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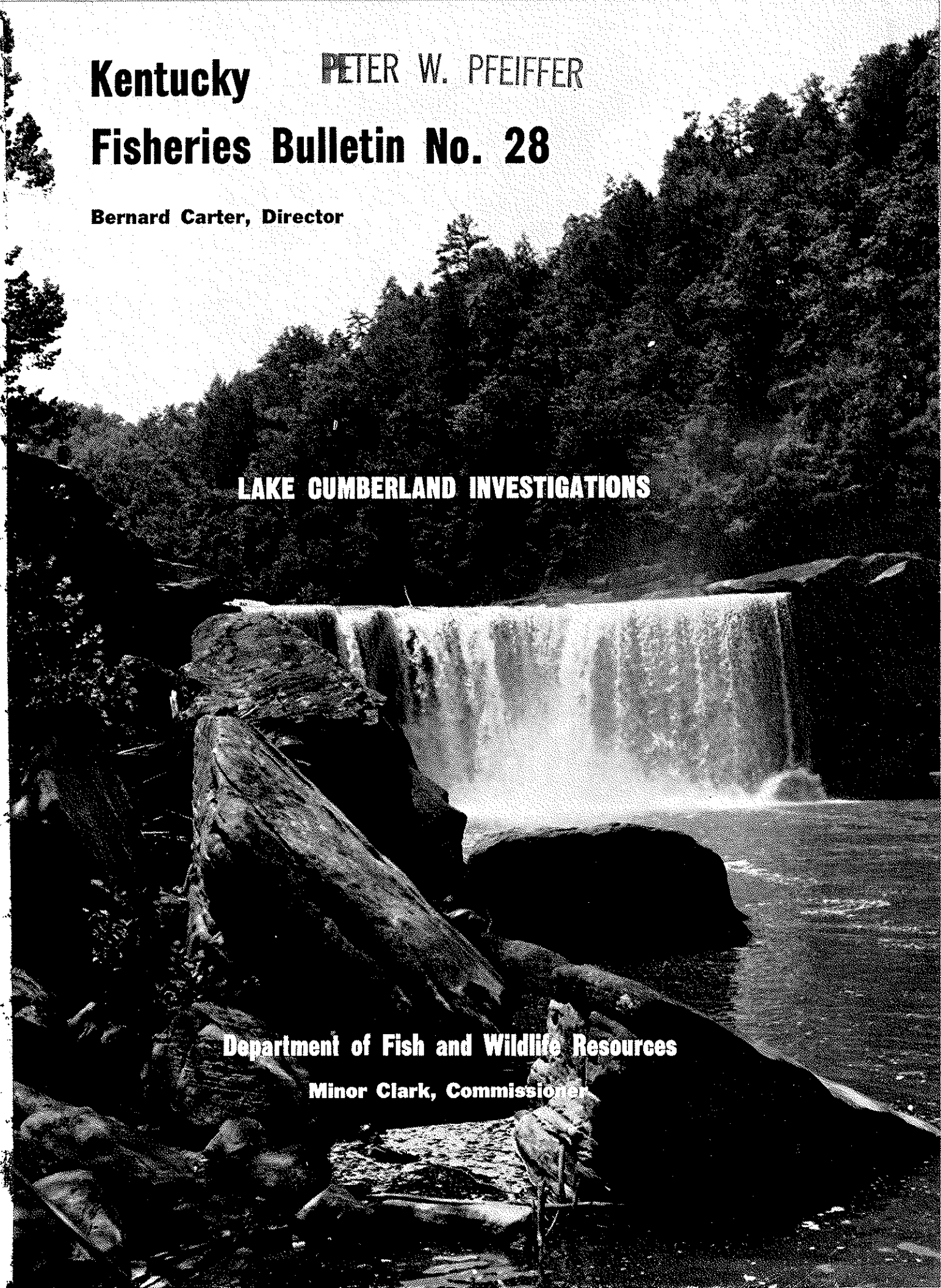
Bernard Carter, Director



LAKE CUMBERLAND INVESTIGATIONS

Department of Fish and Wildlife Resources

Minor Clark, Commissioner

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By

James P. Henley

Principal Fishery Biologist

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James P. Henley
Kentucky Department of Fish and Wildlife Resources
Frankfort, Kentucky

ABSTRACT

A total of 13 fish population samples were made in 1952-55 and 42 samples were made in 1960-64. The carrying capacity of the reservoir was reached in 1954. The standing crop increased from 39.9 pounds per acre in 1952 to a high of 193.6 pounds per acre in 1955. The standing crop of fish present in the lake during the period 1960-64 varied from a low of 91.7 pounds per acre in 1964 to a high of 175.3 in 1960 and 174.5 pounds per acre in 1963.

Following the establishment of threadfin shad in the reservoir in 1960, the gizzard shad have not produced a successful spawn and the threadfin shad has replaced the gizzard shad as the principal forage species in the reservoir.

A sport fishery for rainbow trout Salmo Gairdneri *has been created in Lake Cumberland and the growth of the planted trout has been rapid.*

Introduction

The sport fishery at Cumberland Lake was excellent for five to six years following the impoundment of the Cumberland River in 1950-51. The sport fisheries showed a decline in 1958, although the full extent of this decline in the fisheries was not fully realized until late 1959.

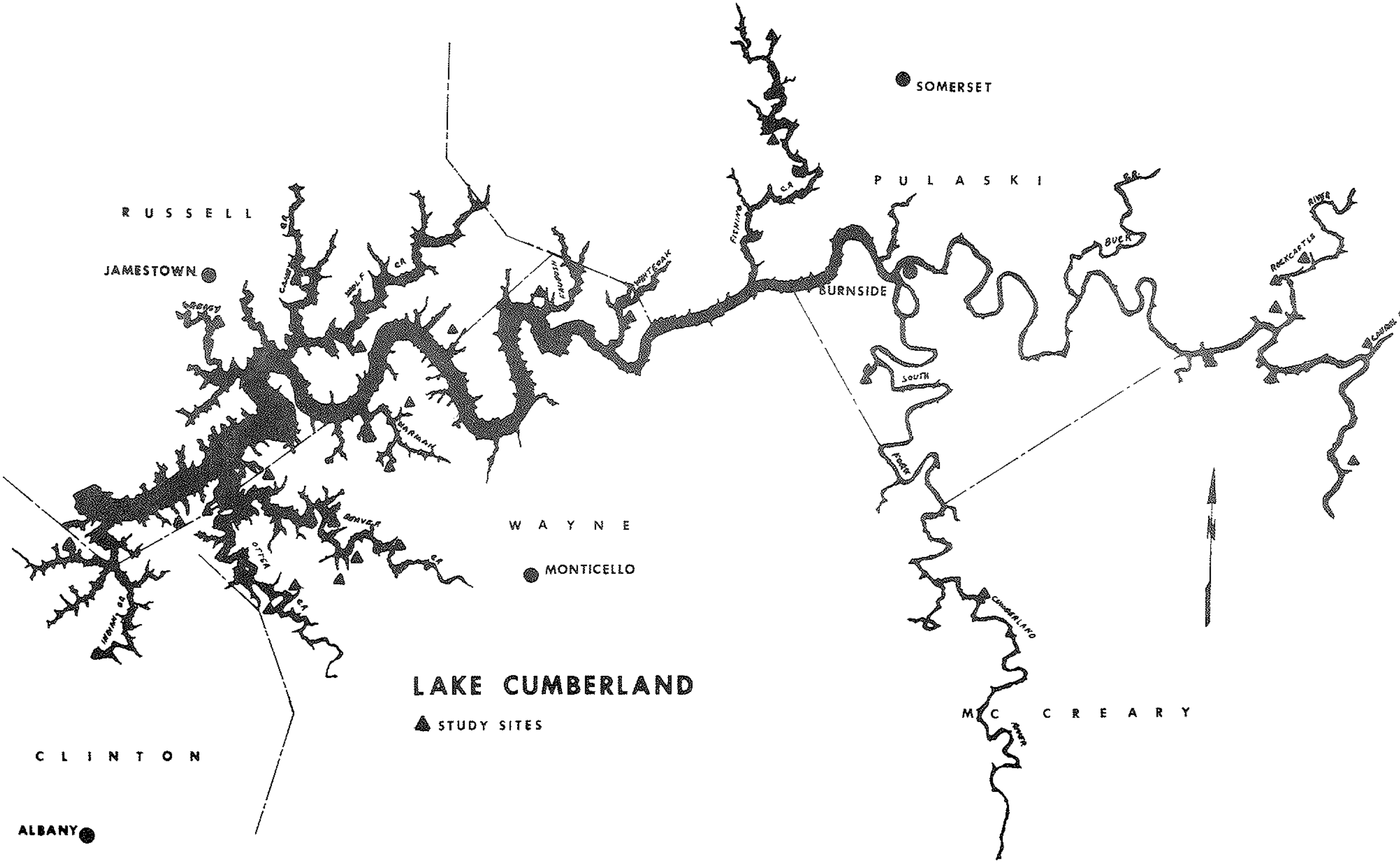
In an effort to gain further knowledge of the reservoir and the cause of the drop in the sport fisheries, the present project was initiated in 1960 to determine the following: species composition of the reservoir; standing crop; to measure the reproduction and survival of the important sport fishes.

The early fish population samples, 1952-1955, were made by Bernard T. Carter. The author carried out the work during 1960-1964.

Description of the Lake

Cumberland Lake was created in the winter of 1950-51 by the completion of Wolf Creek Dam on the Cumberland River. The lake has a surface area of 50,250 acres at summer pool elevation (723 ft. msl), with an average depth of 90 feet. The lake is approximately 100 miles long, has a shoreline of more than 1,000 miles and drains an area of 5,810 square miles.

The upper portion of the lake above Burnside, Kentucky is located within the Cumberland Plateau Physiographic Region (Fenneman, 1938; 329-342, 411-427), and the immediate watershed is typified by deep narrow valleys and steep wooded hillsides. The basic rock structure of the Cumberland Plateau is composed of horizontal layers of Pottsville sandstones and conglomerates interspersed with layers of shale. These rocks have given rise to relatively unproductive soils. Water falling within this watershed and eventually impounded in Cumberland Lake is therefore relatively low in the nutrient minerals believed to be of importance to high fish production.


