Angler Exploitation of Largemouth Bass Determined Using Variable Reward Tags in 2 Central Florida Lakes

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Abstract: Angler exploitation of largemouth bass *(Micropterus salmoides)* on the Conway and Winter Park chains of lakes, was evaluated using reward tags. An estimated 57% and 56% of the largemouth bass in the Conway and Winter Park chains, respectively, were caught by anglers during a 1-year period from 1991 to 1992. Annual exploitation rates were adjusted for tagging mortality and tag loss by 13% and 50%, respectively, for small Hallprint dart tags and 18% and 7%, respectively, for large Hallprint dart tags. Angler non-reporting of tagged fish was assigned a value of 20% based on a previous study. Since anglers on both chains voluntarily released a high percentage (72%) of the tagged largemouth bass they caught, annual exploitation rates *(u)* were 17% on the Conway chain of lakes and 16% on the Winter Park chain of lakes. Total annual mortality estimates *(A)* for largemouth bass during the study were 52% for the Conway chain and 50% for the Winter Park chain. We infer from these data that angler exploitation was not the major factor contributing to mortality in these populations. Anglers surveyed by telephone were highly supportive of reduced bag limits and minimum length limits on these lakes, even though they were already releasing a high percentage of the fish that they caught.

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Increased fishing pressure and advances in angling technology have placed greater demands on Florida's largemouth bass fisheries than in the past. Restrictive harvest regulations have become a practical tool to manage largemouth bass fisheries in Florida (Champeau and Denson 1987; Porak et al. 1987; Champeau et al. 1989; Chapman et al. 1989*a*, 1989*b*; Long et al. 1989; Cailteux et al. 1992; Krause and Dames 1993). Success of harvest regulations has varied among water bodies for many reasons. These include different levels of angler compliance, level of law

enforcement, population dynamics (i.e., recruitment, growth, and mortality rates), and the design of individual lake regulations.

According to Reed and Davies (1980), annual mortality is the primary concern for fisheries management when recruitment is adequate in managed public lakes. Angler exploitation of largemouth bass is the primary component of annual mortality that can be manipulated with a management strategy.

The primary objective of this study was to determine the effects of angler exploitation on largemouth bass populations in 2 central Florida chains of lakes. During the 1-year study period, there was a statewide 10-fish daily bag limit and no minimum length limit for largemouth bass. On 1 July 1992, new regulations for largemouth bass were implemented statewide for the region of the state where the study lakes were located which included a 356-mm minimum length limit and a 5-fish daily bag limit, of which only 1 could be >559 mm. The second objective was to evaluate the potential impact of the newly imposed harvest restrictions for largemouth bass on our study lakes.

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Methods

The Conway chain of lakes is a 712-ha system in Orange County comprised of 4 lakes in suburban Orlando. Plant communities were dominated by Illinois pondweed *(Potamogeton illinoensis)* and eelgrass *(Vallisneria americana)* during the study period. Hydrilla *(Hydrilla verticillata)* expanded during the 1970s, but had been maintained at low levels with grass carp *(Ctenopharyngodon idella)* and herbicides through 1992. The Conway chain of lakes has been classified as mesotrophic (Canfield 1981).

The Winter Park chain of lakes encompasses 400 ha in Orange Country and comprises 5 urban lakes ranging in area from 25 to 183 ha. The entire system receives stormwater runoff from the cities of Winter Park and Maitland. These lakes were considered eutrophic by Canfield (1981). Hydrilla first occurred in the Winter Park chain of lakes during the 1960s and was aggressively managed with herbicides. Except in Lake Minnehaha (39 ha), dominant aquatic plants were eelgrass and Illinois pondweed. Hydrilla was treated with fluridone in Lake Minnehaha during 1991 and was virtually eliminated by the end of the year.

