Angler Exploitation of Largemouth Bass ≥356 mm at Sam Rayburn Reservoir, Texas

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Abstract: Tournament-caught largemouth bass (*Micropterus salmoides*) were tagged and released in Sam Rayburn Reservoir, Texas, in early spring 1989 and 1990. Studies conducted on a sample of these fish indicated 4% initial mortality and 94% tag retention. Angling contests were held for 15 weeks (1 April–15 July) each year to recapture fish. Recapture rates by contest anglers provided estimates of exploitation over the 15-week period. Voluntary release of bass was 52%–57%. The estimated exploitation rates for 15-week periods in 1989 and 1990 were 0.27 and 0.47, respectively. Increased angling vulnerability of tagged fish could have had a positive bias on exploitation rates. Increasing fishing effort and harvest over a 5-year period suggest exploitation has not been detrimental to the fishery. Techniques used in this study required only minimum effort and expense.

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Fishing quality for largemouth bass is directly affected by the level of harvest. Inadequate harvest of legal fish below a slot limit (Gabelhouse 1984), as well as overharvest of fish above a minimum size limit (Rawstron and Hashagen 1972, Rawstron 1974), can adversely affect bass populations. Managers generally strive to regulate angling so harvest occurs without depleting the population. Understanding the impact of angling mortality is critical for assessing a fishery. Exploitation evaluations can provide estimates of angling mortality. When exploitation estimates are combined with creel data, the effects of creel limits, angling pressure, and voluntary release can also be assessed.

The black bass (*Micropterus* spp.) fishery at Sam Rayburn Reservoir was placed under a 356-mm minimum length and 5-fish daily bag limit in 1986 to protect the smaller (younger) fish from overharvest and increase average size of harvestable fish. Standardized sampling using rotenone, electrofishing, and creel surveys has provided information on relative abundance, size structure, angling pressure, har-

vest, and catch rates for the largemouth bass population. However, the extent of angler exploitation of legal fish was unknown.

Mark-and-recapture methods commonly have been used to estimate both largemouth bass population densities and exploitation. Investigators have collected fish for marking primarily by shoreline electrofishing (Aggus and Rainwater 1975, Hammond and Ager 1975, Hickman and Hevel 1975, Ager 1978, Seawell and Hevel 1978, Yeager and Van Den Avyle 1978, Reed and Davies 1980, Garner et al. 1984) and, to a limited extent, by angling tournaments (Farman et al. 1982). A variety of methods and combinations of methods have been used to recapture marked fish including cove rotenone (Aggus and Rainwater 1975), electrofishing (Hickman and Hevel 1975, Seawell and Hevel 1978), seining (Maloney et al. 1962), angling tournaments (Aggus and Rainwater 1975, Hickman and Hevel 1975, Seawell and Hevel 1978), and non-tournament angling (Yeager and Van Den Avyle 1978, Ager 1978, Van Woert 1980). Collection of recaptures by angling tournaments has been suggested to reduce cost and effort (Aggus and Rainwater 1975). Creel surveys have been used in conjunction with mark-and-recapture studies to provide recapture estimates and various recreational angling statistics (Hammond and Ager 1975, Reed and Davies 1980).

Marking typically has been accomplished by insertion of external tags. Tag loss and differential mortality can negatively bias exploitation estimates; therefore, researchers have suggested tests to determine what level of each may be encountered (Yeager and Van Den Avyle 1978). Other factors which may bias exploitation estimates include incomplete reporting of tags, non-random distribution of either marked fish or angling effort, recruitment, and voluntary release (Ricker 1958, Garner et al. 1984).

The objective of the study was to obtain exploitation estimates for largemouth bass (≥356-mm TL) at Sam Rayburn Reservoir, Texas.

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Methods

One thousand largemouth bass were tagged in 1989 and 1,170 in 1990 at Sam Rayburn Reservoir, a 45,911-ha reservoir in Southeast Texas. Tagging was performed on largemouth bass (≥356-mm TL) caught during B.A.S.S. tournaments at the reservoir in March each year. Floy anchor tags (catalog No. FD-68A) inserted near the soft dorsal fin were used to identify fish. Tagged fish were transported and released uniformly in upper-, mid-, and lower-reservoir areas.

Studies were conducted each year to determine mortality and tag retention. In

addition to those largemouth bass tagged and released each year in the reservoir, a sample of tagged fish (50 in 1989, 100 in 1990) were transported to a 0.10-ha pond at the Jasper State Fish Hatchery and held for 20 days. The pond was drained, fish were collected, and counts were made of live fish with tags attached and live fish without tags. Tag retention rates were based on the proportion of fish which had a tag attached on collection day. Mortality rates were based on the proportion of fish missing or dead on collection day.

