and at about the size that striped bass would have been attractive to fishermen, 12 inches and larger.

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OBSERVATIONS ON THE STRIPED BASS, *MORONE SAXATILIS*, IN KEYSTONE RESERVOIR, OKLAHOMA

by

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ABSTRACT

The Oklahoma Department of Wildlife Conservation initiated a program to establish striped bass in Keystone Reservoir in 1965. During the period 1965 to 1969, approximately 2.75 million striped bass ranging from fry to adults have been stocked.

A program to determine if a spawning population of striped bass had developed was started in March 1969. The search for natural reproduction utilized egg sampling, meter netting, shoreline shocking, and shoreline seining methods. Natural reproduction was not found in 1969.

A gill net survey of the striped bass population was conducted from October through December 1969. Thirty individuals ranging in size from 0.9 to 8.9 pounds were taken. Females accounted for 80 percent of the catch with the larger individuals carrying mature ovaries. Age and growth determinations were made on these fish plus 20 others. First year growth was calculated at 10.2 inches, second year at 17.9 inches, third year at 21.3 inches, and fourth year at 23.9 inches.

Egg sampling survey was repeated in 1970. Striped bass eggs were not identified from those taken. However, on June 18, the first six striped bass identified as natural reproduction were taken by shoreline seining. Primary spawning activity appeared to have taken place in the Arkansas River. Early survey results were negative in the Cimarron River. Using data collected in 1969, from seining rates and known stocking rates as an extrapolation base, the

1970 fingerling survival was calculated at 1.45 million minimum from data taken June 20 to June 25.

Early observations on distributional patterns and growth rates of the fingerling striped bass are presented.

INTRODUCTION

In 1965, the Oklahoma Department of Wildlife Conservation initiated a program to establish striped bass *(Morone saxatilis)* in Oklahoma. Keystone Reservoir, located approximately 20 miles west of Tulsa in the northeastern section of the state, was selected to receive part of the first striped bass obtained.

Keystone Reservoir, constructed by the U. S. Army Corps of Engineers, covers 26,300 surface acres at the top of the power pool. It impounds the often turbid Cimarron and Arkansas Rivers. The reservoir receives runoff from a total drainage area of 74,506 square miles. The impoundment was created for flood control, hydroelectric power and navigational purposes and was filled to pool level by February 1965.

"Data collected by the U. S. Army Corps of Engineers about 7 miles below the confluence of the Arkansas and Cimarron rivers reveal: Dissolved solids Max. 10,900 ppm, Min. *682* ppm (weighted average *9500* tons per day); Ca. *125* ppm; Mg. *33* ppm; Na. 827 ppm; Bicarbonate 156 ppm; Sulfates 174 ppm; Chlorides 1370 ppm; pH *7.4 - 8.4*. The yearly weighted average of water discharge is 1,280 cu. ft. per second (U. S. Geological Survey, 1953-1954).

Approximately 2.75 million striped bass have been stocked in Keystone during the period from 1965 to 1969. Sources and sizes of these fish varied. Most were obtained as fry from South Carolina, with others coming from North Carolina and Virginia. Adults were obtained from North Carolina, yearlings from California and fingerlings from Oklahoma fish hatcheries which were reared from fry secured from the above states.

The investigation into the success of the Keystone stockings was launched in March 1969. This project was financed in part by Dingell-Johnson funds (F-29-R). The basic objective was to determine if a spawning population of striped bass had developed in Keystone Reservoir. Field survey methods involved egg sampling, meter netting, electroshocking and shoreline seining. The mature population was surveyed using gill net sampling. Data collections from 1969 are reported in entirety, but only the 1970 egg sampling and early shoreline seining results are covered since data collections continue.

MATERIALS AND METHODS

A systematic method of egg sampling was used to determine if striped bass spawning had occurred in the tributary streams of Keystone Reservoir. Egg sampling was initiated when the water temperature in the lower areas of each river entering the reservoir stabilized at 60 degrees for several days. At one principal location on each of the two rivers, half-meter or 10-inch nets, 32 meshes per inch, were utilized. The net construction followed the design used by May and Fuller (1962). An effort was made to take the sample from the deepest, swiftest section of the stream, utilizing bridges as a base of operations. Primary sampling stations were Blackburn Bridge on the Arkansas River and Silver City Bridge on the Cimarron River. Each site was sampled a minimum of one each 24 hours, except in periods of extreme high water when detritus made sampling impossible. Sampling was continued until water temperatures remained above 75 degrees. Single and simultaneous samples from approximately 6 to 60 minutes in duration were used depending on river conditions. Only surface samples were used. Additional sites both upstream and downstream of the primary points were used as time permitted.

