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Short communication

Post-spawn movements and habitat use by greater redhorse, *Moxostoma valenciennesi*

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Abstract – A combination of radio telemetry and surface observations were used to characterize the movements and habitats of greater redhorse, *Moxostoma valenciennesi*, after spawning in the Grand River, Ontario, Canada. This river supports a large population of greater redhorse that migrate upstream in the spring to spawn on riffles. After spawning, greater redhorse moved as far as 15.2 km downstream of spawning areas and maintained summer home ranges in low velocity runs. Mean (±SE) water depth used by greater redhorse was 46.3±0.9 cm, and water velocities were less than 5 cm/s. Greater redhorse were usually located over cobble/gravel substrates that were covered with *Cladophora.* Although interspecific associations with golden redhorse, *M. erythrurum*, common carp, *Cyprinus carpio*, smallmouth bass, *Micropterus dolomieu,* and northern hog sucker, *Hypentelium nigricans,* were observed, most greater redhorse associated with conspecifics. Areas and habitat types used throughout the summer did not change, until relocation to overwintering areas occurred in early autumn.

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Key words: Catostomidae; Moxostomatini; telemetry; behavior; habitat use; movements; life-history; Grand River; Ontario

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Un resumen en español se incluye detrás del texto principal de este artículo.

Introduction

Two studies have addressed spawning behavior and reproductive biology of greater redhorse (*Moxostoma valenciennesi* Jordan) (Jenkins & Jenkins 1980; Cooke & Bunt 1999), and another report briefly compared the biology of the greater redhorse with that of the copper redhorse, *M. hubbsi* (Mongeau et al. 1992). Very little is known about the behaviour or biology of this fish after spawning ceases in early summer. In fact, the ecology of the greater redhorse at all life history stages is poorly documented, as recognized by Mongeau et al. (1992) and Kay et al. (1994).

In some areas within its range, the greater redhorse is considered rare, but it is a major component of the fish assemblage in the Grand River, Ontario, Canada. To help clarify the ecological role of this species in riverine systems, home ranges and habitats used during various life history phases should be described. The purpose of this study was to determine movement patterns and habitat types used by male and female greater redhorse after spawning.

Material and methods

Greater redhorse were collected, radio-tagged, tracked and observed between the Mannheim weir (Kitchener), and Parkhill dam (Cambridge), in the Grand River, Ontario, Canada. In the area where this study was conducted, the river is mid-sized with typical summer widths between 20 and 40 m, relatively shallow (mean depth <1 m) and has riffle-pool-run sequences. Details of the study site downstream from the Mannheim weir are in Bunt et al. (1998), and riffles used by spawning greater redhorse in 1997 are described in Cooke & Bunt (1999).

We used a combination of seines and gill nets to corral adult greater redhorse 800 m downstream from the Mannheim weir on May 30 and 31, 1997. Handling was minimized, and all fish were held in a mesh pen in the river for no more than 15 min before they were examined, measured and radio-tagged.

Fifteen greater redhorse were externally tagged with small radio transmitters (dimensions: 29 × 10 mm × 7 mm, weight in air: 3.7 g, battery life: ca. 50 days, model MBFT-2, Lotek Inc.), each of which broadcast a unique frequency. Transmitters were attached through the dorsal musculature on the right side of each fish as follows. The head and eyes were covered with a wet cloth to retain moisture, exclude light and instill a calming effect. A few scales were removed approximately 2 cm ventral to the dorsal fin. Removal of scales permitted the insertion of two 6-cm-long, 20-G hypodermic needles on fused syringes, through the dorsal musculature. Transmitter attachment wires (surgical stainless steel) were then passed through the needles to the opposite side of the body. Neoprene coated plastic strips were used as a back-plate over which the attachment wires were twisted together several times. The tagging procedure required approximately 1 min. Males (mean length= 565.6±6.2 mm total length (TL), n=8, Table 1) and females (mean length=601.1±7.8 mm TL, n= 7, Table 1) were tagged and released at the capture site within 1 h of collection.

