Behavioral Characteristics of Adult Walleyes in Meredith Reservoir, Texas as Determined by Ultrasonic Telemetry

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Abstract: Nineteen adult walleyes were implanted with ultrasonic transmitters and tracked for 2 years at Meredith Reservoir, Texas, to determine specific behavioral characteristics. During the spawning period tagged walleyes established an activity pattern consisting of 3 phases: pre-staging, movement to within 5.5 km of the dam; staging, movement to within 2.2 km of the dam; and spawning on the rip-rap of the dam. Individual walleye established home range areas ranging in size from 141 to 2,517 ha. Fish were located most frequently in water ≤8 m deep within 100 m of shore. Most locations were along brushy or rocky shorelines.

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The use of biotelemetry in determining diel and seasonal movements has expanded understanding of behavioral characteristics of fish. Such knowledge is useful in designing management strategies for important fish species. Walleye, *Stizostedion vitreum vitreum*, were introduced in Meredith Reservoir in 1965 and a reproducing population developed. Information regarding life history parameters (Kraai and Prentice 1974), cost-benefit of the fishery (Kraai et al. 1983), and the genetic stock structure (Terre 1985) has been documented. However, little was known concerning spawning movements, home range, depth of water inhabited, distance located offshore, and habitat utilization in the reservoir. Information regarding these behavioral characteristics, however, has been reported for other geographical areas.

Early studies of walleye spawning were primarily concerned with the timing of spawning runs and movements to the spawning grounds (Rawson 1956; Jester 1961, 1962; Forney 1967; Ryder 1968; Anderson 1969; Priegel 1970; Ragan 1975). Few telemetry studies have monitored spawning movements of walleyes in reservoirs. Summers (1979) tracked 50 walleyes for 9 months beginning in March in

Canton Reservoir, Oklahoma. Ager (1976) tracked 28 walleyes in Center Hill Reservoir, Tennessee, but only 4 were monitored during the spawn.

The tendency for individual walleye to confine their activities to specific use areas (home range, home area, residence area, activity area or activity center) has been documented through biotelemetry studies (Ager 1976, Pitlo 1978, Hall 1982). Findings presented for the size and number of specific use areas were not consistent among water bodies.

Information regarding depth of water inhabited has been reported by Fossum (1975), Ager (1976), Kelso (1976), Holt et al. (1977), Fitz and Holbrook (1978), Pitlo (1978) and Einhouse (1981). The depth of water inhabited by walleye has been reported to be influenced by water temperature as well as other environmental variables (Johnson 1969, Ali et al. 1977, Ryder 1977). Although Ager (1976) and Kelso (1976) addressed the distance walleyes were located offshore, their findings were general in scope.

Ager (1976), Pitlo (1978), Einhouse (1981), Schlagenhaft and Murphy (1985), Smith (1985), Kingery and Muncy (1988), and Paragamian (1989) investigated habitat for monitored walleyes. Findings indicate habitat associations of walleye varied among the water bodies studied.

Walleye behavior has been shown to vary both among individual fish within a water body as well as between bodies of water. This study was undertaken to determine spawning season movements, home range, depth of water inhabited and distance from shore, and habitat of walleye in Meredith Reservoir.

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Methods

This study was conducted on Meredith Reservoir, 60 km north of Amarillo, Texas. The reservoir was formed in 1965 with the impoundment of the Canadian River. Surface area at conservation pool is 6,447 ha; however, the reservoir experienced water level fluctuation and ranged from 3,480 to 4,047 ha (maximum depth 25.3 m) during the study. Shoreline length at conservation pool is 146.5 km and the shoreline development index is 5.5. Approximately 33% of the basin is steep sided and the shoreline is littered with rock and boulders. Aquatic vegetation and inundated brush is limited (Durocher et al. 1984).

