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White Sturgeon Spawning Areas in the Lower Snake River

Abstract

We documented 17 white sturgeon *Acipenser transmontanus* spawning locations in the Snake River from the mouth to Lower Granite Dam (river km 0 to173). Spawning locations were determined by the collection of fertilized eggs on artificial substrates or in plankton nets. We collected 245 eggs at seven locations in McNary Reservoir, 22 eggs at three locations in Ice Harbor Reservoir, 30 eggs from two locations in Lower Monumental Reservoir, and 464 eggs at five locations in Little Goose Reservoir. All 17 locations were in high water velocity areas and between 1.0 and 7.0 km downstream from a hydroelectric dam. The documentation of spawning areas is important because this habitat is necessary to maintain natural and viable populations.

Introduction

Fishery managers have identified the need for the protection and enhancement of critical white sturgeon *Acipenser transmontanus* habitat (PSMFC 1992). White sturgeon are ancient fish that evolved in and adapted to free-flowing rivers along the Pacific coast of North America. These long-lived fish are susceptible to overfishing (Rieman and Beamesderfer 1990) and environmental perturbations. Dam construction and operation of the Federal Columbia River Power System has adversely affected white sturgeon populations (Beamesderfer et al. 1995, DeVore et al. 1995). Historically, white sturgeon traveled throughout a diverse Columbia River Basin (Bajkov 1951) seeking out and spawning in favorable riverine habitat at peak seasonal conditions (Scott and Crossman 1973).

The need for more information on the habitat requirements of white sturgeon was given top priority in a workshop held in 1983 that ranked research needs for this species (Fickesien et al. 1984). As a result, several studies were undertaken in the lower Columbia River reservoirs during the late 1980's to determine the current status of white sturgeon populations. The studies documented that spawning in the lower Columbia River occurred during the months of April through July primarily within 8 km to 11 km downstream from a dam when water temperatures were between 10° C and 18°(Parsley et al. 1993, McCabe and Tracy 1994). High water velocities (mean column velocities ≥ 0.8 m/s) and solid bottom substrates of bedrock, boulder, or cobble generally characterize white sturgeon spawning habitat (Parsley et al. 1993). Further work by Parsley and Beckman (1994) revealed that the quantity and quality of spawning habitat was influenced by river discharge, reservoir pool elevation, and river channel morphometry. Thus, hydroelectric development in the Columbia River Basin has reduced the availability of riverine habitat needed by white sturgeon for successful spawning (Parsley and Beckman 1994). Currently, most areas of habitat that would be considered suitable for spawning by white sturgeon in the Columbia and Snake rivers are located immediately downstream from hydroelectric dams.

Miller et al. (1995) reports that the status of 25 discrete white sturgeon populations in the Columbia River basin varies. Only 1 population is considered to be stable and abundant and 5 populations are considered to be relatively abundant, but their numbers are probably reduced from historic levels. The remaining populations are considered to be sparse and declining, and the population of white sturgeon in the Kootenai River in northern Idaho has been listed as endangered. Thus, it's imperative to document localized areas that are important to various life stages of these fish so that further perturbations to those habitats can be avoided.

Prior studies of white sturgeon spawning activities did not present detailed information concerning the exact location of spawning sites. This information is critical if the remaining spawning sites are to be protected and possibly enhanced. During earlier work researchers tested gears for collecting white sturgeon eggs from spawning areas. Gears tested included inverted U-shaped

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plankton nets, beam trawls, and artificial substrates (Parsley et al. 1993, McCabe and Beckman 1990). Variants of the artificial substrates described by McCabe and Beckman (1990) are now widely employed by fisheries professionals interested in documenting spawning by several species of sturgeon. They can be left to fish unattended and are relatively inexpensive; thus, many areas can be sampled at a lower cost than with nets or trawls. The objective of our study was to identify specific sites where white sturgeon spawn in the lower Snake River, focusing on dam tailrace areas.

