COMPARISON OF TWO METHODS OF RECAPTURING MARKED FISH FOR ESTIMATING BLACK BASS POPULATIONS IN A RESERVOIR

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Abstract: The population of largemouth bass (*Micropterus salmoides*) in 2314-ha Melton Hill Reservoir, TN, was estimated by 2 mark and recapture methods. Shoreline electrofishing was used to capture fish for marking, while shoreline electrofishing and a bass fishing tournament were used to obtain recaptures. Both methods yielded estimates of the same magnitude; however, slightly different size selectivities were found with the 2 recapture methods. Species selectivity of shoreline electrofishing and the bass tournament are also compared. The population structure of the black bass population in Melton Hill Reservoir is examined and possible causes for this structure are presented.

Proc. Ann. Conf. S.E. Assoc. Fish & Wildl. Agencies 32: 437-445

The population dynamics of bass (*Micropterus* spp.) have received increased interest in recent years because of increased fishing pressure on reservoir bass populations. Mark and recapture has been the most commonly used method for estimating the number of bass in large bodies of water. Shoreline electrofishing is presently the most practical means for capturing large numbers of bass to mark, especially during the early spring months (Bryant and Houser 1971). Large bass fishing tournaments can provide an additional source of recaptures for population estimates (Holbrook et al., 1972; Holbrook 1975). Grinstead and Wright (1973) used mark and recapture by electrofishing in conjunction with a bass tournament to estimate the bass population in Eufaula Reservoir, OK. Bryant and House (1971) used shoreline electrofishing for both marking and recapturing bass to estimate the bass populations in Beaver and Bull Shoals Reservoirs. Aggus and Rainwater (1975) used the same methods but also obtained recaptures from bass tournaments and creel survey.

The results of these efforts in reservoirs have been marginally effective. There is a need to identify the factors necessary for estimating bass populations in reservoirs. Sample design, effort, numbers of fish to be marked in relation to the size of the water body, and species and size selectivity of the methods should all be examined.

If a large tournament is a feasible tool for estimating bass populations in large reservoirs, it would considerably reduce the total cost. On the other hand, if shoreline electrofishing is necessary to recapture marked fish, a standardized design widely applicable to reservoirs would be helpful in calculating the necessary costs of manpower needs for such an estimate. In this paper, we compare a mark and recapture population estimate based on recaptures from a fishing tournament with one based on captures from shoreline electrofishing.

Melton Hill Reservoir is considered a poor fishing area, especially for bass, and this study was also undertaken to delineate problems associated with poor bass fishing in Melton Hill Reservoir and identify opportunities for enhancement.

MATERIALS AND METHODS

Description of Study Area

Melton Hill Reservoir Dam, closed in 1963, is located at Mile 23.2 on the Clinch River in eastern Tennessee near Knoxville. It impounds a reservoir covering 2,314 ha at normal full pool elevation. Maximum reservoir fluctuation is about 1.5 m, although normal fluctuation is about 0.6 m. The reservoir is narrow and riverine (maximum width about 1.6 km); shoreline length is 232 km. Maximum depth is about 18.3 m. The reservoir consists of a navigation channel which is maintained at 3 m minimum depth and is

Table 1. Physical characteristics of Melton Hill Reservoir at normal full pool elevation.

Area (hectares)	2,314
Length (km)	71
Shoreline length (km)	232
Maximum depth (m)	18.3
Mean depth (m)	6.3
Shoreline development	13.6
Average water retention time (days)	8.5