Automatic egg collection devices similar to those designed by Baker (unpublished) were operated in the Arkansas River sites as water conditions allowed. These devices were checked a minimum of once each day.

Meter net samples were taken to determine the presence of larval striped bass in the tributary streams of Keystone Reservoir. Meter and half-meter nets were used in the headwaters of the reservoir 2 to 3 weeks after the initiation of egg sampling. Sampling frequency was on a 1 to 2 days per week basis and lasted from 6 to 8 weeks. Actual sampling time was generally around 30 minutes with the remainder of the sampling day used to identify specimens. Publications by Mansueti (1958) and May and Gasaway (1967) were used as guides to identify larval fishes.

Shoreline seining was one of the methods used to determine the presence of striped bass fingerlings in the reservoir. Seining effort to reveal natural reproduction was conducted during the last week of May and the first week of June. Fingerling striped bass were first stocked in the reservoir during early June. Sampling effort past that date was directed at collecting information on the habits of the young-of-year striped bass. This effort extended until September. Both day and night samples with 20- and 40-foot drag seines were used. Several sites on each arm of the reservoir were sampled.

A rotenone sample was scheduled but not conducted as sufficient numbers of young striped bass were taken by seining methods.

Shoreline shocking was conducted briefly prior to stocking to obtain information on reproduction and the general striped bass population.

Gill net sampling was conducted during the period September 1 to December 31. Emphasis was placed on the use of nets with sizes between 2- and 4½-inch bar measure to determine if a mature striped bass population had developed in the reservoir. Floating, mid-water, and submerged sets were used to provide information on habits of adults. The primary area of sampling was the main pool of the reservoir, but other locations in the arms of the lake were sampled. General population data were taken in addition to specific life history data on the striped bass.

In 1970, egg sampling was restricted to the use of 10- and 18-inch nets. A more intensive effort was expended during the basic procedures outlined above. The tailwaters of Keystone Dam were added to the sampling schedule.

Meter net sampling was eliminated as a method of obtaining larval striped bass.

Shoreline seining was designated as the basic method for obtaining fingerling striped bass.

RESULTS AND DISCUSSION

1969 Egg Sampling

The survey to find striped bass eggs in the tributary streams of Keystone Reservoir was initiated on April 3, 1969, when the water temperature rose above 60 degrees, daytime high, for several preceding days. Ten-inch and half-meter nets scaled on the meter net pattern were the principal sampling gear. Automatic egg samplers were also used in the Arkansas River.

During normal flow, the depth of water in the Cimarron River was too shallow for the automatic egg sampler. The Silver City Bridge (5 miles upstream from the reservoir) was the primary location for egg sampling. The 10-inch net was used a total of 33 hours 35 minutes, and the half-meter net 14 hours 1 minute total. Norfolk Bridge (approximately 15 miles upstream from the reservoir) was used only on one occasion with 30 minutes total sampling time. The total net sampling time on the Cimarron was 48 hours 6 minutes in which a total of 217 samples were taken. The sampling period extended from April 3 to May 26.

Four sampling sites were located on the Arkansas River with the primary sampling site at Blackburn Bridge (approximately 15 miles upstream from the reservoir). The 10-inch net was used for 48 hours 25 minutes, and the half-meter net for 2 hours 15 minutes. The other three sites were sampled only a total of 1 hour 8 minutes. The automatic samples showed 324 hours 15 minutes sampling time. During the period April 3 to May 28, 236 net samples were taken totaling 52 hours 3 minutes of net sampling time.

The egg sampling produced no striped bass eggs at any location. Striped bass egg identification was based on work by Mansueti (1958) and personal communication with J. T. Brown and Jack Bayless. Eggs from Goldeye were found at all locations with regularity. Eggs of several other species were found but in lesser numbers. Most eggs were taken with the 10-inch nets because this was the only sampling gear that could be used during periods of heavy flow and minor flooding.

Since river rises were the result of cold rains, spawning conditions were not actually conducive for striped bass until these water levels had fallen and the water temperatures had risen. Net sampling was also reduced in effort time and size of net during high water flows. On several occasions, all sampling had to be curtailed due to high current rates and floating debris. Automatic samples could be used only in low flow periods when silt loads were minimal. All net sampling was conducted during daylight hours. Apparently time of day productivity varies greatly. Cheek (1959) noted high productivity during nighttime hours, whereas May and Fuller (1961-1962) indicated greater sampling success in daylight hours.

1969 Meter Net Sampling

With egg sampling concentrated in periods of moderate and low river flows, it was concluded a spawn during high flow periods could have gone undetected. Therefore, half-meter nets were towed with outboards in the headwaters of the reservoir in an effort to find evidence of possible spawn.