Methods

Sampling for white sturgeon eggs was performed in the lower Snake River from the mouth to river km 173 (Figure 1). River kilometer designations were obtained by converting river miles noted on nautical navigation charts produced by the National Atmospheric and Oceanic Administration. We concentrated sampling effort for white sturgeon eggs downstream from four dams: Ice Harbor (river km 16), Lower Monumental (river km 67), Little Goose (river km 113), and Lower Granite (river km 173). The area downstream from Ice Harbor Dam was sampled in 1993, 1994, and 1995 (Figure 2). Sampling downstream from the Lower Monumental (Figure 3), Little Goose (Figure 4), and Lower Granite (Figure 5) dams was done in 1997 and 1998. Sampling for white sturgeon eggs was performed within the known seasonal spawning period (Parsley et al. 1993, McCabe and Tracy 1994), with sampling beginning when water temperatures approached 12°C and ending when tem-

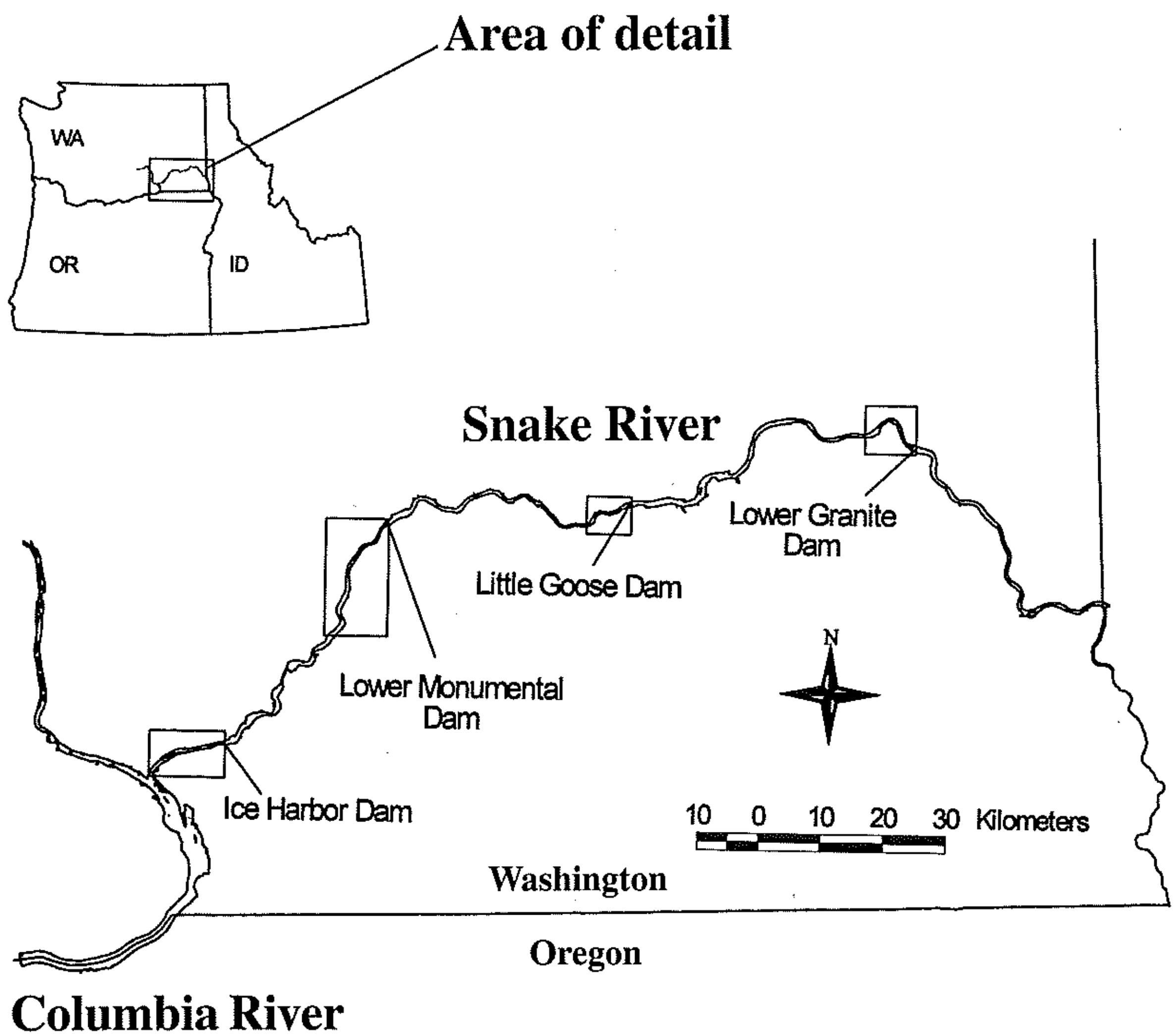

Figure 1. Areas along the lower Snake River where sampling for white sturgeon eggs was performed during 1993-95 and 1997-98.