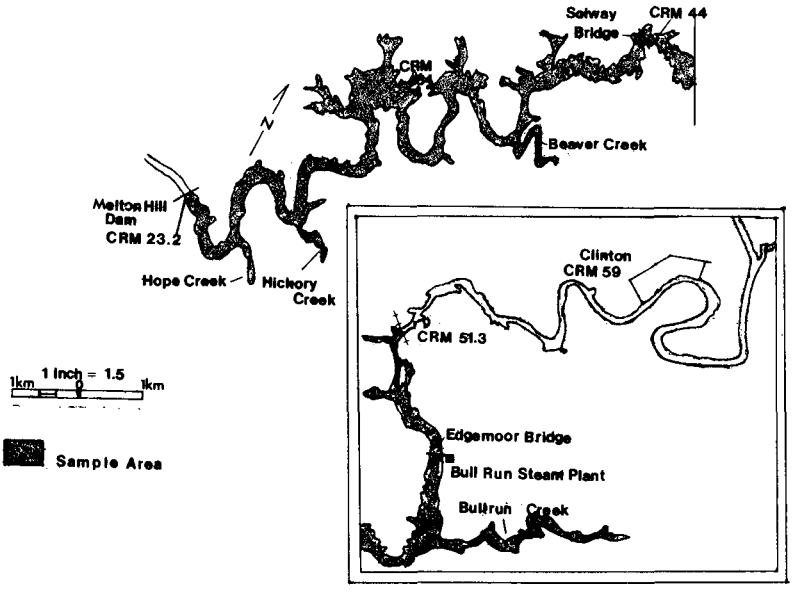

Fig. 1. Map of Melton Hill Reservoir

bordered by shallow mud flats; coves are scarce and generally small. There is 1 large (Bull Run Creek) and 3 smaller creek embayments in Melton Hill Reservoir (Fig. 1). Eurasion watermilfoil (*Myriophylum spicatum*) occupies large areas of the shallow water in the upper one-third of the reservoir. Physical characteristics of Melton Hill Reservoir are given in Table 1. Melton Hill receives most of its inflow from the hypolimnetic discharge from Norris Dam, about 21 km upstream of Melton Hill headwaters. The discharge is typically cold (seldom exceeding 21 C) and is deoxygenated during late summer and autumn. The upper 29 km of the reservoir (above Bull Run Steam Plant) do not normally stratify, except for warming in coves and shallow off-channel areas. Downstream of this point, stratification occurs as a result of solar heating and the thermal discharge from Bull Run Steam Plant.

Tagging

A boat-mounted electrofishing unit (d.c.) was used to capture bass, which were then tagged with numbered Floy FD 67 tags, for a mark and recapture population estimate. All largemouth bass, smallmouth bass, (*M. dolomieui*) and spotted bass (*M. punctulatus*) were held in a live well. All fish longer than 304 mm total length, (which was the minimum size limit for the bass tournament) were tagged in the dorsal musculature next to the spiny dorsal fin and released near the point of capture. The first dorsal spine was clipped as a backup mark in case of tag loss. All bass less than 304 mm total length were measured and released. Only that portion of the reservoir considered to be bass habitat (the lower 53 km) was sampled (Fig. 1), and crews were free to electrofish any location within a designated area to capture bass. The entire shoreline of the designated portion of the reservoir was sampled at least once during the tagging phase. Fish were tagged from 1 April through 5 May 1976. Both day and night electrofishing were tested early in the sampling but most later electrofishing was done during daytime because of the small differences in capture efficiency.

Recapture

Bass tournament – A 1-day bass tournament was organized through 2 local clubs to recapture bass for the first population estimate. The tournament was scheduled for 8 May 1976. An entry fee was charged and prizes were awarded to provide incentive to fishermen. Fishing was allowed from 0600 until 1700 hours with a 304 mm minimum size limit and an artificial lure only restriction. Fishermen returned all fish to a single point for weigh-in. They were checked for tags and tag loss and were weighed and measured. Fish that were not already marked were tagged with Floy FD 67 tags. A left pelvic fin was also clipped as a backup mark. All live, tagged fish were released in the main channel close to the weigh-in point to provide additional marked fish for a second population estimate.

Shoreline electrofishing – Bass habitat in the reservoir was divided into 3 major segments. Shoreline lengths, 1.6 km long were consecutively numbered within each major segment. A table of random numbers was used to select the units to be sampled in each area. This was done to randomize sampling effort and to avoid sampling the entire shoreline area of the reservoir. Sixty-nine of a total of 96 shoreline units were sampled during the recapture period from 17 May to 28 May 1976. All fish longer than 304 mm total length were checked for tags or tag loss; fish less than 304 mm total length were measured.

