# Ecology of the shorthead redhorse, *Moxostoma macrolepidotum* (Leseur) 1817 in Dauphin Lake, Manitoba

BY

Stephen Harbicht

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**ABSTRACT**

Shorthead redhorse, Moxostoma macrolepidotum, from Dauphin Lake were studied during the open water period from 1983 to 1987. Spawning habits, age, length frequency and counts (meristic characters) were evaluated for the shorthead redhorse migrating into the Ochre River, from Dauphin Lake. Shorthead redhorse spawning migrations varied in numbers of fish (857 - 6568) and timing (May 6 - April 26) within the three years of this study. Spawning migrations began when mean daily stream temperatures reached 10 C. Upstream and downstream spawning movements were most intense from mid-afternoon until two hours after darkness. Fish moved up to 32 km upstream and the overall spawning period was 3 to 4 weeks.

The mean fork length for spawning females and males ranged from 353.5 to 375.6 mm and 323.0 to 338.2 mm respectively. Both males and females reached sexual maturity at 5 years however, a few males matured at age 4. Spring caught females produced 12,660 to 44,329 eggs for fork lengths 310 to 418 mm. Both fecundity and egg diameters increased with fork length.

Spawning occurred over a gravel/sand/rock substrate on the downstream side of riffles, at water velocities 0.3 to 0.7 m/sec, and depths of 20 to 90 cm. Shorthead redhorse tagged in Ochre River returned to spawn in the stream in successive years.

Sections of left pectoral fin rays were used for age determinations, with validation accomplished by aging of the right pectoral fin of recaptured tagged fish. Ages up to 18 years were observed. Females grew faster than males. Juvenile shorthead redhorse (less than or equal to 100 mm fork length) preferred planktonic organisms including cladocerans, copepods and ostracods while adult fish (greater than 100 mm fork length) consumed a wider range of food items with chironomids, Ephemeroptera, Mollusca and Diptera other than chironomids being predominant. Shorthead redhorse generally were free from external parasites; acanthocephalans, trematodes and a nematode were the major internal parasites found in the digestive tract. Juvenile shorthead redhorse represented 4% of the diet of juvenile walleye from Dauphin Lake.

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# INTRODUCTION

The redhorse suckers, Moxostoma spp., Family Catostomidae: Tribe Moxostomatini, are a morphologically and biologically diverse group of freshwater fishes found in eastern and central North America. Moxostoma contains four subgenera (Jenkins 1970); (Moxostoma) redhorse suckers, (Scartomyzon) jumprock suckers, (Megapharynx) redhorse suckers, and (Thoburnia) torrent suckers. Moxostoma macrolepidotum (Leseur) the shorthead redhorse is one of seven species in the subgenus Moxostoma, which includes the only two other redhorse species found in Manitoba, M. anisurum the silver redhorse and M. erythrurum the golden redhorse. Distribution of these three species is shown in Fig 1, Jenkins (1980), Franzin et al. (1986) and Franzin W.G. & K.W. Stewart (pers.comm.). The shorthead redhorse has the widest and most northerly distribution of all the redhorses.

Shorthead redhorse occupy a variety of habitats: clear, fast water in large streams with gravel bottoms; natural lakes with shallow well protected localities; impoundments; shallow pools of small rivers with moderate flow velocities; small streams with negligible current; rarely, in brackish water (Sule and Skelly 1985).

The redhorses are caught commercially and marketed as "mullet" and are occasionally caught by sport fisherman.

There have been few comprehensive studies of the ecology of the shorthead redhorse. Meyer (1962) studied the general life history of shorthead redhorse from Des Moines River, Iowa; Reed (1962) evaluated the age, growth and food habits of shorthead redhorses from the Saskatchewan River, Saskatchewan; Sule and Skelly (1985) determined habitat, fecundity, growth and food habits of shorthead redhorses in the Kankakee River, Illinois; Jenkins (1970) presented a complete classification and known ecology for the species found in the tribe Moxostomatini. The majority of the remaining information either deals with only one or two aspects of the species or is a statement of its presence in a specific locality.

This study (1983 to 1987) was conducted in conjunction with a cooperative project on Dauphin Lake, Manitoba ($51^0$ 17′ N, $99^0$ 14′ W) involving the Department of Fisheries and Oceans (Canada), (DFO), and the Department of Natural Resources, Fisheries Branch (Manitoba). DFO's overall project objective was to develop hydrological and ecological data which could be used to attempt to rehabilitate Dauphin Lake's declining walleye population. This portion of the study investigated the reproductive period, spawning behaviour, juvenile and adult growth, dietary composition, meristic and morphometric features and population structure of the shorthead redhorse in Dauphin Lake.