Largemouth bass were collected by electrofishing for length-frequency, age, growth, and mortality estimates on both chains during January–March 1991. Total length (mm TL) and weight (g) were recorded for each fish. Largemouth bass were collected randomly for age samples, but samples were stratified by lake within each chain of lakes. Size-selected samples were also collected to supplement larger size groups (>340 mm) of largemouth bass. Otoliths were removed and processed as described by Porak et al. (1987). Age-length keys, developed from otolith samples and

length-frequency data, were used to estimate the relative age composition of tagged and harvested largemouth bass populations. Ages of tagged largemouth bass were estimated by proportioning the tagging length data into the age-length keys. Total annual mortality *(A)* was calculated from catch curves for ages 3–6. Five hundred largemouth bass in the Conway chain of lakes and 496 largemouth bass in the Winter Park chain of lakes ≥260 mm TL were randomly selected from electrofishing samples, tagged with Hallprint dart tags, and subsequently released to evaluate angler exploitation. Dart tags were used because of various problems (e.g., tag loss, tag separation, and tag location) associated with other tags used during previous studies (Wilbur and Duchrow 1973, Gilbert and Hightower 1981, Tranquilli and Childers 1982, Mattson et al. 1990). Different Hallprint dart tag sizes were used for 2 size groups of largemouth bass. Largemouth bass 260–299 mm TL were tagged with PDB dart tags (7-mm barb width) and those ≥300 mm TL were tagged with PDT dart tags (10-mm barb width). All largemouth bass were tagged below the dorsal fin. Signs at all boat ramps, canals, and local tackle dealers and news releases and presentations to local bass fishing clubs were used to increase public awareness about the tagging study.

A tag reward program was established with variable rewards of $10, $25, and $50 per tag return to encourage angler cooperation. The monetary rewards were specified on signs, but the reward amount for each individual fish tag was unknown to the angler prior to returning each tag. Each tag was imprinted with "Fla. Game & Fish, Ph. 1-800-342-9620, $10–$50 reward" and an individual tag number. Waterproof return envelopes were provided at all boat ramps and local bait-and-tackle dealers.

Annual rate of exploitation *(u)* (Ricker 1975) was calculated for the Conway and Winter Park chains of lakes by dividing the total number of tag returns for largemouth bass (LMB) harvested (N_r) during the first year of the study by the total number of tagged largemouth bass in each water body (N_o). The number of tagged largemouth bass available to anglers were adjusted based on rates of tagging mortality *(m)*, tag loss *(t)*, and angler non-reporting of tags *(nr)*. Tag loss and tagging-induced mortality were different for largemouth bass 260–299 mm TL and those ≥300 mm TL, so these size groups were adjusted independently in the calculations below:

$$u = \frac{N_{rs} + N_{rl}}{[N_o\,(1-t)\,(1-m)\,1-nr)\,]_s + [N_o\,(1-t)\,(1-m)\,(1-nr)\,]_l}$$

u = annual rate of exploitation
N_r = number of tags returned for harvested largemouth bass
N_o = number of largemouth bass tagged
t = rate of tag loss
m = rate of tagging-induced mortality
nr = rate of non-reporting of tags
$_s$ = largemouth bass <300 mm TL
$_l$ = largemouth bass ≥300 mm TL

Tag loss and tagging-induced mortality rates were determined in a previous study by Renfro et al. (1995). The maximum rates of tag loss *(t)* were used for our calculations and were 7% for PDT tags (largemouth bass ≥300 mm TL) and 50% for PDB tags (largemouth bass 260–299 mm TL). Tag-induced mortality, determined as the difference in mortality between controls and test groups, was 13% for largemouth bass 260–299 mm TL and 18% for those ≥300 mm TL. A 20% non-reporting rate was used in the evaluation procedure based on a study done by Nichols et al. (1991).

Angler catch rate was also calculated as described above by modifying N_r to equal the number of tag returns from all largemouth bass caught, including both harvested and released fish.

Prior to implementation of new statewide black bass regulations, 102 anglers that had returned largemouth bass tags were surveyed by telephone during fall 1991. The survey was conducted to determine angler satisfaction with the number and size of their catch, and their opinions about length and bag limits on study lakes.

Results and Discussion

Length-frequency data from 1991 electrofishing samples were characteristic of many largemouth bass populations in Florida with respect to having modal peaks at 30 and 32 cm TL for the Conway and Winter Park chains of lakes, respectively (Fig. 1). Proportional stock densities (PSD) for largemouth bass were 49 and 69 on the

