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

BY

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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.

RESULTS

SHORTHEAD REDHORSE SPAWNING MIGRATIONS IN OCHRE RIVER

Daily counts of upstream and downstream migrating shorthead redhorse, stream water temperature and stream discharge for the years 1983 to 1985 are tabulated in Appendix 1. Shorthead redhorse began their 1983 upstream migration before 6 May (Fig.4), when daily mean water temperature had reached 10 C . The main upstream migration continued from 25 May through to 13 June. Downstream migration ranged from 26 May through to 20 July (Fig.5).

The 1984 upstream migration had commenced by 19 April (Fig.6), when daily mean water temperatures were 12.0 C, but there was a late spring snow fall and stream temperatures dropped to 0 C and discharge rose. Fish migration stopped and fence was washed out. The fish fence was reinstalled on 20 May by which time the upstream migration had resumed and stream temperature had returned to the 10 - 12 C range. Upstream movement continued until 20 June when the fence was removed. Downstream migration had started by 20 May (Fig. 7) and intensified until 20 June.

The shorthead redhorse upstream migration in 1985 began on 26 April (Fig. 8) and continued in pulses until 10 June. Daily mean water temperature ranged between 8.3 and 18.3 C during this period. Downstream migration had begun by 7 May (Fig. 9) and continued until 24 June after which the fence was removed. The majority of the shorthead redhorse had returned to Dauphin Lake by that date.

In the three years of monitoring the Ochre River, the shorthead redhorse began their spawning run each year when daily mean water temperatures reached about 10.0 C. This temperature usually followed the peak discharge associated with the spring runoff. Intensified shorthead redhorse migrations both upstream and downstream usually coincided with an increased discharge event.

All male shorthead redhorse were ripe on their arrival at the spawning grounds, while the majority of the females arrived green. Shorthead redhorse upstream and downstream migrations peaked in the period from mid afternoon until two to three hours after sunset. Shorthead redhorse migrated up to 32 km upstream from the mouth of the river. During the 1984 a shorthead redhorse in spawning condition at site #9 was captured using a electro shocker (Fig. 3).

Whether or not shorthead redhorse were spawning during peak discharge could not be determined due to high turbidity. However, as discharge declined, the water usually cleared allowing observations of spawning activities. Spawning activities were observed in daylight hours, generally from late afternoon to late evening. Water temperatures at this time were 10.0 to 18.3 C. Spawning redhorse usually preferred riffle areas with water depths of 20 - 90 cm and current velocities from .3 to .7 m/sec. Substrates consisted of fine sand, gravel, cobble and the occasional boulder.

During spawning, female shorthead redhorse held a position in the riffle with 4 - 6 males positioned just behind or off to one side of her. Prior to the female releasing her eggs the males would move up beside the female and nudge her sideways. This would be repeated several times by different males and often by two to three males at once. During the release of their sexual products there would be rapid body vibrations by both sexes (the number of males could vary from one to three) and a forward movement into the current causing the sexual products to be broadcast onto the stream substrate. The adhesive eggs were found sticking to boulders, rocks and gravel. Once the gametes had been released, the female and males would drop back downstream, and again hold in the stream, facing the current. It could not be ascertained whether spawning by a group was repeated.

The timing of spawning activity for shorthead redhorse varied each year. Spawning was observed in 1983 between 20 May and 20 June, in 1984 between 25 May and 20 June, and in 1985 from 1 May to 10 June. Nuptial tubercules on the anal and caudal fins of males were well developed throughout the spawning period.

The best evaluation of the upstream run of the shorthead redhorse was done in 1983 because in both 1984 and 1985 there were significant periods when the fence was washed out. There was no apparent difference in timing between upstream migration of males and females. The ratios of females to males in the upstream migrations were, in 1983, 1:0.76, in 1984, 1:1.73 and in 1985, 1:1.35. Sex of downstream migrants was determined in 1984 and 1985 but not in 1983. The males in both years initially returned in higher numbers followed by an increase in numbers of females as the run progressed. About 0.5% of the downstream migrating female shorthead redhorse were sexually immature. These females contained small developing eggs in the ovaries, and probably would have matured in the following year.

One hundred and forty-six (34.2%) of 427 shorthead redhorse tagged in the Ochre River during the 1984 spawning migration returned to the Ochre River in 1985. Twenty-five of these fish were recaptured in the upstream trap and one hundred and twenty-one were captured on their downstream run. The 25 tagged fish recaptured in the upstream trap stayed upstream an average of 15 days with a range of 6 - 29 days.

Length frequency distributions of upstream migrants for the three years are presented in Fig. 10; the data are presented in Appendix 2. The mean fork lengths for all migrating shorthead redhorse were 354.1 mm, 334.3 mm, and 339.6 mm for 1983, 1984 and 1985 respectively. Females were larger than males in all three years. Mean lengths of females and males were 375.6 & 338.2 mm, 364.1 & 323.0 mm, and 353.5 & 328.9 mm in 1983, 1984, 1985, respectively. The longest fork length taken for a female was 505 mm, and for a male, 474 mm.

Age frequency distributions for upstream migrating shorthead redhorse for all three years are presented in Fig.11, and Appendix 3. Ages of spawning fish were 3 - 14 y and 3 - 16 y for males and females, respectively. Age of sexual maturity for both males and females was 5 y (males rarely 4). Modal ages in the spawning runs were for males and females 8 and 8, 6 and 9 and 6 and 7 for 1983, 1984, and 1985, respectively.

FECUNDITY AND EGG SIZE

The reliability of the dried weight method for estimating fecundity was tested by actual counts on 19 ovaries (Appendix 4). This method of fecundity estimation yielded a mean error of +1.67% with a range of -2.78% to +5.23%.

Female shorthead redhorses sampled from the spring spawning migration in the Ochre River contained from 12,660 - 44,329 eggs and had fork lengths of 310 to 418 mm. Females sampled in the early winter from Dauphin Lake had 10,464 - 30,557 eggs and fork lengths of 347 mm to 405 mm. Fecundity showed positive linear relationships to fork length and age. Linear regression equations for fecundity and fork length for spring samples of 1984 and 1985, for the winter 1986 samples and for fecundity and age of the 1984 and 1985 samples are shown in Fig. 12. Insufficient numbers of fish were aged in 1986 to determine the linear regression of fecundity to age.

The mean gonadal somatic indices (GSI),(wet gonad weight expressed as a percentage of wet body weight), for spring caught females was 20.22 % and 14.79 % for years 1984 and 1985 respectively (Table 4.). The females caught in early winter (1986) had a mean GSI of 8.85 %.

Shorthead redhorse larvae drifted downstream at night with maximum drift occurring between 22:00 and 06:00. This corresponded with white sucker and quillback larval drift in Ochre River. Predation on drifting larval fish in the Ochre River by common shiners (<u>Notropis cornutus</u>), spottail shiners (<u>Notropis hudsonius</u>), johnny darters (<u>Etheostoma nigrum</u>), river darters (<u>Percina maculata</u>) was documented. Stomach contents of the above noted species contained as many as 17 unidentified larvae. The time of day this larval predation took place in unknown

DAUPHIN LAKE WATER TEMPERATURE

Dauphin Lake water temperatures for 1984, 1985 and 1987 are presented in Appendix 5. A quadratic regression equation using five day temperature means plotted against the number of days after 1 April was used to evaluate the differences among years. This equation provided the best fit for the temperature data from Dauphin Lake (Fig. 13). The regression equation for each line is given in Table 3. Orthogonal contrast was used to determine whether differences existed between years. There was a significant difference between

1984 and the other two years ($P < 0.05$). There were no significant differences between 1985 and 1987.

DAUPHIN LAKE WATER LEVELS

Mean monthly water levels of Dauphin Lake are shown in Fig. 14. Water levels of Dauphin Lake are regulate by a control structure located at its outlet, Mossy River. The lake level presently is controlled at 260.4 m above sea level in summer and 259.9 m in winter. Maximum outflow is allowed if the water level is 260.4 m or higher and zero outflow if the water level is 259.9 m or lower. The lowest spring level of the four years of this study occurred in 1985; the highest in 1986. Lake levels within any given year can fluctuate over a meter due to limited outflow capacity and the large drainage basin.

AGE ANALYSIS

Juvenile shorthead redhorse 0+ and 1+ cohorts collected in 1984 formed non-overlapping fork length classes (Fig. 15). Therefore the apparent separation allowed for age determination. There was evidence of overlapping fork lengths among cohorts of age 2+ and older; therefore sections of pectoral fin rays were used to determine age of shorthead redhorse older than 1+. The first annulus was usually distinct and laid down very close to the focus of the section if the fish had developed from an early spawn and had good first summer growth. This first annulus was counted as 1+. Fish from a late spawn with poor first summer growth usually did not show a distinct first annulus and the focus was usually considered as the 1+ annulus.

Validation of ages determined from pectoral fin ray sections was based on the examination of remaining pectoral fins from 177 recaptured tagged shorthead redhorse that had been at large more than one year after tagging (Appendix 6). The correct number of annuli from the time of tagging had formed in 143 (80%) of these fish. Thirty-four fin ages could not be validated because of one or more of the following reasons: one or both fins were unreadable, both fin sections gave the same age or the two sections provided ages that differed by more than one year. Plates 1, 2 and 3 are photographs of pectoral fin ray sections from three shorthead redhorse. Plates 1 is an example of good summer growth, but showing a small increment of bone formed on the outer edge of the fin ray. Plate 2 is an example of poor summer growth and showing a small increment of bone formed on the outer edge of the fin ray, while Plate 3 is a fish with good summer growth and showing a good increment of bone formed on the outer edge of the fin ray.

AGE, GROWTH AND CONDITION OF SHORTHEAD REDHORSE

DAUPHIN LAKE SEINE SAMPLES

Juvenile shorthead redhorse were collected by beach seine from the inshore region of Dauphin Lake (Fig. 3).

Bottom substrates at sample sites ranged from sand and silt to gravel and rock in water depths from 0.5 m or less to 1.25 m.

There were apparent differences in the relative strengths of year classes both within and between years (Table 5). The was evidence, in 1984, of a strong 0+ year class (1984) and a poor 1+ year class (1983). Seining effort was increased to weekly in 1985. There was a continued strong 1984 year class, but a relatively weak 1985 year class. The seining effort in 1986 was decreased to biweekly, and a strong 1986 year class and further evidence of a weak 1985 year class was detected. The seining effort in 1987 was decreased to monthly. There was a strong 1987 year class and further evidence of a strong 1986 year class.

Young of the year shorthead redhorse with fork lengths of 16 to 27 mm became collectable by seining during the last half of July. The mean fork length associated with each year class is indicated in Table 5.

There was a significant difference (ANCOVAR) in slope ($P<.001$) and intercept ($P<.001$) of log weight on log fork length between years (Fig. 16). Using least square mean (LSM) from the general linear model the expected mean for 1984 was significantly different from 1985, 1986, and 1987. Log weight and log fork length for 1+ shorthead redhorse were significantly different (ANCOVAR) in slope ($P<.001$) and intercept ($P<.001$) between years (Fig. 17). The expected mean for 1987 was significantly different from 1985 and 1986 and 1986 was significantly different from 1985.

Growth of each year class during the sampling season was evaluated with linear regression analysis of log fork length to days of growth for each year and for each year class. Days are represented by number of days after 1 April.

There was a significant difference (ANCOVAR) in slope ($P<.001$) and intercept ($P<.001$) between years for log fork length on days of growth for 0+ shorthead redhorse (Fig. 18). The expected means were significantly different for all years except 1984 and 1985. There was a significant difference (ANCOVAR) in slope ($P<.001$) and intercept ($P<.001$) between years for log fork length on days of growth for 1+ shorthead redhorse (Fig. 19).

DAUPHIN LAKE GILLNET SAMPLES

Length and age frequency data of shorthead redhorse sampled by gillnets for all years are presented in Fig. 20. The overall sex ratio of females to males was 1:0.824. Mean fork lengths and ages for females were 319.9 mm and 6.4 yr and for males 282.6 mm and 5.5 yr, respectively. The ranges of fork lengths in males and females caught in gillnets were 125 to 448 mm and 131 to 491 mm, respectively. Females at any given age were, on the average, longer than males of the same age. Ages of gillnetted fish ranged for females from 1 to 18 years and for males 1 to 14 years. The modal age for males and females was 5 yr and 6 yr respectively. Percent frequency distributions for fork length and age for each sampling year are presented in Fig. 21 and Fig. 22. Complete fork length and age data are in Appendices 7 and 8. Condition of the fish for each year sampled was evaluated with linear regression of log weight on log fork length (Fig. 23). Analysis of covariance of log weight on log fork length showed no significant differences in intercept and slope among years. The expected means for the following years were significantly different (P<.001); 1984 and the years 1985, 1986 and 1987, 1985 differed from 1987, and 1986 differed from 1987.

Growth of the fish for each year was evaluated with linear regression of log fork length to age. Log fork length on age was significantly different (ANCOVAR) in slope (P<.001) and intercept (P<.001) for between years (Fig. 24). However, using LSM from the general linear model, the expected means were not significantly different between years at (P<.005).

Growth rates of males and females were also evaluated using linear regression. The equation for each line is given in Table 3. Log fork length on age were significantly different (ANCOVAR) in intercept (P<.001) and slope (P<.001) between sexes. Using LSM, from the general linear model, the expected means for the two sexes were significantly different as well (P,.001).

TAG RETURN ANALYSIS

Two hundred and thirty-eight (16.8%) of the 1418 shorthead redhorse tagged in 1984 and 1985 were recaptured within the Dauphin Lake system through the period of 1985 to 1987 (Appendix 6). One hundred and forty-six of the 426 shorthead redhorse tagged in 1984 returned to Ochre River in 1985, 26 were recaptured in the Ochre River from the shorthead redhorse that were tagged in the 1985 spring spawning run and 66 were recaptured from various locations of Dauphin Lake (Fig. 25).

Most recaptures from non-DFO staff or students were by commercial fishermen. Recapture locations ranged from near shore to well off shore (Fig. 25). Two recaptures were from sport fishermen, one each from Wilson River and Valley River. Ten of the 238 (4.2%) shorthead redhorse tagged in 1984 and recaptured in 1985 at the Ochre River fish fence had lost their tags.

The change in length of tagged and fin clipped adult shorthead redhorses that had been at large for one year ranged from -3 to 44 mm. The initial fork length measurement at the time of tagging was taken on live unanesthetized fish. The potential error of this measurement was evaluated on 22 tagged shorthead redhorse which were measured twice during the 1985 spring spawning run. The timing between measurements varied from 1 week to three weeks. Assuming that little growth would occur during this period, the variability of fork length measurement was from -4 to +5 mm. Therefore it was assumed that measurements of live fish had an accuracy of + or - 5 mm.

Tagged shorthead redhorse that were recaptured in the Dauphin Lake commercial fishery varied in fork length from -8 to 36 mm and within these measurements 50% had apparently negative growth.

Eighty female shorthead redhorse tagged in 1984 were recaptured as they returned to Ochre River to spawn in 1985.

An adjusted Peterson estimate (Ricker 1975), based on numbers of tagged shorthead redhorse of the 1984 and 1985 downstream runs in the Ochre River and the tag recaptures from the 1984 and 1985 Dauphin Lake gillnetting program, gave a whole lake population estimate of 9,350 +/- 10,548 (1984) and 33,558 +/- 24966 (1985) for adults > 290mm in fork length.

FOOD HABITS

Stomach contents of shorthead redhorses were identified to 16 general categories (Appendix 9). Fish less than or equal to 100 mm in fork length preferred small planktonic organisms such as cladocerans, copepods, ostracods and very small benthic chironomids and trichopterans. To a much lesser extent Ephemeroptera, Amphipoda, Diptera other than Chironomidae, Conchostracoda and Oligochaeta were found. Shorthead redhorses greater then 100 mm in fork length contained a wider variety of foods, predominantly benthic organisms. Chironomidae, Trichoptera, Ephemeroptera, Mollusca (fragmented shells only) and Diptera, were the most abundant food types while Ostracoda, Amphipoda, algae, and Acarina were found to a lesser extent. Sand was also found in the guts of some shortheads.

Some stomachs contained a large amount of unidentified material. This material was interpreted as being organic and was usually associated with gut samples which contained an abundance of mollusc shell fragments.

The guts of nine adult shorthead redhorses taken in the 1986 winter fishery were examined. Eight of the nine were empty. Therefore feeding during the winter months probably was much reduced. The contents of the one gut containing food was composed of Chironomidae and Trichoptera.

The gut contents of five post spawning shorthead redhorse taken from Ochre River were examined to evaluate feeding during the spawning stage. Feeding did occur at this time with the main diet components being algae, chironomids and to a lesser extent, Trichoptera.

It was possible to observe feeding behavior of one captive juvenile. In addition to feeding on the substrate and sorting food particles from the substrate in the mouth, it also fed on the surface of rocks, plants stems and leaves. Unwanted particles were ejected via the mouth and opercular openings. Water column feeding was also observed when food pellets were placed in the tank.

Four intestinal parasites were found in the gut of the shorthead redhorses: Acanthocephala - Pomphorhynchus bullocolli and Neochinorhynchus sp., Trematoda - Lissorchis gullaris and Nematoda - Dorylaimidae sp. (identified by A. Szalai). No external parasites were found on any of the fish examined during the five years of study. A complete list of parasites associated with shorthead redhorse in Dauphin Lake can be found in Szalai (1989).

MERISTICS AND MORPHOMETRICS

Table 2 is a summary of meristics and morphometrics values associated with all fish examined. During spawning, nuptial tubercules were well developed on the anal, caudal and to a lesser extent on the pelvic and pectoral fins of males.

DISCUSSION

OCHRE RIVER SPAWNING MIGRATION.

In addition to shorthead redhorse the Ochre River also supports spawning runs of northern pike, white sucker, silver redhorse, walleye, sauger, quillback, trout perch and several species of cyprinids. The shorthead redhorse is the last of the larger fish species to arrive on the spawning grounds of Ochre River.

Previous to 1984, Ochre River had a rock crossing located approximately 1.8 km upstream from its mouth. This rock crossing, during the spring freshet, restricted most fish from migrating further upstream. The removal of this rock crossing, and subsequent installation of an overhead bridge, has allowed for unrestricted migration of all fish using the Ochre River.

The gradient in the first 32 km of Ochre River is approximately 0.3%. The only obstructions in this section of the river would be beaver dams that may have survived the spring freshet. The Ochre River also contains several riffle-pool sequences within this section, which provide resting areas and suitable spawning substrate for fish utilizing this river. The riffle-pool sequences which are located closer to the Riding Mountain escarpment are unstable. This instability is due to the upper reaches of the river containing easily eroded shale and a stream gradient which is much greater, causing large movements of stream bed material. This type of stream channel habitat is not ideal for successful spawning. The lower portion of Ochre River contains most of the spawning grounds, but it is also the area that is most affected by the agricultural practices that are being used in the area. These practices include land clearing to the edge of the stream bank and construction of additional drainage channels which bring in water from other drainages. This increases siltation and stream bank erosion rates. This added silt and water affects spawning beds in two ways. First, increased flow changes once stable spawning substrates into unstable ones and secondly the silt will cover fish eggs and suffocate them. There are no historical data to draw upon to evaluate whether these alterations to the system have affected shorthead redhorse.

Shorthead redhorse migration in Ochre River commenced when the mean daily water temperature reached 10 C. Spawning activities began when mean daily water temperatures reached 10 to 12 C. Sule and Skelly (1985) found that both sexes from Kankakee River, Illinois are running ripe when air and water temperatures were 7.0 C, Burr and Morris (1977) noted that spawning activity of shorthead redhorse from Big Rock Creek, Illinois occurred at 16 C, while Meyer (1962) observed spawning at 11.1 C in the Des Moines River, Iowa.

The shorthead redhorse spawning migrations within Ochre River appeared to be affected by stream discharge and temperature. Once stream temperature had reached the critical temperature for migration (10 C), they would begin their spawning run. Throughout the spawning period both up and downstream movements would intensify if the stream discharge increased. Parker (1987) noted the same phenomenon in quillback from Ochre River.

Shorthead redhorse spawning behaviour was observed in Ochre River from 1500 till 2200, which coincides with the daily period of time when the water temperature of Ochre River is the warmest. This daily spawning period is contrary to Burr's (1977) observations of shorthead redhorses from Big Rock Creek, Illinois, he indicated that spawning occurred from 1100 to 1600.

Spawning in the Ochre River occurred in water 20 - 90 cm deep, with water velocity from .3 to .7 m/sec, comparable to that found in a Wabash River tributary (Curry 1980). Burr (1977) noted that spawning occurred in troughs and circular "nests". He suggested that the nests and troughs may have been depressions resulting from bottom disturbances during spawning activity and not the result of nest building behaviour. There was no evidence of nest building in the Ochre River, and activity of the fish produced little disturbance to the substrate. Sexual products were broadcast over the stream substrate.

Scott and Crossman (1980) noted that spawning lasts only a few days. This was obtained from Meyer (1962), who described an Iowa population. Shorthead redhorse in the

Ochre River however, spawned over a 3 to 4 week period.

The late arrival of the shorthead redhorse to spawning areas results in no overlap with the northern pike, walleye and white sucker spawning activities. However quillback and shorthead redhorse spawning do overlap in time and space, which may cause some of the spawned eggs to be over-crowded. This may result in an increase in mortality to the eggs of both species due to either suffocation or an increased risk of fungal or bacterial infection. Shorthead redhorse spawning behaviour probably has little or no effect on the walleye, northern pike or white sucker eggs, as there was little disturbance to the substrate. But the same affect as that identified with quillback eggs may also apply to the spawned eggs of the walleye and white sucker.

Dauphin Lake shorthead redhorse appear to be annual spawners as indicated by the recaptures of tagged ripe adults of both sexes returning to Ochre River. Data on spawning frequency in other populations are not available.

Ochre River has an abundance of spottail shiners (Notropis hudsonius), johnny darter (Etheostomus nigrum), longnose dace (Rhinichthys cataractae), and blacknose dace (Rhinichthys atratulus) throughout the spawning areas of Ochre River. These fish feed on fish eggs and larvae. Stomach analysis done on twenty of these fish indicated their diet included unidentified fish eggs and larval fish. The extent of this predation on shorthead redhorse eggs and larvae was not determined.

FECUNDITY, EGG SIZE AND LARVAL DRIFT

Dauphin Lake shorthead redhorse with fork lengths 310 to 418 mm contained 12,660 to 44,324 eggs, with diameters that varied from 1.53 to 1.81 mm. Becker (1983) examined six shorthead redhorses from the Wisconsin River which had total lengths of 460 to 537 mm and contained 22,000 to 44,000 eggs. Sule and Skelly (1985) found the shorthead redhorses from the Kankakee River had total lengths varying 327 - 418 mm, and 9,491 to 26,550 eggs. Dauphin Lake shorthead redhorse have higher numbers of eggs at given body length than these two riverine populations.

Becker's (1983) egg size measurements (1.6 to 2.1 mm) were similar to those from the Dauphin Lake population. Both egg size and numbers are positively correlated to female body size in Dauphin Lake. Data from other areas are insufficient to determine whether this relationship exists.

To allow for comparisons of GSI (gonad-somatic indices) with other studies the shorthead redhorse values from Dauphin lake were pooled. The GSI for spring caught females was 14.54 (range 7.71 - 20.22) while mean GSI of the early winter caught females was 8.85 with a range of 5.24 to 13.21. The GSI is low in the fall because egg development is not completed before winter. Sule and Skelly (1985) reported mean GSI of 13.9 just before spawning and Becker (1983) reported a GSI of 13.2, measured from his largest female. Both of these values are lower than the GSI observed for Dauphin Lake spawning females. Shorthead redhorse from Dauphin lake have the largest mean GSI reported to date.

The higher mean GSI or fecundity may result from a population living in a productive lake being able to put more energy into producing eggs. River fish would have to expend more energy to maintain position in the current.

Shorthead redhorse larvae drifted in the protolarval stage as defined by Buynak and Mohr (1979). Larval drift occurred at night with the highest numbers occurring between 2200h and 0600h. Drift also appeared to be passive and dependent on stream velocity. Shorthead redhorse larval drift occurs at the same times as white sucker and quillback larval drift. Gale and Mohr (1978) noted a similar pattern of drift for shorthead redhorse, quillback and white sucker larvae drifting in the Susquehanna River, Pennsylvania.

All of the larvae in Ochre River are subject to predation by spottail shiners, johnny darters, common shiners and blacknose dace. The survival of these larvae may be enhanced by nocturnal drifting in large numbers during a short period of time. Parker (1987) presumed survival advantages for nocturnal drifting of quillback larvae in the Ochre River while Gale and Mohr (1978) stated that larvae drifting at night, like particles of floating debris, might be more difficult for sight-feeding predators to detect than larval fish that oriented themselves into the current. Once the shorthead redhorse larvae began drifting, the length of time that they remained in the river was not determined.

Shorthead redhorse larvae continue their development in Dauphin lake. Several years of stream sampling within the Dauphin Lake drainage, has yielded only a few juvenile shorthead redhorses. Shoreline seining of Dauphin Lake produced large numbers of juveniles, while offshore sampling with otter trawls by DFO staff yielded only a small number. It seems that juveniles are more abundant in the inshore areas of Dauphin Lake.

Walleye larvae drift earlier than shorthead redhorse larvae (Gaboury 1985), so there would be very little overlap for "first food" between the larvae of these two species. There is overlap in food types during their first year, but because the walleye larvae reach the lake sooner than the shorthead redhorse larvae and stay off shore where they remain pelagic until they are about 30 mm long (Morsel 1970), there probably is little or no competition for the same food type.

Walleye larvae were captured in the inshore areas of the lake by mid July and they had increased in size to where size and type of food (Harbicht & Franzin, unpublished data) was much different than that required by shorthead redhorse larvae. Quillback and shorthead redhorse larvae drift during the same period of time and rely on the same food types (Parker 1987) during their first season of growth. Only a small number of juvenile quillback were caught in inshore seine samples (Parker 1987), which suggests that either these two species use different areas of the lake for their initial juvenile development or there were very low numbers of juvenile quillback to be captured.

AGE AND GROWTH OF JUVENILE SHORTHEAD REDHORSE

DAUPHIN LAKE SEINING

Beach seining of Dauphin Lake provided usable numbers of juvenile shorthead redhorses throughout most of the sampling periods, except for late fall when seining did not yield fish of any type. Water temperature had dropped substantially by this time and most fish probably moved to deeper waters.

Open water offshore otter trawling in Dauphin Lake in 1983 yielded juvenile shorthead redhorses of age 1+ and older (J. Babuluk, 1984 pers. comm.). Juvenile shorthead redhorses are not restricted to shore line habitat only, but will range throughout the lake. Paired plankton trawling for fish larvae in 1984 and 1985 in Dauphin lake captured very small numbers of larval (0+) shorthead redhorses (Ken Rowes, 1988 pers.comm.) suggesting that 0+ shorthead redhorse preferred the inshore areas of Dauphin Lake. However all age classes of shorthead redhorse were taken by seining from all locations sampled on Dauphin Lake shoreline.

YEAR CLASS STRENGTH

Shorthead redhorse recruitment was variable amoung years and like many other species was probably dependent upon the magnitude of the spawning population, condition of the stream discharge within the spawning streams, lake water levels and temperatures and plankton abundance in Dauphin Lake. There were strong 0+ year classes in 1984, 1986 and 1987, while there was a small 0+ year class in 1985. Spawning migration in 1985 was relatively good, and there should have been sufficient recruitment. Possible reasons for a poor 1985 year class could be low lake water temperatures (Fig. 13) and/or lower than average initial lake water level (Fig. 14). Mills and Mann (1985) have shown strong positive correlation of year class strength of some English cyprinids with temperature or a combination of temperature and high precipitation. Years with low temperatures or high precipitation or both in the month following spawning produced poor year classes. Kallemeyn (1987) showed significant positive correlations between lake level and year class strength for young of year walleye from four lakes in Voyageurs National Park, Minnesota. Weaker year classes were produced when lake levels were lower. A year of high precipitation caused a near failure of the 1986 year class of quillback from Dauphin Lake (Parker 1987). However, there was a strong year class of shorthead redhorse in that same year. The shorthead redhorse's extended spawning period allows the species to spawn through a period of time during which some environmental problems for the survival of the eggs might occur, therefore insuring the survival of the year class (i.e. 1986).

The length-weight relationship can be useful in comparisons using the same population over several years or among populations. There were significant differences in slope and intercept among years in comparisons of length:weight relationships for 0+ and 1+ shorthead redhorse year classes throughout the four year period. These differences may have been the result of varying lake temperatures, water levels, abundance of food and the timing of spawning. If one or more of these environmental conditions are not optimal, the length:weight relationship will be altered. Since both low water temperatures and low lake levels were prevalent in the spring of 1985, these factors may have been the cause of a significantly different length-weight relationship for that year.

The significant differences in slope and intercept of linear regression of summer growth of 0+ and 1+ shorthead redhorses probably resulted from differences in water temperature among the years. The lowest mean daily water temperature during the four years was in 1985, resulting in the slowest growth of 0+ shorthead redhorse, while 1984 had the warmest daily mean water temperature in the period resulting in the fastest growth rate for 0+ and 1+ shorthead redhorse. Growth rate of juvenile shorthead redhorse has a strong positive correlation with water temperature. The variability in R^2, among years for the regression equations of log weight to age developed for the 0+ and 1+ year class may have been due to the long spawning season of the shorthead redhorse resulting in year classes containing wide ranges in fork lengths.

Maximum fork lengths of Dauphin Lake 0+ shorthead redhorse through the years 1984 to 1987 were 65 to 73 mm. Mean summer growth was 25.02 to 51.56 mm. Fall caught young-of-the-year from Ohio were 51-100 mm (Trautman 1981), 43 - 45 mm in N. Wisconsin, 76 - 87 mm in S. Wisconsin and 96 - 103 mm in Lake Poygan, Wisconsin (Becker 1983), but less than 44 mm in the S. and N. Saskatchewan Rivers, Saskatchewan (Reed 1962). The growth rate of Dauphin Lake 0+ shorthead redhorse is slower than the growth rates of the more southern populations, but equals those found in the northern Wisconsin and is much faster then the growth of juveniles from the Saskatchewan River. The southern populations have a much longer growing season which allows the population more time to grow. The northern populations have a much shorter period of growth, therefore they are expected to grow less each year.

AGE AND GROWTH OF DAUPHIN LAKE SHORTHEAD REDHORSE POPULATION.

The advantages of using the fin ray method over the scale method for aging fish has been outlined by several authors (Beamish and Harvey 1969, Beamish and McFarlane 1983, MacCrimmon 1979). Beamish and McFarlane (1983) recommended the use of fin rays for aging white suckers, as the fin rays appeared to give more accurate age estimates than did scales. All previous researchers aged shorthead redhorses using scales. However, when scales were aged from the Dauphin Lake population, fish greater then 6 years had ages that appeared to be unsatisfactory. Annuli of these scales were crowded at the extremities of the scale which resulted in doubtful counts. The validation of annuli formation in pectoral fin rays indicated that the fin ray cross sections are a reliable method for age determination of shorthead redhorses from Dauphin Lake.

Growth of Dauphin Lake shorthead redhorse was compared with four other populations by plotting the mean total length at annulus formation against age (Fig. 26). Where needed, fork lengths were converted to total lengths (TL = 1.11 FL). In the Dauphin Lake population, the relationship was determined to be TL = 1.10 FL. The data of other workers were obtained from Biron Reservoir, Wisconsin River (Becker 1983), Des Moines River (Meyer 1962), Kankakee River (Sule and Skelly 1985), and North/South Saskatchewan Rivers (Reed 1962). Dauphin Lake shorthead redhorse appear to grow more slowly than do those from further south, i.e. Des Moines River, Biron Reservoir and Kankakee River. A much longer growing season would likely account for their faster growth. Dauphin Lake and the North and South Saskatchewan Rivers are at approximately the same latitude, with the Saskatchewan River's shorthead redhorse having slightly faster growth rates. The growth season is possibly longer due to warmer waters being available for a longer period of time. However, only 91 fish were sampled from the Saskatchewan Rivers populations and the data may not represent the true mean length at the various ages for the populations. Because the ages for the other shorthead redhorse populations were determined by scales, the results could have been underestimated due to the inaccuracy in scale aging of fish older than 6 years. This error would then suggest a faster growing population.

Scott and Crossman (1973) have reported that female white suckers are universally longer then males of the same age. This was true for shorthead redhorse in Dauphin Lake and in Kankakee River (Sule and Skelly 1985). This difference is evident at age five in the Dauphin Lake population and becomes more pronounced by sexual maturity.

The oldest aged shorthead redhorse taken from Dauphin Lake was an 18 year old female. Scott and Crossman (1973) suggested a maximum age for shorthead redhorse in Canada of 12 - 14 years and ages further south rarely exceed 9 years. The oldest shorthead redhorse Reed (1962) found in the Saskatchewan River was 12 years.

Only 2.2% of the shorthead redhorse taken in the gillnetting survey of Dauphin Lake were greater than 11 years. This low incidence of older fish may be the result of exploitation by the commercial fishery. Shorthead redhorse by eight or nine years of age, are large enough to be captured in the allowed mesh size of the commercial fishery.

They may therefore, be removed from the population after they become available to the fishery. Suckers are harvested by local fisherman during the winter commercial fisheries to provide additional protein for cattle and hogs.

There was no significant difference in log weight on log fork length of Dauphin Lake shorthead redhorse between years; therefore, for comparisons with other populations all years were pooled (log Wt = -5.3281 + 3.151(log total length). Equations for the data of Sule and Skelly (1985) and Meyer (1962) were log Wt = -5.0768 + 3.028(log total length) and log Wt = -2.454 + 3.0207(log total Length) respectively (Fig. 27). The slopes of the three regressions are similar, but there is a significant difference in intercepts between Des Moines River and the other two populations. Des Moines River fish are more robust than both the Dauphin Lake and Kankakee River populations. Perhaps the Des Moines River is particularly productive or there may be genetic variation between these populations.

TAG RETURN ANALYSIS

Shorthead redhorse in this study showed good retention of Floy anchor tags when compared with studies on quillback (Parker 1987) and white sucker (Franzin and McFarlane 1987). Tags on recaptured shorthead redhorses that had been at large for one year or more had accumulated very little algae along the tag. Tags on quillback that had been at large for the same period of time had acquired large accumulations of filamentous algae (Parker 1987) which would promote tag loss.

The attachment site of the anchor tags on shorthead redhorse healed poorly due to movement of the vinyl tube on the monofilament anchor, preventing the tissue, muscle and skin from healing. This type of wound and the stress associated with it could possibly affect the survival, growth and condition of the fish. The wide variation in growth observed in recaptured shorthead redhorses supports this. In light of this, studies which rely on a tagging program to evaluate growth of a species should be observant of this growth variation due to tagging.

Measurements of commercially caught fish were taken from samples which had been frozen previously then thawed, which may have increased measurement error. As fifty percent of the tag recaptures from the commercial samples had negative growth it provides evidence that measurement error is increased when taking length measurements from previously frozen fish.

