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Habitat use and movements of shovelnose sturgeon in Pool 13 of the upper Mississippi River during extreme low flow conditions

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tailwater area. We used these data collectively to characterize general tailwater conditions.

Results

Movement

A total of 212 telemetry contacts on 27 tagged shovelnose sturgeon was made between 28 April and 3 August 1988. The number of contacts per individual averaged 7.9 (SE = 1.04; range 1 to 20); Mean number of contacts with females was 8.4 (SE = 1.13; n = 22), compared to 5.4 (SE = 2.06; n = 5) for males. Although there was considerable variation in movement patterns among individual fish, the tagged sturgeon tended to remain in the upper, riverine portion of Pool 13 above Sabula, Iowa. Rapid downstream movement of 2 fish was observed, and these individuals may have left the study pool. However, no radio-tagged shovelnose sturgeon were located during intermittent tracking in the pools immediately upstream and downstream of the study pool (i.e., Pools 12 and 14). Several tagged shovelnose sturgeon moved downstream within Pool 13 between 26 May and 18 June, and several more fish moved more than 10 km downriver during the last week in June. These movements occurred during periods of generally declining discharge, but telemetry contacts were not made often enough with radio-tagged fish to detect responses to short-term changes in flows. Detailed analyses of movement patterns in relation to river conditions would not have been meaningful because of the relatively few contacts with individual tagged fish and the often large time gaps between contacts.

Radio-tagged shovelnose sturgeon showed no tendency to congregate in any area except the initial point of capture, and no evidence of spawning activity was observed. No shovelnose sturgeon eggs were collected in a concurrent study to document actual reproduction by this species in Pool 13. Tagged fish were subsequently found in areas in Pool 13 suggested by Hurley & Nickum (1984) as potential spawning areas, but we did not detect movements associated with possible spawning activity there.

Several shovelnose sturgeon were found in narrowly restricted areas for long periods (up to 1 month or longer). Total ranges of movement varied between 1.9 and 54.6 km (mean 18.5 km). There were significant differences between the total movement ranges among fish tagged on different dates: sturgeon tagged on 26 April moved 1.9 to 23.6 km (mean 13.3 km), whereas distances moved by those tagged on 25 May ranged from 2.5 to 54.6 km (mean 24.1 km; $t = 2.83$, $p = 0.009$). Fish tagged on 26 April tended to remain in areas well upstream from those tagged in late May, although some overlap was noted. There was no relation between linear range of movement and fish length ($r^2 = 0.008$, $p = 0.65$). Males and females did not differ significantly in range of movement ($t = 0.83$, $p = 0.41$), although the number of males tagged was small.

Table 1. Numbers of contacts with tagged shovelnose sturgeon in Pool 13 of the upper Mississippi River in spring and summer 1988. Numbers of parentheses are column percentages, N is the number of tagged fish monitored during each season.

Habitat type	Spring (N = 13)	Summer (N = 24)	Combined
Tailwaters	17 (17.9)	14 (12.0)	31 (14.6)
Main-channel	34 (35.8)	73 (62.4)	107 (50.5)
Main-channel border with wing dams	41 (43.6)	20 (17.1)	61 (28.8)
Main-channel border without wing dams	2 (2.1)	8 (6.8)	10 (4.7)
Side channel	1 (1.0)	1 (0.9)	2 (0.9)
Slough	0	0	0
Lake and backwater	0	1 (0.9)	1 (0.5)
All	95 (100)	117 (100)	212 (100)

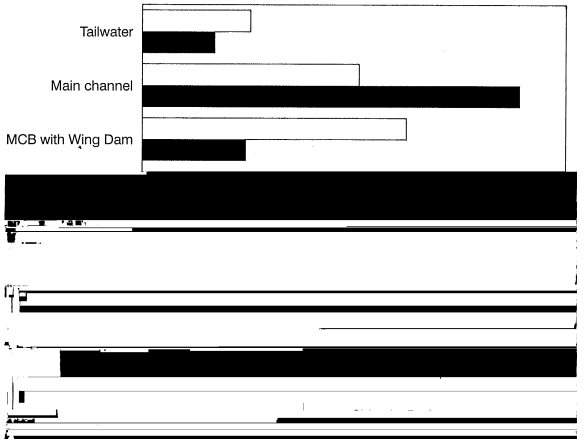

Figure 2. Habitat use by radio-tagged shovelnose sturgeon during spring and summer in Pool 13 of the upper Mississippi River 1988. MCB = main channel border, w/o = without.