The Jasper Chamber of Commerce sponsored the "Lake Sam Rayburn Bass-A-Thon" held 1 April–15 July 1989 and 1990. Contestants were required to purchase badges ($7.50 each) before fishing and rewards of $25, $100, or $1,000 were offered to contest anglers returning live, tagged bass to any cooperating business in the Sam Rayburn Reservoir area. Reward values were randomly assigned to each tag. Badges had to be purchased at least 1 day prior to turning in any tagged bass for the reward. Returns provided recapture of tagged fish by contest anglers. Non-reporting was assumed to be minimal because of contest fee and reward values.

Estimates of total harvest, harvest rate, voluntary release, and angling effort were determined from standardized stratified random creel surveys (TPWD 1989). Fixed access surveys from 1 December 1985 through 30 November 1990 were conducted on 36 days each year (16 week days and 20 weekend days). Creel information for the 1 April through 15 July study periods was obtained from surveys conducted on 11 days (5 week days and 6 weekend days each year). In addition to standard creel interview questions, each angling party was asked the question "Does anyone in your fishing party have a badge to fish in the Jasper Chamber of Commerce Bass-A-Thon?" It was assumed if any member of a fishing party had a badge, then any tagged fish caught by the party would be retained for the reward. Angling pressure was estimated using aerial counts of boats.

Regression analysis, as described by Neter and Wasserman (1974), was used to assess the relationship ($P = 0.05$) between annual largemouth bass harvest and annual largemouth bass angling pressure.

Exploitation rates were calculated as follows:

$$E = r/m$$

where E = exploitation rate of largemouth bass by contest anglers
r = number of tag returns by contest anglers
m = total number of fish tagged, adjusted for tag retention and mortality
The exploitation rate by contest anglers was expanded to obtain the rate for all fishing parties as follows:

$$E_a = \frac{r/m}{p}$$

where p = the proportion of fishing parties with contest badges
This exploitation rate had to be further adjusted to take voluntary release into account. The calculations were adjusted as follows:

$$E_b = \frac{r/m\ (h)}{p}$$

where h = proportion of largemouth bass (≥356 mm) catch that was harvested by non-contest anglers

Results and Discussion

Mortality of tagged bass in pond studies was 2% in 1989 and 5% in 1990. In 1989, 90% of the surviving fish had a tag attached on collection day compared to 96% in 1990. Because the number of fish used each year was different, which could have biased results, mean values for mortality and tag retention for both study periods were used to calculate exploitation. The mean mortality and tag retention rates for both years were 4% and 94%, respectively. The mean 20-day mortality rate (4%) calculated for the pond studies was similar to the 191-day rate (7%) for largemouth bass held in a 0.08-ha pond (Tranquilli and Childers 1982). In another study, Ager (1978) reported no initial mortality for tagged largemouth bass in small ponds.

Total numbers of contest anglers in 1989 and 1990 were 1,108 and 1,533, respectively. Creel data (hours/trip and catch/hour) for contest anglers and non-contest anglers were similar both years indicating angler type introduced no bias. Contestants returned 77 tagged fish in 1989 and 159 in 1990; therefore, after adjusting for mortality and tag retention, E was estimated at 0.085 and 0.151, respectively. Fishing parties with contest anglers comprised 15.0% of the parties seeking largemouth bass during the 1989 contest period and 13.7% during 1990. Voluntary release of legal fish by non-contest anglers during the study periods was 52% in 1989 and 57% in 1990. Further adjusting E for the proportion of anglers that were contestants and voluntary release, the estimated exploitation rate of bass ≥356 mm by all bass anglers during the 15-week period was 0.27 in 1989 and 0.47 in 1990.

Exploitation rates for the 15-week periods were generally consistent with those reported by Reed and Davies (1980) and Ager (1978). Reed and Davies (1980) reported a 24-week rate of 0.43 in a 75-ha Alabama lake; during this period 75% of the annual harvest occurred. Ager (1978) found 80% of a 10-month exploitation (0.564) on largemouth bass occurred during March–May at Lake Tobesofkee, Georgia. During those 3 months, 49% of the total annual largemouth bass effort was expended and 51% of the total annual harvest occurred. At Sam Rayburn Reservoir, fishing effort directed at bass during contest periods in 1989 and 1990 was 38% and 41% of annual effort, respectively. Fifteen-week harvest was 37% and 34% of annual harvest in 1989 and 1990, respectively (Table 1). When compared with the findings of Ager (1978), these proportions suggest angling mortality on largemouth bass was not excessively high for that period of the year.

Rate of exploitation during contest periods increased approximately 45% from 1989 to 1990 while fishing effort increased 39% and harvest 15% (Table 1). Similar increases for effort and harvest were noted for the annual periods (Table 1). How-

Table 1. Largemouth bass angling recreation estimates (SE in parentheses) for 15-week and annual periods, Sam Rayburn Reservoir, Texas, 1989–1990.

