ENVIRONMENTAL CONDITIONS AND STANDING CROPS OF FISHES IN PREDATOR-STOCKING-EVALUATION RESERVOIRS[1]

by
LARRY R. AGGUS
National Reservoir Research Program
U. S. Fish and Wildlife Service
Fayetteville, Arkansas 72701

and

STEVEN A. LEWIS
Oklahoma Department of Wildlife Conservation
Oklahoma City, Oklahoma 73100

ABSTRACT

Relations between environmental variables and fish standing crops were examined in 1972-73 as part of a Predator-Stocking-Evaluation of reservoirs, sponsored by the Reservoir Committee, Southern Division of the American Fisheries Society. High volumes of flow and increased water exchange rates in 1973 were associated with increases in fish standing crops and changes in the size structure of fish assemblages in some study reservoirs. Reservoirs with higher inherent water exchange rates also supported larger standing crops than those with lower exchange rates. However, highly variable responses of fish populations in different reservoirs to environmental change reflect the importance of other physicochemical and biological interactions not measured in this analysis. Combinations of environmental variables explained from 41 to 67% of the variation in selected standing crop components.

INTRODUCTION

The rapid development of culture methods for producing fish of predator species has accelerated the stocking of these fishes into many southern reservoirs. Quantifying the effect of these introductions on the fishery and on existing fish communities has often been neglected because of high cost (Stevens 1975). In an attempt to gain a better insight into factors influencing the success or failure of predator introductions, and the effects of such introductions on existing fish populations, the Reservoir Committee, Southern Division, American Fisheries Society, undertook a two-year predator stocking evaluation (PSE). Field studies were conducted on selected reservoirs during 1972 and 1973 to obtain a data base for evaluating predator stocking and to obtain general information concerning predator-prey relations. An examination of the effect of environmental factors on the size and structure of reservoir fish populations is one facet of this evaluation.

Past analyses of large quantities of reservoir data have often dealt with information obtained by varying methods and also at widely different time intervals. In the PSE study, the cooperating agencies collected data concurrently and systematically from different areas to minimize sample variability and improve predictive value. The present report describes the environmental characteristics of PSE lakes in 1972-73 and the relations of various fish taxa to these environmental variables, and examines reasons for correlated interrelations. Because data were collected simultaneously in the different reservoirs in both years of the study, year-to-year variations in reservoirs were also examined.

METHODS AND MATERIALS

Twenty-six reservoirs from 9 of the 13 member states of the Southern Division, American Fisheries Society, were selected for study on the basis of previous or ongoing attempts to establish fisheries for striped bass, walleyes, or rainbow trout.

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[1] Basic data presented in this study were collected by participating State and Federal agencies as part of a Predator-Stocking-Evaluation (PSE). The study was conducted under the auspices of the Reservoir Committee, Southern Division, American Fisheries Society.

Cooperating agencies provided pertinent physicochemical and biological data in accordance with guidelines set forth by the Reservoir Committee; some pertinent physical and descriptive data were also obtained from the various reservoir-operating agencies. These included the following environmental variables.

(1) Area—mean annual surface area in acres.
(2) Mean depth—in feet.
(3) Outlet depth—midline depth of the principal outlet structure in feet.
(4) Shore development—the shoreline length divided by the circumference of a circle equal in area to that of the reservoir.
(5) Thermocline depth—in feet to the top of the thermocline in mid-August.
(6) Fluctuation—annual vertical water level fluctuation in feet.
(7) Growing season—number of frost-free days.
(8) Storage ratio—Average annual lake volume in acre-feet divided by total annual discharge in acre-feet.
(9) Outflow volume—total annual water outflow in thousands of acre-feet; or (where this information was not available) average volume in acre-feet divided by storage ratio and expressed as thousands of acre feet.
(10) Total dissolved solids—residue (ppm) after evaporation at 180 C.
(11) Reservoir age in years at time of sampling.

We computed total annual outflow to obtain an accurate estimate of year-to-year variation in the volume of water passing through a given impoundment.

Data on temperature, dissolved oxygen and conductance were collected at three stations corresponding to the general locations sampled for estimates of fish standing crop. Vertical profiles for each of the three variables were collected at intervals of 1 m in the region above the thermocline and at 3 m intervals below the thermocline when a thermocline was present, and at 3 m vertical intervals when the water was not stratified. In addition, Secchi disc transparencies were requested at each sampling time, and weekly estimates of lake elevations were also obtained. In many instances, participating agencies were unable to provide portions of these data. However, where data were available, they proved useful in permitting more accurate estimates of such variables as thermocline depth or in verifying estimates of dissolved solids.

