EFFECT OF STRIPED BASS PREDATION ON AN OKLAHOMA TROUT FISHERY

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Abstract: A creel survey was conducted on the lower Illinois River, Oklahoma, during 1977. Striped bass (*Morone saxatilis*) were also collected for food habit information and their relative abundance was noted. Striped bass predation on rainbow trout (*Salmo gairdneri*) occurred only at the downstream sampling site and only for the 1-week period following trout stocking. Trout made up 40% of the food items of these striped bass within 1 week after trout stocking. The trout fishery of the lower Illinois River has declined in overall intensity since 1965, particularly in the downstream reaches. However, the warm-water fishery, particularly for striped bass, has increased dramatically.

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Tenkiller Ferry Reservoir was impounded in 1952 for the dual purposes of flood control and hydroelectric power generation. A put-and-take trout fishery was established in the Illinois River tailwaters of Tenkiller Reservoir in 1965 and this fishery continues today.

Approximately 85,000 catchable-size rainbow trout were transported during 1977 from federal hatcheries in Arkansas and stocked into the 17 km of the Illinois River between Tenkiller Ferry Dam and the old Highway 64 bridge. The area is located in Sequoyah County in eastern Oklahoma about 54 km from the city of Tahlequah. The underspill outlet from Tenkiller Ferry Dam allows the water temperature in the river to remain consistently below 22C (Finnell 1953), however, this underspill outlet creates problems during late summer and fall when deoxygenated hypolimnetic water is released during hydroelectric generating periods. This problem is aggravated by the non-turbulent flow created by the predominantly fine gravel substrate of the Illinois River. Finnell (1953) and Summers (1954) have provided information on water quality of the lower Illinois River, particularly with regard to trout survival. Recent water quality information is also available (Deppert 1978).

Striped bass were first stocked in Keystone Reservoir, an impoundment of the Arkansas River, in 1965. At that time, Keystone was the first impoundment upstream from the confluence of the Illinois River. Some of these fish apparently escaped through the dam (Erickson 1972) and by 1972 striped bass began to enter the creel below Tenkiller Dam. By 1977 reports of predation by large striped bass on stocked trout in the lower Illinois River had become so common that a study to determine the extent of the problem was initiated.

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MATERIALS AND METHODS

All sampling took place at the 3 trout stocking sites along the lower Illinois River (Fig. 1). Site 1 consisted of the area immediately below the Tenkiller Ferry Dam. There is a public access site managed by the U.S. Army Corps of Engineers at this location. Site 2 consisted of an area approximately midway betwen the Highway 64 bridge and Tenkiller Ferry Dam. the stream in this area is under private ownership, although public access is allowed for a modest daily fee. The Gore Landing Public Access site maintained by the U.S. Army corps of Engineers was the third site sampled. This site is approximately 0.8 km upstream from the Highway 64 bridge at the downstream end of the sampling area.