Walleyes (2.27 to 3.74 kg) were collected throughout the reservoir with frame nets and gill nets for surgical implantation of ultrasonic transmitters. After capture, fish were measured (TL mm), weighed (kg), and then restrained in a V-shaped,

padded frame partially submerged in a water-filled container (30.5 × 30.5 × 76.2 cm). Paraffin coated ultrasonic transmitters (Sonotronics, Tucson, Ariz.) were implanted into the body cavity of each walleye using surgical techniques described by Hart and Summerfelt (1975) except anesthesia was not employed. All transmitters had a frequency of 75 kHz, but each had a unique pulsed signal that permitted recognition of individual fish. Fish were released in the vicinity of capture immediately after surgery.

Tagged fish were tracked weekly by boat during daylight hours from April 1986 through May 1988. Tracking of each fish began approximately one week after implantation. A tracking trip consisted of a circuit around the circumference of the reservoir and incorporated 400- to 500-m sections. Tracking of individual fish was concluded as soon as all pertinent data was gathered and recorded, a time period of 5 to 45 minutes. In 1987 tracking was intensified to twice a week from 17 March through 10 April (7 tracking days) to determine specific spawning season movements. In 1988 tracking was further intensified to include 13 days between 14 March and 6 April. In addition, on 31 March and from 2 April through 5 April 1988, tracking was conducted twice each night.

A directional hydroacoustic receiver (Winter 1983) was used to scan for transmitter signals in each section. When a signal was received, it was followed to the general location of the fish. The point of crossover, increasing signal strength followed by an abrupt loss of the signal and the need to reverse the hydrophone 180° to recover the signal, determined fish locations. These fixes were plotted on detailed topographic maps (1:24, 000), superimposed with a scaled grid system (each square equaled 836.9 × 836.9 m), using measurements from known landmarks as reference points.

Home range (Burt 1943) of each walleye was estimated using Program Home Range (Samuel et al. 1985) which computed home range contours based on the harmonic mean measure of fish activity (Dixon and Chapman 1980). Harmonic mean calculation of home range was used to reduce the effects of outliers. Contour levels were treated as percentiles of the distribution of each fish. The 95% level defined home range. Areas of land included in the estimates were subtracted from the total home range area.

Water depth at each fix was determined from sonar records, and the distance walleyes were located from shore was determined using either a rangefinder (accuracy = 99.0% at 45.7 m) or a measured line. Surface water temperature was measured at each fix.

Habitat at the location of each fix was determined by visual inspection or, if the fix occurred in an openwater area, a sonar recorder (Lowrance, Inc.; depth range 0-305 m) was employed to determine bottom topography. Two 20- to 30-m intersecting transects were usually made over each fix to determine bottom contour. Five habitat types were defined: 1) rockshore—non-brushy areas within 30 m of shoreline and littered with rocks and/or boulders, 2) submerged hump—open water >30 m offshore where sonar revealed a distinct underwater rocky knoll, 3) brushshore—flooded woody vegetation within 30 m of shoreline, 4) cleanshore—areas

without vegetation or rock structure within 30 m of shoreline having mud or clay substrate, and 5) openwater—areas >30 m offshore having a smooth bottom contour.

Correlation analysis was used to test the null hypothesis that pairs of variables were independent and not linearly related (Neter and Wasserman 1974). Area of home range and establishment of multiple home range areas (dependent variables) were each paired with the size of tagged fish, number of fixes, and with length of period fish were tracked (independent variables).

Results and Discussion

During the 26-month tracking period, 371 fixes were obtained for 19 walleyes (Table 1). Individual fish were tracked over periods ranging from 87 to 680 days.

Spawning Season Movements

During the 1987 and 1988 spawning seasons at Meredith Reservoir monitored walleyes established a pattern of activity consisting of 3 phases: pre-staging, staging, and spawning. Some overlap occurred between consecutive phases. Prior to the spawning season tagged walleyes were located throughout the reservoir.

During the pre-staging phase (Fig. 1), most tagged walleyes moved to canyons within 5.5 km of the dam. Ager (1976) reported on the movement of 2 tagged female walleyes just prior to the spawning season in Center Hill Reservoir, Tennessee.

Table 1. Walleye tagging and tracking statistics, Meredith Reservoir, Texas, 1986–1988.

