ANGLING PRESSURE AND SPORT FISH HARVEST IN THE PREDATOR-STOCKING-EVALUATION RESERVOIRS[1]

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ABSTRACT

Estimates of angling effort and sport fish harvest in 24 predator-stocking-evaluation reservoirs in 1972 and 1973 indicated mean annual angler-effort was 31.1 hours per acre and total harvest was 18.4 pounds per acre. Harvest-rate was 0.7 fish per hour or 0.6 pounds per hour. Average annual harvest of striped bass was 0.5 pounds per acre; walleye 0.3 pounds per acre. Striped bass harvest was positively related to dissolved solids content and water level fluctuation but negatively related to mean depth. Walleye harvest was positively related to mean depth and negatively to reservoir area. Establishment of significant fisheries for both striped bass and walleye in a single reservoir is improbable. No significant correlation was found between the harvests of stocked striped bass or walleye and the harvests of other sport fishes. Insofar as harvest data reflect production there is no evidence of competition between introduced and indigenous predators in the reservoirs sampled.

The basic objectives of the cooperative predator-stocking-evaluation (PSE) were to collect data on ecological factors which influence the success of predator introductions in reservoirs and to evaluate the effects of introduced predators on existing fish populations (Carver et al. 1977). An obvious measure of predator introduction success is embodied in estimates of their harvest by anglers. Clues to interspecific competition might also be revealed by large fluctuations in harvest of indigenous predators. Therefore, the PSE study plan included statistically reliable estimates of angler effort and harvest by species. These data were obtained for 24 of the reservoirs studied in 1972 and/or 1973.

METHODS AND MATERIALS

Stratified random enumeration of anglers from boat or airplane provided annual estimates of fishing effort. Interviews of anglers provided estimates of length of fishing day, harvest-rate and total harvest, by species. About 90,000 anglers were interviewed during the 2-year study. Sampling designs for many of the reservoirs were provided by Dr. Don W. Hayne, North Carolina Institute of Statistics.

Five of the reservoir estimates (Jordan, Mitchell, Jackson, Sinclair, and Keystone) were reported on a fiscal year basis due to agency accounting constraints. In these instances, the reporting periods were July 1, 1972-June 30, 1973 and July 1, 1973-June 30, 1974. However, they were treated as calendar years 1972 and 1973 in this presentation.

Physicochemical descriptions of the reservoirs were supplied by the cooperating member agencies of the Reservoir Committee (Aggus and Lewis 1977). Total area of the 24 reservoirs included in this analysis was 371,904 acres (about 4% of the United States total), ranging from 906 to 53,515 acres. Mean area was 15,500 acres, more than twice the national mean for reservoirs of 500 acres or more (6,546 acres). Compared to averages of a national sample of 103 reservoirs (Jenkins and Morais 1971), the average PSE reservoir was similar in area, depth, storage ratio and age, but fluctuated less (25 versus 11 feet), had lower dissolved solids content (282 versus 176 ppm) and a longer growing season (192 versus 215 days).

[1] Basic data presented in this report are derived from a cooperative predator stocking evaluation conducted under the auspices of the Reservoir Committee, Southern Division, American Fisheries Society, 1972-73.

Collation and preparation of the data for computer analysis was done by the National Reservoir Research Program, U. S. Fish and Wildlife Service. Correlation and regression analyses were performed on an IBM 370/155 computer at the University of Arkansas Computing Center.

RESULTS AND DISCUSSION

Mean annual angler effort on the 24 reservoirs (45 estimates) was 31.1 hours per acre, or 7.3 days per acre (Table 1). Effort ranged from 2.5 hours per acre on Grenada Lake in 1973 to 101.1 hours per acre on Lake Jackson in 1972. Mean angler-day length was 4.3 hours.

Table 1. Summary of estimated angler effort and harvest rate in 24 PSE reservoirs, 1972-73. The left number of each hyphenated pair represents 1972, and right 1973.

