FISHERY MANAGEMENT REPORT
DESOTO NATIONAL WILDLIFE REFUGE
Missouri Valley, Iowa

Louise Mauldin
U.S. Fish and Wildlife Service
Columbia Fishery Resources Office
May 2000

INTRODUCTION

DeSoto Lake is an 800-acre oxbow lake located at DeSoto National Wildlife Refuge in southwest Iowa. The lake supports a diverse sport fishery. The most recent fishery survey on DeSoto Lake was conducted May 18-19, 1999. The purpose of the survey is to describe the structure of the largemouth bass population in DeSoto Lake and to monitor species composition and relative abundance of the resident fish community. Largemouth bass are popular among anglers. Bass clubs hold bass tournaments each year in the spring. The Columbia Fishery Resources Office, Columbia, Missouri, collected survey data for 1999.

METHODS

The inshore fish community was sampled at several sites by use of a boom-mounted electrofishing boat (pulsed DC current, 707 Volts, 6.5 amps, 4-millisecond pulse width, 60 pulses per second) and Wisconsin type fyke nets on May 18 and 19, 1999. Fyke nets consisted of a 40-ft., ½ in. mesh lead, 2 rectangular frames (30 in. X 48 in.), and five, 2-ft. diameter hoops with a ½-in. mesh. Nets were set perpendicular to shore and fished for a standard net day (24hrs).

Sampling effort in 1999 included 103.3 electrofishing minutes (1.7 hours) and 171.1 fyke net hours. All fish species collected during the sample period were weighed (g) and measured (mm). Scales were removed from representative samples of black crappie. Water conductivity was 625 mmho/cm. Water temperature was 40.5^{o}F, secchi disc was 1.35 meters, and air temperature was in the mid 70s, with west winds ranging from 0-5 mph.

RESULTS

The following fish species were collected in DeSoto Lake:

Code	Common Name	Species Name	Role
BIB	Bigmouth buffalo	*Ictiobus cyprinellus*	Commercial fish
BLB	Black Bullhead	*Ameiurus melas*	Sport fish
BLC	Black Crappie	*Pomoxis nigromaculatus*	Sport or forage fish
BLG	Bluegill	*Lepomis macrochirus*	Sport or forage fish
CAP	Common Carp	*Cyprinus Carpio*	Commercial fish
FRD	Freshwater Drum	*Aplodinotus grunniens*	Sport fish
GSF	Green Sunfish	*Lepomis cyanellus*	Sport or forage fish
GZS	Gizzard Shad	*Dorosoma cepedianum*	Forage fish
LMB	Largemouth Bass	*Micropterus salmoides*	Sport fish
WAE	Walleye	*Stizostedion vitreum*	Sport fish
WHC	White Crappie	*Pomoxis annularis*	Sport or forage fish
YEB	Yellow Bullhead	*Ameiurus natalis*	Sport fish

Common carp and bluegill were numerically the dominant fish species collected in 1999 samples, constituting 48.3 and 26.1 percent of the total catch (Table 1). Common carp and largemouth bass comprised 45.3 and 32.5 percent of the sample weight.

Table 1. Fish collected in DeSoto National Wildlife Refuge, May 18-19, 1999 using pulse DC current (total effort 103.3 minutes (1.72 hours)).

Species	Number	Total Weight (kg)	Average Weight (g)	Average Total Length (mm)	Total Length Range (mm)	Percent Total Weight	Percent Total Number	CPUE No./Hr.	Number* Harvestable and (%)
BIB	1(27)[1]	6.27	6269	719	719	6.1	5.8	15.70	
BLC	34	6.82	200.6	223.5	111-312	6.7	7.4	19.76	33(97%)
BLG	120	6.69	55.8	122.0	51-179	6.6	26.1	70.93	44(37%)
CAP	54(222)[1]	46.2	855.5	422.5	382-521	45.3	48.3	129.07	54(100%)
FRD	1	1.00	1006	419.0	382-521	1.0	0.2	0.58	
GSF	8	0.78	98.7	117.0	66-152	0.8	1.7	4.65	
LMB	42	33.17	789.7	328.5	92-485	32.5	9.1	24.42	22(52%)
GZS	5	0.55	136.5	287	270-296	0.5	0.9	2.33	
WAE	2	0.51	254	302	300-304	0.5	0.4	1.63	2(100%)
TOTAL	461	102.0							

*Bluegill & other sunfish - ≥15 cm Bullhead & Crappie - ≥20 cm Flathead catfish - ≥40 cm Channel catfish - ≥ 25 cm Walleye, Carp & Buffalo - ≥30 cm Largemouth bass - ≥38 cm

[1]One hundred sixty-eight common carp and 26 bigmouth buffalo were collected but not weighed and measured. Their numbers are reflected in the total number of fish collected, percent total number, and CPUE. Their numbers are not reflected in the number harvestable or in the weight and length columns.

Fyke net samples were dominated by black crappie and gizzard shad, which comprised 47.0 and 39.5 percent of the fish sampled in 1999 (Table 2). These fish species also comprised 54.0 and 26.5 percent of the sample weight, respectively. Fyke nets also provided several black bullhead and yellow bullhead which were not seen in electrofishing samples.

Several species are known to inhabit DeSoto Lake, but were not collected in 1999 efforts. Channel catfish are generally collected in limited numbers every summer. Golden shiners and white suckers were collected in 1993 and flathead catfish and northern pike were collected in 1994. Walleye, which are stocked annually as fingerlings to sustain a fishery, are usually collected in limited numbers every summer. Two walleye were collected by electrofishing in 1999.

Established indices developed from long-term databases are used to evaluate the DeSoto Lake fishery. Several assumptions are made when using statistical indices to evaluate fish populations. Two assumptions include, all fish species are equally susceptible to the collecting gear used, and all sizes

Table 2. Fish collected in DeSoto National Wildlife Refuge using fyke nets, 18-19, 1997 (total effort 171.0 hrs).

Species	Number	Total Weight (kg)	Average Weight (g)	Average Total Length (mm)	Total Length Range (mm)	Percent Total Weight	Percent Total Number	CPUE No./Hr.	Number* Harvestable and (%)
BLB	4	0.32g	79.8	171.0	132-236	2.6	3.4	0.02	1(25%)
BLC	56	6.65g	118.8		102-298	54.0	47.0	0.32	52(93%)
BLG	50	0.72	144.8	131.4	67-171	5.8	4.2		2(40%)
WHC	3	0.76g	254.8	263.3	260-268	6.1	2.5	0.02	3(100%)
YEB	4	0.62	155.3	217.3	187-282	5.0	3.4	0.02	2(50%)
GZS	47	3.27	69.6	151.7	64-290	26.5	39.5	0.27	
TOTAL	119	12.34							

*Bluegill & other sunfish - ≥15 cm Bullhead & Crappie - ≥20 cm Flathead catfish - ≥40 cm Channel catfish - ≥ 25 cm
Walleye, Carp, & Buffalo - ≥30 cm Largemouth bass - ≥38 cm

within a species are equally susceptible to the collecting gear. Although these assumptions are made in the statistical realm, they are not true in the biological realm. In reality, larger fish of a species are more susceptible to electrofishing than smaller fish, and some fish species are more susceptible to electrofishing than others. Species such as gizzard shad and white bass, which occupy the open offshore area known as the pelagic zone, are generally out of an electrofisher's range and are not collected in proportion to their abundance. Crappie species, which occupy areas a little deeper and further offshore than other sunfishes, are most effectively collected with trapnets when they move inshore to spawn in the spring.