Fish	Weight (Kg)	Length (mm TL)	Period tracked		Number fixes	Home range area (ha)
			Start[a]	End		
1	3.74	680	27 Mar 86	06 Oct 86	8	375
2	3.86	730	27 Mar 86	10 Oct 87	28	253
3	2.27	600	27 Mar 86	06 Apr 87	37	748
4	3.23	650	28 Mar 86	29 Oct 86	6	285
5	3.63	655	28 Mar 86	17 Mar 87	16	541
6	2.35	593	28 Mar 86	05 Feb 88	37	2,339
7	3.06	612	08 Apr 86	03 Jul 86	9	296
8	2.27	590	09 Apr 86	28 Apr 87	18	178
9	3.36	680	07 Oct 87	03 May 88	16	894
10	3.36	679	07 Oct 87	03 May 88	17	2,118
11	3.46	690	11 Feb 87	14 Apr 88	27	976
12	3.20	630	11 Feb 87	11 May 88	35	2,517
13	3.23	646	03 Mar 87	07 Dec 88	12	141
14	3.18	648	06 Mar 87	11 May 88	28	1,365
15	2.27	610	20 Oct 87	08 Mar 88	14	760
16	2.49	652	22 Oct 87	11 May 88	20	660
17	3.81	700	26 Oct 87	03 May 88	11	571
18	2.90	638	01 Dec 87	03 May 88	16	1,045
19	3.54	670	01 Dec 88	11 May 88	16	390

[a]Date implanted

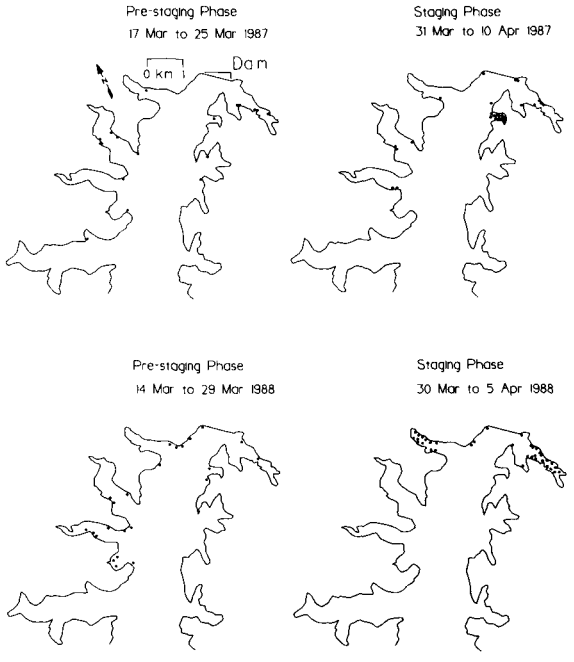

Figure 1. Locations (dots) of tagged, adult walleyes during 1987 and 1988 spawning season, Meredith Reservoir, Texas. In 1987, 11 fish were tracked resulting in 43 fixes. In 1988, 9 fish were tracked resulting in 58 fixes.

Table 2. Dates walleyes stayed in pre-spawning canyons and the date and time located on dam, Meredith Reservoir, Texas, 29 March through 5 April 1988.

Fish number	Dates located in pre-spawning canyon	Date and time located on dam
1	30 March to 5 April	Unknown
2	2 April to 5 April	05 April–2349 hours
3	2 April and 3 April	Unknown
4	1 April and 2 April	Unknown
5	30 March and 31 March	31 March–2314 hours
6	1 April and 2 April	02 April–1937 hours
7	29 March to 31 March	31 March–2307 hours
8	30 March to 2 April	02 April–2349 hours

These fish traveled up to 16.1 km in 24 hours to reach the vicinity of the spawning grounds in the reservoir headwaters.

During the staging phase (Fig. 1), tagged walleyes tended to concentrate in canyons within 2.2 km of the dam. These fish remained in the staging canyons for a period of 1–7 days (Table 2). Summers (1979) reported that walleyes concentrated (staged) along the rip-rap facing of the dam during the March spawning period in Canton Reservoir, Oklahoma.