SOMERSET
PULASKI
RUSSELL
JAMESTOWN
BURNSIDE
WAYNE
MONTICELLO
CLINTON
ALBANY
MC CREARY
LAKE CUMBERLAND
STUDY SITES

The vegetative cover of the immediate watershed is composed primarily of species indigenous to the mixed mesophytic forest climax. However, the upland plateau areas, outside the Cumberland National Forest are for the most part pastureland. Some cultivation is practiced but is confined to small plots of plowed areas.

The lower and greater portion of Cumberland Lake is located within the eastern edge of the Highland Rim Physiographic Region; however, spurs of the Cumberland Plateau extend into the Highland Rim Region, and it is difficult to define exactly the physiography of this section of the lake. The valley floors, now inundated, can be placed correctly in the Highland Rim Region which is best characterized by its underlying limestone rock strata. The upland portions, although primarily a part of the Highland Rim, are invaded by the terminal thrusts of the Cumberland Plateau. The surrounding watershed of this portion of the lake is also infertile (Fenneman, op. cit.); however, the upland topography is much less rugged and broken.

The primary vegetation is essentially the same as that of the Cumberland Plateau except that the forest is confined more to the steep hillsides bordering the lake and its tributary streams. Most of the upland watershed is rolling pastureland. Cultivation is more extensive in this area but is not intensive.

Cumberland Lake is a multipurpose reservoir with an annual drawdown of nearly 40 feet occurring between May and December. The reservoir level rule curve set up by the Corps of Engineers was followed very closely during the four year period with minor exceptions occurring in 1962. The lake elevation rose 17 feet above conservation pool (723 feet msl) during February and March as a result of the flood of record in the upper drainage in March.

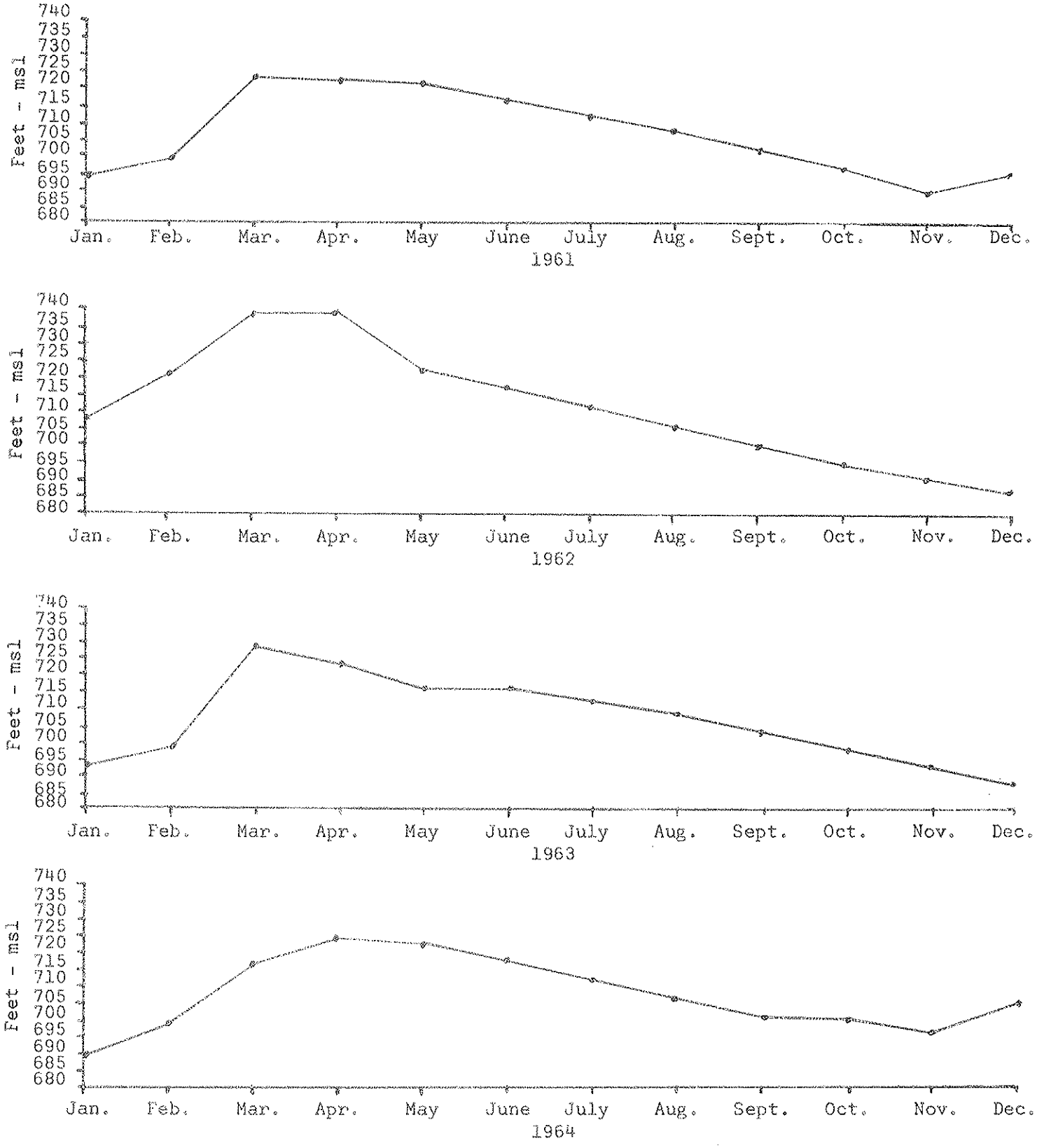


Figure 1. Mean elevation of Cumberland Lake for each month, 1961 - 1964.

Materials and Methods

The fish population data collected during 1952-55 were obtained in the same manner as during the 1960-64 period, with two exceptions: (1) the rotenone was applied by spraying rotenone over the surface of the coves and by dropping a mixture of powdered rotenone and water which was the consistency of mud balls into the deeper portions of the sample area; and (2) a block net was not used to enclose the open end of the cove. A total of 13 studies were conducted during 1952-55 and a total of 42 studies were conducted from 1960-64. All studies were conducted in coves, ranging in size from 0.8 to 2.0 surface acres with a maximum depth of 30 feet. Sampling was done during the months of June through October, when the surface water temperature was 70° F. and above.

A nylon block net of 1 inch (bar measure) 300 feet long and 30 feet deep was used to enclose the coves. The use of a block net formed an excellent boundary for most fishes, at the open end of the cove, nevertheless, a few small fish (1 to 1.5 inches in length) were observed entering the cove on several occasions after the first day pick up of fish. To alleviate a bias in the data, all young-of-the-year fish collected on the second and third day were examined closely and were discarded if normal decomposition had not occurred.

The surface acreages of all coves were determined with a telescopic allodate and the plain table method. Maximum depths and average depths were obtained by sounding and the volume computed in acre feet.

Noxfish, a five per cent emulsifiable rotenone product, was used as the fish toxicant at a concentration of 0.6 to 1 ppm. The required amount of rotenone was premixed with 20 gallons of water in a stainless steel barrel. Forty pounds per square inch of air pressure was placed in the barrel and the mixture was forced to all depths through a weighted perforated plastic

hose. This facilitated an excellent distribution of the rotenone above and below the thermocline.

All fish that surfaced within three days were recovered, identified, measured to the nearest inch and weighed to the nearest 0.02 pound.

Fish population data is reported as suggested by Surber (1959). The fishes are subdivided into five groups: game fish, panfish, predatory fish, commercial fish and forage fish. These fish were further separated into fingerling, intermediate and harvestable size.

Early Fish Population Statistics

Fish population studies were conducted during the first summer of impoundment, however, portions of the 1951 data were lost and could not be included in this report.

Table 1 shows the fish population structure of the reservoir during 1952-55, in total numbers and weights in pounds per acre for fingerling, intermediate and harvestable size fishes.

The standing crop during the four year period increased from a low of 39.9 pounds per acre in 1952 to a high of 193.6 pounds in 1955. Total numbers varied from a high of 2267 fish in 1954 to a low of 896 fish in 1952, Table 1 and Figures 2 and 3.

The gizzard shad made up 42% of the total numbers and 44% of the standing crop in 1952. In 1953, gizzard shad represented 45% of numbers and 47% of the standing crop; 28% of numbers and 39% of the standing crop in 1954; and 48% of the numbers and a low of 37% of the standing crop in 1955 (Figures 2 and 3).

The total numbers of harvestable size commercial fish, such as channel catfish *Ictalurus punctatus*; carp *Cyprinus carpio*; black redhorse *Moxostoma duquesnei* and drum *Aplodinotus grunniens*, increased from a low of 2.2 fish per acre in 1952 to a high of 34.9 fish in 1955. The standing crop of

harvestable size commercial fishes increased from a low of 1.33 pounds per acre in 1952 to a high of 28.0 pounds in 1955.

Harvestable size game fish, such as largemouth and Kentucky bass *Micropterus salmoides* and *Micropterus punctulatus*, white crappie *Pomoxis annularis*, and walleye pike *Stizostedian vitrium* increased from a low number of 1.3 fish per acre in 1952 to a high of 23.7 fish per acre in 1955. The standing crop of harvestable size game fish increased from a low of 0.6 pound per acre in 1952 to a high of 55.9 pounds in 1955. This large increase in the standing crop of harvestable game fishes that occurred in 1954 and 1955 was attributed to a large population of big walleye which were recovered in the samples taken in the headwaters. These two samples totaled 1.75 surface acres and yielded a total of 86 walleye pike that weighed 280.4 pounds. If walleye were deleted from the data for these two studies, the standing crop of harvestable size game fish would approximate the biomass of game fish present in 1960-1964.

The number of harvestable size panfish, mainly bluegill *Lepomis macrochirus* and longear *Lepomis megalotis* increased from a low of 1.0 fish per acre in 1952 to a high of 21.3 fish in 1954. The standing crop of harvestable size panfish increased from 0.13 pound per acre in 1952 to a high of 3.15 pounds in 1954.