Reservoir	*Angler Hours Per Acre*	*Angler Days Per Acre*	*Fish Harvested Per Hour*	*Pounds Harvested Per Hour*
Jordan	6.7-5.1	1.7-1.3	0.4-0.5	0.5-0.5
Mitchell	7.8-5.8	2.0-1.5	0.5-0.4	0.5-0.3
Beaver	33.0-24.0	7.9-5.7	0.4-0.4	0.5-0.5
Bull Shoals	39.1-29.6	9.8-7.0	0.2-0.3	0.2-0.4
Greeson	24.1-15.2	7.3-7.2	0.4-0.4	0.6-0.3
Jackson	101.1	28.1	0.9	0.6
Sinclair	49.6-58.2	13.4-14.2	0.7-0.8	0.5-0.5
Deep Creek	15.2-59.8	3.8-15.0	1.5-0.6	0.8-0.4
Barnett	34.7-70.3	5.8-13.8	1.1-1.3	0.8-1.0
Enid	6.3-7.5	1.4-1.7	1.1-0.8	0.8-0.6
Grenada	3.7-2.5	0.9-0.5	0.5-1.2	0.4-1.0
Okatibbee	39.4-43.6	8.6-8.4	0.8-0.7	0.6-1.1
Sardis	11.6-3.5	2.3-0.7	1.1-1.1	0.9-0.9
Badin	29.3-22.3	7.3-5.6	0.7-0.8	0.4-0.3
Eucha	48.1-59.7	8.4-10.3	1.0-1.0	1.2-0.9
Keystone	27.1-27.1	7.1-7.1	0.8-0.8	0.9-0.9
Spavinaw	35.8-30.1	7.2-7.7	1.4-1.4	1.0-0.9
Cherokee	20.1-28.3	4.3-6.7	0.3-0.4	0.3-0.5
Dale Hollow	15.8-13.6	3.3-2.8	0.5-0.6	0.3-0.5
Watauga	45.3-57.0	8.7-11.4	0.3-0.3	0.3-0.3
Woods	46.2-39.5	9.2-7.5	0.8-0.6	0.6-0.6
Bastrop	51.4-7.8	15.9-2.0	0.5-0.4	0.3-0.5
Cypress Springs	67.7	18.4	1.6	0.7
Spence	29.9	9.2	0.4	0.4
Mean	31.1	7.3	0.7	0.6

Fishing pressure exerted on the PSE reservoirs was about one-half the estimated average on reservoirs nationally (Jenkins 1975). Total 2-year effort on the PSE reservoirs was about 4,072,000 angler-days, or about 17,500,000 angler-hours. Highest annual effort was estimated on Barnett Reservoir (455,400 angler-days in 1973) and lowest on Lake Bastrop (1,810 days in 1973).

Rate of harvest in mean number of fish per hour was lower for the PSE reservoirs (0.7 per hour) than the national sample (0.9 per hour). However, in terms of pounds per hour the PSE mean (0.6 pounds per hour) surpassed the national sample mean (0.5 pounds per hour).

The mean annual harvest of sport fishes in the PSE reservoirs was 18.4 pounds per acre, ranging from 1.6 to 76.1 pounds per acre (Table 2). Black bass (5.7 pounds per acre) and crappie (5.6 pounds per acre) made up 61% of the harvest (Table 2). Adding the harvest of catfishes (2.4 pounds per acre), sunfishes (1.6 pounds per acre) and white bass (1.3 pounds

per acre), accounts for 90% of the total. The mean harvest of striped bass was only 0.5 pounds per acre, but reached 4.7 pounds per acre in Cherokee Lake, Tennessee in 1973. Maximum walleye harvest of 6.0 pounds per acre was recorded in Watauga Lake, Tennessee, in 1973 but the average was only 0.3 pounds per acre.