We attempted to evaluate existing fish standing crops according to the role they might play in reservoir predator-prey dynamics, as well as from a taxonomic basis. We compared the following standing crop components to environmental variables: (1) total standing crop, (2) clupeids, (3) sunfishes, (4) black basses, (5) crappies, (6) catfishes, (7) carp and catostomids, and (8) fish less than 4.5 inches total length ("small fish") as an index of changes in abundance of small fish (potential prey for introduced predators). Adjusted fish standing crop data used in this analysis are those calculated by Grinstead et al. (1977) for the Predator-Stocking-Evaluation reservoirs. Simple correlations were computed to identify relations between environmental variables and these standing crop components. A stepdown multiple-regression procedure was then used to test combined relationships. In this procedure, an independent variable with the highest correlation coefficient is regressed on a selected dependent variable. A partial correlation is then computed and the next variable selected. This procedure permits elimination of highly interrelated independent variables (e.g., storage ratio and outflow volume). Logarithmic transformed data consistently yielded higher correlation coefficients, and all data were transformed to base 10 logarithms for correlation and regression calculations.

SAMPLE CHARACTERISTICS

Reservoirs included in the study exhibited a wide range of physicochemical characteristics (Tables 1 and 2). The largest reservoir in the sample was Bull Shoals Lake, Arkansas (53,515 acres in 1973), and the smallest was Lake Bastrop, Texas (906 acres). Average surface area for all reservoirs was 14,470 acres. The Predator-Stocking-Evaluation sample represented about 7.5% of the total surface area of reservoirs larger than 500 acres in the Southern Division states (National Reservoir Research Program 1976). Mean values of the physiochemical attributes were remarkably similar to those of a

Table 1. Selected physicochemical characteristics of 26 southeastern reservoirs included in the predator-stocking-evaluation (PSE) study, 1972-1973, the left number in each hyphenated pair refers to 1972 and the right to 1973. Where only one number is shown, the values for the two years are identical.

Reservoir	*Surface area (acres)*	*Mean depth (feet)*	*Outlet depth (feet)*	*Shore development*	*Thermocline depth (feet)*	*Water level fluctuation (feet)*
Jordan (Ala.)	5,800	41	96	11.0	NS	2-4
Mitchell (Ala.)	5,850	30	24	13.7	NS	2-3
Beaver (Ark.)	24,535-29,125	55-59	129-143	19.0-19.3	27-20	11-18
Bull Shoals (Ark.)	43,535-53,515	66-70	107-125	24.7-26.9	26-20	15-41
Greeson (Ark.)	6,110-6,700	38-42	50-54	11.2-11.4	23	15-25
Jackson (Ga.)	4,500	22	28	14.4	15-NS	5-3
Sinclair (Ga.)	14,000	21	47	25.2	21-NS	7-6
Deep Creek (Md.)	3,900	25	37	7.4	26-20	6-5
Barnett (Miss.)	32,800-33,000	11	40	4.2	NS	2
Enid (Miss.)	11,875-18,970	15-19	14-18	8.1-8.5	NS	15-36
Grenada (Miss.)	26,140-46,900	13-19	12-24	7.7-7.9	NS	19-30
Okatibbee (Miss.)	2,980-3,340	11	28-30	3.0	16	7-12
Sardis (Miss.)	27,600-46,520	17-24	21-38	6.0-9.0	NS	18-30
Badin (N.C.)	5,350	41	51	11.2	52-66	4-3
Gaston (N.C.)	20,300	22	50	17.5	NS-33	2-1
Canton (Okla.)	6,150-7,550	13-15	27-32	2.1-3.6	NS	4-11
Eucha (Okla.)	2,800-2,880	28	26	6.5	24-21	1
Keystone (Okla.)	28,000-32,000	26-25	32-36	11.5-12.0	39-49	7-33
Spavinaw (Okla.)	1,637	19	12	2.8	24-18	1
Cherokee (Tenn.)	21,960-22,600	45-43	100-98	14.9-14.7	37-36	37-44
Dale Hollow (Tenn.)	26,400-26,536	47-48	81-87	25.0-25.1	24-NS	11-15
Watauga (Tenn.)	6,070-6,030	84	159	9.3-9.1	27	20-19
Woods (Tenn.)	3,840-3,910	20	61-62	8.5	19-15	1-2
Bastrop (Tex.)	906	18	25	5.2	30	5
Cypress Springs (Tex.)	3,425	21	48	5.2	21	5
Spence (Tex.)	4,750-5,750	21-24	64-70	8.0	NS-40	10-3
Mean	14,470	30.2	54.4	11.1	—	11.2

