SEASONAL DISTRIBUTION OF ADULT WALLEYE AS DETERMINED BY ULTRASONIC TELEMETRY IN CANTON RESERVOIR, OKLAHOMA[a]

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Abstract: Ultrasonic transmitters were surgically implanted into 50 sexually mature walleye *Stizostedion vitreum vitreum* (mean weight 1.9 kg) in Canton Reservoir during March 1977. The locations of these fish were determined bimontly from March through November 1977, as an indication of walleye concentration areas in the reservoir. Temperature, dissolved oxygen and pH profiles were also obtained bimonthly at 2 stations during this time. During the March spawning season walleye were all located near the riprap of the dam. The rest of the year the fish showed a preference for areas near submerged islands. There was also a tendency for the walleye to concentrate farther upstream along the perimeters of these islands as the year progressed. This apparent upstream movement by transmitter-equipped walleye may have been related to low dissolved oxygen concentrations near the bottom in the deeper portion of the reservoir during the summer months. However, no correlation was found between walleye locations throughout the year and the measured environmental parameters.

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Before the recent development of ultrasonic and radio tagging methods, fish distribution studies were limited to data collected by conventional tagging, netting and electrofishing operations. While these types of investigations gave information on fish movement and distribution, considerable manpower was usually needed to produce reliable results. With the evolution of small, relatively inexpensive transmitting devices that could be attached to individual fish, researchers were able to effectively undertake behavior studies which documented location changes, movement rates, diel behavior patterns and seasonal and diel habitat preference (Fossom 1975). Recently several authors have published findings on observations of walleye movements and locations using biotelemetry. Folsom (1975) studied the behavior of walleye in the upper Mississippi River, Ager (1976) and Pitlo (1978) monitored movements of walleye in Tennessee and Iowa and Bahr (1977) observed homing of walleye in the Upper Mississippi River.

The Oklahoma Fishery Research Laboratory, a cooperative fishery unit of the Oklahoma Department of Wildlife Conservation and the University of Oklahoma Biological Survey engaged in research to determine walleye locations utilizing ultrasonic telemetry. Conceivably, the results of this study should enable a fisheries biologist to manage Oklahoma's walleye populations more effectively and provide the state's anglers access to a higher quality sportfishery. This study was financed by Federal Aid in Fish Restoration funds, D-J Project F-16, State of Oklahoma.

MATERIALS AND METHODS

Study Area

Canton Reservoir is located in northwestern Oklahoma 4.2 km north of the town of Canton in Blaine County. The North Canadian River was impounded by the United States Army Corps of Engineers in 1948 to form Canton Reservoir. The reservoirs area is 3200 ha at normal pool (1615 msl) with a volume of 147,200,000 m^3 (Gomez and Grinstead 1971). Because of the prevalent north-south winds and relatively shallow depth (maximum 8.6m), the lake rarely stratifies.

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Telemetry Equipment

The ultrasonic transmitters, receiver and hydrophone used in this research were commercially produced by Don Brumbaugh of Tucson, Arizona. The cylindrical transmitters were 64 mm in length, 26 mm in diameter and weighed approximately 20 g. The transmitter's active lifespan was 12 months at a cost of $120.00 each. The transmitters consisted of 2 groups having separate output frequencies of 77.5 $\pm$ 0.75 kHz and 74.5 $\pm$ 0.75 kHz, enabling pulse rates to be far enough apart to distinguish 25 individual fish for each frequency group, while allowing the reception of both frequencies on 1 receiver setting. Pulse rates varied within each output frequency group from about 350 to 1575 msec between pulses.

The variable input receiver used was capable of detecting frequencies from 66 to 84 kHz. The receiver itself consisted of the electronic components enclosed in a plastic box (145 x 76 x 70 mm). The receiver was powered by a 9 v transistor battery. Two models of unidirectional hydrophones were used. The Brumbaugh hydrophone was a 140 mm diameter cone type on a 0.75 m handle, however, most of the fish location was accomplished using a 7.4 m aluminum boat with a Smith-Root SR70H hydrophone. This hydrophone was permanetly mounted onto an existing depth sounder transducer bracket in the boat. This allowed the lowering of the hydrophone through the hull of the boat when locating fish and raising it when not in use to avoid damage.

