THE UNIVERSITY OF MANITOBA

COMPARATIVE ECOLOGY OF FOUR SPECIES OF DARTERS (ETHEOSTOMINAE) IN LAKE DAUPHIN AND ITS TRIBUTARY, THE VALLEY RIVER

by

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ABSTRACT

The johnny darter Etheostoma nigrum, Iowa darter Etheostoma exile, river darter Percina shumardi, and logperch Percina caprodes occur in Lake Dauphin and its largest tributary, the Valley River. Density and relative abundance of the four species in defined river and onshore lake environments were determined by seining throughout most of the ice-free period. In spring river darter and logperch moved into the lower reaches of the river and spawned; but after the reproductive season johnny darter were virtually the only darters remaining in the river. That species was more abundant in non-current than in current. In the lake unbroken sand or mud bottom (non-cover) was avoided by all darters. Beds of aquatic vegetation were inhabited by Iowa darter, with high densities of young-of-the-year occurring in late summer. Rubble beaches exposed to wave action were inhabited chiefly by river darter. Pebble-rubble beaches protected from wave action contained the greatest overlap of the four species, with johnny darter and Iowa darter prominent following the reproductive season. Preference experiments in the laboratory confirmed the avoidance of non-cover areas in the field, but failed to demonstrate preferences for particular types of cover.

The smallest Iowa darter, river darter and logperch caught in the lake shared a diet consisting mainly of copepods and cladocerans, while small johnny darter in the river ate chiefly midge larvae. Larger fish took a variety of benthic foods. Two or more species of darters occurring together in the same environment at the same time usually ate the same range of foods but concentrated on different items.

Differences in environment inhabited and food eaten indicate that the ways of life of the four species are sufficiently dissimilar to account for their coexistence in the same watershed.

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I. INTRODUCTION

Darters are members of the sub-family Etheostominae within the Percidae. They are small, commonly bottom-dwelling fishes confined to fresh waters in North America east of the Rocky Mountains (Winn, 1958b). The American Fisheries Society (1970) lists 109 species, the majority of which occur only in the Mississippi River Drainage (Winn, 1958a). Moving northward, the group becomes less speciose. Only fifteen species have been reported from Minnesota (Carlander, 1941), and the number occurring in Manitoba is further reduced to five (Fedoruk, 1969). Four of these occur in Lake Dauphin and its tributary, the Valley River. They are: the central johnny darter, Etheostoma nigrum nigrum Rafinesque; the Iowa darter, Etheostoma exile (Girard); the river darter, Percina shumardi (Girard); and the northern logperch, Percina caprodes semifasciata (De Kay).

