al. 1978; North et al. 1993). Navigation locks at dams provide another possible passage route (upstream and downstream) for fish, but use of navigation locks by white sturgeon has not been confirmed (Warren and Beckman 1992). Historically, the original fish lock at Bonneville Dam was used successfully for passing white sturgeon upstream; the lock, though still in place, has not been used since 1971.

Some white sturgeon pass downstream through dams, but the route of passage is unknown. Fisheries sampling done by the Oregon and Washington Departments of Fish and Wildlife and angler returns of tagged fish have resulted in several recaptured fish that had moved downstream past one or more dams. North et al. (*in press*) reports that since 1987, the Oregon Department of Fish and Wildlife has recovered four tagged white sturgeon that passed upstream and 74 fish that passed downstream through one or more dams.

Thus, construction of hydroelectric dams on the Columbia and Snake rivers has largely restricted movements of white sturgeon to within impounded reaches, effectively resulting in a series of individual landlocked populations (North et al. 1993). Prior to dam construction in the Columbia River Basin, white sturgeon likely responded to seasonal changes in food and habitat availability by ranging extensively between freshwater, estuarine, and marine environments. Because the physiochemical and biotic characteristics of reservoirs vary greatly within the basin, individual impoundments may not contain optimal conditions for all life stages of white sturgeon (Parsley and Beckman 1994, Beamesderfer et al. 1995). Providing passage at dams could enhance the productivity of white sturgeon populations.

Isolation by dams has also possibly reduced the genetic diversity of the populations within the impoundments. Consistent with this possibility, Brown et al. (1992) found that mitochondrial DNA diversity was greater in white sturgeon downstream from Bonneville Dam than in upstream populations. These findings were questioned by North et al. (1993), however, who theorized that existing white sturgeon passage, though very limited, could maintain adequate gene flow between reservoirs and prevent divergence of populations. Geneticists at the University of Idaho are currently investigating the genetic structure of white sturgeon throughout the Columbia River Basin, which should indicate the degree of passage needed to maintain the genetic integrity of this species.

In addition to possible genetic differences, white sturgeon condition, growth, and size at maturity vary among the lower Columbia River reservoirs (Beamesderfer et al. 1995), presumably due to variations in resource availability among areas. Dams, as barriers to movements, prevent fish from finding more productive habitats. In some impoundments, suitable rearing habitat exists, but spawning habitat is lacking and recruitment of fish is poor (Parsley and Beckman 1994). Conversely, research conducted in the Bonneville Reservoir suggests that spawning conditions are favorable for good recruitment of young-of-the-year white sturgeon in most years, but growth of young fish may be density limited (Beamesderfer et al. 1995). Improving upstream passage for fish would facilitate movement of sub-adult white sturgeon into under-seeded areas.

To better understand how to improve passage opportunities for white sturgeon and to reduce

entrainment of fish during maintenance activities, we propose to examine their behavior and movements near dams and in fishways by using biotelemetry, initially focusing our work at The Dalles Dam because this is where most white sturgeon passage presently occurs (Warren and Beckman 1992). Behavioral information from telemetry studies (e.g., fish response to water velocities in near-dam and fishway environments and depth selection near dams) in combination with hydraulic and physical descriptors of near-dam and fishway environments, will enable us to better understand factors currently influencing or limiting white sturgeon movement at dams. Research on factors that attract sturgeon to particular entrances will be helpful in improving passage at dams (Secor et al. 2002).

Relationship with ongoing studies. This research will compliment ongoing work funded by the U.S. Army Corps of Engineers to investigate passage of lampreys and juvenile and adult salmonids. Work investigating attraction flows for adult salmonids at the entrances to several fishways may provide beneficial hydraulic information. We will collaborate with others conducting telemetry studies on the passage of lampreys and juvenile and adult salmonids by sharing telemetry and laboratory equipment and staff.

The Bonneville Power Administration currently funds several projects investigating the life history and stock status of white sturgeon. The Oregon Department of Fish and Wildlife is the lead agency in collaborative studies with the Washington Department of Fish and Wildlife, the U.S. Geological Survey, the Columbia River Intertribal Fish Commission, and the U.S. Fish and Wildlife Service. These studies are investigating stock status and habitat use of white sturgeon in various reservoirs, quantifying habitats suitable for spawning and rearing, examining the feasibility of transplanting juvenile white sturgeon from areas with higher productivity to areas where recruitment is limited, and exploring the potential to use aquaculture to rebuild white sturgeon populations. Staff at the University of Idaho are conducting a comprehensive system-wide description of the genetic structure of white sturgeon, which will enable fisheries managers to determine the genetic consequences of reduced movement among areas as a result of dam construction and supplementation. The Nez Perce Tribe of Idaho is evaluating the status of the white sturgeon population in the Snake River between Lower Granite Dam and Hells Canyon Dam. The work we are proposing will complement these studies by providing information that could be used to improve passage at the dams, and by providing information on the behavior of fish that may aid efforts to reduce entrainment during maintenance activities.