Spawning stream fidelity by shorthead redhorses (assuming no tag loss) was 34% of tagged shorthead redhorse to Ochre River, the year following tagging. Because these fish were tagged while in spawning condition in 1984, once they reach sexual maturity, females probably spawn annually. Gaboury (1985) tagged 183 shorthead redhorses at a site on the Valley River, another Dauphin Lake tributary, during their 1983 spawning run. There were no recaptures of Valley

River tagged shorthead redhorse at the trap site during the three years that Ochre River was fenced. However other tagged species (walleye and northern pike) that were tagged in Valley River were recaptured at the Ochre River fence site, thus indicating that mixing of other spawning populations did occur between streams. Neighbouring inflowing streams to Dauphin Lake were not sampled for tag returns therefore the extent of mixing of spawning populations between stream could not be determined and will require further investigation.

Spawners from Ochre River dispersed widely in Dauphin Lake. Recapture locations included offshore and inshore waters and the backwater zones of some of the major streams flowing into Dauphin Lake.

The two population estimates for shorthead redhorse of Dauphin Lake showed a wide variation in values. These estimates could either be biased up or downward depending on whether or not the assumptions for the population estimates are being satisfied. All tag returns for shorthead redhorse came from within Dauphin Lake thus providing evidence that no emigration was occurring, however the assumption of no recruitment to Dauphin Lake cannot be supported. The assumption that random mixing of marked and unmarked fish occurs in Dauphin Lake is supported by the wide dispersal of tagged shorthead redhorse that occurred after tagging.

The 1985 population estimate for shorthead redhorse represents the most accurate of the two, as it incorporates a larger number of tagged fish, a higher rate of tag returns and a much larger number of shorthead redhorses were captured in the gillnetting program. By using the 1985 estimate the upper 95% confidence interval is approximately 59,000 which would represent a density of 1.2/ha for adult (> 290mm) shorthead redhorse in Dauphin Lake. Parker (1987) estimated quillback density to be < 1/ha for Dauphin Lake.

FEEDING

Suckers, in general, obtain their food by ingesting bottom material, sorting within the mouth cavity, and ejecting the unwanted material either out of the mouth or opercular openings. Juvenile shorthead redhorse feeding behaviour consists not only of feeding from the substrate, but also feeding within the water column, and searching the surface of plants and rocks for food. Adult shorthead redhorses feed primarily on the bottom as judged by their diet.

Eddy and Underhill (1974) noted that shorthead redhorse is the only Minnesota redhorse that take baited hooks and this is true at Dauphin Lake also.

Eastman (1977) classified Moxostoma macrolepidotum into a feeding group of suckers which is structurally intermediate between mollusc and filter feeders. Their pharyngeal apparatus is adapted to permit moderate mastication by occlusion of the pharyngeal teeth and the palatal organ. Therefore, their food types probably would consist mainly of insect larvae and small shelled molluscs.

Stomach contents from Dauphin Lake adult shorthead redhorse sometimes contained fragmented bivalve shells and at other times intact insect larvae. They are capable of breaking up bivalve shells, but the flexible exoskeleton of insect larvae is not broken.

The dietary habits of adult shorthead redhorse have been described by Sule and Skelly (1985), Meyers (1962), Becker (1983), Scott and Crossman (1980), Jenkins (1970), Yant (1979) and Redd (1962). Their findings are similar to those found for shorthead redhorse in Dauphin Lake. The majority of this literature deals with riverine populations and the most common food type from each study varies widely. Reed (1962) found Ephemeroptera, Yant (1979) Trichoptera, and Sule and Skelly (1985) Chironomids and Trichoptera as the most important, respectively. Shorthead redhorse of Dauphin Lake and in other populations apparently are opportunistic, a function of the habitat occupied, the seasonal availability of foods and the environmental conditions. If habitat conditions favor a particular fauna (i.e. Trichoptera) which may be utilized by shorthead redhorse, then this becomes the most important food item.

Stomachs from juvenile shorthead redhorses from seine samples only were examined. The food habits associated with these fish probably reflected the food organisms available within the inshore region of the lake. The primary food type selected by juvenile was planktonic invertebrates.

An evaluation of prey size eaten by juvenile walleye expressed as a percentage of fork length was done on three years of young-of-the-year walleye samples taken from Dauphin Lake (Harbicht and Franzin unpublished data). The mean prey size of young-of-the-year walleye was 34.7%, of fork length to a maximum of 56% of fork length. Young-of-the-year shorthead redhorse therefore were a potential food source for young-of-the-year walleye. Shorthead redhorse juveniles comprised 4.7% of identifiable food organisms found in stomachs of 329 young-of-the-year walleye.

There was dietary separation, with only slight overlap, between juvenile and adult shorthead redhorse, therefore intraspecific overlap within the same habitat would present little problem. Quillback gut contents from Dauphin lake contained large numbers of copepods and cladocerans suggesting that at times they act as planktivores (Parker 1987). Therefore quillback have dietary overlap with the juvenile shorthead redhorse.

The most common of the four parasites found in the gut of the shorthead redhorse was Pomphorhynchus bulbocolli. This parasite was found in both adult and juvenile shorthead redhorse, but those juveniles which were infected with this parasite had a wide range of numbers per individual. In some cases the concentration of this parasite within the gut appeared to be sufficient to cause blockage to the intestinal tract. Therefore this parasite could play a role in the survival and growth rate of juvenile shorthead redhorse.

MERISTIC AND MORPHOMETRIC CHARACTERS

The meristic and morphometric values of Dauphin Lake shorthead redhorse were similar to those reported by Jenkins (1970) and Phillips and Underhill (1971) with the exception of snout length, caudal peduncle length, head depth, dorsal fin base length, and caudal fin length. These measurements in Dauphin Lake shorthead redhorse were relatively smaller than those reported by the above authors. The Dauphin Lake population lies further north and is a lacustrine population, therefore morphological adaptations may have occurred since their dispersal following Wisconsinan glaciation. Further study might be warranted to follow up these morphological differences with electrophoretic or DNA analysis which would allow comparison of genetic characteristics of the Dauphin Lake population with those from the southern locations.

SUMMARY

The shorthead redhorse population of Dauphin Lake suffers from an occasional reduction in recruitment due to environmental fluctuations. Winter commercial gillnet fishery for walleye and northern pike also take some shorthead redhorse. When the market allows, they are sold together with white suckers as mullet. The gillnet mesh size is regulated at 10.8 cm stretched mesh which results in only the larger and older fish being removed from the population. This allows at least two or three year classes to spawn before they reach harvestable size. Sport fishing on Dauphin Lake concentrates on walleye and northern pike and very few shorthead redhorses are taken. Therefore, environmental change, either natural or man made would influence the condition of this population more than fishing mortality.

The shorthead redhorse of Dauphin Lake plays a role in the dynamics of the fish community. They overlap with quillback for similar food types. During their juvenile stage they provide part of the food base for walleye and northern pike. Shorthead redhorse larvae have been shown to contribute to the first food of walleye fry switching to piscivorous feeding, thus a thorough knowledge of shorthead redhorse biology can make a significant contribution both to understanding the Dauphin Lake community and to potential management decisions about economically important species.

Development of a commercial fishery for shorthead redhorse should take these biological interactions into account. A significant reduction in larval or juvenile abundance for example, might affect growth and survival of piscivorous species. At a minimum, it would shift some predation to cyprind and other catostomid species about which much less is known at present.

As is always the case, a change affecting one species of a fish community cannot be considered in isolation, ultimately the entire community will be affected.

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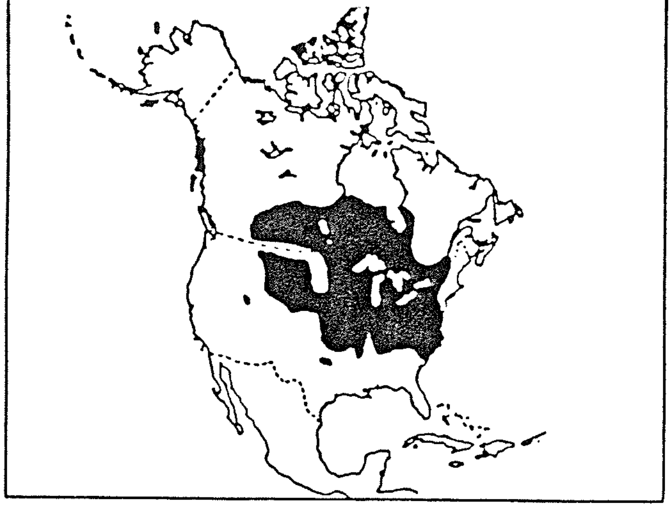
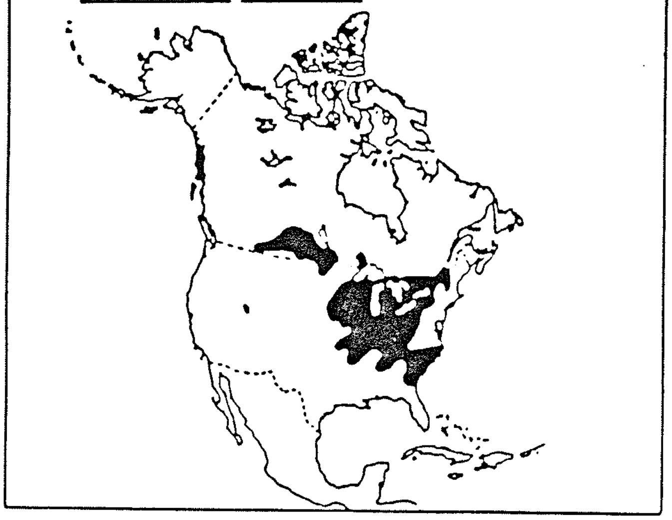
Fig. 1. Geographic distribution for *Moxostoma macrolepidotum*, *M. anisurum* and *M. erythrurum*.

Moxostoma macrolepidotum shorthead redhorse



Moxostoma anisurum silver redhorse



Moxostoma erythrurum golden redhorse

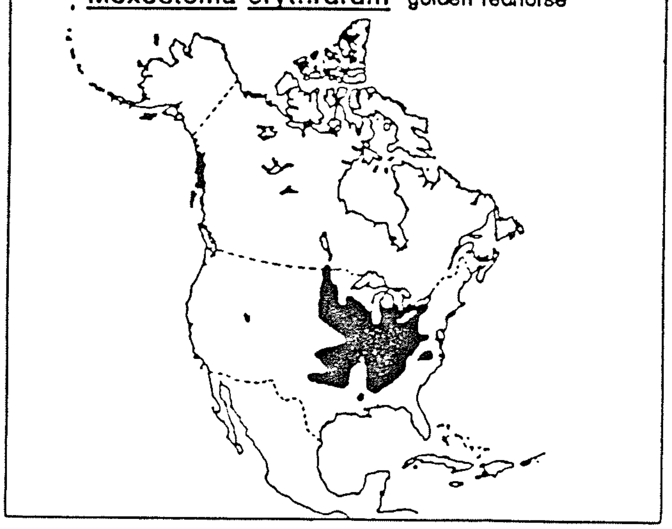


Fig. 2. Location of study area, Dauphin Lake, Manitoba.

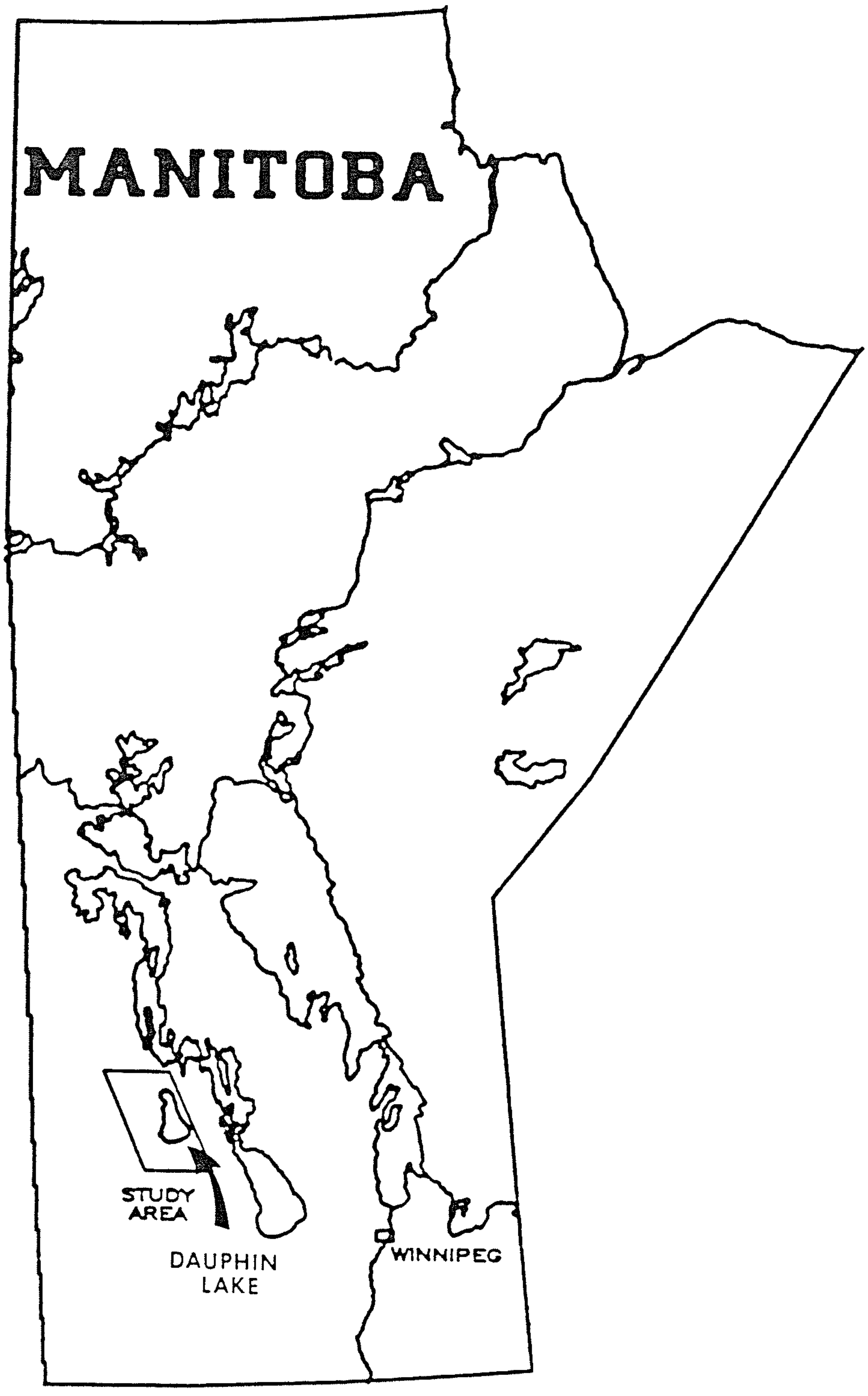

MANITOBA
STUDY AREA
DAUPHIN LAKE
WINNIPEG

Fig. 3. Location of fish fence and upstream sampling of Ochre River in 1983, 1984 and 1985; Seining sites on Dauphin Lake used in 1984, 1985, 1986 and 1987 to sample shorthead redhorse

1. Fish fence location; Seining locations; 2. Bay West of Ochre River; 3. Stoney Point; 4. Sifton Beach; 5. Oak Brae; 6. Million; 7. Methley Beach; 8. Welcome Beach; 9. Furthest point of migration in the Ochre River for shorthead redhorse.

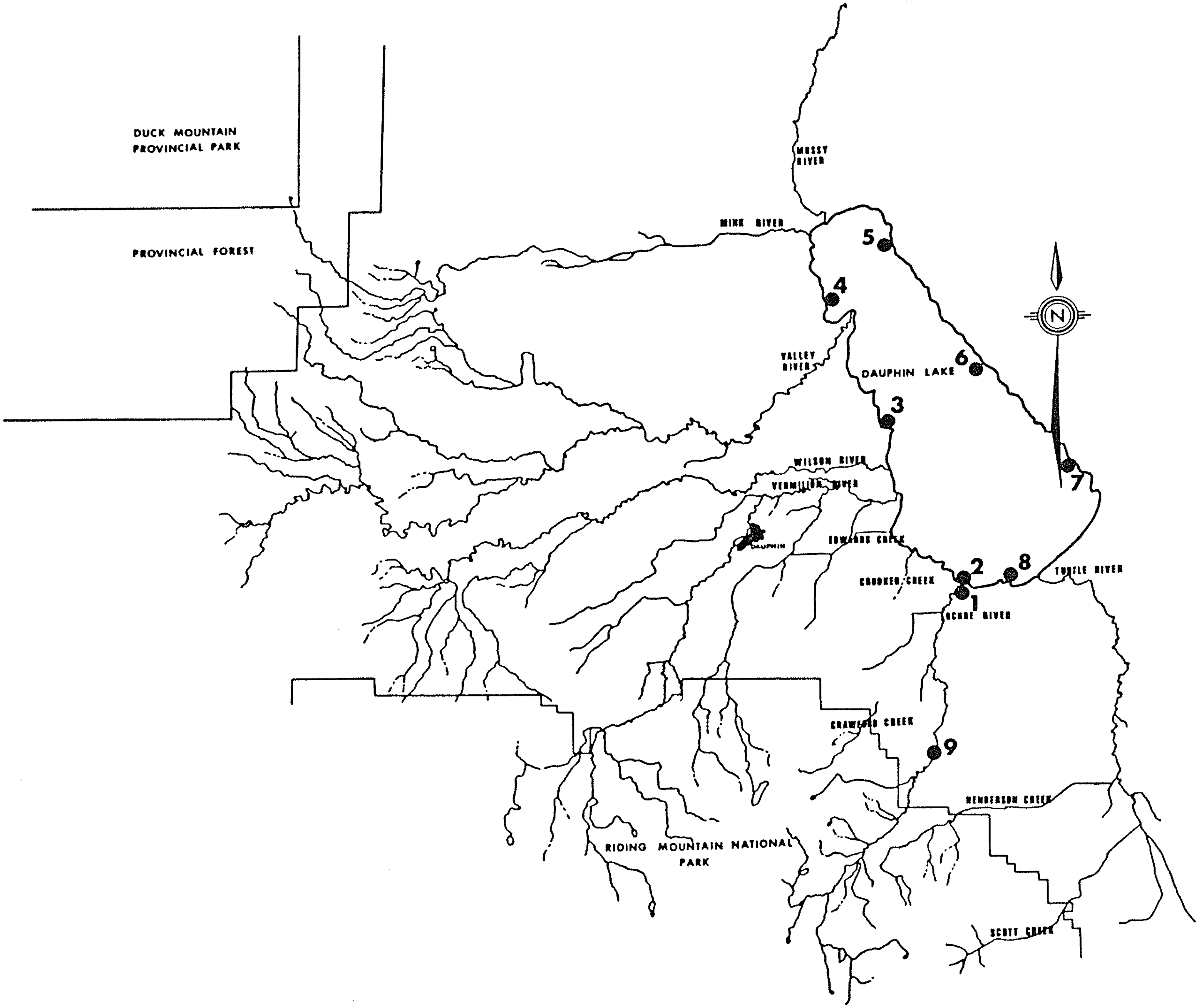
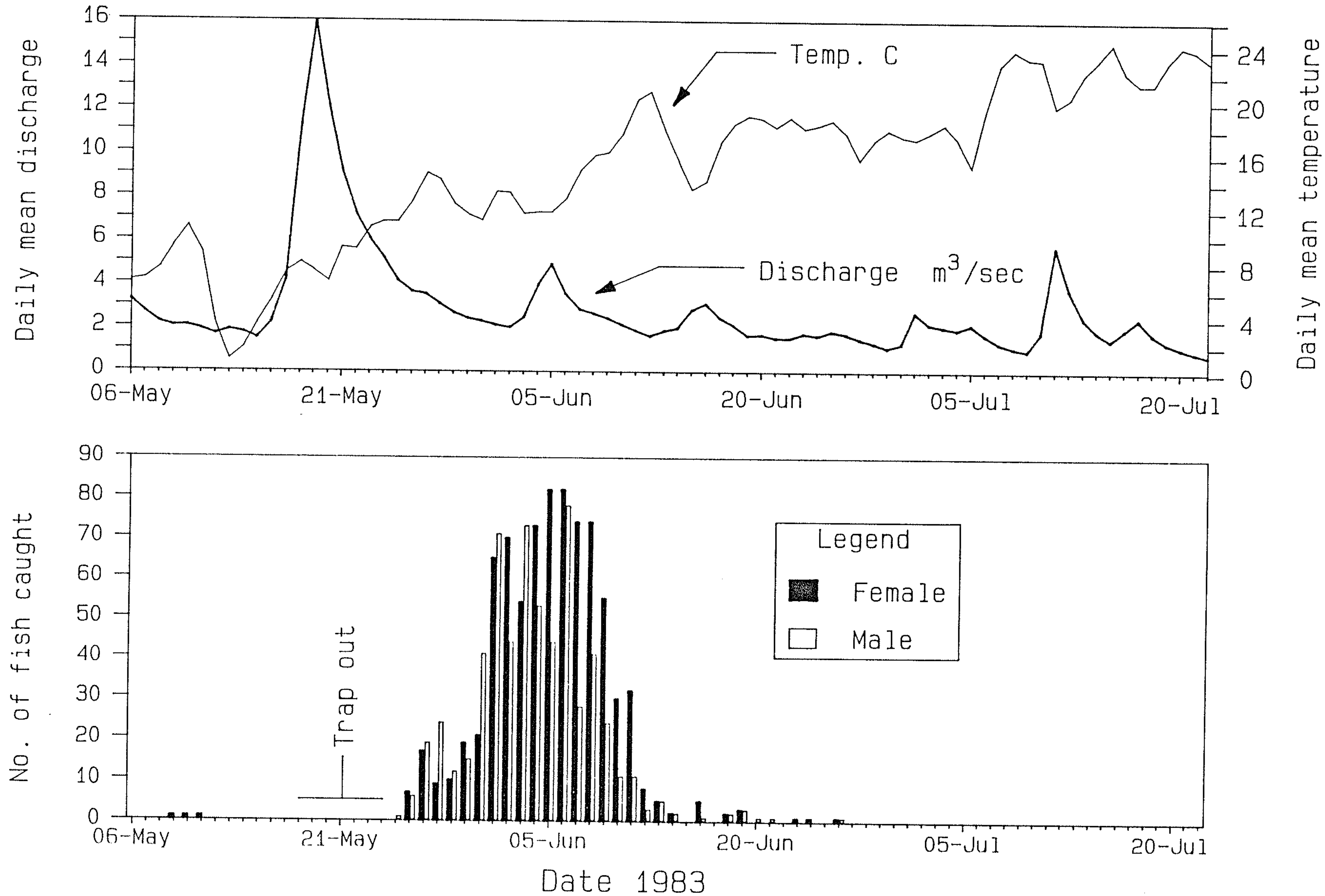

DUCK MOUNTAIN
PROVINCIAL PARK
PROVINCIAL FOREST
MOSSY
RIVER
MINK RIVER
5
4
N
VALLEY
RIVER
6
DAUPHIN LAKE
3
WILSON RIVER
7
DAUPHIN
2
8
1
OCHRE RIVER
9
HENDERSON CREEK
RIDING MOUNTAIN NATIONAL
PARK

Fig. 4. Daily upstream counts of migrating shorthead redhorse, mean daily water temperature and discharge for Ochre River, 1983.



Daily mean discharge
Daily mean temperature
Temp. C
Discharge m3/sec
06-May
21-May
05-Jun
20-Jun
05-Jul
20-Jul
No. of fish caught
Trap out
Legend
Female
Male
Date 1983

Fig. 5. Daily downstream counts of migrating shorthead redhorse, mean daily water temperature and discharge for Ochre River, 1983.

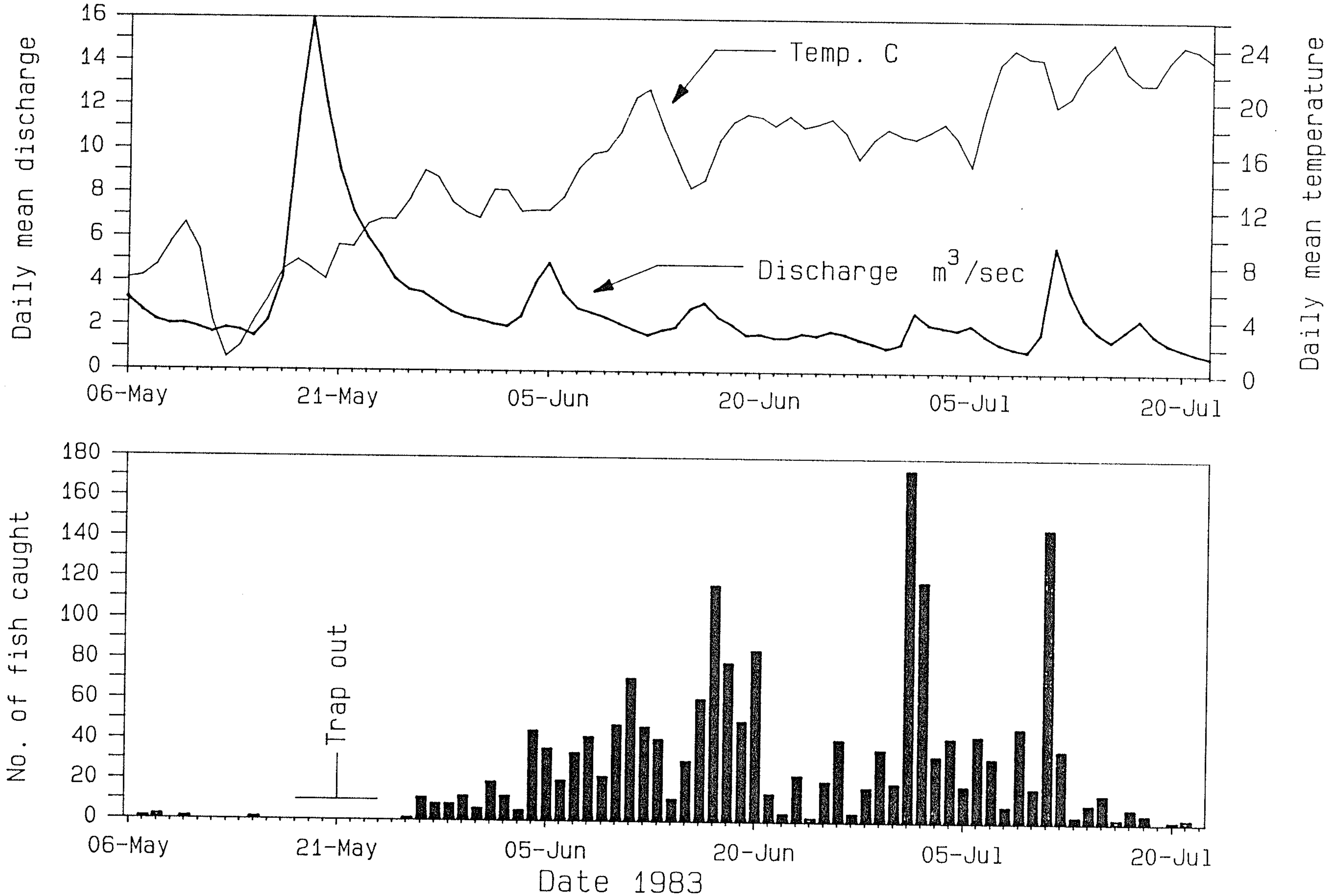
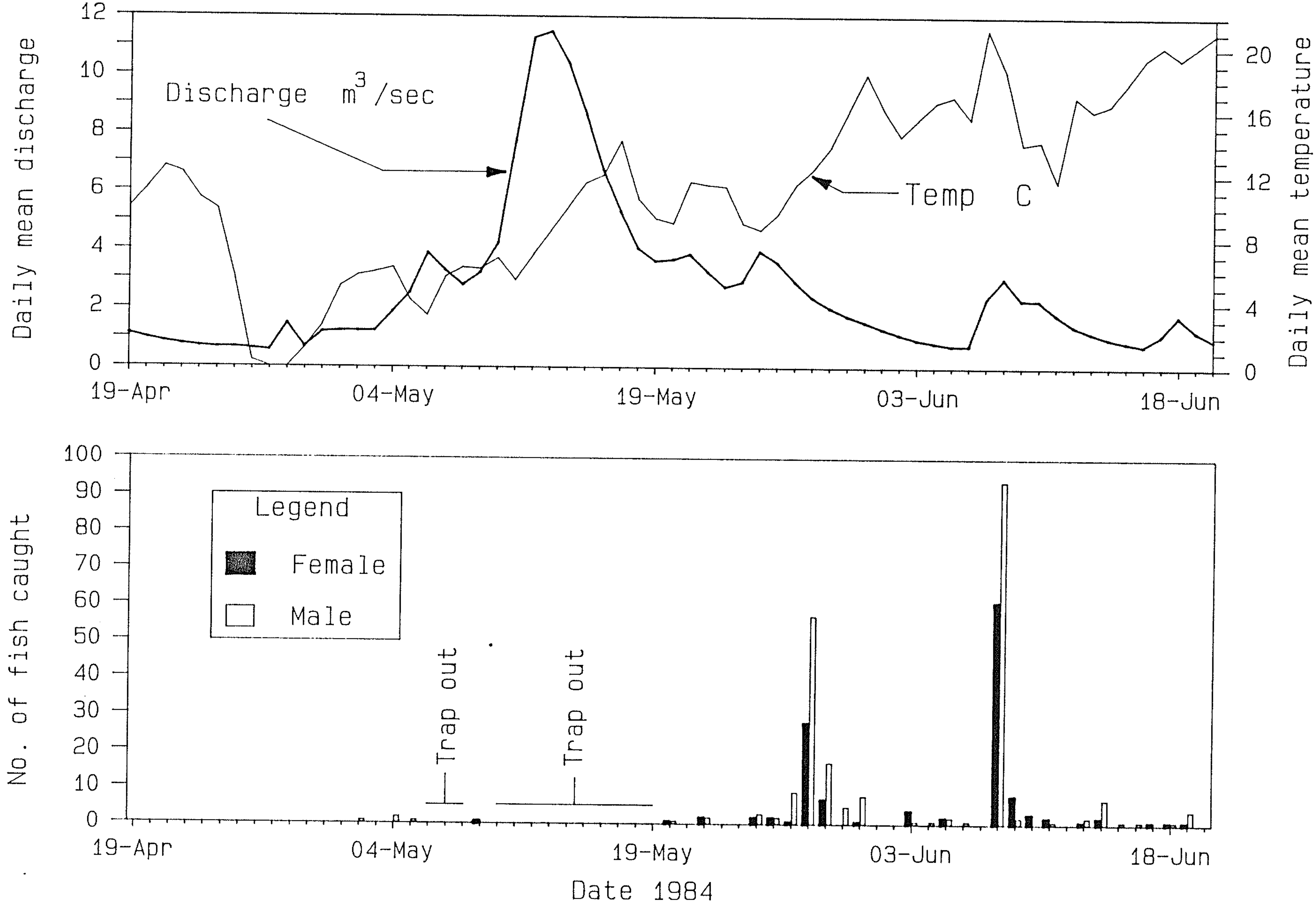
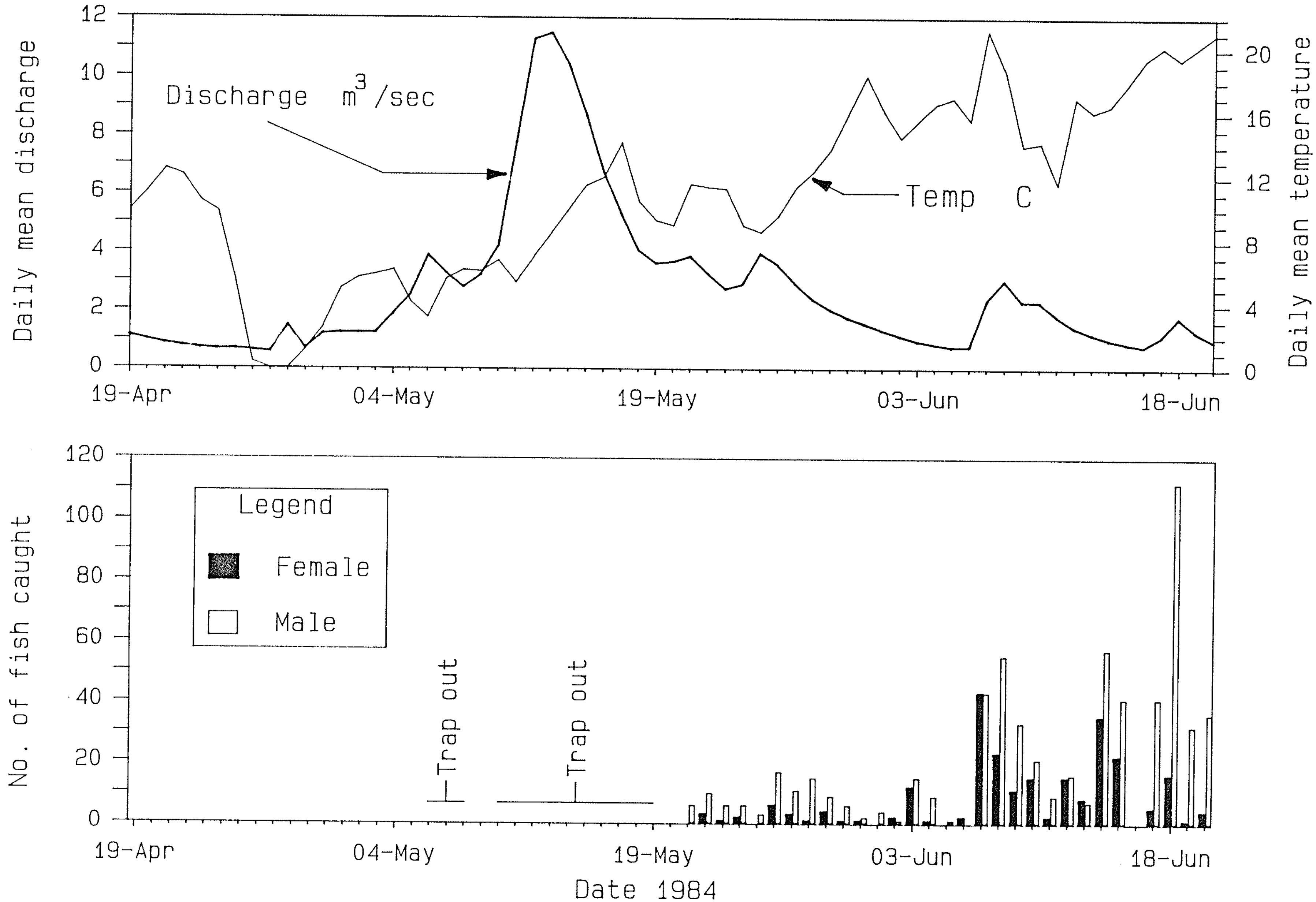

Daily mean discharge
Daily mean temperature
Temp. C
Discharge m3/sec
16
14
12
10
8
6
4
2
0
24
20
16
12
8
4
0
06-May
21-May
05-Jun
20-Jun
05-Jul
20-Jul
No. of fish caught
180
160
140
120
100
80
60
40
20
0
Trap out
Date 1983

Fig. 6. Daily upstream counts of migrating shorthead redhorse, mean daily water temperature and discharge for Ochre River, 1984.



