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METHODS AND TECHNIQUES

NORRIS RESERVOIR SPORT FISHING SURVEY, 1963*

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ABSTRACT

Creel census information availible 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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INTRODUCTION

Considerable creel census information is available for TVA reservoirs but it consists largely of samples of the catch during the peak spring fishing period (Eschmeyer and Tarzwell, 1941; Tarzwell, 1941; Eschmeyer, 1942; Eschmeyer, Manges, and Haslbauer, 1946, 1947; and White and Jaco, 1961). Estimates of total fishing pressure were also made for a few reservoirs soon after their impoundment (Eschmeyer, 1943; Tarzwell and Miller, 1943). Data on fishermen expenditures and the economic value of sport fishing had not been collected for any TVA reservoir.

To provide a measure of annual as well as seasonal fishing pressure, fish catch, and fishermen expenditures on typical TVA lakes, two year-round creel census projects were developed jointly by TVA and the Tennessee Game and Fish Commission. The first, on Norris Reservoir, a storage impoundment, was initiated January 14 and completed December 29, 1963. A similar census began July 1, 1964, on Kentucky Lake, the largest TVA mainstream impoundment.

Major findings of the Norris survey have been summarized in a brochure prepared primarily for fishermen (TVA and Tennessee Game and Fish Commission, 1964; detailed results will be reported elsewhere. This report describes census design and methods developed with the assistance of the Institute of Statistics at North Carolina State University. Arrangements for services of the Institute were made by the Game and Fish Commission.

DESCRIPTION OF RESERVOIR

Norris Dam in east Tennessee, the first built by TVA, was completed in 1936. Located 8 miles below the junction of the Clinch and Powell rivers, it backs water up both streams for a maximum distance of 72 miles. At full pool elevation, 1020 feet above mean sea level, the reservoir has a surface area of over 34,000 acres and a shoreline in excess of 800 miles. The Clinch and Powell rivers arms above their separation contain about 20,000 and 10,000 surface acres, respectively.

Since the reservoir was built primarily for flood control and power production, the water level fluctuates seasonally. Annual drawdown amounts to about 60 feet in a normal operating year and 100 feet or more when rainfall is abnormally low. Reservoir operations in 1963 were within normal drawdown limits, the water levels varying between 1012 and 945 feet.

METHODS

General

The reservoir was sampled by area and by two-week time segments. It was divided into three major areas—the two arms above the forks of the rivers and the portion between the forks and the dam (figure 1). To provide more uniform sampling of the catch, each major area was further divided into five sub-areas, each 5 to 10 miles long. Aerial counts of fishermen and expanded estimates of use and catch were completed biweekly for each major area and the entire reservoir.

Fishing Pressure

Pressure was determined from aerial counts and boat rental records at selected boat docks.

Boats and bank fishermen in each major area were counted from the air once every two weeks. It took approximately one hour to fly each area so the counts gave an almost instantaneous record of boat and bank fishing hours by areas.

Date and hour of plane flights were established from a table of unequal distribution with probability proportional to the amount of fishing (table 1). This table, designed from previous knowledge of fishermen's use of the reservoir, assigned weights to the days of the week and to the hours of the day, with more weight given to days and hours known to receive greater fishing pressure, e.g., week-en days and midday hours. The table was constructed so as to have a total of 1,000. To do so the sum of the daily weights for one week must equal 20, the sum of the hourly weights 25.

Three icosahedron (20-sided) dice were used to select the plane flight time in Area A. The three-digit number rolled established the date and time of this flight. When that number fell in between those given in the table, the next highest number was used. Flight times in areas B and C were determined by dividing the total number in the table (1,000) by 3 and adding to or subtracting the result from the number for the first flight. The chosen flight schedule thus represented three equidistant points on a circle of possible numbers up to 1,000.

Assigned weights for individual days and hours in the table could be changed whenever creel and boat dock records showed a shift in the period of heaviest fishing, as long as their sums remained the same. For the Norris survey the weights for the different days remained the same throughout the year but hour weights were changed several times with the seasons. A new flight schedule was prepared every four weeks.

Boat rental records were obtained at three cooperating docks in each major area. Selected docks were ones that remained open all year, agreed to keep complete records, and wer so located as to discourage boat travel between major areas, but still gave fair distribution within areas.