Objectives, Rationale, and Methods

Little is known about the behavior and distribution of white sturgeon in relation to physical structures of dams. To our knowledge no one has investigated the behavior of white sturgeon near navigation locks, turbine intakes, spill gates, fishway entrances, exits, or within fishways. Knowledge of the distribution and behavior of white sturgeon in close proximity to the dams is needed to better understand how they react to changes in dam operations, which could lead to improved upstream and downstream passage and reduced entrainment during maintenance.

Current fishways at Columbia and Snake river dams seldom pass white sturgeon upstream. The Corps of Engineers will be making modifications to fishways to improve upstream passage

of adult salmonids and Pacific lamprey. Fishway designers need to consider the swimming ability, space requirements, and behavior of white sturgeon to enable these fish to ascend fishways as well. The overall goal of this work is to provide information on improvements (structural or operational) to enhance passage of white sturgeon at dams. In this proposal we outline a pilot study to investigate the feasibility of outfitting white sturgeon of various sizes with telemetry transmitters and monitoring their movement patterns and behavior in and around fishways on the lower Columbia River using existing telemetry infrastructure that is used to monitor passage of adult and juvenile salmonids. Behavior of white sturgeon in fishways and in dam tailraces will be investigated to determine ways to enhance access to fishways.

We propose to accomplish the following objectives during three years of study.

Objective 1. Describe the distribution, movements, and behavior of white sturgeon immediately downstream from dams including fish ladder entrances and exits, in fishways, navigation locks, and immediate tailrace areas.

We will use radio and acoustic telemetry methods to describe the distribution and movements of white sturgeon in dam fishways and in adjacent areas including fish ladder entrances and exits, and in the immediate tailrace and forebay areas. These studies will allow us to determine if white sturgeon congregate in areas that may aid them in locating fishways, cause delay, or make them susceptible to entrainment during maintenance activities. We may also be able to determine the length of time white sturgeon require to ascend fishways and to determine downstream routes of passage through dams. Because The Dalles Dam is presently the only hydroelectric facility with an appreciable number of white sturgeon currently using fishways (Warren and Beckman 1992) we propose that most of this work be done at this Project. Limited monitoring at Bonneville and John Day dams will provide additional information on fish that move between Projects.

In 2004 we secured the proper permits, obtained access to restricted areas on the dam, studied the facility, and determined how to best capture white sturgeon in the immediate vicinity of the dam and fishways. In 2005 we will capture additional fish to meet the project goal of releasing up to 100 adult and sub-adult white sturgeon with transmitters downstream from The Dalles Dam and 50 fish upstream.

Sturgeon will be captured using baited setlines fished in the vicinity of The Dalles Dam, although other methods, such as angling may be used. We will also continue to pursue any opportunities to obtain sturgeon during turbine de-watering operations at The Dalles Dam. Fish captured in this way may be of particular interest as they will have demonstrated movement in the vicinity of the Project. Transmitters used in 2004 were a combination acoustic and radio tag which alternates transmitting an acoustic and radio signal. The tag sends a signal at 20 second intervals. Two acoustic pulses are followed by a single radio pulse each minute. The tags are programmed to shut down 2 years after activation. The use of acoustic and radio signals allows us to better monitor fish movements in and around dams and to locate them in reservoirs during boat tracking surveys for adult salmonids through the lower Columbia River as part of the University of Idaho/NMFS Adult Passage Project (APP).

Telemetry data will continue to be collected in 2005. In addition to the eight fixed hydrophones already in use (7 in the forebay and 1 in the tailrace), sixteen more hydrophones

will be installed in areas of interest along the navigation lock, forebay, and tailrace to increase coverage of key areas. Radio telemetry data are downloaded periodically by personnel from the University of Idaho and stored in the APP database maintained by NMFS personnel in Seattle. Raw telemetry records are processed by personnel from the University of Idaho using automated software developed to code salmonid behavior at dams. Acoustic data are downloaded from fixed receivers periodically by personnel from the USGS. Processed telemetry data will be available for analysis and interpretation. The quality and quantity of the telemetry information will continue to be evaluated to determine how to improve data collection methods.