NS = Thermocline unstable, or no thermocline formed.

much larger sample of 173 mostly southern reservoirs analyzed by Jenkins (1976). The Predator-Stocking-Evaluation reservoirs were considered representative of the broad range of southern impoundments.

Stream flows were highly variable in 1972-73 (Table 3). Rainfall in spring 1973 was unusually heavy over much of the study area, and flow-related environmental characteristics varied accordingly. Average surface area of the reservoirs increased 21%, total water outflow increased 54%, and storage ratios decreased 14%. Dissolved solids decreased 20%, apparently in response to the increased flows. These contrasts between years made some assessment of short-term effects of these factors on fish standing crops possible.

CORRELATION AND REGRESSION ANALYSIS

Correlation and multiple regression analyses were conducted on combined 1972 and 1973 data for 23 of the 26 Predator-Stocking-Evaluation reservoirs. To maintain comparability within the sample, we eliminated three lakes from further calculations—Woods because the fish crop was not sampled in 1973, Spavinaw and Eucha because they were sampled in October or November rather than August.

Table 2. Selected physicochemical characteristics of 26 southeastern reservoirs included in the predator-stocking-evaluation (PSE) study 1972-73, the left number in each hyphenated pair refers to 1972 and the right to 1973. Where only one number is shown, the values for the two years are identical.

Reservoir	*Growing season (days)*	*Storage ratio (years)*	*Annual outflow (acre-feet × 10^3)*	*Total dissolved solids (ppm)*	*Age (years)*
Jordan (Ala.)	238-230	.026-.020	9,146-11,890	83	44-45
Mitchell (Ala.)	228-213	.015	11,700	83	49-50
Beaver (Ark.)	194-209	2.09-0.73	645-2,354	120-80	8-9
Bull Shoals (Ark.)	194-208	1.06-0.45	2,737-8,325	150	21-22
Greeson (Ark.)	220-215	0.82-0.42	283-670	30	12-13
Jackson (Ga.)	210-214	0.08-0.06	1,238-1,650	55-50	61-62
Sinclair (Ga.)	220-215	0.13-0.10	2,262-2,940	48	20-21
Deep Creek (Md.)	166-149	0.73-0.85	134-115	35	48-49
Barnett (Miss.)	248-230	0.12-0.08	3,007-4,538	40	9-10
Enid (Miss.)	228-202	0.57-0.27	313-1,335	40-30	20-21
Grenada (Miss.)	259-213	0.41-0.25	829-3,564	40	18-19
Okatibbee (Miss.)	248-251	0.24-0.16	137-230	40	6-7
Sardis (Miss.)	198-209	0.50-0.37	938-3,018	35	32-33
Badin (N.C.)	193-205	0.03	7,133	50	55-56
Gaston (N.C.)	193-186	0.09	4,962	65	9-10
Canton (Okla.)	198-202	2.02-1.00	40-113	975-900	24-25
Eucha (Okla.)	200-208	.58-.16	135-504	110-100	20-21
Keystone (Okla.)	200-209	0.37-0.07	1,968-11,429	1,700-1,100	8-9
Spavinaw (Okla.)	220-200	0.22-0.06	141-518	115-100	49-50
Cherokee (Tenn.)	195-208	0.22	4,492-4,417	180	30-31
Dale Hollow (Tenn.)	190-200	0.86-0.79	1,443-1,623	138-65	29-30
Watauga (Tenn.)	175-150	0.91-0.79	560-641	80	23-24
Woods (Tenn.)	194-206	0.16-0.12	480-652	118-112	20-21
Bastrop (Tex.)	295-300	3.20-5.00	5-3	450	8-9
Cypress Springs (Tex.)	258-240	0.93-0.21	77-343	105	2-3
Spence (Tex.)	228-232	1.63-3.22	61-43	1,400-1,000	3-4
Mean	213	0.65	2,688	218.0	24.8

Table 3. Unweighted means and ranges, in parentheses, of selected environmental variables in PSE lakes in 1972 and 1973 and ratios of 1973 to 1972 means.