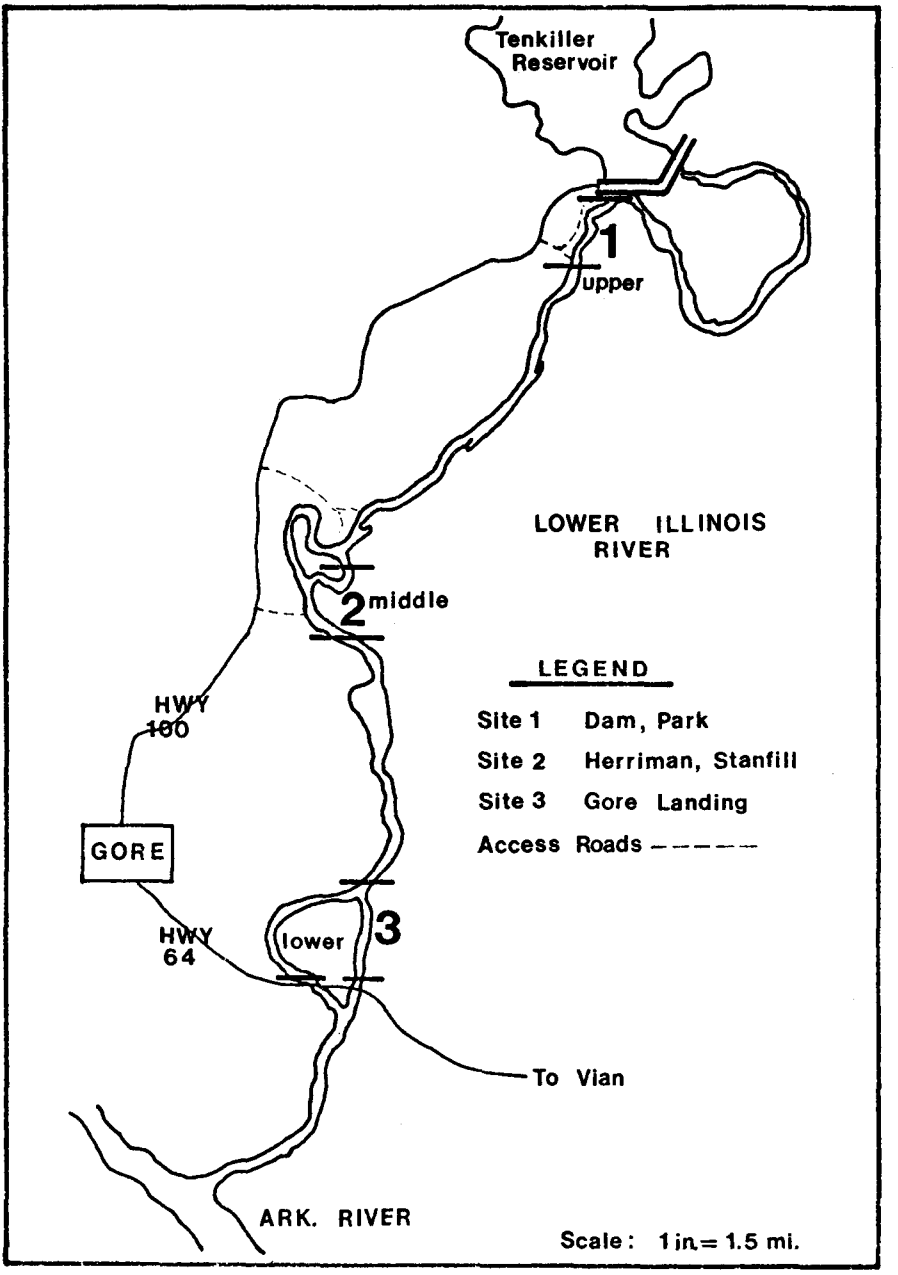

Fig. 1. Lower Illinois River sampling sites.

Field sampling procedures included a creel survey to determine catch rates and harvest for both striped bass and rainbow trout. Trammel nets, gill nets and a boom-type AC electroshocker were used in attempts to capture striped bass for both food habit and relative abundance information. Striped bass stomachs were also obtained for food habit analysis from fishermen interviewed during the creel survey. The creel survey sampling effort was stratified by site, month, day of the week and by angling mode, i.e. from the bank or boat. Stratifications of these types produce more accurate data at less cost (Carlander et al. 1958; DiCostanzo 1956; Best and Boles 1956).

During each month, March 1977 through February 1978, 3 weekdays and 2 weekend days were randomly selected. This resulted in a total of 60 sampling dates and with the addition of holidays, the number of days creeled totaled 64.

Each sampling day was divided into six 2-hour blocks - 3 in the morning and 3 in the afternoon. Each of the 3 sampling sites were then assigned a randomly selected, 2-hour daylight time period for both the morning and afternoon.