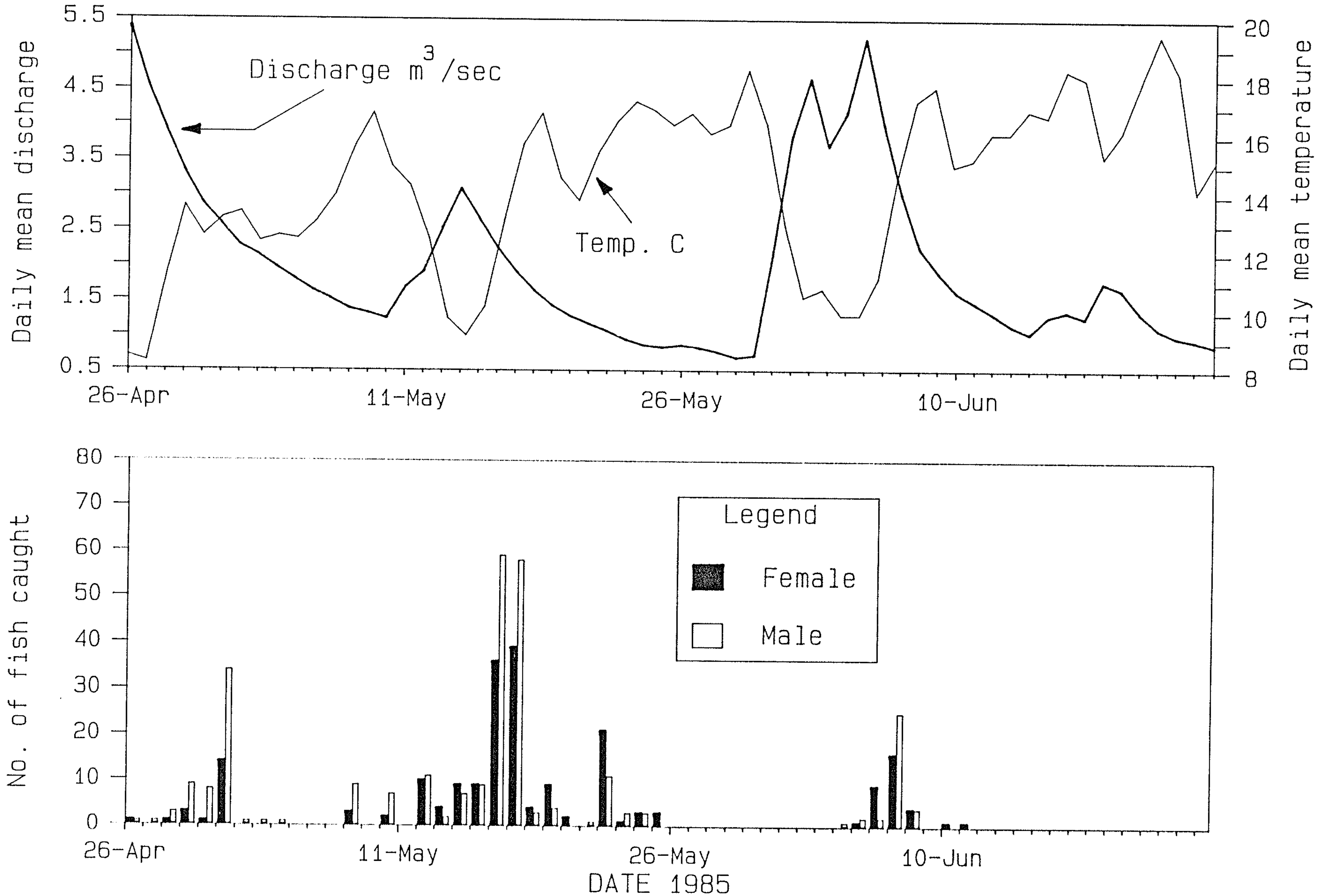
Daily mean discharge
12
10
8
6
4
2
0
Discharge m3 /sec
Temp C
Daily mean temperature
20
16
12
8
4
0
19-Apr
04-May
19-May
03-Jun
18-Jun
No. of fish caught
100
90
80
70
60
50
40
30
20
10
0
Legend
Female
Male
Trap out
Trap out
19-Apr
04-May
19-May
03-Jun
18-Jun
Date 1984

Fig. 7. Daily downstream counts of migrating shorthead redhorse, mean daily water temperature and discharge for Ochre River, 1984.



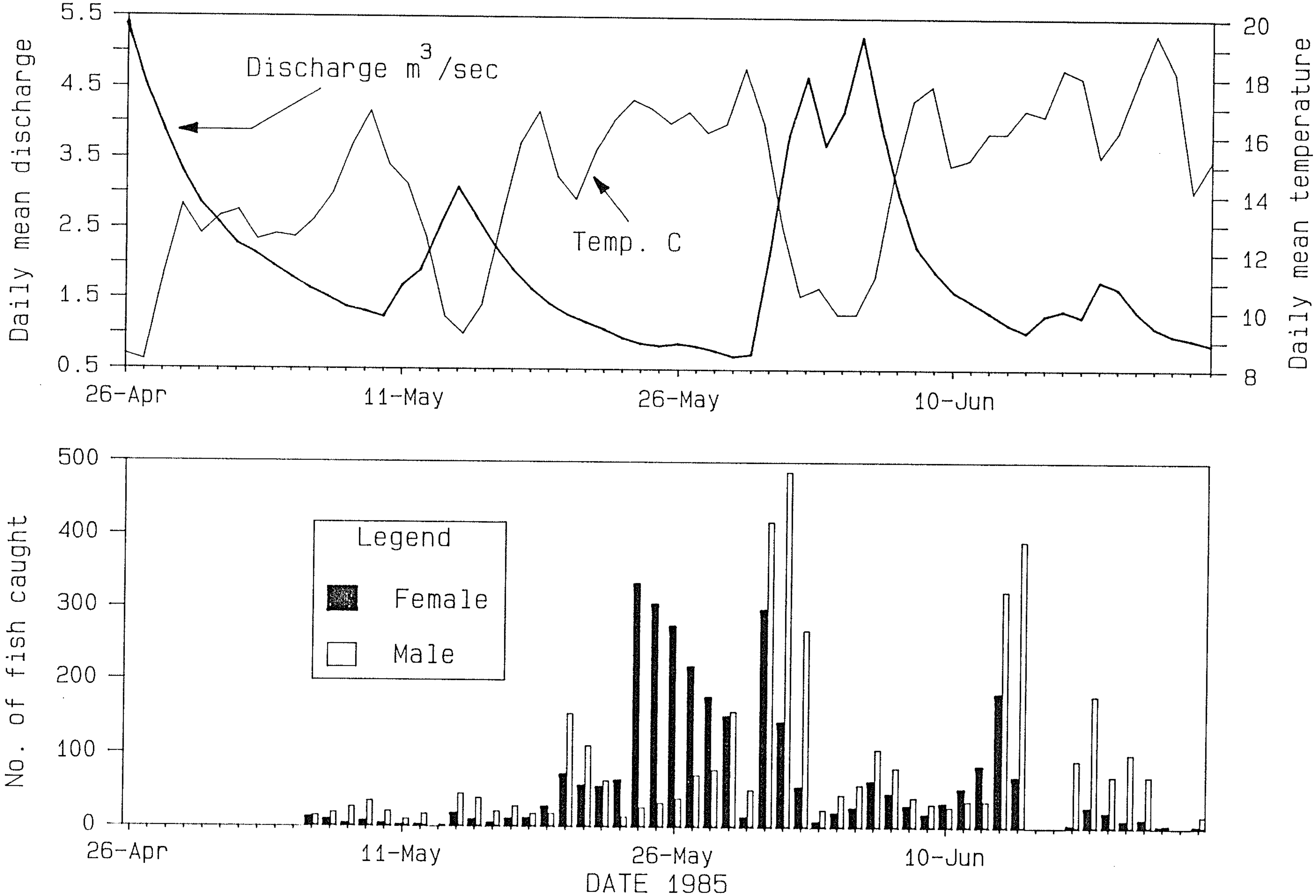
Discharge m3/sec
Temp C
Daily mean discharge
Daily mean temperature
19-Apr
04-May
19-May
03-Jun
18-Jun
Legend
Female
Male
Trap out
Trap out
No. of fish caught
Date 1984

Fig. 8. Daily upstream counts of migrating shorthead redhorse, mean daily water temperature and discharge for Ochre River, 1985.



Discharge m3/sec
Temp. C
Daily mean discharge
Daily mean temperature
5.5
4.5
3.5
2.5
1.5
0.5
20
18
16
14
12
10
8
26-Apr
11-May
26-May
10-Jun
Legend
Female
Male
No. of fish caught
80
70
60
50
40
30
20
10
0
26-Apr
11-May
26-May
10-Jun
DATE 1985

Fig. 9. Daily downstream counts of migrating shorthead redhorse, mean daily water temperature and discharge for Ochre River, 1985.



Discharge m3/sec
Temp. C
Daily mean discharge
Daily mean temperature
5.5
4.5
3.5
2.5
1.5
0.5
20
18
16
14
12
10
8
26-Apr
11-May
26-May
10-Jun
No. of fish caught
500
400
300
200
100
0
Legend
Female
Male
DATE 1985

Fig. 10. Fork length frequency of shorthead redhorse during the 1983, 1984, 1985 spawning runs in the Ochre River.

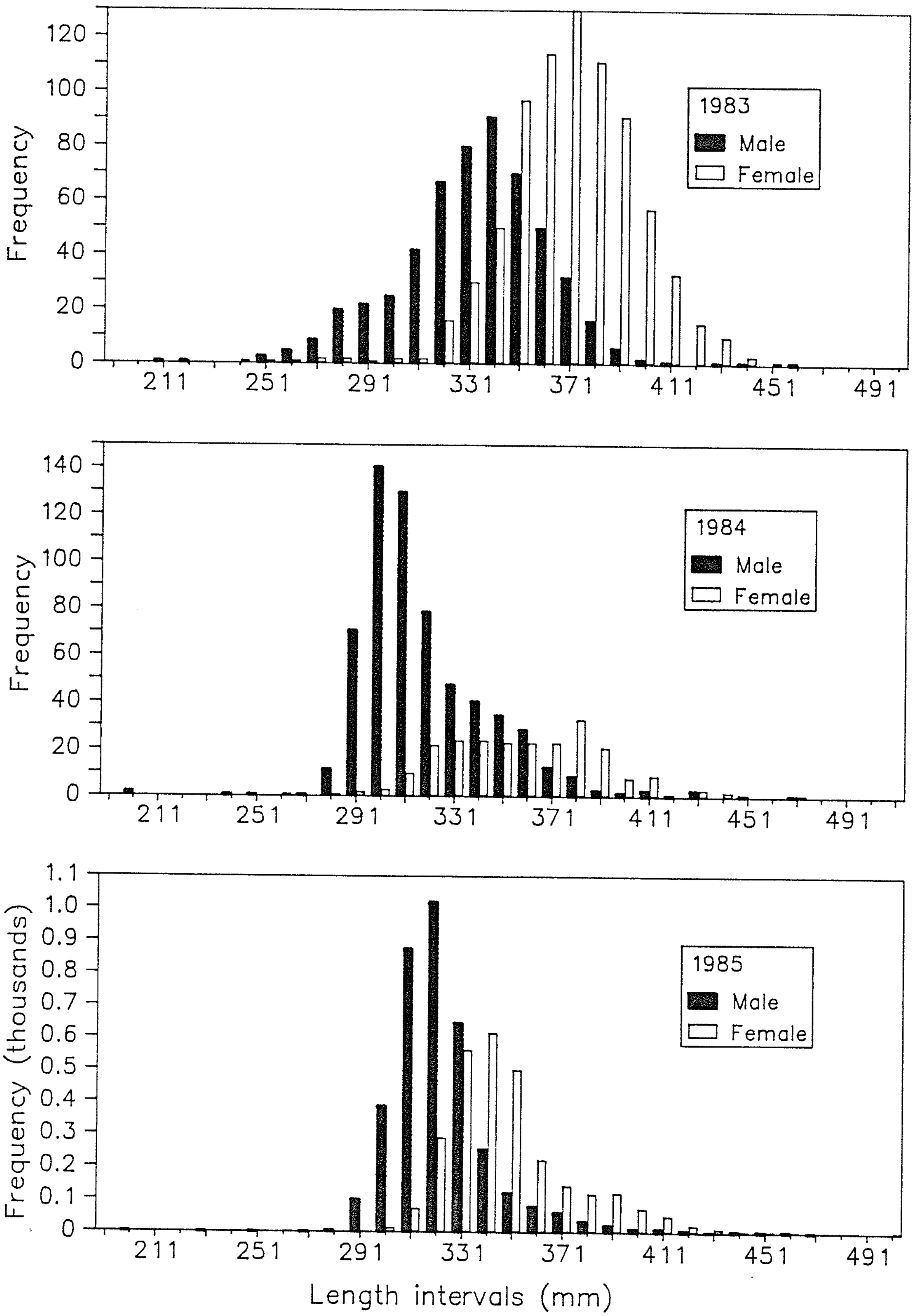
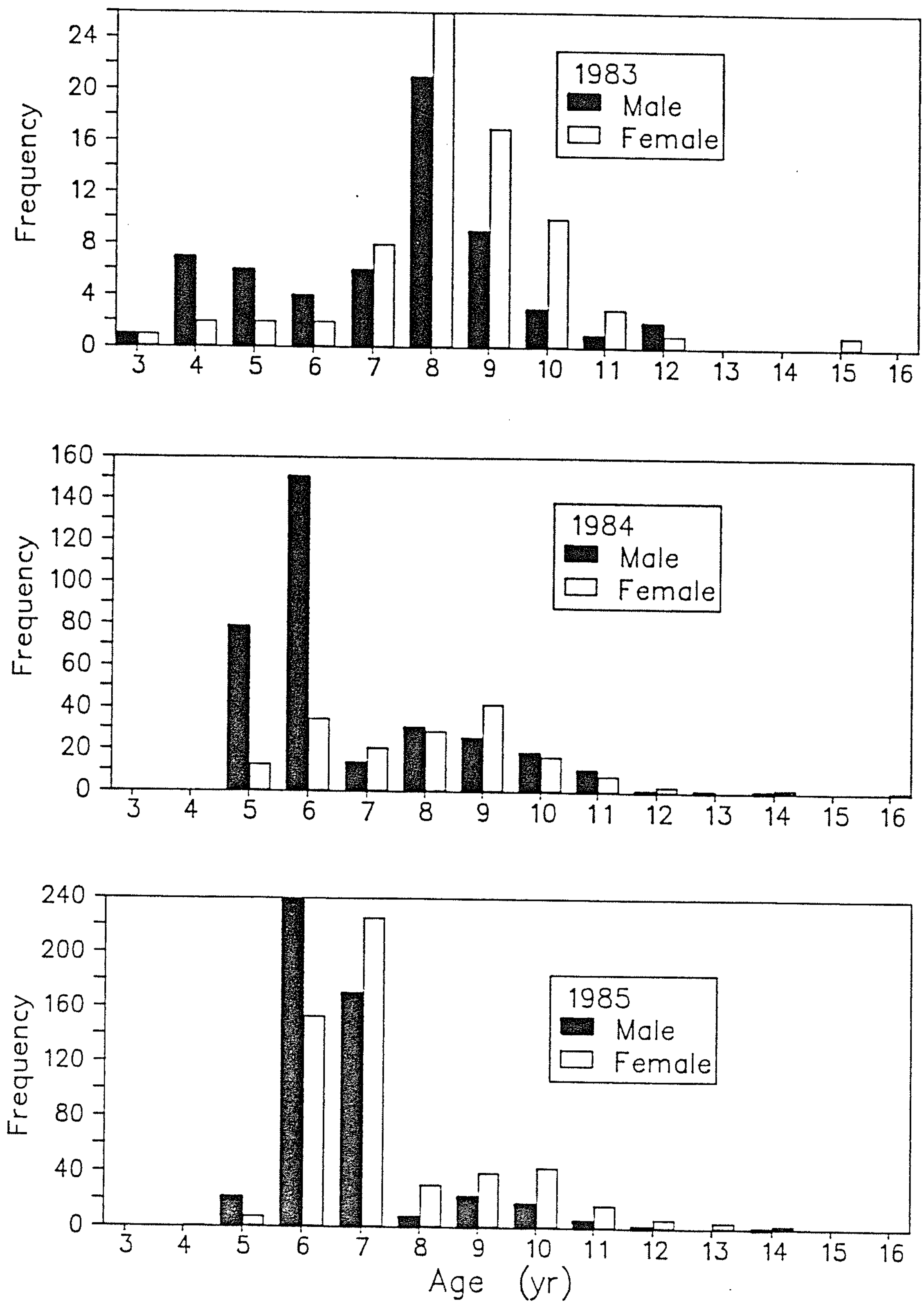

1983
Male
Female
Frequency
0
20
40
60
80
100
120
211
251
291
331
371
411
451
491
1984
Male
Female
Frequency
0
20
40
60
80
100
120
140
1985
Male
Female
Frequency (thousands)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
Length intervals (mm)

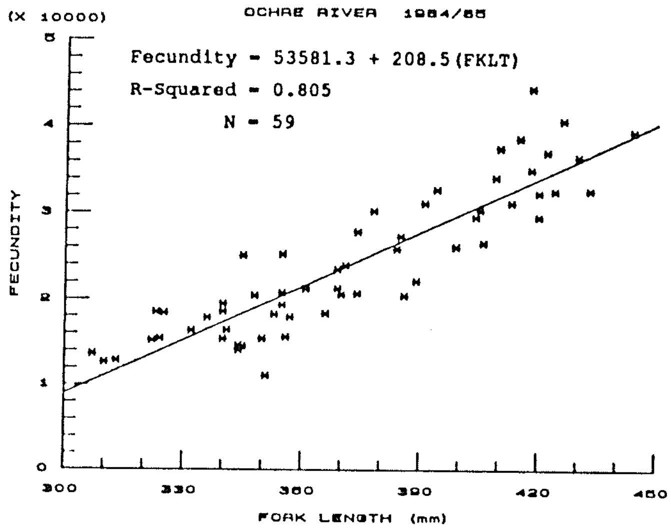
Fig. 11. Age frequency of shorthead redhorse during the 1983, 1984, 1985 spawning runs in the Ochre River.



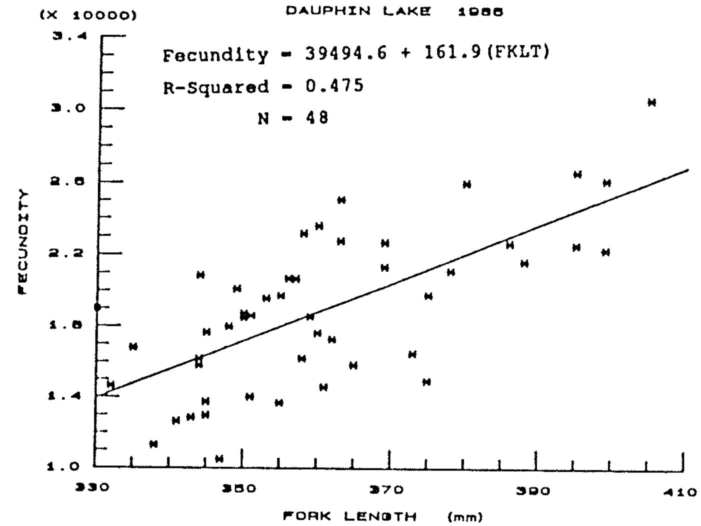
Frequency
1983
Male
Female
1984
Male
Female
1985
Male
Female
3 4 5 6 7 8 9 10 11 12 13 14 15 16
Age (yr)

Fig. 12. Linear regression of shorthead redhorse fecundity to fork length (A,B) and age (C).
A - Spring of 1984 and 1985, Ochre River.
B - Early winter, 1985, Dauphin Lake.
C - Spring of 1984, and 1985, Ochre River.

A


(X 10000)
OCHRE RIVER 1984/85
Fecundity = 53581.3 + 208.5(FKLT)
R-Squared = 0.805
N = 59
FECUNDITY
FORK LENGTH (mm)
0
1
2
3
4
5
300
330
360
390
420
450

B


(X 10000)
DAUPHIN LAKE 1986
Fecundity = 39494.6 + 161.9(FKLT)
R-Squared = 0.475
N = 48
FECUNDITY
FORK LENGTH (mm)
1.0
1.4
1.8
2.2
2.6
3.0
3.4
330
350
370
390
410

C

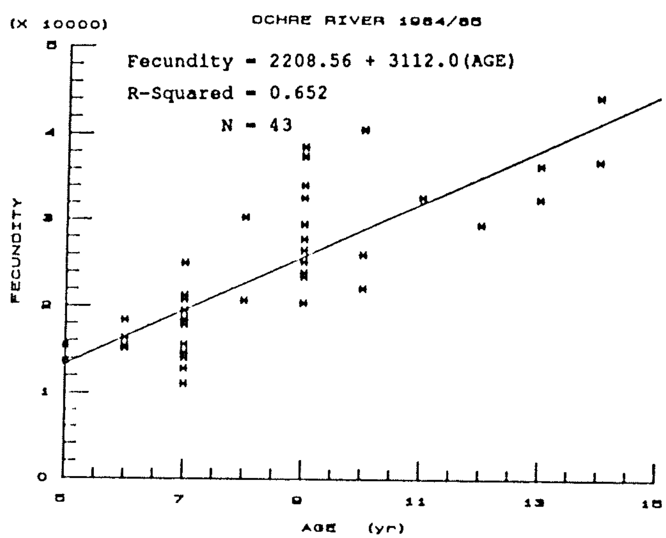

(X 10000)
OCHRE RIVER 1984/85
Fecundity = 2208.56 + 3112.0(AGE)
R-Squared = 0.652
N = 43
FECUNDITY
AGE (yr)
0
1
2
3
4
5
5
7
9
11
13
15

Fig. 13. Quadractic responce function of 5 day mean temperature (C) plotted against time for Dauphin Lake, 1984, 1985, and 1987.

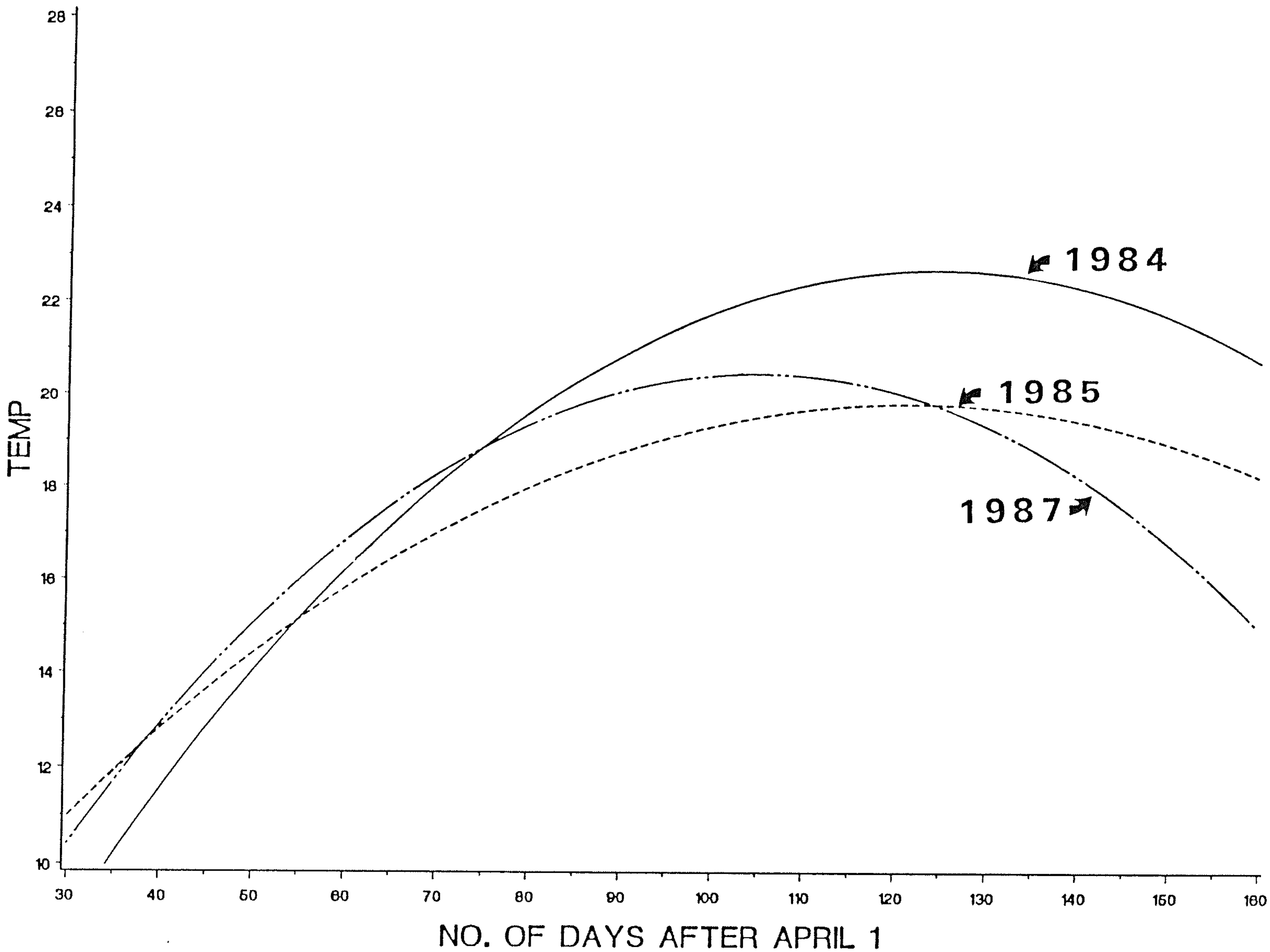
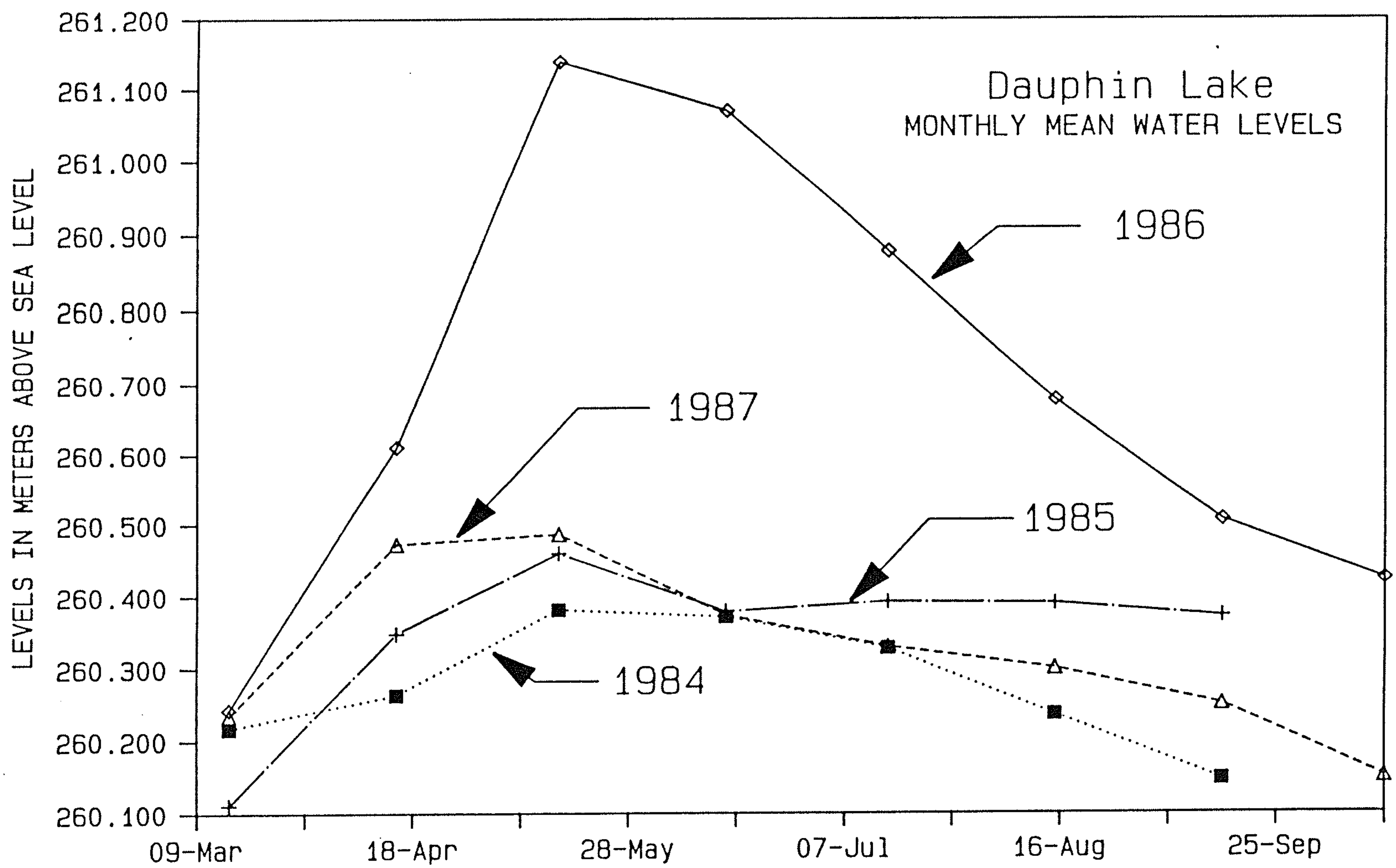
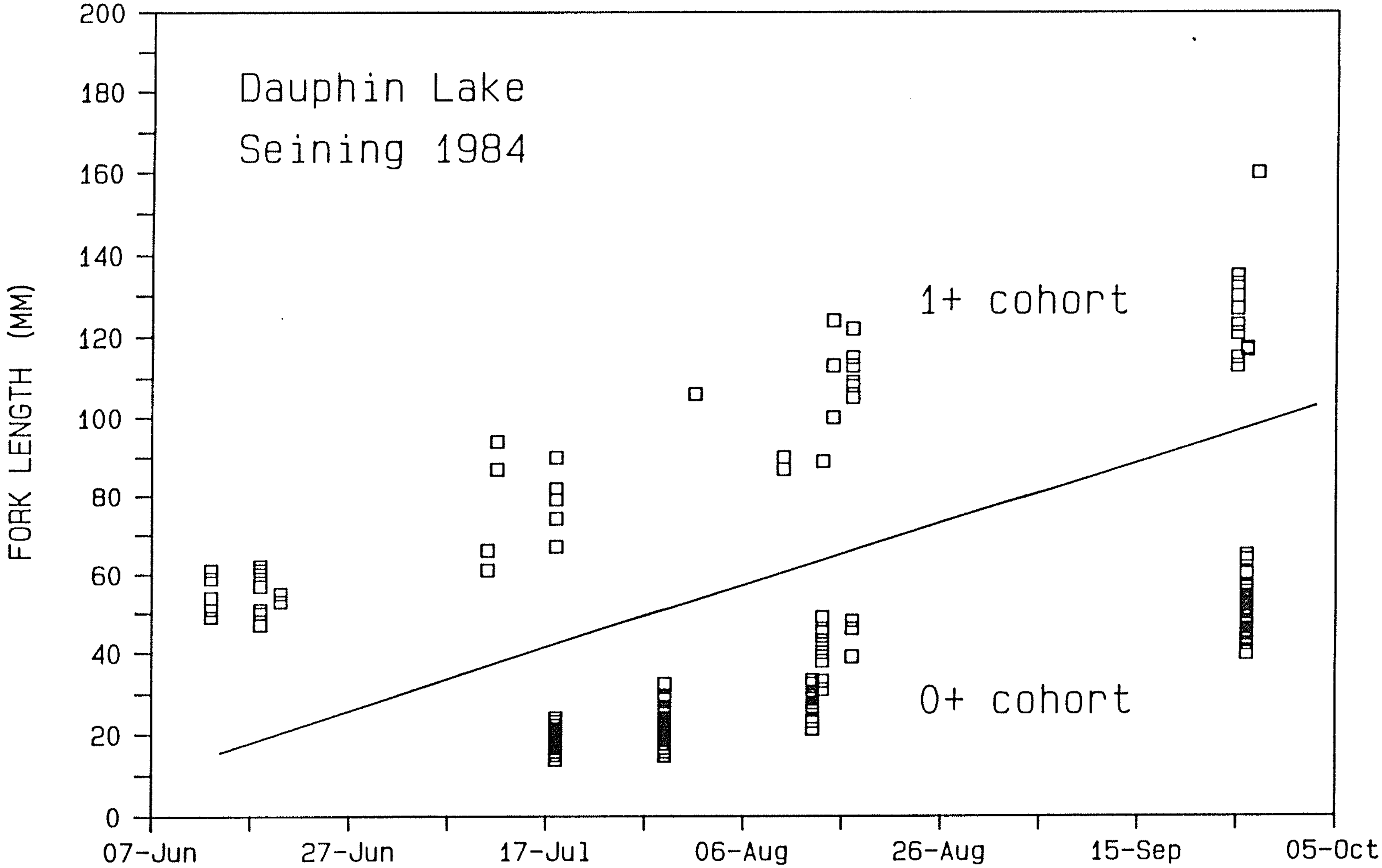

1984
1985
1987
TEMP
NO. OF DAYS AFTER APRIL 1
28
26
24
22
20
18
16
14
12
10
30
40
50
60
70
80
90
100
110
120
130
140
150
160

Fig. 14. Monthly mean water levels for Dauphin lake, 1984 to 1987.