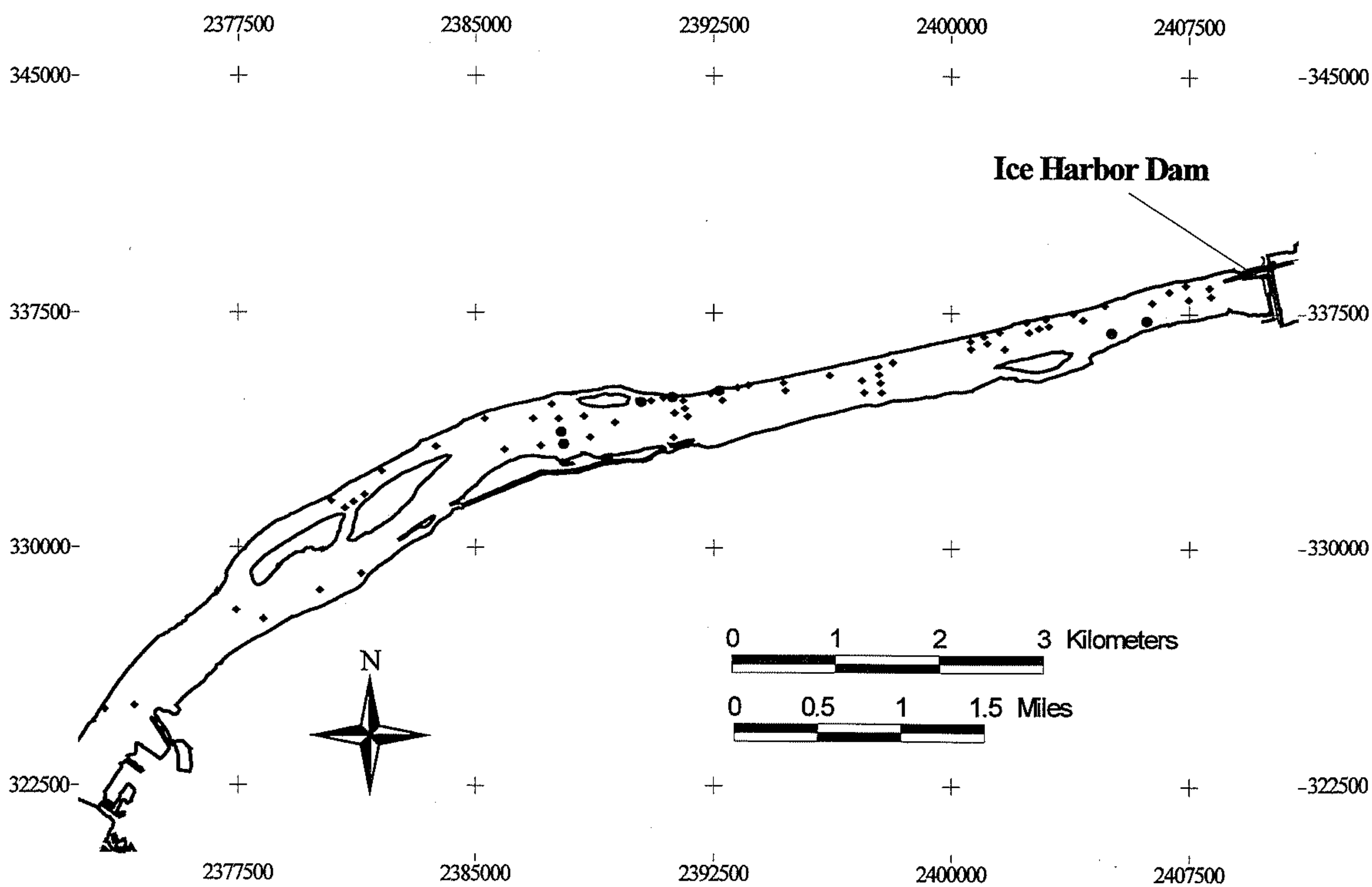

Figure 2. Sites sampled with artificial substrates or plankton nets in McNary Reservoir downstream from Ice Harbor Dam during 1993-95. Black circles depict sites where eggs were collected, and black diamonds depict sites where no eggs were collected. Graticules are in the State Plane Coordinate System, Washington South Zone. The horizontal datum used was NAD27.