When sampling a water body annually, it is beneficial to look at trends in relative abundance and catch per unit effort over time. Catch per unit effort (CPUE) is the number of fish caught per period of sampling. In this case it is the number of fish caught per hour. These trends help indicate whether a fish species is increasing or decreasing in numbers from year to year. Although relative abundance data can be used to indicate trends, it must be interpreted cautiously since it can be biased by non-random distribution and gear selectivity. For example, bigmouth buffalo appear to have declined since 1994, however, electrofishing samples generally under-represent the true abundance of these species. Walleye are also under represented in this analysis due to habitat preferences and gear selectivity.

Relative abundance of carp from DeSoto Lake has shown an increasing trend from the mid to late 1990s, dominating catches in 1996, 1997, and 1999 (Figure 1). CPUE for carp was lowest in 1997 at 26.0/hr and highest in 1992 at 161.2/hr (Figure 2). Relative abundance of bigmouth buffalo over the 10-year period was highest in 1993 and 1994 and has since declined. Long-term data shows that abundance of black bullhead has significantly declined since 1989. CPUE of bullhead during

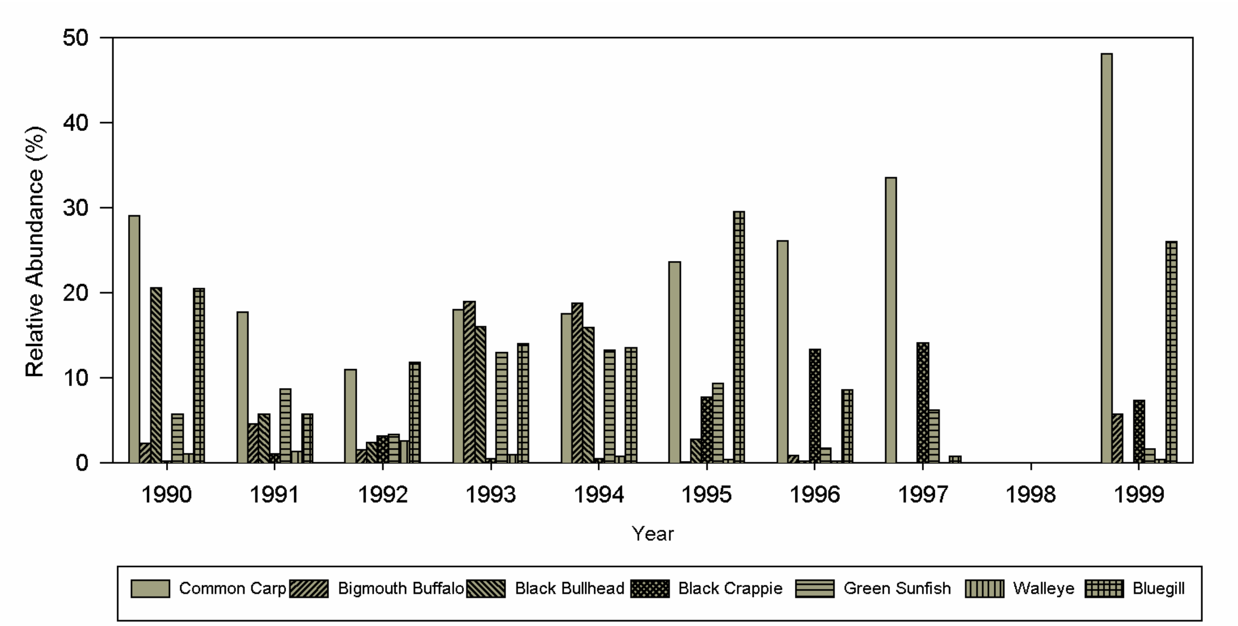

Figure 1. Relative abundance of selected fish species collected by electrofishing at DeSoto National Wildlife Refuge, 1989-1999.

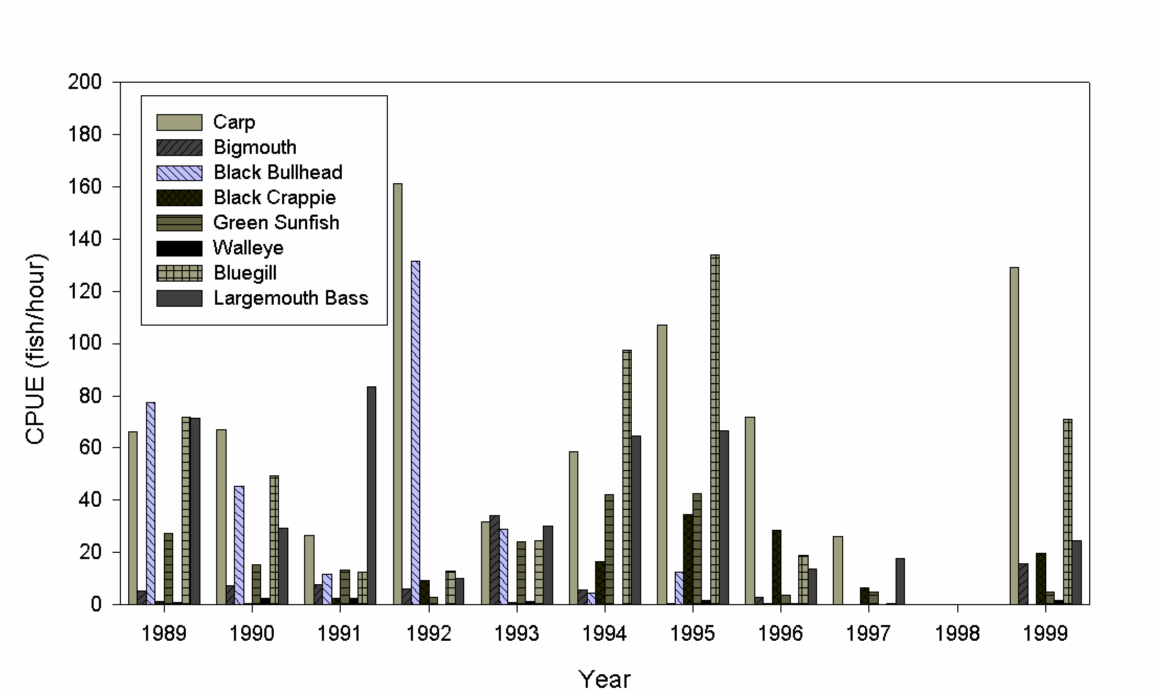

Figure 2. CPUE of sport fishes collected by electrofishing at DeSoto National Wildlife Refuge, 1989-1999.

electrofishing efforts dropped from 77.3/hr in 1989 to near zero levels in 1997 and 1999. Black crappie abundance was stable throughout the early 1990s, increased from 1994-1997 and declined in 1999. Bluegill abundance did not show a strong trend through time, fluctuating from year to year.