The fish population in Cumberland Lake began to level off to the carrying capacity of the reservoir as early as 1954 (Figures 2 and 3), four years after impoundment. A substantial decrease in the recruitment of fingerling and intermediate size panfish as well as a drop in the total crop of fingerling and intermediate size game fish and commercial fish occurred in 1955 (Table 1). A significant decrease also occurred in the total numbers of gizzard shad per acre in 1955, however, the standing crop of shad remained nearly the same as in 1954 (Figure 3).

Table 1. Fish Population Composition of Cumberland Lake. 1952-1955 (13 studies combined - 14.5 acres).

SPECIES	1952						1953						1954						1955					
	Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
GAME FISH																								
Largemouth bass	7.1	0.06	8.9	1.84	1.3	0.58	7.1	0.03	7.6	2.01	5.6	2.44	152.7	0.84	15.7	1.20	3.2	4.83	116.0	0.35	2.0	0.38	2.8	2.15
Smallmouth bass	0.4	t	0.4	0.09									1.1	0.01					0.8	t	0.2	0.04	2.3	0.33
Kentucky bass	18.7	0.12	6.2	1.02			78.9	0.18	4.9	0.41	0.6	0.47	190.3	1.46	5.1	0.70	1.1	0.79	120.7	0.40	9.0	1.00	0.8	0.41
White bass													0.3	0.01							0.8	0.05	3.0	2.50
White crappie	8.0	0.22	45.3	2.53			36.4	0.74	92.9	4.76	4.7	0.96	126.9	2.60	188.5	16.19	8.0	1.92	220.5	0.64	137.5	7.59	1.8	0.37
Black crappie													0.3	0.01	1.9	0.16								
Walleye											1.3	2.42			0.3	0.10	9.0	21.26			2.0	0.42	13.0	50.17
TOTAL	34.2	0.40	60.8	5.48	1.3	0.58	122.4	0.95	105.4	7.18	12.2	6.29	471.6	4.93	211.5	18.35	21.3	28.80	458.0	1.39	151.5	9.48	23.7	55.93
PANFISH																								
Bluegill	48.4	0.32	86.2	1.74			150.6	0.98	217.6	3.51	2.9	0.50	135.7	0.38	319.7	7.14	17.0	2.83	44.5	0.22	10.3	5.89	10.8	1.49
Longear	70.2	0.32	72.9	2.33	1.0	0.13	27.3	0.16	81.8	2.28	2.2	0.30	52.5	0.31	171.5	4.37			17.3	0.13	118.3	3.42	2.0	0.31
Warmouth			1.3	0.02			0.9	t	6.0	0.26			4.5	0.03	7.5	0.23	3.2	0.18	0.5	t	7.6	0.35	0.2	0.18
Green sunfish			6.2	0.16			0.7	t	7.1	0.19			0.5	t	6.7	0.15					2.8	0.08		
Rock bass	28.4	0.23	32.9	0.30			2.4	0.14	1.1	0.14			0.8	t	3.2	0.10	1.1	0.14			1.3	0.04		
TOTAL	147.0	0.87	199.5	4.55	1.0	0.13	181.9	1.28	313.6	6.38	5.1	0.80	194.0	0.72	508.6	11.99	21.3	3.15	62.3	0.35	140.3	9.78	13.0	1.98
PREDATORY FISH																								
Longnose gar															2.4	0.10								
TOTAL															2.4	0.10								
COMMERCIAL FISH																								
Channel catfish	2.7	0.04	11.1	0.79			1.8	0.02	8.0	1.03	5.1	2.03	19.5	0.23	29.9	1.57	12.5	6.76	0.8	0.01	4.8	0.53	12.8	7.99
Flathead catfish	3.1	0.22	0.4	0.04							0.4	0.25	10.1	0.05	4.5	0.36	1.1	1.00	3.8	0.03	3.1	0.16	0.8	2.88
Bullhead	7.1	0.27	10.2	0.68			0.4	t	3.3	0.46	0.2	0.08	1.3	t	1.1	0.15			2.3	t	0.5	0.07	0.8	0.27
Buffalofish											0.2	0.76					0.3	1.19						
Redhorse			27.5	4.47	1.8	0.93			16.4	3.65	5.8	5.16			39.7	13.46	13.3	11.79			16.5	6.78	15.0	12.10
Carp			2.2	0.93	0.4	0.40					0.9	1.71					0.3	0.35			0.2	0.12	0.2	0.52
Hogsucker			3.6	0.58					0.9	0.11					1.1	0.15								
Drum	0.4	0.01	4.0	0.80							2.2	1.88	0.5	t	37.6	4.15	6.9	4.54			9.0	1.36	5.3	4.24
TOTAL	13.3	0.54	59.0	8.29	2.2	1.33	2.2	0.02	28.6	5.25	14.8	11.87	31.4	0.28	113.9	19.84	34.4	24.73	6.9	0.04	34.1	9.02	34.9	28.00
FORAGE FISH																								
Gizzard shad	257.8	1.67	11.1	1.02	92.9	14.93	398.4	1.36	96.0	4.52	148.0	28.99	102.0	0.38	185.3	10.64	337.8	62.40	155.5	0.41	448.0	25.28	280.0	51.57
Misc. cyprinids									0.9	0.01			10.1	0.01					18.0	0.04	2.0	0.03		
Brook silverside													0.3	t	1.3	t			0.3	t	2.0	0.08		
Darters	15.1	0.07	0.4	t			6.2	0.05	1.1	0.01			8.5	0.05	11.5	0.10			2.8	0.30	8.7	0.14		
TOTAL	272.9	1.74	11.5	1.02	92.9	14.93	404.6	1.41	98.0	4.54	148.0	28.99	120.9	0.44	198.1	10.74	337.8	62.40	176.6	0.48	460.7	25.53	280.0	51.57
GRAND TOTAL	467.4	3.55	330.8	19.34	97.4	16.97	711.1	3.66	545.6	23.35	180.1	47.95	817.9	6.37	1034.5	61.02	414.8	119.08	703.8	2.26	786.6	53.81	351.6	137.48
TOTAL NO. AND STANDING CROP/A.			NO. 895.6	WT. 39.86					NO. 1436.8	WT. 74.96					NO. 2267.2	WT. 186.47					NO. 1842.0	WT. 193.55		

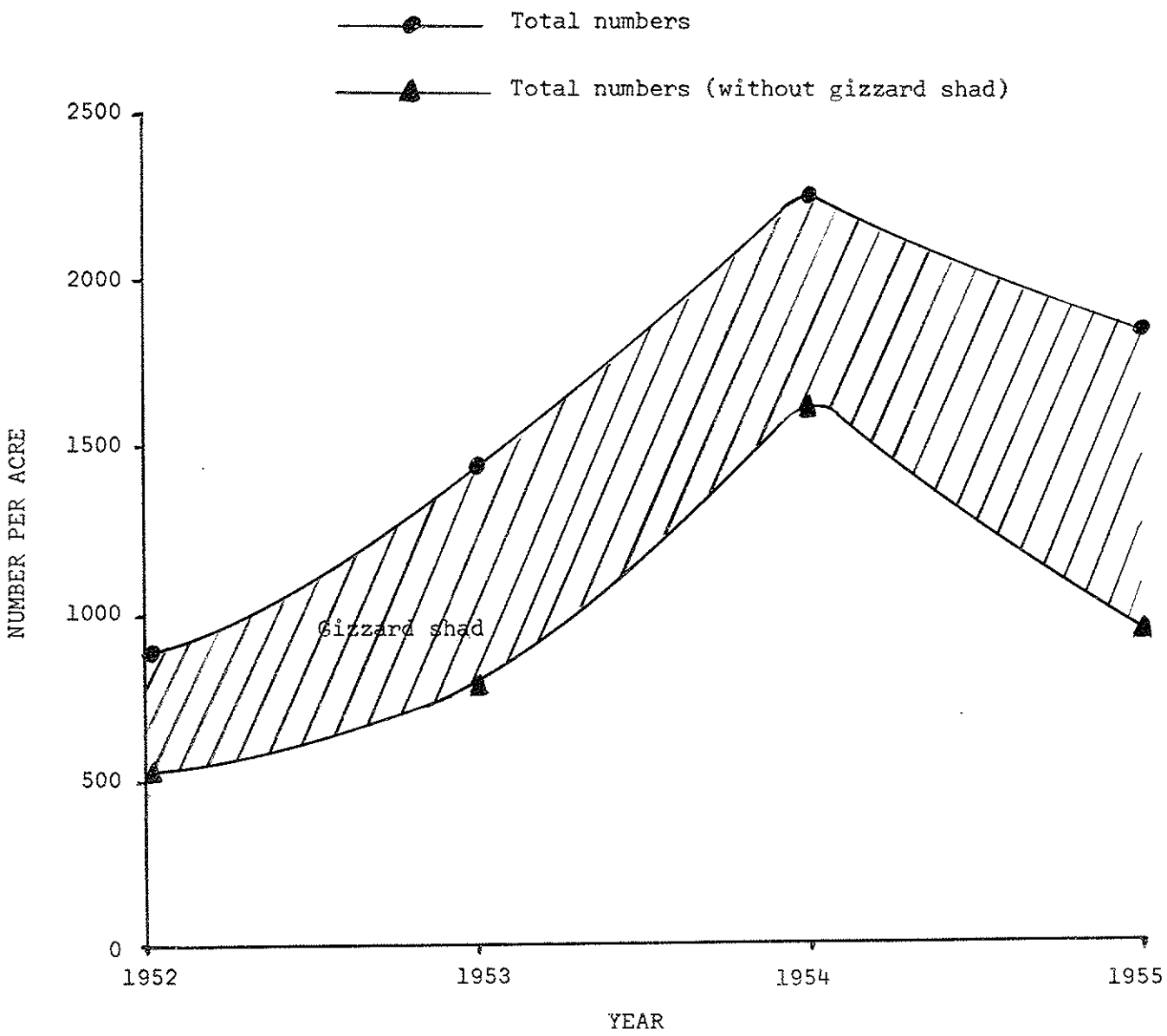


Figure 2. Total numbers per acre (with and without) gizzard shad. Cumberland Lake, 1952 - 1955.

