Distribution, Movement, and Habitat Preference of Saugeye in Thunderbird Reservoir, Oklahoma[1]

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Abstract: Ultrasonic transmitters were surgically implanted in a total of 30 saugeye (*Stizostedion vitreum vitreum* x *S. canadense*) in 1987 and 1988. Horizontal distribution, movement, distance from shore, depth, and habitat were determined during tracking of each fish. Saugeye were located ≤65 m from shore most frequently during all seasons except summer. Saugeye preferred open shore areas, and frequented submerged timber only during fall 1988 and winter 1989 when prey items may have been limited. Saugeye preferred depths of 0–3 m except in summer 1988 and summer and fall 1989, when no depth preference was evident. Saugeye moved to a cove near the dam during late winter and early spring, which appeared to be a prespawning activity. Approximately 33% of tagged saugeye were not located in the lake during the 1988 spawning period, and 1989 tracking revealed upstream spawning movement in the Little River. Movement of saugeye decreased considerably during the summer, when temperatures approached reportedly lethal levels (≥28 C).

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Many states, including Oklahoma, have been investigating the sport fish potential of the saugeye (*Stizostedion vitreum vitreum* x *S. canadense*). Previous studies of saugeye in Thunderbird Reservoir have revealed rapid growth rates, with fish obtaining a mean length of 543 mm by age–2 (Leeds 1988). These fish utilized a previously untapped forage base of inland silversides (*Menidia beryllina*), large shad (*Dorosoma* spp.), and slow-growing white crappie (*Pomoxis annularis*) (Leeds 1988, Leeds and Summers 1987). Although studies of saugeye in Thunderbird Reservoir have provided a valuable beginning in understanding management of this hybrid, little is known about saugeye habitat preferences, movement patterns, and behavioral characteristics. Age–0 saugeye habitat preference was determined in

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Pleasant Hill Reservoir, Ohio, by means of electrofishing and seining (Johnson et al. 1988). Age–0 saugeye were found over fine substrates through summer and fall, but saugeye moved offshore when temperatures exceeded 22 C. Johnson et al. (1988) also noted that saugeye frequented tailwater habitats associated with impoundments of <500 m and retention times of <0.12 years.

This telemetry study was initiated to locate specific areas of seasonal saugeye concentrations and describe saugeye movement patterns in terms of distance from shore, depth, preferred habitats, and temperature ranges.

Methods

Thunderbird Reservoir is located in central Oklahoma approximately 24 km east of the city of Norman in Cleveland County. The reservoir was constructed by the Bureau of Reclamation in 1965 to serve primarily as a flood control and municipal water supply lake and secondarily for recreation and fish and wildlife management. Located near several densely populated metropolitan centers, the reservoir facilities are often saturated by public use.

Thunderbird Reservoir is 2,240 ha in size with a mean depth of 5.9 m and is characterized as slightly turbid and nutrient rich. It supports a low density largemouth bass fishery and a stunted crappie population (Boxrucker 1987). Gizzard shad (*Dorosoma cepedianium*), threadfin shad (*D. petenense*), and inland silversides (*Menidia berryllina*) are the main forage fishes (Summers 1984).

Fifteen saugeye were collected by electrofishing and implanted with transmitters in December 1987 and 1988, so as not to interfere or incur added stress associated with the spring spawning season (Pitlo 1982). Once electrofished, saugeye were sedated immediately in 25 ppm tricaine-methane-sulfonate (MS–222) enroute to surgery. A temporary building was erected on shore to accommodate the surgery. Upon arrival at the surgery station, sedated saugeye were placed in a tub containing 3.5 ppm quinaldine, and after the saugeye were completely anesthetized, total length (mm), weight (g), and sex (if possible) were recorded.

Surgical procedures closely followed Pitlo (1978) and Hart and Summerfelt (1975). Fish were externally tagged with oval disk tags carrying reward and return information. The tags were attached to the musculature of the caudal peduncle with 0.020 stainless steel wire and secured flat against the body wall. Saugeye were then placed in an aerated live well and transported to the release area. Once total equilibrium was regained and normal movement was observed, fish were released.

Coded transmitters operated at 75 kHz frequency with individual frequencies ranging from 73–77 kHz. Ultrasonic tags were 16 mm diameter × 60 mm length, with an air weight of 20 g, water weight of 8 g, and a battery life of ≥365 days.