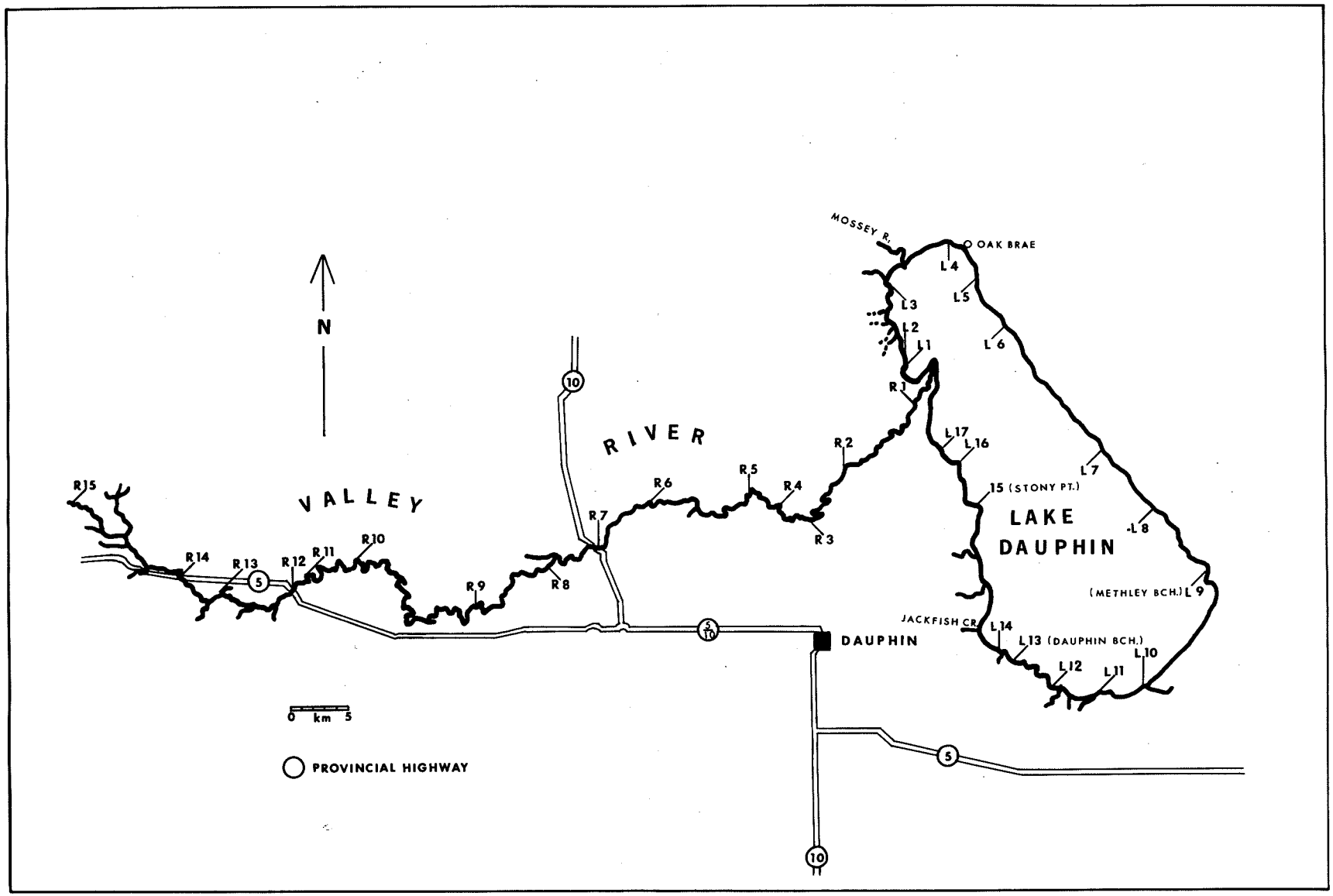
Knowledge of the life histories of johnny darter, Iowa darter, and logperch is incomplete, dealing mainly with reproduction. The life history of the river darter is virtually undescribed. Winn (1958a,b) examined intensively the reproduction of johnny darter, Iowa darter and logperch. Although emphasizing behaviour, he gave detailed accounts of the environment selected for spawning and the seasonal variation in abundance of darters in the spawning areas. Trautman (1957) gave brief descriptions of the environments in which all four species were collected. Information on the distribution of larval darters in lakes was obtained by Fish (1932) for johnny darter and logperch and by Faber (1967 and pers. comm.) for logperch only. Raney and Lachner (1943) and Speare (1960) worked on the age and growth of the johnny

darter. Turner (1921) examined the food of johnny darter and logperch in lakes and streams, while Dobie (1959), Keast and Webb (1966) and Mullan, Applegate and Rainwater (1968) all examined the food of logperch.

This study was undertaken to describe the distribution, relative and absolute abundance and diet of the four species in the different kinds of environment available in Lake Dauphin and the Valley River. Although information was gathered through most of the ice-free period, emphasis was placed on late summer following reproduction, when most young-of-the-year were vulnerable to seining. It was hoped that the knowledge thus obtained would account for the coexistence of the four species of darters in the Lake Dauphin Watershed.