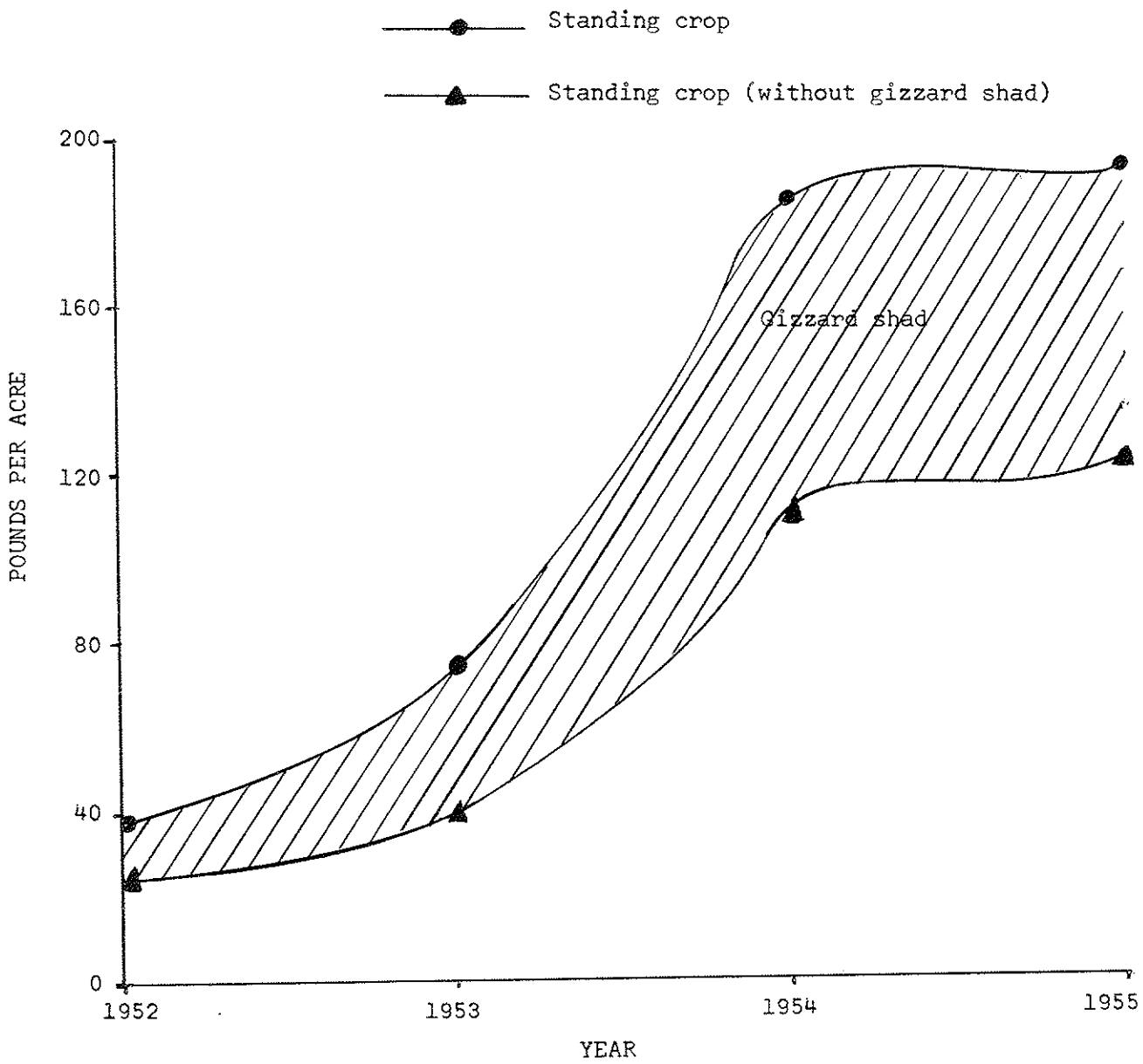


Figure 3. Standing crop in pounds per acre (with and without gizzard shad). Cumberland Lake, 1952 - 1955.

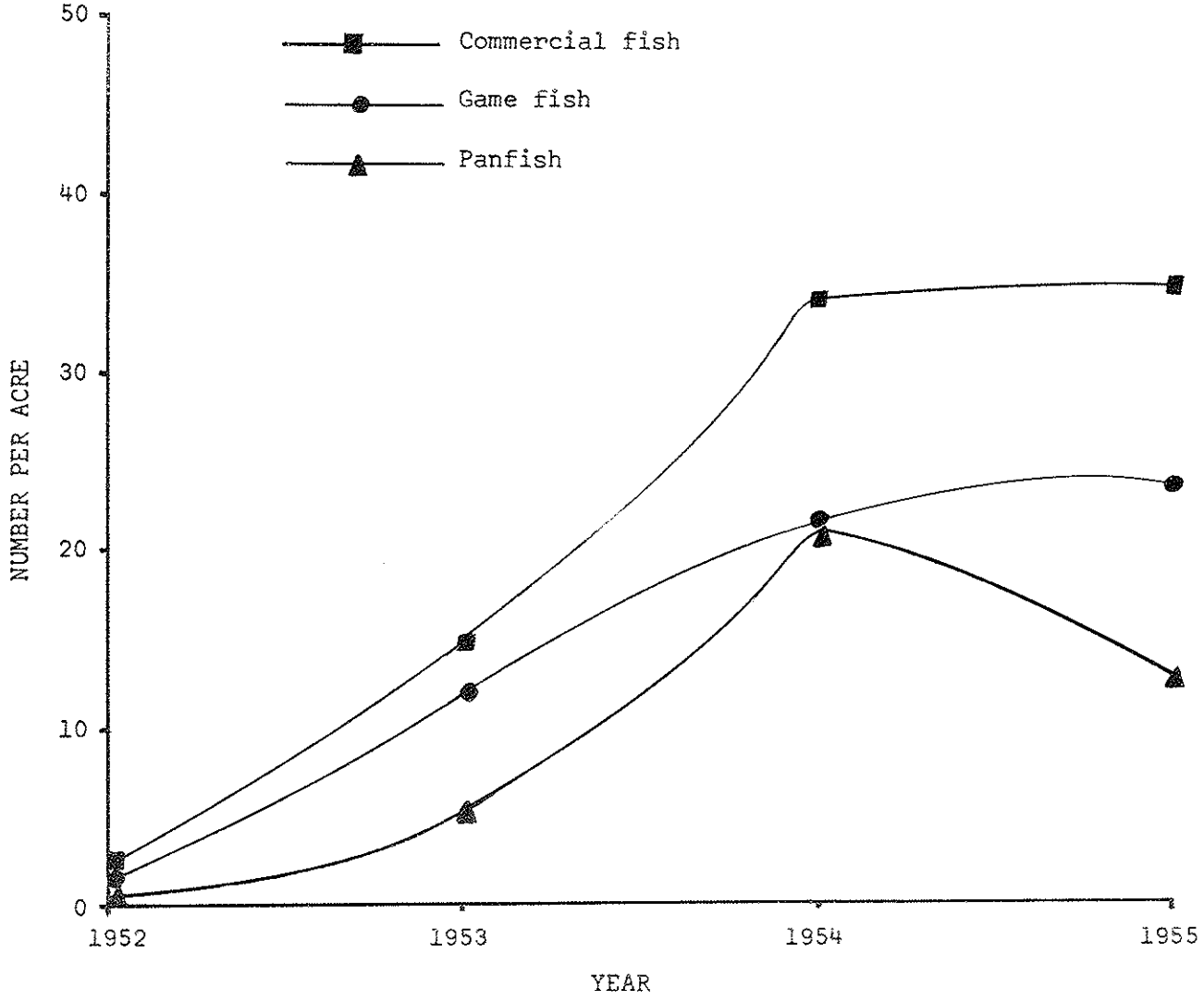


Figure 4. Numbers of harvestable size game fish, panfish, and commercial fish per acre. Cumberland Lake, 1952 - 1955.