A creel census using only completed trips was not feasible because of economic limitations, so fishermen were interviewed at various stages of their fishing trips. This type of survey has been called an incomplete creel survey and DiCostanzo (1956) found that differences in fishing success were insignificant where data from incompleted trips were compared with data from the same trips at their completion.

During this creel survey, a pressure count was conducted at each of the 3 survey sites, once during the morning segment and once during the afternoon. Each count was treated as though it were instantaneous regardless of the time required. Total fishing pressure for a given stratum was determined by the formula:

$$\frac{N_i}{C_i} \times H = X$$

where N_i = Total fishermen counted in ith stratum,
C_i = Number of counts made during ith stratum,
H = Number of hours available for fishing (as determined from solar tables),
and X_i = Total estimated man-hours fished during ith stratum.

Automatic car counters have been used to estimate fishing pressure (Carlander et al. 1958) and were employed in this study as an alternate method of determining fishing pressure. The method used followed Houser and Heard (1957). Traffic counters were placed at all access points along the river and occupants of vehicles were interviewed at randomly selected times to determine the percentage of fishermen in the vehicles being counted. the estimated man-hours fished could then be calculated using the formula:

$$VPFT = X$$

where V = Total vehicles counted,
P = Percent of vehicles containing fishermen,
F = Mean number of fishermen per vehicle,
T = Mean completed trip length (hours),
and X = Estimated man-hours fished.

The variance of these pressure estimates was determined by the formula:

$$S_p^2 = \frac{\sum Y_i^2 - \frac{(\sum Y_i)^2}{n}}{n-1}$$

where Y_i = Number of fishermen observed during a pressure count, i,
n = Number of counts,
and S^2_P = Variance of the fishing pressure.

Two methods are available for determining the catch per unit of effort (CPUE), as defined by Lambou (1966). One of these methods, the mean-of-the-ratios method was chosen by Tait (1953). This method represents the mean of all individual catch rates of each fisherman regardless of the length of time he has fished. Lambou (1966) suggested that this method not be used, as it is not a good measure of angling quality. The other method, and the one used in the present study for determining CPUE, is termed the ratio-of-the-totals. Using this method, the total recorded catch is divided by the total units of effort, i.e. hours fished by all fishermen interviewed. The variances of these estimates were then calculated from the formula used by DiCostanzo (1956):

$$S_R^2 = \frac{\sum Y_i^2 + (\hat{R})^2 \sum X_i^2 - 2(\hat{R}) \sum X_i Y_i}{\frac{\sum X_i^2}{n} \quad (n-1)}$$

where Y_i = Number of fish caught during interview i,
X_i = Number of hours fished during interview i,
$R = \frac{\sum Y_i}{\sum X_i}$ = catch rate or number of fish per hour,
and n = Number of interviews.

The estimate of total harvest for each stratum in this study was derived from the formula used by Lambou and Stearn (1959):

$$A_i = \frac{C_i E_i}{F_i}$$

where A_i = Total fish caught within the ith stratum,
C_i = Total fish checked within the ith stratum,
E_i = Total estimated man-hours fished within the ith stratum,
and F_i = Total man-hours of fishing checked within the ith stratum.

The standard error of the harvest was calculated using the formula used by Summers (1978):

$$S_{\bar{X}3} = \bar{X}_2 \sqrt{\frac{(100\, S_{\bar{X}_1})^2 + (100\, S_{\bar{X}_2})^2}{\bar{X}_1 \qquad \hat{R}} \over 100}$$

where $S_{\bar{X}1}$ = Standard error of pressure,
$S_{\bar{X}2}$ = Standard error of success,
$\bar{X}_1$ = Pressure (fishermen/hr),
R=Catch rate (number or KG/hr),
$\bar{X}_2$ = Harvest (number or KG),
and $S_{\bar{X}3}$ = Sandard error of harvest.

Striped bass were collected to determine both their food habits and their relative abundance at each of the 3 sampling stations. Attempts were made to capture striped bass with both electrofishing gear and trammel nets. Extensive clogging of the nets with filamentous algae and floating debris hampered their capture efficiency, and several nets were washed ashore during water release periods. For these reasons, the use of trammel nets was discontinued after April 1977.