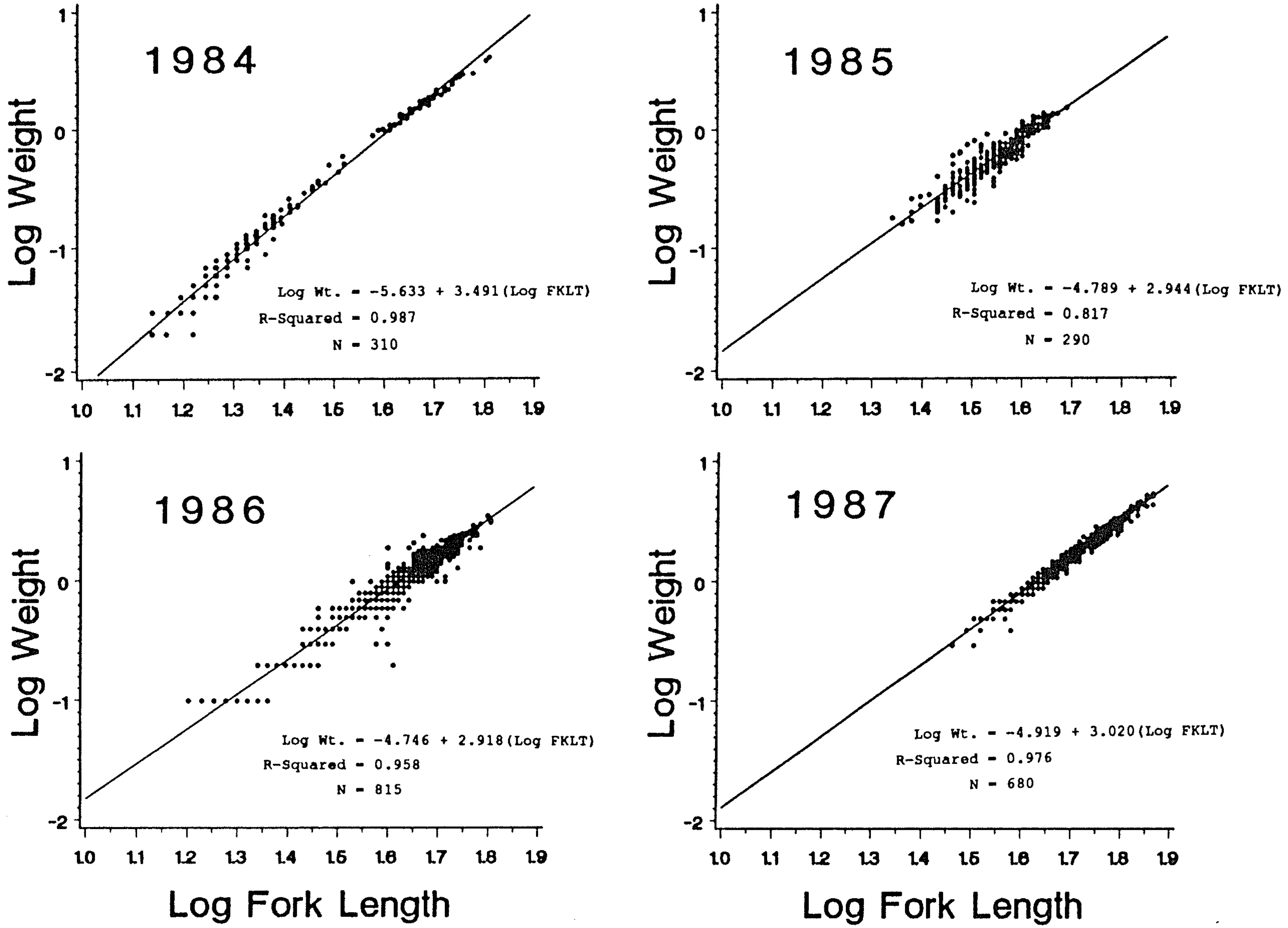
Dauphin Lake
MONTHLY MEAN WATER LEVELS
LEVELS IN METERS ABOVE SEA LEVEL
261.200
261.100
261.000
260.900
260.800
260.700
260.600
260.500
260.400
260.300
260.200
260.100
09-Mar
18-Apr
28-May
07-Jul
16-Aug
25-Sep
1986
1987
1985
1984

Fig. 15. Fork lengths of juvenile shorthead redhorse taken in 1984 seine samples, Dauphin Lake.



Dauphin Lake
Seining 1984
1+ cohort
0+ cohort
FORK LENGTH (MM)
200
180
160
140
120
100
80
60
40
20
0
07-Jun
27-Jun
17-Jul
06-Aug
26-Aug
15-Sep
05-Oct

Fig. 16. Regression of log weight (gm) on log fork length (mm) for 0+ shorthead redhorse, Dauphin Lake.



1984
Log Wt. = -5.633 + 3.491(Log FKLT)
R-Squared = 0.987
N = 310
1985
Log Wt. = -4.789 + 2.944(Log FKLT)
R-Squared = 0.817
N = 290
1986
Log Wt. = -4.746 + 2.918(Log FKLT)
R-Squared = 0.958
N = 815
1987
Log Wt. = -4.919 + 3.020(Log FKLT)
R-Squared = 0.976
N = 680
Log Weight
Log Fork Length
1
0
-1
-2
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9

Fig. 17. Regression of log weight (gm) on log fork length (mm) for 1+ shorthead redhorse, Dauphin Lake.

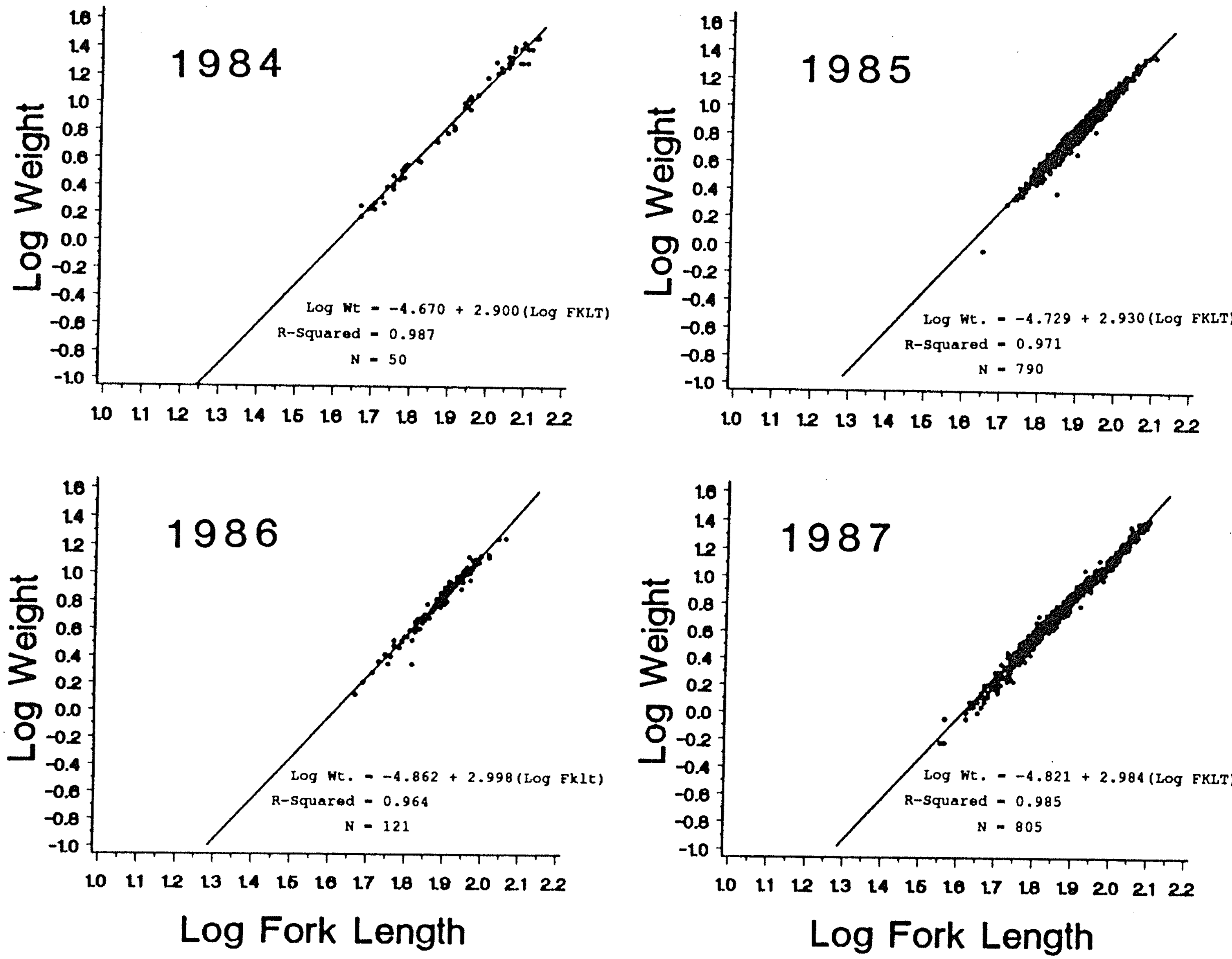
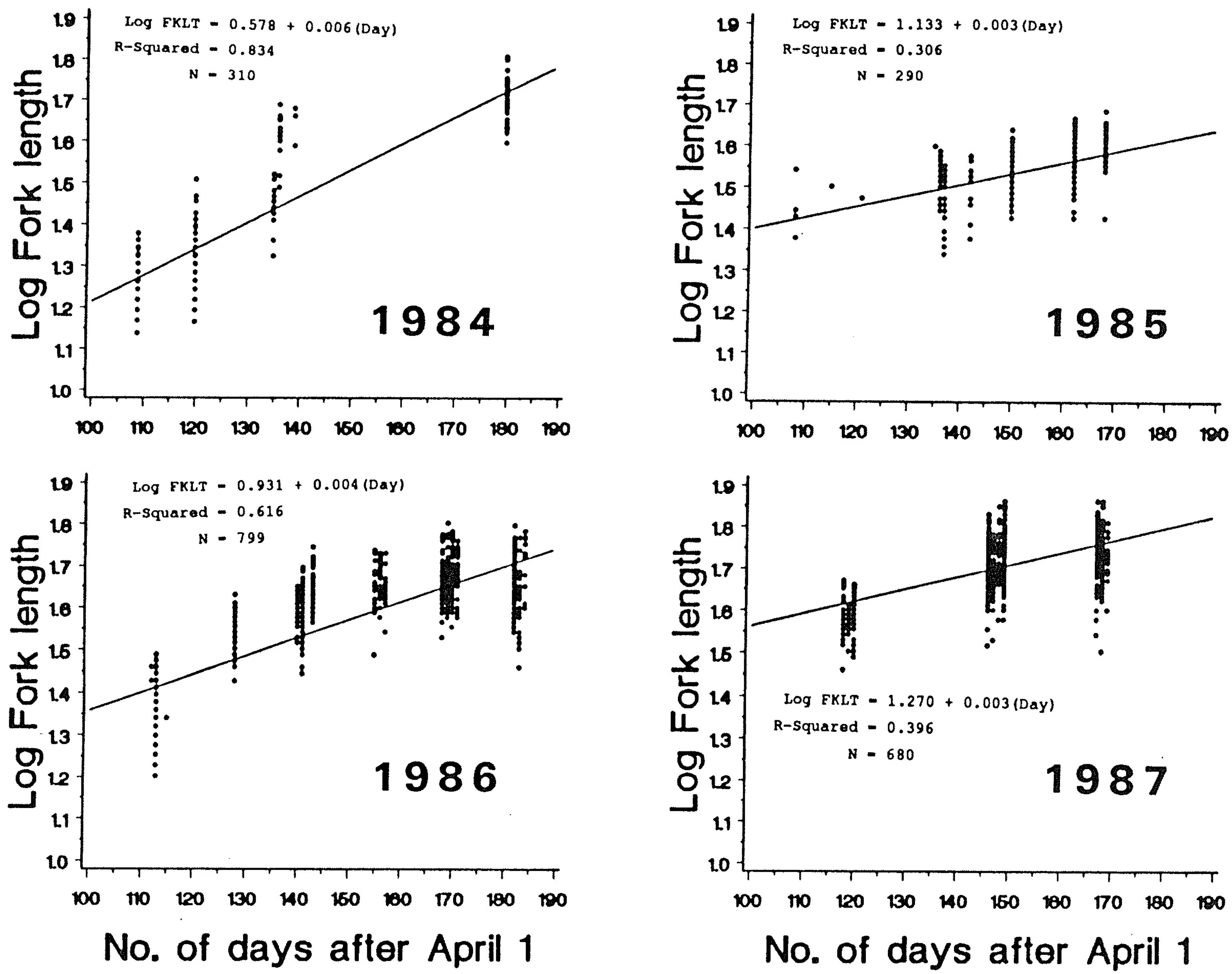

1984
Log Wt = -4.670 + 2.900(Log FKLT)
R-Squared = 0.987
N = 50
1985
Log Wt. = -4.729 + 2.930(Log FKLT)
R-Squared = 0.971
N = 790
1986
Log Wt. = -4.862 + 2.998(Log Fklt)
R-Squared = 0.964
N = 121
1987
Log Wt. = -4.821 + 2.984(Log FKLT)
R-Squared = 0.985
N = 805
Log Weight
Log Fork Length

Fig. 18. Linear regression of log fork length on number of growing days for 0+ shorthead redhorse, Dauphin Lake.



Log FKLT = 0.578 + 0.006(Day)
R-Squared = 0.834
N = 310
1984
Log FKLT = 1.133 + 0.003(Day)
R-Squared = 0.306
N = 290
1985
Log FKLT = 0.931 + 0.004(Day)
R-Squared = 0.616
N = 799
1986
Log FKLT = 1.270 + 0.003(Day)
R-Squared = 0.396
N = 680
1987
Log Fork length
No. of days after April 1
1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9
100 110 120 130 140 150 160 170 180 190

Fig. 19. Linear regression of log fork length on number of growing days for 1+ shorthead redhorse, Dauphin Lake.

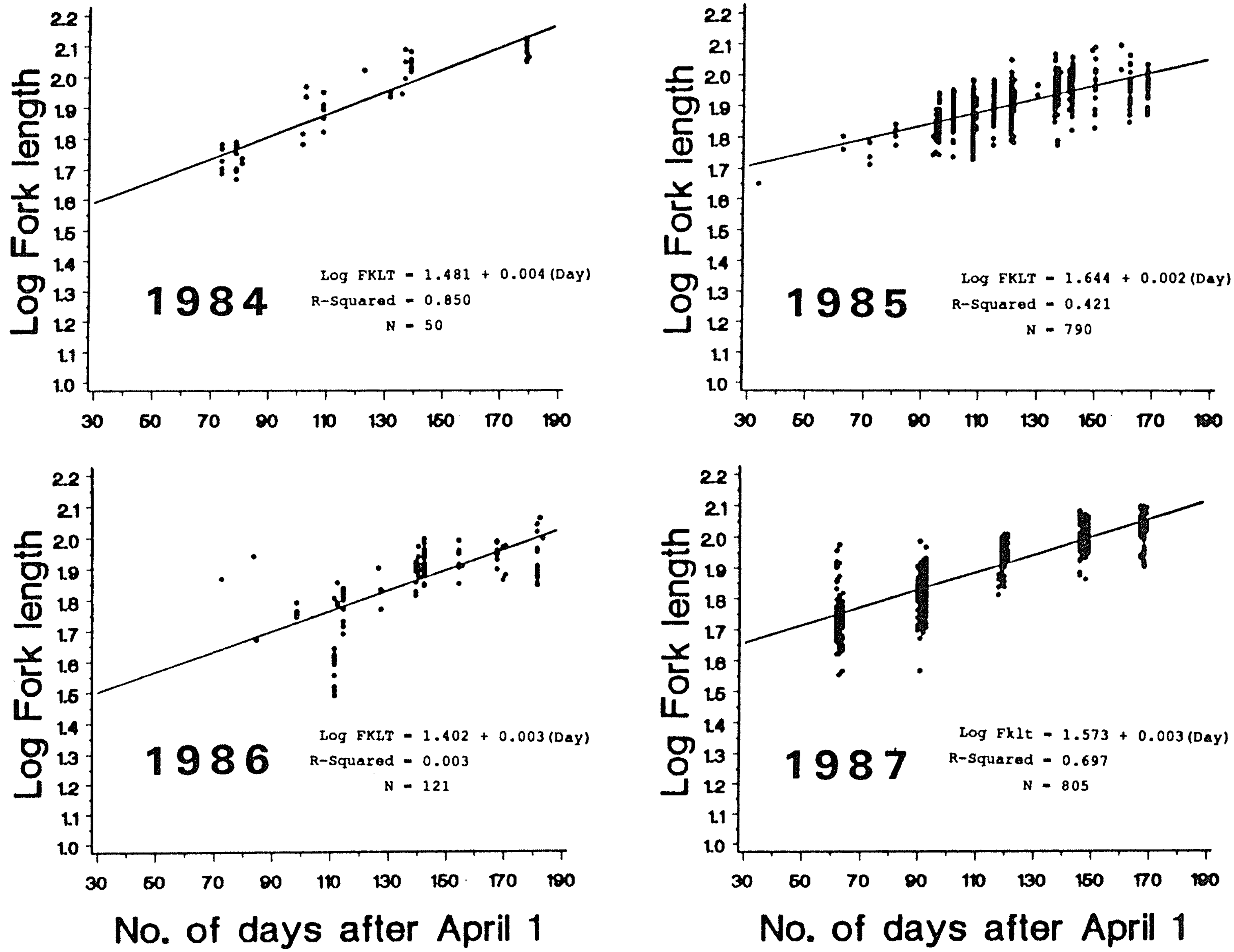
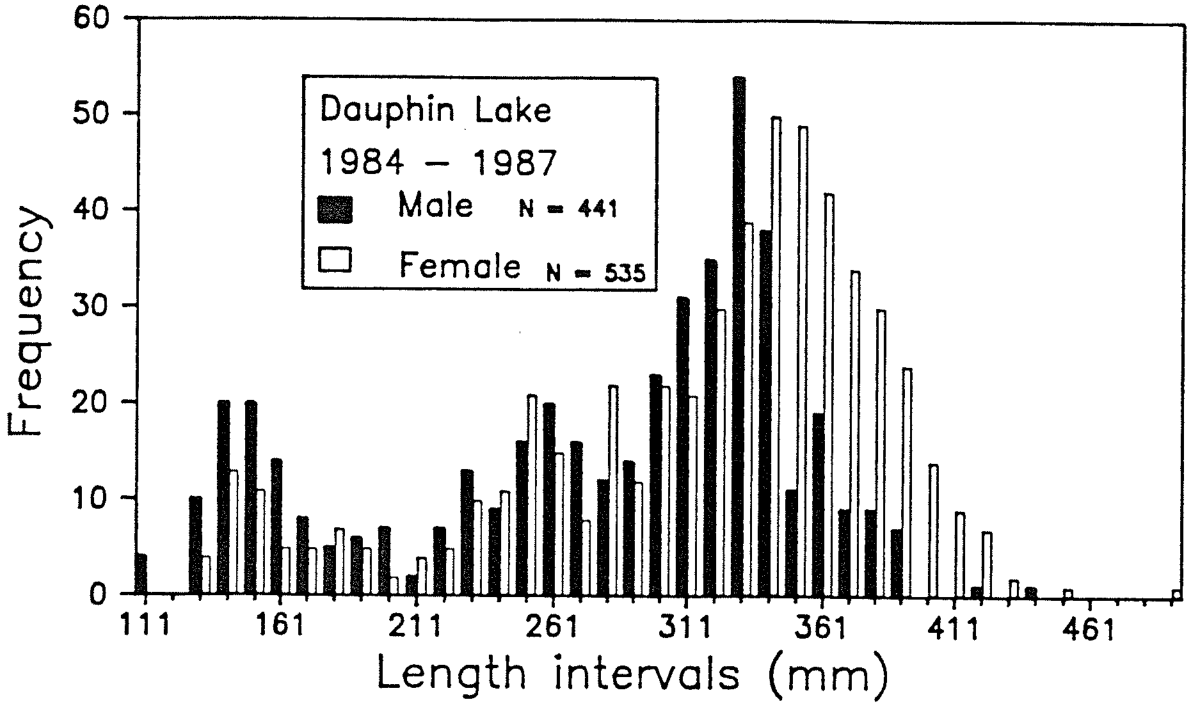
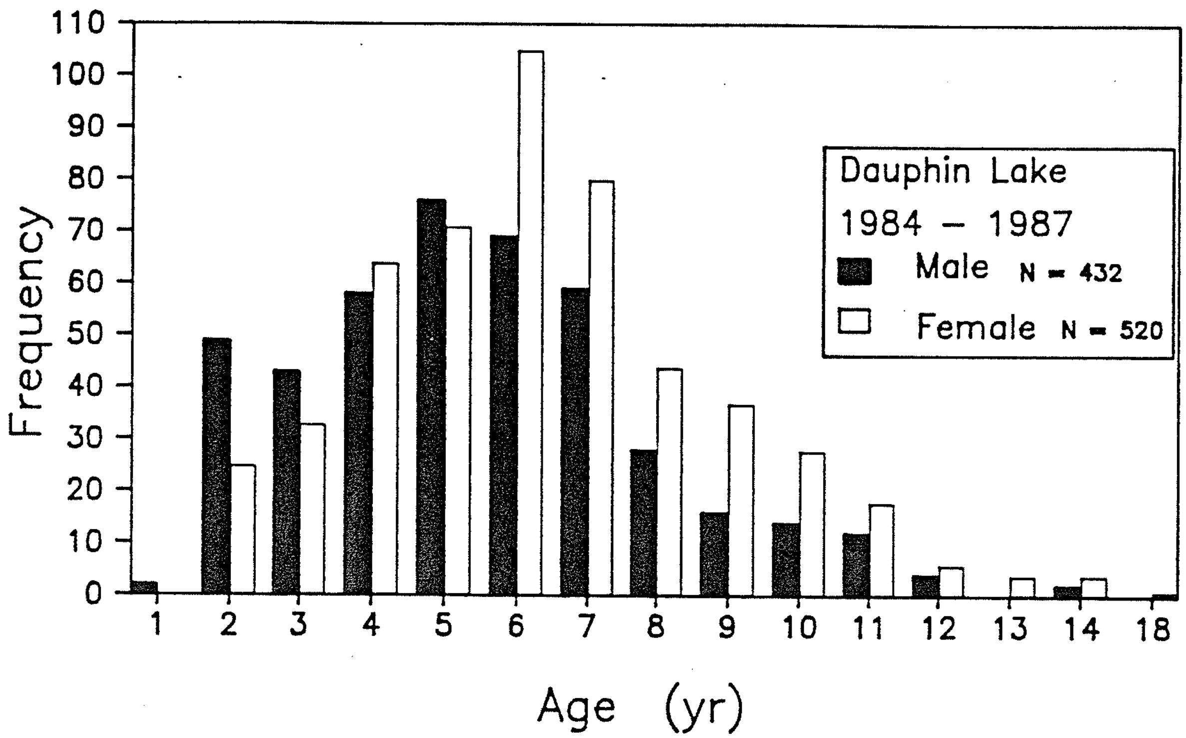

Log Fork length
No. of days after April 1
1984
Log FKLT = 1.481 + 0.004(Day)
R-Squared = 0.850
N = 50
1985
Log FKLT = 1.644 + 0.002(Day)
R-Squared = 0.421
N = 790
1986
Log FKLT = 1.402 + 0.003(Day)
R-Squared = 0.003
N = 121
1987
Log Fklt = 1.573 + 0.003(Day)
R-Squared = 0.697
N = 805

Fig. 20. Fork length and age frequency distributions for shorthead redhorse, gillnetted in Dauphin Lake.

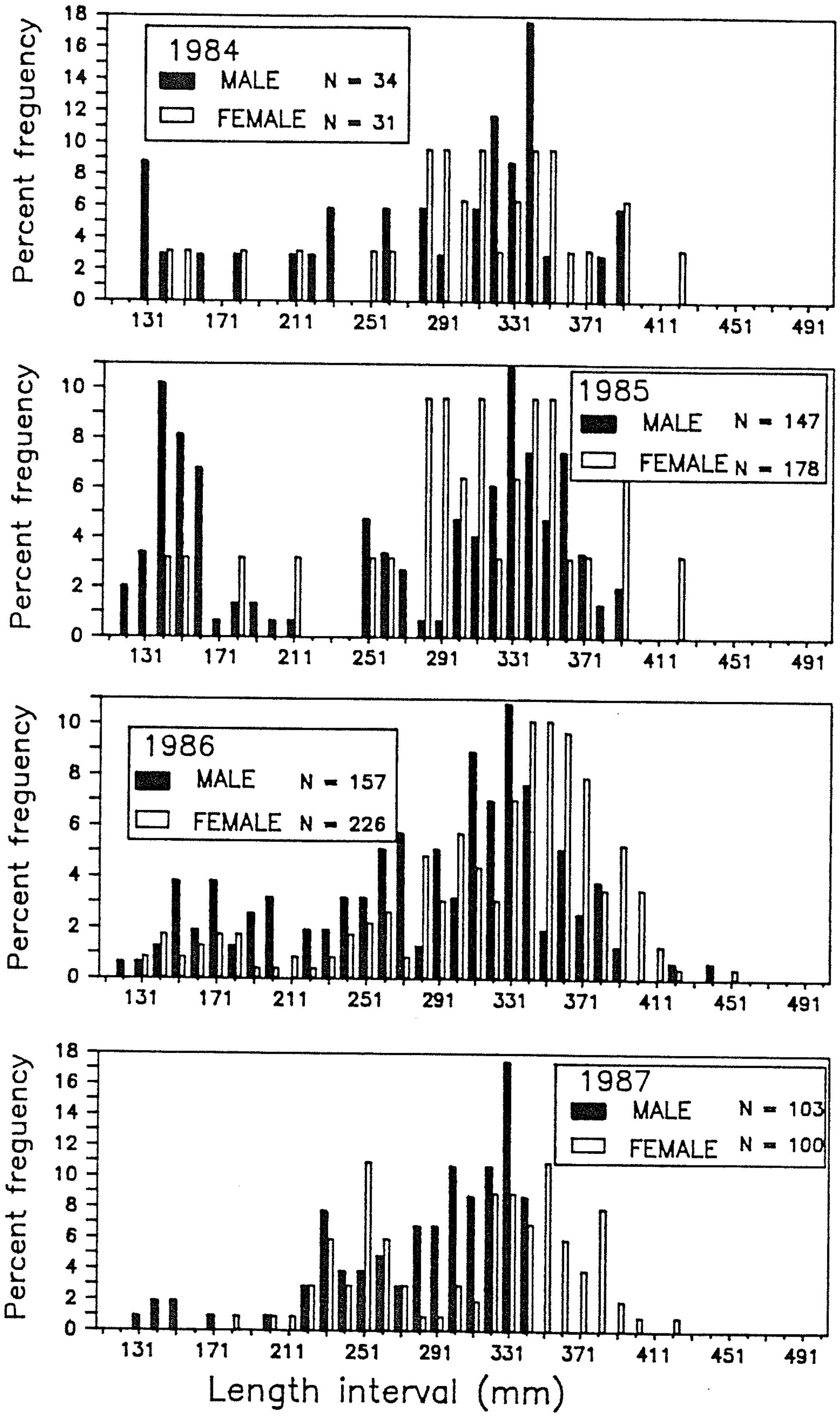


Dauphin Lake
1984 – 1987
Male N = 441
Female N = 535
Frequency
0
10
20
30
40
50
60
111
161
211
261
311
361
411
461
Length intervals (mm)



Dauphin Lake
1984 – 1987
Male N = 432
Female N = 520
Frequency
0
10
20
30
40
50
60
70
80
90
100
110
1
2
3
4
5
6
7
8
9
10
11
12
13
14
18
Age (yr)

Fig. 21. Percent length frequency of shorthead redhorse in gillnet samples for each year, 1984 - 1987, Dauphin Lake.



1984
MALE N = 34
FEMALE N = 31
1985
MALE N = 147
FEMALE N = 178
1986
MALE N = 157
FEMALE N = 226
1987
MALE N = 103
FEMALE N = 100
Percent frequency
Length interval (mm)
131
171
211
251
291
331
371
411
451
491

Fig. 22. Percent age frequency of shorthead redhorse in gillnet samples for each year, 1984 - 1987, Dauphin Lake.

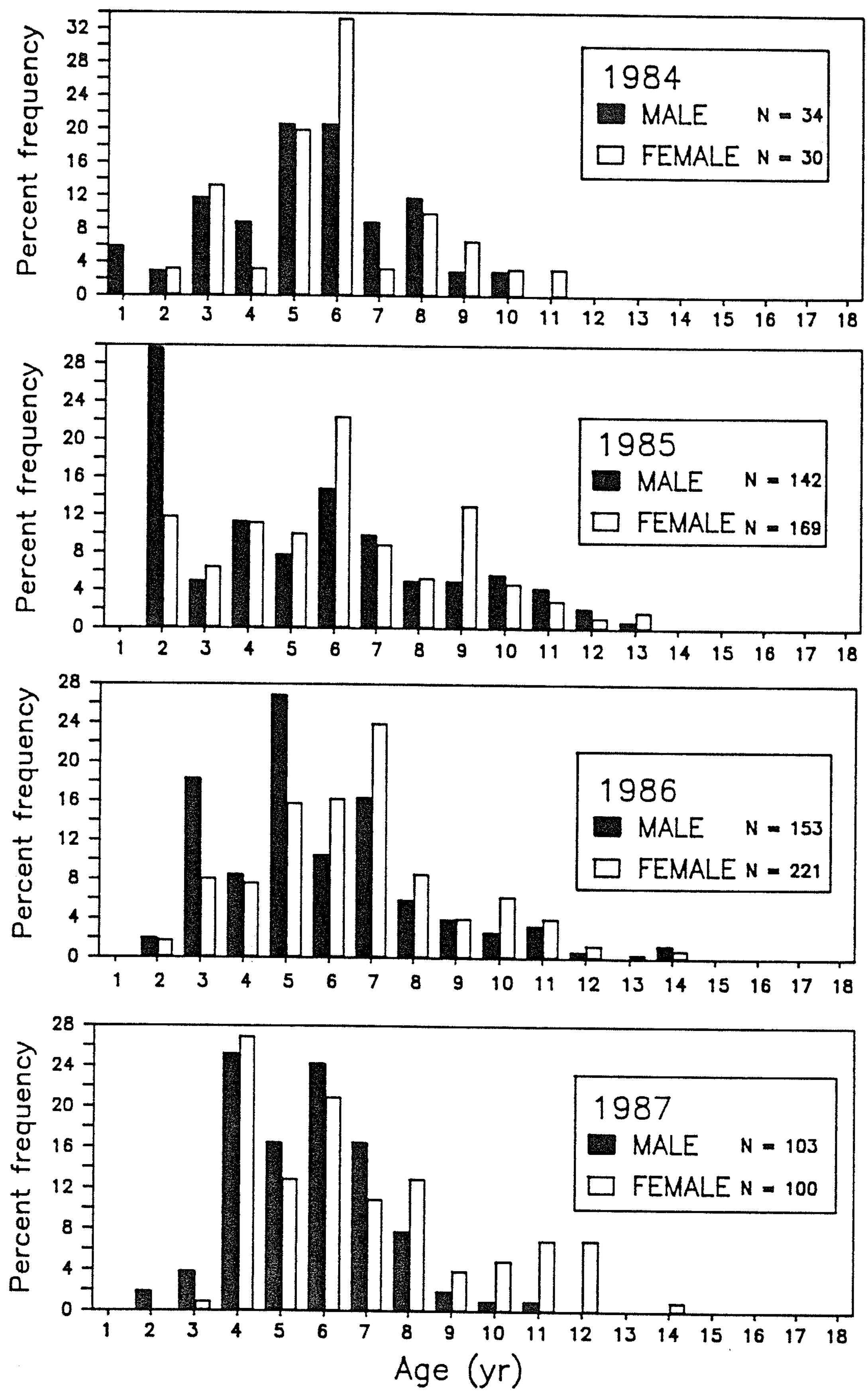

Percent frequency
1984
MALE N = 34
FEMALE N = 30
1985
MALE N = 142
FEMALE N = 169
1986
MALE N = 153
FEMALE N = 221
1987
MALE N = 103
FEMALE N = 100
Age (yr)

Fig. 23. Linear regression of log weight to log fork length of shorthead redhorse sampled by gillnet from Dauphin Lake.

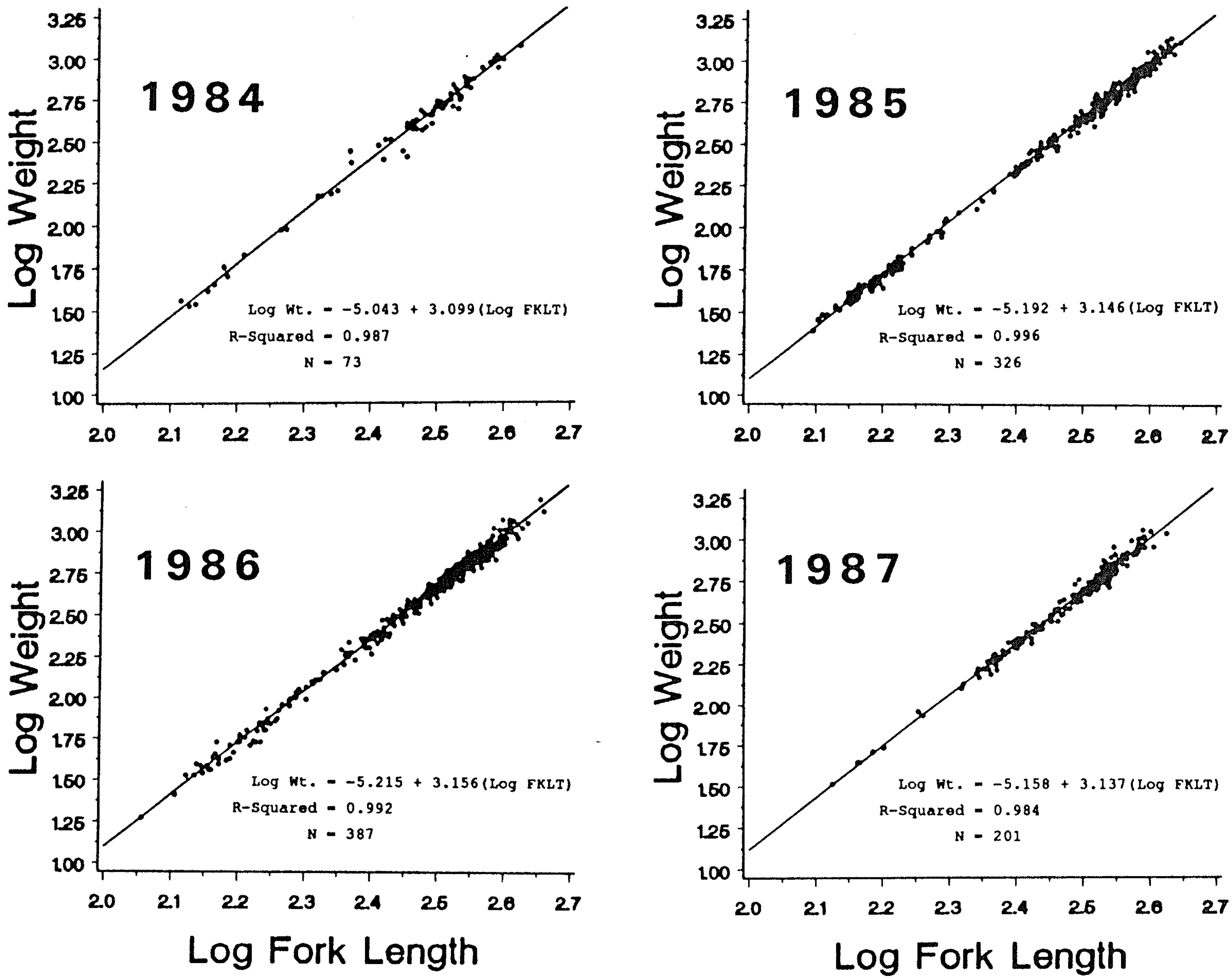

1984
Log Wt. = -5.043 + 3.099(Log FKLT)
R-Squared = 0.987
N = 73
1985
Log Wt. = -5.192 + 3.146(Log FKLT)
R-Squared = 0.996
N = 326
1986
Log Wt. = -5.215 + 3.156(Log FKLT)
R-Squared = 0.992
N = 387
1987
Log Wt. = -5.158 + 3.137(Log FKLT)
R-Squared = 0.984
N = 201
Log Weight
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
Log Fork Length

Fig. 24. Linear regression of log fork length to age of shorthead redhorse sampled by gillnet from Dauphin Lake.