Transmitter Implant

The walleye tagged in this study were collected during March of 1977 using fyke nets set perpendicular to the riprap of the dam. The nets were run after sundown because of the light sensitivity of the walleye. These same nets were also emptied in the morning thus assuring that walleye used for transmitter implants would have been in the nets for no more than 14 hours.

Transmitters were implanted in walleye between 1 March and 29 March. Only sexually mature walleye weighing more than 1 kg were used. An attempt was made to implant transmitter into equal numbers of males and females, and reproductively spent walleye were avoided as much as possible. Walleye were anesthetized at the surgery site in an 8 mg/1 quinaldine and 25 mg/1 MS-222 solution. The surgical procedure used to implant the transmitter was described by Morris (1977). An additional numbered external tag (oval disk type) was placed in the dorsal musculature by means of monofilament. External tags contained reward messages for return of the transmitters. Following revival in fresh water, fish were released into the lake.

Monitoring

Locating the transmitter-equipped walleye was initiated on 4 March 1977 and repeated twice monthly through March 1978. North-south and east-west transects every 300 m over the entire reservoir were made to locate fish. The boat was stopped along these transects, the hydrophone was lowered and the area was checked for walleye. Once a walleye was located, triangulation from known landmarks was employed using a compass and a Rangematic Mark V optical tape measure. All locations presented here were made during daylight hours. An entire check of the reservoir took approximately 5 hours.

No attempt was made to identify individual walleye other than to determine that the fish had not been previously located at another position that same day. This study was one of determining physical location of walleye in order to define possible concentrations areas as opposed to movement study where positive transmitter identification would be necessary. A Spearman ranked correlation analysis was used to compare seasonal location with selected variables of dissolved oxygen, temperature, pH and water level fluctuation. These environmental variables were measured at two samplings stations located at the upper and lower ends of Canton Reservoir.

RESULTS

Transmitter Implants

A total of 50 walleye (27 males and 23 females, mean wt = 1.9 kg) had transmitters surgically implanted. Only 1 of these fish was known to have died from causes other than angling or netting during the 13 month study period. This walleye was found dead on the riprap by an angler on 21 March 1977. This transmitter, in addition to 1 from an angler-harvested fish, was reimplanted in 2 additional walleye, thus keeping the total number of fish tagged in the reservoir through March 1977 at 50.

Eighteen additional transmitter-equipped walleye (9 males and 9 females) were harvested by sport anglers throughout the remainder of the year reducing the transmitter-equipped fish in the population substantially. The majority of these fish (12) were taken during April and May of 1977. Observations by these anglers indicated that the transmitter-equipped fish were in good condition and many had food items in their stomachs. No remarks about sutures being visible were recorded after May 1977.

Walleye Location

Walleye location was initiated on 4 March 1977 and continued through 14 March 1978. Locations were made weekly during March 1977 in order to detect any initial mortality, and continued on a bimonthly basis through December. Adverse weather conditions caused Canton Reservoir to remain ice-covered during January and February 1978, therefore no locations were obtained during these months. Searching resumed for 1 month in March 1978 when the ice cover on the reservoir thawed. A total of 319 walleye were located during the 13 month study.

Typically, Oklahoma's walleye use the rock riprap of the impounding structure as spawning areas (Grinstead 1971). The locations of walleye during the March 1977 and March 1978 spawning period are shown in Fig. 1. Although these walleye probably spawn in only 1.5 m of water, their distance from the riprap indicated that many were not spawning during the daylight hours when they were located.

During the post-spawning period and summer months the transmitter-equipped walleye tended to inhabit areas adjacent to the submerged islands (Fig. 2). This tendency continued through the remainder of the year (Fig. 3). The percentage of walleye found within 200 m of the submerged islands is presented in Fig. 4 for each month fish were located. This summary reveals that from May to November walleye were found within 200 m of these submerged islands 83 to 100% of the time. March and April were characteristic times of spawning when the walleye were located near the riprap. Some walleye were also found near the old river channel in the reservoir. Since impoundment of the reservoir, this channel has been subjected to heavy siltation to the extent that it can no longer be distinguished from the surrounding bottom. This area is still, however, the deepest stratum in the reservoir except for the expanse just in front of the spillway.