Relative Weight (Wr) is a measure of body condition. The measured weight of a fish is compared to an established standard weight of a fish the same length. Wr values greater than 100 indicate the individual fish weighs more than the standard weight. The preferred or target range of Wr values is 90-110. Mean or average Wr values close to 100 indicate fish populations or cohorts are in balance with their food supply. Fish with Wr values less than 85 are underweight, while fish with Wr values greater than 110 are overweight. Either of these extremes indicates that predator:prey ratios are not balanced and that there may be a problem with food supply or water quality.

Proportional Stock Density (PSD) is a measure of the size structure of a population. It is an index of community balance based upon rates of reproduction, recruitment, growth, and mortality. It also represents the percentage of fish that are attractive to an angler. The higher the percentage, the greater the proportion of large fish. PSD is calculated by dividing the number of fish $\geq$ quality size by the number of fish $\geq$ stock size X 100 (Flickinger and Bulow 1993). Sizes are based on percentages of world record length. This standardization allows for the discussion of different water bodies from different regions. The maximum lengths for minimum stock (S), quality (Q), preferred (P), memorable (M), and trophy (T) sizes are identified for individual fish species in graphs found further in this report.

Relative Stock Density (RSD) is the proportion of fish of any designated size group of fish. RSD is generally followed by a subscript indicating the size group (P, M, T) or by the minimum length considered in parentheses. All references to RSD in this report are RSD_P, or the relative stock density of fishes in the preferred or larger size groups.

Largemouth Bass

Largemouth bass are the dominant predator of DeSoto Lake. They are very important in maintaining desirable predator-prey equilibrium and serve as indicators of overall status of recreational fishery resources in small to medium size impoundments.

Late summer samples conducted in the past have shown declining numbers of bass in the lake, causing Service and state biologists concern that DeSoto Lake might be converting to forage fish fishery. Despite decreasing numbers, several bass tournaments have been sponsored by local bass clubs each spring on the lake. Low numbers of large bass from these surveys may be due to the time of season these surveys were conducted. Service staff decided to sample DeSoto Lake during the spring when bass move inshore to spawn and are more susceptible to shocking.

Forty-two largemouth bass were collected by electrofishing in 1999. CPUE was highest for 17-inch (431 mm) bass at 4.65 /hr (Figure 3). Fifty–two percent of the bass sampled were between 15 and 20 inches (preferred to memorable size). In 1997, most bass were between 13 and 16 inches (Figure 3). Bass sampled were in good condition with an average relative weight (Wr) of 106. No young-of-the-

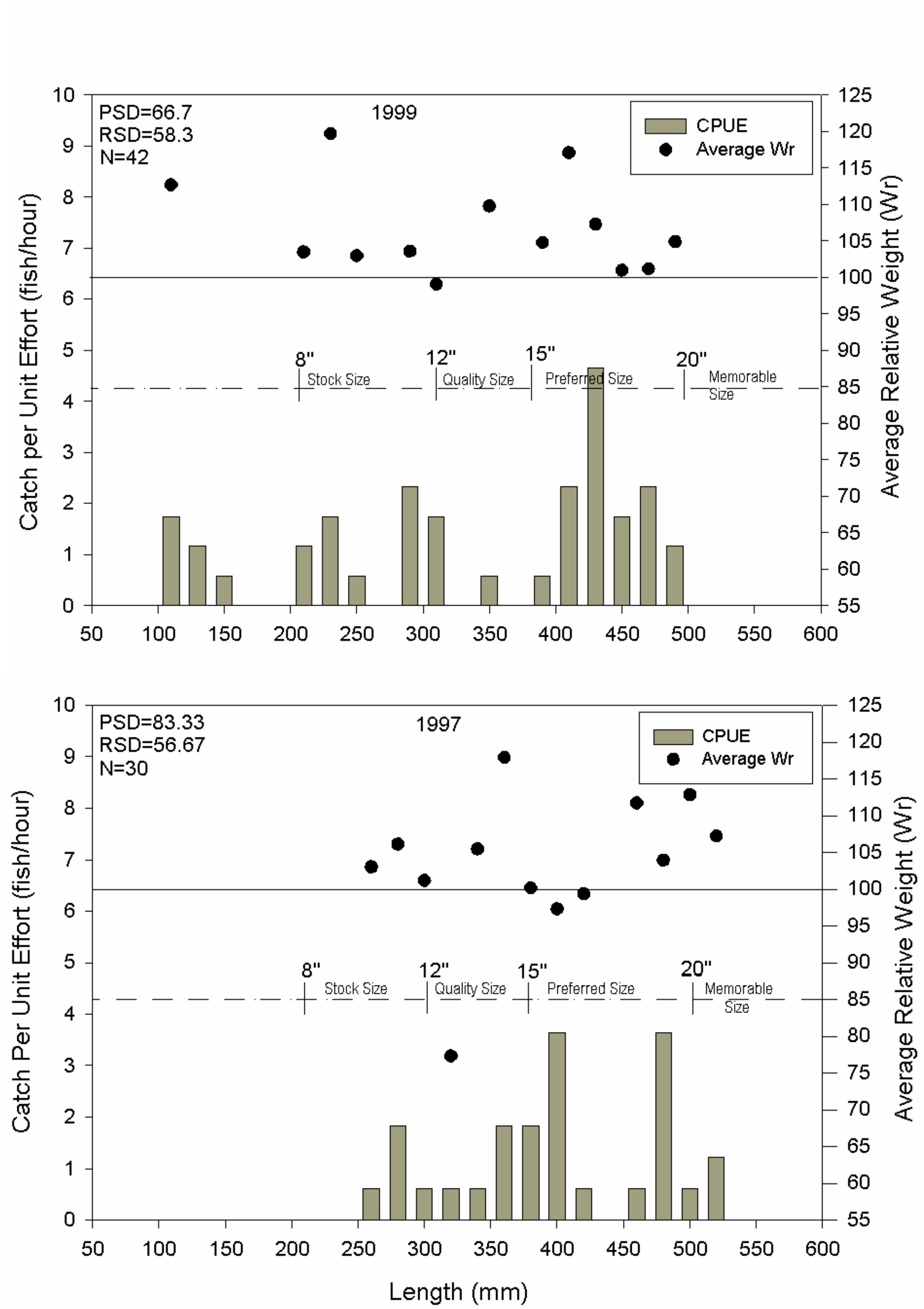

Figure 3. Largemouth bass collected by electrofishing at DeSoto National Wildlife Refuge May 18-19, 1999 (upper) and May 6-8, 1997 (lower).

year (YOY) bass were collected in 1997, because the survey was conducted before bass had spawned that spring. No Age I and Age II bass were collected in 1997 and low numbers were collected in 1999. Age was approximated for the largemouth bass represented in figure 3 based on the average total length for Age I and Age II largemouth bass in Iowa. Low numbers of 1 and 2 year-old fish collected from our survey may indicate a problem with recruitment. To further support possible low recruitment, large numbers of YOY bass were sampled in the fall of 1996; however, no fish of that year class were collected the following spring (1997). The 1996 cohort was either not large enough in size and did not have the energy reserves to survive their first winter due to an insufficient supply of food, or they were consumed by piscivorous fish or birds.