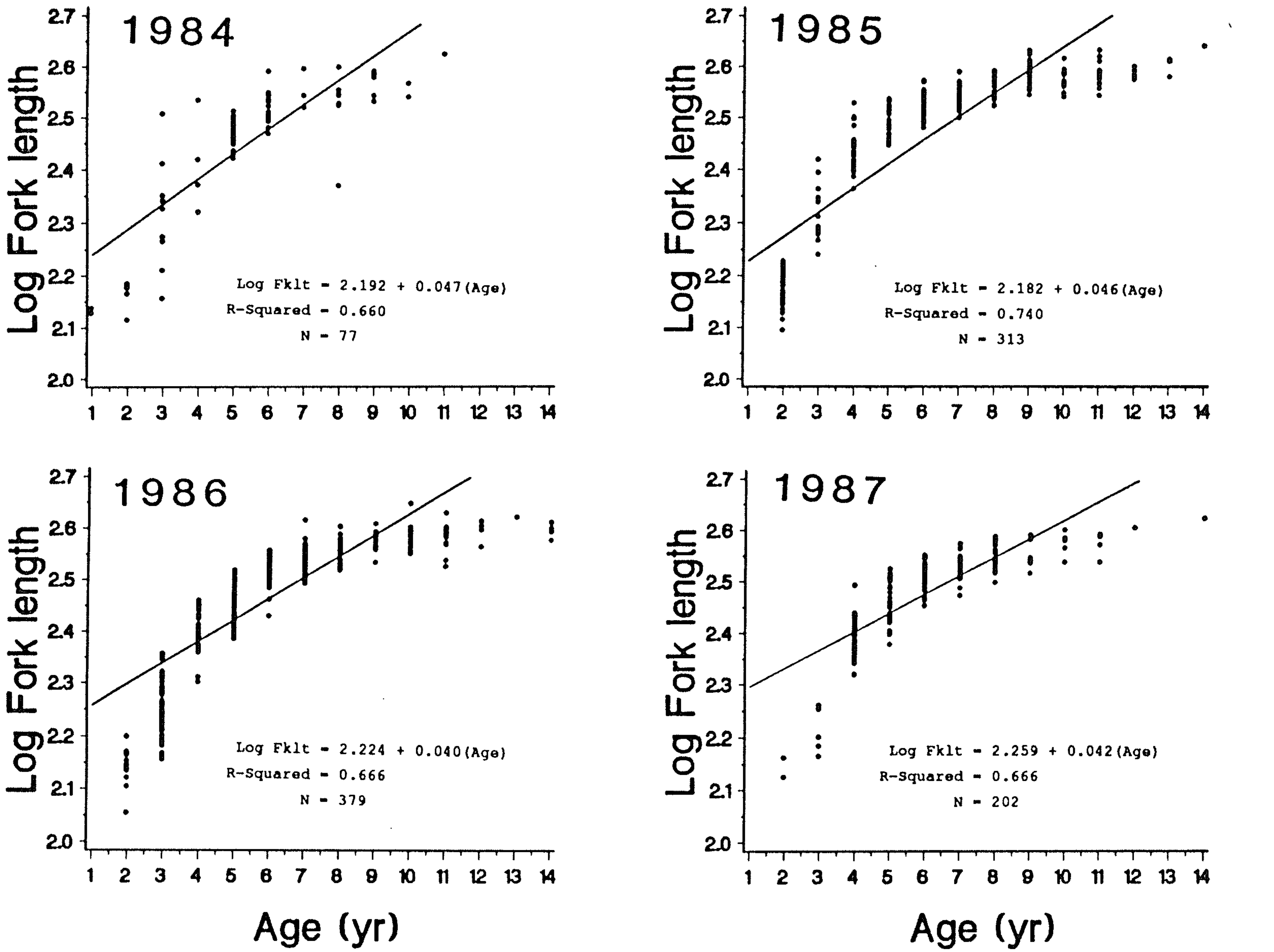
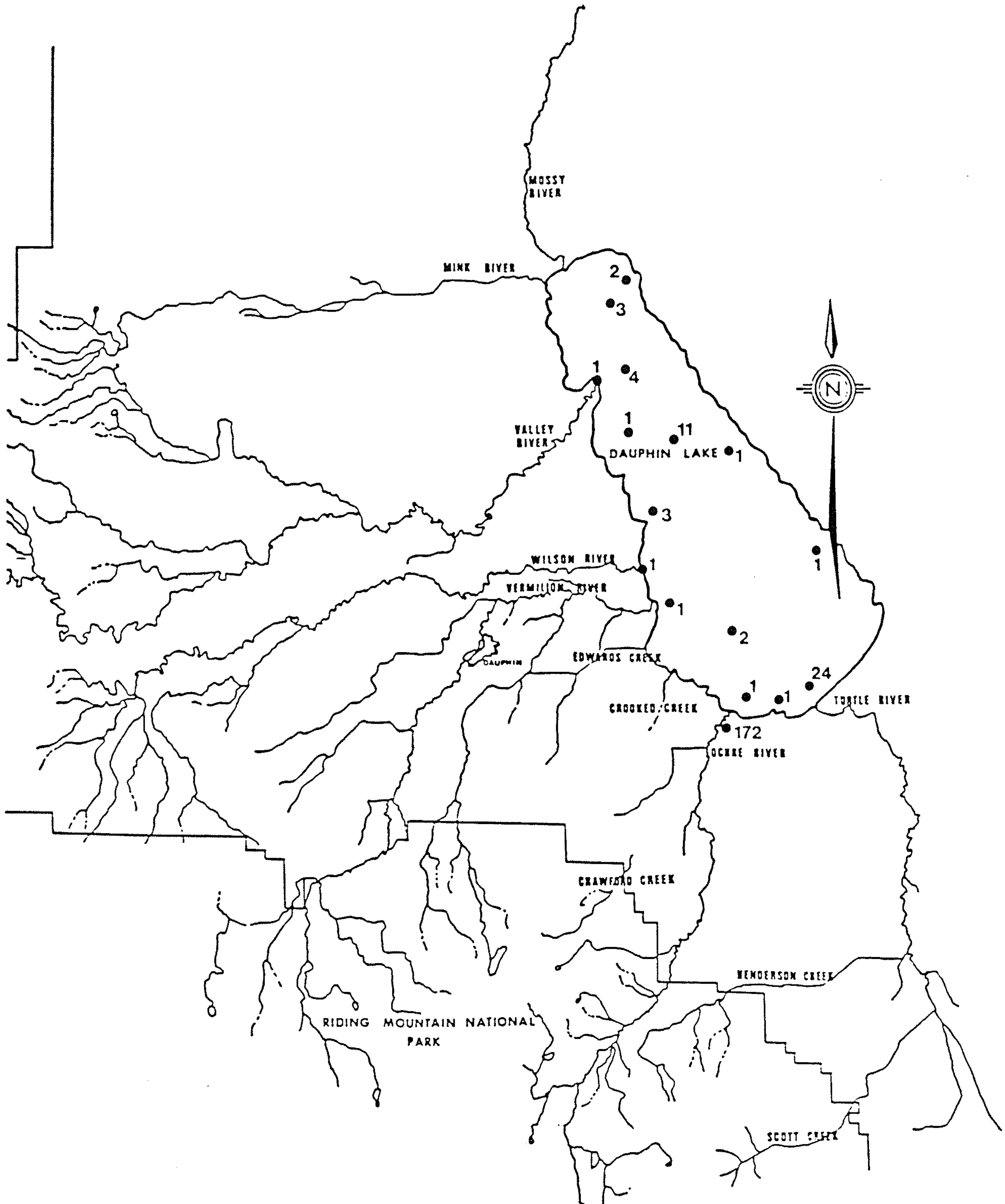

1984
Log Fklt = 2.192 + 0.047(Age)
R-Squared = 0.660
N = 77
1985
Log Fklt = 2.182 + 0.046(Age)
R-Squared = 0.740
N = 313
1986
Log Fklt = 2.224 + 0.040(Age)
R-Squared = 0.666
N = 379
1987
Log Fklt = 2.259 + 0.042(Age)
R-Squared = 0.666
N = 202
Log Fork length
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Age (yr)

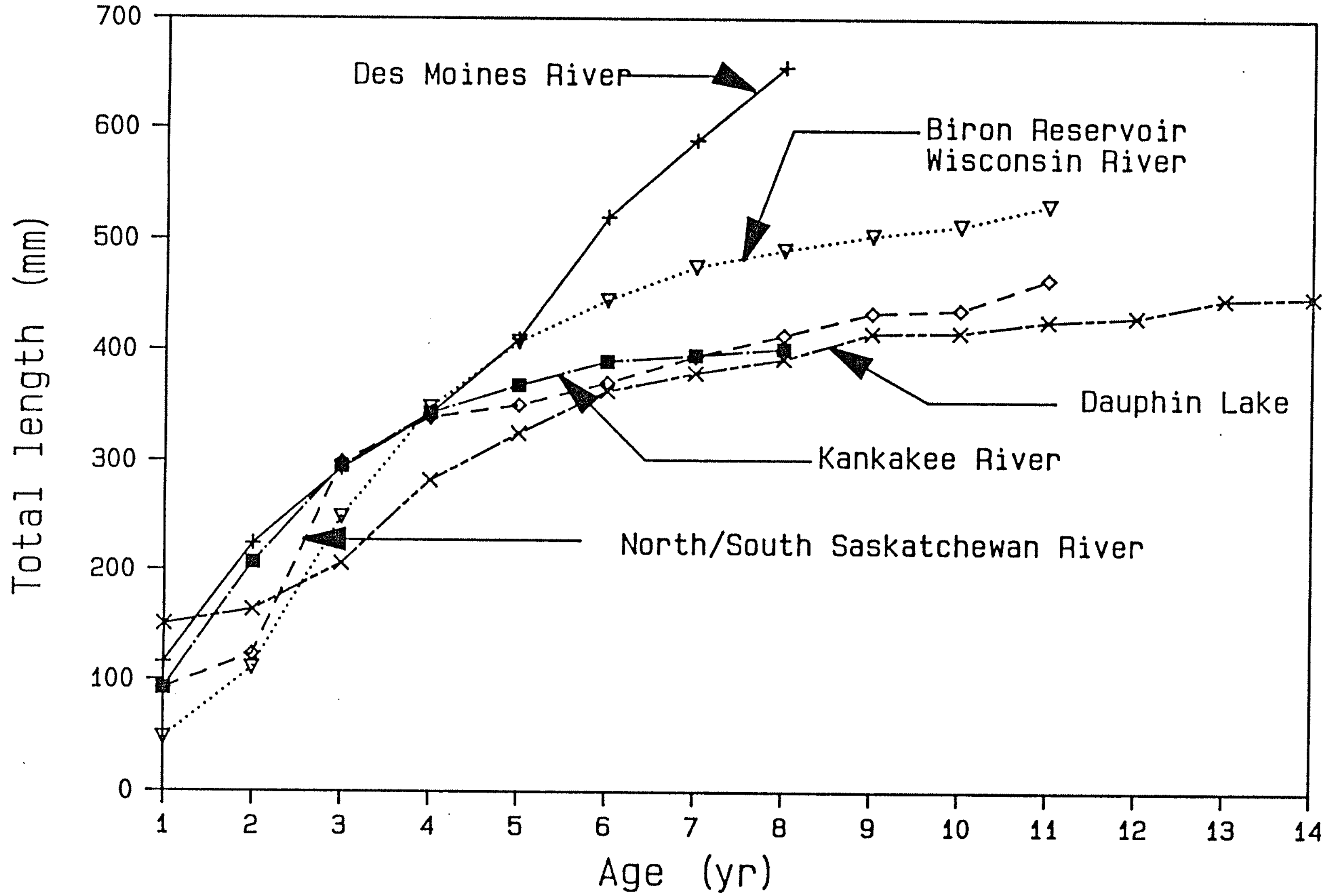
Fig. 25. Locations and numbers of tag recaptures from tagged shorthead redhorse, Dauphin Lake.



MOSSY RIVER
MINK RIVER
VALLEY RIVER
DAUPHIN LAKE
WILSON RIVER
VERMILION RIVER
DAUPHIN
EDWARDS CREEK
CROOKED CREEK
TURTLE RIVER
OCHRE RIVER
CRAWFORD CREEK
HENDERSON CREEK
RIDING MOUNTAIN NATIONAL PARK
SCOTT CREEK
N
2
3
1
4
1
11
1
3
1
1
1
2
1
1
24
172

Fig. 26. Mean total length at annulus formation of five populations of shorthead redhorse.

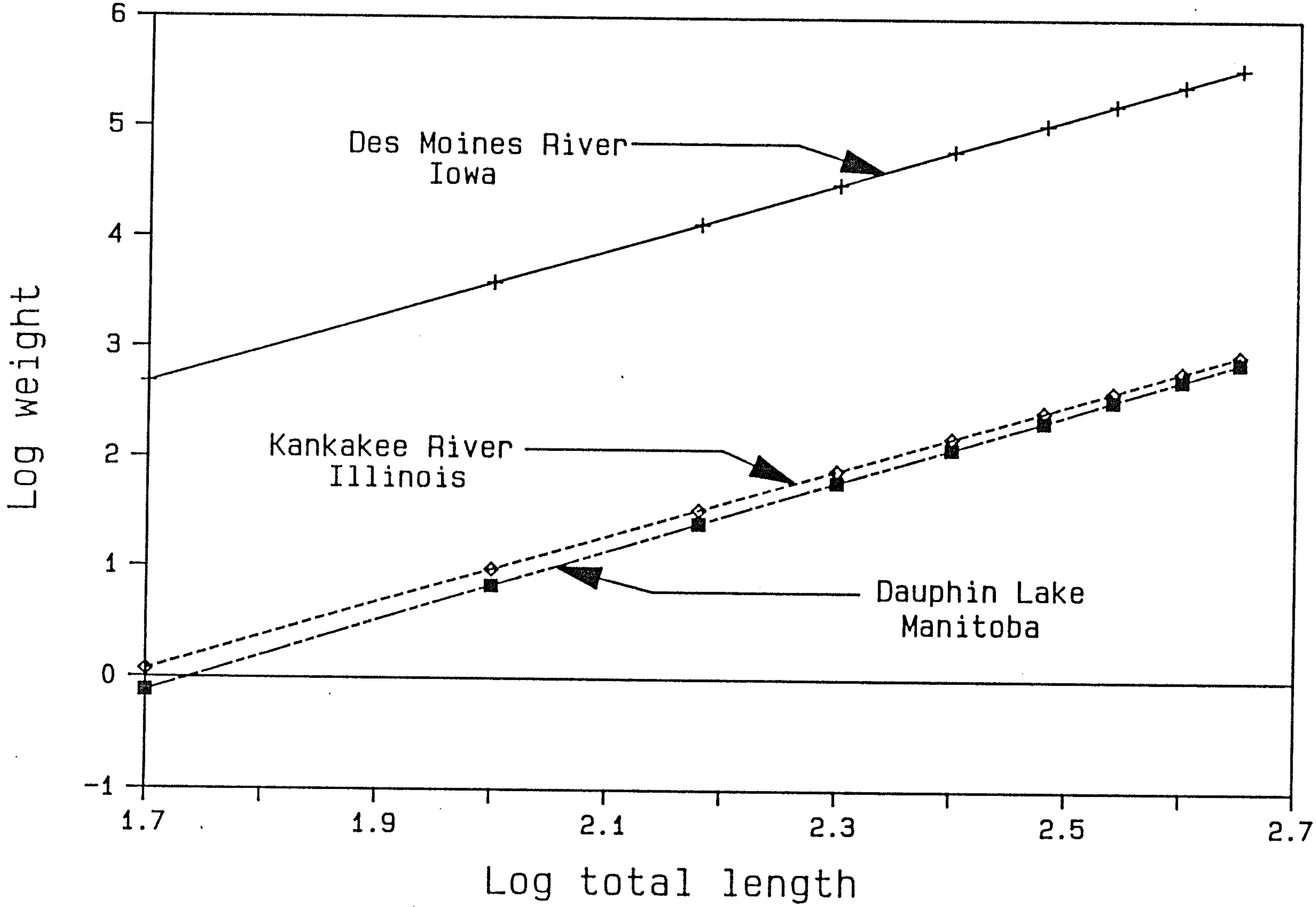
Des Moines River	Meyer (1962)
Kankakee River	Sulę & Skelly (1985)
Saskatchewan River	Reed (1962)
Biron Reservior	Becker (1983)
Dauphin Lake	Present study



Total length (mm)
700
600
500
400
300
200
100
0
Des Moines River
Biron Reservoir
Wisconsin River
Dauphin Lake
Kankakee River
North/South Saskatchewan River
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Age (yr)

Fig. 27. Linear regression of log weight to log fork length for 3 populations of shorthead redhorse.

Des Moines River	Meyer (1962)
Kankakee River	Sule & Skelly (1985)
Dauphin Lake	Present study



Des Moines River
Iowa
Kankakee River
Illinois
Dauphin Lake
Manitoba
Log weight
Log total length
6
5
4
3
2
1
0
-1
1.7
1.9
2.1
2.3
2.5
2.7

TABLE 1. Operational dates of the fish fence that was used to monitor the migration of shorthead redhorse in the Ochre River.

YEAR	FENCE INSTALLED	DATES OF FENCE WASH OUT	FENCE REMOVED
1983	06 May	18 May - 24 May	22 July
1984	15 Apr	06 May - 09 May	22 June
		11 May - 20 May	
1985	14 Apr	18 Apr - 25 Apr	25 June

TABLE 2. MORPHOLOGICAL VARIATIONS OF MOXOSTOMA MACROLEPIDOTUM STANDARD LENGTH IS MEASURED IN MM ALL OTHER BODY MEASUREMENTS ARE EXPRESSED IN THOUSANDS OF STANDARD LENGTH.

CHARACTER	GROUP	N	MEAN	MIN	MAX	STD.*
STANDARD LENGTH	FEMALE	70	303	147	387	40.3
	MALE	44	271	120	332	44.9
	ALL**	118	288	120	387	47.1
BODY DEPTH	FEMALE	70	282	252	321	0.013
	MALE	44	278	230	321	0.017
	ALL	118	280	230	321	0.015
CAUDAL PEDUNCLE LENGTH	FEMALE	70	119	94	141	0.024
	MALE	44	119	95	145	0.012
	ALL	118	118	94	145	0.020
HEAD DEPTH	FEMALE	70	138	122	152	0.006
	MALE	44	137	124	149	0.005
	ALL	118	137	122	150	0.006
CAUDAL PEDUNCLE DEPTH	FEMALE	70	109	99	120	0.005
	MALE	44	108	97	117	0.005
	ALL	118	109	97	120	0.005
INTERORBITAL WIDTH	FEMALE	70	95	86	101	0.003
	MALE	44	95	86	104	0.004
	ALL	118	95	86	104	0.004
EYE LENGTH	FEMALE	70	42	34	53	0.003
	MALE	44	44	37	57	0.004
	ALL	118	43	34	57	0.004
HEAD LENGTH	FEMALE	70	194	173	223	0.010
	MALE	44	197	182	226	0.010
	ALL	118	197	173	226	0.010
SNOUT LENGTH	FEMALE	70	73	59	93	0.008
	MALE	44	74	61	88	0.006
	ALL	118	73	59	93	0.007
LENGTH OF DEPRESSED DORSAL FIN	FEMALE	70	273	236	312	0.014
	MALE	44	294	258	318	0.014
	ALL	117	283	251	318	0.016
LENGTH OF PECTORAL FIN	FEMALE	47	208	183	229	0.010
	MALE	27	211	180	226	0.011
	ALL	79	209	180	230	0.011
DORSAL FIN BASE	FEMALE	70	178	153	212	0.013
	MALE	44	182	161	215	0.013
	ALL	118	179	153	212	0.012
PELVIC FIN LENGTH	FEMALE	70	177	153	254	0.013
	MALE	44	186	161	204	0.009
	ALL	117	181	161	254	0.012

TABLE 2. Con't. MORPHOLOGICAL VARIATIONS OF MOXOSTOMA MACROLEPIDOTUM STANDARD LENGTH IS MEASURED IN MM ALL OTHER BODY MEASUREMENTS ARE EXPRESSED IN THOUSANDS OF STANDARD LENGTH.

CHARACTER	GROUP	N	MEAN	MIN	MAX	STD.*
ANAL FIN LENGTH	FEMALE	70	240	199	259	0.011
	MALE	44	226	211	306	0.022
	ALL	115	249	199	306	0.021
CAUDAL FIN LENGTH	FEMALE	55	262	226	296	0.015
	MALE	38	273	236	306	0.015
	ALL	96	268	226	226	0.017
NO. OF LATERAL LINE SCALES	FEMALE	62	47	45	49	1.140
	MALE	38	46.8	45	49	1.210
	ALL	103	46.9	45	49	1.133
PECTORAL RAY COUNT	FEMALE	70	15.9	14	17	0.760
	MALE	44	16.1	15	17	0.600
	ALL	116	16.0	14	17	0.707
DORSAL RAY COUNT	FEMALE	70	13.1	12	15	0.680
	MALE	44	12.9	12	14	0.390
	ALL	118	13.0	12	15	0.560
ANAL RAY COUNT	FEMALE	70	8.0	8	8	0.000
	MALE	44	7.9	7	8	0.340
	ALL	118	8.0	7	8	0.201
PELVIC RAY COUNT	FEMALE	70	9.0	7	10	0.520
	MALE	44	8.9	7	10	0.550
	ALL	118	8.9	7	10	0.516

** = Males + Females + unknown
* = Standard deviation

Table 3. Regression equations for water temperature of Dauphin Lake, fecundity, Log weight to Log Fklt and Log Fklt to age of shorthead redhorse from Dauphin Lake.

Source	Type of equation	Variables used	Equation	N	R^2
Dauphin Lake water temperature					
Temp 1984	$Y = \beta_0 + \beta_1 X + \beta_2 X$	Temp to Day + Day^2	Temp = -1.795 + (0.399(day))+(-0.002(day)^2)	23	0.850
Temp 1985	$Y = \beta_0 + \beta_1 X + \beta_2 X$	Temp to Day + Day^2	Temp = 4.092 + (0.261(day))+(-0.001(day)^2)	23	0.715
Temp 1987	$Y = \beta_0 + \beta_1 X + \beta_2 X$	Temp to Day + Day^2	Temp = 0.285 + (0.389(day))+(-0.002(day)^2)	23	0.602
Shorthead redhorse fecundity					
1984/85*	$Y = \beta_0 + \beta_1 X$	Fecundity to Fklt	Fecundity = 53581.3 + 208.5(Fklt)	59	0.805
1986**	$Y = \beta_0 + \beta_1 X$	Fecundity to Fklt	Fecundity = 39494.6 + 161.9(Fklt)	48	0.478
	$Y = \beta_0 + \beta_1 X$	Fecundity to age	Fecundity = 2208.56 + 3112.0(Age)	43	0.652
Shorthead redhorse population gillnet survey					
1984	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.043 + 3.099(log Fklt)	73	0.987
1985	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.192 + 3.146(log Fklt)	326	0.996
1986	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.215 + 3.156(log Fklt)	387	0.992
1987	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.158 + 3.137(log Fklt)	201	0.984
All years	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.328 + 3.151(log Fklt)	1018	0.992
1984	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.192 + 0.047(Age)	77	0.660
1985	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.182 + 0.046(Age)	313	0.740
1986	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.224 + 0.040(Age)	379	0.666
1987	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.259 + 0.036(Age)	202	0.666
All years	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.210 + 0.042(Age)	974	0.669
Male shorthead redhorse growth rate					
All years	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.182 + 0.046(Age)	431	0.707
Female shorthead redhorse growth rate					
All years	$Y = \beta_0 + \beta_1 X$	Log Fklt to Age	Log Fklt = 2.255 + 0.037(Age)	520	0.667

Table 3. Con't. Regression equations for water temperature of Dauphin Lake, fecundity, Log weight to Log Fklt and Log Fklt to age of shorthead redhorse from Dauphin Lake.

Source	Type of equation	Variables used	Equation	N	R^2
Junvenile shorthead redhorse seining survey					
0+ 1984	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.633 + (3.491(Log Fklt))	310	0.987
0+ 1985	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.789 + (2.944(Log Fklt))	290	0.817
0+ 1986	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.746 + (2.918(Log Fklt))	815	0.958
0+ 1987	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.919 + (3.020(Log Fklt))	680	0.976
All years	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -5.146 + (3.166(Log Fklt))	2082	0.977
1+ 1984	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.670 + (2.900(Log Fklt))	50	0.987
1+ 1985	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.729 + (2.930(Log Fklt))	790	0.971
1+ 1986	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.862 + (2.998(Log Fklt))	121	0.964
1+ 1987	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.821 + (2.984(Log Fklt))	805	0.985
All years	$Y = \beta_0 + \beta_1 X$	Log Wt to Log Fklt	Log Wt = -4.812 + (2.976(Log Fklt))	1785	0.982
0+ 1984	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 0.578 + (0.006(Day))	310	0.834
0+ 1985	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.133 + (0.003(Day))	290	0.306
0+ 1986	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 0.931 + (0.004(Day))	799	0.616
0+ 1987	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.270 + (0.003(Day))	680	0.396
All years	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 0.857 + (0.005(Day))	2082	0.517
1+ 1984	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.481 + (0.004(Day))	50	0.850
1+ 1985	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.644 + (0.002(Day))	790	0.421
1+ 1986	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.402 + (0.003(Day))	121	0.403
1+ 1987	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.573 + (0.003(Day))	805	0.697
All years	$Y = \beta_0 + \beta_1 X$	Log Fklt to Day	Log Fklt = 1.608 + (0.002(Day))	1785	0.529

Fklt = Fork length
Wt = Weight
* = spring samples
** = winter samples

TABLE 4. EGG SIZE (mm) FOR SHORTHEAD REDHORSE 1984,1985, OCHRE RIVER AND 1986 DAUPHIN LAKE.

YEAR	N	EGG SIZE MIN	EGG SIZE MAX	EGG SIZE MEAN	VAR	MEAN GSI*	MIN GSI	MAX GSI
1984	37	1.208	2.182	1.743	0.048	14.28	7.71	20.22
1985	22	1.157	1.995	1.687	0.050	14.79	14.79	14.79
1986	48	1.240	1.768	1.453	0.020	8.85	5.24	13.21

* GSI =(gonad weight/fish wet weight)x100

TABLE 5. Counts and fork length measurements of junvenile shorthead redhorse caught by seine hauls in Dauphin Lake.

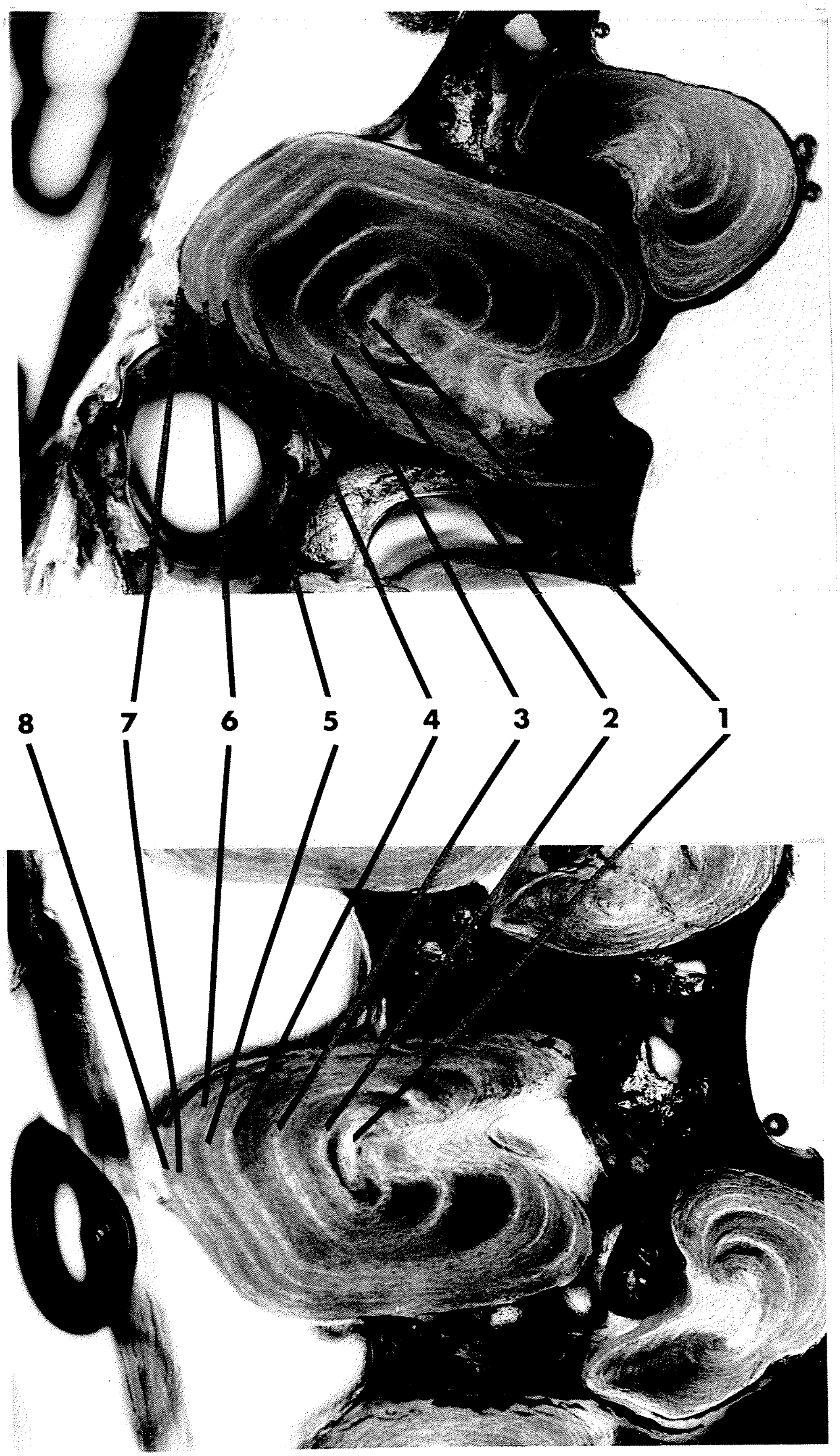
YEAR	YEAR CLASS	N	FORK LENGTH (mm) MEAN	MIN	MAX	STD*	SEINING EFFORT
1984	0+	311	25.02	14	65	14.00	occasional
	1+	51	87.30	47	135	28.86	occasional
1985	0+	292	35.08	22	49	4.96	weekly
	1+	790	80.48	52	126	12.39	weekly
1986	0+	820	41.33	16	64	10.56	biweekly
	1+	122	79.97	47	115	12.39	biweekly
1987	0+	694	51.67	29	73	8.98	monthly
	1+	774	102.85	36	125	17.28	monthly

* = Standard Deviation

Plate 1. Pectoral fin ray section of shorthead redhorse with good summer growth, but showing a small increment of fin ray growth.

A. Tag # 8993, Tagged 31/05/85 FL = 337mm
B. Tag # 8993, Recaptured 02/12/85 FL = 349mm

A



B

Plate 2. Pectoral fin ray section of shorthead redhorse with poor summer growth and showing a small increment of fin ray growth.