Since walleye utilized the rock riprap as a spawning area in March it was logical to use this area as a reference point to determine if these fish moved up the reservoir throughout the remainder of the year. Fig. 5 shows the mean distance of walleye from the riprap for each month. The distances were measured along a line perpendicular to the riprap from the fishes' location. With the exception of June, this indicated that walleye were located progressively further upstream in the reservoir from April through October with a slight retreat in November.

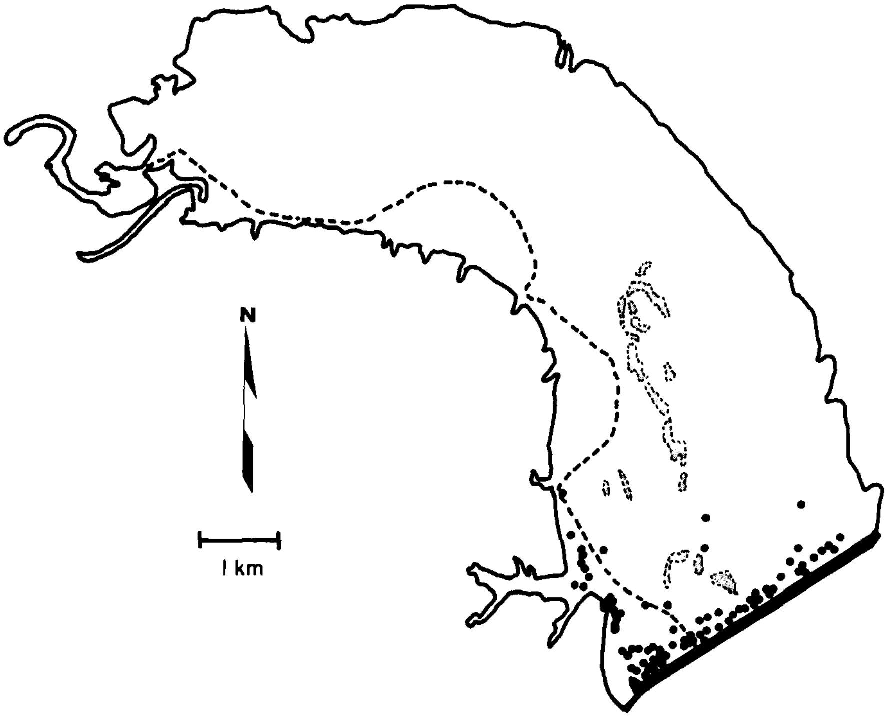

Fig. 1. Locations of walleye during March 1977 and March 1978. Dashed line is old river channel. Shaded areas are submerged islands.

No correlation was found between the walleye locations and the parameters of dissolved oxygen, temperature, pH and water level fluctuation, therefore these measurements are not presented.

DISCUSSION

Walleye equipped with surgically implanted transmitters showed very low mortality. Only 1 fish was found dead during the 13 months. Also no tagged fish appeared to stay in 1 place substantiating that the mortality was limited to only 1 fish.

One of the assumptions of this research was that transmitter-equipped walleye concentrated in the same areas as the non-equipped walleye (i.e., the transmitters did not affect the behavior of these walleye to the point where their distribution was different from other walleye). Bahr (1977) concluded that externally attached radio transmitters did not drastically affect the behavior of walleye. McCleave and Stred (1975) found that Atlantic Salmon swimming speeds were significantly affected by internally placed dummy transmitters. Whether or not the implanted transmitters had a significant effect on the walleye's behavior is unknown. However, several observations during this study suggested that the overall effect on the walleye carrying transmitters was minimal; 1) the spawning urge was not suppressed in most of the fish as evidenced by their return to the spawning area soon after the initial recovery period; 2) transmitter-equipped fish returned again to the spawning area 1 year later; 3) all of the fish recovered by angling were reported to have been in excellent condition and most were also reported to have food items in their stomachs. Pitlo (1978) reported several instances of initial mortality in