II. STUDY AREA

Lake Dauphin, shown in Fig. 1, is a large shallow lake. The shoreline eastward from the lake's only outlet, Mossey R., is a bench sloping gently into the water from a low ridge which runs parallel to the lake. The bench consists of sand and gravel, and is usually overgrown by grasses and willows to the water's edge. Stands of Scirpus commonly grow for a distance of 50 m or more offshore, as do beds of submerged plants, most often Potamogeton. From four kilometers beyond Oak Brae for 23 km southward, the bench ends sharply and drops to the beach at a 40-50° angle. The beach, 2-4 m wide, consists of granitic boulders interspersed with smaller stones, chiefly of limestone. In the water, the bottom consists of a belt of similar composition, 2 m or more in width, beyond which is sand or mud. The ridge parallelling the lake along this beach is higher and unbroken, so that no river flows into the eastern border of the lake. At the end of this stretch of boulder-beach just before Methley Beach the land again slopes gently into the water. The beach may consist of sand and gravel or of mud-flats, and the shoreline is often masked by dense stands of Phragmites, Scirpus and Carex, which grow out into the water. This continues to the middle of the southern border of the lake, where the land again rises slightly to produce a shoreline similar to that on the east side. However, here the bays usually have sand and gravel or sand beaches, as at Dauphin beach. Northward from Jackfish Creek the shoreline again resembles that in the southeast corner of the lake, but after 8 km the terrain of predominately boulder-beach is resumed. Northward along the western border of the lake extensive stands of Scirpus and Phragmites,


N
MOSSEY R.
OAK BRAE
L4
L5
L6
L3
L2
L1
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
VALLEY
RIVER
10
5
L17
L16
L7
15 (STONY PT.)
LAKE
DAUPHIN
L8
(METHLEY BCH.) L9
JACKFISH CR.
L14
L13 (DAUPHIN BCH.)
L12
L11
L10
DAUPHIN
0 km 5
PROVINCIAL HIGHWAY

particularly at the mouths of streams, interrupt the beaches, while the shores become less stony and gradually assume the features of shores found at the north end of the lake.

Most of the lake is 2-3 m in depth, the deepest sounding being only 3.4 m (Stewart-Hay, MS 1951). Except for the shoreline, the bottom of the lake consists solely of mud. Transparency is usually limited to 15-20 cm, making observation of fishes virtually impossible. Water level at the shores can fluctuate considerably, both seasonably and by the action of seiches.

Although only 10-15 m wide near its mouth, the Valley R. is the largest stream entering L. Dauphin. It originates primarily in the Duck Mountains to the west, but one major tributary drains the Riding Mountain area to the southwest. From the mouth to the station furthest upstream the river extends approximately 170 km. All but the lowest 10-12 km consist of a series of riffles and pools, although areas of riffles become less frequent in the lower reaches. Water level is high during spring runoff, but by late summer most riffles are dry or contain only narrow channels of flowing water. At that time the water level in the last 10-12 km varies like that in the proximal portion of the lake, depending on the direction and strength of wind. (In the case of a strong southerly wind the water may visibly flow upstream.) Except after a heavy rain, the water is clear to the bottom in all but the deepest pools.

In addition to the four species of darters, a number of other species of fishes, the majority of them cyprinids, are also found in

the study area. These species are listed below according to whether they were more commonly caught in the river or the lake.

River	Lake
Hybognathus hankinsoni	Coregonus artedii
Notropis cornutus	Esox lucius
Rhinichthys atratulus	Notropis atherinoides
Rhinichthys cateractae	Notropis hudsonius
Semotilus atromaculatus	Pimephales promelas
Semotilus margarita	Ictiobus cyprinellus
Hypentelium nigricans	Moxostoma sp.
Catostomus commersoni	Percopsis omiscomaycus
Culaea inconstans	Perca flavescens
	Stizostedion vitreum vitreum

III. DISTRIBUTION AND ABUNDANCE OF DARTERS IN DIFFERENT ENVIRONMENTS

Part A: MATERIALS AND METHODS

i) COLLECTION OF FISHES

The distribution and abundance of darters in all lake and river environments was determined by seining. To maintain uniformity, only one kind of seine was used. This was a two-man seine with a sown-in bag (1.8 m x 1. 2 m - mesh diam. 0.32 mm). In strong current the seine was spread by one man below the area to be sampled. The second then drove fishes downstream into the seine by vigorously and systematically disturbing the substrate as he moved through the area. Then both men lifted the seine with a forward-sweeping motion. In areas of little or no current the seine was pulled from deep to shallow water, or in water of uniform depth. When this involved seining through plants or over large stones the seine was pulled in a jerky manner to avoid fouling the leadline.