Striped bass had been stocked in 15 of the reservoirs, some were harvested in 11 of them. Annual harvests exceeded 5,000 pounds in Jordan, Mitchell (1972), Beaver, Greeson, (1972), Sinclair, Badin, Keystone, Cherokee, and Spence Reservoirs. Walleye were stocked in 12 PSE reservoirs and harvest was recorded in 10 of them. Annual harvests of walleye exceeded 5,000 pounds in Bull Shoals, Deep Creek, Dale Hollow, Watauga, Woods (1972), and Cypress Springs (1973) Reservoirs.

Where both species were stocked, harvests of both were recorded only in Beaver and Bull Shoals Lakes. Highest annual harvests of striped bass occurred in Lake Keystone (1973), 115,000 pounds, and Cherokee Lake (1973), 106,000 pounds. Highest annual walleye harvest occurred in Watauga Lake, 36,000 pounds. A reproducing population of striped bass is established in Lake Keystone, and of walleye in Watauga Lake.

Compared to the unweighted national averages (Jenkins and Morais 1971), harvests of crappie and sunfish were lower in the PSE reservoirs, and harvests of black bass and catfish were similar. Weighted by reservoir area (Table 3), mean angler effort and fish harvested per hour were higher in the National sample, but total harvest and pounds harvested per hour were higher in the PSE sample. Mean harvest-rates in the PSE reservoir sample were well above the arbitrary "good" fishing standard of 0.5 pounds per hour, or 2.0 pounds per day.

Total harvest in the PSE sample was positively related to angler effort as expected (Fig. 1), but the calculated straight-line relationship was somewhat surprising. Within the angling effort range of 2.5 to 101.1 hours per acre, the harvest-rate remained constant at 0.60 pounds per hour. In the national sample, the calculated rate of harvest dropped from 0.59 pounds per hour at 10 angler-hours per acre to 0.46 pounds per hour at 100 angler-hours per acre. The relatively stable catch rate in the PSE reservoirs suggests that many anglers shifted their effort to other waters when a certain minimum success rate was reached.

Stepwise multiple regression analysis of PSE reservoir harvests on 11 environmental variables indicated that water level fluctuation, storage ratio and age of reservoir were all negatively related to total, black bass, crappie, catfish and white bass harvest. Coefficients of determination (R^2) for the formulas derived ranged from 40 to 72%. These relationships apply to a relatively small number of reservoirs over a 2-year span, and hence are not of broad predictive utility. Copies of the formulas are available from the National Reservoir Research Program.

Two formulas concerning striped bass and walleye harvest are included because of their management implications. Regression formulas for estimation of striped bass and walleye harvest in the PSE reservoirs are: a) striped bass harvest in pounds per acre = 15.19 + 0.0014 (dissolved solids in ppm) + 0.063 (fluctuation in feet) — 0.193 (mean depth in feet) + 14.442 log(mean depth). Number of observations = 19. Coefficient of determination = 0.59 Pr = 0.01; b) walleye harvest in pounds per acre = 0.62 + 0.080 (mean depth in feet) —0.000085 (area in acres). Number of observations = 13. Coefficient of determination = 0.89 Pr = 1.6×10^{-5}. Striped bass harvest was positively related to dissolved solids content and water level fluctuation and negatively to mean depth. In contrast, walleye harvest was positively related to mean depth and negatively to reservoir area. This implies that establishment of significant fisheries for both these predators in a single reservoir is improbable.

Simple correlation analysis of interrelations of harvests of major sport fish revealed no significant correlation between harvest of striped bass or walleye and other fishes. Harvests of black bass, crappie, sunfish and catfishes were all positively correlated (0.01 significance level). White bass harvest was positively correlated only with catfish harvest. Insofar as harvest data may reflect production, there is no evidence of competition between the introduced and indigenous predators in the PSE reservoir sample. Long-term (e.g., 10 years or more) records of harvest would be required to identify interspecific competition by this approach.

Table 2. Summary of harvest of major sport fishes in PSE reservoirs.