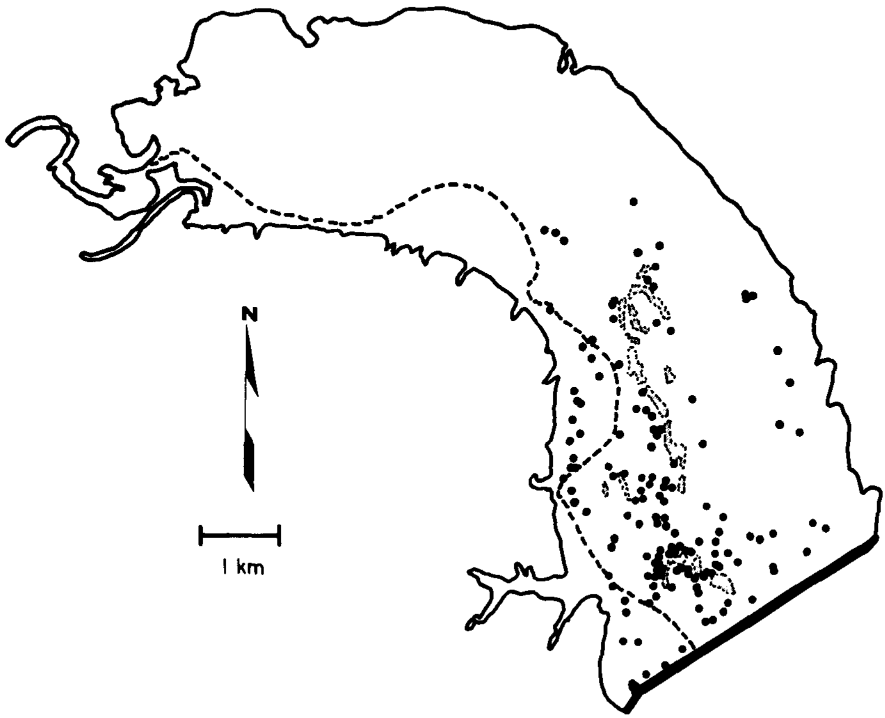

Fig. 2. Locations of walleye during April, May, June, July and August, 1977.

tagged walleye, but most of these were attributed to the holding period prior to release. Therefore, based on the results of this research it is believed that transmitter attachment following the procedures described here may be an adequate method for determining walleye locaitons reliably.

Many popular articles have been published on the use of "structure" as habitat for several fish species. In many instances in this study the observed locations of walleye were near the edges of submerged islands in Canton. Walleye may have been attracted to these areas because they were the only "structure" in the reservoir. Kelso (1976) found that walleye in West Blue Lake, Manitoba preferred steeply sloping shoreline and that movement was restricted to these areas. Ager (1976) noted that walleye in Center Hill Reservoir, Tennessee prefered different types of habitat, including heads of tributaries, near shore, in deep water and rock banks. Pitlo (1977) found walleye at the edge of steep structures. He concluded that it was vegetation present in these areas of West Lake Okoboji, Iowa that attracted the fish to this type of habitat.

Although accurate determinations of walleye depth distribution were not made in this study it was assumed that because of their negative photactism (Scherer 1971) the fish were generally located near the bottom. Angler reports during the spring and summer on recaptured walleye substantiated this theory. Ager (1976) suggested that depth selection in walleye may be limited by hypolimnetic oxygen depletion. Fossum (1975) concluded that the walleye did not show a preference for depth. Bahr (1977) found that walleye in the Upper Mississippi River preferred depths of less than 5 m, and Pitlo (1978) found that walleye had a depth preference of 2 to 6 m in the summer but went to deeper depths in the fall and spring. Scherer (1971) stated that in laboratory experiments the strength of