Daytime positions of greater redhorse were determined to within 3 m by triangulation using shore-based landmarks. To document movements, the reach between the Mannheim weir and Parkhill dam – approximately 17 river km – was scanned for valid transmitter signals every 3 or 4 d by inflatable boat from June 2 to July 20. To collect habitat data, crews with polarized glasses observed and recorded substrate, water velocity, cover and habitat types from the positions of tagged and untagged greater redhorse throughout the study reach during each tracking episode. Habitat data were collected until late July, and patterns of general activity and abundance of greater redhorse within the study reach were documented until late October.

When greater redhorse were located, depth at each fish position was measured with a graduated wading pole (to within 1 cm). Surface water velocity was recorded to the nearest 5 cm/s using an ultrasonic Doppler-shift velocity meter (Sigma Inc.). Substrate was classified according to a modified Wentworth scale (Cummins 1962), and vegetation and cover were evaluated by type and abundance. Habitats were identified and classified as run, riffle or pool. Critical values for all statistical tests were evaluated at α=0.05, and all means are reported ±1 S.E.

Results and discussion

Greater redhorse spawning usually ends by the first week of June in the Grand River (Cooke & Bunt 1999), earlier than other larger and cooler rivers (i.e., Jenkins & Jenkins 1980; Mongeau et al. 1992). As reported for greater redhorse congeners (Kwak & Skelly 1992), a major rain event or noon water temperatures above approximately 15°C usually terminates spawning for the season in the Grand River (Cooke & Bunt 1999).

Radio-tagged greater redhorse were tracked for 33–62 d. We located radio-tagged fish on 113 occasions and each fish was pinpointed 7.5±0.4 times (range 4–10). By the second week of June, no greater redhorse were located in areas where spawning occurred. Mean downstream movement

Table 1. Codes, genders, lengths and weights of greater redhorse used in this study. The tagging date and the number of days each fish was tracked is indicated.

Code	Sex	Total length (mm)	Weight (g)	Tagging date	Days tracked
30	m	595	2680	30-May	51
31	f	585	2425	30-May	34
32	m	548	1975	30-May	62
33	m	579	2525	30-May	45
34	m	561	2325	30-May	34
35	f	601	2750	30-May	34
36	f	646	4000	31-May	44
37	m	542	1825	31-May	44
38	m	575	2050	31-May	44
39	f	598	2260	31-May	44
40	f	592	2610	31-May	33
41	f	588	2150	31-May	33
42	m	555	2090	31-May	44
43	f	598	2700	31-May	33
44	m	570	2275	31-May	44

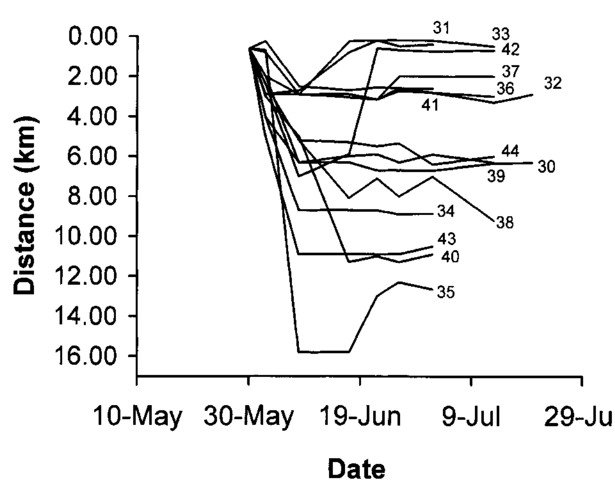

Fig. 1. Areas of the Grand River used by radio-tagged greater redhorse after spawning (n=15). The position of the Mannheim weir is at 0 km on the ordinate axis. Numbers represent individual fish as reported in Table 1.

among males was 5.4±0.9 river km (range 2.4–8.6 km). Females used 7.0±1.9 km of the river (range 2.1–15.2 km). Female greater redhorse used in this study were significantly larger than males (Mann-Whitney *U*-test, $U=53$, $P=0.004$), but the difference in net movement between males and females was not significant ($U=31$, $P=0.728$). There was also no significant correlation between total length and net movement for either sex (Pearson correlation analysis, males: $r=0.33$, $P=0.425$, females: $r=-0.17$, $P=0.721$). Although considerable variation occurred in the movement patterns of one female and one male (fish #35 and fish #42, Fig. 1), most fish tended to remain in the same area of the river (±ca. 1 km) after the first two weeks of June. By mid-June, radio-tagged fish were uniformly distributed throughout the study reach (Fig. 1). On three occasions, radio-tagged greater redhorse were visually observed among groups of untagged individuals, suggesting that the behaviour of radio-tagged and untagged fish was similar.