Where estimates of the densities of darters were desired, a barrier-net was used to enclose small areas to be sampled, thereby preventing the escape of fishes during seining. In shallow areas of strong current enclosing was accomplished with the barrier-net or a combination of net and large stones, but the upstream end was usually left open. Blocking of the upstream end was often impractical, and escape against the current was thought to be minimal. In areas of slight or no current the barrier-net was set up to form a rectangle, one side of which was usually the river bank or lake shore. (See Plate 1.)

Repeated seine hauls, each covering most of the enclosed area,

Plate 1: Barrier-net set in typical fashion in Lake Dauphin.

were made until virtually all the darters were captured. If fewer than ten darters were caught in the first haul, seining was stopped when three consecutive hauls yielded no darters. If ten or more were caught on the first haul, seining was stopped after three consecutive hauls produced one or none.

When barrier-nets were used, only 20-50% of the darters caught were taken in the first seine haul, so that this method was considered at least twice as effective as seining without a barrier in capturing darters. Thus only samples of darters taken within barriers were used in estimates of density. Those samples are here called complete samples. Darters taken by sampling without the use of barrier-nets formed incomplete samples, which were nevertheless useful in determining the relative abundance of species in given environments (assuming that such seining was equally efficient in taking all four species).

Extensive attempts to capture darters smaller than 12 mm using a plankton net and stationary surber sampler proved unsuccessful.

ii) MEASUREMENT OF ENVIRONMENTAL VARIABLES

So that abundance of darters could be correlated with particular features of the environment, the following variables were measured immediately after each sample of fish was taken: area sampled, depth, aquatic plants, substrate, surface velocity (in the river) or height of waves (in the lake), and the time of day. Where vegetation was present it was identified, its density noted, and the percent of substrate covered by it estimated. The categories of particle size given by Longwell and Flint (1955) formed the basis for the following categories

used to describe substrate: rubble (stones greater than 64 mm diam), pebble (2-64 mm diam), and fine substrate (particles less than 2 mm diam). For every sample the percent of bottom covered by each category of substrate was estimated. Mean surface water velocity was determined by timing the progress of a floating object for a distance of 0.45-1.5 m in both the slowest and fastest portions of the area sampled.

The following additional environmental variables, which tended not to vary within a station, were also measured: water temperature, transparency (taken by secchi disk), and weather conditions.

iii) SAMPLING IN 1968, AND THE DEFINITION OF BASIC ENVIRONMENTS TO BE SAMPLED IN 1969

In 1968, sampling was of an exploratory nature. That is, an attempt was made to determine what kinds of environment were available and to what extend they were populated by the four species of darters. All sampling was of the incomplete type. The pattern of sampling and the results obtained are given in Appendix 1. On the basis of those results, environmental variables which had the greatest observable effect on the numbers of darters were selected, and a potentially large number of combinations of environmental variables was reduced to a few 'basic' environments. These provided a guide for sampling in 1969, and were defined as follows for the lake:

a) Non-cover: An area lacking any type of cover (either plants or stones) over at least 75% of the bottom.

b) Plant-cover: An area having plants growing over at least 75% of the bottom. Included were beds of aquatic plants at depths of 0.15-0.9 m. growing in fine substrate sometimes interspersed with pebble or

rubble, and with the substrate often partially or totally covered with plant debris. Areas containing the stout-stemmed emergent plants Scirpus and Phragmites were sampled only in May and June, when there was new growth and beds of non-emergent plants were scarce. The latter, including beds of Ranunculus and Potamogeton, were sampled after June. A broad-leaved species of Potamogeton was most frequently encountered. Often the plant beds were protected on the offshore side by extensive stands of Scirpus. Plate 2 shows an example of this environment.