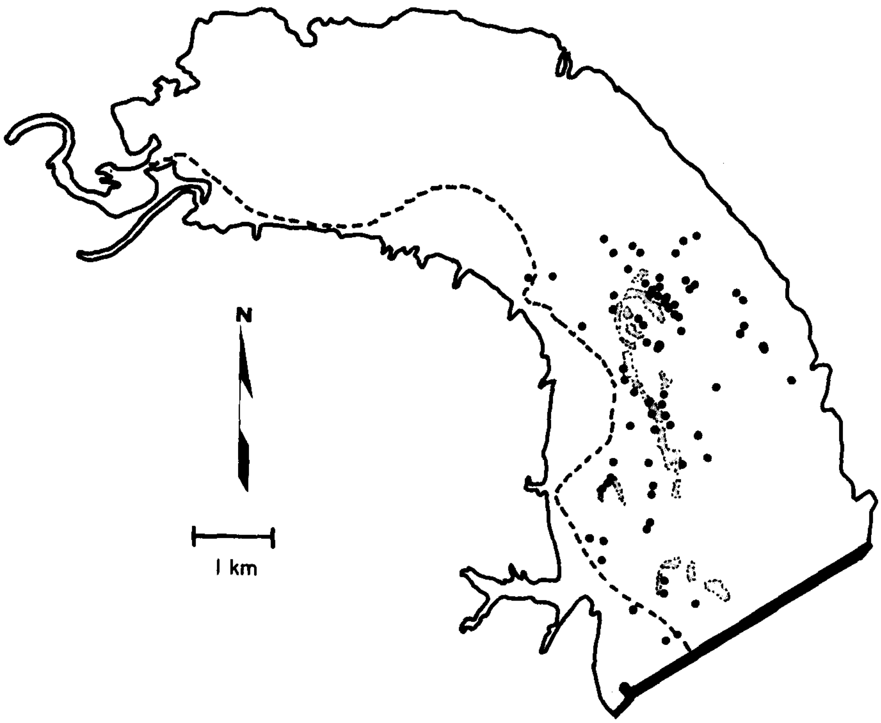

Fig. 3. Locations of walleye during September, October and November, 1977.

negative phototactic response (which often regulates depth) was largely dependent on the given oxygen concentration present. Scherer's findings agree with those stated above by Ager (1976) and this situation may explain the upstream movement of Canton Reservoir walleye during the summer months in the reservoir.

During the hot summer months the prevailing south winds blow directly over the lakes dam and riprap before they cause significant wave action in the reservoir. At noraml pool the dam is 10 m above the surface, therefore the wind does not create substantial mixing until it is about 0.75 km out from the riprap. This causes little mixing near the dam and though temperature was not stratified, DO was substantially lower (4.0 mg/ l) near the bottom. No significant difference, however, was found between the upper and lower reservoir for annual mean temperatures at the bottom. Although walleye location was not correlated with DO concentration these fish may have oxygen requirements that cause them to move to a more favorable area when DO falls below a critical value.

There is little doubt that physical and chemical environmental variables do play a significant role in determining walleye behavior. However, information presented here and by others (Ager 1976, Bahr 1977, Pitlo 1978) suggest that this relationship may be far too complex to be revealed by these methods.

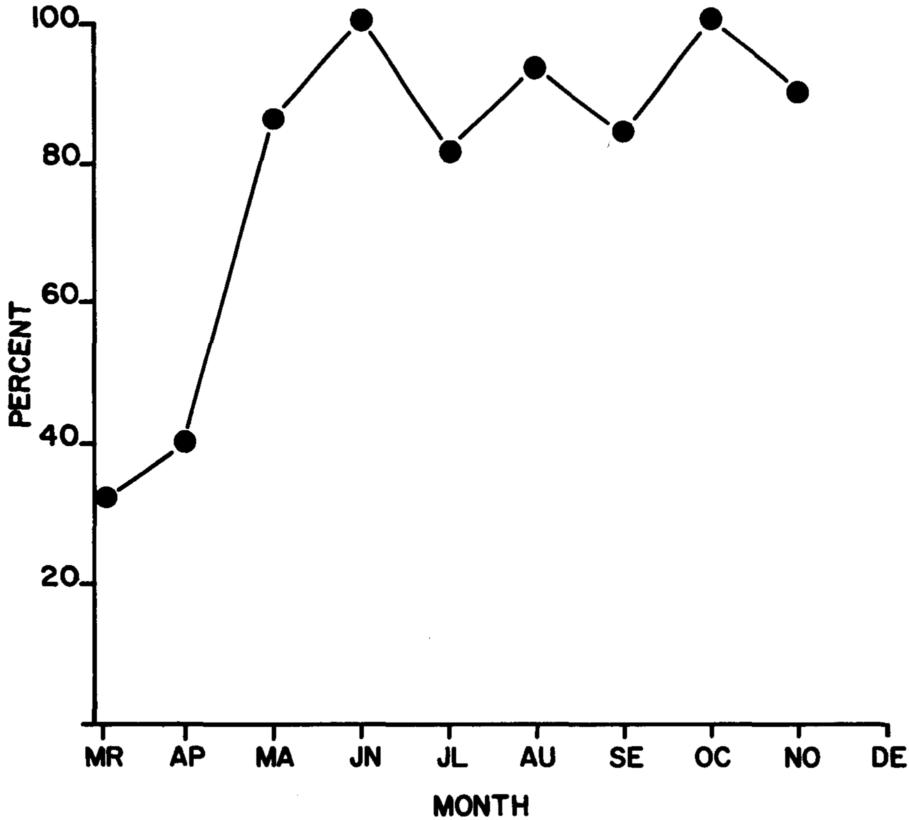

Fig. 4. Percentage of walleye found within 200 m of submerged islands by month.