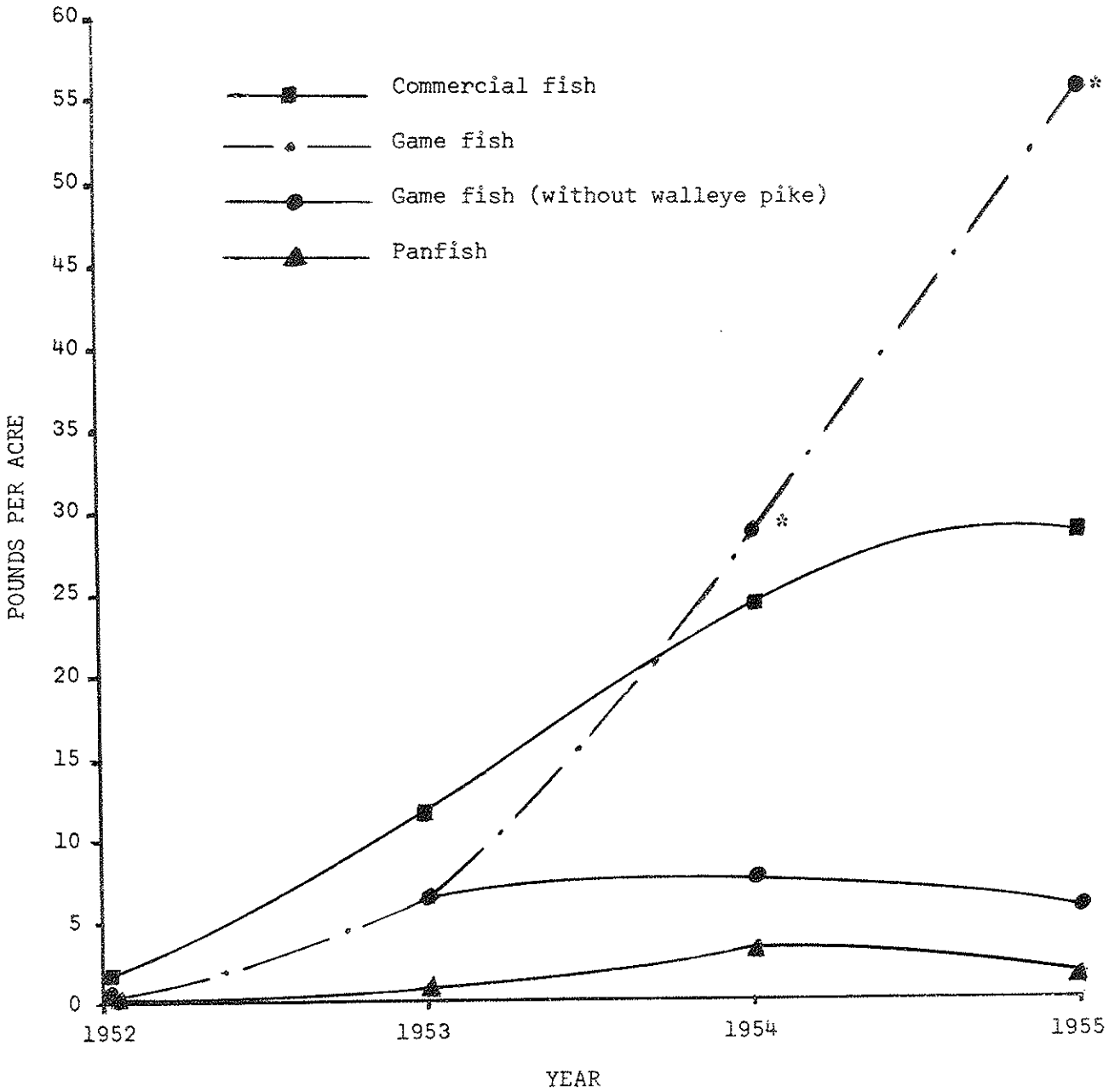


Figure 5. Pounds of harvestable size game fish, panfish, and commercial fish per acre. Cumberland Lake, 1952 - 1955.

* 95% walleye (headwater studies)

The fingerling and intermediate size white crappie dropped from 2.6 pounds and 16.2 pounds per acre, respectively, in 1954 to only 0.6 pound and 7.6 pounds in 1955. Conversely, the young-of-the-year white crappie increased nearly one hundred per acre during this same period. The total standing crop of intermediate size commercial fishes decreased also, from 19.84 pounds per acre in 1954 to 9.02 pounds in 1955. These losses in standing crop of the fish groups mentioned above were generally offset by substantial gains in the intermediate size gizzard shad and the harvestable size walleye pike as mentioned before.

The A_t values for Cumberland Lake ranged from a low of 42.6% (unbalanced with forage species) in 1952 to a high of 71.0% in 1955. The A_t values remained constant during 1953 and 1954 at a value of 63.9%.

Table 2. Standing crop and per cent of harvestable size fish present in Cumberland Lake 1952-1954.

Year	Standing Crop		A_t
	Lbs./acre	No./acre	
1952	39.8	896	42.6
1953	75.0	1437	63.9
1954	186.5	2267	63.8
1955	193.6	1842	71.0

Present Fish Population Statistics

The fish populations of Cumberland Lake were sampled a total of 42 times between 1960-1964. The same cove areas were not sampled 2 years in succession, with the exception of two study coves; one located in the upper region of the reservoir and one located in the lower region. Studies showed that non-pelagic fishes declined in numbers and weight in a large reservoir such as Cumberland Lake if sampling was conducted three years in succession. Effort was made to sample the various ecological environs of the reservoir during each year.

Fifty-two species of fish were collected during the fish population sampling between 1960-1964, Table 3. The four species, threadfin shad, white bass, striped bass and rainbow trout were stocked in the reservoir between 1957 and 1962. One blue sucker, *Cycleptus elongatus* LeSueur, was collected in a gill net in the headwater area of the reservoir in 1961, but never occurred in the rotenone samples.

The standing crop of fish varied during the five year study period from a high of 175.3 pounds per acre in 1960 and 174.5 pounds in 1963, to a low of 91.7 pounds per acre in 1964. Total numbers of fish varied from a high of 2520 fish per acre in 1960 and a low of 1296 fish per acre in 1964, Table 4 and Figures 6 and 7.

The substantial decline in the standing crop that occurred in 1964 (82.8 pounds per acre) was caused by the lack of recruitment of the gizzard shad into the population during 1961-1964. Following the first successful spawn of threadfin shad *Dorosoma petenense* Gunther in 1960, the gizzard shad population has decreased from 55% of the total number of fish in the population in 1960 to a low of 10% in 1964 (Figure 6). The slight increase in standing crop of gizzard shad during 1963 was not due to a successful spawn of this species, but was caused by a relatively high occurrence of large size gizzard shad in the cove sampling. The size structure of the gizzard shad population has shifted from a uniform size distribution of shad (1 to 6 inches) to an adult population of only 10-12 inch gizzard shad. Wyatt and Zeller (1962) following rotenone treatment for selective reduction of gizzard shad, stocked threadfin shad and observed similar changes in the gizzard shad population. The high population density of threadfin shad seemed to create a situation that inhibited the gizzard shad's ability to successfully reproduce.

Table 3. A list of fishes collected from Cumberland Lake, 1960-1964.

POLYODONTIDAE	
Polyoden spathula (Walbaum)	Paddlefish
LEPISOSTEIDAE	
Lepisosteus osseus (Linnaeus)	Longnose gar
CLUPEIDAE	
Dorosoma cepedianum (LeSueur)	Gizzard shad
Dorosoma petenense (Gunther)	Threadfin shad
SALMONIDAE	
Salmo gairdneri (Richardson)	Rainbow trout
HIODONTIDAE	
Hiodon tergisus (LeSueur)	Mooneye
CYPRINIDAE	
Semotilus atromaculatus (Mitchill)	Creek chub
Notropis atherinoides (Rafinesque)	Emerald shiner
Pimephales notatus (Rafinesque)	Bluntnose minnow
Pimephales promelas (Rafinesque)	Fathead minnow
Notropis spilopterus (Cope)	Spotfin shiner
Cyprinus carpio (Linnaeus)	Carp
Carassius auratus (Linnaeus)	Goldfish
Notropis boops (Gilbert)	Bigeye shiner
Notropis galacturus (Cope)	Whitetail shiner
CATOSTOMIDAE	
Hypentelium nigricans (LeSueur)	Northern hogsucker
Ictiobus bubalus (Rafinesque)	Smallmouth buffalo
Moxostoma duquesnei (LeSueur)	Black redhorse
Mosostoma erythrurum (Rafinesque)	Golden redhorse
Minytrema melanops (Rafinesque)	Spotted sucker
Carpiodes velifes (Rafinesque)	Carp sucker (high fin)
Cycleptus elongatus (LeSueur)	Blue sucker
ICTALURIDAE	
Ictalurus natalis (LeSueur)	Yellow bullhead
Ictalurus melas (Rafinesque)	Black bullhead
Ictalurus punctatus (Rafinesque)	Channel catfish
Noturus sp.	Madtom
Pilodictis olivaris (Rafinesque)	Flathead catfish

Table 4. Fish Population Composition of Cumberland Lake. 1960-1964 (42 studies combined - 47.1 acres).

SPECIES	1960						1961						1962						1963						1964					
	Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
GAME FISH																														
Largemouth bass	31.8	0.3	10.5	2.0	4.3	6.1	35.4	0.2	6.1	0.8	2.3	2.7	16.3	0.1	1.2	0.2	2.2	2.2	55.3	0.2	5.4	0.9	2.8	2.0	85.6	0.2	5.7	1.0	2.4	3.5
Smallmouth bass							0.5	t	0.8	0.2	0.3	0.3	0.1	t	0.3	0.1	0.3	0.3	6.5	0.1			0.2	0.2	1.2	t	2.3	0.1	0.2	0.8
Kentucky bass	20.0	0.2	9.0	2.4	2.3	2.0	62.6	0.4	5.7	0.8	2.8	1.2	52.3	0.7	8.1	1.1	2.4	1.2	67.6	0.7	6.4	0.8	3.5	2.0	34.3	0.5	8.8	1.2	1.2	0.8
White bass	3.4	0.1	6.0	1.0	0.5	0.5	4.4	0.1	9.2	2.3	5.6	2.6	2.1	0.1	2.0	0.2	0.3	0.3	6.1	0.1	0.2	t	0.1	0.1	2.0	0.1	24.3	0.5	1.0	0.6
White crappie	5.1	0.1	7.4	0.9	3.6	1.0	82.0	1.2	14.3	1.4	3.5	1.1	68.1	1.0	49.4	5.5	11.0	3.8	133.7	0.5	7.8	0.7	10.2	2.8	30.3	0.7	13.6	2.1	9.0	3.8
Black crappie															0.2	t	0.1	t									1.0	0.1		
Sauger																	0.1	0.1												
Walleye					0.5	2.8	0.1	t	t	t							0.1	0.1												
Grass Pickerel																					0.2	t								
TOTAL	60.3	0.7	32.9	6.3	11.2	12.4	149.6	1.9	36.1	5.5	14.5	7.9	138.9	1.9	61.2	7.1	16.5	8.0	269.2	1.6	19.8	2.4	16.8	7.1	153.4	1.5	55.7	5.0	13.8	9.5
PANFISH																														
Bluegill	57.5	0.4	53.1	2.7	12.1	2.0	212.0	0.6	70.0	2.7	9.3	1.6	252.1	1.0	63.2	2.9	6.7	1.2	48.5	0.5	54.3	2.3	6.9	1.2	79.0	0.6	34.2	1.7	2.8	0.7
Longear	149.3	0.9	56.9	2.9	1.5	0.2	116.4	1.0	109.2	4.0	1.0	0.2	145.5	0.8	114.3	4.4	2.0	0.4	104.6	1.1	103.3	3.3	1.0	0.1	51.2	0.8	93.1	4.1	1.2	0.2
Warmouth	3.4	t	1.3	t	0.7	0.1	1.2	t	4.3	0.2	0.1	t	2.4	t	2.5	0.1	0.2	t			0.2	t	0.4	0.1	1.1	t	1.4	0.1	0.4	0.1
Green sunfish							0.1	t	0.3	t					0.1	t					0.2	t	0.2	t						
Rock bass	0.3	t																												
Redear									0.1	t																				
TOTAL	210.5	1.3	111.3	5.6	14.3	2.3	329.7	1.6	183.9	6.9	10.4	1.8	538.9	1.8	180.1	7.4	8.9	1.6	153.1	1.6	158.0	5.6	8.5	1.4	131.3	1.4	128.7	5.9	4.4	1.0
PREDATORY FISH																														
Mooneye							0.4	t									0.1	0.1			0.1	t					0.1	t		
Longnose gar			0.8	t	0.2	0.8			0.2	0.2	0.1	0.2	0.1	t	0.2	0.1	2.2	4.9			0.1	t	0.2	0.3			1.2	0.6	0.4	1.0
TOTAL			0.8	t	0.2	0.8	0.4	t	0.2	0.2	0.1	0.2	0.1	t	0.2	0.1	2.3	5.0			0.2	t	0.2	0.3			1.3	0.6	0.4	1.0

