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ABSTRACT -- Cottonmill Lake, a 17.4 ha impoundment located in Buffalo County, Nebraska, was a fishery dominated by common carp (*Cyprinus carpio*). As a result of the poor sportfish populations, angler participation in May and June of 1993 was low (503 ± 210 angler hours) and angler catch rates for all fish species (0.5 ± 0.4 fish/angler hour) was less than desired. In 1995, before rehabilitation, bluegill (*Lepomis macrochirus*) trap net catch per unit effort (CPUE) was 1.5 ± 0.9, largemouth bass (*Micropterus salmoides*) catch per hour of electrofishing was 8.0 ± 0.5, and channel catfish (*Ictalurus punctatus*) CPUE in gill nets was 7.5 ± 2.5. In 1999, the Nebraska Game and Parks Commission (NGPC) and city of Kearney completed a lake rehabilitation project at Cottonmill Lake by removing 84,995 m^3 (300,000 ft^3) of sediment and adding two islands and four breakwater jetties. Standardized NGPC fishery survey conducted in 2003, four years after rehabilitation, found a significant increase in number of bluegill (CPUE = 28.3 ± 7.4; $p = 0.012$; $F = 12.86$; df = 1) and largemouth bass (CPUE = 496.0 ± 5.8; $p < 0.001$; $F = 34.33$; df = 1). In addition, angler participation in May and June 2006 was higher after rehabilitation (11,122 ± 1,333 angler hours), and angler catch rates for all species (1.5 ± 0.4 fish/angler hour) increased. The estimated angler expenditure while fishing at Cottonmill Lake during May and June 2006 increased to $367,026 in 2006 from an estimated $26,004 during May and June 1993.

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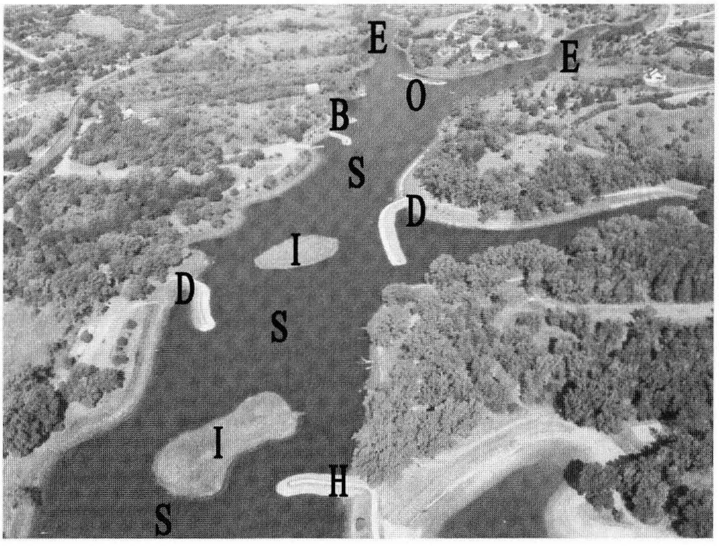
Key words: angler participation, creel survey, lake rehabilitation, Nebraska, quality fishery.

Aquatic habitat rehabilitation projects are conducted to improve fish habitat that has been lost or degraded due to natural aging and anthropogenic impacts (Allen et al. 2003). Healthy aquatic habitat is critical to develop a quality fishery and fisheries managers need to consider the entire lake ecosystem for improvements made to aquatic habitat (Minns et al. 1996, Willis et al. 2004). A successful lake rehabilitation project not only improves the quality of aquatic habitat, but also can increase the value of the resource (Bradshaw 1996).

In the Midwest, sedimentation contributes to degraded water quality and lake aging by decreasing water volume, smothering fish spawning sites, reducing diversity and abundance of aquatic life, and encouraging macrophytes (Summerfelt 1999). Sedimentation also increases the rate of lake eutrophication. Secondary problems associated with eutrophication include: increased frequency of algal blooms, decreased water transparency, increased density of littoral macrophytes, and increased occurrences of summer and winterkill events.

An additional threat to many Midwest fisheries is the presence of common carp (*Cyprinus carpio*). Common carp can affect lake water quality by increasing turbidity (Forester and Lawrence 1978). Increased turbidity has been linked to reduced growth in sportfish (Moorman 1957) and a decline in recruitment success of bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) (Forester and Lawrence 1978, Baur et al. 1979).

