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Home Range Tendency of the Largemouth Bass (*Micropterus salmoides*)

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lations, the substantial contribution to reproduction becomes even more apparent. In a few cases where freshwater fish production has been measured, the annual production of gametes is a large fraction of total production (LeCren 1962). LeCren estimated that the total production of perch in Windermere during 1940 was 23,700 kg whereas gamete production was 21,000 kg. He further estimated that comparable figures for average brown trout, *Salmo trutta* (age group III and older), were 1.75 kg and 0.42 kg respectively. Production data for this species were taken from Frost and Smyly (1952).

A complete study of the cost of reproduction in freshwater fishes seems to be in order. In elucidating the relation between somatic and gametic production, the timing of reproduction, the occurrence of atresia, and the efficiency of gamete production should be of some concern.

Species with protracted spawning periods are less satisfactory for study than those which have but one brief spawning interval. The ovary of the carp, for example, shows a gradual diminution in weight during the summer. It would be necessary to estimate the number and size of gamete discharges when studying a fish such as this. Thus, if the losses as gametes are to be considered in a production study, careful attention must be paid to the timing of reproduction. In addition, if atresia is quite common in a fish population and if the efficiency of gamete production is found to be high, the relative importance of gamete losses would be considerably less than they now appear. Definitive data for natural fish populations are needed to fill these gaps in our knowledge.

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HOME RANGE TENDENCY OF THE LARGEMOUTH BASS (*MICROPTERUS SALMOIDES*)[1]

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Abstract. By repeated sampling of a population of largemouth bass, including individually marked fish, and by use of reference markers along the shoreline, the observance of a home range by the bass was demonstrated. Of 96 recaptures considered, 59% were recaptured within 100 ft, 83% within 200 ft, and 96% within 300 ft of the original point of capture. The extent of movement away from the initial point of capture did not increase with time. After being offshore over winter the bass again demonstrated a marked tendency to resume the use of the same segment of shoreline they had frequented the previous summer. Straying from the home range followed by return to it was also observed. Observations on the dispersion of bass along the shoreline are given.

Introduction

By sampling individually marked bass, an attempt has been made to describe their distribution along the shoreline and the extent of their movements. In a study related to movements, Ball (1944) tagged 52 largemouth bass in Third Sister Lake, a 10-acre lake in Michigan. From a limited number of recaptures, he concluded that the largemouth bass moved at random within the lake. Gerking (1953), Gunning (1959), and Gunning and

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Shoop (1963) have all demonstrated the observance of a home range by the closely related smallmouth bass (*M. dolomieui*) as well as several other stream-dwelling centrarchids. Generally, their results show that the smaller species have a home range of 100–200 linear ft of stream whereas the larger species have a home range of 200–400 ft. Fajen (1962) in a study of home pools in streams found 15 of 187 smallmouth bass made voluntary trips of 100–2,350 ft to other pools. Later these fish returned to their home pools. In a somewhat different approach that emphasized homing ability, Larimore (1952) captured and subsequently moved smallmouth bass away from their home pools. He demonstrated that after displacement, smallmouth bass will return to home pools. In a similar study Rodeheffer (1941) moved 767 marked fish, including 20 smallmouth bass, across a bay of Douglas Lake, Michigan. Although some fish did return to the original site of capture, recaptures elsewhere in the lake indicated a random movement of transferred fish. Parker (1956) displaced largemouth bass in two lakes. In one lake 18%, and in the other lake 25% of the fish returned to the original point of capture. Parker concluded that a fish population can contain a segment that demonstrates a home range while another segment may move at random. Gerking (1959) reviewed much of the literature on the observance of home range and homing by fishes. Lewis, Summerfelt, and Bender (1962) called attention to a uniformity of distribution of bass along the shoreline of small lakes.