Table 4. (continued)

SPECIES	1960						1961						1962						1963						1964					
	Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.		Fing.		Inter.		Harv.	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
COMMERCIAL FISH																														
Channel catfish	7.5	t	9.3	1.2	16.5	14.1	12.5	0.1	14.3	1.7	10.2	6.7	15.6	0.2	7.4	1.0	5.0	3.9	4.1	t	6.0	1.0	6.5	4.0	1.4	t	5.5	0.9	2.6	1.4
Flathead catfish	2.3	t	1.5	0.2	0.7	0.6	6.6	0.1	2.8	0.3	2.1	1.7	3.0	t	3.4	0.4	1.2	2.8	2.2	t	1.6	0.3	2.0	1.2	5.3	t			2.4	0.5
Bullhead							t	t					0.2	t	0.7	0.1														
Paddlefish											0.1	0.6			0.4	0.3	0.2	4.1												
Buffalofish					0.5	3.2	0.2	t			1.2	4.7					1.5	6.5			0.1	0.1	3.2	1.4					0.8	4.3
Redhorse	2.0	0.1	17.2	4.6	12.3	12.6	3.5	t	13.2	4.2	8.0	7.6	6.1	0.1	8.4	2.0	6.2	6.3			4.4	1.3	4.1	4.4			1.0	0.6	2.1	3.3
Carp					2.1	6.5					5.5	13.7					6.6	21.1					5.3	17.7					5.0	16.8
Carpsucker													0.5	t			0.4	1.5			0.1	0.1	3.3	2.7						
Hogsucker			0.5	0.1					t	t																				
Spotted sucker																	0.1	0.2												
Drum	2.8	t	23.4	2.5	5.2	3.3	32.3	0.9	51.6	3.8	3.4	2.2	5.2	0.1	43.8	4.5	0.7	1.2	0.1	t	31.2	3.9	2.7	1.4	2.0	0.1	24.3	6.0	3.9	1.7
TOTAL	14.6	0.1	51.9	8.6	37.3	40.3	55.1	1.1	81.9	10.0	30.5	37.2	30.6	0.4	64.1	8.3	21.9	47.6	6.4	t	43.4	6.7	27.1	32.8	8.7	0.1	30.8	7.5	16.8	28.0
FORAGE FISH																														
Gizzard shad	881.9	8.2	202.4	28.3	298.7	53.8	295.9	1.5	15.7	2.1	180.0	45.9	38.4	0.6	45.1	2.6	193.2	54.1	169.2	0.9	23.1	2.3	307.7	110.5	8.5	t	55.0	3.9	61.2	22.7
Threadfin shad	166.9	1.4	369.8	4.2	0.2	t	51.3	0.3	4.7	0.2	0.1	t	643.5	2.2	212.4	5.3	2.6	0.5	26.1	0.5	4.0	0.1	0.1	0.1	575.0	1.8	10.4	1.2		
Misc. cyprinids	2.0	t	7.2	0.1			209.7	0.5	2.1	t			52.4	0.2	3.0	0.1			12.6	0.1	13.1	0.1			8.2	0.1				
Brook silverside	9.7	0.3					29.7	0.1	t	t					0.1	t			7.3	t	8.5	0.1			6.4	t				
Darter	12.5	0.1	23.3	0.4			26.5	0.2	6.7	0.1			23.0	0.3	5.2	0.1			15.4	0.1	12.0	0.2			18.6	0.2	7.8	0.3		
Madtom							t	t							0.1	t														
TOTAL	1073.0	10.0	602.7	33.0	298.9	53.8	613.1	2.6	29.2	2.4	180.1	45.9	757.3	3.3	265.9	8.1	195.8	54.6	230.6	1.6	60.7	2.8	307.8	110.6	616.7	2.1	73.2	5.4	61.2	22.7
GRAND TOTAL	1358.4	12.1	799.6	53.5	361.9	109.6	1147.9	7.2	331.3	25.0	235.6	93.0	1465.8	7.4	571.5	31.0	245.4	116.8	659.3	4.8	282.1	17.5	360.4	152.2	910.1	5.1	289.7	24.4	96.6	62.2
TOTAL NO. AND STANDING CROP/A.			NO. 2519.9	WT. 175.2					NO. 1714.8	WT. 125.2					NO. 2282.7	WT. 155.2					NO. 1301.8	WT. 174.5					NO. 1296.4	WT. 91.7		

The threadfin shad has replaced the gizzard shad as the primary forage species in the reservoir (Figure 6), however, they have not replaced the gizzard shad to the same extent with regard to the standing crop (Figure 7). Threadfin shad represented 25% of the total fish population in 1960 and have increased to a high of 48% of the total numbers in 1964. However, severe winter kills of threadfin shad occurred in 1961 and again in 1963 with the threadfin shad population comprising only 3% and 2%, respectively, of the total numbers of fish in the coves sampled those years (Figures 6 and 7).

The numbers and weights of harvestable-sized commercial fish, game fish and panfish are shown in Figures 8 and 9. Commercial fishes showed an overall decrease in total numbers and weights during the study period. A low in numbers per acre occurred in 1962, with a corresponding high in the standing crop occurring during the same year, indicating that the individual fish in the population were generally larger than during the other years of the study.

The total numbers of harvestable-sized game fishes increased steadily during the first three years of the study (1961-63) with a slight decline occurring in 1964. The standing crop of game fish, however, decreased from a high of 12 pounds per acre in 1960 to a low of 7 pounds in 1961. The standing crop remained at this level through 1963 with a slight increase occurring in 1964 (Figures 8 and 9). The condition of the basses and white crappie improved greatly during this period, although it cannot be shown in the figures. The growth and survival of young-of-the-year black bass, mostly Kentucky bass, and white crappie showed a marked improvement following the introduction of threadfin shad in the lake. During preliminary investigations conducted in late 1959, the young-of-the-year Kentucky bass were averaging two to three inches in length by October of the same year, and

the white crappie were paper thin and averaged one to two inches in length. However, in October of 1960 following the first successful spawn of threadfin shad, the bass increased from 2 to 3 inches in length to 6 to 8 inches in length following their first summer of growth and the white crappie were averaging 3 to 4 inches in length. This substantial increase in the growth rate of bass and white crappie strongly indicates that the threadfin shad has definitely increased the amount of forage available to all sizes of the game fishes.

The harvestable size panfish (mainly bluegill and longear) declined steadily in total numbers and standing crop during the study period (Figures 8 and 9). The panfishes dropped from a high of 14 harvestable size fish per acre in 1960 to a low of only 4 per acre in 1964. The standing crop of harvestable size panfish dropped gradually from a high of 2 pounds per acre in 1960 to a low of only 1 pound in 1964. Cumberland Lake does not abound in panfish habitat, which explains the low standing crop of this group.

Reproduction

The reproduction of most species of fishes with the exception of gizzard shad showed a marked improvement during the study period. The total numbers of young-of-the-year fishes per acre increased more than 50% from 1961 through 1964, although only slight variations in the standing crop were observed during this same period (Table 4).

Fingerling-size black bass increased from a low of 52 per acre in 1960 to a high of 129 young bass per acre in 1964. Young-of-the-year white crappie increased from a low of 5 per acre in 1960 to a high of 134 per acre in 1963. The fingerling-size game fish group increased from a total of 60 fish per acre in 1960 to a high of 269 game fish per acre in 1963 (Table 4). The decrease in fingerling size game fish in 1964 was caused by a light spawn

of white crappie which had spawned successfully the past three years. The increases in the young-of-the-year game fishes can be attributed to the control of the reservoir drawdown by the United States Army Corps of Engineers during the spawning period of the black bass in the months of May and June and to the successful introduction of the threadfin shad.

Panfish and commercial fishes showed a substantial decrease in numbers from 1960 through 1964, however, the fishes spawned adequately from year to year to sustain a relatively high population density.

Cumberland Lake is a deep reservoir and the preferred habitat of the panfishes is lacking. There will never be a very large population of these fishes.

A_t Values

The A_t values for the Cumberland Lake fish population ranged from a low of 63% in 1960 to a high of 87% in 1963. There was a 12% increase in A_t values between 1960 and 1961 and this was caused by a decrease in the total standing crop of 50 pounds per acre in 1961. This loss was ascribable chiefly to a decrease of intermediate and harvestable-size gizzard shad. The A_t value was similar in 1961 and 1962, however, an increase of 12% was recorded in 1963. This increase was due to a gain of 56 pounds per acre in the standing crop of large gizzard shad. The secondary low in the A_t value (68%) occurred in 1964 and was ascribable to a decrease of 88 pounds per acre of the large size gizzard shad.

Table 5. Standing crop and percent of harvestable size fish present in Cumberland Lake 1960-1964.