Population estimates – Separate population estimates were made based on recaptures from the bass tournament and the total shoreline electrofishing using Bailey's modification of the Petersen method (Ricker 1958) by the formula: $p = \frac{M(C+1)}{R+1}$ where P equals number of fish in the population, M equals the number of marked fish, C equals the number of fish captured in the second sample, and R equals the number of marked fish recaptured. Confidence limits were calculated using Chapman's poisson approximation method (Chapman, 1948).

RESULTS

Initial Tagging

A total of 242 bass larger than 304 mm was tagged prior to the tournament. Low numbers of smallmouth and spotted bass were tagged (21 and 9, respectively).

Length frequencies of bass over 304 mm total length marked prior to the tournament are shown in Fig. 2. The relatively high proportion large fish in the sample is atypical of bass populations in most reservoirs (Aggus and Rainwater 1975). This phenomenon may be due to extremely low fishing pressure, poor spawning success, or poor recruitment in recent years.

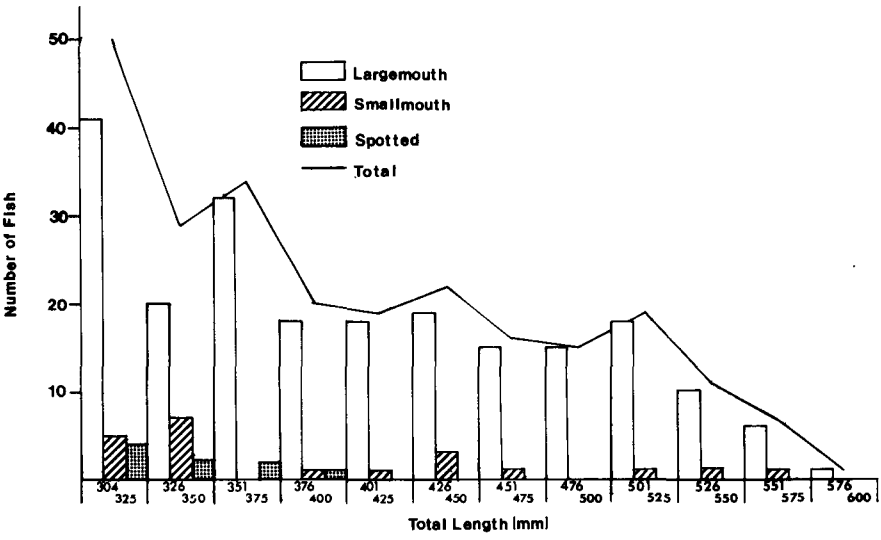

Fig. 2. Length frequency of black bass longer than 304 mm taken by electrofishing from Melton Hill Reservoir prior to the tournament.

The proportions of smallmouth and spotted bass were relatively low in all except the 2 smallest length classes. Spotted bass were absent from length classes larger than 376-400 mm. This is probably due to the small maximum size attained by spotted bass.

The effort required to mark these fish was 20 electrofishing unit days. Tagging was slow because of the apparent low population of black bass in the reservoir and because of less than ideal weather during some of the tagging period.

Tournament Catch

Tournament participation and catch were hampered by poor weather conditions. A cold front passed through the area on the night before the tournament. The weather was windy and cool the morning of the tournament (May 8). Seventy-four anglers caught a total of 31 bass (Table 2), of which 3 were spotted bass; no smallmouth were taken. Length distribution of fish taken during the tournament (Fig. 3) was similar to that of those taken during the tagging phase (Fig. 2). There was some size and species selectivity in the tournament catch compared with the electrofishing catch. Fish in the 326-350 mm and 401-425 mm length classes were relatively more numerous and fish in the 351-375 mm, and several larger-size groups, were relatively less numerous in the tournament catches than in the electrofishing sample. Spotted bass taken in the tournament represented a larger proportion of the 2 smallest length classes than in the electrofishing sample; however, the small sample size involved in the tournament catch precludes comparison with the pretournament data.

Seven tagged bass were returned in the tournament catch of 31 total fish (Table 3). Six of the 28 largemouth bass and 1 spotted bass caught were tagged. From these data, the population of largemouth bass, 304 mm or longer (Table 3) in Melton Hill Reservoir was estimated to be 862 or 0.37 per ha. The 95% confidence interval (349 to 2,260) is relatively large due to the low number of fish taken in the tournament and the small number of recaptures.