The shorthead redhorse of Dauphin lake provided an opportunity to study a population that is unique in that it is a lucustrine population. There is little known about the ecology of the shorthead redhorse in this northern latitude, to some extent determine the role the shorthead redhorse plays in the ecosystem of Dauphin Lake and the importance the shorthead redhorse has to the walleye population of Dauphin Lake.

## STUDY AREA

### Dauphin Lake

Dauphin Lake is approximately 305 km northwest of Winnipeg, Manitoba (Fig.2). It has a surface area of 497 km2, a maximum width of 19.3 km, a maximum length of 41.8 km, an average depth of 2.4 m and a maximum depth of 3.6 m. It is a remnant of glacial Lake Agassiz and is situated on lowlands that are primarily made up of glacial till overlain by clay deposited by Lake Agassiz. A portion of the Manitoba escarpment (Riding Mountains and Duck Mountains), lies south, west, and north west of Dauphin Lake and forms most of the watershed supplying the lake. The streams which discharge off the escarpment, flow through deposits of glacial till and soft shale in their upper reaches and pass through Lake Agassiz clay deposits at lower elevations. Because of this, and agricultural and drainage practises now affecting the watershed, Dauphin Lake receives large quantities of fine sediments, resulting in high turbidity throughout the open water season (Chapman 1987). This turbidity is compounded by the shallowness and wind exposure of the lake.

The eastern shoreline of Dauphin Lake varies from areas which are dominated by rock, boulder and sand to areas of sand and silt. The south, west and north shorelines are mainly sand and silt with a few boulder points.

**OCHRE RIVER**

The Ochre River watershed comprises a total area of 344 $km^2$ which lies mainly within Riding Mountain National Park. The river has an average gradient of 2 percent. The lower 30 km of the river has a lower gradient and is confined in a well defined channel which overflows its banks during high water periods. This lower stretch contains a number of riffle-pool sequences. The riffles have rock, gravel and sand substrates, while the pools have sand and silt bottoms. Since the major portion of Ochre River is in Riding Mountain National Park, man-made modifications to the channel are limited to the lower 30 km section of the river within the agricultural zone. Natural drainages in the lower reaches have been altered to allow water from other drainages to discharge into Ochre River. Land clearing to the river's edge in the lower section has caused increased siltation and erosion of the stream banks.

## MATERIALS AND METHODS

### FISH SAMPLING

Fish spawning migrations in the Ochre River were monitored using a two way fish fence. The fence was a modification of the design of Anderson and McDonald (1978). The fish fence was located in a riffle area 1.6 km upstream from the mouth of Ochre River at Dauphin Lake (Fig. 3). It was felt that once the spawning fish had migrated this far upstream, they would probably spawn in the stream. The fish fence was installed each year at the first opportunity possible, usually after the spring runoff had subsided. During normal operation, the wings from each side of the box ran to the shore and directed all fish moving upstream or downstream into the appropriate collection box. The date of installation varied over the three years because of differences in warming and discharge rates each spring (Table 1). Part or all of the fence often washed out after major precipitation events and had to be reinstalled once the water level subsided again. The fence was operated until late July 1983 to ensure that all large fish species utilizing Ochre River for spawning were evaluated, but in 1984 and 1985 the fence stayed in operation only until the majority of the migrating fish had returned to Dauphin Lake.

Daily stream discharge information was obtained from Environment Canada, Water Surveys of Canada (1983, 1984, 1985). Water temperatures at the fence site were recorded with a Ryan Continuously Recording Submersible Recorder during the 1983 and 1984 seasons and with a Robertshaw Recording Thermometer in 1985. Mean daily temperatures (Appendix I) were calculated from the means of each four hour period.

Migrating fish were held in the upstream and downstream boxes until they could be passed over the fence in the direction that they were migrating. They were released at least twice a day. The capture boxes each could accommodate approximately one hundred fish without causing damage to the fish. All fish were counted and identified to species. Shorthead redhorse fork lengths, measured from the anterior extremity to the notch in the tail fin, (to the nearest mm) and weights (to the nearest 10 gms) were taken in 1983 and 1984, but only fork length was taken in 1985. Sex and maturity stages of all fish were determined by external appearance and by applying gentle pressure on the abdomen. If the sex products did not flow freely they were considered green; if they flowed freely they were considered ripe. If a male's sexual products appeared clear or dilute, they were considered spent and when a female abdomen was flaccid and the sexual products released consisted of clear fluid, they were considered spent. External features such as abraded pectoral, anal and caudal fins or a swollen vent were also used to identify a spent fish.

