



Figure 5
Recovery of Game Fishes
Subsequent to Stream Alteration

FLORIDA'S STATE-WIDE TAGGING PROGRAM

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ABSTRACT

The Florida Game and Fresh Water Fish Commission has conducted a state-wide fish tagging program for the years 1961 through 1964. Rewards from \$25.00 to \$10,000.00, offered by the Joseph Schlitz Brewing Company, insured a high return to the Commission of those fish caught by the anglers. During the four year period, 28,805 fresh-water fish were tagged and released in 120 lakes, rivers, and canals throughout the state. Ten species of fish were tagged with the largemouth bass providing the highest returns. 27.9 per cent of the 9,079 bass tagged were returned. The recaptures for six other centrarchids were considerably lower, ranging from 4.3 per cent for the bluegill (11,658 tagged) to 13.8 per cent for the redbreast sunfish (370 tagged). *Tilapia nilotica*, tagged in a number of Fish Management Areas, provided a return of

15.0 per cent (349 tagged). The grand total returned for all species was 12.5 per cent. The largemouth bass was the only species which was returned in any significant number during the second and third year after tagging. The weighted estimate of survival rates for the largemouth bass were: 1961, 14.2 per cent; 1962, 16.2 per cent; and 1963, 14.8 per cent. The mean rates of exploitation for the largemouth bass were: 1961, 21.2 per cent; 1962, 25.7 per cent; and 1963, 27.7 per cent. Since the period from tagging until recapture was quite short for most species, little growth information was obtained.

INTRODUCTION

In December, 1960, the Florida Game and Fresh Water Fish Commission, the Florida State Board of Conservation, and the Joseph Schlitz Brewing Company joined forces in undertaking a state-wide fish tagging program. The program was advertised as "Florida's \$500,000 Fishing Derby" with the Schlitz Brewing Company providing rewards, which ranged between \$25.00 to \$10,000.00, for the fishermen who caught the tagged fish. The State Board of Conservation was responsible for the tagging of the salt-water species and the Game and Fresh Water Fish Commission, the fresh-water species. This report deals only with the work done in Florida's fresh-waters.

The program, which was carried out each year from 1961 through 1964, was aimed at providing biological information pertaining to the fresh and salt-water fisheries in Florida, promoting sales of the sponsor's product, and advertising fishing in Florida. The two state agencies were given a free hand in conducting the tagging program as they desired. In general, the objects of the research phase of the program were to obtain information regarding growth rates, migration, survival, and rate of harvest of Florida's fresh-water fishes.

METHODS

The state was divided into four contest zones (Figure 1). Each zone was officially opened during different months with the contest running for three or four consecutive months in each zone. The months were chosen to coincide with the major fishing season in each area of the state and to permit the tagging crews to cover the entire state in a systematic manner. During 1961 and 1962, the contest dates were: Zone I, January 1 to March 31; Zone II, February 1 to April 30; Zone III, March 1 to May 31; and Zone IV, April 1 to June 30. In 1963 and 1964, the dates were: Zone I and Zone II, February 1 to May 31; Zone III, April 1 to July 31; and Zone IV, May 1 to August 31.

One fish in each zone carried a reward of \$10,000 each year. Other tags were worth \$1,000, \$100.00, \$50.00 and \$25.00. The value of each tag was known only by the Schlitz Brewing Company. During the first year of the contest, the tagged fish caught prior to and after the contest were given a value of \$3.00 each. However, since there was good evidence that some fishermen were holding their marked fish in freezers until the contest officially opened so that they would receive a higher reward, fish caught prior to the contest were awarded full value for the past three years. Also, to further insure that tagged fish would be returned after the official close of the contest, special \$500.00 Conservation Awards were assigned to a number of the late caught fish.

Tagged fish, when caught by a fisherman, were taken to the local Schlitz wholesaler where the fish's weight, length, and the date and location of recapture were recorded on a special form. A copy of the pertinent information was forwarded to the Game and Fresh Water Fish Commission.

The fish were collected for tagging by using boat-mounted electro-fishing gear which was powered by a 240 volt A. C. generator. The col-



Figure 1. The four zones in Florida's Fishing Derby. 1961 - 1964.

lecting and tagging process was described in detail by Copeland and Huish (1962). Monel metal strap tags were the primary tags employed with some Petersen disc tags being used in the 1962 Fishing Derby (Huish and Copeland, 1962).

The tags were identified by the word "Schlitz", a prefix letter, and a number which identified the individual fish. The prefix letter designated the zone in which the fish were released and the year that it was tagged.