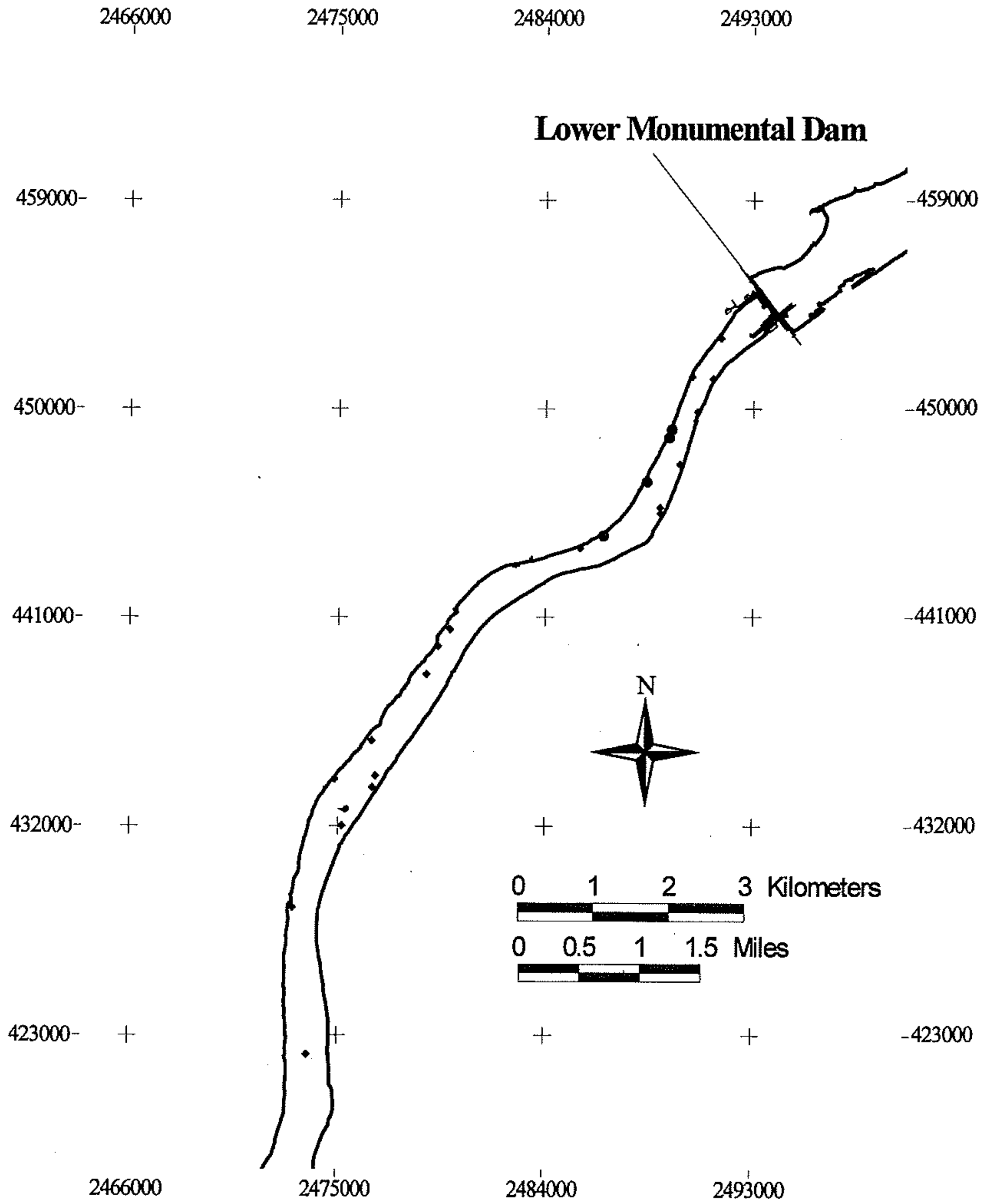

Figure 3. Sites sampled with artificial substrates in Ice Harbor Reservoir downstream from Lower Monumental Dam during 1997-98. Black circles depict sites where eggs were collected, and black diamonds depict sites where no eggs were collected. Graticules are in the State Plane Coordinate System, Washington South Zone. The horizontal datum used was NAD27.