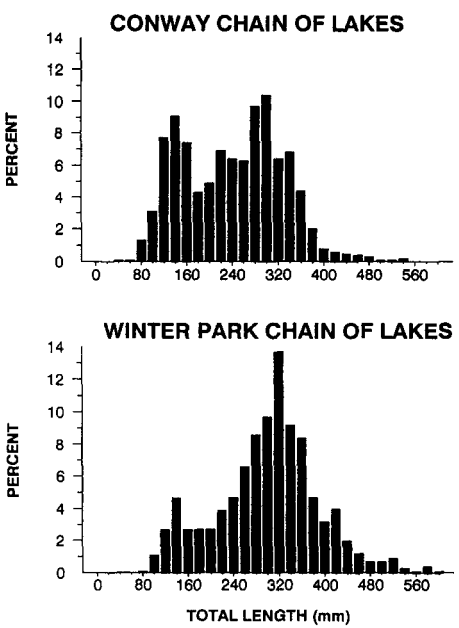

Figure 1. Length-frequency of largemouth bass collected by electrofishing in the Conway ($N = 1{,}084$) and Winter Park ($N = 702$) chains of lakes, Florida, spring 1991.

Conway and Winter Park chains, respectively. Relative stock densities (RSD_{36}) were 14 on the Conway chain and 21 on the Winter Park chain.

Anglers returned 30% of the tags from the Conway chain of lakes and 31% from the Winter Park chain of lakes over a 1-year period from 1991 to 1992 (Table 1). Tag return data indicated high voluntary release rates (72%) by largemouth bass anglers in both chains of lakes. Creel data on Lake Conway also revealed that anglers released 72% of the largemouth bass caught during spring 1992 (Porak et al. 1995).

An estimated 57% of the largemouth bass in the Conway chain and 56% in the Winter Park chain were caught by anglers during the 1-year period when tag returns were adjusted for tag loss, tag-induced mortality, and non-reporting of tags. Annual exploitation rates were estimated to be 17% on the Conway chain of lakes and 16% on the Winter Park chain of lakes (Table 1).

Although anglers caught over 56% of the tagged bass in both systems, high voluntary release rates by largemouth bass anglers resulted in moderately low estimates of exploitation. Both the catch rate and exploitation rate on the Conway and Winter Park chains were conservative estimates because 72% of the tagged fish caught by anglers were released back into the study lakes after the tags had been removed from the fish. Some tagged bass were probably caught by anglers on more than 1 occasion during the 1-year study period, but they could not have been reported a second time because their tags had been removed.

Total annual mortality estimates *(A)* from catch curves for largemouth bass ages 3–6 was 52% in the Conway chain of lakes and 50% in the Winter Park chain. Although comparisons of estimates from tagging studies and catch curve estimates must be viewed with caution, we infer from these data that angler exploitation was not the major factor contributing to mortality in these populations. Krause and Dames (1993) reported that exploitation rates as high as 51% accounted for up to 82% of the total annual mortality of largemouth bass in the Escambia River, Florida, during years prior to implementing a length limit.

Higher exploitation rates of largemouth bass were also reported by researchers from other southeastern states. Parks and Seidensticker (1992) working on Sam Rayburn Reservoir, Texas, estimated exploitation rates of largemouth bass

Table 1. Annual exploitation data for tagged largemouth bass from the Conway and Winter Park chains of lakes, Florida, 1991–1992.

Parameter	Conway	Winter Park
N tagged	500	496
N caught by anglers	150	154
N reported harvested	44	43
Catch-and-release rate	72%	72%
Exploitation rate *u* (Unadjusted)	9%	9%
Exploitation rate *u* (Adjusted)[a]	17%	16%

a. Tag returns were adjusted for tag loss, tag-induced mortality and non-reporting of tags to calculate this exploitation rate.

at 27% and 47% for 15-week periods in 1989 and 1990, respectively, with release rates of 52%–57% during their study. Reed and Davies (1980) determined that exploitation of largemouth bass over a 24-week period was 43% in Chambers County Lake, Alabama. Ager (1978) estimated the exploitation rate for largemouth bass was 56% in Lake Tobesofkee, Georgia, during a period when total annual mortality was 91%.

Tagging indicated that anglers harvested largemouth bass by age 2 from the Conway (16%) and Winter Park (14%) chains of lakes. The dominant age groups harvested by anglers were ages 3 and 4 from both chains of lakes (Fig. 2). Age-4 (32%) and age-5 (9%) largemouth bass were harvested at rates higher than their relative abundance in the Conway chain of lakes. In the Winter Park chain of lakes, age-3 (28%), age-4 (40%), and age-5 (14%) largemouth bass were harvested at rates higher than their relative abundance. Greater than 90% of the largemouth bass harvest occurred from ages 2 to 5 in both systems.