Table 2. **Population estimates of largemouth bass longer than 304 mm total length from tournament and shoreline electrofishing recapture methods from Melton Hill Reservoir.**

Tournament	
Number of fish tagged[1]	208
Number of fish caught in tournament	28
Number of tagged fish returned	6
Peterson population estimate (Bailey's *modification*)	862
95 percent confidence interval	349-2,260
Shoreline Electrofishing	
Number of fish tagged[1]	221
Number of fish in electrofishing sample	82
Number of tagged fish in sample	14
Peterson population estimate (Bailey's modification)	1,223
95 percent confidence	692-2,192

[1] Adjusted to allow for tag return prior to recapture period.

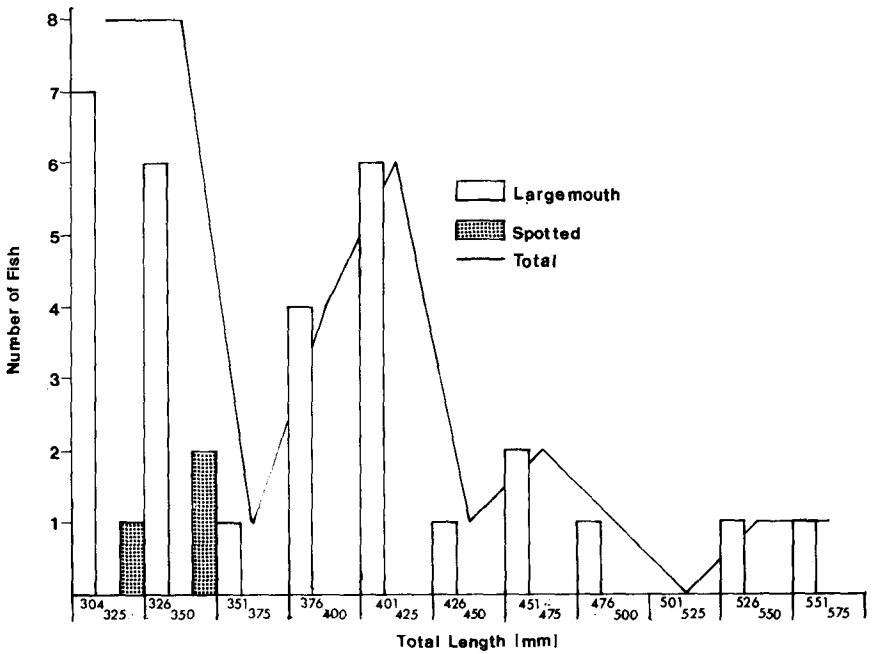

Fig. 3. Length frequency of fish caught in the Melton Hill Bass Tournament.

Table 3. Summary of catch from bass tournament, Melton Hill Reservoir, May 8, 1976.

Number of fishermen	72
Hours fished	729[a]
Hours per hectare	0.32
(Hours per acre)	0.13
No. of bass weighed in	31[b]
Catch rate	
Fish per hour	0.04
Kg. per hour	0.04
Lbs. per hour	0.08
Fish released alive	21 (68%)

[a]Estimated hours—actual is less, since some fishermen quit before official time.
[b]Only bass longer than 304 mm total length were weighed in.

Electrofishing Recaptures

Length frequencies of bass larger than 304 mm (Fig. 4) showed a somewhat different population structure from those shown in either the initial tagging or tournament catch; however, the differences were not major. Fish in the 326-450-mm length classes were relatively less numerous. Smallmouth were less numerous, especially in the 304-305-mm size classes. Smallmouth were absent from the 3 largest size classes. Spotted bass showed similar patterns in the tagging and recapture studies, except that they were absent from the 376-400-mm size class during the recapture period. None of the bass released after the tournament was taken in the recapture efforts. The differences in the size distribution of fish may be due to seasonal differences in the size of bass occupying shallow shoreline habitat or to site selectivity in the tagging phase (randomly selected shoreline lengths were sampled in the recapture phase).

Recapture effort required 10.7 electrofishing unit days (Table 2); mean number of fish captured was lower (8.5 per day) than during initial tagging effort (12.1 per day). This lower value is probably due to the randomized effort and offshore movement of some fish following spawning.