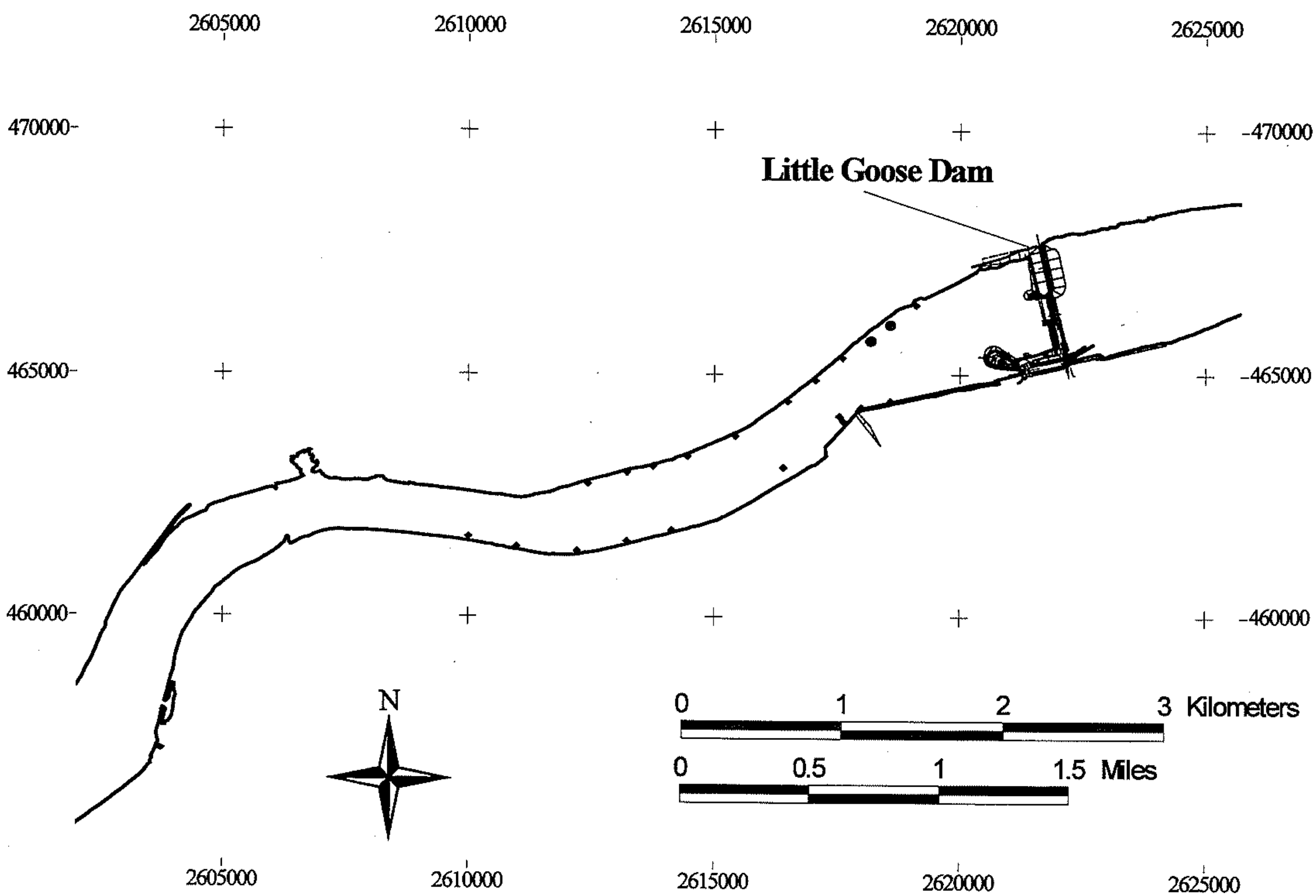

Figure 4. Sites sampled with artificial substrates in Lower Monumental Reservoir downstream from Little Goose Dam during 1997-98. Black circles depict sites where eggs were collected, and black diamonds depict sites where no eggs were collected. Graticules are in the State Plane Coordinate System, Washington South Zone. The horizontal datum used was NAD27.