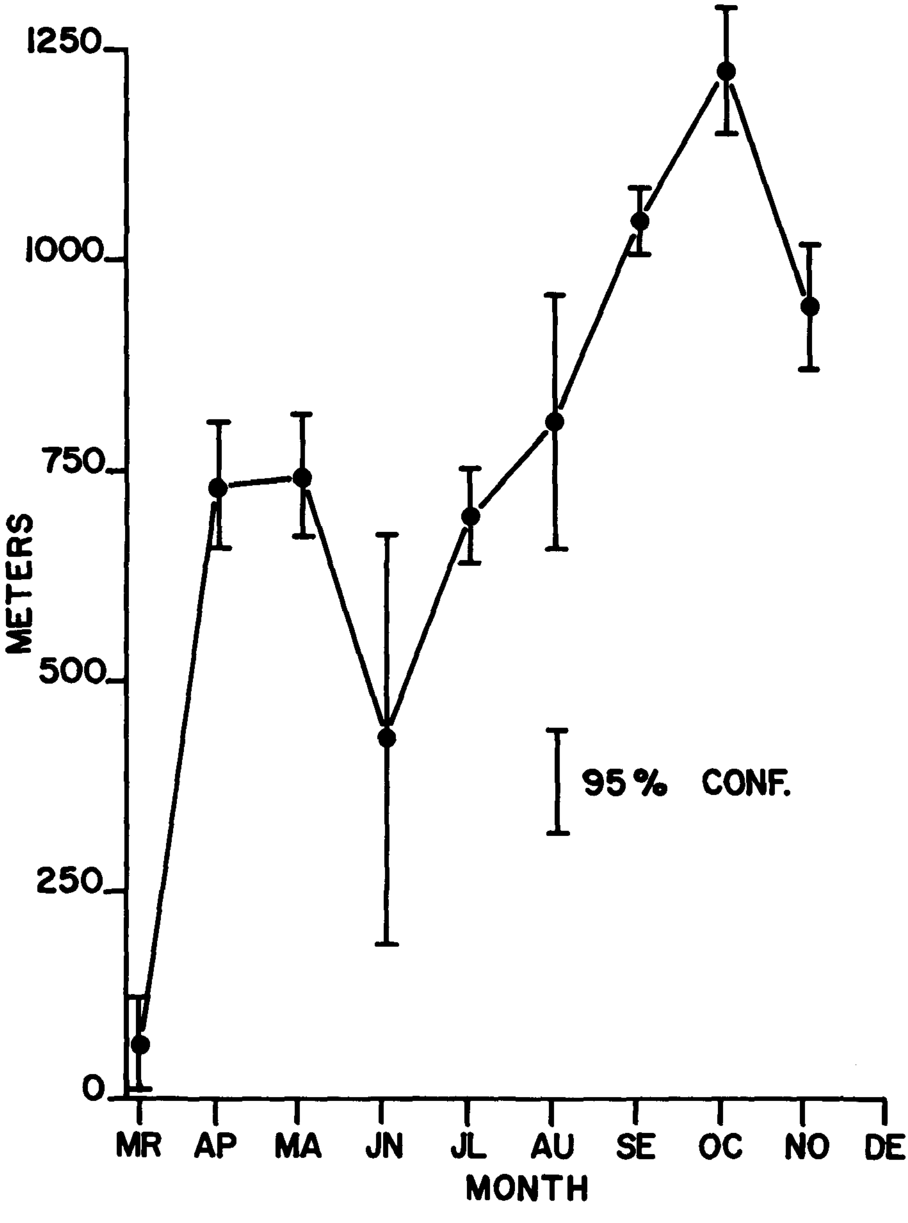

Fig. 5. Monthly mean distance (m) of walleye from dam.

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