The majority of the fish tagged were caught in the lakes in which they were released. However, in some cases, because of the inefficiency of the electric shocker in certain bodies of water or because of the great ease in which fish were collected in other bodies of water, some fish were tagged, transported by a tank truck, and released in waters quite foreign to their native lake. Copeland and Huish (1962) found little difference on a statewide basis in the returns of fish which were transported and those that were released in their home lake. However, in some isolated cases, radical differences were noted. For example, in 1961, 689 bluegill and redear sunfish were transported from Lake Hollingsworth in central Florida to some canals west of Fort Lauderdale and Miami in South Florida. Two fish were recaptured. This was obviously the case of too great a distance transported or too drastic a change in environment. Lake Hollingsworth was a fertile lake in a phosphate mining area

with a heavy plankton bloom and a pH of around 8.0 while the South Florida canals had a pH slightly acid or close to neutral with a brown water color characteristic of a bog pool. After 1961, these differences were taken into consideration and transplants were carried out only in similar bodies of water over short distances.

TAG RETURNS

During the four years of the tagging program, 28,805 fresh-water fish were tagged and released in 120 lakes, rivers and canals throughout Florida (Table 1). Ten species of fish were tagged with largemouth bass providing the highest returns. 27.9 per cent of the 9,079 bass tagged were returned by fishermen. More bluegill were tagged (11,658) than any other species over the four years of the program with 4.3 per cent being recaptured. Although only 370 redbreast sunfish and 97 spotted sunfish were tagged, 13.8 and 11.3 per cent respectively turned up in the angler's creel. In certain areas of the state, these two species make up a high percentage of the fishermen's catches. Three hundred forty-nine *Tilapia nilotica*, which were tagged and released in a special Fish Management Area in 1962 and 1963, provided returns of 15.0 per cent. Only 17 channel catfish were tagged during the four-year program and the return of 11.8 per cent is not considered useful information. Thirty-two of 119 tagged chain pickerel were recaptured. This species is abundant and an important part of the fishery in a comparatively few of Florida's many lakes.

Table 1. Number of fish tagged and recaptured in Florida's fresh waters, 1961-1964.

SPECIES	Number Tagged	Number Returned	Per Cent Returned
Largemouth Bass	9,079	2,537	27.9
Bluegill	11,658	507	4.3
Redear Sunfish	4,068	201	4.9
Black Crappie	2,444	154	6.3
Warmouth	604	39	6.4
Redbreast Sunfish	370	51	13.8
Spotted Sunfish	97	11	11.3
Chain Pickerel	119	32	26.9
Channel Catfish	17	2	11.8
Tilapia	349	52	15.0
TOTAL	28,805	3,586	12.5

The grand total returned for all tagged species was 12.5 per cent. Five per cent of the 19,241 centrarchids tagged, excluding largemouth bass, were returned to the Schlitz wholesalers. The returns for the largemouth bass correspond closely with that reported by Dequine and Hall (1950) in six large lakes of central Florida. From a total of 1,616 bass tagged, Dequine and Hall obtained a return of 22.9 per cent. During the 1961-1964 contests, the bass returns for the same six lakes were: 1961, 13.9 per cent; 1962, 24.1 per cent; 1963, 25.9 per cent; and 1964, 7.8 per cent. It is still possible to obtain additional returns for the 1964 tagged bass; but, the percentage returned obviously will not approach that obtained in the earlier years.

The percentages for each size group of largemouth bass tagged were fairly close in all zones except Zone II (Table 2). A higher percentage of the fish tagged in Zone II were from the smallest and largest size groups. The high percentage of large bass tagged in this zone was the result of a fish rescue operation in 1962. A section of the Everglades was being drained and approximately 250 fish were

moved to a nearby canal. One hundred seventy-two bass which averaged 4.3 pounds each were tagged. (26.7 per cent recaptured).

Table 2. Size frequency of largemouth bass tagged in Florida's fresh-waters. 1961-1964.

Size Group Inches	ZONES			
	I	II	III	IV
7 - 10	19.1%	35.1%	14.3%	20.4%
11 - 13	38.9%	31.6%	47.1%	38.8%
14 - 16	26.8%	12.5%	24.4%	24.9%
17 - 20	12.1%	11.5%	10.4%	11.0%
21 ←+	3.1%	9.2%	3.9%	4.8%
Total Number	2,227	1,348	3,499	2,005

There was little difference between the percentages of bass in each size group that were tagged and the percentages returned for that size group from each zone.

The majority of the recaptures were usually made in a relatively short time after tagging and the opening of the contest (Table 3). With the exception of largemouth bass, 97.0 per cent or more of the tagged centrarchids which were recaptured were caught within four months after tagging. 77.0 per cent of all recaptured largemouth bass were caught in less than six months after tagging.

Table 3. The time interval between tagging and recapture for all species tagged in Florida. 1961-1964.