Half-meter net samples were taken in the Cimarron River at the headwaters of Keystone. During the period May 1 to May 30, sampling time totaled 4 hours 5 minutes. No striped bass were observed in these samples. Gizzard shad larvae were most numerous, but larvae of white bass and several other species occurred in lesser numbers. Daytime sampling utilized open water, cove and shoreline areas. Surface samples were most numerous but some midwater samples were taken.

The headwaters of the Arkansas arm of Keystone were also sampled with the half-meter net. A total of 95 drags were completed with the net time totaling 6 hours 31 minutes. The study period was from April 28 to June 6. No striped bass were observed but white bass exhibited their greatest concentration in this arm. Gizzard shad was the dominant species taken, and river shiners were found regularly. Adults of both the river shiner and gizzard shad were also taken.

1969 Shoreline Shocker Sampling

A boom-shocker, with a 230-volt AC generator, was used on five occasions in Keystone Reservoir. A total of 26.5 hours shocking time was expended in the Salt Creek area of the Cimarron arm and the Arkansas River. Four striped bass from 4 to 6½ inches in length were taken, but no young-of-year were found. A shocking trip covering the lower 60 miles of the Arkansas River was conducted. No striped bass were found with sampling covering both midstream and shoreline areas. Carp, river carpsucker, bigmouth and smallmouth buffalo, gizzard shad and longnose gar were numerous, but several species of sunfish, white bass, largemouth bass, flathead catfish and white crappie were found in lesser numbers.

1969 Shoreline Seine Sampling

Shoreline seining for fingerlings was initiated on May 28. No striped bass were taken before June 5, when approximately 290,000 one- to two-inch fingerling striped bass were stocked. Stockings were made in the upper portion of the Arkansas arm where meter-net samples indicated an abundance of forage size young-of-year shad.

Seine sampling was conducted early with a 20- by 6-foot by 3/16-inch mesh drag seine. Later a 40- by 6-foot by ¼-inch drag seine was substituted. All hauls were stepped off to obtain distance estimates and were pulled as rapidly as possible. All fish were separated by species, counted and measured.

Shoreline seining was continued after stocking to provide information on stocking success; indicate growth rates; and provide data on movements and distributional patterns for future striped bass seining operations. Length frequency data were plotted in an attempt to determine if natural reproduction occurred.

During the period May 29 to December 3, a total of 200,510 feet (38 miles) of shoreline was seined in Keystone Lake and the Arkansas River. Seine samples were taken at all periods of the day but not on a truly random or scheduled basis. During the month of August most samples were taken during night and early morning hours because this was found to be the most productive period. Gray (1957) noted the success of nighttime shoreline seining in the Santee-Cooper Reservoir, South Carolina.

A total of 403 striped bass were recorded from a total of 54,878 fish taken with the seines (Table I). Young-of-year gizzard shad were prominant with 26,749 taken, followed by 10,063 adult gizzard shad, 9336 river shiners, and 4247 white bass. Only 15 of the 51 sampling areas in all sections of the lake produced striped bass. Although many areas of differing bottom types were sampled, sandy areas appeared to be the most productive for striped bass. Seining with the wind on windy shallow banks produced the best catches of striped bass. Night seining in late summer was also more productive.

The largest number of striped bass was taken from the Keystone Ramp area near the central pool of the lake (105 fish). The area which produced the largest ratio of striped bass per unit of effort was the area north of the Keystone Ramp (1.33 fish per 100 feet of shoreline seined).

Striped bass showed a well-defined migration toward the Cimarron arm of the lake as the summer progressed. By mid-August 85.6 percent of the striped bass catch was made from the Cimarron arm. All fish were stocked in the upper Arkansas arm in June.

The striped bass also showed a more pronounced schooling tendency by late summer. One haul produced 27 and another 16 striped bass in mid-August, whereas most hauls earlier had taken only single specimens. On one occasion in early August, young-of-year white bass and striped bass were observed foraging together. Seine samples indicated these schools had a ratio of striped bass to white bass of approximately one to five.

All striped bass were measured upon capture and a representative sample was preserved. The remainder were returned to the lake. Table 2 shows growth of the stocked fish at approximately 2-week intervals. Approximately two weeks after stocking the average was 43.4 mm, and by September 3 the average had increased to 96.4 mm.

No striped bass differing significantly from the average were taken. When sufficient numbers were taken, growth curves were plotted, and all fish fitted into a normal growth pattern. Length distribution data analyzed from the August 19 samples indicate some members of the year class grew approximately 2.5 times faster than the slowest individuals (Table 3).