A. Tag # 5008, Tagged 20/05/85 FL = 330mm
B. Tag # 5008, Recaptured 02/12/85 FL = 333mm

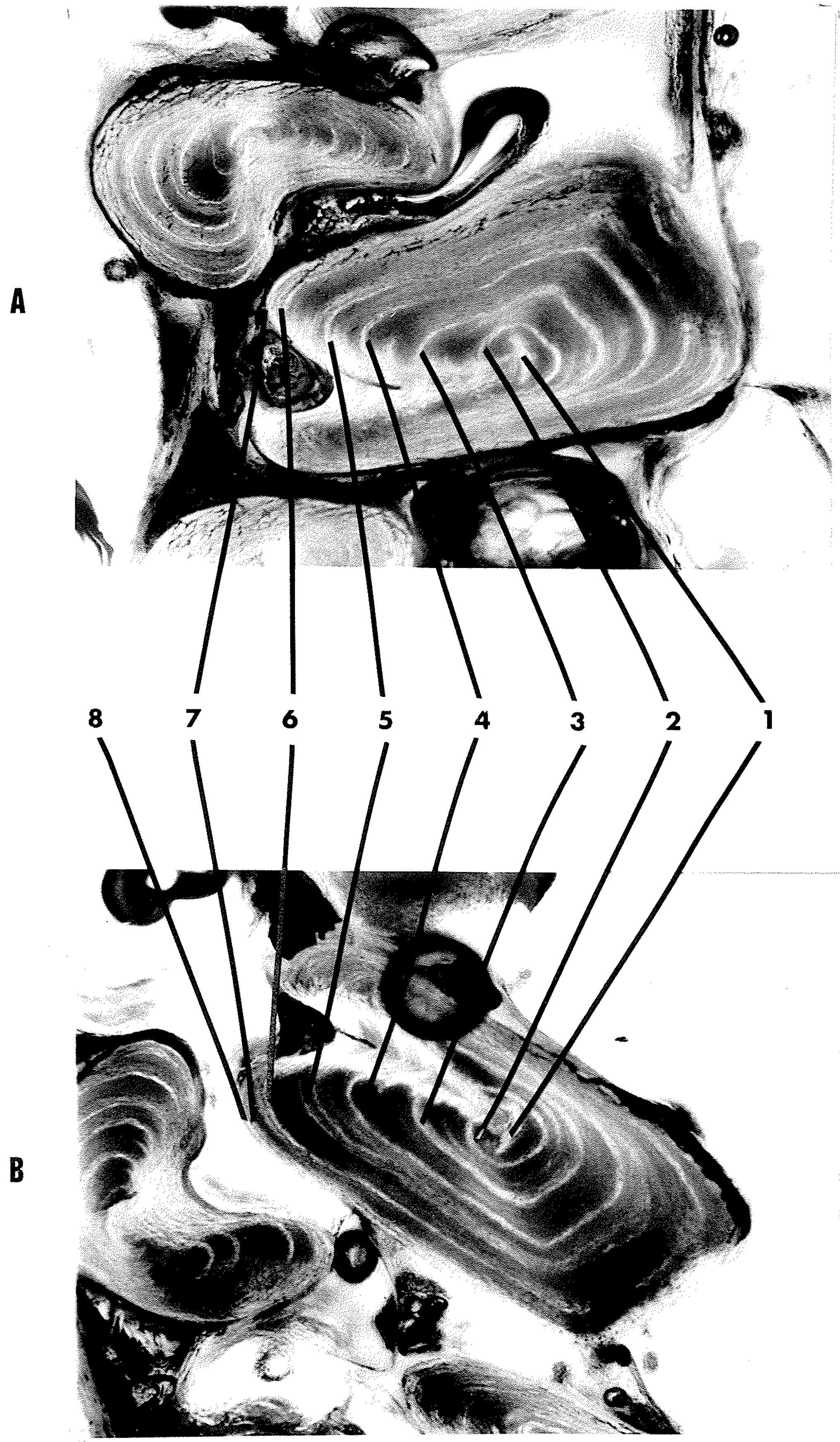
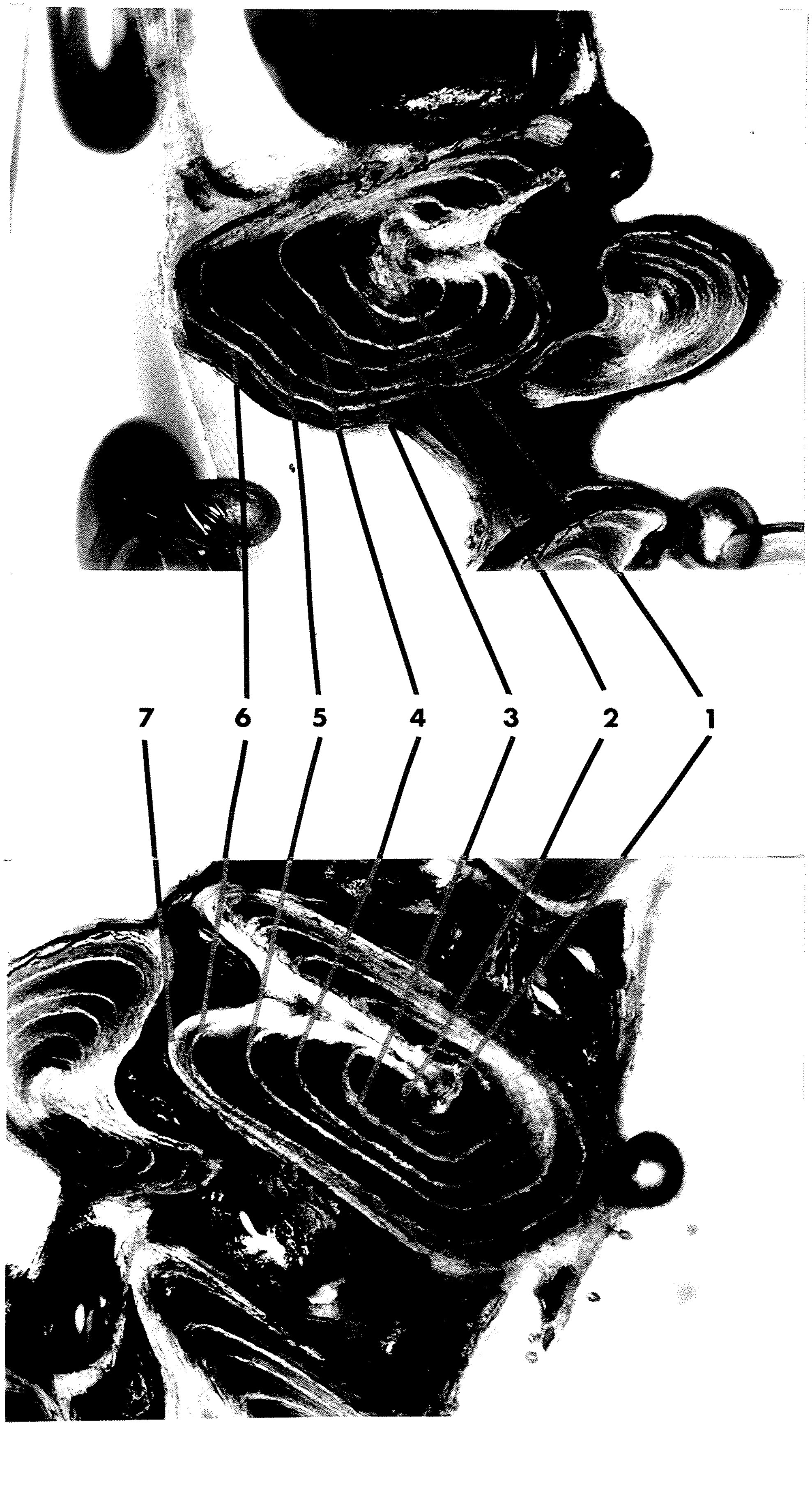

A
8
7
6
5
4
3
2
1
B

Plate 3. Pectoral fin ray section of shorthead redhorse with good summer growth and showing a good increment of fin ray growth.

A. Tag # 8853, Tagged 25/05/85 FL = 337mm
B. Tag # 8853, Recaptured 02/12/85 FL = 345mm

A



B

APPENDIX 1. Catch summary of shorthead redhorse migration, water temperature and stream discharge during fish fence operation on Ochre River, 1983,1984 and 1985.

1983 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	MALE	TOT.*	DOWN STREAM COUNT TOTAL
06-May	6.7	3.22			1	
07-May	6.9	2.69			2	1
08-May	7.7	2.22			4	2
09-May	9.3	2.03	1		1	
10-May	10.8	2.06	1		2	1
11-May	8.8	1.90	1		1	
12-May	3.8	1.69			1	
13-May	1.0	1.87			0	
14-May	1.9	1.78			0	
15-May	3.6	1.52			1	1
16-May	5.4	2.23			1	
17-May	7.4	4.20			1	
18-May	8.1	11.20	TRAP OUT			
19-May	7.5	16.00	TRAP OUT			
20-May	6.7	12.10	TRAP OUT			
21-May	9.2	9.15	TRAP OUT			
22-May	9.1	7.18	TRAP OUT			
23-May	10.7	6.04	TRAP OUT			
24-May	11.1	5.18	TRAP OUT			
25-May	11.1	4.15		1	2	
26-May	12.6	3.65	7	6	17	1
27-May	14.7	3.53	17	19	36	11
28-May	14.2	3.09	9	24	33	8
29-May	12.4	2.69	10	12	26	8
30-May	11.6	2.44	19	15	34	12
31-May	11.2	2.31	21	41	62	6

1984 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	MALE	TOT.	DOWNSTREAM COUNT FEM.	MALE	TOT.
19-Apr	9.9	1.11						2
20-Apr	11.1	0.98						
21-Apr	12.5	0.86						
22-Apr	12.1	0.78						
23-Apr	10.5	0.70						2
24-Apr	9.8	0.67						
25-Apr	5.5	0.67						
26-Apr	0.4	0.63						
27-Apr	0.0	0.58						
28-Apr	0.0	1.48						
29-Apr	1.2	0.69						
30-Apr	2.6	1.21						
01-May	5.0	1.24						
02-May	5.7	1.24		1	1			1
03-May	5.9	1.24						
04-May	6.2	1.88		2	2			
05-May	4.2	2.52		1	2			1
06-May	3.2	3.90	TRAP OUT					
07-May	5.6	3.28	TRAP OUT					
08-May	6.2	2.80	TRAP OUT					
09-May	6.1	3.21	1		1			
10-May	6.8	4.24						6
11-May	5.4	7.73	TRAP OUT					
12-May	7.0	11.30	TRAP OUT					
13-May	8.5	11.50	TRAP OUT					
14-May	10.0	10.40	TRAP OUT					

1985 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	MALE	TOT.	DOWNSTREAM COUNT FEM.	MALE	TOT.
26-Apr	8.5	5.38	1	1				
27-Apr	8.3	4.55		1	2			
28-Apr	11.2	3.92	1	3	6			
29-Apr	13.6	3.33	3	9	14			
30-Apr	12.6	2.87	1	8	13			
01-May	13.2	2.58	14	34	52			
02-May	13.4	2.28		1	1			
03-May	12.4	2.15		1	1			
04-May	12.6	1.97		1	1			
05-May	12.5	1.80						
06-May	13.1	1.64				12	15	27
07-May	14.0	1.52				9	19	28
08-May	15.6	1.38	3	9	12	4	27	31
09-May	16.8	1.32				7	35	42
10-May	15.0	1.24	2	7	9	4	21	25
11-May	14.3	1.68				1	10	11
12-May	12.5	1.91	10	11	21	2	17	19
13-May	9.8	2.52	4	2	6		2	2
14-May	9.2	3.09	9	7	16	17	45	62
15-May	10.2	2.68	9	9	18	9	39	48
16-May	13.1	2.26	36	59	95	5	21	26
17-May	15.7	1.92	39	58	97	10	28	38
18-May	16.8	1.65	4	3	7	11	18	29
19-May	14.6	1.43	9	4	13	27	18	45
20-May	13.8	1.28	2		2	71	154	225
21-May	15.4	1.17		1	1	56	110	166

APPENDIX 1. Con't. Catch summary of shorthead redhorse migration, water temperature and stream discharge during fish fence operation on Ochre River, 1983,1984 and 1985.

1983 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	UPSTREAM COUNT MALE	UPSTREAM COUNT TOT.*	DOWN STREAM COUNT TOTAL	1984 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	UPSTREAM COUNT MALE	UPSTREAM COUNT TOT.	DOWNSTREAM COUNT FEM.	DOWNSTREAM COUNT MALE	DOWNSTREAM COUNT TOT.	1985 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	UPSTREAM COUNT MALE	UPSTREAM COUNT TOT.	DOWNSTREAM COUNT FEM.	DOWNSTREAM COUNT MALE	DOWNSTREAM COUNT TOT.
01-Jun	13.3	2.13	65	71	136	19	15-May	11.5	8.68	TRAP OUT						22-May	16.5	1.07	21	11	23	54	63	117
02-Jun	13.3	2.01	70	44	114	12	16-May	12.0	6.76	TRAP OUT						23-May	17.2	0.95	1	3	4	63	14	77
03-Jun	11.7	2.49	54	73	134	5	17-May	14.2	5.34	TRAP OUT						24-May	16.9	0.87	3	3	6	331	27	358
04-Jun	11.8	3.96	73	53	136	45	18-May	10.5	4.07	TRAP OUT						25-May	16.4	0.84	3		3	303	33	336
05-Jun	11.8	4.93	82	44	127	36	19-May	9.3	3.63	TRAP OUT						26-May	16.8	0.87				273	39	312
06-Jun	12.8	3.57	82	78	163	20	20-May	9.0	3.69	1	1	2				27-May	16.1	0.84				217	71	288
07-Jun	14.9	2.85	74	28	103	34	21-May	11.6	3.87					6	8	28-May	16.4	0.78				176	78	254
08-Jun	16.0	2.66	74	41	116	42	22-May	11.4	3.27	2	2	4	3	10	16	29-May	18.3	0.70				150	157	307
09-Jun	16.2	2.45	55	24	79	22	23-May	11.3	2.76				1	6	10	30-May	16.4	0.72				13	51	64
10-Jun	17.6	2.17	30	11	41	48	24-May	9.0	2.91				2	6	9	31-May	13.0	2.15				296	418	714
11-Jun	20.1	1.89	32	11	43	71	25-May	8.6	3.98	2	3	5		3	3	01-Jun	10.5	3.83				142	486	628
12-Jun	20.7	1.65	8	3	11	47	26-May	9.6	3.59	2	2	4	6	17	23	02-Jun	10.8	4.68				54	268	322
13-Jun	18.0	1.89	5	5	11	41	27-May	11.4	2.93	1	9	10	3	11	24	03-Jun	9.9	3.70				7	24	31
14-Jun	15.6	2.01	2	2	7	11	28-May	12.4	2.40	28	57	85	1	15	16	04-Jun	9.9	4.18		1	1	19	44	63
15-Jun	13.5	2.85	0	0	0	30	29-May	13.8	2.06	7	17	24	4	9	13	05-Jun	11.2	5.25	1	2	3	26	58	84
16-Jun	14.1	3.12	5	1	6	61	30-May	16.1	1.78	0	5	5	1	6	7	06-Jun	14.6	4.02	9	2	11	62	106	168
17-Jun	17.0	2.49	0	0	1	117	31-May	18.4	1.57	1	8	9	1	2	3	07-Jun	17.2	3.03	16	25	41	45	81	126
18-Jun	18.3	2.16	2	2	5	79	01-Jun	16.2	1.35					4	4	08-Jun	17.7	2.26	4	4	8	29	41	70
19-Jun	18.9	1.69	3	3	7	50	02-Jun	14.5	1.15				2	1	3	09-Jun	15.0	1.91				17	32	49
20-Jun	18.7	1.73		1	2	85	03-Jun	15.6	0.98	4	1	5	12	15	17	10-Jun	15.2	1.62	1		1	32	28	60
21-Jun	18.1	1.57		1	1	14	04-Jun	16.6	0.87		1	1	1	9	10	11-Jun	16.1	1.47	1		1	52	36	88
22-Jun	18.8	1.57			0	4	05-Jun	17.0	0.78	2	2	4	0	1	1	12-Jun	16.1	1.32				83	36	119
23-Jun	18.0	1.77	1		1	23	06-Jun	15.6	0.79		1	1	2	0	2	13-Jun	16.9	1.15				181	322	803
24-Jun	18.2	1.68	1		1	2	07-Jun	21.2	2.38				43	43	86	14-Jun	16.7	1.04				68	391	459
25-Jun	18.6	1.87			0	20	08-Jun	18.6	3.05	61	94	155	23	55	78	15-Jun	18.3	1.28						
26-Jun	17.6	1.76	1	1	2	41	09-Jun	14.0	2.33	8	2	10	11	33	44	16-Jun	18.0	1.35						
27-Jun	15.7	1.54			0	4	10-Jun	14.2	2.32	3		3	15	21	36	17-Jun	15.3	1.26				3	91	94
28-Jun	17.1	1.36			0	17	11-Jun	11.6	1.84	2	1	3	2	9	11	18-Jun	16.2	1.77				27	179	206
29-Jun	17.9	1.14			0	36	12-Jun	17.0	1.44				15	16	31	19-Jun	17.9	1.67				20	70	90
30-Jun	17.4	1.33			0	19	13-Jun	16.1	1.22	1	2	3	8	7	15	20-Jun	19.5	1.34				9	100	109

APPENDIX 1. Con't. Catch summary of shorthead redhorse migration, water temperature and stream discharge during fish fence operation on Ochre River, 1983,1984 and 1985.

1983 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	UPSTREAM COUNT MALE	UPSTREAM COUNT TOT.*	DOWN STREAM COUNT TOTAL
01-Jul	17.2	2.74			2	174
02-Jul	17.7	2.19			6	119
03-Jul	18.3	2.07			0	33
04-Jul	17.2	1.94			3	42
05-Jul	15.2	2.18			0	18
06-Jul	19.2	1.72			0	43
07-Jul	22.7	1.36			1	32
08-Jul	23.8	1.14			4	8
09-Jul	23.2	1.01			5	47
10-Jul	23.1	1.81			16	17
11-Jul	19.6	5.74			18	145
12-Jul	20.3	3.80			0	36
13-Jul	22.0	2.51			5	3
14-Jul	23.1	1.88			3	9
15-Jul	24.3	1.50			3	14
16-Jul	22.2	1.95			0	2
17-Jul	21.3	2.47			5	7
18-Jul	21.3	1.79			2	4
19-Jul	22.9	1.39			0	0
20-Jul	24.1	1.16			0	1
21-Jul	23.8	0.95			0	2
22-Jul	23.0	0.80				0
TOTAL			805	615	1545	1862
SEX RATIO	F:M		0.7			

1984 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	UPSTREAM COUNT MALE	UPSTREAM COUNT TOT.	DOWNSTREAM COUNT FEM.	DOWNSTREAM COUNT MALE	DOWNSTREAM COUNT TOT.
14-Jun	16.5	1.03	2	7	9	35	57	92
15-Jun	17.9	0.91		1	1	22	41	63
16-Jun	19.4	0.80		1	1			
17-Jun	20.2	1.14	1		1	5	41	46
18-Jun	19.4	1.79	1	1	2	16	112	128
19-Jun	20.2	1.29	1	4	5	1	32	33
20-Jun	21.0	0.98				4	36	40
TOTAL			131	226	358	239	624	884
SEX RATIO	F:M		1.7			2.6		

1985 DATE	WATER TEMP C	DISC. M^3/SEC	UPSTREAM COUNT FEM.	UPSTREAM COUNT MALE	UPSTREAM COUNT TOT.	DOWNSTREAM COUNT FEM.	DOWNSTREAM COUNT MALE	DOWNSTREAM COUNT TOT.
21-Jun	18.2	1.11				11	70	81
22-Jun	14.1	1.00				2	4	6
23-Jun	15.2	0.95						
24-Jun		0.87				2	16	18
TOTAL			207	280	489	3012	4013	7325
SEX RATIO	F:M		1.3			1.33		

* Male + Female + Unknown Sex

APPENDIX 2. Fork length-frequency distributions for spawning shorthead redhorse from Ochre River.

Year 1983 Length Interval (mm)	Males Length (mm)				Females Length (mm)				Combined Length (mm)			
	N	MEAN	STD	%	N	MEAN	STD	%	N	MEAN	STD	%
191 - 200									1	200.0		0.07
201 - 210									1	203.0		0.07
211 - 220	1	213.0		0.18					5	213.0	1.225	0.33
221 - 230	1	226.0		0.18					4	226.0	1.630	0.27
231 - 240									7	235.6	2.992	0.47
241 - 250					1	241.0		0.13	8	243.1	2.532	0.53
251 - 260	3	253.7	1.155	0.55	1	252.0		0.13	13	255.3	2.394	0.87
261 - 270	5	265.0	3.162	0.92	1	270.0		0.13	24	265.7	2.660	1.60
271 - 280	9	277.9	3.100	1.65	2	274.5	0.707	0.26	27	277.0	2.542	1.80
281 - 290	20	286.4	3.360	3.66	2	282.5	2.121	0.26	32	286.3	3.366	2.13
291 - 300	22	295.5	2.939	4.03	1	292.0		0.13	31	294.7	3.081	2.07
301 - 310	25	304.9	3.308	4.58	2	305.0	0.707	0.26	30	305.1	3.118	2.00
311 - 320	42	316.5	2.965	7.69	2	317.5	3.536	0.26	50	316.5	2.971	3.34
321 - 330	67	326.6	2.814	12.27	16	327.8	2.176	2.08	96	326.7	2.835	6.40
331 - 340	80	336.4	3.012	14.65	30	336.8	2.680	3.90	121	336.5	2.899	8.07
341 - 350	91	345.6	2.824	16.67	50	346.3	2.993	6.49	160	345.9	2.888	10.67
351 - 360	70	355.2	2.833	12.82	97	356.1	3.051	12.60	185	355.8	2.914	12.34
361 - 370	50	365.9	2.860	9.16	114	366.1	2.880	14.81	174	366.0	2.866	11.60
371 - 380	32	375.0	2.840	5.86	130	375.7	2.916	16.88	171	375.6	2.930	11.41
381 - 390	16	385.8	3.250	2.93	111	385.9	2.725	14.42	130	385.9	2.829	8.67
391 - 400	6	394.8	1.329	1.10	91	394.6	2.529	11.82	100	394.6	2.471	6.67
401 - 410	2	405.0	0.000	0.37	57	405.4	2.907	7.40	62	405.4	2.838	4.14
411 - 420	1	414.0		0.18	33	414.6	2.761	4.29	34	414.6	2.725	2.27
421 - 430					15	425.3	2.920	1.95	15	425.3	2.920	1.01
431 - 440	1	438.0		0.18	10	435.1	2.726	1.30	12	435.8	2.927	8.05
441 - 450	1	443.0		0.18	3	445.7	3.215	0.39	4	445.0	2.944	0.27
451 - 460					1	453.0		0.13	1	453.0		0.07
461 - 470	1	466.0		0.18					1	466.0		0.07
Total	546				770				1499			
Mean		338.2	29.644			375.6	26.060			354.1	39.304	
Min		213.0				241.0				200.0		
Max		477.0				453.0				466.0		

APPENDIX 2. Con't. Fork length-frequency distributions for spawning shorthead redhorse from Ochre River.

Year 1984 length Interval (mm)	Males Length (MM)				Females Length (MM)				Combined Length (MM)			
	N	MEAN	STD	%	N	MEAN	STD	%	N	MEAN	STD	%
201 - 210	2	205.5	0.707	0.32					2	205.5	0.707	0.23
241 - 250	1	246.0		0.16					1	246.0		0.12
251 - 260	1	255.0		0.16					1	255.0		0.12
261 - 270					1	266.0		0.42	1	266.0		0.12
271 - 280	1	279.0		0.16					1	279.0		0.12
281 - 290	12	287.2	2.406	1.93	1	284.0		0.42	13	286.9	2.465	1.52
291 - 300	71	296.2	2.885	11.43	2	295.0	1.414	0.85	73	296.2	2.856	8.52
301 - 310	141	305.8	2.768	22.71	3	308.0	0.000	1.27	144	305.9	2.756	16.80
311 - 320	130	315.3	2.887	20.93	10	315.7	2.710	4.24	140	315.3	2.867	16.34
321 - 330	79	325.7	2.971	12.72	22	327.5	1.819	9.32	101	326.1	2.858	11.78
331 - 340	48	336.2	2.873	7.73	24	334.9	2.842	10.17	72	335.8	2.908	8.40
341 - 350	41	345.6	2.880	6.60	24	345.8	2.904	10.17	65	345.7	2.867	7.58
351 - 360	35	355.1	2.881	5.64	23	355.9	2.581	9.75	58	355.4	2.727	6.77
361 - 370	29	366.6	2.527	4.67	23	366.5	2.626	9.75	52	366.6	2.546	6.07
371 - 380	13	375.1	2.900	2.09	23	374.6	2.445	9.75	36	374.8	2.587	4.20
381 - 390	9	385.7	1.936	1.45	33	385.5	2.938	13.98	42	385.5	2.734	5.02
391 - 400	3	395.0	0.000	0.48	21	394.8	3.330	8.89	24	394.8	3.106	2.80
401 - 410	2	405.5	6.364	0.32	8	405.8	3.327	3.39	10	405.7	3.623	1.17
411 - 420	3	424.3	3.055	0.48	9	415.9	2.315	3.81	9	415.9	2.315	1.05
421 - 430	1	428.0		0.16					4	425.3	3.096	0.47
431 - 440	3	435.3	1.528	0.48	3	435.3	1.528	1.27	3	435.3	1.528	0.35
441 - 450					2	442.0	0.000	0.85	2	442.0	0.000	0.23
451 - 460	1	456.0		0.16					1	456.0		0.12
461 - 470												
471 - 480	1	472.0		0.16	1	473.0		0.42	2	472.5	0.707	0.23
Total	621				236				857			
Mean		323.0	26.409			364.1	32.293			334.3	33.604	
Min		205.0				266.0				205.0		
Max		472.0				473.6				473.0		

APPENDIX 2. Con't. Fork length-frequency distributions for spawning shorthead redhorse from Ochre River.

Year 1985 Length Interval (mm)	Males Length (MM)				Females Length (MM)				Combined Length (MM)			
	N	MEAN	STD	%	N	MEAN	STD	%	N	MEAN	STD	%
201 - 210	2	206.5	2.121	0.05					2	206.5	2.121	0.03
231 - 240	1	240.0		0.02					1	240.0		0.02
241 - 250					1	245.0		0.03	1	245.0		0.02
251 - 260	1	252.0		0.02	1	258.0		0.03	2	255.0	4.243	0.03
261 - 170					1	265.0		0.03	1	265.0		0.02
271 - 280	2	280.0	0.000	0.05					2	280.0	0.000	0.03
281 - 290	8	287.1	3.226	0.22					8	287.1	3.227	0.12
291 - 300	103	297.0	2.706	2.77	1	294.0		0.03	105	297.0	2.703	1.50
301 - 310	391	306.2	2.805	10.53	15	307.7	2.769	0.53	406	306.3	2.814	3.18
311 - 320	878	316.0	2.792	23.64	75	316.8	2.760	2.63	953	316.1	2.795	14.51
321 - 330	1022	325.4	2.753	27.52	291	326.3	2.705	10.21	1314	325.6	2.763	20.01
331 - 340	649	334.9	2.710	17.47	563	335.7	2.789	19.75	1212	335.3	2.774	18.45
341 - 350	258	344.7	2.717	6.95	616	345.7	2.845	21.61	874	345.5	2.829	13.31
351 - 360	124	355.7	2.872	3.34	501	355.0	2.944	17.57	626	355.2	2.937	9.53
361 - 370	83	365.5	2.466	2.23	224	364.9	2.930	7.86	307	365.1	2.821	4.67
371 - 380	64	375.0	3.055	1.72	144	375.1	2.634	5.05	208	375.1	2.764	3.17
381 - 390	37	385.5	2.902	0.99	119	385.3	2.886	4.17	156	385.4	2.881	2.38
391 - 400	25	396.6	2.501	0.67	123	395.4	2.810	4.31	148	395.6	2.787	2.25
400 - 410	15	405.9	3.105	0.40	74	405.0	2.707	2.60	89	405.3	2.772	1.36
411 - 420	15	415.3	2.582	0.40	52	414.4	2.530	1.82	67	414.6	2.552	1.02
421 - 430	10	426.9	2.846	0.27	23	425.6	2.456	0.81	33	422.9	2.616	0.50
431 - 440	5	437.4	1.949	0.13	13	434.5	3.017	0.46	18	435.3	3.025	0.27
441 - 450	8	444.6	3.249	0.22	5	445.2	3.271	0.17	13	444.8	3.132	0.19
451 - 460	6	455.0	3.033	0.16	5	452.4	1.342	0.17	11	453.8	2.677	0.16
461 - 470	6	464.0	3.011	0.16	2	464.0	2.828	0.70	8	464.5	2.777	0.12
471 - 480	1	474.0		0.02					1	474.0		0.02
501 - 510					2	504.0	1.414	0.70	2	504.0	1.414	0.02
Total	3714				2851				6568			
Mean		328.9	22.635			353.5	25.201			339.6	26.731	
Min		205.0				245.0				205.0		
Max		474.0				505.0				505.0		

Combined = males + females + unknown sex

Appendix 3. Age-frequency distributions for migration of spawning shorthead redhorses from Ochre River.

YEAR 1983

Age (yr)	Males Fork Length (mm)				Females Fork Length (mm)				Combined * Fork Length (mm)			
	N	MEAN	STD	%	N	MEAN	STD	%	N	MEAN	STD	%
3	1	290.0		1.66	1	294.0		1.37	3	299.0	90.835	1.73
4	7	315.6	27.712	11.66	2	332.5	6.364	2.74	17	291.3	40.819	9.83
5	6	312.5	27.848	10.00	2	327.0	29.699	2.74	14	307.4	33.135	8.09
6	4	325.5	20.745	6.66	2	362.0	2.828	2.74	10	337.7	19.477	5.78
7	6	342.0	8.325	10.00	8	343.0	40.089	10.96	20	346.3	27.298	11.56
8	21	348.0	16.613	35.00	26	373.0	32.317	35.62	55	361.4	27.541	31.79
9	9	362.0	15.098	15.00	17	383.0	16.342	23.29	28	376.9	18.967	16.19
10	3	363.0	15.524	5.00	10	401.0	13.548	13.70	17	389.9	20.886	9.83
11	1	381.0		1.66	3	409.3	13.503	4.11	5	389.0	18.221	2.89
12	2	391.5	31.820	3.33	1	397.0		1.37	3	393.3	22.720	1.73
13												
14												
15					1	447.0		1.37	1	447.0		0.58
Total	60				73				173			
Mean		342.9	27.769			376.8	33.079			353.4	42.293	
Min		280.0				252.0				200.0		
Max		414.0				447.0				447.0		

* Combined = males + females + unknown sex

Appendix 3. Con't. Age-frequency distributions for migration of spawning shorthead redhorses from Ochre River.

YEAR 1984

Age (yr)	Males Fork Length (mm)				Females Fork Length (mm)				Combined * Fork Length (mm)			
	N	MEAN	STD	%	N	MEAN	STD	%	N	MEAN	STD	%
3												
4												
5	79	307.0	12.568	23.51	13	317.5	16.924	7.60	92	308.1	13.750	18.15
6	151	315.9	14.308	44.94	35	340.6	20.874	20.47	186	320.1	17.977	36.69
7	14	340.0	15.855	4.17	21	360.1	21.157	12.28	35	352.7	21.377	6.90
8	31	353.3	19.388	9.23	29	375.3	20.362	16.96	60	363.4	22.339	11.83
9	26	366.0	27.385	7.74	42	363.2	21.421	24.56	68	370.9	23.983	39.77
10	19	362.6	14.462	5.65	17	397.1	26.539	9.94	36	373.5	23.819	7.10
11	11	379.7	29.550	3.27	8	419.2	31.425	4.68	19	394.2	34.258	3.75
12	1	363.0		0.29	3	410.3	13.429	1.75	4	398.5	26.083	0.79
13	1	364.0		0.29					1	364.0		0.19
14	1	385.0		0.29	2	432.0	7.071	1.17	3	416.3	27.592	0.59
16					1	435.0		0.58	1	435.0		0.19
Total	336				171				507			
Mean		327.8	28.389			365.6	32.732			340.5	34.843	
Min		279.0				266.0				266.0		
Max		472.0				473.0				473.0		

* Combined = males + females + unknown sex

Appendix 3. Con't. Age-frequency distributions for migration of spawning shorthead redhorses from Ochre River.

YEAR 1985

Age (yr)	Males Fork Length (mm)				Females Fork Length (mm)				Combined * Fork Length (mm)			
	N	MEAN	STD	%	N	MEAN	STD	%	N	MEAN	STD	%
3												
4					1	258.0		0.18	1	258.0		0.09
5	22	309.1	7.625	4.49	8	335.0	7.630	1.49	30	316.2	14.157	2.92
6	239	323.9	11.288	48.78	154	340.9	13.188	28.73	394	330.6	14.581	38.36
7	171	329.2	12.134	34.90	226	350.3	13.450	42.16	397	341.2	16.594	38.66
8	8	345.1	13.601	1.63	31	368.4	18.961	5.78	39	363.6	20.21	3.80
9	23	365.7	12.528	3.33	40	381.9	15.324	7.46	63	375.9	16.286	6.13
10	18	369.8	17.013	2.61	44	390.9	21.162	8.21	62	384.8	22.113	6.04
11	6	359.3	9.993	0.87	17	396.1	19.599	3.11	23	386.5	23.975	2.24
12	2	389.5	0.707	0.29	7	403.7	16.879	1.31	9	400.6	15.907	0.88
13					5	428.2	25.292	0.93	5	428.2	25.29	0.49
14	1	395.0		0.14	3	423.7	23.459	0.56	4	416.5	23.924	0.39
Total	490				536				1027			
Mean		329.9	18.161			357.2	25.257			344.2	25.986	
Min		280.0				258.0				258.0		
Max		403.0				466.0				466.0		

* Combined = males + females + unknown sex

APPENDIX 4. SHORTHEAD REDHORSE FECUNDITIES, DAUPHIN LAKE 1984, 1985, 1986.

YEAR	FORK LENGTH (mm)	WEIGHT (gm)	WET WT OF EGGS (gm)	% BODY WT	ACTUAL EGG COUNT	% DIFF.	WT. METHOD EGG COUNT	STD.* OF DRY EGGS	EGG SIZE (mm)	STD.* OF EGG SIZE	AGE (yr)
1984	307						13630	0.0047	1.2080	0.0472	5
1984	310	490	47.9	9.78	12589	-0.56	12660	0.0048	1.6113	0.0135	
1984	322	640					15194	0.0061	1.5995	0.0388	6
1984	325	600	66.7	11.12	18643	1.32	18400	0.0089	1.5430	0.0231	6
1984	332	630			16548	1.32	16332	0.0033	1.6740	0.0151	6
1984	340	660					19486	0.0165	1.6177	0.0234	7
1984	340	710	61.2	8.62	15358	-0.05	15366	0.0023	1.6980	0.0304	6
1984	340	610			18892	1.70	18576	0.0028	1.2900	0.0230	
1984	341	640					16412	0.0018	1.6360	0.0205	
1984	345	900					25033	0.0025	1.8231	0.0316	7
1984	345	660	80.2	12.15			14498	0.0096	1.9200	0.0352	7
1984	348	690	53.2	7.71			20445	0.0035	1.3612	0.0024	
1984	350	740	81.5	11.01	15653	1.68	15394	0.0146	1.9040	0.0305	
1984	355	720					25185	0.0869	1.7795	0.0515	9
1984	355	750	103.1	13.75			20802	0.0029	1.7860	0.0316	7
1984	355	790	69.1	8.75			19327	0.0209	1.4789	0.0305	
1984	357	760					17936	0.0220	1.9022	0.0170	
1984	369	880	129.6	14.73	24188	2.99	23486	0.0068	1.8750	0.0222	9
1984	370	640	129.4	20.22	20966	1.78	20600	0.0062	1.7280	0.0180	
1984	371	755					23937	0.0059	1.7690	0.0263	9
1984	374	1010					27779	0.0095	1.5190	0.0095	9
1984	374	490	98.7	20.14			20719	0.0149	1.7885	0.0380	8
1984	378	880	161.0	18.30			30223	0.0309	1.8668	0.0293	
1984	384	750					25814	0.0387	1.8680	0.0298	
1984	385	930					27248	0.0028	1.4270	0.0104	
1984	386	900	78.8	8.76			20466	0.0064	1.5263	0.0158	9
1984	389	880					22138	0.0064	1.8229	0.0238	10
1984	391	1075	210.2	19.55	32739	5.23	31113	0.0104	1.8575	0.0435	
1984	394	1200	217.0	18.08			32745	0.0424	2.0809	0.0398	11
1984	399	1100					26063	0.0227	1.9558	0.0262	10
1984	404	1110	174.6	15.73	29461	-0.19	29516	0.0196	1.9930	0.0353	9
1984	406	1170			27478	3.62	26518	0.0249	2.1820	0.0239	9
1984	410	1160	184.4	15.90			37478	0.0280	1.7970	0.0437	9
1984	418	1370	176.8	12.91	34745	-0.77	35016	0.0138	1.7990	0.0511	
1984	420	1150	192.1	16.70			32318	0.0307	1.7180	0.0366	
1984	422	1390	235.9	16.97	38310	3.51	37010	0.0151	2.0240	0.0332	14
1984	424	1320	251.0	19.02			32557	0.0277	2.0648	0.0735	13

APPENDIX 4. Con't. SHORTHEAD REDHORSE FECUNDITIES, DAUPHIN LAKE 1984, 1985, 1986.