Characteristics	*1972* *Mean*	*1972* *Range*	*1973* *Mean*	*1973* *Range*	*Ratio 1973 to 1972 means*
Area (acres)	13,140	(906-43,950)	15,810	(906-53,515)	1.20
Mean depth (feet)	29.6	(11-84)	30.8	(11-84)	1.04
Outlet depth (feet)	52.7	(12-159)	56.2	(12-159)	1.07
Shore development	10.9	(2.1-25.2)	11.2	(2.8-26.9)	1.03
Growing season (days)	215.0	(166-295)	211.7	(146-300)	.98
Fluctuation (feet)	8.8	(1-37)	13.6	(1-44)	1.55
Dissolved solids (ppm)	241.7	(30-1700)	194.3	(30-1100)	.80
Age of reservoir (years)	24.3	(2-61)	25.3	(3-62)	—
Outflow volume (× 10^3 acre - ft.)	2110.2	(5-11,700)	3258.1	(3-11,890)	1.54
Storage ratio (years)	0.70	(.015-3.2)	0.60	(.015-5.0)	.87

Simple correlations between environmental variables and the eight selected components of the fish standing crop indicated that with the exception of reservoir age, all of the environmental characteristics tested were related to one or more standing crop component (Table 4). Flow-related variables (storage ratio [negative] and annual outflow volume [positive]) were significantly correlated with seven of the eight standing crop components tested. Surface area was positively correlated with clupeid, catfish, carp and catostomids, and total crop. Dissolved solids content was negatively correlated with crops of black bass, catfish, and carp and catostomids, and positively with small fish. Length of growing season was significantly correlated with crops of black bass and small fish. Mean depth, outlet depth, thermocline depth and fluctuation were each correlated with only one of the standing crop components tested.

Table 4. Logarithmic simple correlations between eleven environmental variables and standing crops (pounds per acre)—clupeid, sunfish, black bass, catfish, crappie, carp and catostomids, small fish, and total crop in 23 PSE lakes during 1972 and 1973.

	Dependent variable							
Independent variable	*Clupeid*	*Sunfish*	*Black Bass*	*Catfish*	*Crappie*	*Carp and Catostomids*	*Small fish*	*Total Crop*
Area	+0.43**	–	–	+0.42**	+	+0.38**	–	+0.30*
Mean depth	+	+	–	–	+	+0.42**	–	+
Outlet depth	+	+	–	–	–	+0.29*	+	+
Shore development	+	+0.33*	–	–	+	+0.43**	+	+
Growing season	+	+	+0.57**	–	+	–	+0.36*	+
Storage ratio	−0.43**	−0.41**	−0.38**	–	−0.34*	–	−0.41**	−0.53**
Thermocline depth	+	+0.33*	–	–	+	+	+	+
Fluctuation	+	–	–	+0.40**	–	+	–	+
Dissolved solids	+	–	−0.30*	−0.31*	–	−0.32*	+0.34*	+
Age	–	+	–	+	+	+	–	+
Outflow volume	+0.55**	+0.30*	+0.44**	+	+0.35*	+0.33*	+0.48**	+0.56**

*P = .05, r = .29, **P = .01, r = .38
[a] fish less than 4.5 inches total length

We used multiple regressions to further explore and quantify relations between environmental variables and each of the standing crop components (Table 5). As expected from the correlation analysis, combinations of water-flow-related variables accounted for a substantial portion of the variation in standing crops. Regressions involving combinations of flow-related variables, growing season, and/or dissolved solids were consistently produced. The multiple regressions selected explained from 41 to 67% of the variation in standing crop components, and all combinations of variables produced highly significant relations (P>.0001).

YEARLY VARIATIONS

The consistently high correlation between water-flow-related variables and standing crop components and their importance in multiple regression expressions prompted further examination of these relations. Plotting of ratios of 1973 to 1972 annual water outflows (Fig. 1) revealed that total flow of water through reservoirs in 1973 was at least

Table 5. Multiple regression equations relating the total crop and certain of its components to various environmental variables in the PSE reservoirs. Only the most significant regressions are included. The symbol R^2, the coefficient of determination, indicates the percentage of variability in each dependent variable explained by the listed combinations of independent variables. The significance level is the chance of obtaining an R^2 as large or larger by chance when the hypothesis of no correlation is true. All values are base 10 logarithmic expressions.