In 2005 we will continue to explore ways to monitor movements of white sturgeon within fishways. Effort in 2004 was directed at obtaining an understanding of general fish movements adjacent to the dam. While fish released may enter the fishways, we will also explore methods of attaching transmitters directly to fish within the fishways. These transmitters would have a more frequent burst rate to increase the probability of detection within the fishway and at the entrances and exits.

Objective 2. Determine routes of passage taken by downstream migrants and if fallback occurs for fish that ascend fishways.

In conjunction with Objective 1, during years 1-2 monitoring along the upstream face of The Dalles and Bonneville dams will provide information on routes of downstream passage taken by downstream migrants. This will also provide information to determine if fallback of fish that ascend The Dalles fishway occurs or if these fish continue upriver and contribute to the upstream population. Up to 50 additional white sturgeon will be captured and tagged with transmitters in The Dalles Dam forebay. Alternatively, we may be able to tag fish that are stranded during turbine de-watering operations. Data logging receivers with antennas or hydrophones mounted on the upstream face of The Dalles Dam record movements of fish that remain in close proximity to the dam, while periodic mobile tracking will be done to locate fish that move upstream. The geographic coordinates of locations where fish are found will be recorded and displayed via a geographic information system.

Facilities and Equipment

The Columbia River Research Laboratory, a field station of the U.S. Geological Survey's Western Fisheries Research Center, is located in Cook, Washington along the Columbia River. The facility is approximately 60 miles east of Portland, Oregon and is located on the grounds of the U.S. Fish and Wildlife Service's Willard National Fish Hatchery. The laboratory has wetlab and drylab facilities, office space, and a mechanical shop. The electrical system is connected to backup generators for emergency use during power outages.

The laboratory has a fleet of approximately 30 vessels ranging in length from 18 to 30 feet in length that are capable of performing limnological and fish sampling tasks. Staff at the facility are involved in telemetry studies using radio and acoustic transmitters and receivers.

The office has exceptional computational capabilities and a T-1 line connecting to the Internet. Staff use a variety of graphical and analytical software, and geographic information systems including Arc/Info and ArcView to facilitate data summarizations and presentations.

The University of Idaho (UI) maintains an extensive array of fixed site receivers at all mainstem hydropower dams in the lower Columbia River and additional receivers in the mainstem and at tributary mouths to document salmonid and lamprey movements. UI and National Marine Fisheries Service (NMFS) personnel also conduct regular mobile tracking surveys to document year-round movements of telemetered salmonids and lamprey. The NMFS, Northwest Fisheries Science Center houses the existing adult radiotelemetry database for the Columbia River (over 200 million records, 78GB). Personnel at NMFS use a Solaris operating system and scripts that allow automated loading of over 300,000 records each day. The Oracle-based system allows easy data extraction and summary.

Personnel from the University of Idaho (UI) maintain a network of over 160 telemetry receivers in the Columbia River basin, including monitoring of fishways at all eight dams on the lower Columbia and Snake rivers for adult anadromous salmonid and lamprey passage evaluations. UI personnel also maintain several boats to conduct mobile track surveys of fish with radio and acoustic tags in the lower Columbia River that can assist monitoring of sturgeon with transmitters.

Impacts

The proposed activities will be coordinated with ongoing projects funded by the Corps of Engineers, the Bonneville Power Administration, and others. Antennas and hydrophones will be mounted at the entrances and exits of fishways and along turbines and spill gates to monitor movements of fish along the dam structure. Project assistance will be necessary to construct and mount these devices to the satisfaction of the Project and the researchers. It will be necessary to have boat access into the Boat Restricted Zones upstream and downstream from the dams to capture white sturgeon and to test equipment.

Subcontracts

Each agency will require a separate contract. For some tasks, the USGS contracts with Johnson Controls International (JCI) for biological technician support services. All JCI contractors conduct work under the technical direction of USGS personnel.

Key Personnel and Project Duties

Agency	Personnel	Roles
USGS	Michael J. Parsley	Project Leader; project administration, reporting, analysis

	Eric Kofoot	Technician, field data collection, data summarization
NMFS	Dr. Mary Moser	Principal Investigator, data maintenance, analysis, reporting
UI	Dr. Chris Peery	Principal Investigator, data collection, analysis, reporting.

Technology Transfer

These studies have wide applicability to ongoing efforts underway by state, federal, and tribal fisheries managers and hydropower operators to recover white sturgeon populations. The project leader and principal investigators will ensure that information and analyses from this work are available to resource managers via presentations at professional meetings, workshops, and when otherwise requested. Technical findings may be published in peer-reviewed journals. The USGS's Columbia River Research Laboratory produces metadata records in compliance with National Biological Information Infrastructure standards.

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