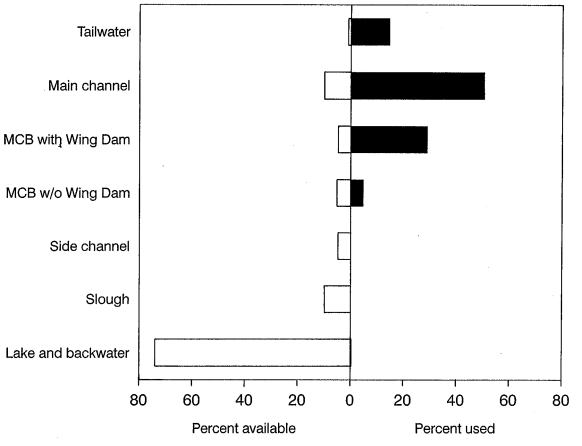

Figure 3. Habitat availability and use by radio-tagged shovelnose sturgeon in Pool 13 of the upper Mississippi River, April-August 1988. MCB = main channel border, w/o = without.

Habitat use

Radio-tagged shovelnose sturgeon were most often found in the main channel (50%), but they were also found in main channel border areas with wing dams (29%) and the tailwaters of Lock and Dam 12 (15%; Table 1). There were significant differences in habitats used during the spring and summer periods ($\chi^2 = 24.3$; $p = 0.000$; $df = 5$). Main channel border areas with wing dams and the main channel areas were most often during spring, whereas the main channel was used most in summer (Figure 2). Use of main channel border areas without wing dams was limited, but these areas were used more often in summer than in spring. Side channels and closing dam areas were rarely used. We located only one fish in the lower, lacustrine area of the pool; its last known location was on the upriver side of Lock and Dam 13. Shovelnose sturgeon found near wing dams were typically located between the outer end of the wing dam and the edge of the main channel, usually just downstream from the wing dam. These sites were typically more turbulent than the surrounding areas and contained deep scour holes. We rarely found radio-tagged fish in areas directly behind a wing dam, and slough areas were never used. We observed no reaction to the tracking boat, regardless of habitat type.

Habitats were not used in proportion to their availability. Main channel, main channel border areas with wing dams, and tailwater areas were used in much larger proportions than they were available (Figure 3), whereas lake and backwater, the most abundant habitat types, were almost never used. Habitat types used by shovelnose sturgeon in spring and summer of 1988 made up only 25% of all available habitat in Pool 13.

Habitat conditions

Radio-tagged shovelnose sturgeon were found in water depths that ranged from 2.7 to 8.2 m (mean = 5.3 m SE = 0.2 m) and were found in depths ranging from 4.6 to 6.1 m more than 60% of the time. Clean sand was the predominant substrate type in areas where tagged fish were found; 92% of all observations were made over sand bottom. We occasionally found shovelnose sturgeon in areas with a mixed sand and silt substrate (3.4%), and one fish was sampled twice over rock and gravel substrates.

Surface current velocities at shovelnose sturgeon locations ranged from 0.13 to 0.64 m s^{-1} (mean = 0.36 m SE = 0.17 m). Shovelnose sturgeon were most commonly found in areas with surface current velocities of 0.20–0.64 m s^{-1} (bottom velocities were not measured). Current velocities at 0.6 × depth were slightly less than at the surface, ranging from 0.12 to 0.60 m s^{-1} (mean = 0.32 m SE = 0.016 m). Bottom current velocities ranged from 0.0 to 0.52 m s^{-1}

hibit diel activity patterns, and gaps between telemetry contacts in our study would have prevented detection of movements away from locations where tagged fish were found during the day.