The boom-type electrofishing boat used for this study consisted of a single phase 3000 watt, AC generator; a Coffelt Electronics variable voltage pulsator (VVP); and 2 booms

with steel cable electrodes. The conductivity of the water varied from 18-24 umhos/cm and 450-500 V were necessary to successfully take fish.

Electrofishing samples were taken at each of the 3 sampling sites at least once monthly, May 1977 through March 1978. Sites 1 and 2 were able to be electrofished only during water release periods. Site 3, however, could be, and was sampled prior to water release. One hour after initiation of water release, site 1 was sampled, followed in succession by site 2 and then site 3 once again, this time during high flow conditions. Each sample consisted of 50 minutes of electrofishing. Striped bass were counted, weighed, measured and stomachs were taken for food habits analysis.

To determine the food habits of striped bass and the extent of their predation on stocked rainbow trout, stomach samples were collected from fishermen's catch during regularly scheduled creel survey days, from electrofishing samples and from local bait dealers. Stomachs were wrapped in cheesecloth and preserved in 10% formalin solution. Food contents were classified by type, enumerated and their volume measured to determine the percent by both number and volume of each food item.

RESULTS

Creel Survey

The total man-hours of fishing as shown by pressure and traffic counts at the 3 access sites on the lower Illinois River are shown in Table 1. Estimates derived from the 2

TABLE 1. Annual fishing pressure on the lower Illinois River estimated by two methods during 1977-78.

	Site 1		Site 2		Site 3	
	Pressure count	Traffic count	Pressure count	Traffic count	Pressure count	Traffic count
Shoreline fishermen Pressure (man-hours)	25,619	30,028	31,137	32,924	18,543	21,814
Confidence limits (P=0.95)	±6,882	-	±8,960	-	±5,579	-
Boat fishermen Pressure (man-hours)	0	-	0	-	55,383	-

methods were reasonably similar, and it appears that annual fishing pressure was higher at sites 1 and 2 than at site 3. Trout made up the majority of the catch at sites 1 and 2 also, but only a small proportion of the catch at site 3 (Fig. 2).

The catch rate and total trout harvested were both greater at sampling site 2 than at sites 1 or 3 (Table 2). The percentage return of stocked trout was considerably higher at both sites 1 and 2 than at site 3.

During 1977-78, the lower Illinois River trout fishery provided an estimated 75,299 man-hours of recreation. Overall, 41% of the bank fishermen were successful in catching at least one trout, and 62% of the stocked trout reached the creel. The overall trout catch rate for the Illinois River was 0.66 trout per man-hour of bank fishing during the 1977-78 season.

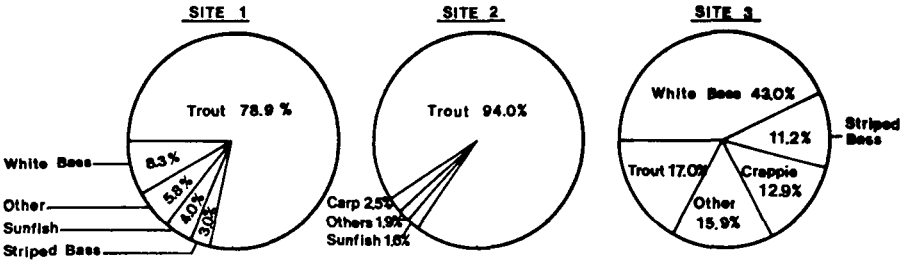

Fig. 2. Species composition of the catch at 3 sites on the lower Illinois River, 1977-78.

TABLE 2. Estimates of creel survey parameters for the Illinois River trout fishery, 1977-78. (Numbers in parentheses represent 95% confidence limits).