Fourteen of the 82 "legal" largemouth taken during the post-tournament period were recaptures (Table 2). The number of largemouth tagged at the time of recapture was 221. The population estimate based on this return is 1,223 fish or 0.53 fish per ha. The 95% confidence interval of the estimate (692-2,192) overlaps the confidence interval of the tournament estimate (349-2,260).

DISCUSSION

The population structure of largemouth bass in Melton Hill Reservoir is different from those in most reservoirs although samples taken at different times of year exhibit great variability (Aggus 1975; Holbrook 1975). The relatively low numbers of small bass (251-325 mm) in the sample (Figs. 4 and 5) may indicate some problem with reproductive success of young-of-the-year survival. The cold temperature, limited bass habitat, and low forage species probably all contribute to the problem. The tournament and electrofishing recapture population estimates are similar in magnitude. The tournament appeared to exert a slightly different size selectivity than shoreline electrofishing. The 304-350 mm fish were relatively more abundant and larger fish were relatively less abundant in the tournament. Smallmouth bass were absent from the tournament catch precluding any conclusions about size selectivity.

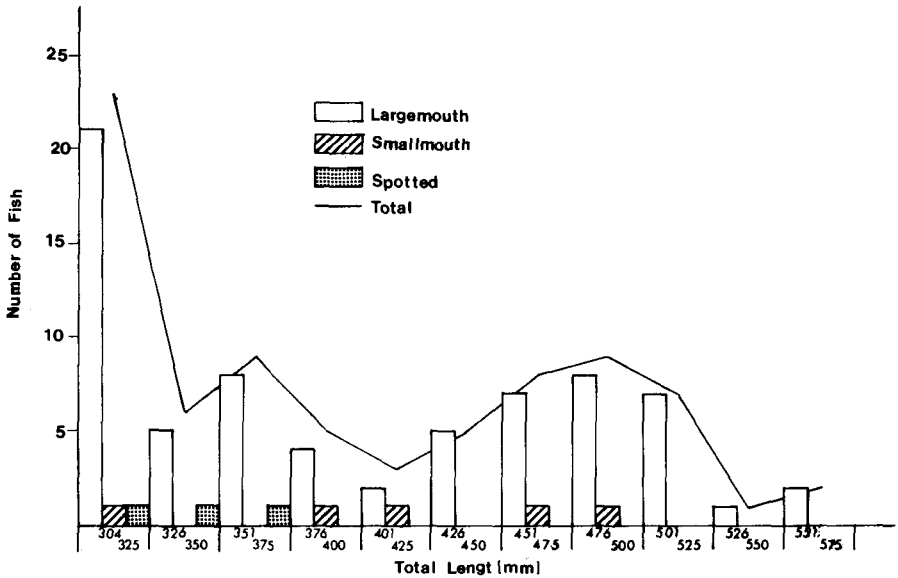

Fig. 4. Length frequency of bass larger than 305 mm taken from Melton Hill Reservoir during the recapture phase.

The estimated number of 304 mm and larger largemouth bass in Melton Hill (0.51/ha) is lower than recent estimates for other large reservoirs reported from the literature (Table 4). Estimates ranged from 0.65 per ha for Lake Sidney, Lanier, GA, to 5.32 per ha for Beaver Reservoir, AR. Not all of the estimates were made on the same size fish so they are not all comparable. There are also some differences in time of year when the estimates were made. Van Den Avyle (1976) indicated that there are seasonal differences in the relative numbers of onshore and offshore bass populations so that estimates made during the summer and fall are much lower.

Based on our observations, it appears that it would be advantageous to place maximum effort (a large number of electrofishing units) on the reservoir during a short time period in both mark and recapture phases and to minimize the time between mark and recapture (e.g., less than 1 week) to avoid seasonal movements to or from shallow water. A tournament provides an easy method of obtaining recaptures but weather can drastically affect the catch rate, even at an optimum time of year, and tournament angling shows a somewhat different size and perhaps species selectivity. A tournament held during optimum weather conditions with a larger number of participants (more than 100) on Melton Hill Reservoir would probably have provided an estimate statistically as good as or better than the electrofishing recaptures; however, size selectivity and concentration of effort (lack of fisherman dispersal) are possible sampling problems associated with the method. Smallmouth bass, and spotted bass to a lesser extent, are difficult to sample with electrofishing gear, and tournament angling shows even less promise as a means for capturing these species efficiently.