The small number of contacts with some radio-tagged fish in our study may have occurred for several reasons. Several of our radio-tagged sturgeon were caught by commercial fishermen in Pool 13, and their transmitters returned. Other fish may have been caught and not reported. Shovelnose sturgeon were sometimes difficult to locate due to relatively low signal strengths, particularly in the deep pool below Lock and Dam 12. Transmitter failure was also possible, but no evidence of failure was noted.

Shovelnose sturgeon are not normally abundant in the areas near the tailwaters of Lock and Dam 12 until late April, when commercial fishermen begin to capture large numbers of fish moving upriver (Wayne Kress personal communication). This upriver movement is likely related to spawning. Timing of the downriver movement was similar among fish tagged on the different dates, but our data were insufficient to determine if it was directly related to flow patterns. Movement of tagged sturgeon downriver occurred between 26 May and 18 June, and several fish moved more than 10 km downriver during the last week in June. The reason for this movement is unknown, although it occurred during a period of generally declining flows. The fish may have been homing to downstream areas, or the movement may have been a spawning or post-spawning migration.

Shovelnose sturgeon captured and tagged on 25 May generally dispersed much farther downstream than those tagged on 26 April, which suggests localized stocks that migrated upriver at different times during spring, although it is not known if different stocks exist. Hurley (1983) reported no movement between pools by radio-tagged shovelnose sturgeon in the same pool in 1982, suggesting that fish living in Pool 13 may spawn within the pool (although they did observe some movement between pools over a period of several years). Temporal segregation of spawning in the vicinity of the tailwaters was possible, but no fish with extrudable sex products were observed on either tagging date.

Our results indicate that shovelnose sturgeon used the tailwater, main channel, and main-channel border habitats in spring 1988 because of the low spring flows. Shovelnose sturgeon are not typically found in the main channel or tailwaters in the spring when the upper Mississippi River normally reaches peak flow levels and the gates of the dam are opened to allow a free-flowing river. Hurley et al. (1987) found shovelnose sturgeon to be most abundant in areas outside the main channel, often behind wing and closing dams, in side channels, and in the main channel border during high spring flows in 1982. Shovelnose sturgeon in our study were rarely found in side channels or near closing dams during the low spring flows in 1988. This suggests that these areas may serve as refuges during periods of high spring flows. Additional sampling should be conducted in downriver, lacustrine areas of the pool to confirm the use, if any, of that area by shovelnose sturgeon. The contact with one fish near Lock and Dam 13 suggests that this area contains at least some suitable habitat for shovelnose sturgeon.

Despite the low flow rates in 1988, shovelnose sturgeon were consistently found in areas of relatively swift current, in several habitat types. This species is known to inhabit areas with a swift current (Pflieger 1975), often in main channel (Hubert & Schmitt 1982) or main channel border areas, often associated with wing dams (Pitlo 1981). Hurley et al. (1987) found that shovelnose sturgeon in Pool 13 utilized current velocities of 0.40–0.70 m s^{-1} at the surface and 0.20–0.40 m s^{-1} on the bottom. The mean bottom velocity used by shovelnose sturgeon in our study was 0.23 m s^{-1}, at the lower end of this range. The generally lower velocities used by shovelnose sturgeon in 1988 may be more a function of availability than preference because river conditions in 1982 were characterized by high spring flows and near-normal summer flows. Water depths at locations used by shovelnose sturgeon in our study averaged 1 m deeper than those reported by Hurley et al. (1987) in 1982. Water depth and substrate type may be only secondary factors affecting shovelnose sturgeon distribution. Also, the lack of a significant relation between depth and water temperature suggests that shovelnose sturgeon were