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Abstract. Center Lake, having a surface area of 264 acres, is located in northwestern Iowa. During 1958 management problems in the form of stunted bullheads and carp along with very poor fishing, indicated the lake should be renovated. During October, 1958 liquid toxaphene was applied at a rate of 0.05 ppm. Apparently, a complete kill resulted.

During 1962 an estimate of the bluegill population was made. Nearly 1,100,000 bluegills or about 500 pounds per acre, were present at that time. The 1962 black crappie population was estimated at 250,000 or about 140 pounds per acre.

Based on a comprehensive creel census conducted on the lake during 1963, 1964, 1965, and 1966 approximately 124,200 angler trips totaling nearly 311,500 hours were made to the lake during the 4-year period. During these trips an estimated 1,054,853 fish totaling 291,305 pounds were creeled. An average year produced an estimated angler harvest of 275 pounds per acre. The high harvest rate occurred during 1964 when an estimated 480 pounds per acre were creeled.

Center Lake, having a surface area of 264 acres, is located in northwestern Iowa. This eutrophic lake of glacial origin has a maximum depth of about 14 feet. During periods of normal water levels, the shoal area is steeply sloping to about the 5-foot contour and is composed mainly of scattered boulders and sand. The remainder of the lake is composed of mud and silt. Because the shoreline is largely wooded and undeveloped, the littoral zone contains excellent habitat for fish in the form of dead limbs and fallen trees. Two sloughs connecting with the lake during periods of normal water levels make excellent spawning habitat for most fish present in the lake.

Moen (1962) aptly stated the management problems in Center Lake when he said,

> Late in the summer of 1958 stunted bullheads (3 years old, averaging 3.7 inches in length) were present at a population of about 580 pounds per acre. Carp Carp were the next most abundant species, comprising 213 pounds per acre. Other species, including walleye, northern pike, largemouth bass, black crappies, bluegills, and common sucker, accounted for less than an estimated 5 pounds per acre.

Based on these observations and very poor fishing, the decision was made to eliminate the existing fish population. It was decided the lake would be restocked for maximum production of largemouth bass and bluegills.

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On October 1, 1958 the lake was treated with liquid toxaphene at a rate of 0.05 ppm. Apparently, a complete kill resulted. The toxicity of the lake remained high throughout the winter. By May, 1959, minnows in a live-box lived for 2 weeks, thus it was assumed the lake had detoxified.

Restocking

Restocking of the lake began during June, 1959 with the addition of 60,000 largemouth bass advanced fry (Table 1).

Table 1. Species, numbers and size of fish stocked into Center Lake, 1959-66.

Year	Date	Species	Number	Size
1959	June	Largemouth bass	60,000	Advanced fry
	September	Largemouth bass	22,000	Fingerlings
1960	March	Bluegill	9,000	Adults
	July	Yellow bullhead	200	Adults
	August	Yellow bullhead	10,000	Fingerlings
	August	Largemouth bass	35,000	Fingerlings
1962	June	Largemouth bass	30,000	Advanced Fry
1963	August	Northern pike	53	Adults
	September	Largemouth bass	8,300	Fingerlings
	October	Northern pike	45	Adults
	November	Northern pike	24	Adults
	November	Northern pike	32	Fingerlings
1964	January	Northern pike	34	Adults
	April	Northern pike	259	Adults
	August	Yellow bullhead	6,000	Fingerlings
	September	Largemouth bass	10,000	Fingerlings
	October	Largemouth bass	4,000	Fingerlings
1965	August	Northern-muskie hybrids	18	Fingerlings
	September	Largemouth bass	10,000	Fingerlings

During the last week of July, a severe oxygen depletion, precipitated by dying algae, was experienced. Following this summerkill no dead leargemouth bass were noted. It was assumed that even though the water had not been toxic to minnows it had been toxic to the small stocked bass. Fingerling bass were stocked in September, 1959. Trawling in October indicated good survival of this stocking. With the successful establishment of a predator population, 9,000 adult bluegills were stocked during March, 1960. Crappies were inadvertently stocked along with the bluegills in 1960. Yellow bullheads and northern pike have been stocked since.