The spawning phase was defined on the basis of the movement of 5 tagged fish in 1988. Two fish moved from their staging canyon to the rip-rap facing of the dam between 1900 and 2400 hours on 31 March, 2 fish followed this same pattern on 2 April, and 1 fish on 5 April (Table 2). It was assumed that spawning occurred. Subsequent locations of these fish revealed they had left the vicinity of the dam and staging canyons.

Home Range

Tagged walleyes established home range areas in Meredith Reservoir (Fig. 2). The size of home range areas varied among individual fish from 141 to 2,517 ha (Table 1). The majority (79%) of tagged fish occupied areas <1,200 ha. No significant correlations were found between size of home range area and either the size of the fish ($r = -0.17$, $P = 0.49$), number of fixes ($r = 0.59$, $P = 0.01$), or length of period tracked ($r = 0.54$, $P = 0.02$). Einhouse (1981) reported summer and fall home range sizes of tagged walleyes in Chautauqa Lake, New York, varied from 37 to 3,496 ha and 57% of these fish confined their movements to <1,200 ha. Pitlo (1978) reported tagged walleyes in Lake Okoboji, Iowa, established activity areas only during summer months (7 to 77 ha). The mean size of activity areas for walleyes tracked 1 summer in Jamestown Reservoir, North Dakota, was 45.4 ha. (Hall 1982).

Five of the 19 walleyes (26%) tracked in Meredith Reservoir utilized multiple home range areas (Fig. 2). There were no significant correlations between the establishment of multiple home range areas and either the size of tagged fish ($r = -0.12$, $P = 0.63$), the number of fixes ($r = 0.06$, $P = 0.80$), or length of period tracked ($r = 0.07$, $P = 0.75$). Einhouse (1981) reported that 18% of tagged walleyes, primarily fish weighing >2 kg, utilized multiple activity areas.

Depth and Distance from Shore

Tagged fish were located in relatively shallow water (Fig. 3). The mean monthly depth at walleye fixes never exceeded 8 m which was similar to the findings of other investigators. Fossum (1975) and Holt et al. (1977) found tagged walleyes occupied depths ranging from 1.5 to 3.8 m. Pitlo (1978) reported most tagged walleyes were found in water <8 m deep. Einhouse (1981) found a depth range of 2–7 m for tagged walleyes and Hiltner (1983) reported that adult walleyes are usually found in water depths of 0 to 5.3 m. Johnson (1969) found walleyes in study lakes in northern Minnesota extended their range into deeper, cooler water when surface water temperatures rose above 21 C. Tagged walleyes in Meredith Reservoir did not demonstrate a pattern of inhabiting deeper water during warmer months (Fig. 3). Ager (1976) reported similar findings for walleyes tracked in Center Hill Reservoir, Tennessee.

Most walleye fixes were within 50 m of shore and the mean monthly distance from shore never exceeded 100 m (Fig. 3). Tagged walleyes did not demonstrate a consistent pattern of seasonal movement to or from shore (Fig. 3). Ager (1976) reported that monitored walleyes preferred to remain >30 m offshore during all seasons of the year. Kelso (1976) continuously tracked walleyes for 1 week in West Blue Lake, Manitoba and found they were usually located within 100 m of shore.