Materials and Methods

This study was conducted on an 8.4-acre farm pond (Baker's Pond) constructed in 1938 in Williamson County, Illinois. The pond has an average depth of 6 ft and at the time of the study supported a fish population that included the largemouth bass, bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), green sunfish (*L. cyanellus*), warmouth (*Chaenobryttus coronarius*), black crappie (*Pomoxis nigromaculatus*), black bullhead (*Ictalurus melas*), channel catfish (*I. punctatus*), and golden shiner (*Notemigonus chrysoleucas*).

To facilitate recording the point of capture of the bass, 71 numbered stakes were placed as reference points at 50-ft intervals along the 3,510-ft shoreline. For the distributional data these intervals were grouped into 200-ft segments.

The bass were captured by uses of a 230-volt, 180-cycle, alternating-current generator equipped with three electrodes. Each sampling involved traversing the shoreline twice. Sampling was done both during daylight hours and at night.

The process of sampling involved maneuvering the boat close to shore, stopping only during the handling of captured bass. When a bass was captured, one person measured and tagged the fish. A second person recorded the tag number, the total length of the fish, and the point of capture. By referring to the shoreline markers (stakes), the point of capture was estimated to the nearest 5 ft. The fish were released at the point of capture. Distances from the initial point of capture to the points of recapture were measured along the shoreline with the exception of cases in which the fish had apparently moved across a cove or across the lake. For these fishes the distance moved was measured in a straight line from the initial point of capture to the point of recapture.

Numbered monel strap tags were placed on the mandible. Similar tags were used by Corson (1957) in a study which showed little difference in growth or activity

Table 1. Frequency of distance of recapture from original point of capture of largemouth bass in an 8.4-acre pond

Time since first capture (weeks)	Distance from first point of capture (ft)													
	25	50	75	100	125	150	175	200	225	250	275	300	500	700
1	3	2		1		2		2	1	1				
2			3	3				1				1		
3	2	1	1	1										
4	1	2	1											
5		2	1	1	1		2		1		1			
6	1				1									1
7	1		1					1						
8	1	1		1		1					1	1		
9		2				1					1			
10	1			1			1		1				1	
11	3	2												
12				1										
13						1							1	
14					1									
15		1	1	1	1	1				1				
16	2			2					1					
17						2							1	
18		1		1		1	1							
19			1								1			
20	1	2		1	1									
21							1							
22														
23			1											
24			1											
Total	16	16	11	14	5	9	5	4	4	2	4	2	3	1

of rainbow trout (*Salmo gairdneri*) wearing these tags.

The distribution of the bass along the shoreline was evaluated by calculating the percentage of the total bass captured during a particular month in specific 200-ft segments of the shoreline.

Commencing on May 2 and continuing through October 24, 1965 the pond was sampled once per week. Four samplings were made from April 5 through April 8, 1966. Tagging of the fish was limited to the period of May 2 to June 19, 1965, with the exception of three large fish that were tagged subsequently. A total of 200 fish above 9 in. in total length were tagged.

Tagging and recapture permitted a population estimate by a modification of the Schnabel method as applied by Lewis, Summerfelt, and Bender (1962).

Results

From May 6 to October 24, 1965 a total of 121 recaptures were made. The recaptures included 79 different fish and 26 that were recaptured more than once. The greatest number of recaptures of an individual fish was six. Four recaptures were made in both the first and second shoreline traverse in the same day. The second recapture on the same day was not included in the data. Thus the total number of recaptures considered was 117. Distributional data were obtained from a total of 412 captures including both tagged and nontagged fish.

Sampling on April 5 through 8, 1966, after the fish had overwintered, resulted in the capture of 20 marked fish.

Of the 117 total recaptures made during 1965, 21 were made either across a cove or across the lake from the original point of capture. Of the remaining 96 recaptures, 57 (59%) were within 100 ft of the point at which they were marked. An additional 23 were within 200 ft, giving a total of 80 (83%) recaptures that were within 200 ft or less of the original point of capture. Similarly, 92 (96%) recaptures moved 300 ft or less (Table 1). The distances moved by the 21 fish recaptured across a cove or across the lake from the original point of capture varied from 200 to 1,100 ft when distance was measured along the shortest possible route, i.e., across a cove or across the lake.