Largemouth bass greater than 380 mm (15-inch) constituted 4.8 percent of the total fish sample in 1999 and 50 percent of the largemouth bass sample. There is currently a 15-in minimum length limit in effect for largemouth bass, with a daily bag limit of three.

Figure 4 depicts the CPUE of bass greater than 150 mm (6 inches) and greater than 380 mm (15 inches) for the years 1989-1999. There is a noticeable difference in CPUE of bass >380 in 1989 and 1990 and then again in 1997 and 1999.

PSD of the DeSoto largemouth bass population is the percentage of fish in the sample greater than 203 mm (8 inches), which is also greater than 304 mm (12 inches). The desirable range for bass is 40-60 percent. PSD values larger than 60 percent indicate too many fish are larger than 12 inches. PSD values smaller than 40 percent indicate a lack of large size fish. PSD of this sample was 66.7, close to the desirable range.

Relative Stock Density (RSD) is a measure of the size structure of fish >380 mm (15 inches) in length. RSD is the percentage of a sample greater than 304 mm (12 inches) that is also greater than 380 mm (15 inches). Ideal ranges are 20-30 percent. The RSD of the 1999 sample was 58.3 percent. This indicates that a large portion of sampled bass greater than 12 inches were also greater than 15 inches.

High PSD and RSD values in 1999 and throughout much of the 1990s indicate that the largemouth bass community is dominated by larger, older bass (Figure 5). This provides quality fish for the avid bass fisherman. However, low recruitment, mainly due to slow growth, may cause problems in the future.

A mark-recapture bass population estimate was first completed for DeSoto in 1989 and yielded a point estimate of 3,361 fish greater than 150 mm (6 inches). The number of bass over 150 mm may have temporarily stabilized at about 2,000 fish in the early 1990s. Although mark-recapture numbers have not been sufficient to determine a point estimate since 1995, the CPUE of fish larger than 200 mm may provide an indication of large bass numbers. The CPUE of fish larger than 200 mm declined to 7.8 fish/hour in 1995 and reached an all-time low of 2.4 fish/hour in 1996, which again may be related to the time of season the survey was conducted. Largemouth bass were collected at a rate of 17.7 fish/hour in May 1997. Mean weight and length of these fish were the largest in recent years, but are still smaller than the 1989-1991 fisheries.

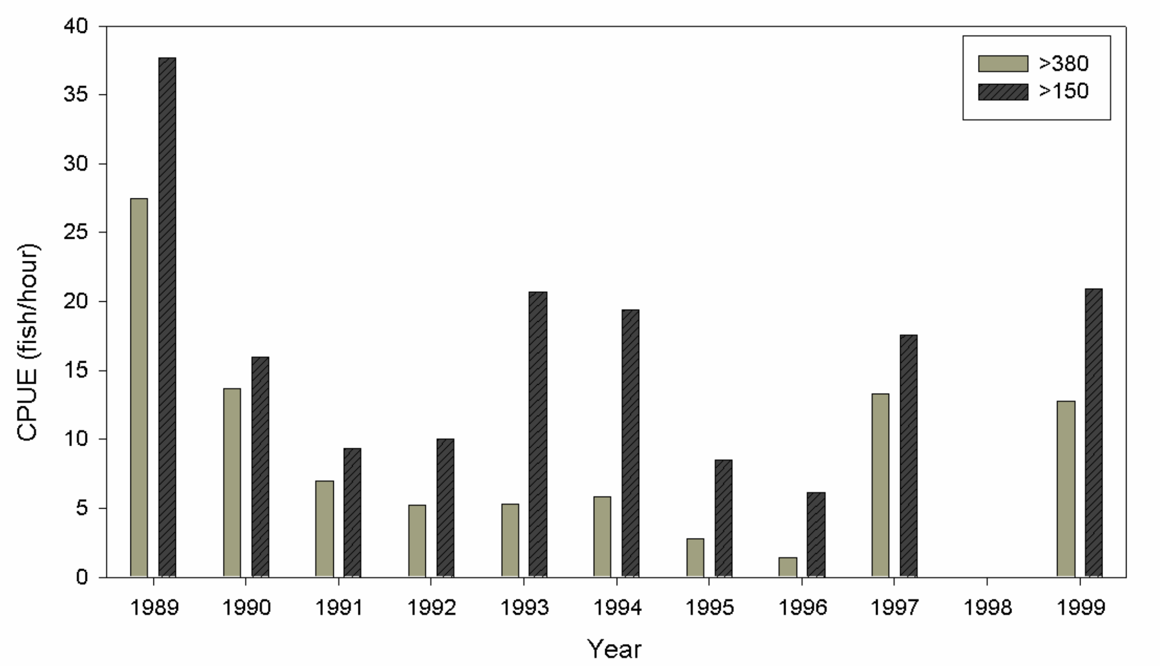

Figure 4. CPUE of largemouth bass collected in both community and bass samples from 1989-1999 at DeSoto National Wildlife Refuge.

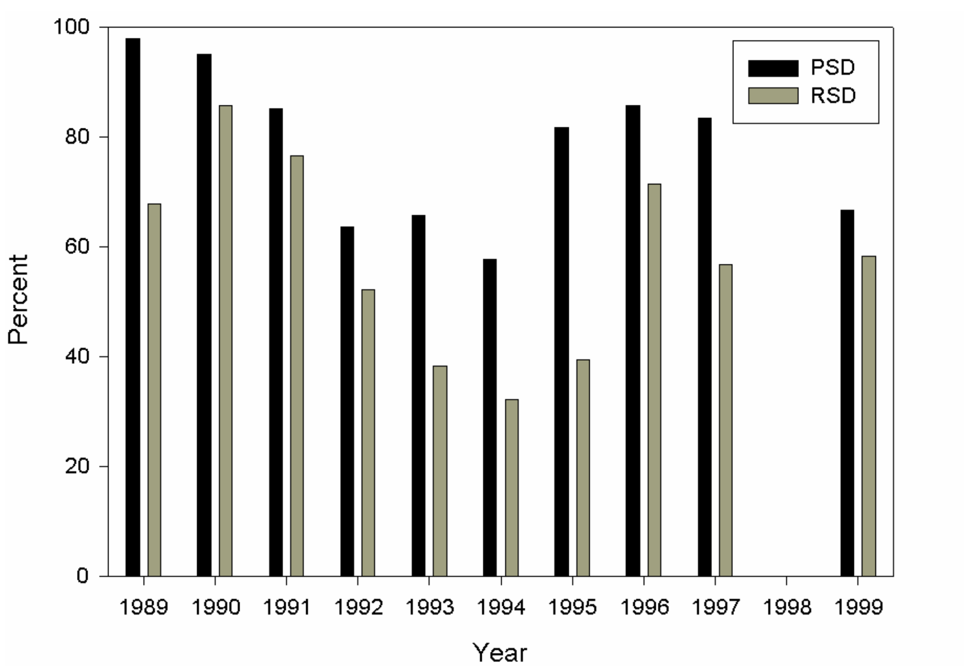

Figure 5. PSD and RSD of largemouth bass collected in both community and bass samples from 1989-1999 at DeSoto National Wildlife Refuge.