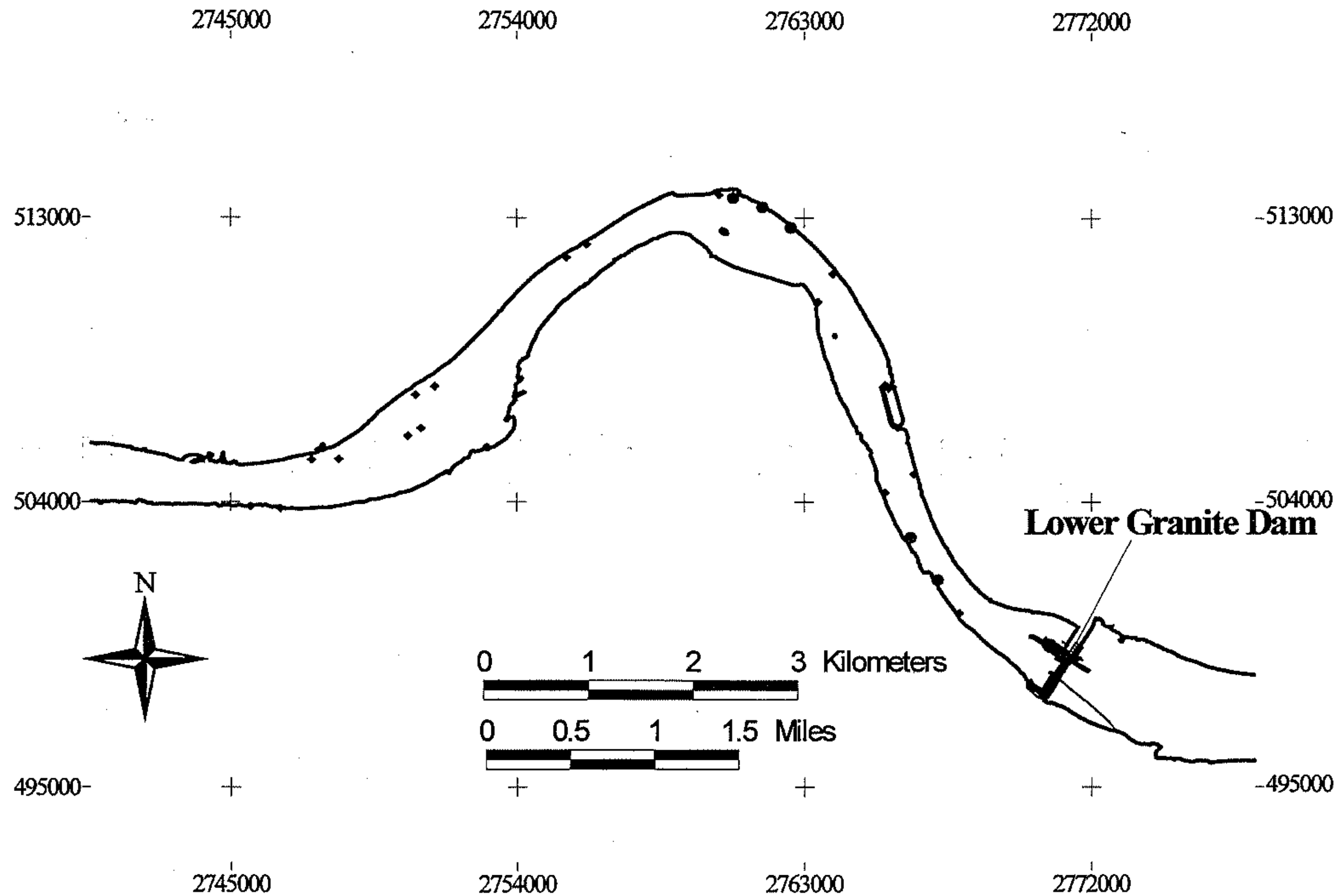

Figure 5. Sites sampled with artificial substrates in Little Goose Reservoir downstream from Lower Granite Dam during 1997-98. Black circles depict sites where eggs were collected, and black diamonds depict sites where no eggs were collected. Graticules are in the State Plane Coordinate System, Washington South Zone. The horizontal datum used was NAD27.

peratures exceeded 19°C. This corresponded to a period from mid-May to mid-July during all years.

The sampling gears used to collect eggs included U-shaped plankton nets (Parsley et al. 1993) and artificial substrates (McCabe and Beckman 1990). The U-shaped plankton nets were used only downstream from Ice Harbor Dam. They were constructed of 1.59-mm knotless mesh attached to an inverted U-shaped frame. Two spherical lead weights (4.5 kg each) were attached to the lower corners of the frame. Paired plankton nets were fished by anchoring the vessel at the sampling site and lowering the nets until they made contact with the bottom of the river. Generally, the nets were fished at each site for 30 min once or twice weekly. We modified the design of the artificial substrates used by McCabe and Beckman (1990) by adding an additional cross-brace to each side of the frame to better support the filter material. Artificial substrates were deployed at sampling sites and typically checked once weekly. White sturgeon eggs were readily identified in the field from other eggs collected by their large size and opaque coloration. Weekly retrieval of the artificial substrates and deployment of the U-shaped plankton nets was occasionally interrupted by mechanical problems, severe weather, or high river discharges that created dangerous sampling conditions.