Year	Standing Crop		A_t
	Lbs./acre	No./acre	
1960	175.2	2520	62.6
1961	125.2	1715	74.3
1962	155.2	2283	75.3
1963	174.5	1302	87.2
1964	91.7	1270	67.8

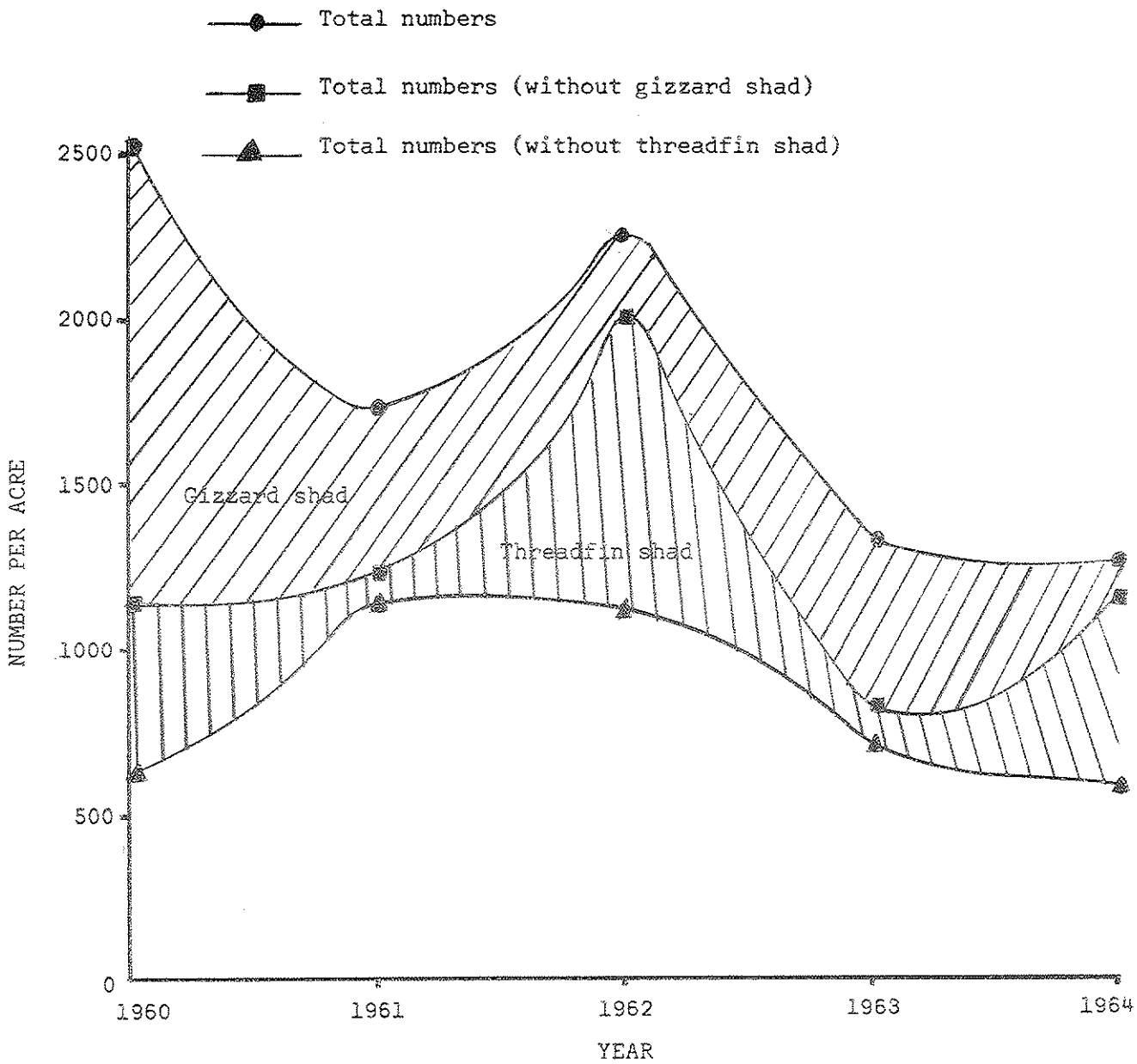


Figure 6. Total number per acre (with and without gizzard and threadfin shad). Cumberland Lake, 1960 - 1964.

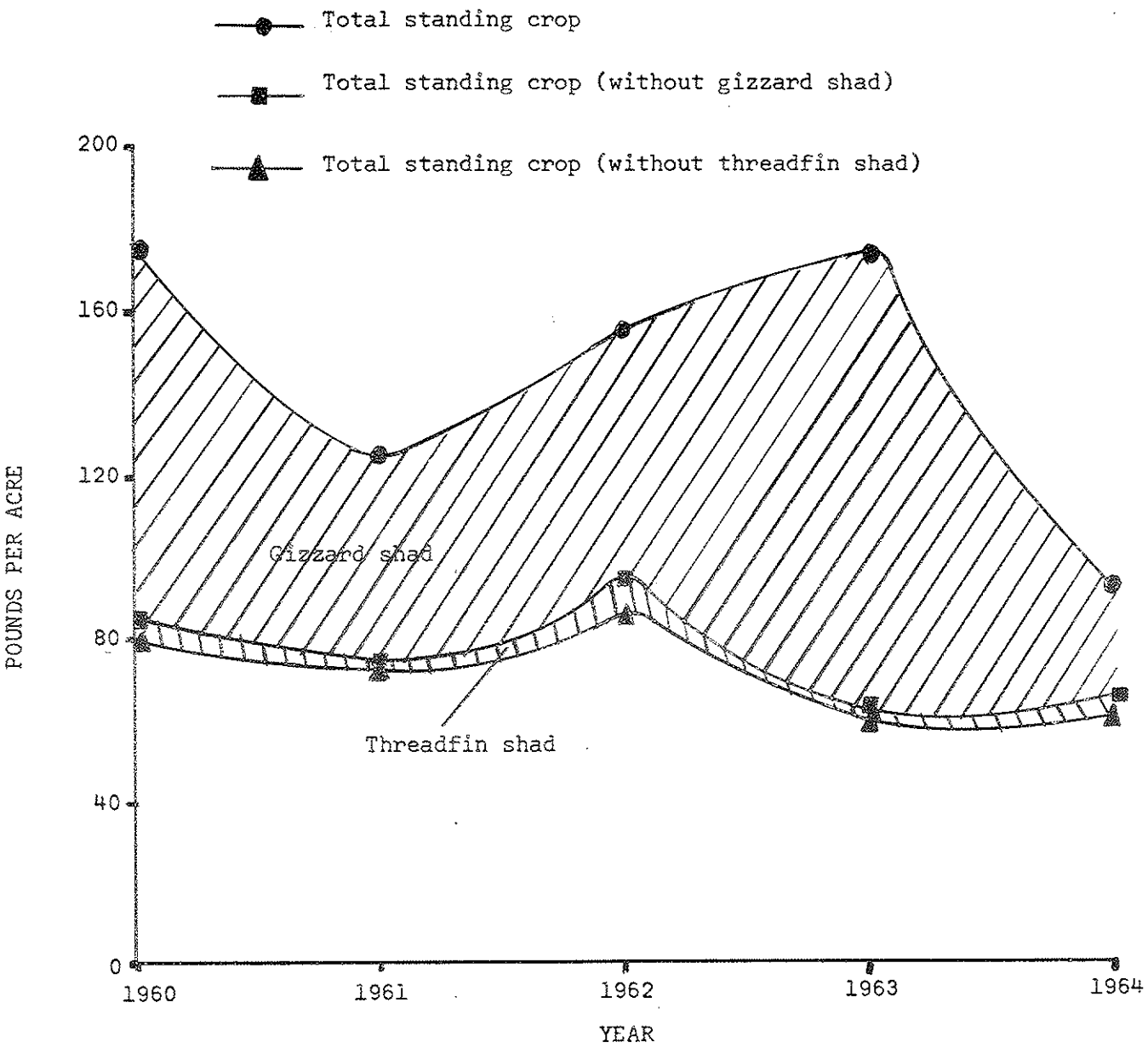


Figure 7 . Standing crop in pounds per acre (with and without gizzard and threadfin shad). Cumberland Lake, 1960 - 1964.

