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Dennis N. Schmitt
Iowa State University

Wayne A. Hubert
Iowa State University

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Movement of Yellow Perch Between East and West Okoboji Lakes, Iowa¹

DENNIS N. SCHMITT and WAYNE A. HUBERT²

Iowa Cooperative Fishery Research Unit, Iowa State University, Ames, Iowa 50011

Movement of yellow perch (*Perca flavescens*) from Lake East Okoboji into Lake West Okoboji was confirmed. Recapture trends suggested general movements into Lake West Okoboji in autumn and return into Lake East Okoboji before spawning in spring. Thermal gradients occurring due to seasonal differences in direction of interlake flows and differential warming and cooling rates of the two lakes, appeared to be major ecological factors that governed these interlake movements.

INDEX DESCRIPTORS: Yellow perch, movement, dispersal, lake, seasonal.

Despite the large volume of literature on yellow perch, *Perca flavescens*, little is known of the seasonal movement patterns of perch populations. It is generally assumed that perch in lakes move off-shore into deep water during winter and in-shore in the spring to spawn. Clady (1977) found evidence of homing to spawning sites. Perch tagged during the spawning period in 20,700-ha Oneida Lake, New York, were recaptured in the same locations in subsequent years. None were recaptured at spawning sites other than the one where they had been tagged. After spawning, the Oneida Lake perch dispersed throughout the lake.

Distinct seasonal migratory patterns have been observed in estuarine populations of yellow perch by Mansueti (1960) and Muncy (1962). They observed perch spawning in fresh and brackish water in early April, followed by mid-April dispersal throughout the river to its mouth. An upstream movement was indicated in autumn by tag returns from upper reaches of the river.

Long-range dispersal of tagged yellow perch in Lake Michigan was observed by Smith and Van Oosten (1939). However, in Green Bay only a few fish tagged during the spawning season moved substantial distances; more than 72% were recaptured within the tagging area (Mraz 1952).

Dispersal of tagged yellow perch after spawning in Lake East Okoboji, Iowa, and movement of perch into an interconnected lake, Lake West Okoboji, are described in this paper. On the basis of limnological information about the lake, and literature concerning yellow perch, it is suggested that environmental factors stimulate interlake movement. The interpretation may be useful in the understanding of fish movement in other interconnected lake systems.

STUDY AREA

The Okoboji lakes are located in Dickinson County, northwestern Iowa. The two lakes are part of a flowage system containing seven major lakes (Jones and Bachmann 1974). The drainage pattern is southerly from Minnesota to Spirit Lake and over a spillway into East Okoboji Lake. Water flows through Lake East Okoboji into Upper Gar, Minnewashta, and Lower Gar lakes, then over a spillway into the Missouri River drainage. Lake West Okoboji generally drains through a channel (15-m wide × 2-m deep, 100-m long) into Lake East Okoboji.

Lake East Okoboji is long (10.6 km) and narrow (maximum width 1.4 km), and is divided into four basins. It has a surface area of 743 ha,

a maximum depth of 6.7 m, and a mean depth of 3.2 m. The lake is highly eutrophic and produces high densities of blue-green algae that persist through the summer and fall.

Lake West Okoboji is 8.7 km long and up to 4.4 km wide. This 1558-ha lake has a maximum depth of 41.5 m and a mean depth of 11.5 m. It is less eutrophic than Lake East Okoboji and has relatively clearer water than most prairie lakes.

METHODS

Yellow perch were tagged in Lake East Okoboji during November 1978 and April 1979. Capture gears were fyke nets and gill nets. All the fish tagged were longer than 160 mm (total length) and were released at the point of capture in either Area VIE or VII in Lake East Okoboji (Fig. 1). The perch were marked with Floy anchor tags, Model FD-68B. Tags were inserted at the base of the second dorsal fin with a Dennison tagging gun. Each tag was identified by a five-digit numeral and the inscription, "ICFU ISU AMES IA." Tag returns (identity numeral, date, and location of capture) were obtained from anglers. Returns were solicited with posters at bait shops, in newspaper articles, in letters to registered ice house owners, by personal contact with individual anglers, and in talks to local sportsman's groups. Selected anglers who fished frequently maintained fishing logs to record recaptures as well as their total catch. Perch dispersal patterns were analyzed on the basis of tag returns by dividing the lakes into 10 areas (Fig. 1).

RESULTS

A total of 1310 yellow perch were tagged and released in Lake East Okoboji during two tagging periods; 63 were tagged in November 1978 and 1247 in April 1979. A total of 143 returns (11%) were obtained: 73 from Lake East Okoboji, 68 from Lake West Okoboji, 2 from Lake Minnewashta, and 2 from undetermined locations. Tags were returned from all areas of both lakes, except the northernmost end of Lake West Okoboji, Area I (Fig. 1).

Fifteen of the 63 fish (24%) marked in November 1978 were reported caught over a 19-month interval — 13 from West Okoboji and 2 from East Okoboji. Twelve of the recaptures in West Okoboji were made in the winter. The two tags from Lake East Okoboji were returned in the summer (July 1979 and June 1980).