Cottonmill Lake, a 17.4 ha impoundment located 2.4 km west of Kearney, Nebraska, in Buffalo County, was an example of a Midwest lake that had experienced heavy sedimentation and had an abundance of "rough fish". The average depth of Cottonmill Lake was reduced from 3.6 m in the pre-1900's to 0.6 m in 1994 (Brakhage 2006) and in 1995 rough fish comprised 87% of the total fish captured during the standardized fish survey. In 1997, the Nebraska Game and Parks Commission (NGPC) and the city of Kearney initiated a lake rehabilitation project at Cottonmill Lake (Fig. 1). Project highlights included the removal of approximately 84,995 m^3 (300,000 ft^3) of accumulated sediment, fish population renovation, and creation of four breakwater jetties, two islands, and several underwater structures including: rock piles, wooden cribs, and cedar trees (*Juniperus virginiana*) to benefit Centrarchidae species (Rogers and Bergersen 1999). Along with the jetties and islands, a new pump system for pumping water from the Kearney Canal into Cottonmill Lake was installed to reduce future sedimentation problems. The rehabilitation project was completed in 1999 and post-project evaluation efforts continued through 2006. In 1999, bluegill and largemouth bass fingerlings were stocked at a rate of 1,000/0.4047 ha (1,000/acre) and 100/0.4047 ha (100/acre), respectively. Channel catfish (*Ictalurus punctatus*) were stocked at a rate of 50/0.4047 ha (50/acre). Largemouth bass were stocked



Key:

B – breakwater jetty built to protect boat access site and reduce shoreline erosion
D – wing dike built to protect cove and shoreline from erosion
E – excavation for cove habitat improvement
H – handicap-accessible fishing pier
I – island created for habitat and to reduce wave-related shoreline erosion
O – offshore breakwater built to reduce shoreline erosion
S – area of sediment removal

Figure 1. Aerial view of Cottonmill Lake in 1999 after completion of a lake rehabilitation project.

twice in 2000 and channel catfish were stocked every year except 2004 and 2006 following the initial stocking. The objective of our study was to evaluate pre- and post-rehabilitation: (1) relative abundance of largemouth bass, bluegill, and channel catfish; (2) angler participation; and (3) angler catch rates for largemouth bass, bluegill, and channel catfish.

METHODS

Standardized population surveys consisting of trap and gill netting and electrofishing were completed in May 1995 prior to rehabilitation and following completion of rehabilitation in May 2003. Trap netting was completed at four sites by using one double-throated trap net (1.27 m x 0.86 m frames with 2.5 cm stretch mesh) per site. Trap nets were set perpendicular to shore with the lead line extended to approximately 1 m in depth and fished overnight. Electrofishing, using pulsed-DC current (300 Volts and 6-7 Amps), consisted of four 15 minute stations. Experimental gill nets were set in open water and allowed to fish overnight. The gill nets were 45.7-m long by 1.8-m deep, and consisted of six 7.6-m panels with bar mesh sizes of 19, 25, 38, 51, 64, and 76 mm. Catch per unit effort (CPUE) was the number of fish collected per net night for trap and gill nets and for electrofishings was the number of fish collected per hour of electrofishing. CPUE from the 1995 and 2003 standardized surveys for bluegill, largemouth bass, and channel catfish were analyzed by using an Analysis of Variance (ANOVA) and statistical significance was set *a priori* at $p = 0.05$. Each species was analyzed separately and all means are presented ± SE.

Pre-rehabilitation creel survey data were collected in May and June 1993 from Cottonmill Lake and a post-rehabilitation creel survey was completed in May and June 2006. A roving creel survey with 10 sampling periods was conducted each month. Three time strata were chosen for the sampling periods (0600-1100 hours, 1100-1600 hours, 1600-2100 hours). NGPC Creel Software (Newcomb 1992) was used to design the survey schedule and analyze collected data. Creel survey results (means ± SE) were compared year to year and evaluated to determine increases or decreases.

RESULTS

Results from standardized sampling showed an increase in CPUE of target fish species at Cottonmill Lake after the rehabilitation. Bluegill CPUE increased from 1.5 ± 0.9 to 28.3 ± 7.4, electrofishing CPUE for largemouth bass increased from 8.0 ± 0.5 to 496.0 ± 5.8, and gill net CPUE for channel catfish went from 7.5 ± 2.5 to 34.0 ± 15.0 (Table 1). The increases in CPUE were significant for bluegill ($p = 0.012$; $F = 12.86$; $df = 1$) and largemouth bass ($p < 0.001$; $F = 34.33$; $df = 1$), but not for channel catfish ($p = 0.224$).