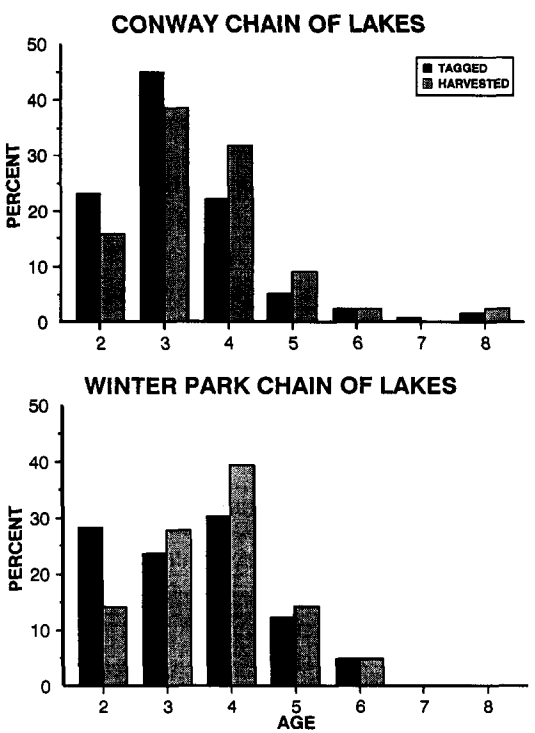

Figure 2. Estimated age (in years) composition (%) of largemouth bass tagged in Conway ($N = 500$) and Winter Park ($N = 496$) chains of lakes, Florida, and the estimated age at harvest of those reported from tag returns ($N = 44$ for Conway and $N = 43$ for Winter Park), 1991–1992.

A 356-mm minimum length limit implemented in 1992 for largemouth bass has the potential to significantly reduce harvest of largemouth bass in the Conway and Winter Park chain of lakes. This length limit should restrict the harvest of ≤age-4 fish in the Conway chain and ≤age-3 fish in the Winter Park chain (Table 2). Age-at-harvest data calculated from tagging results indicated that a 356-mm minimum length limit would have restricted 87% of the largemouth bass harvest in the Conway chain and 42% of the harvest in the Winter Park chain had the rule been imposed prior to the exploitation study.

It is reasonable to assume that a reduction in harvest might allow more fish to grow to larger sizes unless compensatory natural mortality occurs in these populations. However, low exploitation rates during 1991–1992, due to high voluntary release of largemouth bass by anglers, strongly suggests that a reduction in harvest from the new length limit may not significantly affect the total annual mortality and size structure of the population in these 2 systems.

A majority of the anglers surveyed by telephone on the Conway (72%) and Winter Park (62%) chains were satisfied with the number of largemouth bass they caught during 1991. Prior to new statewide regulations, anglers from Conway (88%) and Winter Park (96%) chains reported they would be satisfied keeping ≤5 largemouth bass per day. However, >44% of the anglers from both systems were dissatisfied with the sizes of largemouth bass they caught. Most anglers thought a length limit (83%) or reduced daily bag limit (80%) would improve bass fishing on these lakes. High voluntary release rates by bass anglers in 1991 in both systems and 1992 in the Conway chain had shown that they already supported the concept of catch-and-release. Thus, anglers should be supportive of the newly imposed 356-mm length limit and 5-fish daily bag limit for largemouth bass in the Conway and Winter Park chains of lakes.

Table 2. Mean size at age for largemouth bass collected during spring electrofishing samples from the Conway ($N = 129$) and Winter Park ($N = 118$) chains of lakes, Florida, 1991.

Age	Sex	Conway	Winter Park
1	Male	114	155
	Female	153	148
2	Male	256	274
	Female	234	285
3	Male	306	322
	Female	337	359
4	Male	326	347
	Female	364	402
5	Male	364	384
	Female	437	491
6	Male	408	366
	Female	452	515
7	Male		
	Female		582

In summary, information on age, growth, and mortality is critical to understanding the need for and the effects of restrictive harvest regulations. A tag reward program for largemouth bass was a practical method to evaluate the potential impact of harvest regulations on the Conway and Winter Park chains of lakes. Combined with information on the age structure of the population, age-at-harvest, mean size at age, and total annual mortality, exploitation data revealed that fishing mortality was not the major mortality factor in these populations. Although catch rates were high, 72% voluntary release rates of largemouth bass by anglers resulted in low exploitation rates.