1969 Gill Net Sampling

The gill net survey was conducted to determine if a mature population of

striped bass had developed. Standard gill nets which varied in size from 2- to 4½-inch bar mesh were used. These nets were 100 yards long and 7 feet deep, all hobbled. With one exception, the nets were raised after one night sets.

During the period October 9 to December 12, 35,200 feet of net, set for one night durations, were used. Of this total, 2100 feet were set near the surface extending from a depth of 4 feet. The bottom depth was from 15 to 40 feet. The areas sampled were in the lower Arkansas arm, lower Cimarron arm and the central pool.

The total number of fish captured was 812 (Table 4) with white crappie, bigmouth and smallmouth buffalo, flathead and channel catfish being the dominant species. Thirty striped bass were taken, all coming from bottom sets. Catch rates for striped bass were low early in the period but increased as the fall season progressed. Time of the year was important in sampling as noted by Neal (1967).

Eighty percent of the striped bass taken were female. These fish ranged in size from 0.9 to 8.9 pounds. When captured, 66.7 percent were alive in the nets. Twenty fish were taken in 2-inch nets and ranged from 0.9 to 8.9 pounds, average 1.8 pounds (Table 5). In 2½-inch net only 2 fish were taken, each weighing 4.2 pounds. A 2½-inch trammel net was used on several occasions and produced one 4.5 pound striped bass. Six striped bass were taken in 3-inch nets and ranged from 1.7 to 8.3 pounds (average 5.8 pounds). One 8.8 striped bass was taken in 3½-inch net. Selectivity according to mesh size is indicated, but the effects of these fish bridling and pocketing is also shown. The total catch by mesh size is shown on Table 6.

The average depth from which all striped bass were taken was 20 feet. The 0.9 to 2.6 pound fish came from a mean depth of 16.8 feet, the 4.2 to 4.6 pound fish from 22.3 feet and the 6.6 to 8.9 pound fish were captured in 29.3 feet of water. The total capture depth ranged from 10 to 40 feet. Stevens (1958) noted gill net capture depths of 20 to 40 feet for striped bass in the Santee-Cooper Reservoir, South Carolina. All Keystone striped bass taken in gill nets were captured along one large sandy beach, northwest of Keystone Ramp.

Stomachs from 18 of the 28 fish checked had some fish remains present. Gizzard shad was the only identifiable forage found and was present in 15 of the 18 fish. Major striped bass food habit studies have found shad to be an important forage (Neal 1957; Stevens, 1958). The fish remains in the other 3 fish were unidentifiable. As many as 8 shad were found in a single fish. Shad taken from the stomachs appeared to be young-of-year which measured 3 to 5 inches long.

Six of the larger striped bass females had well-developed ovaries which measured 4 to 5 inches in length and were 1½ to 2 inches in diameter.

Floating and submerged net efficiency was demonstrated for fall gill net sampling. Floating nets were set congruent to submerged nets of the same mesh size. On each occasion, striped bass were picked up in the bottom sets but not in the floating sets.

A tendency for striped bass to school with others of the same size was illustrated with a series of alternating nets with mesh sizes of 2-, 2½- and 3-inches set perpendicularly to the shore. The 2-inch nets produced 10 small striped bass whereas no stripped bass were taken in the larger mesh sizes.

Scale samples from 50 fish, taken by sportsmen and project investigators, were used for striped bass age and growth determinations. The direct proportion method was used in length relations. Calculated growth at the end of the first year was 10.2 inches, second year 17.9 inches, third year 21.3 inches, and the fourth year 23.9 inches (Table 7). Preliminary observations on striped bass in Keystone Reservoir indicate growth rates favorable to those found by Stevens (1958) Santee-Cooper Reservoir, South Carolina; and Scruggs (1955) Santee-Cooper Reservoir, South Carolina. These rates exceed those reported by Mansuetik Chesapeake Region (1955); Scofield, California (1928); and Talbot, California (1966).

There appears to be wide variation in the growth rates of any particular year class. Several yearling striped bass were observed in March and April 1969 from 3¼ inches to 6 inches. Electro-shocking crews found small schools of yearling striped bass in May 1970 measuring 5½ to 6½ inches.

Male striped bass at age 2 (approximately 3 pounds) have been observed in spawning condition. Mature females at 6 pounds (age 3) have also been noted. Difference in male and female growth rates were not distinguished.