		Sport fish harvest in pounds per acre							
Reservoir	*Year*	*Total*	*Catfishes*	*White bass*	*Sunfishes*	*Black basses*	*Crappie*	*Striped bass*	*Walleye*
Jordan	1972	2.6	0.1	0.4	t	1.7	0.2	0.3	XX
	1973	2.4	0.1	0.4	0.0	1.7	0.6	0.1	XX
Mitchell	1972	3.5	t	0.2	0.1	2.0	0.7	0.2	XX
	1973	2.0	0.0	0.1	0.0	1.0	0.7	0.0	XX
Beaver	1972	17.4	0.5	4.6	0.3	6.4	4.7	0.5	0.0
	1973	11.6	0.5	1.3	0.1	6.1	3.2	0.4	t
Bull Shoals	1972	9.9	0.6	3.2	0.2	3.7	1.2	t	0.4
	1973	10.4	0.6	1.4	0.3	5.9	0.5	t	0.2
Greeson	1972	12.6	1.2	0.2	0.2	5.4	1.8	3.8	0.0
	1973	4.5	0.3	0.2	0.2	2.9	0.8	t	0.0
Jackson	1972	60.2	7.4	0.2	9.5	17.8	24.9	0.0	XX
Sinclair	1972	23.1	6.4	0.8	1.3	7.1	7.0	0.2	XX
	1973	29.4	6.4	0.6	1.5	10.9	8.8	1.0	XX
Deep Creek	1972	12.0	1.1	0.0	0.3	2.3	0.9	XX	0.1
	1973	22.0	0.7	0.0	0.4	1.9	1.0	XX	0.3
Barnett	1972	27.1	2.5	0.0	8.5	9.9	6.0	0.0	XX
	1973	76.1	12.8	0.0	4.5	22.8	35.7	0.0	XX
Enid	1972	5.2	0.2	0.0	0.1	0.5	4.5	XX	0.0
	1973	4.5	0.0	t	0.1	0.6	3.9	XX	0.0
Grenada	1972	1.6	0.2	0.0	0.1	0.2	1.2	XX	XX
	1973	2.3	0.2	t	0.3	0.1	1.7	XX	XX
Okatibbee	1972	21.1	1.1	0.0	1.5	13.1	4.3	0.0	XX
	1973	28.3	2.0	0.0	1.7	12.5	11.2	0.0	XX
Sardis	1972	9.9	0.1	0.0	0.3	1.6	8.0	0.0	XX
	1973	3.1	0.1	0.0	0.3	0.8	2.1	0.0	XX
Badin	1972	10.3	0.6	1.0	1.8	2.3	2.0	0.2	XX
	1973	7.6	0.4	0.8	1.1	1.9	1.3	0.4	XX
Eucha	1972	58.2	9.7	16.0	1.3	17.0	14.1	XX	0.0
	1973	51.9	12.4	5.1	3.6	19.1	11.7	XX	0.0
Keystone	1972	24.6	8.0	3.1	0.1	1.2	7.5	3.6	t
	1973	24.6	8.0	3.1	0.1	1.2	7.5	3.6	t
Spavinaw	1972	36.9	7.0	5.2	3.5	10.2	11.0	XX	t
	1973	25.6	2.5	6.3	2.4	5.9	8.5	XX	0.0
Cherokee	1972	6.2	0.8	1.1	0.4	1.3	1.3	1.1	XX
	1973	13.1	0.7	2.2	1.0	1.7	2.8	4.7	XX
Dale Hollow	1972	5.6	0.4	0.8	1.1	1.9	0.7	XX	0.5
	1973	6.3	0.5	0.3	0.9	2.3	0.8	XX	0.9
Watauga	1972	14.2	1.0	0.0	0.2	3.2	3.8	XX	4.4
	1973	14.6	0.2	0.0	1.1	3.0	1.9	XX	6.0
Woods	1972	25.5	1.3	0.0	2.4	7.4	12.9	XX	0.2
	1973	23.3	1.6	0.0	1.2	10.2	9.0	XX	0.0
Bastrop	1972	13.4	1.5	0.0	1.4	10.0	0.1	0.0	XX
	1973	3.7	0.5	0.0	0.1	2.3	t	t	XX
Cypress Springs	1973	49.9	5.2	0.0	15.3	9.7	17.6	XX	1.5
Spence	1973	11.0	1.2	1.4	0.2	5.6	1.8	0.8	XX
Mean		18.4	2.4	1.3	1.6	5.7	5.6	0.5	0.3

t = less than .05 pounds
XX = not stocked

Table 3. Comparison of area-weighted values for angler effort, sport fish harvest and harvest-rate between the 24 PSE reservoirs and a National sample of 103 reservoirs (Jenkins and Morais 1971).