Literature Cited

Ager, L. W. 1978. Exploitation and mortality of largemouth bass in Lake Tobesofkee, Georgia. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 32:429–436.

Cailteux, R., D. A. Dobbins, and J. Nordhaus. 1992. Evaluation of a size restrictive harvest regulation for largemouth bass in Lake Jackson. Fla. Game and Fresh Water Fish Comm., Fed. Aid in Sport Fish Restor., Annu. Rep., Proj. F-37, Tallahassee. 7pp.

Canfield, D. E. 1981. Chemical and trophic state characteristics of Florida lakes in relation to regional geology. Fla. Coop. Fish and Wildl. Res. Unit, Final Rep., Gainesville. 444pp.

Champeau, T. R. and K. W. Denson. 1987. Effectiveness of a catch-and-release regulation for largemouth bass in a Florida lake. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 41:150–158.

———, ———, and P. W. Thomas. 1989. South Florida region fish management report. Fla. Game and Fresh Water Fish Comm., Annu. Rep., Tallahassee. 72pp.

Chapman, P. G., R. J. Johnson, and W. V. Fish. 1989*a*. Sportfish enhancement project. Fla. Game and Fresh Water Fish Comm., Annu. Rep., Tallahassee. 15pp.

———, ———, and ———. 1989*b*. Sportfish enhancement project. Fla. Game and Fresh Water Fish Comm., Final Rep., Tallahassee. 63pp.

Gilbert, R. J. and J. E. Hightower. 1981. Assessment of tag loss and mortality of largemouth bass in an unfished reservoir. Univ. Ga., Coop. Fish and Wildl. Res. Unit, Athens. 37pp.

Krause, R. A. and H. R. Dames. 1993. Centrarchid fishery research: north Florida streams research project. Fla. Game and Fresh Water Fish Comm., Fed. Aid in Sport fish Restor., Compl. Rep., Proj. F-36, Tallahassee. 22pp.

Long, E. A., D. A. Dobbins, and B. R. Lubinski. 1989. Lakes Talquin and Jackson investigations. Fla. Game and Fresh Water Fish Comm., Fed. Aid in Sport Fish Restor., Annu. Rep., Proj. F-31, Tallahassee. 34pp.

Mattson, M. T., J. R. Waldman, D. J. Dunning, and Q. E. Ross. 1990. Abrasion and protrusion of internal anchor tags in Hudson River striped bass. Am. Fish. Soc. Symp. 7:121–126.

Nichols, J. D., R. J. Blohm, R. E. Reynolds, R. E. Trost, J. E. Hines, and J. P. Bladen. 1991. Band reporting rates for mallards with reward bands of different dollar values. J. Wildl. Manage. 55:119–126.

Parks, J. O. and E. P. Seidensticker. 1992. Angler exploitation of largemouth bass ≥356 mm at Sam Rayburn Reservoir, Texas. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 46:320–326.

Porak, W. F., S. Crawford, and J. R. Estes. 1987. Population dynamics of largemouth bass resources. Fla. Game and Fresh Water Fish Comm., Fed. Aid in Sport Fish Restor., Final Rep., Proj. F-24, Tallahassee. 97pp.

———, ———, and D. J. Renfro. 1995. Management of exploited largemouth bass populations. Fla. Game and Fresh Water Fish Comm., Fed. Aid in Sport Fish Restor., Compl. Rep., Proj. F-24, Tallahassee. 31pp.

Reed, R. B. and W. D. Davies. 1980. Estimating rate of exploitation from tag returns and fishing effort. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 34:151–157.

Renfro, D. J., W. F. Porak, and S. Crawford. 1995. Tag retention of Hallprint dart tags and tag-induced mortality in largemouth bass. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 49:224–230.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board. Can. 191, Ottawa, Can. 382pp.

Tranquilli, J. W. and W. F. Childers. 1982. Growth and survival of largemouth bass tagged with Floy anchor tags. North Am. J. Fish. Manage. 2:184–187.

Wilbur, R. L. and R. M. Duchrow. 1973. Differential retentions of the Floy tags on largemouth bass *(Micropterus salmoides)* in hatchery ponds. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 26:407–413.