Results from creel surveys showed an increase in numbers of target fish species caught, estimated number of angler trips, estimated hours fishing, and overall catch rates. A total of 394 ± 164 angling trips resulted in an estimated 503 ± 210 hours of fishing in 1993. In 2006, an estimated 5,561 ± 666 anglers spent 11,122 ± 1,333 hours fishing. In 1993, anglers caught 521 ± 296 fish with a catch rate of 0.5 ± 0.4 fish/hr. In 2006, anglers caught an estimated 18,098 ± 2,768 fish with a catch rate of 1.5 ± 0.4 fish/hr. Total angler catch of bluegill and largemouth bass increased from 0 prior to rehabilitation to 11,349 ± 1,787 and 5,187 ± 1,029, respectively (Table 2). Estimated catch of channel catfish increased (57%) in post-rehabilitation surveys with the mean weight increasing from 0.2 kg (harvest weight

Table 1. Mean catch per unit effort (CPUE) (± SE) for bluegill, largemouth bass, and channel catfish collected in Cottonmill Lake, Nebraska, during standardized population sampling before and after rehabilitation. Means for each gear type that are followed by an * are significantly different ($p < 0.05$).

			CPUE	
Species	Gear	Effort	1995	2003
Bluegill	Trap net	4 net/nights	1.5 ± 0.9	28.3 ± 7.4*
Largemouth bass	Electrofishing	4/15 minute stations	8.0 ± 0.5	496.0 ± 5.8*
Channel Catfish	Gill net	2 net/nights	7.5 ± 2.5	34.0 ± 15.0

Table 2. Estimated angler trips, hours fished, number of parties and anglers interviewed, catch rate for all species, and the number of bluegill, largemouth bass, and channel catfish caught in 1993 and 2006 at Cottonmill Lake, Nebraska.

Measured Variables	1993	2006
Estimated angler days	394 ± 164	5,561 ± 666
Estimated angler hours	503 ± 210	11,122 ± 1,333
Parties interviewed	8	202
Anglers interviewed	11	454
Angler catch rate (for all species)	0.5/h ± 0.4	1.5/h ± 0.4
Number of bluegill caught	0	11,349 ± 1,787
Number of largemouth bass caught	0	5,187 ± 1,029
Number of channel catfish caught	450 ± 310	658 ± 147

102 ± 65 kg/number harvested 450 ± 310) to 0.7 kg (131 ± 41kg/ 181 ± 60). In 1993, there were only two species of fish caught by anglers, channel catfish and common carp. In 2006, five species were recorded in the angler catch: channel catfish, largemouth bass, bluegill, crappie (*Pomoxis* spp.), and northern pike (*Esox lucius*).

DISCUSSION

Lake rehabilitation projects have become a popular way of restoring a fishery and increasing the lifespan of a lake. Cottonmill Lake was chosen for rehabilitation because of the proximity to an urban area and potential to create a quality fishery.

Raising funds for large-scale rehabilitation projects can be difficult; thus, it is prudent to assess the outcome of these efforts. One goal of adding habitat structures in an enhancement project is to improve angler catch rates (Tugend et al. 2002). Logically, an increase in angler catch rates increases the popularity of the fishery and thus increases the economic benefits derived from the lake.

Our fish population sampling demonstrated a significant increase in bluegill and largemouth bass relative abundance between pre- and post-project surveys (Table 1). Although not significant, channel catfish relative abundance increased and the fish sampled were larger post-rehabilitation. Channel catfish are tolerant to poor lake conditions (Hubert 1999), so were able to maintain a fishable population, despite shallow lake depths (average depth < 0.7m), absent aquatic vegetation, a high proportion of "rough fish," and poor water quality prior to lake rehabilitation. After the rehabilitation, improved water quality and aquatic habitat contributed to more channel catfish and a larger average size. Alternatively, largemouth bass and bluegill have been shown to decline in impoundments with the presence of common carp (Forester and Lawrence 1978, Baur et al. 1979), thus, they were only able to maintain a low relative abundance before the rehabilitation. After the project, their relative abundance as measured by CPUE increased significantly.

Creel survey results indicated a substantial increase in the number of angler days and angler hours during May and June (Table 2). From 1993 to 2006 the estimated number of angler days increased by 5,167 days (1,300%) and the estimated angling hours increased by 10,619 hours (2,100%). Along with increased fishing pressure, the angler catch increased substantially. These results were much higher than noted in a comparison of pre- and post-creel data from a restoration project on a backwater area of the upper Mississippi River, which had an increase of 58% in angler effort and 117% increase in angler catch (Gent et al. 1995). A similar study on Lake Kissimmee, Florida, found no significant difference between pre- and post-data for electrofishing and creel data (Allen et al. 2003). The smaller size and poor pre-project habitat of Cottonmill Lake, along with the close proximity to a large human population base might explain the improved response observed in our project. Ideally more data could have been collected pre- and post-rehabilitation to base our analysis, but the dramatic difference in biological and creel survey results confirmed the success of the project.