1970 Egg Sampling

The 1970 project excluded the use of automatic egg sampling and meter net sampling. Egg sampling using 10- by 18-inch diameter nets began on April 3. Striped bass were known to be concentrated in deep pools at the upper end of the reservoir in the Cimarron arm in late February, but temperatures did not reach spawning range until early April. Due to bottom draw at Keystone Dam, temperatures at the regulation station sampling point below the dam did not reach 60 degrees until April 23.

Sampling time totaled 158.7 hours with the 10-inch nets and 21.8 hours on the 18-inch nets. An abandoned bridge near Oilton on the Cimarron River, approximately 8 miles upstream from Keystone Reservoir, was the principal sampling station. A total of 37 sampling days with an average of 4.9 hours total net time per day was used from April 3 to May 15. Eggs exhibiting characteristics of striped bass were taken on April 19; however, the oil globule was not prominent. Two general peaks of spawning activity were indicated on April 28 and May 6. Both peaks occurred during falling water after a substantial rise. Striped bass spawning peaks were noted during low or falling water in the Roanoke River by Hassler, *et al* (1962). Egg sampling data is given in Table 8.

The sampling station used on the Arkansas River was located on a bridge near Blackburn, as it was in 1969. Sampling effort at this location totaled 156.6 hours with the 10-inch net and 18.1 hours with the 18-inch net in 37 days of sampling. Eggs similar to striped bass eggs were taken on all sampling days from May 6 to May 18 when sampling was terminated due to schedule conflicts. Peak activity occurred on May 18 at temperatures of 74 degrees when 16 eggs were taken in the 1½-hour sampling period. May 12 also produced 8 eggs with 6 hours effort.

Eggs were staged using the guidelines set forth by Mansueti (1958). It was determined the eggs ranged from 22 to 28 hours in age. Using the nomagraph provided by J. T. Brown (unpublished), the eggs if striped bass, would have had adequate transport time to hatch. Eggs taken from the Cimarron and staged were in the same age range but would have settled out before hatching.

Egg sampling effort was extended at the regulating dam, approximately 5 miles below Keystone Dam. The 10-inch nets were used 181.1 hours, and the 18-inch nets 7.9 hours. No eggs of any type were taken. Water temperatures at this location ranged up to 17 degrees cooler than those in the tributary rivers of the reservoir.

It is apparent the sampling effort was terminated before the striped bass below the dam engaged in spawning activity. Spot checks with egg nets were used in mid-June when fishing reports showed mature fish in spawning condition, but results were negative.

1970 Shoreline Seining

Seine sampling was initiated on June 18 in Keystone Reservoir. Daytime hauls with a 20- by 6-foot 3/16-inch seine were made. The first haul of 125 feet produced 6 striped bass fingerlings which were identified as natural reproduction. These fish were taken from the Arkansas arm. Seining on this date in the Cimarron arm produced no striped bass.

Seine effort produced 19 striped bass on June 20 and 102 fingerlings were netted on June 22. These fish averaged 47 mm. (range 35 to 62 mm.) and were distributed throughout all sampling areas on the Arkansas arm. Samples taken on June 24 indicated striped bass were moving up into the Cimarron from the central pool. Two seine hauls below Keystone Dam on June 25 produced 12 striped bass, also averaging 47 mm. in length. June 26 samples indicated additional penetration into the Cimarron and showed three size class waves at 61, 47 and 41 mm. The smallest class was found at the upper sampling station on the Arkansas arm. No explanation can be given for the movement of striped bass into the Cimarron, but forage and a higher salt content (Eley, Carter, and Dorris, 1969) may be factors.

As of July 10, 546 striped bass had been taken by seining 91,930 feet of shoreline. The average size of the largest group was 83 mm. on the date. Most hauls were made early in the morning at sand bar sites. Although 6328 feet of effort were extended in the upper sections of the Cimarron, no striped bass were found in these sites. It appears the striped bass moved from the Arkansas arm up into the Cimarron arm. Figure 1 reveals distribution patterns in sequential order.

An estimate of the total spawn was calculated using striped bass numbers recovered from known stocking rates in 1969 as an extrapolation base. Sites producing striped bass in 1969 were reseined in 1970 at the same time periods and with similar techniques. The fingerling survival from data taken from June 20 through June 25 was calculated at 1.45 million. This is considered to be a minimum, as fish were known to be transporting through Keystone Dam at the time of the estimate.

SPORT FISHING

A creel survey was not conducted, but good information on sport fishing for striped bass was contributed by dock operators, law enforcement personnel, sporting groups, and interested sportsmen.

Sport fishing for striped bass in 1969 produced much better returns than in 1968. The most productive area appeared to be Keystone Dam tailwater area where 40 fish were officially reported, and unofficial reports ranged up to 80. The largest was approximately 12 pounds with many in the 6 to 9 pound class. The most productive lures were yellow jigs and doll flies fished on the bottom.