Bluegill

Relative abundance of bluegill in 1999 was 26.1 percent, a substantial increase from 1997 (0.8 percent). CPUE of bluegill increased from 0.61/hr in 1997 to 71/hr in 1999. CPUE was highest for fish in the 80-90 mm range (Figure 6). About 37 percent of the bluegills sampled in 1999 were of harvestable size, an increase from 16 percent in 1996. A low CPUE of bluegill in 1996 and 1997 may reflect the time period in which the survey was conducted. Low abundance in 1996 could be the result of sampling in late summer in which YOY were dominant. The 1997 fish survey was conducted in early May, probably prior to the production of bluegill that year. Prey abundance (zooplankton, littoral invertebrates), interspecific competition for prey, and continual stockings of predatory fish into the lake also may have contributed to the yearly variation in bluegill abundance.

PSD of this sample was 47.1%, close to the ideal range of 20-40% for prey species like the bluegill. A RSD value of 0.0 indicates that of the fish collected in 1999, there were no bluegill of preferred (8 inches), memorable (10 inches), or trophy size. Bluegill collected in 1999 were in very good condition with an average Wr of 109.0.

Black Crappie

Over the past 10 years, black crappie have constituted less than 15 percent of total fish caught in each year's electrofishing samples. CPUE was highest in years 1995 and 1996 at 34.7/hr and 28.4/hr, respectively. CPUE in 1999 electrofishing samples has decreased to 19.8/hr.

Black crappie constituted 47 percent of the fish collected in fyke nets in 1999 (Table 2). Black crappie collected from both gears were in good condition with an average Wr of 98.4 in electrofishing samples and 99.8 in fyke net samples.

The majority of black crappie sampled in 1999 were between 6.6-8.6 inches in length (Figure 7 and Figure 8). This is down from 9 to 11 inch range in 1997. PSD and RSD values of both electrofishing and fyke net samples indicate a larger proportion of fish in the stock and quality size ranges (5.9-9.8 in).

Scales were removed from 72 black crappie to determine the age structure of the population in 1999. The oldest black crappie sampled was Age V+ and would have been spawned in the spring of 1994 (Figure 9). Growth rates fall in the upper half of the accepted range for black crappie in Iowa (Carlander 1977). Crappie in the Midwest generally don't spawn successfully until Age III (9 inches). The majority of black crappie sampled in 1999 were Age III+ and Age IV+. These fish fall into the stock and quality size classes. Generally, crappie in impoundments with shad exhibit pulses or dominate year-classes every three to four years. Crappie harvest should continue to be good as harvestable numbers will be adequate. Stock size black crappie collected in our 1999 survey should recruit into the quality size range (7.8 in), providing anglers with continued harvest success.

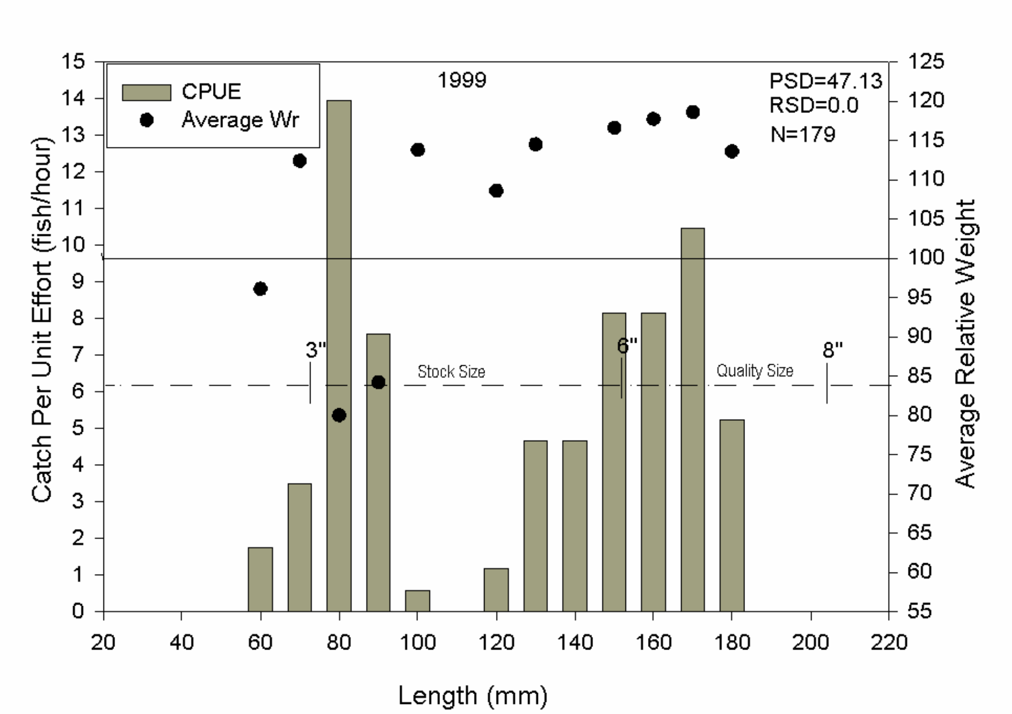

Figure 6. CPUE and average Wr of bluegill collected by electrofishing samples at DeSoto National Wildlife Refuge, 1999.

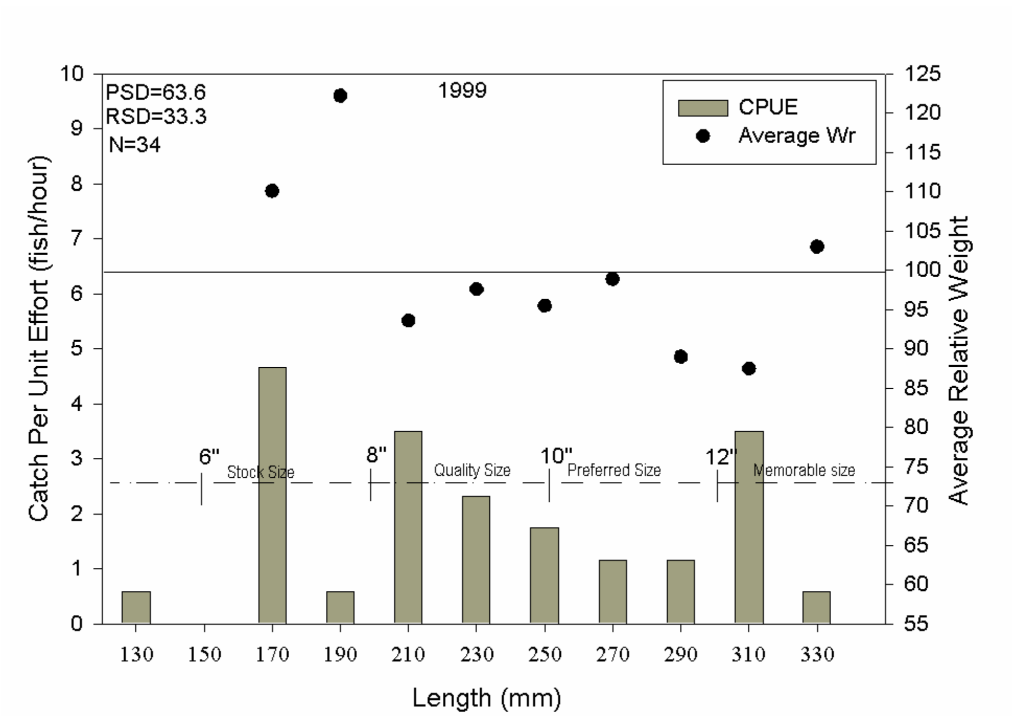

Figure 7. CPUE and average Wr of black crappie collected by electrofishing samples at DeSoto National Wildlife Refuge, 1999.