Tag returns from marked perch by area and period of capture are shown in Table 1. Most tag returns from Lake East Okoboji were in summer — 92% from May through August 1979; 6 were returned during winter (December 1979-March 1980). Tagged perch were caught during all seasons in Lake West Okoboji, but the largest numbers were caught during the winter, December 1979 through March 1980.

Dispersal distances of Lake East Okoboji yellow perch from point of

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Table 1. Return of yellow perch tagged in Lake East Okoboji, by area and period of capture.

Period	Lake and Area ^a													
	WEST OKOBOJI							EAST OKOBOJI						
	I	II	III	IV	V	VI	Total	VI	VII	VIII	IX	X	Unknown	Total
Nov. 1978 - Mar. 1979	-	-	-	-	5	5	10	-	-	-	-	-	-	0
May - Aug. 1979	-	2	5	1	7	-	15	38	2	9	-	1	14	64
Sept. - Nov. 1979	-	3	-	1	7	5	16	-	-	-	-	-	-	0
Dec. 1979 - Mar. 1980	-	4	-	4	13	6	27	4	-	2	-	-	-	6
May - June 1980	-	-	-	-	-	-	0	2	-	-	1	-	-	3
Totals by Area	0	9	5	6	32	16	68	44	2	11	1	1	14	73

^aSee Figure 1 for location of areas.

release to point of recapture ranged from 0 to 10 km (Table 2). Five fish (7%) were captured 8-10 km from the release point during the 4 months after they were tagged in spring, but most (76%) were captured within 4 km of the release point during that time. Recaptures 5 to 7 months after release were primarily (76%) from locations 4 to 8 km from the release points.

Two male perch tagged in April 1979 were recaptured 5 days later in Lake West Okoboji, a minimum of 5 km from the point of release. The straight-line path of their movement traversed the main body of Lake West Okoboji.

Angler log book records were used to assess the distribution of fishing pressure in relation to tag returns (Table 3). The 36 anglers maintaining logs fished mostly in Lake West Okoboji (2,970 of 3,400 hours or 87% of the total logged hours of fishing). Of the 430 hours logged in Lake East Okoboji, 249 (58%) were in Area VIE between May 1 and August 31, 1979.

The 36 anglers reported catching 11,805 fish, of which 51 were tagged — 36% of all reported recaptures. Of the total recaptures by these anglers, 21 were made in Lake East Okoboji (Area VIE) from May through August 1979, and 3 were made in Lake West Okoboji during that period. During that time, 37% of the logged fishing hours were in Area VIE of Lake East Okoboji. During the fall and winter, angling effort was limited almost exclusively (97%) to Lake West Okoboji where 21 recaptures were made between September 1979 and March 1980.

DISCUSSION

This study demonstrated that yellow perch move from Lake East Okoboji into Lake West Okoboji. Seasonal variation in recapture locations probably was related not only to dispersal patterns of perch but also to seasonal fishing patterns of anglers. Fishermen log books and creel surveys (Rose 1956; Christianson 1978) indicated seasonal trends in fishing activity on the two lakes. Nevertheless, the results indicate that many perch moved from Lake East Okoboji into Lake West Okoboji in early autumn and lived in West Okoboji during the winter.

We suggest that kinetic responses of yellow perch to variations in temperature, currents, and chemical gradients led to the interlake movements observed. The drainage area of Lake East Okoboji is larger than that of West Okoboji (Bachmann and Jones 1974). During periods of rising water levels, East Okoboji rises at a more rapid rate than West Okoboji, resulting in a flow of water from East into West

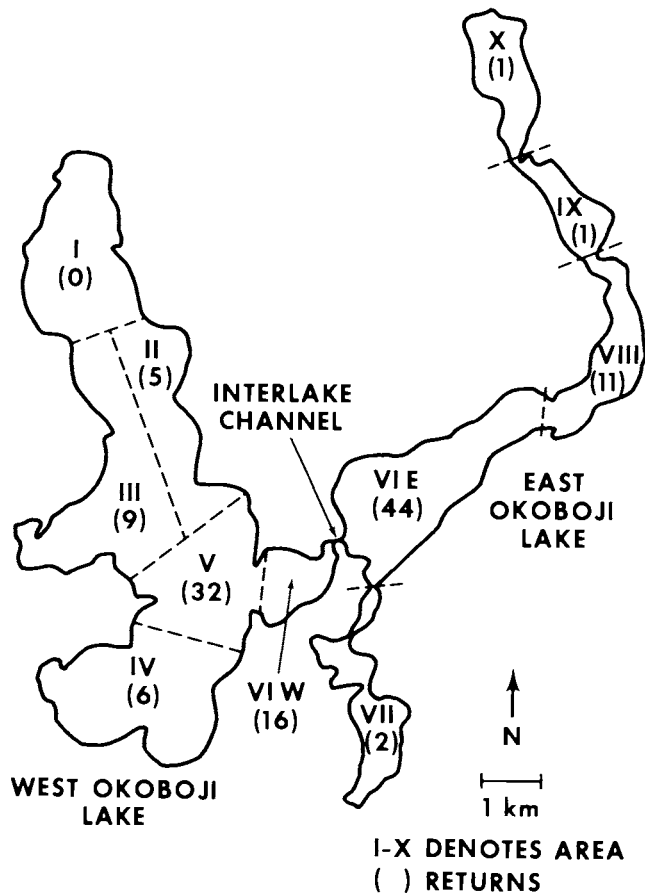


Fig. 1. Recapture locations by area (I-X) of yellow perch (numbers shown in parentheses) tagged in Lake East Okoboji (Areas VIE and VII), 1978 or 1979.