Dependent variable	*Constant for simplified model*	*Regression coefficient*	*Independent variable*	R^2	*Probability of a larger* R^2
Clupeid crop	− .8266	+ .5927	Outflow	0.67	4.9×10^{-9}
		− .7063	Shore development		
		− .4407	Age		
		+ .2650	Dissolved solids		
Sunfish crop	−6.0970	− .4235	Storage ratio	0.46	.00001
		+ .0108	Fluctuation		
		+ .7368	Outlet depth		
		+2.6409	Growing season		
Black bass crop	−7.0952	+3.5869	Growing season	0.58	2.4×10^{-7}
		− .2355	Dissolved solids		
		+ .3387	Outlet depth		
		− .1410	Storage ratio		
Crappie crop	1.9851	1.3707	Area	0.46	.00001
		−1.7838	Shore development		
		− .5903	Dissolved solids		
Carp and Catostomids	−4.0775	+ .6911	Dissolved solids	0.41	.0001
		+ .7768	Outflow		
		+ .5844	Storage ratio		
Small fish crop[1]	−4.4515	+ .2010	Outflow	0.46	.00001
		+ .3107	Dissolved solids		
		+1.9648	Growing season		
Total standing crop	1.5143	+ .2513	Outflow	0.52	3.2×10^{-6}
		+1.0861	Growing season		
		+ .1461	Dissolved solids		
		− .1892	Shore development		

[1] Less than 4.5 inches long

twice that in 1972 in an area from central Texas through west-central Oklahoma eastward to central Mississippi and Tennessee. East and west of this area, differences between years were less pronounced.

We subdivided the Predator-Stocking-Evaluation sample on the basis of (1) ratios of 1973 to 1972 annual outflow to compare year-to-year variations and (2) storage ratios of less or more than 0.165 to make comparisons based on inherently different flow-through rates (Table 6). The sample was first divided on the basis of whether annual releases in 1973 were (1) 1.5 times (or more) greater than those of 1972, or (2) less than 1.5 times greater than those of 1972. Standing crop components between the two groups were compared as ratios of 1973 to 1972 unweighted standing crops and components computed for each category.

Reservoirs with relative outflows in 1973 more than 1.5 times those of 1972 showed marked increases in total standing crop (22%) in 1973 (Table 7). Crops of clupeids, sunfish, catfish, and carps and catostomids increased substantially, and crops of small fish increased about 150% which suggested strong recruitment in these reservoirs. With the exception of crappie, standing crop components were more stable in reservoirs which

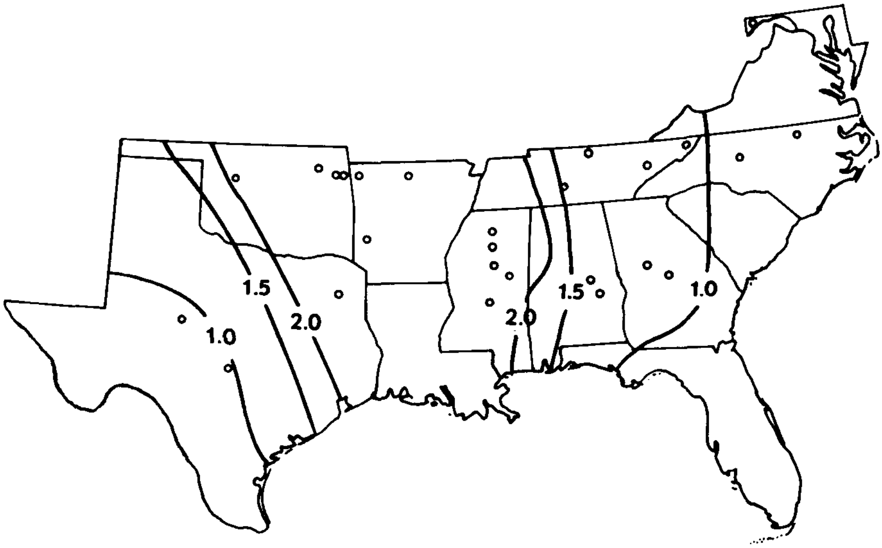

Figure 1. Geographical areas in which total outflow from predator-stocking-evaluation lakes in 1973 was 2 times, 1.5 times, and about equal to total outflow in 1972. Open circles indicate location of the PSE reservoirs.