Dock operators maintained records on the number of boats rented, the number of persons per boat, and the number of hours boats were rented. All boat rentals were recorded on cards, with the time of departure and return stamped by time clock. Rental card information (total rental hours and rental hours at flight time) was tabulated at the end of each two-week period. When rental boats were coming in or going out during the hour of plane flight, partial hours were recorded.

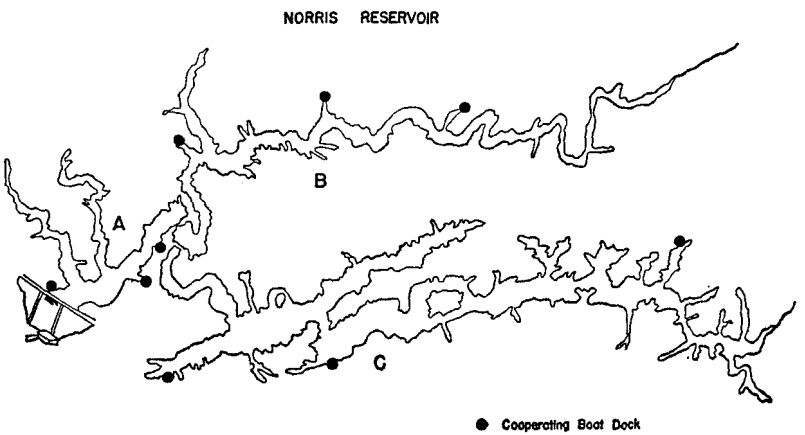

Figure 1. Major sampling areas, Norris Reservoir sport fishing survey

Table 1. Table of "unequal distribution" used to select flight times for two-week period, Norris Reservoir

Days	Weight	Hours A. M. 7:00	8:00	9:00	10:00	11:00	12:00	P. M. 1:00	2:00	3:00	4:00	5:00
		1	2	3	3	3	3	3	2	2	2	1
First Week												
Monday	1	1	3	6	9	12	15	18	20	22	24	25
Tuesday	2	27	31	37	43	49	55	61	65	69	73	75
Wednesday	3	78	84	93	102	111	120	129	135	141	147	150
Thursday	2	152	156	162	168	174	180	186	190	194	198	200
Friday	2	202	206	212	218	224	230	236	240	244	248	250
Saturday	5	255	265	280	295	310	325	340	350	360	370	375
Sunday	5	380	390	405	420	435	450	465	475	485	495	500
Second Week												
Monday	1	501	503	506	509	512	515	518	520	522	524	525
Tuesday	2	527	531	537	543	549	555	561	565	569	573	575
Wednesday	3	578	584	593	602	611	620	629	635	641	647	650
Thursday	2	652	656	662	668	674	680	686	690	694	698	700
Friday	2	702	706	712	718	724	730	736	740	744	748	750
Saturday	5	755	765	780	795	810	825	840	850	860	870	875
Sunday	5	880	890	905	920	935	950	965	975	985	995	1000

Explanatory note
Numbers in table begin with 1 (weight of Monday) X 1 (weight of 7:00 a.m. Monday) equals 1; 1 (weight of Monday) X 2 (weight of 8:00 a.m. Monday) equals 2, which added to the previous answers for 7:00 a.m. Monday (1) equals 3. This accumulative process is continued for each day and hour throughout a two-week unit.

Table 2. Summary of fishing pressure data and estimates for two-week period (May 6-19, 1963), Norris Reservoir

1	2	3	4	5	6	7	8	9	10	11	12
Area of reservoir	Total boat rental hours	Plane count		Dock boats rented at time of plane count	Estimated total pressure in hours			Average length of trip (hours)		Estimated number of fishermen	
		Boats	Bank fisher-men		Boats	Boat fishermen	Bank fishermen	Boat	Bank	Boat	Bank
A	1,539.8	42	53	9.0	7,186	15,090	9,068	6.8	3.9	2,219	2,325
B	2,053.0	111	121	21.8	10,453	26,133	11,395	7.1	4.3	3,681	2,650
C	6,206.7	333	256	63.2	32,703	73,103	25,141	7.2	2.4	10,153	10,475
Total	9,799.5				50,342	114,326	45,604			16,053	15,450