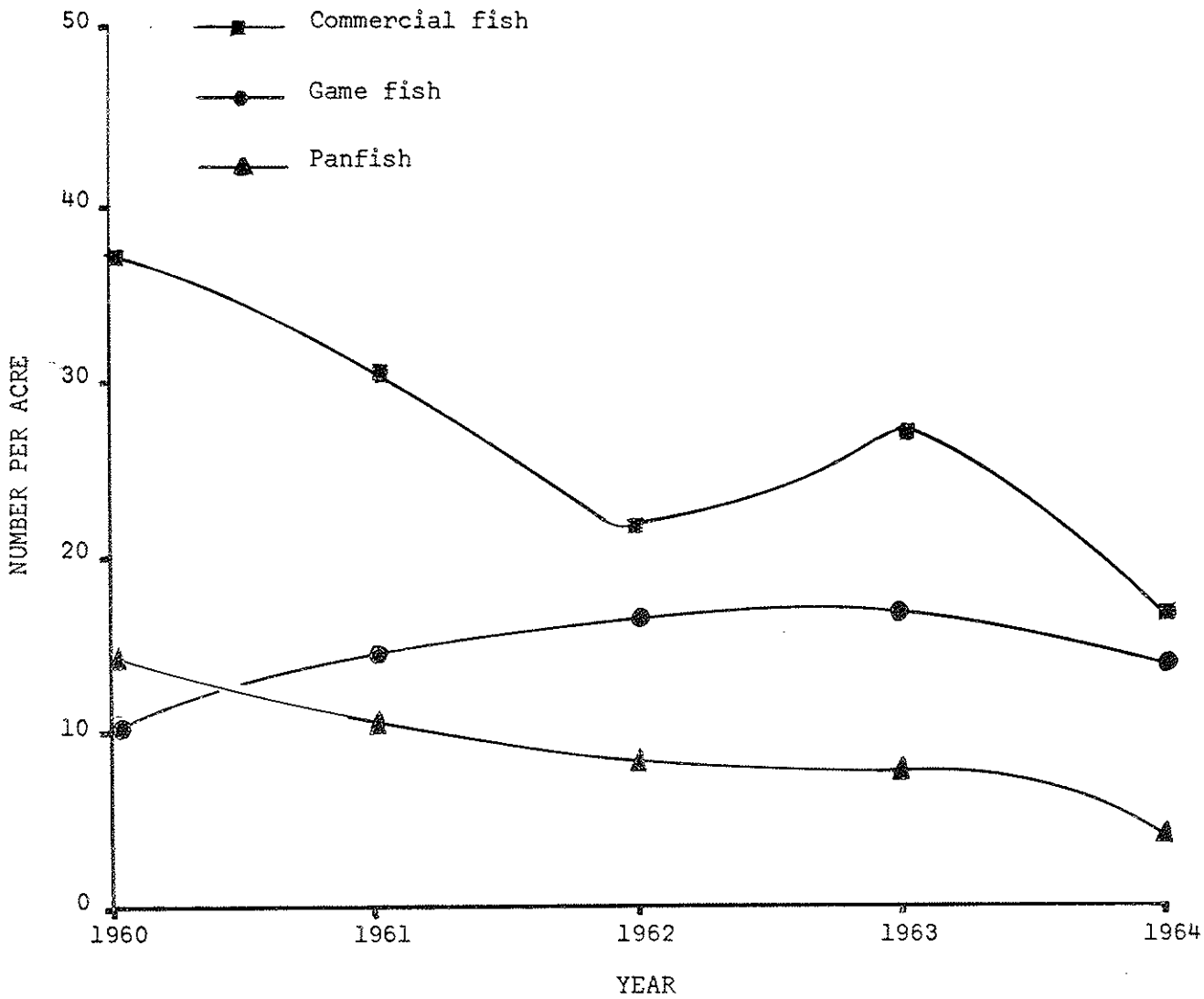


Figure 8. Numbers of harvestable size game fish, panfish, and commercial fish per acre. Cumberland Lake, 1960 - 1964.

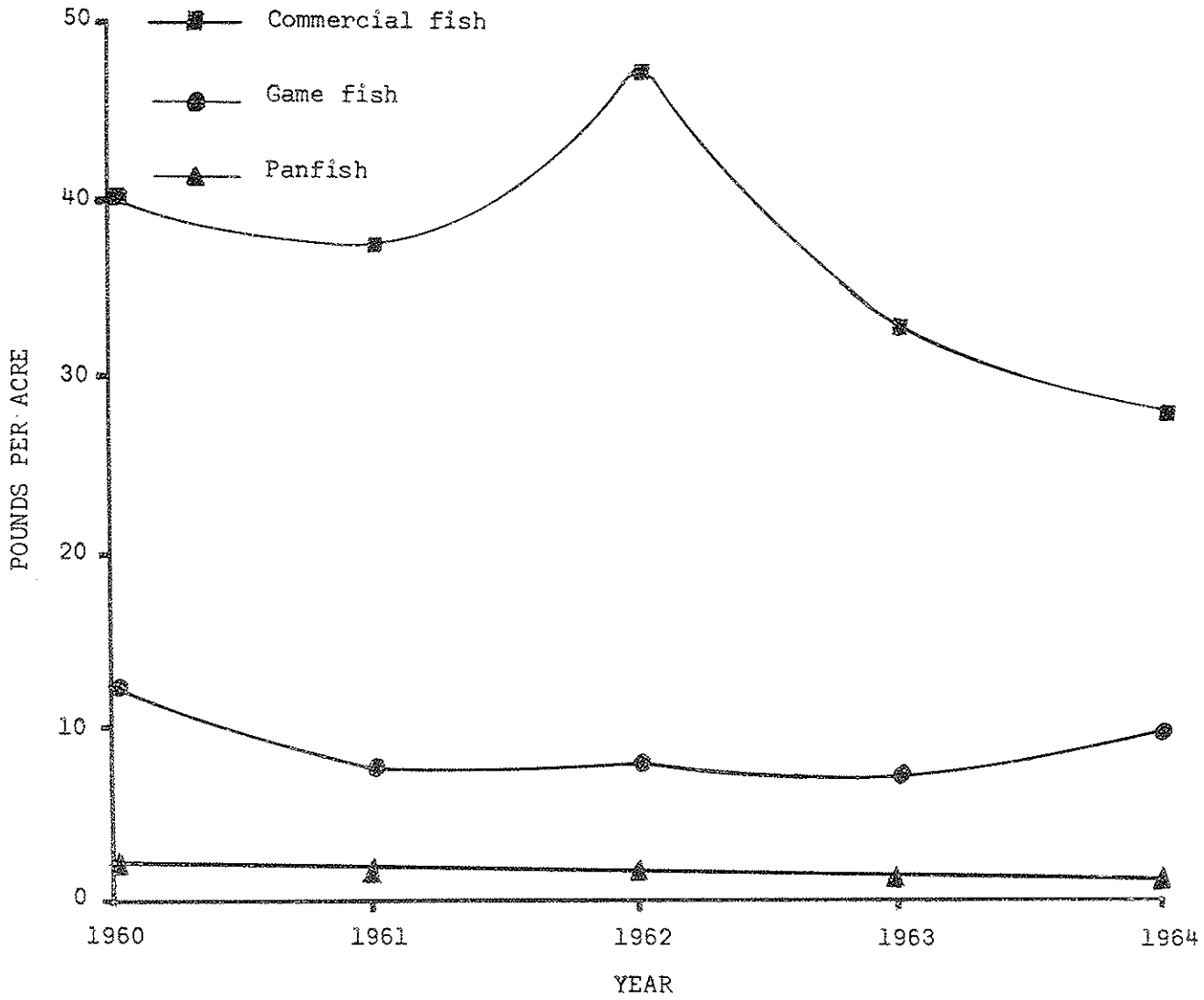


Figure 9. Pounds per acre of harvestable size game fish, panfish, and commercial fish. Cumberland Lake, 1960 - 1964.

Introduction of New Species

Since impoundment of the Cumberland River in the winter of 1950-51 many non-indigenous species have been stocked by individuals interested in a particular species of fish and by the Department of Fish and Wildlife Resources.

Probably the first non-indigenous species to be stocked (no records) was the white bass *Roccus chrysops* (Rafinesque) by a group of interested sportsmen from the Corbin and London areas of Kentucky. This stocking has been very successful and has made a major contribution to the sport fisheries of Cumberland Lake.

The only exotic forage species that has been introduced (on record) is the threadfin shad *Dorosoma petenense* (Gunther). Since impoundment there has been great concern of the lack of available and suitable forage. Although the gizzard shad is very prolific, their rapid growth to a non-forage size by mid-August makes them less desirable as a forage species, especially for the young-of-the-year fishes. Threadfin shad were introduced in 1957 (300 adults) at two locations, however no substantial reproduction was recorded until 1960. Threadfin shad normally spawn in May and early June and obtain a length of 1 to 1 1/2 inches by October. Because of their slower growth rate as compared to that of the gizzard shad, threadfin shad are much more available as a forage species.

The rock fish *Roccus saxatilis* (Walbaum) was introduced as early as December 1957, however little is actually known of this species in Cumberland Lake. A total of 811 rock fish (7 to 17 inches) have been stocked to date but no natural reproduction has been recorded. A rock fish that weighed 34 pounds was caught by Benny Polston in September, 1964. Growth of this fish was exceptional, but only two other small rock fish have been recovered.

An experimental introduction of rainbow trout *Salmo gairdneri* Richardson was made in 1962. A total of 148,878 rainbow trout (3 - 10 inches) have been stocked to date. No rainbow trout have been collected in the cove studies, however excellent growth has been obtained by the trout. Rainbow trout weighing between 3 and 4 pounds are regularly caught by fishermen now and one seven pound trout was caught in 1965. No reproduction has been reported, but more work in the tributary streams is needed.

Discussion and Conclusions

Studies were conducted on Cumberland Lake during 1952 through 1955 and again in 1960 through 1964. The purpose of the studies was to determine: (1) the species composition of fish; (2) the standing crop; (3) the survival and growth of the important game fishes; (4) the reproduction of the important game fishes.

The method of rotenone application found to be most effective and concurrently showing a higher rate of recovery of fish was by pumping the rotenone and water mixture to all depths through a weighted perforated plastic hose. It was found necessary to increase the diameter of the holes in the plastic hose as the depth increased so an even distribution of rotenone could be applied.

The standing crop of fish in Cumberland Lake increased from a low of 39.1 pounds per acre in 1952 to a high of 193.6 pounds in 1955. The fish population reached the carrying capacity of the reservoir 4 to 5 years after impoundment of the Cumberland River. The sport fishery declined in quantity and quality between 1957 and 1959, because of a lack of successful spawn of the important game fishes and a suitable forage species. Threadfin shad were introduced in 1957, however, no appreciable spawn was recorded until 1960. The introduction of threadfin shad has enhanced the sport fisheries more than any other single factor.

A recommendation was made to the U. S. Army Corps of Engineers to hold the lake level constant during the spawning period of the black basses. Many black bass nests were being left stranded above the lake level, when normal drawdown of the lake occurred during the months of May and early June.

The threadfin shad has suppressed the gizzard shad population and has replaced the gizzard shad as the principal forage species in the reservoir. The gizzard shad population decreased from 55% of the total number of fish in 1960 to a low of 10% in 1964. The threadfin shad has replaced the gizzard shad in total number but has not replaced them in standing crop.

The reproduction of most species of fish has been generally high through the course of the two studies 1952-55 and 1960-64. Young-of-the-year black bass as well as white crappie have consistantly averaged over one hundred per acre form 1954-55 and 1963-64.

A severe winter kill of threadfin shad occurred during 1961 and again in 1963. Threadfin were in wind-rows along the shore in certain areas of the lake. The apparent cause of death was the sudden change in water temperature. Threadfin shad were found in distress as they moved from under ice cover and into an area of ice free water. Due to the large size of Cumberland Lake, there is little fear that a complete kill of threadfin shad would ever occur.

Striped bass and rainbow trout were introduced in order to increase the predator population and to add additional sport fishes. The introductions were successful, but it is not known if these species will maintain themselves.

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Bernard T. Carter was project leader from 1951-1955 during which time he was in charge of the fish population studies.

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