Reports of catches of 22 striped bass came from all areas of Keystone Lake proper, but the Salt Creek area near Mannford was the most productive. Generally, fish from the reservoir were smaller than those from the tailwaters. Lures used in capture included spoons, purple shad, true shad, mepp spinners, minnows, and bombers. No estimate was made of the number reported compared to the actual number caught in the lake and the tailwaters, but the percentage reported is believed to be quite small.

Striped bass fishing in 1970 did not become productive in the lake or tailwaters until late May. From May 14 to July 1, official reports totaled 52 striped bass taken in the tailwaters and 6 taken from the lake. Ripe males were taken and ranged in weight from 3 to 13 pounds; ripe females from 6 to 12½ pounds. One large female was taken with eggs running. Water temperatures fell within tolerable limits for reproduction although the photo period was much longer than normal for striped bass in lower latitudes. Unofficial but reliable sources placed the 1½-month striped bass run harvest at 150 to 200 fish above 5 pounds with numerous smaller individuals taken.

The fishery is now productive enough to attract many sportsmen to the tailwater area. Success warrants the use of surf rods and large reels and often home-made jig or doll fly lures. The fishing is popular and the fish is prized.

TABLE 1

SPECIES COMPOSITION OF FISH TAKEN BY SEINE SAMPLING IN KEYSTONE RESERVOIR 1969.

(Young-of-Year) SPECIES	NUMBER	PERCENT	(Young-of-Year) SPECIES	NUMBER	PERCENT
GIZZARD SHAD	26,749	48.74	CARP	135	.25
GIZZARD SHAD - Adult	10,063	18.34	CRAPPIE	132	.24
RIVER SHINER	9,336	17.02	GAMBUSIA	60	.11
WHITE BASS	4,247	7.74	FATHEAD MINNOW	34	.06
RED SHINER	1,805	3.28	LONGNOSE GAR	27	.05
DRUM	733	1.34	GOLDENSHINER	20	.04
SUNFISH	429	.78	SMALLMOUTH BUFFALO	13	.02
STRIPED BASS	403	.73	GOLDEYE	11	.02
RIVER CARPSUCKER	262	.48	LARGEMOUTH BASS	5	.01
CHANNEL CATFISH	210	.38	OTHERS	4	.01
BROOK SILVERSIDE	200	.36	TOTAL	54,878	100.00

CONCLUSION

The project objective was to determine if a spawning population of striped bass had developed in Keystone Reservoir. This objective was met. As noted at the onset of this paper, much of the information reported is restricted to observations due to the limited scope of the research. Age and growth data, food habit data, etc., were obtained as secondary to project procedures, but these data should be outlined as full-scale projects in the future.

The striped bass appears to be well on its way to being established as a major sport fish in Oklahoma. With the verification of natural reproduction in substantial numbers, a perpetual source of brood stock could be the successful completion of the major objective. Since the ultimate objective is to make striped bass more available to all Oklahoma sportsmen, several hurdles remain. Most Oklahoma striped bass fisheries will be based on a put-grow-and-take concept and will demand a usuable source of brood stock for a stripping operation. Spawning activity was apparent in the Cimarron and Arkansas rivers and below Keystone Dam. Electrofishing was used to take a few individuals below Keystone Dam but not on a dependable basis. Methods must be developed to supply a stripping operation with ripe fish on a regular schedule. The stripping operation, although well-developed on the east coast, must endure the local growing pains. Investigations might also be aimed at the securing of brood stock from the tributary streams of Keystone. The long-range benefits of striped bass to the sport fishery and the standing crops in Oklahoma reservoirs will dictate the extent of participation by the Oklahoma Department of Wildlife Conservation in the future of this exotic.

TABLE 2

STRIPED BASS FINGERLING GROWTH IN KEYSTONE, JUNE 16 - SEPTEMBER 3.

DATE	NUMBER	AVERAGE LENGTH MM	RANGE MM
6-16 - 6-17	5	43.4	40 - 55
7-01 - 7-02	7	50.9	38 - 59
7-14	8	57.8	44 - 74
8-04	35	73.2	60 - 90
8-19	114	81.0	55 - 114
9-03	7	96.4	88 - 122

TABLE 3

NUMBER	SIZE MM
3	51 - 60
13	61 - 70
44	71 - 80
35	81 - 90
13	91 - 100
5	101 - 110
1	111 - 120

TABLE 4

SPECIES COMPOSITION OF KEYSTONE GILL NET SAMPLING, OCTOBER, NOVEMBER, DECEMBER 1969.