A standard approach to assess the success or failure of a project is to analyze the derived economic benefits. The average angler fishing in Nebraska in 2006 spent $66 per day of fishing (United States Fish and Wildlife Service 2006). Extrapolating the estimated number of angler days in May and June provides an estimate of $26,004 spent in 1993 compared to $367,026 in 2006. The difference would be greater if we corrected for inflationary changes between 1993 and 2006. The rehabilitation of Cottonmill Lake cost approximately $1.5 million dollars. The estimated expenditures by anglers at Cottonmill Lake should surpass the lake restoration costs in a few years.

Overall, the lake rehabilitation project at Cottonmill Lake was successful. A cooperative effort of several coordinating entities from state, city, and local levels resulted in successful funding, planning, and completion of a $1.5 million lake restoration. We were able to rehabilitate a poor lake environment, supporting low public use, by excavating sediment, constructing shoreline improvements (e.g., jetties), and building islands to create a high quality aquatic environment capable of supporting a popular and high-use sport fishery. Fish population response was exceptional, with Cottonmill Lake now supporting excellent populations of largemouth bass, bluegill, and channel catfish that are sought highly and used by anglers. Fish population and angler survey information have documented substantial improvements in fish populations and angler use. In addition to fishery benefits, clear water and improved aesthetic conditions resulting from the project have promoted many activities such as boating and wildlife viewing at Cottonmill Lake.

LITERATURE CITED

Allen, M. S., K. I. Tugend, and M. J. Mann. 2003. Largemouth bass abundance and angler catch rates following a habitat enhancement project at Lake Kissimmee, Florida. North American Journal of Fisheries Management 23:845-855.

Baur, R. J., D. H. Buck, and C. R. Rose. 1979. Production of age-0 largemouth bass, smallmouth bass, and bluegills in ponds stocked with grass carp. Transactions of the American Fisheries Society 108:496-498.

Bradshaw, A. D. 1996. Underlying principals of restoration. Canadian Journal of Fisheries and Aquatic Sciences 53 (Supplement 1):3-9.

Brakhage, P. 2006. Project improves water quality at Cottonmill Lake. Nebraska Department of Environmental Quality, Report (unpublished). Lincoln, Nebraska.

Forester, T. S., and J. M. Lawrence. 1978. Effects of grass carp and carp on populations of bluegill and largemouth bass in ponds. Transactions of the American Fisheries Society 107:172-175.

Gent, R., J. Pitlo, Jr., and T. Boland. 1995. Largemouth bass response to habitat and water quality rehabilitation in a backwater of the Upper Mississippi River. North American Journal of Fisheries Management 15:784-793.

Hubert, W. A. 1999. Biology and management of channel catfish. American Fisheries Society Symposium 24:3-22.

Minns, C. K., J. R. M. Kelso, and R. G. Randall. 1996. Detecting the response of fish to habitat alteration, in freshwater ecosystems. Canadian Journal of Fisheries and Aquatic Sciences 53 (Supplement 1):403-414.

Moorman, R. B. 1957. Some factors related to success of fish populations in Iowa farm ponds. Transactions of the American Fisheries Society 86:361-370.

Newcomb, B. 1992. User's guide for Nebraska creel surveys. Fisheries Division, Nebraska Game and Parks Commission. Kearney, Nebraska.

Rogers, K. B., and E. P. Bergersen. 1999. Utility of synthetic structures for concentrating adult northern pike and largemouth bass. North American Journal of Fisheries Management 19:1054-1065.

Summerfelt, R. C. 1999. Lakes and habitat management. Pp 285-320 *in* Inland fisheries management in North America, second edition (C. C. Kohler and W. A. Hubert, editors). American Fisheries Society, Bethesda, Maryland.

Tugend, K. I., M. S. Allen, and M. Webb. 2002. Use of artificial habitat structures in U.S. lakes and reservoirs: a survey from the Southern Division AFS Reservoir Committee. Fisheries 27:22-27.

United States Fish and Wildlife Service. 2006. National survey of fishing, hunting, and wildlife-associated recreation. Report. Washington, District of Columbia.

Willis, T. C., M. T. Bremigan, and D. B. Hayes. 2004. Variable effects of habitat enhancement structures across species and habitats in Michigan reservoirs. Transactions of the American Fisheries Society 133:399-411.

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