Table 2. Minimum distance traveled from point of release to point of capture for yellow perch tagged in Lake East Okoboji in April 1979.

Time Interval	Kilometers from point of release				Total Returns
	0-4	4-6	6-8	8-10	
May - August 1979	58	3	10	5	76
September - November 1979	1	7	6	3	17
December 1979 - April 1980	6	9	8	8	31
May - July 1980	2	1	-	-	3
Total	67	10	24	16	127

MOVEMENT OF YELLOW PERCH

Table 3. Compilation of angler catch, effort, and recapture data from 36 log books by area and season in the Okoboji lakes (Tags = tag recaptures).

Lake and Area	Dec. 1978-March 1979			April-August 1979			September-Nov. 1979			Dec. 1979-March 1980			Tag Returns by Area
	Catch	Hours	Tags	Catch	Hours	Tags	Catch	Hours	Tags	Catch	Hours	Tags	
West													
I				504	84	-	1122	282	-	689	314	-	0
II	46	4	-	444	138	-	1295	262	1	833	153	2	3
III				138	25	-	735	142	-	184	68	-	0
IV	139	16	-	282	51	-	916	207	-	346	142	1	1
V	984	346	3	602	124	3	500	106	4	774	280	5	15
VIW	20	32	-				472	146	6	127	48	2	8
East													
VIE				553	249	21	31	6	-	6	3	-	21
VII													0
VIII				19	5	2	11	12	-	30	48	-	2
IX													0
X							2	7	-				0
Totals	1189	398	3	2542	676	26	5084	1170	11	2989	1056	10	

Okoboji. During spring, water in East Okoboji warms more rapidly than that in West Okoboji, probably due to differences in water depth, lake volume, and watershed area. Data published by Bachmann and Jones (1974) showed differential warming rates in the two lakes in 1971 and 1972. As a result, relatively warm water flows through the interconnecting channel into Lake West Okoboji in spring. Perch in reproductive condition, having an attraction to warmer water, are likely to encounter the thermal gradient, respond to it, and swim into Lake East Okoboji.

Possibly the thermal attraction is most important when yellow perch become sexually mature for the first time. After initial spawning in Lake East Okoboji, homing behavior may cause the fish to return to Lake East Okoboji to spawn in later years. Clady (1977) found strong evidence of homing to specific locations in Oneida Lake, New York.

Tagging data indicated dispersal after spawning throughout the two lakes, but most of the tagged fish tended to remain in East Okoboji Lake during summer. In the autumn, Lake East Okoboji tends to cool more rapidly than Lake West Okoboji (Bachmann and Jones 1974). At the same time, during the low flow autumn period, water tends to drain from Lake West Okoboji into Lake East Okoboji, setting up a thermal gradient between the lakes. Possibly perch encountering warmer waters of the thermal gradient have a tendency to move from Lake East Okoboji to Lake West Okoboji.

Further kinetic behavior resulting in movement from Lake East Okoboji to West Okoboji is likely to occur as a result of water quality differences after ice formation. The eutrophic conditions in Lake East Okoboji tend to lead to anoxic conditions during winter, especially at the upper end of the lake. Although water quality deteriorates in Lake East Okoboji, water of better quality flows from Lake West Okoboji into the southern end of Lake East Okoboji where fish living in the lake would tend to become congregated. Probably a chemical gradient tends to attract more perch from Lake East Okoboji into Lake West Okoboji during many winters.

Rapid dispersal of some yellow perch from the tagging location into Lake West Okoboji was observed in spring. It is suggested that the rapid movement of some perch into Lake West Okoboji was related to further spawning activity by individual fish. Water temperature rises more rapidly in East than in Lake West Okoboji. Consequently suitable spawning temperatures occur later in the spring in Lake West Okoboji. Some fish may have moved from a suitable

spawning environment in Lake East Okoboji to other suitable areas in Lake West Okoboji at a later date when water had warmed. The capture of male perch over widely separated spawning areas indicates that they may have moved long distances in search of suitable spawning conditions within one season. Additional evidence of extensive movement was noted by Schmitt (1981) in another mark and recapture study. Yellow perch, primarily males, marked and released in the spring in one bay of Lake West Okoboji were recaptured in two other bays during the spawning season.

This discussion suggests that thermal gradients occurring because of seasonal differences in direction of interlake flows and the differential heating and cooling rates of the two lakes are major ecological factors governing interlake movements of yellow perch. This behavior supports the observations of Neill and Magnuson (1974) that temperature is very important in influencing habitat use and also suggests the importance of temperature as an ecological resource (Magnuson et al. 1979).

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