

White sturgeon (*Acipenser transmontanus*) passage at the Dalles Dam, Columbia River, USA

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Summary

White sturgeon (*Acipenser transmontanus*) ≥ 95 cm TL were monitored using acoustic and radio telemetry at a large hydroelectric dam (the Dalles Dam) on the Columbia River, during March 2004 through November 2005 to determine timing and routes of passage and to characterize general movements. Transmitters were surgically implanted into 148 fish during the study; 90 were released into the tailrace and 58 into the forebay. We documented 26 passage events by 19 tagged fish: eight upstream via fish ladders and 18 downstream, mostly through open spill gates. During the study 17 fish entered the two ladders one or more times; 11 entered only the east ladder, three entered only the north ladder, and three entered both ladders at sometime. Residence time within the ladders by individual fish was variable, ranging from about 1 min to nearly 6 months (median = 7.7 h). Only six fish successfully ascended the east ladder, one fish twice. We could not unequivocally determine which fish ladder one fish used to pass upstream. Differences in construction between the north and east fish ladders may account for the greater success of the east fish ladder in passing sturgeon upstream. Changes to operations at hydroelectric dams to benefit migrating anadromous salmonids may influence upstream or downstream passage by white sturgeon. Altering patterns and timing of spill discharge, altering fish ladder entrance attraction flows, and the use of lights, sound, and partial barriers to direct other species of fish to preferred passage routes have unknown effects on sturgeon passage. A better understanding of the consequences to the metapopulation of increasing or precluding upstream or downstream passage is needed.

Introduction

White sturgeon *Acipenser transmontanus* are an important cultural, recreational, and commercial resource in the Columbia River Basin. Prior to dam construction, this amphidromous species likely responded to seasonal changes in food and habitat availability by ranging extensively between freshwater, estuarine, and marine environments. However, the construction of hydroelectric dams is believed to have created 24 functionally discrete populations within the basin in addition to the one geographically isolated population in the Kootenai River (Fig. 1). The populations vary considerably in abundance and age structure among river reaches (Beamesderfer et al., 1995). The greatest sturgeon abundance and density occurs in the 235 km long unimpounded river downstream from the lower-most dam in the basin. This is considered to be

one of the largest and most productive sturgeon populations in the world (DeVore et al., 1995). Conversely, the geographically isolated white sturgeon population from the Kootenai River has been listed as endangered since 1994. Populations in many of the reservoirs appear to be persisting, but at an abundance lower than prior to impoundment. The variation in status among areas has been attributed to a number of factors including differences in exploitation rates and recruitment success, reduced access to marine food resources, and suitability of hydrologic conditions within available habitats (Beamesderfer et al., 1995; DeVore et al., 1995).

The dams have reduced spawning habitats (Parsley and Beckman, 1994), impacted primary and secondary production (Coutant, 2004), and limited upstream and downstream passage (Warren and Beckman, 1993). Because the physical, chemical 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). 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. In some impoundments suitable rearing habitat exists, but spawning habitat is lacking and recruitment of fish is poor (Parsley and Beckman, 1994). In others, spawning conditions are favorable but growth of young fish may be density limited (Beamesderfer et al., 1995).

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 s^{-1} , and that the transition to burst-and-glide swimming occurred when velocities reached 2.5 body lengths s^{-1} . The large body size of sturgeon may also impede progress through submerged orifices in fishways designed for salmonids.