	Area-weighted mean	
	PSE reservoirs	*National sample*
Angler-days per acre	5.9	6.7
Angler-hours per acre	25.8	30.4
Angler-hours per day	4.4	4.3
Fish harvested per hour	0.71	0.85
Pounds harvested per hour	0.62	0.54
Pounds per fish	0.92	0.66
Fish harvested per acre	18.4	25.1
Pounds harvested per acre	15.6	14.6

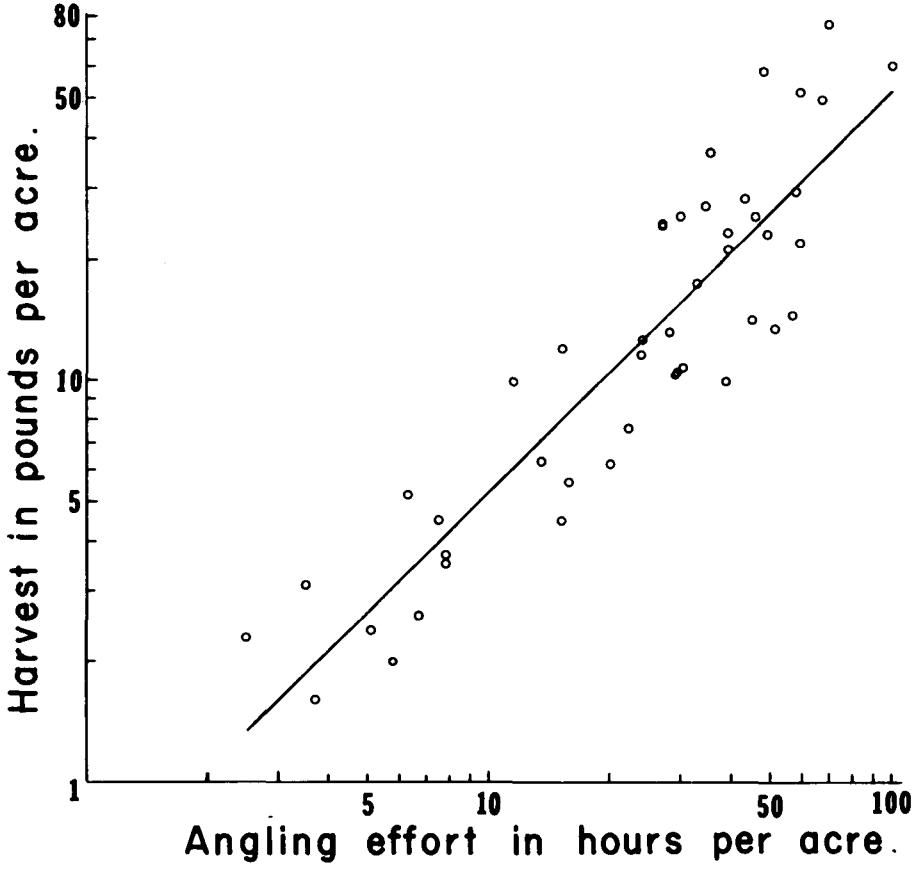

Figure 1. Logarithmic plot of sport fish harvest on angling effort in the PSE reservoirs, 1972-73. The regression formula is log (sport fish harvest in pounds/acre) = $-0.2610 + 0.9876$ log (angler-hours/acre). N = 45, $R^2 = 0.81$, Pr = $> 1.0 \times 10^{-6}$

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