While sampling downstream from Ice Harbor Dam, we mapped and navigated to sampling sites using river navigation charts and visual markers. Sampling sites that were plotted on the navigation charts were transferred into a geographic information system (GIS) by assigning geographic coordinates using the State Plane Coordinate System, North American Datum of 1927 (NAD27), Washington South Zone. These coordinates were used within the GIS to generate the map of sampling sites in the Snake River section of McNary Reservoir (Figure 2).

Sampling sites in Ice Harbor, Lower Monumental, and Little Goose reservoirs were recorded with a Rockwell[2] PLGR+ Global Positioning System (GPS) receiver using Precise Positioning Service[3]. The NAD27 was used as the datum for all recorded GPS positions. Position coordinates were converted to the State Plane Coordinate System, Washington South Zone, then directly downloaded into a GIS to generate the maps of sampling sites for Ice Harbor, Lower Monumental, and Little Goose reservoirs (Figures 3, 4, and 5).

Results

We sampled for white sturgeon eggs at a number of sites in the lower Snake River, and identified 17 sites where spawning occurred. Sampling effort was not equal among reservoirs and years, and two gears were used in Ice Harbor Reservoir. White sturgeon spawning was documented in McNary, Ice Harbor, Lower Monumental, and Little Goose reservoirs (Table1), and all white sturgeon eggs were collected between 1.0 and 7.0 km downstream from a dam. White sturgeon are broadcast spawners, and our sampling methods allowed us to collect eggs where they settled on the substrate. Thus, exact locations where spawning occurred were not determined, but spawning and egg incubation sites must be in close proximity to each other.

Spawning by white sturgeon in the Snake River downstream from Ice Harbor Dam occurred further downstream from this dam (7.0 km) than spawning occurred downstream from the other three dams. Sampling in McNary Reservoir was performed during 1993 through 1995 between river km 3.2 to 15.1, and all white sturgeon eggs were collected between 1.2 and 7.0 km downstream from Ice Harbor Dam (Figure 2). Spawning by white sturgeon in this river reach occurred in several areas, based on our collection of 245 eggs from seven sites (Table 1). At these seven sites, eggs were collected with artificial substrates from the lower two sites and the upper two sites, and eggs were collected in the plankton nets at the other three sites as well as at the lower two sites.

Spawning by white sturgeon in Ice Harbor Reservoir occurred within 3.9 km downstream from Lower Monumental Dam (Figure 3). Sampling in Ice Harbor Reservoir was performed between river km 56.0 to 65.5, and all white sturgeon eggs were collected between 2.0 and 4.0 km downstream from Lower Monumental Dam. We collected 22 eggs at three sites in Ice Harbor Reservoir during 1997 and 1998 (Table 1). The spawning occurred within a 1.8-km reach along the north shoreline.

Spawning by white sturgeon in Lower Monumental Reservoir occurred within 1.0 km of Little Goose Dam. Sampling during 1997 and 1998 was

TABLE 1. Characteristics of locations where white sturgeon eggs were collected in the lower Snake River. State Plane coordinates can be used to locate the sites on the accompanying figures, or used as input into a geographic information system. The coordinates use the horizontal datum NAD27 and are in Washington South Zone.

Reservoir	Depth[1] (m)	Geographic coordinates		Number of eggs collected[2]	
		Northing	Easting	1993-95	1997-98
McNary	5	333716	2387658	179	—
McNary	5	333286	2387769	39	—
McNary	7	334636	2390205	3	—
McNary	8	334790	2391183	1	—
McNary	8	335009	2392662	1	—
McNary	3	336882	2405061	21	—
McNary	5	337264	2406167	1	—
Ice Harbor	6	444505	2486517	—	7
Ice Harbor	7	446831	2488390	—	2
Ice Harbor	6	449119	2489475	—	13
Lower Monumental	7	465331	2617624	—	16
Lower Monumental	8	466005	2618588	—	14
Little Goose	5	513615	2760782	—	1
Little Goose	8	513328	2761701	—	2
Little Goose	8	512681	2762584	—	272
Little Goose	8	502856	2766321	—	2
Little Goose	8	501508	2767172	—	187

[1]Depths are approximate due to varying pool elevations.
[2]Dashes indicate years when no sampling was performed in the reservoir.

performed between river km 109.6 and 112.5. During our sampling, we collected 30 eggs from two sites in Lower Monumental Reservoir (Table 1). Both sites were located along the north shoreline within 200 m of each other. Eggs were not collected with artificial substrates located immediately upstream or downstream from these sites, suggesting that this spawning area is rather limited in extent. All white sturgeon eggs collected in Lower Monumental reservoir were collected between 1.0 and 1.2 km downstream from Little Goose Dam (Figure 4).