Carefully designed shoreline electrofishing mark and recapture programs show promise in estimating populations; however, estimates obtained will probably be expensive and difficult to justify except for a specific purpose on a few selected impoundments.

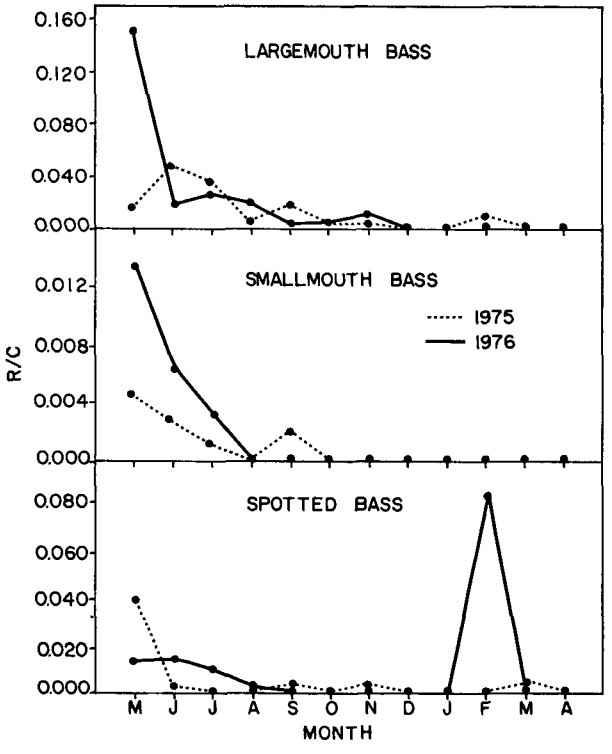

Fig. 5. Length frequency of bass smaller than 305 mm taken by electrofishing from Melton Hill Reservoir during the recapture phase.

Table 4. Comparison of numbers of largemouth bass estimated by mark and recapture methods in various reservoirs. Estimated numbers per acre are shown in parenthesis.

Reservoir, Date	*Method*	*Reference*	*Reservoir Area (ha)*	*Size of Bass In Estimate*	*Estimated No. Per Hectare*
Lake Carl, Blackwell, OK March-July 1969	Electrofishing Mark and Recapture	Weicker and Brown 1971	1,335	>177 mm	1.19 (0.48)
Lake Sidney, Lanier, GA August 1971	Electrofishing Mark and Recapture	Holbrook 1975	15,388	>305 mm	0.65 (.76)
Watts Bar Reservoir, TN September 1974	Electrofishing Bass Tournament Recapture	Holbrook 1975	15,783	>305 mm	1.84 (0.74)
Beaver Reservoir, AK April 1975	Electrofishing Mark and Recapture	Aggus and Rainwater In Press	11,421	>305 mm	5.32 (2.15)
Bull Shoals, AK April 1975	Electrofishing Mark and Recapture	Aggus and Rainwater In Press	18,458	>305 mm	1.65 (0.87)
Eufaula, OK April 1972	Electrofishing	Grinstead and Wright	41,481	>254 mm	2.0 (0.80)

There are also problems with the mark and recapture method for estimating largemouth bass populations. Van Den Avyle (1976), Lewis et al. (1962), Lewis and Flickinger (1967), and Parker and Hasler (1959) pointed out problems involving offshore and shoreline "subpopulations" of largemouth. Despite these problems, shoreline electrofishing mark and recapture remains as the most useful tool in estimating populations in large impoundments. There is apparently some mixing of the "subpopulations" in the early spring (Van Den Avyle 1976) and probably the highest population estimate will be obtained at that time of year. Mark and recapture estimates require considerable manpower, are expensive, and will probably be difficult to justify except on a very limited basis. Considering this effort, use of a bass tournament to obtain recaptures remains an attractive alternative.

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