The mean water depth at the exact location where greater redhorse were located was 46.3±0.9 cm ($n=245$). The mean water depth in riffles where greater redhorse spawned earlier in the same year was 34.4±1 cm and the mean surface water velocity was 38±2 cm/s (Cooke & Bunt 1999). Post-spawn habitat was deeper and water velocities were reduced compared to spawning areas. All greater redhorse observations but one ($n=245$), were in water with surface velocities <5 cm/s (log-likelihood ratio test, G=326.7, $P<0.001$). Most fish were located over cobble/gravel (42% of observations, G=377.8, $P<0.001$) fully covered with *Cladophora* (38% of observations) followed by scattered *Cladophora* (50% coverage, 15% of observations) and sparse *Cladophora* (20% coverage, 13% of observations, G=528.6, $P<0.001$). Runs, specifically the margins of runs, were the most frequently used habitat type (78.8%), followed by riffles (20%) (G=407.1, $P<0.001$). Pools were used infrequently (1.2%).

Untagged greater redhorse were observed in groups of up to 12 individuals on 153 occasions. During 3.9% of total observations with multiple fish, greater redhorse were observed to associate with golden redhorse *M. erythrurum.* In addition, northern hog sucker, *Hypentelium nigricans*, common carp, *Cyprinus carpio*, and smallmouth bass, *Micropterus dolomieu* were associated with greater redhorse for 1.3%, 2.6% and 3.9%, respectively, of total observations with multiple fish. Similar to our findings, Mongeau et al. (1992) reported that greater redhorse formed associations with common carp and smallmouth bass. When greater redhorse associated with conspecifics in the Grand River, the mean aggregation size was 1.6±0.1 individuals.

It has been suggested that greater redhorse inhabit large, clear-water streams with sand, gravel and boulders throughout the year, and that they are particularly sensitive to siltation (Trautman 1981; Yoder & Beaumier 1986). Other congeners are sensitive to silt (e.g., river redhorse, *M. carinatum*, Jenkins 1970; black redhorse, *M. duquesnei*, Parker 1989), and this likely affects their distribution and abundance. Similar to our observations, Yoder & Beaumier (1986) noted that greater redhorse were collected by electrofishing most commonly in riffle-run habitats with boulder, cobble and gravel substrates. Over 99% of our greater redhorse locations were in slow current. Although the substrate consisted mostly of cobble/gravel, silt was present within interstitial spaces. We observed greater redhorse creating silt plumes while they fed.

Radio transmitter batteries expired by late July, but greater redhorse were visually located and appeared to use similar habitat until approximately the second week in September. Crews continued to monitor the study reach for greater redhorse activity from late September to late October, but no fish were observed. Thus, there appeared to be no change in greater redhorse behavior or habitat until overwintering movements occurred in early autumn.

Resumen

1. Radio-telemetría y observaciones de superficie fueron utilizados en el Rio Grand (Ontario, Canada) para caracterizar los movimientos y el habitat de *Moxostoma valenciennesi*, despues de la puesta. Este rio mantiene una población considerable de *M. valenciennesi* que migra rio arriba en primavera para reproducirse en zonas de chorreras.

2. Despues de la puesta *M. valenciennesi* se mueve aguas abajo 15.2 km desde las zonas de freza donde mantienen "home ranges" veraniegos en tablas de baja velocidad. La profundidad media del agua fue de 46.3±0.9 cm y la velocidad media menor de 5 cm · seg^{-1}. Generalmente, los individuos de *M. valenciennesi* fueron localizados sobre sustratos de grava y piedra cubiertos de *Cladophora.* Aunque observamos asociaciones interespecificas con *M. erythrurum*, *Cyprinus carpio*, *Micropterus dolomieu*, y *Hypentelium nigricans*, la mayor parte de los individuos de *M. valenciennesi* fueron observados asociados con individuos de su misma especie. Las areas y los tipos de habitat utilizados a lo largo del verano no cambiaron hasta que al inicio del otoño se produjo una recolocación de areas para el invierno.

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