Weekly tracking was conducted with random 4-hour time blocks (0000–0400, 0400–0800, 0800–1200, 1200–1600, 1600–2000, and 2000–2400 hours in 1988, and 6-hour time blocks (0600–1200, 1000–1600, and 1600–2200 hours) in 1989. The entire lake was traversed during each tracking period. Temperature and dissolved oxygen profiles were taken bimonthly at 4 stations on the reservoir in 1988 and 3 stations in 1989.

Once a tagged saugeye was located, the location was plotted on a map of the lake. Distance from shore was measured with a range finder when possible. A chart recorder was used to determine the depth of the water column where the fish was located.

Habitat was determined by visual inspection of substrate and structure in conjunction with the chart record to determine topography. Habitat was categorized in 3 major subdivisions of area, terrain, and cover. Area was evaluated as shoreline, point, cove, or open water (≥65 m from shoreline). Terrain was evaluated as flat, sloping, drop off, or channel. Cover was classified as none—soft substrate, timber—any woody vegetation, rocky—rocks and/or boulders present, or aquatic vegetation—all other vegetation other than woody.

Minimum distance in kilometers per day was determined for each fish by measuring distance traveled between weekly locations. These measurements were statistically analyzed with a nonparametric analysis of variance (ANOVA) and chi-square test to determine variations in seasonal travel.

Horizontal distribution categories of <65 m and ≥65 m, depth categories of 0–3 m, 0–6 m, and 0–>6 m, and habitat categories were also statistically analyzed for seasonal variations by nonparametric ANOVA and chi-square test. Seasons were categorized as follows: winter (Dec–Feb), spring (Mar–May), summer (June–Aug), and fall (Sep–Nov). Statistical significance for all tests was declared at $P < 0.05$.

Results

Individual saugeye locations determined in 1988 and 1989 ($N = 436$ and $N = 401$, respectively) indicated saugeye frequented fewer areas of the lake during summer (Fig. 1). Saugeye were located in or near the Little River during the spring seasons. During the possible optimum spawning period (7.1–16.0 C) approximately 33% of the tagged saugeye could not be located in the lake during 1988. The missing saugeye were again located in the reservoir approximately 2–4 weeks after the onset of the spawning season. During the spawning period of 1989, approximately 75% of the 1989 transmittered saugeye were located in the Little River. Some of the saugeye from 1988, whose transmitters were still operating, were also located in the river.

There was a significant difference in horizontal distribution among seasons in each year. Saugeye were located most frequently near the shoreline (<65 m) in all seasons except summer (Fig. 2). ANOVA between the same seasons of different years showed no significant difference in distance from shore for summer and fall seasons.

Results of chi-square analysis for depth distribution indicated that saugeye were most often found in shallow waters in winter and spring, but were more evenly distributed during summer and fall (Fig. 2). There was no significant difference in saugeye depth distribution between the 2 fall seasons.