A mark-recapture program on shorthead redhorse spawning in the Ochre River was initiated in 1984 and continued in

1985. Floy anchor tags were used to tag 424 shorthead redhorse in 1984 and an additional 935 in 1985. Tags were inserted into the left side of the fish just below the middle of the dorsal fin base. The T bar of the tag was securely locked through the interneural spines. Only fish in good condition were tagged. A few fish from the upstream migration were tagged to allow for evaluation of time spent in the spawning stream. The majority of fish tagged were from the downstream migrants. No anaesthetic was used during the tagging operation.

The first four rays of the left pectoral fin were removed from each tagged fish for aging purposes. After removal from the fish, fins were dried in envelopes, then imbedded in cold-cure epoxy resin. Transverse sections .50 - .70 mm thick were cut from the base of the fin rays using an Isomet low-speed sectioning saw. These sections were mounted in Diatex mounting medium on glass slides. Ages were estimated from presumed annuli counted using a compound microscope with a bright field condenser and a green filter.

Commercial and sport fishermen were paid a $2.00 reward for each tag returned with information on location and date of capture of each tagged fish. This information was augmented with recaptures obtained from the Department of Fisheries and Oceans, Dauphin Lake projects throughout this study.

During the 1985 fish fence operation, any recaptured tagged shorthead redhorse were checked for tag number, fork length, maturity, and the first four rays of the right pectoral fin were removed for age validation. Untagged fish which had a clipped left pectoral fin and showed scarring at the tag site were classified as fish showing a tag loss.

The distance of movement in the Ochre River above the fish fence for shorthead redhorses was evaluated by direct observation, seining with a small, fine mesh bagless seine and a Coffelt BP4 electroshocker.

Spawning behaviour of shorthead redhorse was observed during daylight hours at times when water clarity was sufficient to allow for light penetration to the bottom of the stream. During the spawning act an observation point was chosen which offered enough elevation to see down into the water (spawning area) as well as to provide cover to limit any distraction of the fish.

Larval fishes were sampled in the Ochre River by using larval drift samplers as described in Franzin and Harbicht, (unpublished data). The drift nets were set in fast current near the water surface (approximately 20 cm below the surface). The larval drift samplers were used in 1984, 1985 and 1986. They sampled the stream continuously throughout the entire larval drift period and each sampler was cleaned at least twice a day.

During the period of larval drift in the Ochre River, a subsample of minnows, were captured with a Colfelt BP4 electro shocker. These were preserved in 10% formalin and their gut content was examined at a later date.

**FECUNDITY AND EGG SIZE**

Ovaries were removed from 37 and 22 pre-spawning females migrating up the Ochre River in 1984 and 1985 respectively. The fish sampled represented the range of fork lengths that were found in the spawning runs. A further 48 ovaries were removed from ripening females collected by commercial fishermen on Dauphin Lake in the early winter of 1986. All fish were weighed to the nearest 10 gms in 1984 and 1985 and in 1986 to the nearest .1 gm. Fork lengths of all fish were measured to the nearest 1 mm in all three years.

The ovaries were removed, weighed and preserved in Gilson's solution (Bagneal 1978). Twenty-four hours after initial fixation, the eggs were gently separated to allow for penetration of the preservative. All ovaries were left in fixative for at least 4 months before the eggs were counted. The eggs were washed several times with water to remove ovarian tissue. Numbers of eggs were estimated by using the dried weight method. Five groups of 1000 eggs each, along with the remaining eggs from each fish were air dried for a minimum of forty-eight hours at about 21 C. All dried samples were weighed with a Mettler AE 160 balance to the nearest .0001 gm. The mean weight of an individual egg was determined by dividing the weight of each 1000 egg group by 1000. Fecundity was determined by dividing the mean weight of an individual egg into the total dried weight of the sample. The accuracy of the dried weight estimation was evaluated by counting nineteen complete ovaries in conjunction with the dried weight method and calculating the percentage difference.

Egg size was determined from preserved eggs. Subsamples of 20 eggs were removed from each 1000 egg sample and each egg in these subsamples was measured to the nearest .01 mm with a pair of digital calipers. The mean size of eggs from each pair of ovaries was calculated from the grand ( i.e. mean of means) mean of the 5 sub-groups.