Population Sizes and Growth Rates

Bluegill. Seine hauls late in the 1960 summer, using 500 feet of one-fourth-inch web indicated a large number of young bluegills. Since this is a special study lake, it was thought desirable to have a more definite knowledge of this year-class size. During September, 1962, a simple Peterson-type estimate of the bluegill population was made. Bluegills were captured for marking with an otter

trawl. One week later the ratio of marked to unmarked fish captured through trawling operations indicated a population of 562,000 bluegills. Seining during this same period captured marked to unmarked buegills at a ratio indicating a population of 1,157,000 fish or about 500 pounds per acre. The population estimate obtained by seining was considered excessive, whereas trawling seemed to have produced a more realistic figure. Consequently, the size of this year class was estimated at between 500,000 and 600,000 (Moen op. cit.). Recent observations, however, indicate the population estimate obtained by seining was more nearly correct.

Growth rates for the 1960 year class of Center Lake bluegills were obtained by using the standard scale examination method (Table 2). These total lengths at each annulus are only slightly below those reported by Mayhew (1956) for bluegills in West Okoboji Lake.

Table 2. Mean total length in inches at each annulus for the 1960 year-class of bluegills in Center Lake as determined from examination of scale samples.

	Mean length at each annulus					
Sample Size	1	2	3	4	5	6
108	2.1	4.5	5.3	6.2	6.8	7.1

Test netting failed to indicate the presence of young bluegills until 1964. During 1964 an abundance of them was sighted near the weedy areas of the lake. One seine haul in an area considered as poor habitat for young bluegills captured nearly 5,500. Based on these observations, it was apparent they would present a management problem in the near future. Consequently, it was decided to try and selectively lower the population of these fish by applying light dosages of rotenone. Beginning early in September, 1964 and continuing for 9 days, 22.5 gallons of liquid rotenone was applied along the shoreline at a rate of 1 gallon per 1,000 shoreline feet, or a calculated application rate of about 0.05 ppm. Because of the many problem involved in making an accurate estimate of the number of young bluegills destroyed, the range of the estimated number killed was quite wide, between 500,000 and 1,000,000. During these applications fewer than 100 adult fish—including largemouth bass, northern pike, bluegills, and crappies—died. The effectiveness of this technique was apparent during 1965 when seining captured only fair numbers of yearling bluegills. Small hatches of bluegills have been observed during 1965 and 1966.

Black Crappie. During 1960, test netting demonstrated the presence of one young crappie for each 4 to 5 young bluegills. This ratio of about 20% was found in subsequent samplings done dur-

ing 1961 and 1962 (Moen op. cit.). By assuming the bluegill population in 1962 to be approximately 1,100,000, then the crappie population should have been nearly 250,000, or about 140 pounds per acre.

The average total length of crappies was determined from actual measurements taken near the end of each growing season. The overall growth is about average for this species in other lakes of the region (Table 3).

Table 3. Mean total length in inches for the 1960 and 1964 year-classes of black crappies from Center Lake as determined from actual meausurements taken near the end of each growing season.

Mean length at end of each growing season						
1960	1961	1962	1963	1964	1965	1966
3.4	6.4	7.3	8.2	8.4	9.3	9.4
				2.6	6.6	8.1

Seine hauls using 500 feet of one-fourth-inch web failed to capture significant numbers of young crappies until 1964. Since these young crappies were inhabiting the deeper portion of the lake at the time chemical work was done on the young bluegills, they were not measurably affected by the treatment. There has been good survival of this year class and they are now clearly the most abundant year class of crappie in the lake. Their growth during the first 3 years approximated that of the 1960 year class. Reproduction for this species during 1965 and 1966 has been limited.

Miscellaneous Species. The largemouth bass population is excellent with 3 year classes present, 1959, 1962 and 1964. Natural reproduction of this species has been limited until 1966.

Several attempts to establish a yelow bullhead population in Center Lake have been unsuccessful.

In recent years black bullheads have become well established in the lake even though there is no record of them having been stocked. In the near future this species is not expected to cause management problems, such as those experienced prior to renovation.