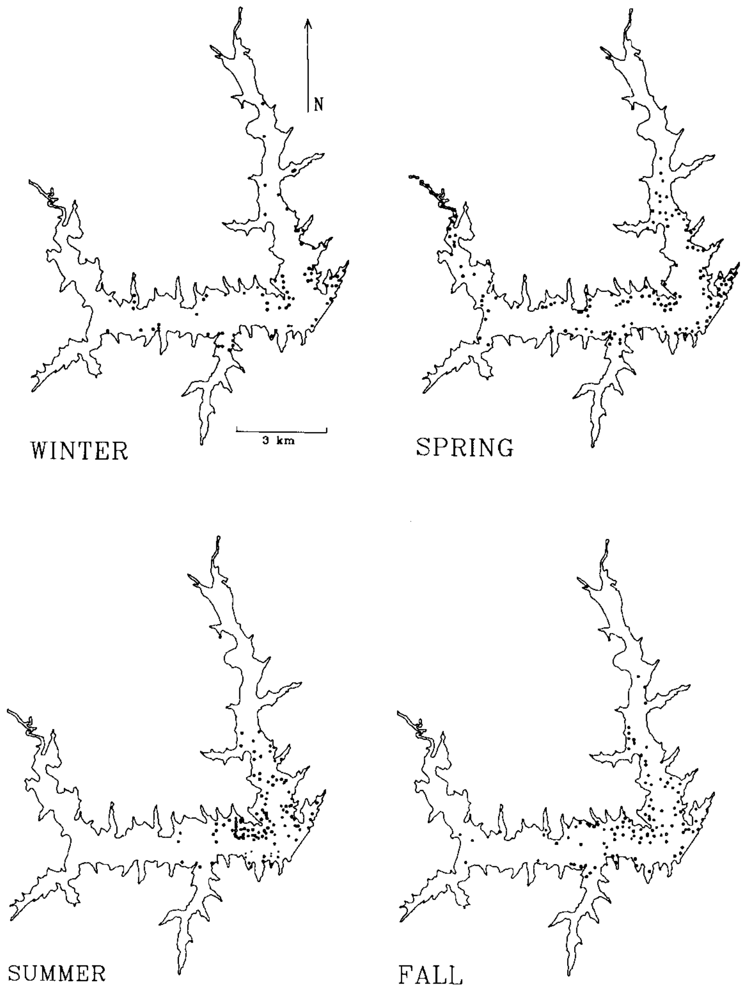

Figure 1. Seasonal saugeye locations in Lake Thunderbird, Oklahoma, 1988 and 1989.

Shoreline appeared to be the most preferred area for saugeye during spring, fall, and winter for both years (Fig. 3). Cove use increased during winter 1988 and 1989 and spring 1988. Use of points remained relatively equal through all seasons for both years. Area use was significantly different among seasons for each year. Results of ANOVA between the same seasons of different years indicated a significant difference between the 2 spring seasons.

Saugeye most frequently occurred over flat terrain through all seasons in 1988, but they selected sloping terrain in the spring and summer of 1989 (Fig. 3). Saugeye seemed to use drop offs equally throughout seasons of each year. Channel use increased in spring 1989. Chi-square analysis of terrain indicated significant differ-

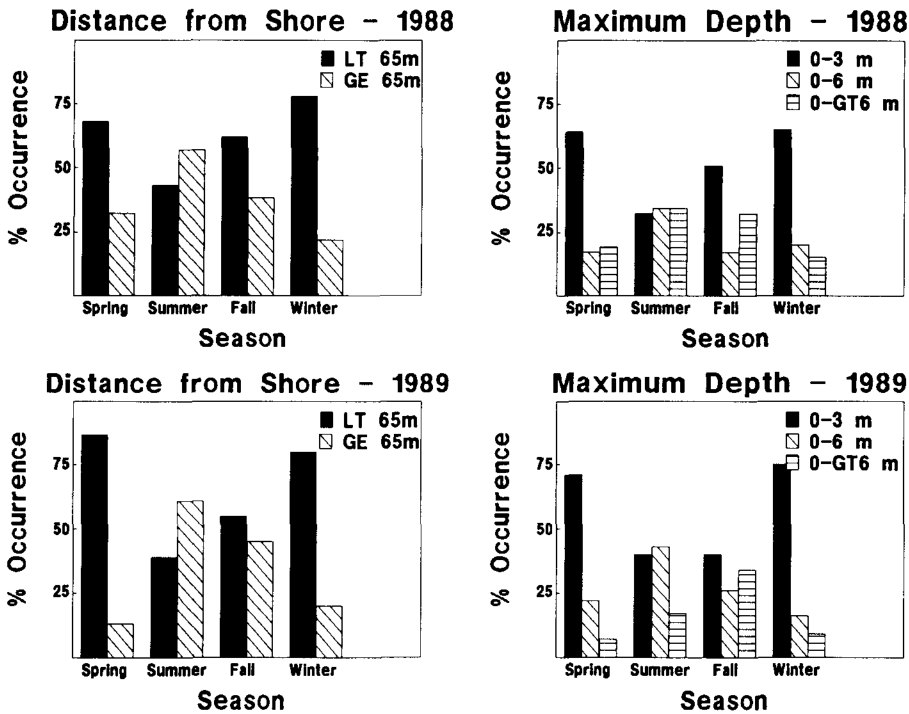

Figure 2. Seasonal distance from shore (<65 m and ≥65 m) and maximum depth (0–3 m, 0–6 m and 0–>6 m) of saugeye in Lake Thunderbird, Oklahoma, 1988 and 1989.

ences among seasons of each year, and ANOVA between same seasons of different years indicated significant differences in the use of flat and sloping terrain in spring and summer between years (Fig. 3).