c) Protected pebble-rubble: An area of shoreline which is protected from wave action by stands of emergent plants or by a point of land, and in which at least 75% of the bottom is covered by a mixture of pebble and rubble. In this environment, the bottom was usually gently sloping, and the seine was usually pulled onshore from a depth of 0.3-0.75 m. The ratio of pebble to rubble varied roughly in the range 4:1-1:4. Most stones were usually limestone fragments, and in most cases there was proportionately more pebble towards shore. From July on, the substrate was often covered with heavy growths of filamentous algae. Plate 3 shows an example of protected pebble-rubble environment.

d) Exposed rubble: An area of shoreline exposed to wave action, in which at least 75% of the bottom is covered by rubble. In this environment, the bottom sloped sharply, and the seine was usually pulled onshore from a depth of 0.6-1 m. The stones were largely granitic. From July on, the substrate at some stations was covered by heavy growths of filamentous algae. An example of this environment is shown in Plate 4.

'Basic' environments in the river were defined as follows:

a) Current: An area within which surface velocity reaches at

Plate 2: A submerged bed of Potamogeton, comprising plant-cover environment. Note extensive offshore stands of Scirpus, which protect this area from wave action.

Plate 3: Protected pebble-rubble environment, sheltered by a dense stand of Scirpus and Phragmites (in background).

Plate 4: Exposed rubble environment.

Plate 5: A complex of current and non-current environments in the river. Indicated by arrows are:

i) A stretch of current with a bottom of rubble.

ii) A uniform stretch of current with a bottom of fine pebble.

iii) An area of deep non-current with a bottom of rubble.

least 0.45 m/sec, and does not fall below 0.15 m/sec. The current environment was always part of a complex in which shallow, turbulent stretches of current alternated with quieter, deeper pools and channels. (See Plate 5.) Depths and surface velocities up to 0.4 m and 1.2 m/sec respectively were sampled in May, although rapids with greater flow were present. After May depth and surface velocity in all areas of current fell below those values. In some cases, the bottom was covered by pebble less than 2 cm diam, and the current quite uniform. More often the bottom was covered by rubble, so that flow was very irregular (sometimes ranging from 0.2 to 0.9 m/sec in a single sample). In the latter case, the substrate was sometimes covered with filamentous algae or moss. Many areas of current environment sampled were intermediate between the two types described above.

b) Shallow non-current: An area of which at least 75% is no more than 0.3 m in depth, and in which surface velocity does not exceed 0.15 m/sec. This environment was usually adjacent to a bank or sandbar. In many cases the bottom was covered by fine substrate, or pebble, or a mixture of both. Often the substrate was heavily silted and interspersed with sticks, other debris, or patches of aquatic plants.

c) Deep non-current: An area of which at least 75% exceeds 0.3 m in depth, and in which surface velocity does not exceed 0.15 m/sec. This environment included a wide range of situations in the river. The maximum depth sampled was 1 m, while substrate ranged from all fine substrate to mostly rubble. As in shallow non-current environment, the substrate was often heavily silted and interspersed with debris and

patches of plants. (Dense plant-beds, which were seen in deep and shallow non-current environments, were not sampled in 1969.)

iv) SAMPLING PLAN FOR 1969

In 1969, sampling was designed primarily to produce: (a) estimates of densities of darters (based on complete sampling) in the basic environments during the late summer, following reproduction, which was thought to be the time of greatest probable demand on food resources, (b) estimates of the relative numbers of the four species (based on both complete and incomplete sampling) in basic environments throughout the year, and (c) distribution of river darter and logperch in the river at various times of the year.

Since very few darters of any species were caught in non-cover environment in the lake during 1968, this environment was not sampled in 1969.

There were six sampling periods. The first five, beginning with early May, were at three week intervals, the fifth period lasting from July 27 to August 4 and representing late summer, following reproduction. The final sampling period was in September.

In early August complete sampling to obtain estimates of density was carried out at three stations for each basic environment. When it appeared desirable to confirm the absence of a particular species, and/or collect additional specimens, a large incomplete sample was taken as well. In addition, incomplete samples were taken at three other stations for each environment, so that samples from a total of six stations were available for study of relative numbers of the four