

— NOTE —

**Observations of Swimming Ability In Shovelnose Sturgeon  
(*Scaphirhynchus platyrhynchus*)**

**ABSTRACT**

Swimming performance and behavior of five adult (57 - 69 cm fork length) shovelnose sturgeon, *Scaphirhynchus platyrhynchus*, were studied in a 945-L swim tunnel at 16° C. Fifteen-minute critical swimming speeds ranged from 65 to 116 cm s<sup>-1</sup>. Sturgeon swam volitionally at low speeds (5 - 30 cm s<sup>-1</sup>), but at higher speeds (40 - 120 cm s<sup>-1</sup>) sturgeon alternated between active swimming and appressing themselves to the bottom of the tunnel. This second behavior is enhanced by sturgeon morphology - streamlined body shape, flat rostrum, and large pectoral fins. It allows shovelnose sturgeon to exploit river bottoms as a refugia from current and maintain position in high velocities.

Though numbers have declined since 1900, shovelnose sturgeon (*Scaphirhynchus platyrhynchus*) is the most abundant and widespread sturgeon in the Mississippi River drainage (Pflieger 1975, Etnier and Starnes 1993). Shovelnose sturgeon are typically found in or adjacent to the main channel of large rivers, but their horizontal distribution varies with discharge, presence of structure, and water temperature (Moos 1978, Hurley et al. 1987). Although shovelnose sturgeon inhabit areas of high water velocities and can migrate long distances (Hurley et al. 1987), there is no information on their swimming ability. We report swimming performance (reviewed in Beamish 1978) and behavior of five shovelnose sturgeon studied in a laboratory swim tunnel.

Sturgeon were collected 28 February, 1997 from the lower Mississippi River near the mouth of the Arkansas River (river km 935), transported to the laboratory, and allowed two days to recover from handling and transport. Swimming trials were conducted in a 945-L Brett (1964) type swim tunnel at 16° C. Sturgeon were subjected to an increasing velocity test and 15-minute critical swimming speeds were determined. Each fish was acclimated one hour in the tunnel operating at 5 cm s<sup>-1</sup>. Velocity was increased to 10 cm s<sup>-1</sup> and was followed by subsequent speed increases of 10 cm s<sup>-1</sup> increments upon successful completion of a bout. Fish were rested five minutes between each velocity increment. Sturgeon that did not swim were physically stimulated by gently fanning the caudal fin with a metal probe. A swimming trial ended in fatigue, identified when a fish could not maintain position without bracing against the downstream retaining screen. Critical swimming speeds were calculated according to Brett (1964): critical swimming speed =  $U_1 + (T_1/T_2 \times U_2)$ ; in which  $U_1$  is the highest velocity maintained for the prescribed time period,  $T_1$  is the amount of time swam at the fatigue velocity,  $T_2$  is the prescribed period of swimming (15 minutes), and  $U_2$  is the velocity increment (10 cm s<sup>-1</sup>). The cross-sectional area of all sturgeon were less than 10% of the cross-sectional area of the working section, therefore speeds were not corrected for solid blocking (Brett 1964).

Fifteen-minute critical swimming speeds ranged from 64.67 to 116 cm s<sup>-1</sup> (Table 1) and were comparable to 10-minute critical swimming speeds of approximately 60 to 70 cm s<sup>-1</sup> reported for similar sized lake sturgeon, *Acipenser fulvescens*, tested at 14° C (Peake et al. 1995). Although all tests ended in fatigue, speeds reported here for shovelnose sturgeon are not measurements of swimming alone. Unlike lake sturgeon, shovelnose sturgeon did not actively swim for the duration of the experiment, even under continuous stimulation. We were able to encourage a single sturgeon (number four) to swim the majority of a trial, therefore, 64.7 cm s<sup>-1</sup> best represents 15-minute critical swimming speed (Table 1).

Table 1. Fifteen-minute critical swimming speeds of shovelnose sturgeon.