Time period	Angling effort (Angler hours)	Harvest (*N*)	Harvest rate (Fish ≥356mm/hour)
1 Apr 89–15 Jul 89	472,376 (76,684)	53,378 (11,193)	0.113 (0.015)
1 Dec 88–30 Nov 89	1,234,614 (142,393)	143,215 (27,689)	0.116 (0.018)
1 Apr 90–15 Jul 90	769,417 (96,861)	63,092 (14,651)	0.082 (0.016)
1 Dec 89–30 Nov 90	1,863,844 (188,594)	184,894 (28,904)	0.097 (0.012)

ever, harvest rates (fish/hour) during the contest periods declined 27% and annual harvest rates declined 15%.

A pattern of annually increasing fishing effort and harvest was observed at Sam Rayburn Reservoir from 1986 through 1990. A strong correlation ($R^2 = 0.939$) was found between these parameters over the 5-year period (Fig. 1). Ricker (1958) stated a strong correlation between effort and catch over annual periods indicates exploita-

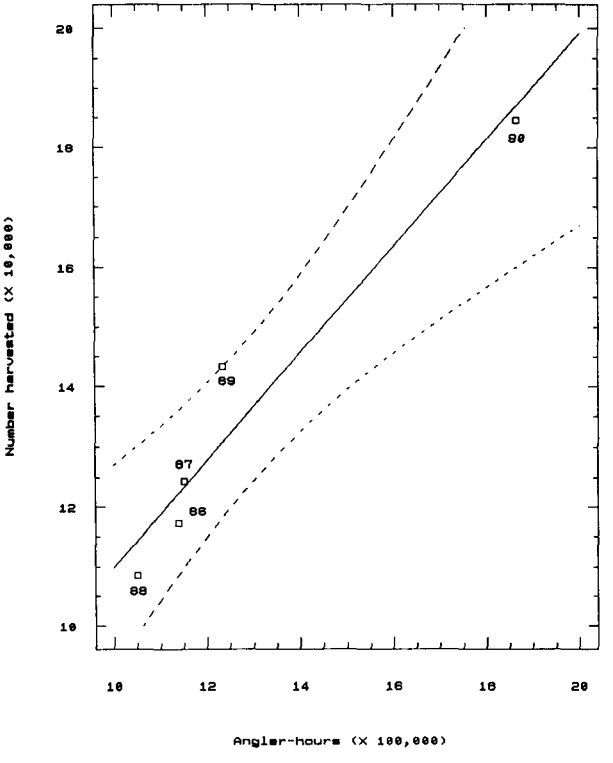

Figure 1. Relationship between annual largemouth bass harvest and directed angling effort, Sam Rayburn Reservoir, Texas, 1986–1990. Year is shown at each point along with linear regression line. Dashed lines are 95% confidence limits.

tion is not severe. This suggests the exploitation rates observed in this study should not be detrimental to the Sam Rayburn Reservoir largemouth bass population.

As with any exploitation estimate based on mark-and-recapture methods, accurate enumeration is difficult because of the numerous factors which can bias results. Factors which could have affected exploitation estimates during this study were recruitment of fish to harvestable sizes and vulnerability differences between tagged and untagged fish. Although recruitment in Sam Rayburn Reservoir is normally strong each year (Seidensticker 1989), this probably had little influence on exploitation estimates for this short study period.

Tagged fish used in this study may have been more vulnerable to angling than the overall population because they were caught at least once before recapture. Burkett et al. (1986) reported vulnerability differences among largemouth bass in Ridge Lake, Illinois. In that study, approximately 15% of the fish >200 mm had never been caught during 4 seasons of catch-and-release fishing; however, these fish were mostly in the 201–254 mm range. If a similar proportion of legal-sized largemouth bass in Sam Rayburn Reservoir is not vulnerable to angling, then exploitation estimates in this study are higher than actual exploitation.

Voluntary release of largemouth bass by anglers was very important in reducing exploitation in this study and should continue to be advocated by conservation agencies in situations where angling pressure is sufficient to adversely impact sustainable harvest. Protection of largemouth bass populations from high exploitation can also be accomplished through the use of proper length and bag limit regulations, based on factors such as reproduction, recruitment, growth rates, angling pressure, and harvest.

Estimates of exploitation in this study required only minimum effort (6 man-days) and cost and, from that standpoint, mark-and-recapture techniques using tournament-caught fish are attractive. Collection of a comparable sample using electrofishing would have taken 15–20 man-days. Further evaluations to determine relative differences between angler-caught fish and the overall population would be useful in developing a clearer understanding of exploitation estimates derived from such techniques.

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