Saugeye were located most frequently in areas with no cover during all seasons (Fig. 3). Highest occurrences near timber occurred in fall 1988 and winter 1989. There was no significant difference in cover use among the 1989 seasons. However, use of timber and aquatic vegetation was significantly greater during summer 1989 compared to summer 1988.

Mean minimum distance and range of distances traveled each season showed that saugeye moved significantly less in the summer seasons (Fig. 4). Individual saugeye were positioned consistently in the same vicinity for at least 8 weeks in most instances in the summer. There were no other differences between seasons, although saugeye appeared to move much further during fall 1988 compared to fall 1989.

Temperature profiles for 1988 and 1989 revealed possible lethal temperatures of 28–31 C from 0–5 m depth at all stations during July and from 0–6 m at all stations during August. Dissolved oxygen levels were <3.2 mg/l between 6–8 m for all stations in July and August of both years.

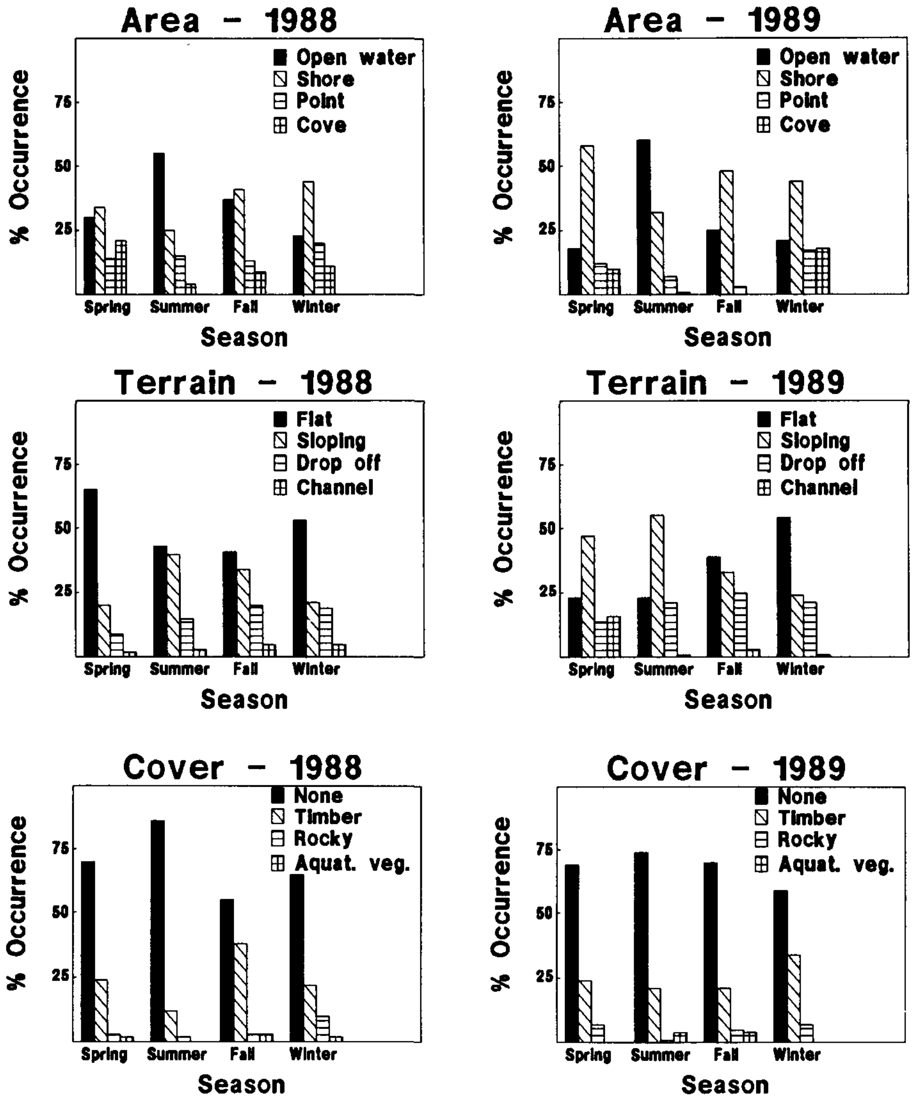

Figure 3. Seasonal habitat use of saugeye in Lake Thunderbird, Oklahoma, 1988 and 1989.