We collected 464 eggs at five sites in Little Goose Reservoir during 1997 and 1998 (Table 1). Sampling was performed between river km 161.0 to 171.9. All white sturgeon eggs collected in Little Goose Reservoir were collected between 1.3 and 5.8 km downstream from Lower Granite Dam (Figure 5). Spawning occurred in two general areas, both on outside bends of the river channel. Two of the artificial substrates fished in these areas (one from each general area) collected the majority of the eggs. One artificial substrate in the lower of the two areas collected 272 eggs, and an artificial substrate in the upper area collected 187 eggs for a total of 459 eggs. The remaining five eggs were collected at three sites near the two artificial substrates where most of the eggs were collected. Eggs were not collected on artificial substrates located just upstream and downstream from these areas (Figure 5). Thus, we believe that these spawning areas are limited in extent.

Discussion

Although fisheries for white sturgeon in the Columbia River Basin have been regulated for over 100 years, it wasn't until 1983 that spawning areas used by these fish were documented. During that year, employees from the Washington Department of Fisheries collected fertilized eggs downstream from Bonneville Dam (J.D. DeVore, Washington Department of Fish and Wildlife, pers. comm.). Spawning has since been documented in several reservoirs and river reaches in the Columbia River Basin. Spawning has been documented in the Columbia River downstream from Bonneville, The Dalles, John Day, and McNary dams (Parsley et al. 1993, McCabe and Tracy 1994), downstream from Priest Rapids dam (authors, unpublished data), and at the confluence of the Pend d'Orelle River (R.L. & L. Environmental Services Ltd. 1994). Spawning by white sturgeon has also been documented in the middle

Snake River (K. Lepla, Idaho Power Company, pers. comm.) and Kootenai River (V. Paragamian, Idaho Fish and Game, pers. comm.).

The documentation of spawning areas is important because this habitat is necessary to maintain natural and viable populations. The information presented here identifies, within meters, areas where white sturgeon have spawned. We believe that spawning by white sturgeon in the lower Snake River may occur in other locations near the sites we sampled because hydrologic and thus habitat conditions vary from year to year. However, it is unlikely that spawning occurs much further downstream from where we collected eggs because the water velocities, an important physical microhabitat variable for spawning (Parsley and Beckman 1994) decrease rapidly due to the backwater effects caused by the downstream dam. Although no historic record of spawning sites exists for the lower Snake River, it is probable that prior to impoundment, spawning occurred in favorable locations throughout the lower Snake River.

The identification of white sturgeon spawning areas is aided by the descriptions of spawning habitat provided by Parsley et al. (1993) and McCabe and Tracy (1994), who described the physical characteristics of white sturgeon spawning habitat in the Columbia River in detail. Although we did not measure water velocities in this study, the sites where we collected eggs had very high, turbulent velocities. Sites where eggs were not collected generally had lower or more laminar velocities. The sites where eggs were collected were often near river bends or areas with variable bottom topography that created constantly changing eddies and currents. Habitats such as this may allow white sturgeon to hold position in these high velocity environments while at the same time providing good dispersal of the adhesive eggs.

The artificial substrates we used enable sampling in a variety of habitats, but there were areas downstream from the dams that possess characteristic white sturgeon spawning habitat that we could not or would not sample. Those areas include the federally maintained navigation channel and the boat restricted zone downstream from each dam. Generally, sampling was precluded from these areas by excessive water velocities, large standing waves, or other conditions that made these areas unsafe for the sampling crews.

The amount of available spawning habitat for white sturgeon increases and decreases on an arrhythmic and seasonal basis because of differences in river discharge and water temperature (Parsley and Beckman 1994). These in turn are influenced by natural fluctuations in hydrologic conditions and the need to meet power production, flood control, and irrigation requirements. Currently, there are proposals to alter the management of the water storage projects on the Columbia and Snake rivers to increase survival of juvenile anadromous salmonids. If management of the hydropower system changes to restore a more natural river, we could see an increase in available spawning habitat and activity that would be beneficial to sustaining these white sturgeon populations (Auer 1996, Beamesderfer et al. 1995).

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Footnotes

1. The mention of trade names does not imply endorsement by the U.S. Geological Survey.
2. The Precise Positioning Service (PPS) is available to the military and certain federal civilian agencies. This Global Positioning System service differs from the Standard Positioning Service available to civilian users; PPS provides an accurate position (currently ±10-m without performing differential corrections.

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