Table 6. Classification of PSE reservoirs on the basis of (1) ratios of 1973 to 1972 annual releases < 1.5:1 and ⩾ 1.5:1, and (2) major use type, mainstream (M; storage ratio < .165 or storage (S; storage ratio ⩾ .165).

1973 water releases < 1.5 × 1972			*1973 water releases ⩾ 1.5 × 1972*		
Reservoir	*1973/1972 Ratio*	*Type*	*Reservoir*	*1973/1972 Ratio*	*Type*
Jordan	1.3	M	Beaver	3.6	S
Mitchell	1.0	M	Bull Shoals	3.5	S
Jackson	1.3	M	Greeson	2.4	S
Sinclair	1.3	M	Barnett	1.5	M
Deep Creek	0.9	S	Enid	4.3	S
Badin	1.0	M	Grenada	4.3	S
Gaston	1.0	M	Okatibbee	1.7	S
Cherokee	1.0	S	Sardis	3.2	S
Dale Hollow	1.1	S	Canton	2.8	S
Watauga	1.1	S	Keystone	5.8	M
Bastrop	0.6	S	Cypress Springs	4.5	S
Spence	0.7	S			

exhibited less variation in outflow between 1972 and 1973. Responses of individual reservoirs were highly variable which suggested that other environmental and biological characteristics not quantified in these analyses were also very important.

Similar treatment of mainstream reservoirs (storage ratio less than 0.165), and storage reservoirs (storage ratio greater than 0.165) indicated that total, clupeid, and sunfish and catfish crops were consistently higher in mainstream impoundments (Table 8). Relative variations between 1972 and 1973 for all standing crop components tested were much

Table 7. Average total standing crops (pounds per acre) and selected components of the total crops in 12 PSE lakes where 1973 water releases were less than 1.5 times those of 1972, and in 11 where 1973 releases were equal to or greater than 1.5 times those of 1972. Standing crops in each category were compared as ratios of 1973 to 1972 standing crop values in each category.

	1973 release < 1.5 × 1972			*1973 releases ⩾ 1.5 × 1972*		
Standing crop	*1972*	*1973*	*Ratio*	*1972*	*1973*	*Ratio*
Clupeids	109	128	1.17	131	168	1.28
Sunfish	115	108	0.94	40	59	1.48
Black bass	32	34	1.06	26	30	1.15
Crappie	4	11	2.75	32	32	1.00
Catfish	44	42	0.95	28	40	1.43
Carp & Catostomids	95	87	0.92	78	108	1.38
Small fish[1]	91	83	0.91	61	151	2.48
Total	450	470	1.04	396	485	1.22

[1] Less than 4.5 inches long.

Table 8. Average total standing crop (pounds per acre) and selected components of total crop in 8 mainstream reservoirs (storage ratio less than .165) and 15 storage reservoirs (storage ratio more than .165), and comparison of standing crop components between years expressed as ratios of 1973 to 1972 crop.

	Mainstream			*Storage*		
Standing crop	*1972*	*1973*	*Ratio*	*1972*	*1973*	*Ratio*
Clupeids	206	193	.94	93	149	1.60
Sunfish	149	127	.85	43	62	1.44
Black bass	40	34	.85	23	30	1.30
Crappie	13	12	.93	15	26	1.73
Catfish	62	58	.94	40	59	1.48
Carp & Catostomids	98	76	.78	81	105	1.30
Small fish[1]	128	158	1.23	51	92	1.80
Total crop	630	539	.86	314	445	1.42

[1] less than 4.5 inches long

greater in storage impoundments. This suggested a much greater overall response of fish populations in storage reservoirs to the high rainfall of 1973.

Attempts to relate vertical water level fluctuations to differences in standing crop components between 1972 and 1973 were inconclusive. Eight of the 11 reservoirs in which 1973 outflows were equal to or more than 1.5 times those of 1972 had much higher spring and early summer pool elevations in 1973 (April-July average = +16.6 feet). Six of these impoundments showed marked increases in both total and small-fish standing crops, and two showed little variation. The 12 reservoirs with outflows in 1973 less than 1.5 times those of 1972 had essentially stable pool levels throughout the study period.