One bass was recaptured six times and all locations were within 150 ft of the initial point of capture. Further, the distance moved did not increase with time (Table 1). The bass moved greater distances in May, June, and July than at other times of the year, and this period was prior to and during the spawning season.

Of the 20 total recaptures made in the spring of 1966, 13 (65%) were within 100 ft and 17 (85%) were within 400 ft of the point at which they were marked.

The movements of some individual fish are of particular interest. In two cases, individuals were repeatedly captured at one location but later moved to a distant location. One of these fish was captured five times within a 75-ft segment of shoreline; however, the final capture was made 430 ft away. Another bass showing a preference for one area moved 225 ft, and later showed a preference for the new location. In another pattern, each of two bass was captured in a different location, but both moved 335 ft away only to return to within 10 ft of their former locations. Another type of movement behavior in the present study involved two bass which moved long distances and then displayed a preference for the new location. Finally, one bass displayed unique movements in that it was captured twice within a 30-ft segment of shoreline and then moved 530 ft to the north only to return 535 ft back to the former location. It then traveled 345 ft to the south and was recaptured twice more within 60 ft of this last location.

Table 2. Percentage of total number of bass captured per month in 200-ft segments of the shoreline

Segment of shoreline	Bass captured per segment (per cent of total captured per month)					
	May	June	July	Aug.	Sept.	Oct.
A	2.7	3.1	2.6	*5.8*	*6.7*	*5.8*
B	2.7	*7.7*	*11.7*	*9.6*	*13.3*	*9.6*
C	4.1	*6.2*	*7.8*	*7.7*	*10.0*	3.9
D	*7.5*	*13.8*	*9.1*	*9.6*	*13.3*	3.9
E	3.4	4.6	2.6	*7.7*	0.0	1.9
F	4.1	*9.2*	*9.1*	1.9	0.0	*5.8*
G	4.1	1.5	0.0	0.0	*10.0*	*5.8*
H	*8.9*	1.5	2.6	0.0	*10.0*	1.9
I	*6.2*	3.1	*7.8*	*5.8*	*6.7*	*11.5*
J	4.8	3.1	*9.1*	3.8	3.3	*5.8*
K	4.8	*7.7*	*9.1*	*5.8*	3.3	0.0
L	*6.9*	*9.2*	*6.4*	0.0	0.0	1.9
M	*10.3*	*6.2*	0.0	3.8	3.3	*5.8*
N	*5.5*	3.1	2.6	*7.7*	0.0	*7.6*
O	*8.9*	*7.7*	*10.4*	*5.8*	*10.0*	3.9
P	4.8	0.0	1.3	*5.8*	0.0	1.9
Q	4.1	*10.8*	3.9	*11.5*	3.3	*7.6*
R	*6.2*	1.5	3.9	*7.7*	*6.7*	*15.4*

[a]If the captures were equally distributed over the 18 shoreline segments each would have a value of 5.5. Values exceeding 5.5 are italicized to reflect tendencies toward clumping.

The percentage of the total catch for any month that occurred in any 200-ft segment of the shoreline ranged from 0.0 to 15.4 (Table 2). If the bass had been evenly distributed, each segment would have contained 5.5% of the total fish captured.

The population estimate of bass 9 in. or larger in the pond used for this study was calculated to be 644 fish with confidence limits of 461 and 980 at the 95% level. Since the estimate stabilized after 10 shoreline traverses, the final estimate based on 16 samplings is considered reasonably reliable.

By comparing the catch per trip around the lake to the total population, it was found that an average of 1.2% of the population was captured on the first traverse and 0.7% on the second traverse of any one sampling date. Further, with only four exceptions, the fish taken on the second trip were different individuals than those taken on the first.