Table 2—Continued

Explanatory notes on method of calculating estimated fishing pressure

Column 2 = From three cooperating docks in area

" 5 = Includes partial hours for boats coming in or going out during hour of flight

" 6 = $\frac{\text{(Col. 2)(Col. 3)}}{\text{Col. 5}}$

" 7 = (Col. 6)(Average no. fishermen per boat as determined from boat rental records)

" 8 = $\frac{\text{(Col. 4)(Col. 6)}}{\text{Col. 3}}$ or $\frac{\text{(Col. 2)(Col. 4)}}{\text{Col. 5}}$

" 9 = From boat rental records

" 10 = From creel census records of completed trips

" 11 = $\frac{\text{Col. 7}}{\text{Col. 9}}$

" 12 $\frac{\text{Col. 8}}{\text{Col. 10}}$

Total hours of boat pressure were determined from the ratio of rented boats out at flight time to the boats counted by plane and the total boat rental hours for the two-week period. Total boat hours and the average number of fishermen per boat, as determined from dock records, gave the total hours of boat fishing pressure. Total hours of bank fishing pressure were calculated from the boat to bank fisherman ratio determined on the plane flight and the estimated total boat hours, or from the ratio of rented boats out at flight time to the bank fishermen counted by plane and the total boat rental hours.

Number of boat and bank fishermen were estimated from the total hours of each type of pressure and the average length of trip. Average length of boat fishing trips was obtained from boat dock rental records, bank fishing trips from completed trip information collected by census takers.

The data and calculations for estimating total pressure in hours and total fishermen for a two-week period are summarized in table 2.

Creel Census (Catch)

A census taker for each major area was equipped with boat, motor, trailer, and other census equipment. Each clerk worked one sub-area a day in random order during a five-day work week; thus the entire lake was covered each week. The work week included Wednesday, Saturday, Sunday, and two other week days selected at random. Wednesday was selected because businesses in nearby cities closed at noon, and fishing pressure then was similar to that experienced on week ends.

Fishermen were interviewed for a continuous eight-hour period beginning between 7 and 10 a.m. Interview starting times were changed each week so that both morning and evening peak fishing periods would be covered regularly. Census takers were also instructed to vary the starting point but to cover each sub-area in the allotted eight-hour period. On days with heavy fishing pressure it was necessary to randomly sample clusters of fishermen in order to maintain this schedule.

Interview information, recorded on a standard creel census form approved by the Bureau of the Budget, included area and sub-area, number and type (boat or bank) of fishermen, hours fished, successful fishermen, method of fishing, number and weight of fish caught by species, and pertinent lake data (figure 2). Census card information was coded, punched, and tabulated on automatic data processing equipment by two-week segments.

Total number of fish caught was estimated by multiplying the creel census catch per hour by the previously determined hours of bank and boat pressure. Species composition was determined from percentages in the creel samples. Total weight of the catch was estimated by relating total species numbers to average weights from creel samples.

Expenditures

In addition to questions on catch and fishing time, every tenth fisherman interivewed was asked to enumerate total out-of-pocket expenses for that particular trip. This included expenditures for meals, refreshments, bait, tackle, outboard gas and oil, licenses, boat rental and launching fees, lodging, and travel. This economic information was recorded on the back of the regular creel form (figure 2).

Average trip and total expenditures of boat and bank fishermen were calculated every two weeks. Capital investments for boats, motors, tackle, etc., were not included, so the total estimated expenditure is a conservative one. Nevertheless, it did provide an indication of the magnitude of money spent by fishermen with local merchants; motel owners, service station, bait stand, and boat dock operators.