SPECIES	NUMBER	WEIGHT	PERCENT BY NUMBER	PERCENT WEIGHT
WHITE CRAPPIE	230	244.0	28.4	9.0
SMALLMOUTH & BIGMOUTH BUFFALO	144	570.7	17.7	21.0
FLATHEAD CATFISH	119	1,014.2	14.7	37.2
CHANNEL CATFISH	117	386.2	14.4	14.2
WHITE BASS	74	100.5	9.1	3.7
STRIPED BASS	30	97.6	3.6	3.6
BLUE CATFISH	25	68.3	3.1	2.5
CARP	22	27.3	2.7	1.0
FRESHWATER DRUM	14	89.7	1.7	3.3
LARGEMOUTH BASS	12	39.9	1.5	1.5
RIVER CARPSUCKER	9	8.7	1.1	.3
WALLEYE	9	56.7	1.1	2.0
GIZZARD SHAD	4	3.6	.5	.1
LONGNOSE GAR	3	15.7	.4	.6
TOTAL	812	2,723.1	100.0	100.0

TABLE 5

STRIPED BASS TAKEN FROM KEYSTONE RESERVOIR BY GILL NETS - OCTOBER, NOVEMBER, DECEMBER 1969.

SEX	WEIGHT (Pounds)	GILL NET MESH (Inches)	LENGTH (Inches)	DEPTH (Feet)	STOMACH	ALIVE
Female	2.3	2	18.0	17	4 shad	A
Male	2.0	2	16.6	17	Empty	A
Female	1.5	2	14.5	17	Empty	A
Female	2.5	2	17.8	17	1 Shad	A
Male	1.2	2	12.9	15	1 Shad	A
Female	1.6	2	14.9	15	4 Unidentified	A
Female	2.2	2	17.1	15	1 Shad	D
Male	1.5	2	13.9	17	Empty	A
Male	1.3	2	13.8	15	4 Shad	A
Female	1.6	2	15.9	15	Empty	A
Female	1.3	2	15.6	13	Empty	D
Female	1.7	2	16.4	17	2 Shad	A
Female	2.4	2	17.1	15	Empty	A
Male	2.6	2	18.1	17	3-4" Shad	D
Female	2.4	2	18.0	29	2 Shad	D
Female	1.7	3	14.9	20	Empty	A
Female	1.6	2	13.8	18	Empty	A
Female	0.9	2	12.4	24	Empty	D
Female	1.4	2	14.3	10	3 Shad	D
Female	2.1	2	16.4	13	6-3" Shad	A
Male	4.2	2½	19.5	20	1-5" Shad	A
Female	4.2	2½	20.2	18	3 Unidentified	A
Female	4.6	3	21.7	23	2 Shad	A
Female	4.5	2½ Trammel	22.5	28	3 Unidentified	A
Female	8.8	3½	27.5	40	Empty	A
Female	8.9	2	26.3	24	3 Shad	A
Female	7.1	3	25.8	28	Empty	D
Female	6.7	3	25.1	28	8-3" Shad	D
Female	6.6	3	24.8	28		D
Female	8.3	3	25.5	28		D

TABLE 6
KEYSTONE GILL NETTING CATCH BY MESH SIZE AND EFFORT.

SPECIES	2" G Net		2½" G Net		2½ Trammel Net		3" G Net		3½" G Net		4" G Net		4½" G Net	
	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.	No.	Lbs.
River Carpsucker	6	5.6	3	3.1										
Smallmouth & Bigmouth Buffalo	18	16.6	27	54.0	2	8.4	60	273.0	36	209.3			1	9.4
Carp	14	13.3	4	4.8			1	.4	3	8.8				
Longnose Gar	1	3.2	1	9.5					1	3.0				
Flathead Catfish	2	3.0	21	80.6	1	2.4	23	138.7	35	231.1	33	438.8	4	69.6
Blue Catfish	13	27.3	12	41.0										
Channel Catfish	46	85.1	51	181.7	1	3.7	7	30.9	12	84.8				
Gizzard Shad	4	3.6												
White Bass	63	76.5	8	16.3			3	7.7						
Largemouth Bass	1	1.4	8	23.7			3	14.8						
White Crappie	118	96.0	109	145.8	1	.4	2	1.8						
Freshwater Drum	1	.6	2	9.5	1	6.0	1	.5	4	31.3	3	23.7	2	18.1
Walleye	4	23.6	2	12.3			1	5.9	2	14.9				
Striped Bass	20	40.9	2	8.4	1	4.5	6	35.0	1	8.8	—	—	—	—
TOTAL	311	396.7	250	590.7	7	25.4	107	508.7	94	642.0	36	462.5	7	97.1
Effort (Ft.)	4500		5700		2400		8900		6900		3200		3600	
Total Weight	2,723.1													
Total Number	812													

TABLE 7

AVERAGE CALCULATED LENGTHS AND ANNUAL LENGTH INCREMENTS IN INCHES OF STRIPED BASS FROM THE KEYSTONE RESERVOIR, 1969.