Discussion

On the basis of the present data the largemouth bass observes a home range. This finding is not in agreement with Ball's conclusion that bass show no tendency to stay in one location. This difference may be due to the difference in the two populations. The 10-acre lake on which Ball worked had a population of only 219 bass over 6 in. in length, whereas the 8.4-acre lake considered in the present study had a population of 644 bass 9 in. or more in length.

Each of the 644 adult bass had 5.5 ft of shoreline to occupy if no overlap existed among them and if each occupied a territory of exactly the same size. Thus, even though individual bass exhibited a tendency to remain in the same part of the shoreline, they did not occupy exclusively the minimum segment of the shoreline allotted to them. The fact that an average of only 1.2% of the population was captured on a given trip around the lake indicates that a limited number were on the shoreline at any one time. If it is assumed that 1.2% of the population captured on a particular trip represents the majority of the fish distributed along the shoreline at the time of sampling and this portion of the population is divided into the length of shoreline, a maximum of 450 ft of shoreline would have been available to each fish. This value approaches the length of shoreline constituting what appeared to be the maximum shoreline length of the home range of 96% of the population.

In considering the longer movements which involved crossing either a cove or the lake, straight-line distances were tabulated. Clearly, if the bass had followed the shoreline around, they would have covered a considerably greater distance than if they had moved across the open water. Yet, in no case was a bass captured at points along a probable shoreline route; therefore, the bass probably swam directly across the open water.

The occurrence of straying and subsequent homing exhibited by individual bass corroborates similar observations by Fajen (1962) on the smallmouth bass.

The recaptures in the spring of 1966 indicate that after overwintering in deeper water, a large percentage of the bass return to the same segment of shoreline which they occupied the previous summer.

An attempt was made to learn whether or not the distribution of the bass along the shoreline was uniform, random, or clumped (Odum 1959, p. 213–217). Unfortunately, the numbers of fish taken in any one trip around the lake were inadequate to make such an analysis, and the combined samples for any one month do not, of course, represent distribution at any one point in time. The frequency of occurrence of fish per segment for each month (Table 2) gives some indication of the nature of dispersion. The degree of uniformity of occurrence in the different segments was rather marked considering that some variation in habitat existed.

The population estimate indicated a dense bass population in Baker's Pond. This estimate showed approximately 80 bass 9 in. or longer per acre. Although the population density may not have affected the movement and distribution, further investigation of such an effect is desirable.

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PASSIVE DISPERSAL OF VIABLE ALGAE AND PROTOZOA BY CERTAIN CRANEFLIES AND MIDGES

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Abstract. Four species of aquatic Diptera, *Tipula triplex* Walker (Tipulidae), *Bittacomorpha clavipes* (F.) (Ptychopteridae), *Chaoborus punctipennis* (Say) (Culicidae), and *Tendipes* sp. (Tendipedidae), were collected aseptically and used to inoculate sterile soil-water extract. Twenty-one genera of algae, five Protozoa, a moss protonema and *Alternaria* were identified in the 51 cultured "washings." Comparisons by "Student's *t*" showed that *B. clavipes* carried significantly more algae and Protozoa than the other three insect species, and *T. triplex* carried more than the midges. Found in over 18% of the cultures were the blue-green algae *Anabaena, Anacystis, Chroococcus* and *Phormidium,* and the green algae *Chlamydomonas, Chlorella, Chlorococcum* and *Protococcus.* The protozoans were found at lower frequencies. It is suggested that these viable algae and Protozoa are carried by these four insect species across land barriers.

Introduction

The dispersal and distribution of viable algae and Protozoa into isolated ponds, lakes, and streams is of basic ecological importance. Colonization by some algae leads to problems in the treatment of water for human consumption (Palmer 1962) and affects the quality of natural waters for human and animal consumption and recreation.

In recent years, several researchers have demonstrated