DISCUSSION

Unusually heavy rainfall over much of the study area in 1973 influenced relations between environmental variables and fish standing crops in Predator-Stocking-Evaluation lakes. Of the 11 environmental variables tested, storage ratio, outflow volume, growing season, and dissolved solids were consistently related to fish standing crop components. Except for growing season, these variables were influenced by the high 1973 inflows. Relative to geographical variation, annual variation in length of growing season changes little from year-to-year. This variable is important in setting broad limits on fish production in southern reservoirs (Jenkins 1974), but it is one which probably exerts only minor year-to-year effects in a given location.

Annual fluctuations in the total quantity of water entering a reservoir and its turnover rate were important to fish production in the PSE lakes. Jenkins (1976) found that differences in storage ratio explained a large portion of standing crop variation in 20 Oklahoma impoundments. He also found substantial differences in standing crops between hydropower mainstream (storage ratio less than 0.165) and hydropower storage reservoirs with similar nutrient levels—apparently a direct result of differences in storage ratio (Jenkins 1974).

In the present study, the mainstream impoundments with high rates of flow-through (storage ratio less than 0.165) had larger mean total crops, clupeid crops, sunfish crops and crops of small fish, and exhibited less year to year variation in fish crops than did storage impoundments which had low flow-through rates. Most storage lakes which experienced large increases in total outflow in 1973 showed marked increases in crops of small fish, clupeids and sunfish. The increases in biomass included substantial short-term restructuring of fish communities in these impoundments. During periods of high inflow, as in 1973, storage lakes may become similar to mainstream impoundments in physical characteristics and fish standing crops. The recent evaluation of striped bass introductions in southern impoundments, conducted by the Striped Bass Committee (Bailey 1975), tends to support these observations. Bailey reported that stocking of fingerling striped bass was about 80% successful in mainstream reservoirs, but only about 55% successful in storage impoundments. These relationships illustrate the need for management biologists to frequently reexamine reservoirs when considering predator introductions or continued predator stocking.

Large correlation coefficients were indicated between total fish standing crop and both total quantity of water released and storage ratio. Content of dissolved solids was not as highly correlated. The positive influence of dissolved solids on fish production has been well demonstrated (e.g., Ryder 1965 and Jenkins 1968). However, in considering the effect in a given body of water, on a year-to-year basis, the total quantity of nutrients passing through that body of water may be of greater importance to fish production than the concentration of nutrients per unit volume. This was reflected in a number of Predator-Stocking-Evaluation reservoirs where the concentration of total dissolved solids decreased with greatly increased 1973 inflows, while total fish standing crops increased markedly. Large annual variations in volumes of water passing through Predator-Stocking-Evaluation lakes suggest that total quantities of detritus entering these impoundments can vary greatly from year to year, and may be an important nutrient influence on fish production.

During 1973, flooded shoreline vegetation in many fluctuating reservoirs was an added source of detritus. Responses of fish stocks to these increased water levels in Predator-Stocking-Evaluation reservoirs, although generally positive, were highly variable, and effects of fluctuation could not be quantified.

Combinations of environmental variables generally accounted for about one-half the variation in fish standing crop components tested. Coefficients of determination were variable and indicated that responses of different taxa to selected environmental factors were not the same. The relations were highly significant, however. The multiple regression expressions presented in this report describe the relations of combined environmental variables to fish standing crops, but because they were collected over a short time interval and under unusual inflow conditions, they should be used cautiously for predictive purposes.

Reservoirs selected for the Predator-Stocking-Evaluation study were representative of the major types of southern impoundments, but small sample size and the shortness of the sampling period placed serious constraints on data interpretation. Long-term sampling of a small number of reservoirs under the sampling design set forth in the Predator-Stocking-Evaluation study could be valuable in developing hypotheses about variability in reservoir fish populations. Collection of data over five or more years from each of the Predator-Stocking-Evaluation reservoirs should permit quantification of other important environmental relations that may have been masked by the extreme dominance of flow-related variables in the present study. Combining these data with predator-prey relations as presented by Jenkins and Morais (1977) should offer further insight into effects of predator stocking on reservoir fish populations.

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