	Site 1	Site 2	Site 3	Combined
Trout stocked	19,100	40,400	23,100	80,100
Trout harvested	9,573	34,986	4,862	49,422
	(±1,080)	(±2,100)	(±415)	(±3,557)
Percent return	50.1	86.6	21.0	61.7
Catch per unit of effort (trout/h)	0.384 (±0.046)	1.124 (±0.059)	0.262 (±0.044)	0.656 (±0.032)

Boat fishermen were present only at site 3 and their estimated total annual harvest of trout was only 166 fish. Only 7% of boat fishermen interviewed were fishing for trout; the majority of boat fishermen (65%) were fishing for striped bass. In contrast, only 1% of bank fishermen were fishing for striped bass. Boat fishermen spent an estimated total of 55,383 hours fishing, caught approximately one striped bass for every ten man-hours of fishing effort and harvested an estimated total of 5,178 striped bass.

Striped Bass Distribution

Striped bass were not present in the lower Illinois River during the months January through April (Fig. 3). From June through August striped bass were present at all 3 sampling sites, but they were present at site 3 from May through December. The month of July produced the highest fisherman and electrofishing catch rate for striped bass. In all months except May and June the electrofishing catch rate for striped bass was greater at site 3 than for the other 2 sites combined, and striped bass exceeding 1 kg in weight were never caught at sites 1 or 2.

During the summer there was a tendency for striped bass to move in and out of the study area in relation to the volume of flow. The catch rate of striped bass taken by electrofishing at site 3 was positively correlated with the flow rate of the river and the linear correlation coefficient of 0.879 (df 1,12) was significant at the .05 level. A total of 118 striped bass was collected by electrofishing at site 3 during water release periods, while only 19 striped bass were collected during periods of low flow.

Striped Bass Food Habits

Trout were taken only from stomach samples of striped bass collected at sampling site 3. A total of 111 striped bass stomachs were examined and 22 trout were found. There were no trout found in striped bass smaller than 5.0 kg. All striped bass found to have consumed trout were collected within 1 week after trout stocking. Indeed, 40% of the food

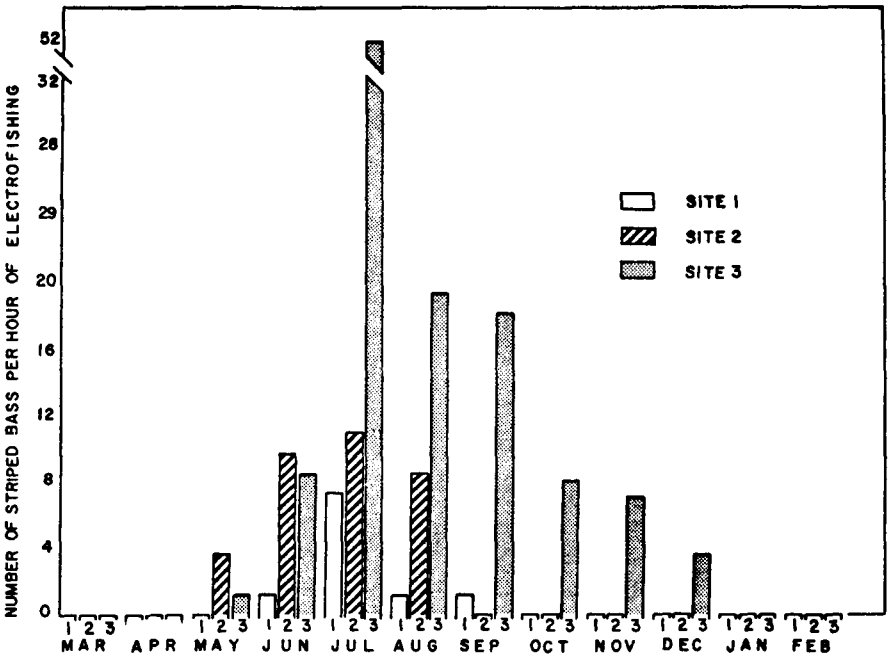

Fig 3. Relative abundance of striped bass at 3 sites along the lower Illinois River, 1977-78.

items examined from striped bass collected within 1 week after trout stocking were trout (Fig. 4). By volume, trout made up 64% of the striped bass stomach contents. In contrast, gizzard shad made up 56% by number of the diet of striped bass within 1 week after trout stocking and 75% at other times.