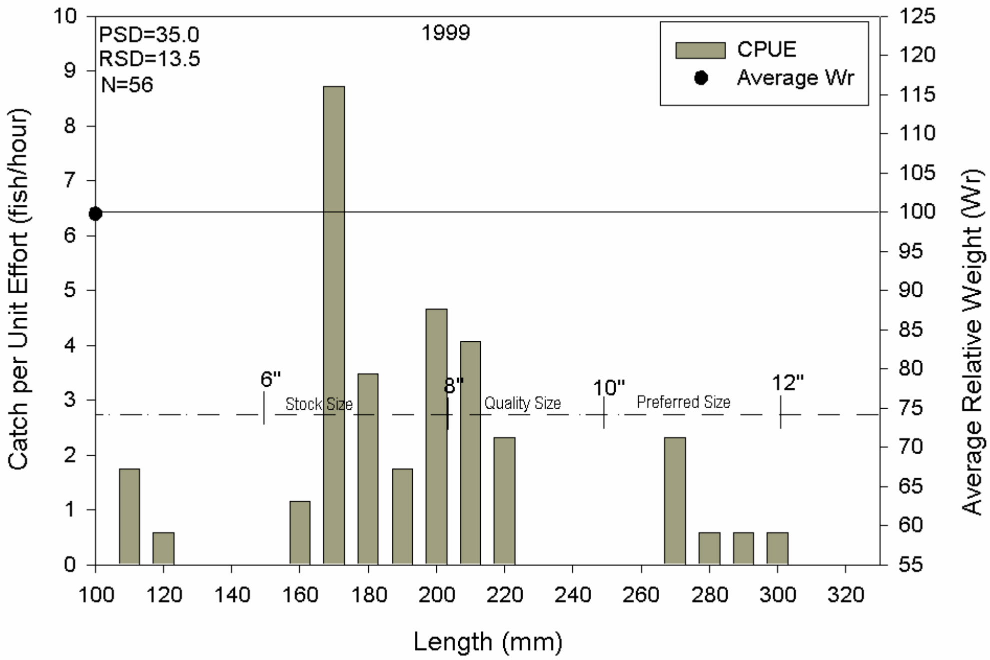

Figure 8. CPUE of black crappie collected by fyke nets samples at DeSoto National Wildlife Refuge, 1999.

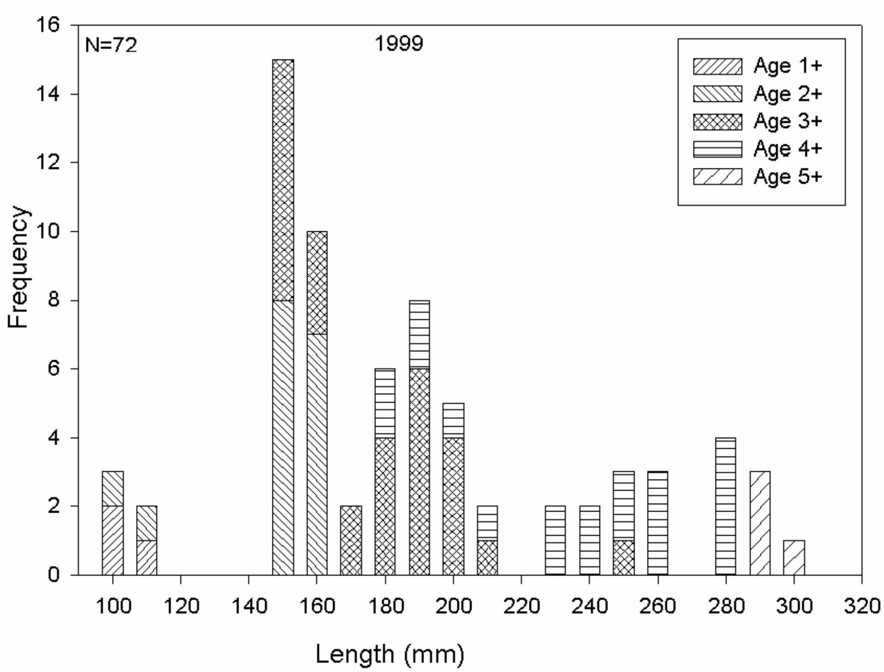

Figure 9. Ages of black crappie collected at DeSoto National Wildlife Refuge, May 1999.

White Crappie

Electrofishing in 1999 was not successful in capturing white crappie. White crappie numbers are usually small in DeSoto Lake. White crappie constituted 3.1 percent of the fish collected in 1996 and 2.5 percent in 1999 samples. Impoundments are generally dominated by one of the two crappie species. White crappie prefer warmer, more turbid waters than black crappie, which dominate DeSoto Lake. White crappie made up 2.5 percent of the fyke net catch. Sampled crappie were in good condition with an average Wr of 96.0 and all were of harvestable size (8"). They were quality size, ranging from 260 mm-268 mm. Scales were removed from three white crappie. One crappie was Age IV+ and the other two crappies were Age V+.

Common Carp and Bigmouth Buffalo

Electrofishing CPUE of common carp increased from 26.0/hr in 1997 to 129.07/hr in 1999. Relative abundance for this species increased from 34 percent in 1997 to 48.3 percent in 1999 (Figure 1). An upward trend in carp abundance (1995-1999) may be the result of an increase in available spawning habitat related to the floods of recent years.

All of the carp sampled in 1999 were of harvestable size (greater than 12 inches). They continue to be in very poor condition (Figure 10) with an average Wr of 69.1. Commercial fishermen usually do not have a market for very low quality fish. The large PSD (73.58) and the low RSD (0.0) of this sample is indicative of a population which has few stock size fish and low numbers of fish that are in the preferred size range. Carp appear to be stockpiled and competing for resources. Figure 10 may also indicate cropping of larger carp by commercial fishermen.

Relative abundance of bigmouth buffalo in 1999 was 5.8 percent of the total fish caught by electrofishing, higher than that reported in 1995, 1996, and 1997. It is not clear whether bigmouth buffalo population declines from 1995-1999 are real or are an artifact of inefficient sampling for this particular species. No bigmouth buffalo were collected by electrofishing in 1997.

Commercial harvest of carp in DeSoto Lake continues to decline. Commercial harvest has dropped from 7,960 pounds in 1995 to 1,645 pounds in 1996 to just 357 pounds in 1999. The decline in harvest may be explained by less fishing effort expended by commercial fisherman and the lower numbers of large carp. Commercial harvest of bigmouth buffalo also continues to fall; dropping from 34,028 pounds in 1995 to 18,092 pounds in 1996 to 8,752 pounds in 1999.