AGE GROUP	NO. OF FISH	AVG. TOTAL LGTH (IN.)	CALCULATED TOTAL LENGTH AT END OF YEAR			
			1	2	3	4
I	29	14.57	9.21			
II	8	22.46	12.32	18.99		
III	9	24.73	11.73	17.84	21.86	
IV	4	27.28	8.93	16.03	20.08	23.87
Grand Avg. and Total	50		10.15	17.93	21.31	23.87
Increments of Growth			10.15	7.68	3.38	2.56

TABLE 8

STRIPED BASS EGG COLLECTION DATA, KEYSTONE RESERVOIR, 1970.

	CIMARRON RIVER			ARKANSAS RIVER		
April 1970 Date	Sample Time	Water Temp. F°	Fall/ Raise	Sample Time	Water Temp. F°	Fall/ Raise
3	20	55		5	53	
6	20	56		60	54	
7	330	64	F	225	56	F
8	360	63	F	270	58	F
9	260	60	F	270	61	F
10	360	68	F	360	62	F
11	240	64	F	240	63	F
12	240	69	R	240	64	R
13	360	54	F	330	57	F
14				370	54	F
15	120	65	F			
16	270	64	F	570	60	F
17	40	65	R	300	62	R
18	225	64	R	240	63	R
19	240	64	R	80	62	R
20	240	62	R			
21	180	63	F	10	62	R
22	360	63	F	45	65	F
23	240	64	F	360	62	F
24	240	61	F	240	62	F
25	240	64	F	240	63	F
26	240	64	F	240	63	F
27	450	75	F	360	67	F
28	450	73	F	360	72	F
29	450	74	F	450	72	F
30						

TABLE 8 (CONT.)

May 1970 Date	CIMARRON RIVER Sample Time	Water Temp. F°	Fall/ Raise	ARKANSAS RIVER Sample Time	Water Temp. F°	Fall/ Raise
1	750	63	R	540	65	R
2	240	64	F	240	66	R
3	240	69	F	240	70	F
4	450	69	F	450	66	F
5	450	70	F	450	70	F
6	450	70	F	450	71	F
7	450	70	F	375	70	F
8	450	66	F	375	69	F
11	450	72	F	450	73	F
12	240	78	F	360	75	F
13	240	73	F	240	76	F
14	240	77	F	360	75	F
15	90	68	R	90	70	F
18				90	74	F

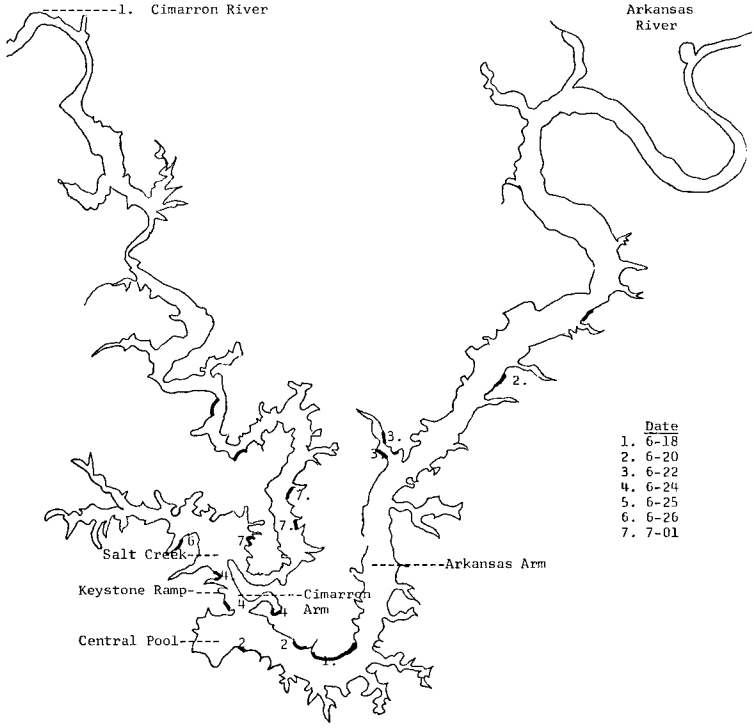

FIGURE 1. Distribution of 1970 striped bass natural reproduction in Keystone Reservoir.

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