Striped bass were observed feeding on newly stocked trout on 25 August and 16 November 1977 at site 3. The trout, after being stocked, would congregate near the surface toward the middle of the river and the bass would either take them from the surface or drive them to the shoreline.

DISCUSSION

There have been several changes in the characteristics of the Illinois River trout fishery since the 1965 creel survey by Hicks (1966). While the average length of a fishing trip has remained constant, total estimated annual trout fishing pressure has decreased almost 67% and the trout stocking rate has decreased 38%. Approximately 67% of the trout stocked in 1965 were ultimately harvested, while 62% were harvested in 1977. In 1965 less than 3% of the total fishing pressure on the lower Illinois River consisted of boat fishing; in 1977, approximately 42% of all fishing was done from boats, and almost 93% of these boat fishermen were fishing for warm-water species.

These changes are undoubtedly the result of man-caused environmental changes to the Arkansas River system which includes the Illinois River as a tributary. These changes are a result of the development of the Arkansas River Navigation system and the construction of Robert S. Kerr Reservoir in 1970. The completion of this mainstream reservoir immediately downstream from the confluence of the Illinois River has created an essentially lentic condition below and just upstream from the highway 64 bridge

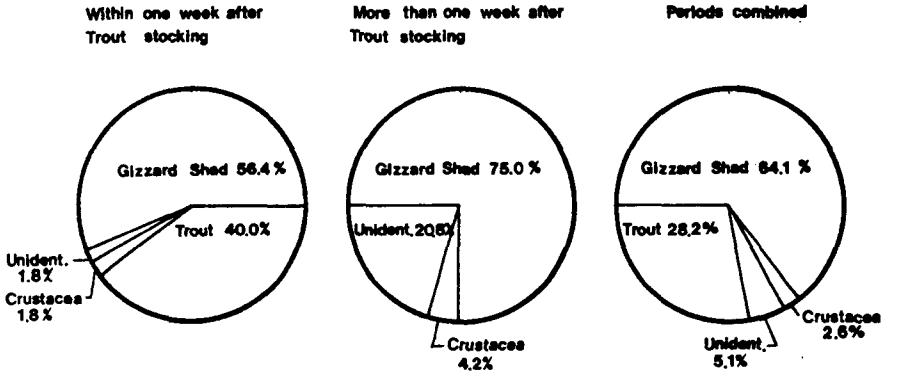

Fig. 4. Percent by number of food items taken from striped bass larger than 5.0 kg at site 3 on the lower Illinois River during 1977-78.

crossing the lower Illinois River. The portion of the Illinois River downstream from this bridge was thereby changed from a primarily cold-water fishery to a warm-water fishery as evidenced by the ODWC's redesignation of the area as non-trout water in 1976.

Striped bass were first stocked in the Arkansas River system in 1965 and have recently become periodically abundant in the lower portions of the Illinois River up to the Gore Landing area (site 3), particularly during high-flows in the summer and fall. Indeed, fully 50% of the annual fishing effort in this area is directed at striped bass.

It is felt that many of the changes in the Illinois River trout fishery between 1965 and 1977 are the result of the environmental changes that have occurred at the Gore Landing area (site 3) and the adaptation of striped bass to these changed conditions. The reduced return rate for stocked trout in the Illinois River as a whole (62% in 1977 as opposed to 67% in 1965) can be directly traced to the low return rate at site 3 (21% as opposed to an overall return rate of 75% for sites 1 and 2). This low return rate for trout stocked at site 3 can be directly attributed to the appearance of striped bass as a trout predator in this portion of the river.

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