Fish	Standard Length (cm)	Fork Length (cm)	Mass (kg)	Critical Swimming Speed (cm s <sup>-1</sup> )
1	53.0	57.0	0.62	116.0
2	53.0	57.0	0.68	88.0
3	61.0	64.5	1.02	116.0
4	63.0	68.0	1.27	64.67
5	64.0	69.0	1.13	92.0

Shovelnose sturgeon in our experiments exhibited two mechanisms for maintaining position against water current - swimming and substrate appression. At low tunnel velocities (5 - 30 cm s<sup>-1</sup>), sturgeon rarely required stimulation; they swam freely. Above 40 cm s<sup>-1</sup>, fish alternated swimming with substrate appression; water flowing over the sturgeon's body compressed the fish against the tunnel bottom, while the pectoral fins clamped against the Plexiglas surface and the caudal fin remained motionless. This second behavior appeared to conserve energy since sturgeon spending more time actively swimming during bouts typically fatigued quicker. As tunnel velocities increased, sturgeon were increasingly reluctant to swim volitionally and were less responsive to stimulation. At speeds greater than 70 cm s<sup>-1</sup>, sturgeon only briefly swam in the water column (1 - 10 seconds) and were eventually unable to maintain position by swimming or substrate appression.

Substrate appression was facilitated by the body form of shovelnose sturgeon (wide, flat head, large pectoral fins, and flat ventral body surface), which has been observed in other benthic fish (Matthews 1985, Moffat and Davison 1986, Facey and Grossman 1990). Hurley et al. (1987) found shovelnose sturgeon in the upper Mississippi River to be sedentary much of the year, occupying flow regimes where bottom and surface velocities were 20 - 40 cm s<sup>-1</sup> and 40 - 70 cm s<sup>-1</sup>, respectively. This behavior is likely utilized by shovelnose sturgeon under natural conditions and may enhance exploitation of low velocity microhabitats within high velocity macrohabitats in rivers.

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## LITERATURE CITED

- Beamish, F.W.H. 1978. Swimming capacity. Pages 101-187 in W.S. Hoar and D.J. Randall, eds. *Fish Physiology*. Vol. 7. Academic Press, New York.
- Brett, J.R. 1964. The respiratory metabolism and swimming performance of young sockeye salmon. *Journal of Fisheries Research Board of Canada* 21:1522-1529.
- Etnier, D.A. and W. C. Starnes. 1993. *The Fishes of Tennessee*. University of Tennessee Press, Knoxville. 681 pages.
- Facey, D.E. and G.D. Grossman. 1990. The metabolic cost of maintaining position for four North American stream fishes: effects of season and velocity. *Physiological Zoology* 63:757-776.
- Hurley, S.T., W.A. Hubert, and J.G. Nickum. 1987. Habitats and movements of shovelnose sturgeons in the upper Mississippi River. *Transactions of the American Fisheries Society* 116:655-662.
- Matthews, W.J. 1985. Critical current speed and microhabitats of the benthic fishes *Percina roanoka* and *Etheostoma flabellare*. *Environmental Biology of Fishes* 12:303-308.
- Moffat, R. and W. Davison. 1986. A note on the swimming performance of two species of teleost fish, the trout, *Salmo trutta* and the koaro, *Galaxias brevipinnis*. *Mauri Ora* 13:71-79.
- Moos, R.E. 1978. Movement and reproduction of shovelnose sturgeon, *Scaphirhynchus platyrhynchus* (Rafinesque), in the Missouri River, South Dakota. Doctoral dissertation. University of South Dakota, Vermillion.
- Peake, S., F.W.H. Beamish, R.S. McKinley, C. Katopodis, and D.A. Scruton. 1995. Swimming performance of lake sturgeon, *Acipenser fulvescens*. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2063. 26 pages.
- Pflieger, W.L. 1975. *The Fishes of Missouri*. Missouri Department of Conservation, Jefferson City. 343 pages.

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