Since renovation, no carp were captured from the lake until the spring of 1966 when one young and one adult were taken.

Angler Harvests and Utilization

Following chemical treatment Center Lake was out of production, as far as the fisherman was concerned, for over 3 years. During the latter part of 1962 the bluegills and crappies had attained a size acceptable to anglers. Since angler utilization of the lake was expected to increase, it seemed desirable to have an estimate of the total number of each species caught and of total fishing pressure. Consequently, a comprehensive creel census, similar to that described by Rose in 1956, was used. This census

was first used on this lake in 1963 and has been employed each year since. The census period during the first 3 years extended from May through October. The 1966 census period encompassed only the months of May through September. Fishing pressure during the remainder of the year is too light to justify a full-scale census.

As expected, bluegill was the most abundant species creeled, comprising 71% of the total estimated 4-year catch. Nearly all of these fish came from the 1960 year class. (Table 4).

Black crappie were second in creel abundance accounting for nearly 17% of the estimated harvest. Prior to 1966 nearly all of the crappie caught were from the 1960 year class. During 1966 the bulk of the catch was composed of 1964 year class fish. Fishing for other species in the lake was quite poor. The small number. of largemouth bass caught can probably be explained by the lack of angling for this species. Most of the bass recorded were caught accidentally by bluegill and crappie fishermen.

One of the most enlightening aspects of this project is the total amount of fish creeled when expressed in pounds per acre. During 1963, 1964, 1965, and 1966 anglers harvested approximately 170, 480, 260, and 190 pounds per acre. The 480 pounds per acre angler harvest for 1964 may seem unreal but from personal observation this figure should be reasonably close. It was not uncommon to see parties creel 200 bluegills during an afternoon of fishing. The most striking figure here is not only the high harvest for 1964 but rather the consistency with which high yields occurred. During an average year 275 pounds of fish per acre were creeled from this lake.

Angling pressure was quite heavy during these census periods, totaling nearly 124,200 angling trips, or an average of about 31,000 trips per year. Nearly 311,000 hours were spent fishing in this lake, approximately 77,800 hours per year. Average fishing pressure amounted to 117 angling trips totaling 295 hours per acre per year.

One of the best means of determining fishing success is by examining the number of fish creeled per fishing hour. Fishing success has been excellent during the census period in each of the 4 years with observed fish per hour rates of 4.6, 4.12, 2.58 and 2.19 annually.

Discussion

It is apparent the renovation of this lake has been highly successful as demonstrated by the many hours of high quality fishing during the last 4 years. The 3.53 average fish-per-hour rate for this period is substantially better than the 2.07 and 1.27 rates observed for two other lakes in this region during the same time.

Table 4. Comprehensive creel census data for Center Lake, 1963-66.

	1963*		1964*		1965*		1966**	
Species	Fish	Weight	Fish	Weight	Fish	Weight	Fish	Weight
Bluegill	167,824	29,100	309,542	71,444	173,918	44,372	101.042	33,612
Black crappie	51,652	10,360	135,550	49,232	51,208	20,690	25,500	10,868
Bullhead	2,530	2,428	2,628	3,126	9,016	3,452	9,927	4,549
Largemouth bass	1,758	2,504	798	1,734	448	860	622	1,074
Yellow perch	204	28	34	14	136	194	43	13
Northern pike	0	0	186	564	0	0	287	1,087
Total	233,968	45,420	448,738	126,114	234,726	68,568	137,421	51,203
Angler trips	22,766		45,406		30,290		25,804	
Angler hours	49,118		108,914		90,744		62,795	
Fish/man	10.27		9.87		7.74		5.33	
Fish/hour	4.68		4.12		2.58		2.19	

*Census period May through October
**Census period May through September

Prior to renovation there was no indication that fishing in this lake would improve in the near future. Thus, it is assumed, that without this project, angler utilization of this lake would have been insignificant during the past 4 years.

The bulk of the bluegills caught were from the 1960 year class. These fish were in good body condition but by some standards they were small. Even though these fish were small, they were readily caught and because of this they were highly desired by people participating in this form of recreation.

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