Black Bullhead

Long-term data suggests that black bullhead populations have declined. The reduction in the DeSoto Lake bullhead population is probably the result of stocking flathead catfish and to a lesser extent, walleye. Electrofishing did not yield bullheads in 1997 or 1999, but several were caught in fyke net samples in those years.

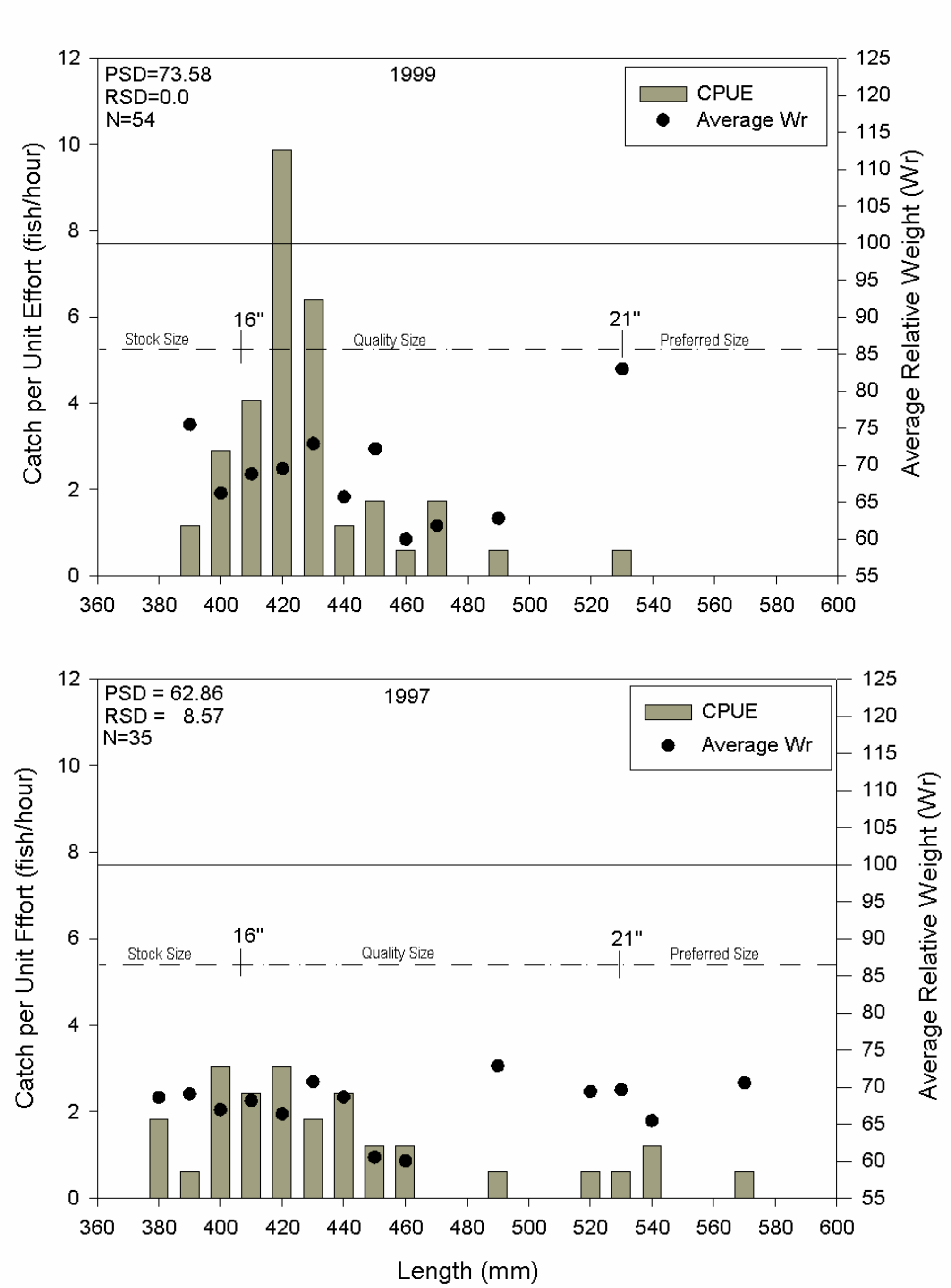

Figure 10. CPUE and average Wr of common carp collected by electrofishing samples at DeSoto National Wildlife Refuge, 1999 (upper), and 1997 (lower).

DISCUSSION

At present, our survey shows that larger, older fish, dominate the DeSoto Lake bass population and that there are few intermediate size fish present. Recruitment of bass into the exploited portion of the population appears to be a chronic problem. Success in collecting large numbers of YOY largemouth bass in late summer samples in previous years and low numbers of fish in spring, suggests that slow growth during the first year of life plays a major role in low recruitment. Slow growth results in poor foraging, increased predation, and low energy reserves for overwintering, ultimately resulting in lower survival. Before becoming piscivorous, largemouth bass feed predominantly on invertebrates. First they feed on zooplankton and then shift to aquatic insect larvae. Low abundance of aquatic invertebrates, or the reduction in mean size, affects the rate of growth of YOY bass. If largemouth bass lack the size advantage to feed on bluegill or other fish in the first season, they will continue to feed on invertebrates, potentially into the next growing season (Keast and Eadie 1985). Early shift to piscivory has shown to increase first year growth in bass (Keast and Eadie 1985). With higher growth rates, these bass are larger in size and have a better chance of survival, particularly through the first winter (Oliver et al. 1979, Gutreuter and Anderson 1985). These YOY bass, with greater net energy gains, are more likely to survive the winter and enter stock size the following season, than a group of smaller individuals still feeding on invertebrates.

Underlying factors of slow growth of the bass population in DeSoto Lake are speculative, but could encompass competition by YOY bluegill and other fish competing for zooplankton and insect larvae, or poor water quality caused by the addition of external loading of nutrients (mainly phosphorous) into the lake system, particularly in spring surface runoff from feces of hundreds of thousands of migrant waterfowl.

To increase bass recruitment, 5-inch or larger largemouth should be stocked in DeSoto Lake. The stocking of 5 to 6-inch bass will increase overwinter survival rates, it would increase the percentage of fish recruiting to stock size, and it may have noticeable effects on the structure of the prey community. Survival from stockings should increase the consumption of intermediate size bluegill and/or other fish.

Long-term trends in relative abundance show carp have dominated overall catch in the late 1990s. Black bullhead populations have decline over the decade as a result of an increase in predators. Trends in other species this past decade have exhibited various cycles. Quality and preferred sizes of black crappie will provide good fishing for the next year, as will bluegill.

Several different species have been stocked in the lake to control gizzard shad and bullhead. This probably has increased competition for food. White bass were stocked in 1996 to provide additional predation pressure on gizzard shad. Adult white bass feed almost exclusively on gizzard shad in Ozark reservoirs. The stocking decision was coordinated with Iowa Department of Natural Resources and Nebraska Game and Parks Commission Fishery Biologists who serve on the DeSoto Lake Fishery Management Coordinating Committee. Three hundred twenty-seven, 10-inch white bass were stocked in April of 1996 and four hundred, 8 to12-inch bass were stocked in 1999. Other fish stocked in DeSoto Lake in 1999 included three hundred, 8-inch channel catfish and two hundred, 9-inch walleye.