Species	Total Returned	Per Cent Returned Within 3 Months	Per Cent Returned Within 4 Months
Largemouth Bass	2,537	48.4	68.3
Bluegill	507	87.2	97.0
Redear Sunfish	201	93.5	99.0
Black Crappie	154	98.0	100.0
Warmouth	39	89.7	97.4
Redbreast Sunfish	51	94.1	100.0
Spotted Sunfish	11	100.0	100.0
Channel Catfish	2	50.0	50.0
Chain Pickerel	32	62.5	75.0
Tilapia	52	52.8	54.7

GROWTH

Since over 97 per cent of the smaller members of the centrarchid family which were recaptured were caught within four months after tagging, little growth information was obtained for these species. Three hundred live bass were free over one year (Table 4). The longest period between tagging and recapture was 40.5 months. However, in a great many cases, the length and weights that were reported at the time of recapture were too unreasonable to be accepted as true. This was usually a case of high negative growth in both length and weight. Likewise, fish that were free only a few months were often reported at the time of recapture at lengths and weights too unrealistic to be accepted. Therefore, even though some of the data may have been correct, no reliability could be placed on the information and the growth data was rejected as not valid. (If the program is continued in future years, the fish with

the tag intact will be turned in to the Game and Fresh Water Fish Commission so that the fish may be measured and weighed by technical personnel.)

Table 4. Largemouth bass tagged and recaptured in Florida's freshwaters. 1961-1964.

Year Tagged	Number Tagged	Number 1961	Number 1962	Returned 1963	Returned 1964	Per Cent Returned
1961	1803	384	49	11	3	24.8
1962	3558		914	145	27	30.5
1963	1702			471	70	31.8
1964	2016				463	23.0
TOTAL	9079					27.9

SURVIVAL AND HARVEST

The survival rate and mean rate of exploitation (harvest) were estimated for the largemouth bass on a state-wide basis by using the methods described by Ricker (1958). The weighted estimate of survival rate between years (s) was obtained by

$$\hat{s} = \frac{R_2 / R_3 / \dots / R_n}{R_1 / R_2 / \dots / R_{n-1}} \quad \text{where}$$

R_1 equals the recaptures in year of marking, and R_2, R_3 etc. equal recaptures in later years.

The mean rate of exploitation (u) was estimated by

$$\hat{u} = \frac{R_1 / R_2 / R_3 \dots / R_n}{M (1 / s / s^2 / \dots / s^{n-1})} \quad \text{where}$$

M equals the number of fish marked, R equals recaptures in successive years, and s the survival rate.

The weighted estimate of survival rate for the largemouth bass based on the recoveries for the fish tagged during the first three years of the program were: 1961, 14.2 per cent; 1962, 16.2 per cent; and 1963, 14.8 per cent. On a state-wide basis, these survival rates for the three years are quite close. However, when survival is calculated for each zone of the fishing derby, differences are noted with the survival in Zone II being considerably lower in most cases than in the other zones (Table 5). More small bass were tagged in Zone II than in the other zones (Table 2). Therefore, the survival rate was probably

Table 5. Weighted estimate of annual survival rate for largemouth bass tagged in four zones of Florida. 1961-1963.

Year Tagged	Zone I	Zone II	Zone III	Zone IV
1961	11.6%	3.4%	17.7%	18.0%
1962	14.0%	2.9%	20.9%	18.2%
1963	18.5%	8.3%	18.4%	7.0%

lowered in this zone by the presence of these smaller fish which would be more susceptible to natural predation. The estimate of annual survival rate by size class for all zones were: 7-10 inch groups, 5 to 12 per cent; 11-20 inch groups, 10 to 23 per cent; and 21 inches and over, 14 to 38 per cent.

The highest survival recorded was for the bass of Zone III which were tagged in 1962 (20.9 per cent for all size groups combined). This is the area of Florida noted for its big bass—bass in the 10 to 15 pound class. Conversely, the southern portion of Zone II is an area where five and six pound bass are common and ten pound bass exceptionally rare (area of lowest survival). Most of Zone II is subtropical and bass can feed and grow throughout the year (Clugston, 1964). Perhaps the bass in subtropical Florida do not live as long as those 200 miles to the north. This may support the idea that bass with an abundance of food and long growing season die of "old age" before actually living very long (Stroud, 1948). Difficulty has been encountered in reading bass scales from subtropical Florida, so the life span of bass in this area cannot be estimated.

At the writing of this paper, there is still a possibility of additional bass which were tagged in 1963 being caught and turned in. Thus the survival rates may rise for the 1963 fish.