TVA RESERVOIR
FISHING CENSUS

Budget Bureau No. 74-6209
Approval expires April 30, 1964

Interview No.____ Date____

Reservoir 1 2 3 4 5 6 7 8

Area 1 2 3 4 5 6 7 8 9 10

Sub-area 1 2 3 4 5 6 7 8 9 10

Type fisherman: Boat____ Bank____

Lake elevation____

Temperature: Air____ Water____

Launching site:

Commercial dock: Yes____ No____

Access area: Public___ Private____

Number fishermen 1 2 3 4 5 6 7 8 9 10

Number children/hours fished____/____

Time fishing started____

Time of interview____

Fishing method: (1)Still___ (2)Casting___

(3)Trolling____ (4)Other____

(5)Combination____

Successful fishermen 1 2 3 4 5 6 7 8 9 10

Hours fished____

Code	Species	Number	Pounds
1	Walleye		
2	Sauger		
3	Largemouth bass		
4	Smallmouth bass		
5	Spotted bass		
6	White bass		
7	Black crappie		
8	White crappie		
9	Bluegill		
10	Other sunfish		
11	Channel catfish		
12	Flathead catfish		
13	Drum		
14	Carp		
15	Trout		
16	Other(sp.)		
17			
18			
	Total		

ECONOMIC INFORMATION

State____ City____

Main reason for trip____

Boat: Type____ Length____ Motor (hp)____

Rental fees: Boat $____ Motor $____ Launching $____

Type of license 0 1 2 3 4 5 6 7 8 9

Gas and oil purchased for boat: Gallons____ Cost $____

Meals purchased today: Number____ Cost $____

Light refreshments purchased for today: Cost $____

Ice for today's trip: Pounds____ Cost $____

Lodging place last night____ Cost $____

Bait and tackle purchased for today's trip:

(1)Natural bait $____ (2)Artificial lures $____ (3)Hooks $____

(4)Sinkers $____ (5)Line $____ (6)Floats $____

(7)Swivels $____ (8)Dip net $____ (9)Stringer $____

(10) Other $____

Miles traveled today____

Mileage cost (calculated)____

License cost $____

Total trip expenditure $____

Remarks: ____

Figure 2. Both sides of standard interview form used by census takers

CONCLUSIONS

This aerial census design worked satisfactorily on Norris Reservoir. It would appear to be equally applicable to other impoundments with numerous access areas and privately owned commercial boat docks, and where the large area or length of shoreline makes it difficult to get instantaneous fishermen counts by car, boat, or other means. This method also has merit for estimating total fishing pressure and catch for predetermined, short time periods.

Sampling errors (one standard error) of the Norris survey ranged from 10.2 per cent for number of fishermen to 13.0 per cent for total expenditures. Since the expanded estimates of pressure and catch are dependent largely on the results of the aerial counts, over-all reliability could probably be improved by cutting down on creel sampling and increasing the number of flights. This would also reduce total costs since plane flights were relatively inexpensive compared with the cost of creel sampling.

Total survey cost to the two agencies was approximately $25,000. One biologist made the aerial counts, collected boat rental data, and coordinated the creel census. All tabulations and expansion of data were performed by punch card equipment and statistical clerks. As a result, the number of fisheries personnel of both agencies was considerably reduced from that used in previous censuses. Furthermore, with the machine tabulations, complete data were available for analysis and reporting the same week the project was terminated.

Probably the greatest value to TVA and the Tennessee Game and Fish Commission is that for the first time relatively complete information on fish catch and fishing pressure are now available for a storage reservoir at all seasons of the year. It is now possible to sub-sample Norris with more reliability and much less effort to obtain future comparative data. We are also in a good position to evaluate the effects of fish management efforts on this lake as well as natural conditions that might affect fishing. Finally, we have a much better idea of the economic value of sport fishing in our reservoirs.

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A POSITIVE APPROACH TO COASTAL SPORT FISHERY PROBLEMS

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Adequate habitat is an absolute necessity for coastal marine and estuarine fishes. The importance of estuarine and coastal nursery areas for weakfish, flounders, tautog, striped bass, scup, American shad, spot, bluefish, Atlantic croaker, seatrout, black drum, and menhaden has been adequately demonstrated. The American Fisheries Advisory Committee of the Department of Interior at their June 1963 meeting in Washington concluded that protection of estuaries is essential. The need for positive action concerning fish habitat was emphasized by Assistant Director James T. McBroom of the Bureau of Sport Fisheries and Wildlife in an address at the 1964 Annual Meeting of the Western Association of Game and Fish Commissioners.

Protection of some vital coastal and estuarine habitat is being afforded by creation of state and national parks, wildlife refuges, private preserves and recreation areas. The State of Massachusetts has