YEAR	FORK LENGTH (mm)	WEIGHT (gm)	WET WT OF EGGS (gm)	% BODY WT	ACTUAL EGG COUNT	% DIFF.	WT. METHOD EGG COUNT	STD.* OF DRY EGGS	EGG SIZE (mm)	STD.* OF EGG SIZE	AGE (yr)
1985	313						12868	0.0059	1.3841	0.0442	7
1985	323						18499	0.0040	1.2750	0.0169	7
1985	324						15432	0.0070	1.1570	0.0556	5
1985	336						17839		1.6620		7
1985	344						14078	0.0076	1.5250	0.0346	7
1985	344						14640	0.0145	1.5006	0.0147	7
1985	351				10773	-2.78	11081		1.6350		7
1985	353						18245	0.0146	1.7080	0.0200	7
1985	356						15615	0.0028	1.5960	0.0296	7
1985	361				21246	-0.07	21260	0.0017	1.5440	0.0221	
1985	366						18337	0.0046	1.6520	0.0129	7
1985	369				21444	0.68	21299	0.0033	1.6620	0.2380	7
1985	405	1220					30329	0.0061	1.8520	0.0217	8
1985	409						34133	0.0077	1.7040	0.0288	9
1985	413	1170	173.1	14.79	31401	0.77	31161	0.0475	1.9950	0.0137	
1985	415				39511	2.34	38606	0.0082	1.7560	0.0635	9
1985	418				44375	0.10	44329	0.0130	1.9340	0.0462	14
1985	420						29513	0.0045	1.9090	0.0254	12
1985	426						40602	0.0055	1.8006	0.0295	10
1985	430						36489	0.0157	1.9547	0.0317	13
1985	433						32630	0.0134	1.9554	0.0337	9
1985	444						39344	0.0471	1.9600		
1986	330	657					18974	0.0231	1.2728	0.0367	
1986	332	610	53.9	8.84			14635	0.0095	1.5859	0.0333	7
1986	335	524	45.0	8.59			16791	0.0092	1.3137	0.0426	
1986	338	617	45.4	7.36			11272	0.0166	1.6103	0.0066	
1986	341	638	54.5	8.54			12642	0.0169	1.5760	0.0196	
1986	343	612	39.1	6.39			12846	0.0259	1.4016	0.0512	
1986	344	629	61.8	9.83			15814	0.0155	1.3430	0.0228	8
1986	344	675	61.7	9.14			16169	0.0469	1.5064	0.0325	
1986	344	611	65.5	10.72			20862	0.0125	1.4280	0.0255	8
1986	345	639	54.1	8.47			17654	0.0105	1.3799	0.0478	8
1986	345	708	50.1	7.08			13741	0.0510	1.4323	0.0205	8
1986	345	635	33.3	5.24			12964	0.0063	1.2958	0.0156	
1986	347	703	50.2	7.14			10464	0.0296	1.6507	0.0091	
1986	348	669	49.0	7.32			17988	0.0063	1.2833	0.0290	
1986	349	687					20109	0.0078	1.4407	0.0234	8

APPENDIX 4. Con't. SHORTHEAD REDHORSE FECUNDITIES, DAUPHIN LAKE 1984, 1985, 1986.

YEAR	FORK LENGTH (mm)	WEIGHT (gm)	WET WT OF EGGS (gm)	% BODY WT	ACTUAL EGG COUNT	% DIFF.	WT. METHOD EGG COUNT	STD.* OF DRY EGGS	EGG SIZE (mm)	STD.* OF EGG SIZE	AGE (yr)
1986	350	715	75.1	10.50			18465	0.0069	1.6138	0.0247	
1986	350	603	49.9	8.28			18731	0.0092	1.2781	0.0230	
1986	351	685	45.8	6.69			14011	0.0073	1.4240	0.0247	
1986	351	682	51.7	7.58			18595	0.0137	1.3306	0.0284	
1986	353	668	65.9	9.87			19574	0.0107	1.4725	0.0635	
1986	355	670	69.0	10.30			19733	0.0143	1.5770	0.0293	8
1986	355	683	58.5	8.57			13677	0.0220	1.6288	0.0153	7
1986	356	627	58.5	9.33			20700	0.0110	1.4380	0.0331	
1986	357	665	53.1	7.98			20681	0.0075	1.3177	0.0463	6
1986	358	729	56.3	7.72			23155	0.0070	1.3391	0.0336	
1986	358	702	52.6	7.49			16215	0.0091	1.5364	0.0071	8
1986	359	669	50.0	7.47			18536	0.0129	1.3290	0.0382	7
1986	360	760	68.1	8.96			23585	0.0042	1.2404	0.0458	
1986	360	789	61.5	7.79			17638	0.0233	1.4110	0.0279	
1986	361	718	62.3	8.68			14572	0.0031	1.5143	0.0181	
1986	362	694	69.4	10.00			17288	0.0197	1.6731	0.0251	10
1986	363	602	70.2	11.66			22760	0.0119	1.3426	0.0342	
1986	363	673	78.6	11.68			25044	0.0050	1.4433	0.0273	7
1986	365	688	40.4	5.87			15840	0.0104	1.2670	0.0185	
1986	369	691	72.6	10.51			21332	0.0082	1.3566	0.0200	8
1986	369	661	77.4	11.71			22668	0.0348	1.4816	0.0333	
1986	373	807	66.2	8.20			16505	0.0186	1.5353	0.0198	
1986	375	382					19780	0.0123	1.3725	0.0404	8
1986	375	872	90.5	10.38			14934	0.0179	1.7677	0.0340	
1986	378	869	72.4	8.33			21122	0.0126	1.5449	0.0280	
1986	380	869	66.1	7.61			25992	0.0105	1.4058	0.0581	
1986	386	808	71.3	8.82			22627	0.0160	1.5177	0.0307	
1986	388	795	77.0	9.69			21637	0.0099	1.4591	0.0490	
1986	395	1093	109.0	9.97			22535	0.0111	1.7570	0.0186	11
1986	395	879					26596	0.0332	1.7600	0.0915	
1986	399	894	118.1	13.21			26140	0.0173	1.6263	0.0178	
1986	399	879	90.8	10.33			22287	0.0241	1.4575	0.0324	
1986	405	1090	102.4	9.39			30557	0.0061	1.4533	0.0309	

* = Standard deviation

APPENDIX 5. DAUPHIN LAKE WATER AND AIR TEMPERATURES (C).

DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP
05-May-84	12.4	12.4	5.4	05-May-85	14.2	14.2	13.2	05-May-87	14.7	14.7	15.5
06-May-84	11.3	23.7	0.1	06-May-85	13.1	27.3	8.6	06-May-87	14.1	28.8	12.8
07-May-84	11.7	35.4	1.9	07-May-85	13.8	41.1	11.5	07-May-87	14.1	42.9	12.9
08-May-84	12.3	47.7	4.6	08-May-85	15.5	56.6	19.3	08-May-87	14.4	57.3	22.4
09-May-84	12.6	60.3	6.2	09-May-85	14.7	71.3	16.0	09-May-87	14.0	71.3	8.7
10-May-84	12.7	73.0	6.8	10-May-85	13.0	84.3	8.0	10-May-87	13.0	84.3	9.6
11-May-84	12.6	85.6	6.4	11-May-85	14.2	98.5	13.4	11-May-87	13.6	97.9	9.9
12-May-84	12.1	97.7	4.2	12-May-85	12.5	111.0	5.8	12-May-87	14.6	112.5	25.4
13-May-84	13.4	111.1	9.7	13-May-85	12.2	123.2	4.8	13-May-87	16.7	129.2	14.4
14-May-84	13.6	124.7	10.5	14-May-85	12.6	135.8	6.5	14-May-87	15.1	144.3	12.0
15-May-84	14.6	139.3	15.3	15-May-85	13.0	148.8	8.0	15-May-87	15.1	159.4	20.9
16-May-84	16.2	155.5	22.5	16-May-85	13.8	162.6	11.6	16-May-87	15.3	174.7	11.9
17-May-84	15.7	171.2	19.9	17-May-85	15.0	177.6	17.1	17-May-87	14.0	188.7	8.2
18-May-84	13.6	184.8	10.5	18-May-85	15.1	192.7	17.3	18-May-87	13.4	202.1	8.1
19-May-84	12.4	197.2	5.7	19-May-85	12.9	205.6	7.6	19-May-87	14.0	216.1	13.5
20-May-84	13.3	210.5	9.1	20-May-85	12.9	218.5	7.6	20-May-87	13.6	229.7	8.0
21-May-84	14.2	224.7	13.5	21-May-85	14.6	233.1	15.3	21-May-87	10.9	240.6	3.2
22-May-84	13.7	238.4	11.3	22-May-85	14.5	247.6	14.5	22-May-87	11.2	251.8	5.4
23-May-84	12.8	251.2	7.1	23-May-85	15.1	262.7	17.2	23-May-87	12.5	264.3	14.2
24-May-84	11.9	263.1	3.1	24-May-85	13.6	276.3	10.5	24-May-87	12.5	276.8	16.0
25-May-84	12.3	275.4	4.7	25-May-85	13.7	290.0	11.3	25-May-87	12.9	289.7	14.0
26-May-84	13.2	288.6	8.9	26-May-85	13.6	303.6	11.0	26-May-87	13.3	303.0	12.6
27-May-84	12.9	301.5	7.5	27-May-85	13.5	317.1	10.2	27-May-87	13.4	316.4	14.7
28-May-84	13.9	315.4	11.9	28-May-85	14.3	331.4	14.0	28-May-87	14.8	331.2	16.7
29-May-84	14.9	330.3	16.6	29-May-85	19.8	351.2	16.1	29-May-87	16.6	347.8	16.9
30-May-84	16.2	346.5	22.4	30-May-85	17.8	369.0	11.2	30-May-87	18.3	366.1	18.7
31-May-84	16.1	362.6	21.8	31-May-85	15.0	384.0	5.7	31-May-87	19.7	385.8	23.7
01-Jun-84	17.8	380.4	14.6	01-Jun-85	12.0	396.0	4.4	01-Jun-87	18.9	404.7	16.9
02-Jun-84	18.2	398.6	15.4	02-Jun-85	13.3	409.3	8.9	02-Jun-87	15.5	420.2	10.9
03-Jun-84	17.6	416.2	14.2	03-Jun-85	12.5	421.8	5.8	03-Jun-87	13.4	433.6	11.5
04-Jun-84	17.7	433.9	14.4	04-Jun-85	11.5	433.3	8.3	04-Jun-87	15.0	448.6	12.2
05-Jun-84	18.0	451.9	15.4	05-Jun-85	14.8	448.1	13.5	05-Jun-87	15.4	464.0	15.9
06-Jun-84	17.0	468.9	14.7	06-Jun-85	16.5	464.6	18.7	06-Jun-87	16.1	480.1	20.0
07-Jun-84	17.0	485.9	16.9	07-Jun-85	18.5	483.1	20.0	07-Jun-87	17.2	497.3	12.9
08-Jun-84	16.3	502.2	12.4	08-Jun-85	17.8	500.9	16.9	08-Jun-87	16.9	514.2	11.2
09-Jun-84	15.3	517.5	10.4	09-Jun-85	18.9	519.8	12.3	09-Jun-87	17.8	532.0	17.0
10-Jun-84	17.5	535.0	10.2	10-Jun-85	18.9	538.7	10.7	10-Jun-87	17.9	549.9	17.2
11-Jun-84	19.3	554.3	15.9	11-Jun-85	18.9	557.6	12.2	11-Jun-87	18.0	567.9	19.9
12-Jun-84	18.5	572.8	12.5	12-Jun-85	18.9	576.5	12.4	12-Jun-87	19.7	587.6	21.0
13-Jun-84	18.0	590.8	12.0	13-Jun-85	20.0	596.5	16.9	13-Jun-87	21.3	608.9	22.9
14-Jun-84	17.8	608.6	13.3	14-Jun-85	16.0	612.5	13.6	14-Jun-87	21.8	630.7	20.0
15-Jun-84	19.5	628.1	19.9	15-Jun-85	15.0	627.5	15.9	15-Jun-87	21.0	651.7	24.6
16-Jun-84	21.8	649.9	18.7	16-Jun-85	16.3	643.8	12.2	16-Jun-87	20.9	672.6	25.5
17-Jun-84	21.3	671.2	17.7	17-Jun-85	19.3	663.1	13.7	17-Jun-87	22.3	694.9	19.8
18-Jun-84	21.0	692.2	17.5	18-Jun-85	20.5	683.6	14.8	18-Jun-87	22.1	717.0	19.9

APPENDIX 5. Con't. DAUPHIN LAKE WATER AND AIR TEMPERATURES (C).

DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP
19-Jun-84	22.0	714.2	18.4	19-Jun-85	20.5	704.1	16.6	19-Jun-87	23.7	740.7	21.0
20-Jun-84	22.3	736.5	18.6	20-Jun-85	21.8	725.9	22.3	20-Jun-87	24.5	765.2	22.3
21-Jun-84	21.5	758.0	19.6	21-Jun-85	18.8	744.7	12.3	21-Jun-87	23.4	788.6	23.1
22-Jun-84	20.3	778.3	17.9	22-Jun-85	15.0	759.7	9.5	22-Jun-87	24.1	812.7	23.9
23-Jun-84	19.3	797.6	17.2	23-Jun-85	15.3	775.0	11.1	23-Jun-87	21.9	834.6	19.3
24-Jun-84	20.5	818.1	17.1	24-Jun-85	15.0	790.0	10.1	24-Jun-87	19.6	854.2	16.8
25-Jun-84	21.8	839.9	22.5	25-Jun-85	14.3	804.3	12.2	25-Jun-87	17.4	871.6	12.6
26-Jun-84	20.8	860.7	19.5	26-Jun-85	15.3	819.6	12.1	26-Jun-87	17.2	888.8	14.7
27-Jun-84	21.3	882.0	18.9	27-Jun-85	15.3	834.9	11.7	27-Jun-87	18.0	906.8	17.9
28-Jun-84	23.8	905.8	19.7	28-Jun-85	14.0	848.9	9.8	28-Jun-87	17.9	924.7	15.1
29-Jun-84	24.0	929.8	23.5	29-Jun-85	14.3	863.2	13.5	29-Jun-87	18.2	942.9	15.7
30-Jun-84	21.0	950.8	17.9	30-Jun-85	18.0	881.2	15.6	30-Jun-87	19.2	962.1	16.0
01-Jul-84	21.3	972.1	17.9	01-Jul-85	19.3	900.5	16.4	01-Jul-87	19.8	981.9	18.8
02-Jul-84	21.8	993.9	17.8	02-Jul-85	20.8	921.3	19.1	02-Jul-87	19.9	1001.8	17.0
03-Jul-84	21.0	1014.9	16.7	03-Jul-85	21.8	943.1	21.0	03-Jul-87	20.7	1022.5	16.8
04-Jul-84	20.8	1035.7	15.9	04-Jul-85	20.5	963.6	20.1	04-Jul-87	21.4	1043.9	23.4
05-Jul-84	19.8	1055.5	11.9	05-Jul-85	23.3	986.9	21.6	05-Jul-87	21.8	1065.7	19.7
06-Jul-84	19.8	1075.3	11.2	06-Jul-85	22.0	1008.9	24.2	06-Jul-87	21.3	1087.0	19.5
07-Jul-84	17.3	1092.6	15.8	07-Jul-85	23.8	1032.7	21.1	07-Jul-87	19.9	1106.9	17.0
08-Jul-84	20.0	1112.6	19.7	08-Jul-85	22.0	1054.7	18.3	08-Jul-87	20.5	1127.4	16.2
09-Jul-84	21.5	1134.1	18.4	09-Jul-85	21.0	1075.7	16.5	09-Jul-87	20.3	1147.7	18.0
10-Jul-84	23.5	1157.6	19.5	10-Jul-85	22.0	1097.7	16.2	10-Jul-87	19.5	1167.2	17.4
11-Jul-84	24.5	1182.1	20.8	11-Jul-85	22.8	1120.5	20.2	11-Jul-87	18.5	1185.7	12.4
12-Jul-84	23.5	1205.6	18.8	12-Jul-85	21.0	1141.5	16.8	12-Jul-87	17.8	1203.5	12.8
13-Jul-84	22.8	1228.4	19.7	13-Jul-85	20.0	1161.5	18.2	13-Jul-87	19.2	1222.7	14.8
14-Jul-84	19.0	1247.4	17.1	14-Jul-85	19.0	1180.5	15.7	14-Jul-87	19.8	1242.5	15.8
15-Jul-84	20.0	1267.4	17.6	15-Jul-85	20.3	1200.8	16.7	15-Jul-87	19.3	1261.8	17.1
16-Jul-84	20.8	1288.2	17.3	16-Jul-85	19.5	1220.3	17.1	16-Jul-87	19.7	1281.5	19.7
17-Jul-84	21.8	1310.0	17.8	17-Jul-85	19.8	1240.1	15.9	17-Jul-87	19.6	1301.1	16.4
18-Jul-84	23.0	1333.0	19.0	18-Jul-85	19.0	1259.1	14.2	18-Jul-87	18.5	1319.6	15.2
19-Jul-84	22.6	1355.6	16.7	19-Jul-85	17.8	1276.9	15.5	19-Jul-87	17.6	1337.2	17.9
20-Jul-84	22.3	1377.9	19.2	20-Jul-85	19.0	1295.9	14.1	20-Jul-87	18.3	1355.5	17.0
21-Jul-84	22.3	1400.2	23.2	21-Jul-85	18.5	1314.4	14.0	21-Jul-87	17.6	1373.1	15.2
22-Jul-84	23.3	1423.5	18.6	22-Jul-85	20.0	1334.4	20.5	22-Jul-87	17.5	1390.6	15.4
23-Jul-84	22.0	1445.5	18.1	23-Jul-85	20.0	1354.4	19.2	23-Jul-87	19.0	1409.6	17.6
24-Jul-84	23.3	1468.8	18.6	24-Jul-85	20.0	1374.4	15.9	24-Jul-87	22.1	1431.7	18.8
25-Jul-84	22.8	1491.6	19.8	25-Jul-85	20.0	1394.4	16.8	25-Jul-87	22.3	1454.0	19.4
26-Jul-84	23.0	1514.6	19.3	26-Jul-85	20.0	1414.4	14.8	26-Jul-87	21.4	1475.4	19.6
27-Jul-84	24.5	1539.1	21.1	27-Jul-85	20.0	1434.4	17.5	27-Jul-87	23.0	1498.4	21.0
28-Jul-84	24.8	1563.9	26.3	28-Jul-85	20.0	1454.4	15.4	28-Jul-87	25.1	1523.5	25.1
29-Jul-84	25.3	1589.2	25.0	29-Jul-85	20.0	1474.4	16.3	29-Jul-87	24.6	1548.1	21.6
30-Jul-84	24.5	1613.7	22.7	30-Jul-85	20.0	1494.4	18.6	30-Jul-87	23.9	1572.0	19.9
31-Jul-84	23.0	1636.7	21.1	31-Jul-85	21.5	1515.9	17.4	31-Jul-87	22.9	1594.9	22.1
01-Aug-84	23.5	1660.2	20.2	01-Aug-85	21.0	1536.9	17.7	01-Aug-87	23.9	1618.8	

APPENDIX 5. Con't. DAUPHIN LAKE WATER AND AIR TEMPERATURES (C).

DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP
02-Aug-84	25.5	1685.7	21.5	02-Aug-85	21.3	1558.2	19.2	02-Aug-87	22.8	1641.6	
03-Aug-84	27.0	1712.7	22.3	03-Aug-85	21.8	1580.0	17.7	03-Aug-87	19.8	1661.4	
04-Aug-84	27.8	1740.5	23.0	04-Aug-85	21.3	1601.3	18.2	04-Aug-87	17.9	1679.3	
05-Aug-84	26.8	1767.3	23.9	05-Aug-85	22.0	1623.3	19.6	05-Aug-87	18.0	1697.3	
06-Aug-84	25.8	1793.1	21.3	06-Aug-85	21.0	1644.3	19.9	06-Aug-87	18.4	1715.7	
07-Aug-84	25.3	1818.4	22.3	07-Aug-85	20.0	1664.3	17.9	07-Aug-87	21.6	1737.3	
08-Aug-84	20.8	1839.2	15.4	08-Aug-85	20.5	1684.8	16.8	08-Aug-87	22.6	1759.9	
09-Aug-84	20.5	1859.7	17.6	09-Aug-85	19.0	1703.8	10.7	09-Aug-87	21.1	1781.0	
10-Aug-84	21.8	1881.5	16.5	10-Aug-85	19.0	1722.8	10.6	10-Aug-87	19.6	1800.6	
11-Aug-84	22.0	1903.5	23.1	11-Aug-85	19.0	1741.8	11.0	11-Aug-87	19.7	1820.3	
12-Aug-84	22.8	1926.3	23.3	12-Aug-85	19.0	1760.8	13.0	12-Aug-87	17.9	1838.2	
13-Aug-84	24.3	1950.6	22.2	13-Aug-85	18.3	1779.1	12.0	13-Aug-87	17.2	1855.4	
14-Aug-84	24.5	1975.1	22.7	14-Aug-85	17.8	1796.9	14.1	14-Aug-87	17.2	1872.6	
15-Aug-84	21.5	1996.6	15.2	15-Aug-85	18.0	1814.9	11.3	15-Aug-87	16.6	1889.2	
16-Aug-84	21.8	2018.4	21.3	16-Aug-85	18.5	1833.4	11.5	16-Aug-87	16.6	1905.8	
17-Aug-84	22.5	2040.9	19.3	17-Aug-85	18.3	1851.7	11.0	17-Aug-87	16.4	1922.2	
18-Aug-84	22.3	2063.2	21.9	18-Aug-85	18.0	1869.7	10.8	18-Aug-87	17.3	1939.5	
19-Aug-84	22.5	2085.7	26.2	19-Aug-85	17.5	1887.2	10.9	19-Aug-87	16.7	1956.2	
20-Aug-84	21.3	2107.0	19.5	20-Aug-85	17.5	1904.7	10.9	20-Aug-87	17.1	1973.3	
21-Aug-84	20.3	2127.3	13.5	21-Aug-85	17.8	1922.5	13.8	21-Aug-87	16.4	1989.7	
22-Aug-84	20.5	2147.8	12.8	22-Aug-85	18.3	1940.8	16.0	22-Aug-87	14.6	2004.3	
23-Aug-84	20.8	2168.6	17.8	23-Aug-85	18.3	1959.1	14.3	23-Aug-87	15.2	2019.5	
24-Aug-84	23.3	2191.9	22.2	24-Aug-85	19.8	1978.9	19.1	24-Aug-87	18.0	2037.5	
25-Aug-84	24.8	2216.7	24.1	25-Aug-85	19.3	1998.2	19.2	25-Aug-87	17.3	2054.8	
26-Aug-84	25.0	2241.7	23.6	26-Aug-85	18.8	2017.0	15.6	26-Aug-87	16.7	2071.5	
27-Aug-84	20.8	2262.5	23.4	27-Aug-85	18.5	2035.5	12.8	27-Aug-87	19.2	2090.7	
28-Aug-84	20.8	2283.3	19.2	28-Aug-85	18.8	2054.3	11.5	28-Aug-87	18.4	2109.1	
29-Aug-84	17.3	2300.6	15.3	29-Aug-85	18.8	2073.1	13.0	29-Aug-87	17.6	2126.7	
30-Aug-84	16.5	2317.1	13.2	30-Aug-85	18.8	2091.9	16.7	30-Aug-87	15.2	2141.9	
31-Aug-84	16.5	2333.6	10.2	31-Aug-85	18.5	2110.4	16.0	31-Aug-87	14.1	2156.0	
01-Sep-84	15.8	2349.4	10.4	01-Sep-85	18.3	2128.7	11.9	01-Sep-87	15.0	2171.0	
02-Sep-84	16.8	2366.2	12.0	02-Sep-85	18.8	2147.5	14.7	02-Sep-87	14.3	2185.3	
03-Sep-84	16.5	2382.7	10.4	03-Sep-85	18.8	2166.3	16.5	03-Sep-87	14.9	2200.2	
04-Sep-84	17.8	2400.5	11.1	04-Sep-85	18.8	2185.1	9.6	04-Sep-87	15.3	2215.5	
05-Sep-84	17.0	2417.5	12.7	05-Sep-85	18.8	2203.9	11.9	05-Sep-87	15.0	2230.5	
06-Sep-84	16.3	2433.8	17.8	06-Sep-85	17.5	2221.4	10.6	06-Sep-87	15.7	2246.2	
07-Sep-84	18.8	2452.6	14.4	07-Sep-85	18.5	2239.9	5.5	07-Sep-87	15.0	2261.2	
08-Sep-84	16.3	2468.9	10.0	08-Sep-85	17.3	2257.2	6.9	08-Sep-87	14.2	2275.4	
09-Sep-84	14.0	2482.9	8.4	09-Sep-85	18.0	2275.2	7.9	09-Sep-87	14.2	2289.6	
10-Sep-84	13.0	2495.9	7.7	10-Sep-85	17.5	2292.7	8.7	10-Sep-87	13.9	2303.5	
11-Sep-84	13.0	2508.9	6.7	11-Sep-85	17.5	2310.2	9.6	11-Sep-87	13.2	2316.7	
12-Sep-84	13.8	2522.7	10.3	12-Sep-85	17.3	2327.5	13.2	12-Sep-87	13.8	2330.5	
13-Sep-84	13.5	2536.2	9.5	13-Sep-85	17.8	2345.3	15.9	13-Sep-87	13.1	2343.6	
14-Sep-84	14.0	2550.2	9.3	14-Sep-85		2345.3	15.5	14-Sep-87	13.8	2357.4	
15-Sep-84	14.5	2564.7	9.8	15-Sep-85			15.6	15-Sep-87	14.7	2372.1	

APPENDIX 5. Con't. DAUPHIN LAKE WATER AND AIR TEMPERATURES (C).

DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP	DATE	MEAN WATER TEMP	CUM. WATER TEMP	MEAN AIR TEMP
16-Sep-84	14.0	2578.7	13.0	16-Sep-85			17.5	16-Sep-87	14.8	2386.9	
17-Sep-84			18.6	17-Sep-85			13.4	17-Sep-87	14.6	2401.5	
18-Sep-84			17.0	18-Sep-85			5.7	18-Sep-87	13.3	2414.8	
19-Sep-84			13.5	19-Sep-85			3.8	19-Sep-87	12.9	2427.7	
20-Sep-84			12.2	20-Sep-85			4.0	20-Sep-87	13.0	2440.7	
21-Sep-84			7.6	21-Sep-85			10.5	21-Sep-87	13.6	2454.3	
22-Sep-84			3.4	22-Sep-85			6.8	22-Sep-87	15.4	2469.7	
23-Sep-84			1.6	23-Sep-85			2.4	23-Sep-87	15.3	2485.0	
24-Sep-84			0.5	24-Sep-85			2.1	24-Sep-87	14.3	2499.3	
25-Sep-84			2.2	25-Sep-85			5.0	25-Sep-87	13.3	2512.6	
26-Sep-84			5.0	26-Sep-85			8.1	26-Sep-87	13.4	2526.0	
27-Sep-84			2.8	27-Sep-85			4.1	27-Sep-87	13.2	2539.2	
28-Sep-84			6.9	28-Sep-85			2.9	28-Sep-87	13.7	2552.9	
29-Sep-84			6.6	29-Sep-85			3.4	29-Sep-87	12.9	2565.8	
30-Sep-84			5.9	30-Sep-85			3.4	30-Sep-87	11.1	2576.9	
								01-Oct-87	10.6	2587.5	
								02-Oct-87	8.9	2596.4	
								03-Oct-87	9.8	2606.2	
								04-Oct-87	11.5	2617.7	
								05-Oct-87	9.8	2627.5	
								06-Oct-87	8.8	2636.3	
								07-Oct-87	8.2	2644.5	
								08-Oct-87	6.1	2650.6	
								09-Oct-87	4.1	2654.7	
								10-Oct-87	2.3	2657.0	
								11-Oct-87	3.3	2660.3	
								12-Oct-87	4.5	2664.8	
								13-Oct-87	5.7	2670.5	
								14-Oct-87	5.1	2675.6	
								15-Oct-87	4.8	2680.4	
								16-Oct-87	4.9	2685.3	
								17-Oct-87	4.9	2690.2	
								18-Oct-87	4.2	2694.4	
								19-Oct-87	3.6	2698.0	

Appendix 6. Shorthead redhorse recapture tagging data for Dauphin Lake and Ochre River 1985,1986 and 1987.

TAG #	SEX	DATE TAGGED	ORIG FKLT (mm)	ORIG AGE (YR)	DATE RECAP	RECAP FKLT (mm)	RECAP AGE (YR)	RECAP LOC	FKLT CHANGE (mm)	CORRECT NO. OF ANNULI FORMED
Y8181	F	07-MAY-85	390	8	24-MAY-85	392	NA	OCHRE R.	2	
Y8113	F	18-JUN-84	394	11	31-JUN-85	405	12	OCHRE R.	11	YES
Y8132	F	07-MAY-85	332	7	24-MAY-85	331	NA	OCHRE R.	-1	
B3861	M	25-MAY-84	305	NA	31-JUN-85	330	7	OCHRE R.	25	
Y5636	F	12-JUN-84	357	8	24-MAY-85	370	9	OCHRE R.	13	YES
Y5292	F	08-JUN-84	389	9	31-JUN-85	391	10	OCHRE R.	2	YES
T5692	F	07-JUN-84	402	10	24-MAY-85	414	10	OCHRE R.	12	NO
Y5871	F	15-JUN-84	335	6	01-JUN-85	347	7	OCHRE R.	12	YES
Y7805	F	03-JUN-84	385	11	25-MAY-85	387	11	OCHRE R.	2	NO
Y7807	M	03-JUN-84	319	6	03-JUN-85	330	7	OCHRE R.	11	YES
Y5293	F	08-JUN-84	395	11	25-MAY-85	400	12	OCHRE R.	5	YES
Y7821	M	30-MAY-84	320	6	01-JUN-85	336	7	OCHRE R.	16	YES
Y8695	F	09-MAY-85	335	6	25-MAY-85	332	NA	OCHRE R.	-3	
Y5709	F	14-JUN-84	326	6	01-JUN-85	350	7	OCHRE R.	24	YES
Y5042	F	10-MAY-85	340	7	25-MAY-85	338	NA	OCHRE R.	-2	
Y5656	F	09-JUN-84	383	8	01-JUN-85	386	9	OCHRE R.	3	YES
Y8181	F	18-JUN-84	338	6	25-MAY-85	365	NA	OCHRE R.	27	
Y5666	F	09-JUN-84	390	10	02-JUN-85	394	11	OCHRE R.	4	YES
Y5698	F	07-JUN-84	371	7	25-MAY-85	385	7	OCHRE R.	14	NO
Y3872	M	26-MAY-84	308	6	02-JUN-85	317	6	OCHRE R.	9	NO
Y5299	F	08-JUN-84	378	9	25-MAY-85	397	9	OCHRE R.	19	NO
Y5660	M	09-JUN-84	311	5	02-JUN-85	332	6	OCHRE R.	21	YES
Y5750	F	14-JUN-84	335	6	25-MAY-85	350	6	OCHRE R.	15	NO
Y5763	M	10-JUN-84	304	6	03-JUN-85	316	7	OCHRE R.	12	YES
Y8176	F	09-MAY-85	389	11	25-MAY-85	391	NA	OCHRE R.	2	
Y5649	M	13-JUN-84	312	6	06-JUN-85	331	7	OCHRE R.	19	YES
Y8683	M	09-MAY-85	325	6	25-MAY-85	327	NA	OCHRE R.	2	
Y5641	M	13-JUN-84	308	6	06-JUN-85	327	7	OCHRE R.	19	YES
Y7865	F	07-JUN-84	400	11	25-MAY-85	412	12	OCHRE R.	12	YES
Y5859	M	15-JUN-84	348	9	28-MAY-85	353	9	OCHRE R.	5	NO
Y5268	F	07-JUN-84	363	6	26-MAY-85	373	7	OCHRE R.	10	YES
Y8121	F	18-JUN-84	362	9	28-MAY-85	376	10	OCHRE R.	14	YES
B3858	M	24-MAY-84	317	6	07-JUN-85	334	7	OCHRE R.	17	YES
Y5030	F	12-JUN-84	359	6	28-MAY-85	356	6	OCHRE R.	-3	NO
Y5863	M	31-MAY-84	333	6	08-JUN-85	342	7	OCHRE R.	9	YES
Y8144	M	08-MAY-85	330	6	28-MAY-85	330	6	OCHRE R.	0	YES
Y5895	M	17-JUN-84	385	14	08-JUN-85	395	14	OCHRE R.	10	NO
Y5484	M	10-MAY-85	322	6	29-MAY-85	322	6	OCHRE R.	0	YES
Y5754	M	11-JUN-84	365	10	08-JUN-85	372	11	OCHRE R.	7	YES
Y5880	M	17-JUN-84	307	6	29-MAY-85	323	7	OCHRE R.	16	YES
Y7895	M	14-JUN-84	311	6	09-JUN-85	320	7	OCHRE R.	9	YES
Y5717	F	14-JUN-84	357	9	29-MAY-85	367	9	OCHRE R.	10	NO
Y8114	M	18-JUN-84	331	6	09-JUN-85	343	7	OCHRE R.	12	YES
Y5770	F	10-JUN-84	421	NA	29-MAY-85	424	NA	OCHRE R.	3	
Y5719	M	14-JUN-84	303	5	10-JUN-85	323	6	OCHRE R.	20	YES
Y5872	F	15-JUN-84	331	6	29-MAY-85	362	7	OCHRE R.	31	YES
Y7564	M	28-MAY-84	296	5	10-JUN-85	330	6	OCHRE R.	34	YES
Y5035	M	12-MAY-85	335	6	29-MAY-85	334	6	OCHRE R.	-1	YES
Y5896	M	17-JUN-84	347	10	11-JUN-85	357	11	OCHRE R.	10	YES
Y8138	M	08-MAY-85	332	6	29-MAY-85	337	6	OCHRE R.	5	YES
Y5664	M	09-JUN-84	319	7	11-JUN-85	331	6	OCHRE R.	12	NO
Y3847	F	27-JUN-84	392	NA	31-MAY-85	394	7	OCHRE R.	2	
Y5710	F	14-JUN-84	367	6	12-JUN-85	370	10	OCHRE R.	3	NO
Y5072	F	17-JUN-84	374	8	31-JUN-85	390	9	OCHRE R.	16	YES
Y5741	F	14-JUN-84	329	6	12-JUN-85	350	7	OCHRE R.	21	YES

Appendix 6. Con't. Shorthead redhorse recapture tagging data for Dauphin Lake and Ochre River 1985,1986 and 1987.