The mean rate of exploitation (harvest rate) for the largemouth bass based on the recoveries of bass tagged the first three years were: 1961, 21.2 per cent; 1962, 25.7 per cent; and 1963, 27.7 per cent. The overall harvest in Zone I was slightly higher than in the other zones. All years combined, the mean rate of exploitation was approximately 30 per cent in Zone I and 20 to 25 per cent in the other zones. Very little difference was found in harvest rates for the bass 11 through 20 inches in total length (25.5 to 29.0 per cent) but the 7-10 inch groups and the 21 inch and over groups were slightly lower (19.6 and 17.5 per cent respectively). Since only four of the 19,241 smaller centrarchids which were tagged during the four years of the Derbys were returned later than one year after tagging, their mean rate of exploitation is considered to be the same as their total percentage returned (Table 1).

MIGRATION

Because of the necessity of tagging fish over the entire state and a relatively short period of time in which to do it each year, the tagged fish were simply recorded as to the lake in which they were released. Therefore, the only migration that was noted was when a fish would pass from one lake into another by canals or rivers. Some fish were reportedly caught in lakes in to which it was physically for them to have migrated. This was probably the case of fishermen who did not wish to disclose the location of their prize catch to other anglers. Some migration occurred between lakes in a number of the chains of lakes in central Florida; but, as reported by Dequine and Hall (1950), no definite pattern between any of the lakes was detectable.

In 1963, three lots of 25 bass each were taken from their "home" lake, tagged, and released in different lakes but lakes which were connected to their home lake by canals approximately $\frac{1}{4}$ -mile long. The six major lakes in the chain ranged between 105 to 500 surface acres. The bass were released in the approximate center of the "foreign" lake. Of the 75 bass tagged, 21 were recaptured, 12 had returned to their "home" lake, 7 were caught in the lakes in which they were released, and 2 were caught in other lakes in the chain. In 1961 and 1962, a total of 56 bass were tagged in the same chain but were not transported from their "home" lake to the other lakes. Twelve of the tagged bass were recaptured with nine of them caught in their "home" lake. The average time between tagging and recapture for the 1963 tagged

bass in this chain was 108 days. Although the numbers of fish involved may be considered small, there does appear to be a tendency to return to their "home" lake or remain there if not transported. In reviewing the work of other investigators, Gerking (1959) includes the largemouth bass as a species in which homing has been demonstrated.

DISCUSSION

This tagging program was somewhat unique from other reported tagging studies because of the high rewards offered and the extensiveness of the publicity given the program. Therefore, a high return of the tagged fish caught by anglers was assured. Butler (1962) points out the importance of high rewards or valuable prizes in guarantying high returns of recaptured tagged fish.

The large rewards offered obviously effected the amount of fishing pressure on the waters in which fish were tagged. When it became general knowledge that tagged fish were present in a lake, great numbers of fishermen thronged to the site. Because of this pressure, the harvest rates reported in this paper are probably higher than actually occurs in the majority of Florida's waters. According to Kimsey (1956) the use of jaw tags may increase the harvest rate. He suggests that a jaw tag may interfere with normal feeding and thus make a hooked bait or artificial lure more attractive.

Kimsey (op. cit.) cited many examples of tagging studies employing jaw tags in which there were very few tag returns after a one-year period. Because of experiments in an aquarium and a hatchery, he believed that the nonreturn of jaw-tagged bass after one year was the result of tag shedding and not natural mortality. Tag returns for bass were higher after one year in the present study (3.4 per cent of the 27.9 per cent total) than in the studies cited by Kimsey, but much lower than that reported by Kimsey (1957) when staple and disk-dangler tags were used in Clear Lake, California (12.0 per cent of the 28.2 per cent total). It was not possible to measure the tagging mortality or tag loss in the present investigation so the effect of these factors on the survival and harvest estimate is not known. A number of bass were able to retain their tags for over three years. Since only four of the smaller Florida centrarchids were recaptured after one year's freedom, they may have had a high tag loss. Their mouth parts are much smaller and softer than the largemouth bass and the tags may have been easily lost in feeding.

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METHODS AND TECHNIQUES

NORRIS RESERVOIR SPORT FISHING SURVEY, 1963*

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ABSTRACT

Creel census information available for TVA reservoirs consisted largely of samples of the catch during the peak spring fishing period. Estimates of total fishing pressure were scarce and economic data nonexistent.

To obtain such information, TVA and the Tennessee Game and Fish Commission conducted a one-year sport fishing survey of Norris Reservoir. This report describes census design and methods developed with the assistance of the Institute of Statistics at North Carolina State University.

The reservoir was divided into three major areas. Expanded estimates of boat and bank fisherman use, catch, and expenditures in each area were completed biweekly. Total hours of pressure and numbers of fishermen were determined from aerial counts and boat rental records from selected boat docks. Harvest information was collected by creel clerks Saturday, Sunday, Wednesday, and two other week days selected randomly. Economic data were obtained from 10 per cent of the fishermen contacted.

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