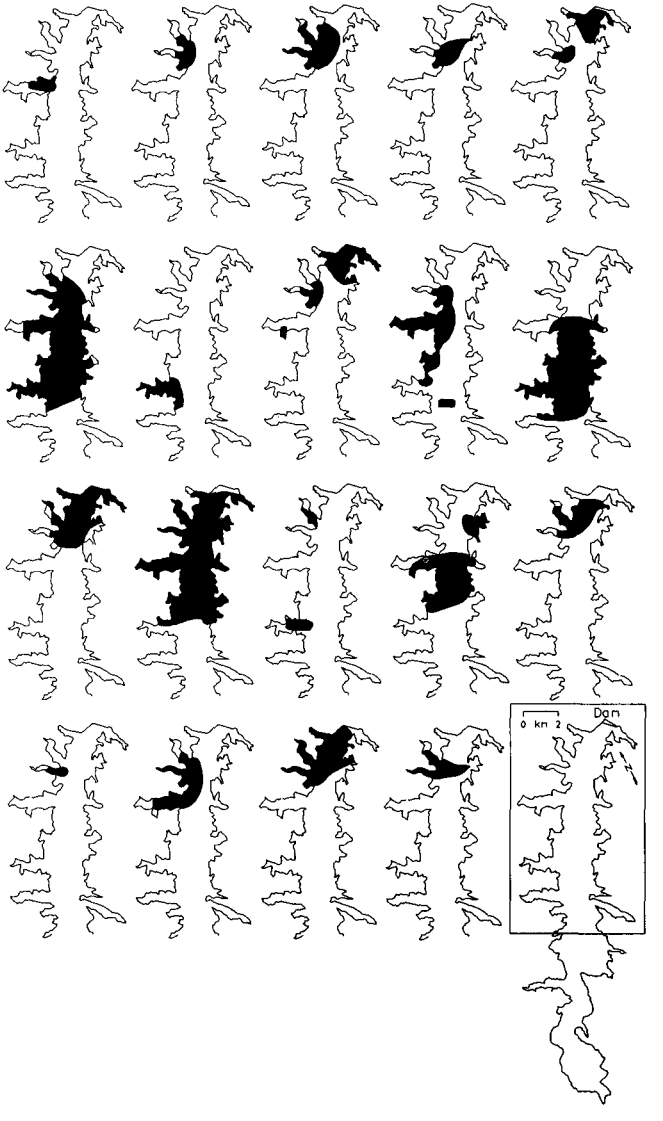

Figure 2. Home ranges (shaded area) of 19 tagged adult walleyes tracked at Meredith Reservoir, Texas, 1986–1988.

Habitat

Tagged fish in Meredith Reservoir were most frequently located along brushy or rocky shorelines (Table 3). Sixty percent of fixes were in these habitat types. Other telemetry studies have shown walleyes associate with a variety of habitat types: mud and rock shorelines with brush or in open water areas (Ager 1976), submerged beds of aquatic vegetation (Pitlo 1978, Einhouse 1981), submerged

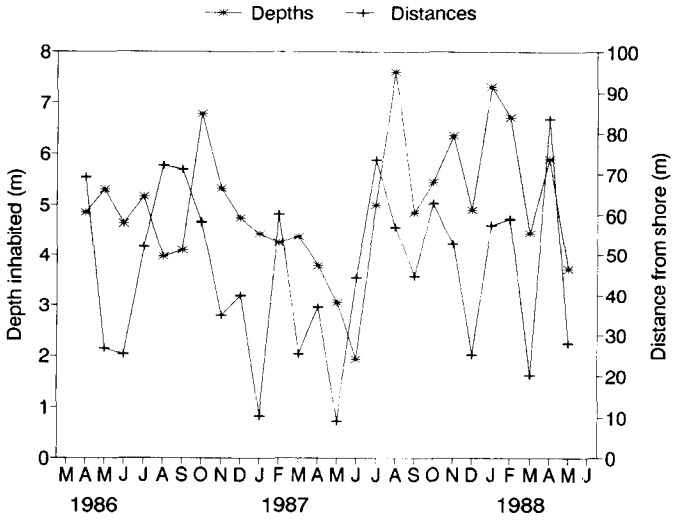

Figure 3. Mean monthly water depths inhabitated and mean monthly distances from shore for 19 adult walleyes tracked at Meredith Reservoir, Texas, 1986–1988.

Table 3. Habitat at 371 walleye fixes, Meredith Reservoir, Texas, 1986–1988.

Habitat	%
Brushshore	32.3
Rockshore	28.6
Openwater	21.0
Submerged hump	13.5
Cleanshore	4.6

islands (Summers 1979), steep rocky shorelines or in open water areas (Schlagenhaft and Murphy 1985), and downed trees or rock and boulder bars (Smith 1985).

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