TAG #	SEX	DATE TAGGED	ORIG FKLT (mm)	ORIG AGE (YR)	DATE RECAP	RECAP FKLT (mm)	RECAP AGE (YR)	RECAP LOC	FKLT CHANGE (mm)	CORRECT NO. OF ANNULI FORMED
Y5055	F	14-JUN-84	327	6	26-MAY-85	362	7	OCHRE R.	35	YES
Y5670	F	09-JUN-84	357	9	12-JUN-85	364	10	OCHRE R.	7	YES
Y5949	F	14-JUN-84	413	10	26-MAY-85	429	11	OCHRE R.	16	YES
Y7808	M	03-JUN-84	315	6	13-JUN-85	330	7	OCHRE R.	15	YES
Y8320	M	25-MAY-85	330	8	26-MAY-85	328	8	OCHRE R.	-2	YES
Y5264	M	14-JUN-84	369	9	13-JUN-85	374	10	OCHRE R.	5	YES
Y5653	F	03-JUN-84	356	7	26-MAY-85	372	8	OCHRE R.	16	YES
Y8106	F	18-JUN-84	402	10	13-JUN-85	404	11	OCHRE R.	2	YES
Y5051	F	15-JUN-84	325	6	26-MAY-85	344	7	OCHRE R.	19	YES
Y8104	M	18-JUN-84	388	11	13-JUN-85	390	12	OCHRE R.	2	YES
Y5752	F	11-JUN-84	328	6	26-MAY-85	359	6	OCHRE R.	31	NO
Y7873	M	04-JUN-84	316	6	13-JUN-85	329	7	OCHRE R.	13	YES
Y5737	F	14-JUN-84	335	5	26-MAY-85	339	6	OCHRE R.	4	YES
Y8120	M	18-JUN-84	385	NA	13-JUN-85	389	12	OCHRE R.	4	
Y8644	M	06-MAY-85	340	6	27-MAY-85	340		OCHRE R.	0	
Y7888	F	14-JUN-84	350	10	13-JUN-85	362	11	OCHRE R.	12	YES
Y7837	F	27-MAY-84	357	8	27-MAY-85	365	9	OCHRE R.	8	YES
Y5731	M	14-JUN-84	348	8	13-JUN-85	355	NA	OCHRE R.	7	
Y8107	F	18-JUN-84	338	6	27-MAY-85	359	7	OCHRE R.	21	YES
Y5897	F	17-JUN-84	332	6	13-JUN-85	354	7	OCHRE R.	22	YES
Y5285	F	08-JUN-84	383	8	27-MAY-85	393	9	OCHRE R.	10	YES
Y7832	M	03-JUN-84	306	6	13-JUN-85	323	7	OCHRE R.	17	YES
Y5704	M	15-JUN-84	345	9	27-MAY-85	374	10	OCHRE R.	29	YES
Y7824	M	28-JUN-84	336	6	13-JUN-85	342	7	OCHRE R.	6	YES
Y7866	F	07-JUN-84	352	NA	28-MAY-85	352	NA	OCHRE R.	0	
Y7898	M	14-JUN-84	294	5	14-JUN-85	338	6	OCHRE R.	44	YES
Y5738	F	14-JUN-84	356	7	28-MAY-85	366	8	OCHRE R.	10	YES
Y5868	M	15-JUN-84	319	5	14-JUN-85	345	6	OCHRE R.	26	YES
Y5716	M	14-JUN-84	354	NA	29-MAY-85	358	NA	OCHRE R.	4	
Y7854	F	07-JUN-84	365	8	29-MAY-85	380	9	OCHRE R.	15	YES
Y7811	F	02-JUN-84	373	9	22-MAY-85	380	10	OCHRE R.	7	YES
Y5047	M	10-MAY-85	320	7	23-MAY-85	320	7	OCHRE R.	0	YES
Y8078	F	27-JUN-85	339	7	15-NOV-86	350	8	OCHRE R.	11	YES
Y5277	F	08-JUN-84	315	6	24-MAY-85	338	7	OCHRE R.	23	YES
Y5866	M	15-JUN-84	325	6	14-JUN-85	340	7	OCHRE R.	15	YES
Y5284	F	08-JUN-84	361	12	24-MAY-85	375	12	OCHRE R.	14	NO
Y7886	F	14-JUN-84	360	7	28-MAY-85	374	8	OCHRE R.	14	YES
Y7845	F	04-JUN-84	392	10	31-JUN-85	398	11	OCHRE R.	6	YES
Y5052	F	15-JUN-84	374	10	27-MAY-85	383	11	OCHRE R.	9	YES
Y7803	M	03-JUN-84	314	5	31-JUN-85	338	6	OCHRE R.	24	YES
Y8360	F	15-MAY-85	346	7	27-MAY-85	346	7	OCHRE R.	0	YES
Y7896	F	14-JUN-84	328	6	31-JUN-85	334	7	OCHRE R.	6	YES
Y5029	F	12-MAY-85	334	7	26-MAY-85	331	7	OCHRE R.	-3	YES
Y5065	M	15-JUN-84	327	6	01-JUN-85	341	7	OCHRE R.	14	YES
Y7843	F	03-JUN-84	389	9	26-MAY-85	398	10	OCHRE R.	9	YES
Y8124	M	17-JUN-84	367	11	01-JUN-85	371	11	OCHRE R.	4	NO
Y7844	F	03-JUN-84	377	10	13-MAY-85	377	10	OCHRE R.	0	NO
Y5852	M	15-JUN-84	360	8	01-JUN-85	360	9	OCHRE R.	0	YES
Y5298	F	08-JUN-84	370	9	14-MAY-85	390	10	OCHRE R.	20	YES
Y5889	M	17-JUN-84	368	9	01-JUN-85	372	9	OCHRE R.	4	NO
Y5684	F	07-JUN-84	384	10	16-MAY-85	395	10	OCHRE R.	11	NO
Y5062	M	15-JUN-84	365	9	01-JUN-85	370	9	OCHRE R.	5	NO
Y7862	F	07-JUN-84	403	9	24-JUN-85	416	12	OCHRE R.	13	NO
Y5768	M	10-JUN-84	310	5	02-JUN-85	326	6	OCHRE R.	16	YES
Y5481	M	09-MAY-85	381	6	16-MAY-85	379	NA	OCHRE R.	-2	

Appendix 6. Con't. Shorthead redhorse recapture tagging data for Dauphin Lake and Ochre River 1985,1986 and 1987.

TAG #	SEX	DATE TAGGED	ORIG FKLT (mm)	ORIG AGE (YR)	DATE RECAP	RECAP FKLT (mm)	RECAP AGE (YR)	RECAP LOC	FKLT CHANGE (mm)	CORRECT NO. OF ANNULI FORMED
Y7864	M	07-JUN-84	310	6	02-JUN-85	332	7	OCHRE R.	22	YES
Y8108	F	18-JUN-84	377	10	31-MAY-85	378	NA	OCHRE R.	1	
Y5729	M	14-JUN-84	335	5	02-JUN-85	353	6	OCHRE R.	18	YES
B3847	F	27-MAY-84	392	NA	22-MAY-85	400	10	OCHRE R.	8	
Y5701	M	15-JUN-84	321	6	05-JUN-85	334	7	OCHRE R.	13	YES
Y5873	F	17-JUN-84	406	9	22-MAY-85	425	10	OCHRE R.	19	YES
Y5659	M	09-JUN-84	335	6	06-JUN-85	349	7	OCHRE R.	14	YES
Y8364	F	15-MAY-85	349	7	26-MAY-85	347	7	OCHRE R.	-2	YES
Y5898	M	17-JUN-84	306	6	06-JUN-85	326	7	OCHRE R.	20	YES
Y5280	M	08-JUN-84	367	9	28-MAY-85	378	10	OCHRE R.	11	YES
Y5300	M	18-JUN-84	365	9	28-MAY-85	375	10	OCHRE R.	10	YES
B3863	F	25-MAY-84	345	7	27-MAY-85	357	7	OCHRE R.	12	NO
Y5067	F	15-JUN-84	391	8	28-MAY-85	408	8	OCHRE R.	17	NO
Y5297	F	08-JUN-84	418		26-MAY-85	427	7	OCHRE R.	9	
Y7846	F	04-JUN-84	392	9	28-MAY-85	398	10	OCHRE R.	6	YES
Y5693	F	07-JUN-84	375	9	14-MAY-85	398	10	OCHRE R.	23	YES
Y5877	M	17-JUN-84	325	6	29-MAY-85	337	7	OCHRE R.	12	YES
Y5899	M	17-JUN-84	318	6	16-MAY-85	326	7	OCHRE R.	8	YES
Y5694	F	07-JUN-84	367	9	26-MAY-85	375	10	OCHRE R.	8	YES
Y8135	M	07-MAY-85	336	NA	07-MAY-85	345	NA	OCHRE R.	9	
Y5673	F	10-JUN-84	349	7	26-MAY-85	368	8	OCHRE R.	19	YES
B3854	F	24-MAY-84	354	6	22-MAY-85	366	7	OCHRE R.	12	YES
Y8883	F	24-MAY-85	397	9	29-MAY-85	394	9	OCHRE R.	-3	YES
Y8103	M	10-JUN-84	312	6	14-JUN-85	333	7	OCHRE R.	21	YES
Y8313	M	14-JUN-85	334	6	29-MAY-85	333	6	OCHRE R.	-1	YES
B3864	F	26-MAY-84	383	8	26-MAY-85	NA	8	OCHRE R.		NO
Y5672	F	10-JUN-84	359	6	29-MAY-85	364	7	OCHRE R.	5	YES
Y7867	F	07-JUN-84	427	NA	15-MAY-85	430	12	OCHRE R.	3	
Y8158	F	08-MAY-85	350	6	29-MAY-85	352	6	OCHRE R.	2	YES
Y5480	M	09-MAY-85	325	6	18-MAY-85	322	NA	OCHRE R.	-3	
Y8126	M	19-JUN-84	370	10	30-MAY-85	380	11	OCHRE R.	10	YES
Y8331	F	17-MAY-85	341	6	27-MAY-85	341	6	OCHRE R.	0	YES
Y5860	M	15-JUN-84	310	6	31-MAY-85	320	7	OCHRE R.	10	YES
Y5297	F	08-JUN-84	418	8	20-JUN-85	430	8	OCHRE R.	12	NO
Y7826	F	03-JUN-84	395	10	12-MAY-85	399	10	OCHRE R.	4	YES
Y5061	F	15-JUN-84	398	11	22-MAY-85	413	12	OCHRE R.	15	YES
Y8145	M	08-MAY-85	322	7	31-MAY-85	321	NA	OCHRE R.	-1	
Y5746	M	14-JUN-84	324	6	24-JUN-85	328	7	OCHRE R	4	YES
Y7883	M	14-JUN-84	349	8	18-JUN-85	352	9	OCHRE R	3	YES
B3856	M	24-MAY-84	326	NA	24-JUN-85	338	7	OCHRE R	12	
Y7876	M	14-JUN-84	318	6	19-JUN-85	328	7	OCHRE R	10	YES
Y5269	M	14-JUN-84	359	8	14-JUN-85	367	11	OCHRE R	8	NO
Y5740	M	14-JUN-84	311	6	19-JUN-85	333	7	OCHRE R	22	YES
Y5878	M	17-JUN-84	336	9	14-JUN-85	343	9	OCHRE R	7	NO
Y7882	M	14-JUN-84	316	5	14-JUN-85	333	6	OCHRE R	17	YES
Y5748	M	14-JUN-84	361	NA	14-JUN-85	359	10	OCHRE R	-2	
Y5867	M	15-JUN-84	344	8	14-JUN-85	350	9	OCHRE R	6	YES
Y8118	M	18-JUN-84	325	6	18-JUN-85	328	7	OCHRE R	3	YES
Y7899	M	14-JUN-84	356	8	21-JUN-85	362	9	OCHRE R	6	YES
B3875	M	26-MAY-84	316	6	14-JUN-85	335	7	OCHRE R	19	YES
Y7834	M	03-JUN-84	306	6	21-JUN-85	327	7	OCHRE R	21	YES
Y7875	M	04-JUN-84	313	6	18-JUN-85	321	7	OCHRE R	8	YES
Y8125	M	17-JUN-84	317	6	14-JUN-85	325	7	OCHRE R	8	YES
Y5642	F	13-JUN-84	368		14-JUN-85	374	11	OCHRE R	6	

Appendix 6. Con't. Shorthead redhorse recapture tagging data for Dauphin Lake and Ochre River 1985,1986 and 1987.

TAG #	SEX	DATE TAGGED	ORIG FKLT (mm)	ORIG AGE (YR)	DATE RECAP	RECAP FKLT (mm)	RECAP AGE (YR)	RECAP LOC	FKLT CHANGE (mm)	CORRECT NO. OF ANNULI FORMED	
Y8330	M	17-MAY-85	327	6	21-JUN-85	323	6	OCHRE R	-4	YES	
Y8179	F	07-MAY-85	313	7	15-NOV-86	321	8	DAUPHIN L.	8	YES	
Y8570	F	28-MAY-85	359		15-NOV-86	367	8	DAUPHIN L.	8		
Y8699	F	09-MAY-85	342	8	15-NOV-86		9	DAUPHIN L.		YES	
Y8777	F	21-MAY-85	347	7	15-NOV-86	344	8	DAUPHIN L.	-3	YES	
Y8054	F	27-JUN-85	357	7	15-NOV-86			DAUPHIN L.			
Y8055	M	27-JUN-85	343	7	15-NOV-86	345	8	DAUPHIN L.	2	YES	
Y8481	F	26-MAY-85	357	6	15-NOV-86	363	7	DAUPHIN L.	6	YES	
Y0867	F	01-JUN-85	354	6	15-NOV-86	367	7	DAUPHIN L.	13	YES	
Y8425	F	27-JUN-85	402	10	15-NOV-86	399	10	DAUPHIN L.	-3	NO	
Y8887	F	24-MAY-85	373	7	15-NOV-86	369	7	DAUPHIN L.	-4	NO	
Y8423	F	27-JUN-85	340	7	15-NOV-86	349	8	DAUPHIN L.	9	YES	
Y0876	M	31-MAY-85	319	6	15-NOV-86	326	7	DAUPHIN L.	7	YES	
Y5709	F	14-JUN-84	326	6	01-JUN-85	350	7	DAUPHIN L.	24	YES	
Y0872	F	01-JUN-85	320	7	15-NOV-86	324	8	DAUPHIN L.	4	YES	
Y5889	M	17-JUN-84	368	9	01-JUN-85	372	9	DAUPHIN L.	4	NO	
Y5023	M	20-MAY-85	340	6	15-NOV-86	338	7	DAUPHIN L.	-2	YES	
Y8046	F	28-MAY-85	326	6	15-NOV-86		7	DAUPHIN L.		YES	
Y8351	M	14-MAY-85	324	6	04-SEP-85	328	6	DAUPHIN L.	4	YES	
Y8817	F	25-MAY-85	352	9	15-NOV-86			DAUPHIN L.			
Y5005	F	20-MAY-85	350	7	15-NOV-86		8	DAUPHIN L.		YES	
Y7861	M	07-JUN-84	307	6	15-NOV-86	329	8	DAUPHIN L.	22	YES	
Y8199	F	07-MAY-85	319	6	15-NOV-86	332	7	DAUPHIN L.	13	YES	
Y8814	F	25-MAY-85	347	7	15-NOV-86	343	7	DAUPHIN L.	-4	NO	
Y5855	F	15-JUN-85	308	6	15-NOV-86	344	8	DAUPHIN L.	36	NO	
Y5024	F	20-MAY-85	370	7	15-NOV-86	365	7	DAUPHIN L.	-5	NO	
Y8057	M	25-JUN-85	337	6	15-NOV-86	355	7	DAUPHIN L.	18	YES	
Y8993	F	31-MAY-85	316	6	02-DEC-85	349	6	DAUPHIN L.	33	YES	PLATE #1
Y8396	F	16-MAY-85	340	7	15-NOV-86	341	8	DAUPHIN L.	1	YES	
Y6960	F	26-MAY-85	382	7	02-DEC-85	377	7	DAUPHIN L.	-5	YES	
Y8496	F	26-MAY-85	320	6	15-NOV-86	338	7	DAUPHIN L.	18	YES	
Y8818	F	25-MAY-85	386	11	02-DEC-85	381	9	DAUPHIN L.	-5	YES	
Y7863	F	07-JUN-84	382	9	15-NOV-86	395	11	DAUPHIN L.	13	YES	
Y8806	F	25-MAY-85	342	7	02-DEC-85	340	6	DAUPHIN L.	-2	YES	
Y8726	F	24-JUN-85	345	7	15-NOV-86	355	8	DAUPHIN L.	10	YES	
Y8343	M	18-MAY-84	332	6	02-DEC-85	329	6	DAUPHIN L.	-3	YES	
Y8817	F	25-MAY-85	352	9	15-NOV-86	346	10	DAUPHIN L.	-6	YES	
Y8376	M	15-MAY-85	352	7	02-DEC-85	355	7	DAUPHIN L.	3	YES	
Y8984	M	31-MAY-85	332	7	28-JUL-86	340	8	DAUPHIN L.	8	YES	
Y8278	F	24-MAY-85	367	7	02-DEC-85	359	7	DAUPHIN L.	-8	YES	
Y8175	M	09-MAY-85	332	6	15-NOV-87	341	8	DAUPHIN L.	9	YES	
Y0859	M	01-JUN-85	331	6	02-DEC-85	328	6	DAUPHIN L.	-3	YES	
Y8671	F	19-MAY-85	345	6	15-NOV-87	364	8	DAUPHIN L.	19	YES	
Y8858	F	25-MAY-85	371	6	02-DEC-85	364	6	DAUPHIN L.	-7	YES	
Y8959	M	31-MAY-85	340	7	15-NOV-87	NA	8	DAUPHIN L.			
Y5008	M	20-MAY-85	330	7	02-DEC-85	333	7	DAUPHIN L.	3	YES	PLATE #2
Y8233	M	06-JUN-85	357	8	15-NOV-87	365	10	DAUPHIN L.	8	YES	
Y8783	M	21-MAY-85	308	6	15-NOV-86	313	7	DAUPHIN L.	5	YES	
Y8253	M	06-JUN-85	328	6	15-NOV-87	337	8	DAUPHIN L.	9	YES	
Y5021	F	20-MAY-85	345	6	15-NOV-86	345	7	DAUPHIN L.	0	YES	
Y5659	M	09-JUN-84	335	6	15-NOV-87	354	8	DAUPHIN L.	19	NO	
Y8470	F	31-MAY-85	360	9	15-NOV-86		10	DAUPHIN L.		YES	
Y0865	M	01-JUN-85	319	7	15-NOV-87	NA	9	DAUPHIN L.		YES	
Y8990	F	31-MAY-85	339	NA	02-DEC-85	339	5	DAUPHIN L.	0	YES	

Appendix 6. Con't. Shorthead redhorse recapture tagging data for Dauphin Lake and Ochre River 1985,1986 and 1987.

TAG #	SEX	DATE TAGGED	ORIG FKLT (mm)	ORIG AGE (YR)	DATE RECAP	RECAP FKLT (mm)	RECAP AGE (YR)	RECAP LOC	FKLT CHANGE (mm)	CORRECT NO. OF ANNULI FORMED	
Y8451	M	31-MAY-85	331	6	15-NOV-87	339	8	DAUPHIN L.	8	YES	
Y8878	F	24-MAY-85	384	10	02-DEC-85	376	9	DAUPHIN L.	-8	YES	
Y8003	F	29-MAY-85	386	10	15-NOV-86		10	DAUPHIN L.		NO	
Y8368	M	15-MAY-85	336	6	02-DEC-85	329	6	DAUPHIN L.	-7	YES	
Y8661	M	20-MAY-85	316	7	15-NOV-86	323	8	DAUPHIN L.	7	YES	
Y8004	F	29-MAY-85	355	6	02-DEC-85	365	6	DAUPHIN L.	10	YES	
Y5487	F	10-MAY-85	334	7	15-NOV-86	345	8	DAUPHIN L.	11	YES	
Y8018	M	29-MAY-85	347	7	15-NOV-86	345	8	DAUPHIN L.	-2	YES	
Y8773	M	22-MAY-85	343	7	15-NOV-86	341	8	DAUPHIN L.	-2	YES	
Y8243	F	06-JUN-85	349	5	02-DEC-85	355	5	DAUPHIN L.	6	YES	
Y8439	M	31-MAY-85	329	6	15-NOV-86	325	7	DAUPHIN L.	-4	YES	
Y8001	M	28-MAY-85	311	6	02-DEC-85	310	6	DAUPHIN L.	-1	YES	
Y7896	F	14-JUN-84	328	6	31-MAY-85	334	7	DAUPHIN L.	6	YES	
Y8945	M	30-MAY-85	335	6	15-NOV-86	332	7	DAUPHIN L.	-3	YES	
Y7869	F	07-JUN-84	354	8	02-DEC-85	360	8	DAUPHIN L.	6	YES	
Y8291	F	24-MAY-85	373	7	15-NOV-86	375	8	DAUPHIN L.	2	YES	
Y8853	F	25-MAY-85	337	6	02-DEC-85	345	6	DAUPHIN L.	8	YES	PLATE #3
Y8386	F	16-MAY-85	347	6	15-NOV-86	351	7	DAUPHIN L.	4	YES	
Y8142	M	08-MAY-85	329	6	15-NOV-86	332	7	DAUPHIN L.	3	YES	

APPENDIX 7. Length-frequency distributions for shorthead redhorse Dauphin Lake 1984, 1985, 1986, 1987.

Length Interval (mm)	Males Length (mm)				Females Length (mm)				Combined * Length (mm)			
	N	MEAN	STD **	%	N	MEAN	STD	%	N	MEAN	STD	%
111 - 120	4	127.3	1.708	0.91					1	114.0		0.10
121 - 130									4	127.0	1.708	0.41
131 - 140	10	135.3	2.541	2.27	4	137.0	4.243	0.75	15	135.9	2.987	1.53
141 - 150	20	144.8	2.221	4.54	13	145.8	2.340	2.43	35	145.2	2.282	3.56
151 - 160	20	156.2	2.943	4.54	11	155.7	3.101	2.06	32	155.9	2.992	3.26
161 - 170	14	166.7	2.525	3.17	5	164.4	2.702	0.93	19	166.1	2.706	1.93
171 - 180	8	175.5	2.778	1.81	5	173.8	1.304	0.93	13	174.8	2.400	1.32
181 - 190	5	187.2	2.588	1.13	7	184.1	2.734	1.31	12	185.4	2.999	1.22
191 - 200	6	194.7	1.966	1.36	5	194.2	2.168	0.93	11	194.5	1.968	1.12
201 - 210	7	206.1	2.734	1.70	2	205.5	6.364	0.37	10	206.4	3.340	1.02
211 - 220	2	216.0	4.243	0.45	4	216.0	4.690	0.75	6	216.0	4.099	0.61
221 - 230	7	226.1	3.288	1.59	5	225.2	2.864	0.93	12	225.8	3.019	1.22
231 - 240	13	233.8	2.088	2.95	10	235.9	3.247	1.87	23	234.7	2.803	2.34
241 - 250	9	247.4	3.395	2.04	11	246.2	2.750	2.06	20	246.8	3.041	2.04
251 - 260	16	255.6	3.324	3.63	21	2564.6	2.481	3.93	37	255.0	2.882	3.77
261 - 270	20	265.9	2.961	4.54	15	264.8	3.256	2.80	35	265.4	3.089	3.56
271 - 280	16	274.8	3.256	3.63	8	273.3	2.964	1.50	24	274.3	3.179	2.44
281 - 290	12	286.5	2.908	2.72	22	285.2	2.905	4.11	34	285.7	2.932	3.46
291 - 300	14	294.9	2.433	3.17	12	293.9	2.678	2.24	26	294.5	2.549	2.65
301 - 310	23	307.0	2.523	5.22	22	306.2	3.265	4.11	45	306.6	2.902	4.58
311 - 320	31	315.6	2.838	7.03	21	315.8	3.192	3.93	52	315.7	2.956	5.30
321 - 330	35	325.1	2.972	7.94	30	326.7	2.507	5.61	65	325.9	2.855	6.62
331 - 340	54	335.4	2.809	12.24	39	335.0	2.814	7.29	93	335.2	2.801	9.47
341 - 350	38	345.6	2.990	8.62	50	346.1	3.071	9.35	88	345.9	3.029	8.96
351 - 360	11	355.0	2.450	2.49	49	354.2	2.799	9.16	60	354.4	2.736	6.11
361 - 370	19	366.6	2.835	4.31	42	365.7	2.749	7.85	61	365.9	2.789	6.21
371 - 380	9	373.3	2.598	2.04	34	375.3	2.780	6.36	43	374.9	2.830	4.38
381 - 390	9	385.1	3.408	2.04	30	385.7	3.341	5.61	39	385.6	3.322	3.97
391 - 400	7	393.7	2.498	1.70	24	395.3	3.226	4.49	31	395.0	3.114	3.16
401 - 410					14	405.1	2.445	2.62	14	405.1	2.445	1.43
411 - 420					9	415.0	2.500	1.68	9	415.0	2.500	0.92
421 - 430	1	430.0		0.23	7	423.3	3.251	1.31	8	424.1	3.834	0.83
431 - 440					2	435.0	5.657	0.37	2	435.0	5.567	0.20
441 - 450	1	448.0		0.23					1	448.0		0.10
451 - 460					1	454.0		0.18	1	454.0		0.10
491 - 500					1	491.0		0.18	1	491.0		0.10
Total	441				535				982			
Mean		282.6	74.329			319.9	69.685			302.1	74.905	
Min		125.0				131.0				114.0		
Max		448.0				491.0				491.0		

* Combined = males + females + unkonwn sex
** STD = Standard Deviation

Appendix 8. Age-frequency distributions for shorthead redhorse
Dauphin Lake 1984, 1985, 1986, 1987.

Age (yr)	Males Fork Length (mm)				Females Fork Length (mm)				Combined * Fork Length (mm)			
	N	MEAN	STD **	%	N	MEAN	STD	%	N	MEAN	STD	%
1	2	136.5	2.121	0.05					2	136.5	2.121	0.21
2	49	149.6	12.007	11.34	25	149.2	8.105	4.81	79	148.8	11.268	8.25
3	43	186.8	33.158	9.95	33	189.4	30.129	6.35	76	187.9	31.695	7.93
4	58	254.2	22.921	13.43	64	258.7	25.548	12.31	123	256.2	24.601	12.84
5	76	295.1	25.564	17.59	71	296.5	24.798	13.65	147	295.8	25.120	15.34
6	69	323.8	22.125	15.97	105	334.6	17.188	20.19	174	330.3	19.954	18.16
7	59	333.8	13.852	13.66	80	355.1	15.641	15.38	139	346.1	18.237	14.51
8	28	339.9	25.795	6.48	44	369.2	15.560	8.46	72	357.8	24.636	7.52
9	16	363.9	155.670	3.70	37	385.1	20.213	7.12	53	378.7	21.190	5.53
10	14	371.2	25.929	3.24	28	384.0	12.994	5.38	42	379.7	19.010	4.38
11	12	376.8	22.079	2.79	18	396.8	33.487	3.46	30	388.8	30.689	3.13
12	4	381.0	9.557	0.93	6	400.7	10.912	1.15	10	392.8	14.133	1.04
13					4	406.5	17.214	0.77	4	406.5	17.214	0.42
14	2	388.5	10.607	0.05	4	418.8	15.586	0.77	6	408.7	20.304	0.63
18					1	454.0		0.19	1	454.0		0.10
Total	432				520				958			
Mean		282.9	73.401			318.6	69.646			301.4	74.300	
Min		125.0				131.0				114.0		
Max		396.0				454.0				454.0		

* Combined = males + females + unknown sex
** STD = Standard Deviation

APPENDIX 9. STOMACH CONTENT ANALYSIS OF SHORTHEAD REDHORSE FROM DAUPHIN LAKE.

Sam. #	FKLT	DATE		SAND	CHIR.	TRIC.	EPHE.	OSTR.	CONC.	CLAD.	AMPH.	COPE.	MOLL.	GAST.	DIPT.	ACAR.	OLIG.	ODON.	ACAN.	NEMA.	TREM.
				GROUPS OF ORGANISMS IDENTIFIED																	
10	52	26-08-87			ABUN					ABUN		ABUN			RARE						
15	54	03-09-87								FEW		ABUN									
3	55	02-06-87		FEW	ABUN					ABUN										FEW	
2	58	02-06-87			FEW					ABUN											
5	59	01-07-87			RARE	RARE				ABUN		ABUN									
6	64	01-07-87			ABUN					ABUN		ABUN									
7	66	01-07-87		FEW	FEW	FEW				ABUN		ABUN									
1	78	02-06-87			FEW					ABUN											
4	78	01-07-87			ABUN					ABUN											
17	86	01-07-87			ABUN			ABUN		FEW		FEW									
19	87	24-08-87		ABUN	FEW			ABUN			FEW	ABUN			FEW						
11	94	26-08-87		FEW	ABUN	FEW		FEW		ABUN		ABUN							FEW		
9	101	26-08-87			ABUN	RARE				FEW	RARE				RARE						
8	102	26-08-87		ABUN	FEW	FEW		FEW		FEW		FEW							FEW		
18	110	24-08-87		FEW	FEW					FEW		ABUN	FEW								
118	113	26-09-84			FEW														RARE		
26	113	14-08-85			ABUN		RARE								FEW						
20	114	02-07-87			ABUN	RARE	FEW	ABUN			FEW				FEW	FEW				FEW	
24	115	14-08-85			ABUN	RARE		ABUN	RARE			RARE				RARE					
25	118	14-08-85			FEW	RARE		ABUN				REW			FEW	RARE					
115	120	26-09-84			FEW		FEW										RARE				
110	121	26-09-84		FEW	FEW							FEW									
16	125	02-09-87			ABUN			ABUN				FEW	FEW								
102	130	25-09-84	EMPT.																		
13	132	01-06-87			FEW	ABUND															
23	135	14-08-85			ABUN		FEW		RARE	ABUN	RARE				FEW						RARE
112	135	26-09-84								FEW		FEW									
21	143	14-08-85		FEW	FEW	FEW	RARE	ABUN		FEW		ABUN			FEW	FEW					
14	144	27-08-87		ABUN	ABUN			FEW		FEW	ABUN										
22	155	14-08-85			FEW	FEW	FEW			ABUN		FEW		RARE	FEW					RARE	
116	160	27-09-84			RARE										RARE						
12	168	28-07-87		FEW	ABUN	FEW				FEW											
5265	176	26-08-87				ABUN	FEW						FEW		FEW				RARE		
5261	187	26-08-87			FEW	FEW				RARE			ABUN						FEW	FEW	
5260	189	26-08-87				RARE							RARE						FEW	FEW	
111	198	24-08-87											FEW						FEW		
5266	200	26-08-87					FEW							FEW					RARE	RARE	
5257	242	26-08-87			FEW								FEW						FEW		
5263	251	26-08-87			FEW		RARE						FEW							FEW	
3274	261	24-08-87			FEW	FEW							ABUN	RARE					FEW		
37	263	07-07-83			FEW	FEW						RARE									
5258	265	26-08-87			FEW	FEW	RARE						ABUN						FEW	FEW	
5262	265	26-08-87											FEW						FEW		
5267	266	26-08-87			FEW	FEW	RARE						ABUN	RARE					FEW	FEW	

APPENDIX 9. Con't. STOMACH CONTENT ANALYSIS OF SHORTHEAD REDHORSE FROM DAUPHIN LAKE.

Sam. #	FKLT	DATE		SAND	CHIR.	TRIC.	EPHE.	OSTR.	CONC.	CLAD.	AMPH.	COPE.	MOLL.	GAST.	DIPT.	ACAR.	OLIG.	ODON.	ACAN.	NEMA.	TREM.	ALGA
				GROUPS OF ORGANISMS IDENTIFIED																		
5259	266	26-08-87			FEW	ABUN	RARE						FEW	FEW								
101	271	25-09-84			RARE		FEW															
47	277	27-08-86					ABUN						FEW	RARE			FEW					
42	278	04-08-86			ABUN	FEW	FEW	RARE			RARE		FEW	RARE							FEW	
44	285	04-08-86			FEW		FEW						ABUN							FEW		
31	288	01-06-86			RARE	RARE		RARE					ABUN									
49	295	10-06-85			RARE	ABUN		FEW					ABUN	RARE					FEW			
43	311	04-08-86			FEW	ABUN	FEW						ABUN		RARE				FEW			
8818	311	11-02-86	EMPT.																			
46	314	27-08-86			FEW	ABUN	FEW															
32	320	01-06-86				ABUN		RARE					ABUN	RARE						RARE	RARE	
34	320	01-06-86			ABUN	ABUN		FEW					ABUN	FEW	RARE					FEW	RARE	
40	321	07-07-85			FEW	FEW	FEW				RARE		FEW		RARE			RARE	RARE	FEW		
27	322	27-09-84			FEW	FEW				RARE			RARE									
38	327	07-07-85			ABUN	FEW	FEW						ABUN	RARE	FEW				FEW	FEW		
8278	329	11-02-86			FEW	ABUN													RARE			
39	335	07-07-85			ABUN	FEW	FEW						ABUND		FEW							
859	335	11-02-86	EMPT.																			
30	340	27-09-84			ABUN	RARE							RARE		RARE				FEW		RARE	
8368	340	11-02-86	EMPT.																			
28	342	26-09-84			FEW		ABUN															
36	344	20-08-83			RARE	RARE	ABUN															
45	344	27-08-86			ABUND		ABUN				RARE		ABUN							FEW	FEW	
8001	344	11-02-86	EMPT.																FEW			
50	348	10-06-85			ABUN	ABUN							FEW									
41	352	04-08-86			ABUN	ABUN	ABUN						FEW							RARE		
8364	356	11-02-86	EMPT.																			
8993	361	11-02-86	EMPT.																			
33	362	01-06-86			ABUN	ABUN		RARE						RARE	RARE				FEW	RARE	RARE	
8806	364	11-02-86	EMPT.																			
48	365	27-08-86				ABUN	ABUN	RARE					FEW		RARE				FEW	FEW		
8343	370	11-02-86	EMPT.																			
35	373	27-06-83			FEW	ABUN		RARE					ABUN									
29	403	27-09-84			FEW		ABUN											FEW		RARE	RARE	
51	337	09-06-85		FEW	ABUN														FEW			ABUN
52	340	09-06-85		FEW	ABUN	FEW																ABUN
53	325	09-06-85			FEW	ABUN																FEW
54	315	09-06-85		FEW	ABUN	FEW											FEW	RARE				FEW
55	369	09-06-85			FEW	FEW	FEW						FEW									ABUN

Empt.= empty, Chir.= Chironomidae, Tric.= Trichoptera, Ephe.= Ephemeroptera, Ostr.= Ostracoda, Conc.= Conchostraca, Clad.= Cladocera, Amph.= Amphipoda, Cope.= Copepoda, Moll.= Mollusca, Gast.= Gastropoda, Dipt.= Diptera other than Chironomidae, Acar.= Acarina, Olig.= Oligochaeta, Odon.= Odonata, Acan.= Acanthocephala, Nema.= Nematoda, Trem.= Trematoda, Alga.= Algae.
Rare = 1 or 2 items, Few = 3 to 20 items, Abun = greater than 20 items.