**SAMPLING OF SHORTHEAD REDHORSES FROM DAUPHIN LAKE**

**SEINING**

Beach seines (30 m, 6.4 mm mesh and 18 m, 3.2 mm mesh) were used to capture fish along the shoreline of Dauphin Lake. Seining was conducted during the daylight hours from late June until mid September, 1984 to 1987. The seining program in 1984 was irregular and consisted of 100 m hauls with the 18 m bagged seine at the mouth of Ochre River. The seining program was expanded to weekly samples in 1985, then truncated to biweekly in 1986 and monthly in 1987 using the 30 m bagged seine. Sample sites were selected to represent common types of shorelines found on Dauphin Lake. The stations (Fig.3) were #2 - west side of Ochre River (silt/sand with emergent vegetation), #3 - Stoney Point (sand/silt with scattered large boulders), #4 - Sifton Beach (sand/silt/gravel away from shore and rock/gravel close to shore), #5 - Oak Brae (sand/silt and scattered boulders away from shore and rock/ gravel close to shore), #6 - Million (hard packed sand and scattered boulders away from shore and sand/gravel/scattered boulders close to shore), #7 - Methley Beach (sand and a few large boulders) and #8 - Welcome Beach (sand/silt away from shore and boulders/gravel close to shore). One 100 m seine haul was made perpendicular to the shore at each site except at Oak Brae and Stoney Point where the depth of water restricted the wading distance from shore At these sites 2 or 3 shorter hauls were made instead.

Shorthead redhorse were removed from the seine catches and stored on ice until fork length to the nearest 1 mm and wet weight to the nearest .1 gm could be determined. Fish that were kept for stomach content analysis or specimen storage were subsequently preserved, whole body, in 10% formalin.

Near shore water temperatures of Dauphin Lake were measured at a depth of 1 meter with a chart recorder for 1984 and 1985 and a Ryan Continuous Recording Submersible Recorder in 1987. Mean monthly water levels of Dauphin lake were obtained from Environment Canada, Water Survey of Canada (1984,1985,1986,1987).

**GILLNETTING**

Sampling of the lake population for the period 1984 to 1987 was accomplished using a standard gang of gillnets

(6 - 20 meter panels consisting of 3.8cm, 6.4cm, 8.9 cm, 10.2cm, 10.8 cm, 12.7 cm stretched mesh opening). Net sets were positioned according to a random sampling design, throughout the lake and sampled at three intervals during the open water season; just after ice out, mid summer, and mid to late fall. Each net was set for an average period of 14 hours. All fish collected were identified to species, measured for fork length (nearest 1 mm), weighed (nearest .1 gm) and sex and maturity were determined. The left pectoral fin rays were removed from shorthead redhorses and used for age determination as described earlier.

**AGE AND GROWTH**

Thin sections of pectoral fin rays are the most reliable technique for age determination of white suckers (Beamish and Harvey 1969, Beamish and McFarlane 1983, Chalanchuk 1984). This method was therefore used for aging of shorthead redhorse. Validation of fin ray ages was done using the total of 177 recaptured tagged fish taken in the 1985 fish fence operation, the 1985-87 gill netting survey and commercial fish catch sampling through the same period of time. Regression analysis was used to examine growth with age and length:weight relationships. Growth and lemgth:weight relationship between years was compared using analysis of covariance.

Fork length frequency distributions for juveniles captured in the seining program were plotted against time for each sampling period. The separation of 0+ and 1+ cohorts was evident as there was no overlap in fork length between groups. The 2+ and 3+ cohorts overlapped in fork length, therefore, separation of these cohorts was not possible. Growth rates during the growing season, as well as between years was determined and evaluated using linear regression analysis. Analysis of covariance was used to compare between year data.

**DIETARY ANALYSIS**

Digestive tracts were removed from 54 adult and 29 juvenile shorthead redhorse collected by seines and gill nets at various times from just after spring breakup to early winter. Each digestive tract was preserved in 10% formalin until examination. Contents of the entire length of juvenile digestive tracts were removed by applying gentle pressure and forcing the contents out, while adult digestive tracts were cut open longitudinally for their entire length and the contents lifted out with forceps. Stomach contents were examined under a stereo microscope. Identifiable organisms were counted, but in cases where the gut was filled with fragmented bivalue shells or invertebrate body parts volume or numbers of any particular organism could not be estimated. Only presence/absence and a subjectively determined estimate of abundance of a particular food item were recorded. The amount of each item consumed by each fish analyzed was categorized as abundant (greater than 20 items found), few (3 to 20 items found) and rare (1 to 2 items found).

## MERISTICS AND MORPHOMETRICS

Meristic counts and morphometric measurements were taken from shorthead redhorses that were collected either by seine hauls or gill net catches throughout 1985 and 1986. A total of 118 juvenile and adult shorthead redhorses were examined. Characters were measured or counted according Hubbs and Lagler (1964) and Reist (1985). All measurements were taken with digital calipers to the nearest .01 mm. The characters examined are presented in Table 2.