Completion of fish habitat projects by local groups and refuge staff in recent years, including helicopter-assisted placement of large cedar tree piles in October 1995 has benefited the sport fishery of

DeSoto Lake. The importance of such structure was demonstrated in 1994 and 1997 samples when larger numbers of harvestable size crappie were collected around sunken trees and a beaver lodge. Habitat improvement projects should be pursued at every opportunity. The large cedar tree piles are located far enough from shore to make electrofishing and fyke netting ineffective sampling gears. The real value of this habitat may be shown in increasing angler success.

RECOMMENDATIONS

1. Stock 5-6 inch fingerling largemouth bass and evaluate recruitment.
2. Encourage commercial harvest of common carp and bigmouth buffalo.
3. Continue monitoring recreational and forage fish populations.
4. Continue efforts to increase fish habitat.

LITERATURE CITED

Carlander, K.D. 1977. Handbook of freshwater fishery biology, volume two. The Iowa State University Press, Ames, Iowa. 431 pp.

Flickinger, S.A., and F.J. Bulow. 1993. Small impoundments. Pages 469-492. *In* Kohler, C.C. and W.A. Hubert (editors). Inland Fisheries Management in North America, American Fisheries Society 114:317-327.

Gutreuter, S.J., and R.O. Anderson. 1985. Importance of body size to the recruitment process in largemouth bass populations. Transactions of the American Fisheries Society 114:317-327.

Keast, A., and J.M. Eadie. 1985. Growth depensation in Year-0 largemouth bass: the influence of diet. Transactions of the American Fisheries Society 109:176-186.

Oliver,T.D., G.F. Holetron, and K.E. Chua. 1979. Overwinter mortality of fingerling smallmouth bass in relation to size, relative energy reserves, and environmental temperatures. Transactions of the American Fisheries Society 108:130-136.

APPENDIX A. Post-Renovation Fish Stocking Record of DeSoto Lake, DeSoto NWR.

Date	Species	Number	Size (in)	No./(lb.)	WT.(lb.)	Source
8/15/85	BLG	96,480	1	2680	36	GNFH
8/15/85	FHM	43,200	1-2	800	54	GNFH
8/22/85	BLG	99,960	1	2380	42	GNFH
8/22/85	LMB	54,720	2.25	228	240	GNFH
8/26/85	LMB	44,688	2.25	228	196	GNFH
8/26/85	LMB	334	6	10	33	GNFH
8/26/85	LMB	162	17-19	(3.5 EA.)	567	GNFH
8/26/85	FHM	400,000	2	300	1333	ICC
9/30/85	BLG	1,600	6	3	533	GNFH
10/2/85	CCF	1,500	7	17	88	ICC
10/2/85	CCF	160,000	2	187	855	ICC
10/10/85	FCF	4,500	4-5	50	90	SNFH
10/10/85	BLG	170,000	1-2	1000	170	ICC
4/14/86	NOP	800,000	FRY	50,000	16	GNFH
4/15/86	NOP	200,000	FRY	100,000	2	GNFH
4/24/86	WAE	500,000	FRY	100,000	5	GNFH
4/28/86	WAE	1,200,000	FRY	109,100	11	GNFH
5/1/86	WAE	522,500	FRY	104,500	5	GNFH
6/10/86	CCF	8,000	3.5-7	25	320	ICC
6/12/86	LMB	120,000	1	23,000	52	GNFH
7/22/86	PAH	800	4-5	105	7.6	GNFH
4/2/87	WAE	10,450	6	25	418	MNDNR
4/18/87	NOP	880,000	FRY	62,587	14	GNFH
4/16/87	WAE	800,000	FRY	100,000	8	CORDOVA, IL
4/21/87	WAE	200,000	FRY	100,000	2	CORDOVA, IL
6/87	BLC	2,500	ADULT	3.5	715	IDNR

Date	Species	Number	Size (in)	No./(lb.)	WT.(lb.)	Source
10/29/87	CCF	8,450	6-7	10	845	SNFH
4/11/88	NOP	1,000,000	FRY	58,824	17	GNFH
4/18/88	WAE	1,250,000	FRY	138,888	9	CORDOVA, IL
4/21/88	WAE	1,200,000	FRY	133,333	9	GPNFH
5/88	BLC	800	ADULT	3.5	230	IADNR
4/13/89	NOP	1,300,000	FRY	60,000	21.7	GNFH
4/18/89	NOP	1,700,000	FRY	60,000	28.3	GNFH
4/24/89	WAE	800,000	FRY	130,000	6.2	CORDOVA, IL
4/27/89	WAE	1,600,000	FRY	120,000	3.3	GNFH
5/10/89	NOP	20,000	2-3	631	31.7	NG&P
8/29/89	CCF	8,000	6-10	7.5	1067	NG&P
8/29/89	FCF	10,000	2-3	245	41	MDC
3/26/90	NOP	3,000,000	FRY			GNFH
4/19/90	WAE	800,000	FRY			CORDOVA, IL
4/20/90	WAE	1,600,000	FRY			GNFH
6/6/90	WAE	8,000	1-2	6.7	1200	GPNFH
8/2/90	LMB	39,000	2-3			GNFH
10/11/90	WAE	10,000	4			IRNFH
4/91	NOP	3,000,000	FRY	35,714	84	GNFH
4/91	WAE	2,400,000	FRY	72,727	33	GNFH
9/91	CCF	6,327	9	4.5	1402	GNFH
4/7/92	NOP	3,067,000	FRY	38,345	80	GNFH
4/19/92	WAE	2,400,000	FRY	100,000	27	GNFH
6/11/92	LMB	58,914	1.0	3,273	18	GNFH
8/4/92	CCF	8,000	6-8			IADNR
9/25/92	WAE	9,360	4-5	468	20	RYDELL, NWR
4/20/93	NOP	3,074,200	0.2	4.6	80	GNFH

Date	Species	Number	Size (in)	No./(lb.)	WT.(lb.)	Source
9/27/93	NOP	1,219	14.6	0.6	762	GNFH
8/10/94	FCF	300	15			IADNR
9/15/94	CCF	8,000	4		54	GPNFH
9/29/94	WAE	1,100	8-10			RYDELL, NWR
10/25/94	CCF	2,800	7			RATHBURN, IA
07/25/96	FCF	350	4-15		75	IADNR
09/26/95	CCF	5,100	7		797	RATHBURN, IA
09/28/95	WAE	2,500	6		167	GNFH
04/30/96	WHB	327	10		450	GNFH
08/96	FCF	250	9-12			IADNR
09/19/96	WAE	2,240	4		56	GNFH
09/24/96	CCF	1,831	7-8			IADNR
04/23/97	WHB	400	11-15		550/0.73	GNFH
08/28/97	CCF	2400	7		248/0.13	IADNR
09/17/97	WAE	2100	5-6			GNFH
04/15/98	WHB	400	12		600/1.5	GNFH
10/06/98	WAE	2000	6		117/17	GNFH
09/21/98	CCF	3000	7			IADNR
04/99	WHB	327	10			GNFH
09/99	CCF	300	8			IADNR
09/99	WAE	200	9			GNFH

APPENDIX B. Electrofishing and fyke net sites at DeSoto National Wildlife Refuge, 1999.