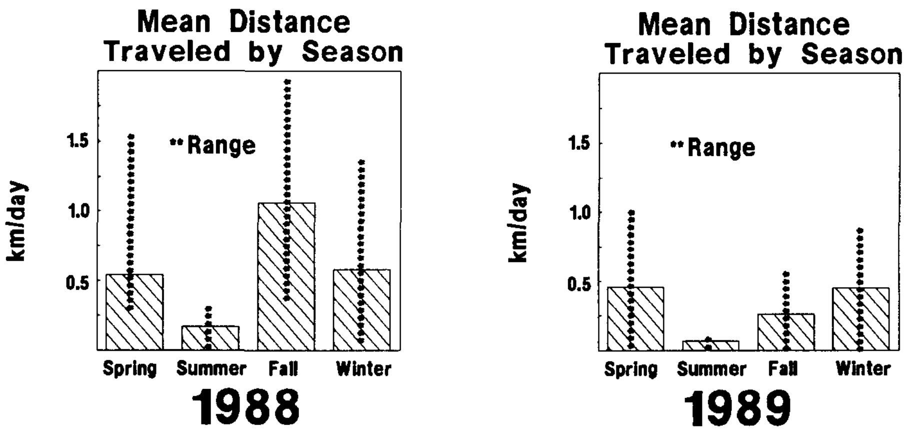

Figure 4. Seasonal mean minimum distance traveled (km/day) by saugeye in Lake Thunderbird, Oklahoma, 1988 and 1989.

Discussion

Saugeye distribution was limited only during the summer months. Saugeye appeared to move offshore when surface water temperatures approached 27 C. They were located further offshore and in deeper waters through summer seasons and during a portion of the fall seasons when conditions were similar to summer.

Hokanson (1977) reported the physiological optimum of sauger and walleye was 20–28 C, and the ultimate upper incipient lethal water temperature was recorded at 28–34 C. As water temperatures exceeded 28 C, Saugeye movements may have been restricted to a narrow region that had adequate water temperatures and dissolved oxygen levels.

Holt et al. (1977) hypothesized the decrease in summer movement of walleye could be partly influenced by greater availability of forage fish during summer months. This could also be possible for saugeye in Thunderbird Reservoir. Hokanson (1977) stated fish kills were rare in nature and generally occurred only when escapement was blocked, when the coolest water available to fish exceeded the lethal temperature, or when the water was deficient in oxygen. There were instances when individual saugeye were located in areas of critical temperature and low oxygen values, yet no mortality of transmitter equipped fish occurred. It is also likely that lethal temperatures for these saugeye were never reached, and/or saugeye were able to withstand extreme conditions for brief periods of time.

Saugeye increased their use of cove areas during the spring of both years, particularly in an area near the dam. It appears this may be a prespawning activity, as F. hybrids have been found to produce viable eggs and fry (Hearn 1986). Coves usually have warmer, more constant temperatures than other areas of the lake due to protection from wind and wave action. Saugeye may be searching for optimum spawning temperatures in these cove areas. An alternative explanation for the increase in cove use is that forage fish frequently inhabit these areas due to warmer temperatures, and saugeye may use these areas to efficiently search for food by pursuing a more confined forage fish population.

Saugeye used all types of terrain in Lake Thunderbird. Terrain usage seems to follow closely with distance from shore and maximum depths. Saugeye were more frequently found closer to shore in shallow water and over flat surfaces in the winter season. Saugeye were located over flat surfaces more often when offshore, and over slopes most frequently when closer to shore in the summer season. Frequency of locations in fall and summer seasons are perhaps similar in terrain because water temperatures remained elevated throughout a major portion of the fall season.

Saugeye appeared to prefer areas without cover throughout the year. This could be attributed to their foraging techniques. Telemetry and electrofishing observations indicate that saugeye are found in close proximity to schooling fish. Schooling fish generally disperse when they move into areas of dense cover, and return to schools once they move to open uncovered areas.

Saugeye occurrence increased near timber in the fall season 1988 and winter 1989. Ney (1978) stated walleye were more active in spring and fall because of lowered food availability during those seasons. Saugeye may be more actively pursuing prey in timbered areas because of decreased prey availability.

Lake depth does not appear to be a major consideration when assessing saugeye stockings except for the possibility of encountering lethal temperatures during the summer. A minimum lake depth of 5–6 m may diminish this possibility.

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