Evaluation of Fish Eradication and Game-fish Restocking in a Central Iowa Pond

Dennis L. Scarnecchia
Iowa State University

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DENNIS L. SCARNECCHIA

Department of Animal Ecology, Iowa State University, Ames, IA 50011

Changes in fish community and population structure associated with fish eradication and subsequent restocking were investigated in a small (0.25 ha) impoundment in Boone County, Iowa. In September 1985, when fish were eradicated with rotenone, the fish community consisted of eight species. Large numbers of small bluegills (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), and stunted crappies (*Pomoxis* spp.) dominated the pond numerically, but seven large carp (*Cyprinus carpio*) and 18 large bigmouth buffalo (*Ictiobus cyprinellus*) constituted 80% of the total biomass. The only quality angling (popular species of desirable size) was for a few largemouth bass (*Micropterus salmoides*) and channel catfish (*Ictalurus punctatus*). The pond was then restocked with juvenile bluegills and channel catfish in October 1985, followed by juvenile largemouth bass in June 1986. By autumn 1987, an estimated 110 bluegills (95% confidence limits 72,235) were at least 80 mm long, and 25 large bass (95% confidence limits 16, 61) were in the pond. The quality of sport angling opportunities had been improved, and biomass of centrarchids increased by about half. Total biomass had dropped from 81 kg before eradication in 1985 to 18 kg in 1987, but the loss was primarily carp and buffalo, which are of little interest to Iowa anglers. The pond and its fish community should be monitored periodically to assess quality of habitat and angling opportunities.

INDEX DESCRIPTORS: farm ponds, fish stocking, fish management, Iowa

Iowa has more than 80,000 small man-made ponds, located primarily on farms in the southern half of the state (Hill and Schwartz, Undated). In addition to providing water for livestock use and irrigation, and habitat for diverse game and non-game animals, these ponds are often managed to provide high-quality angling for popular game fishes such as bluegills (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and channel catfish (*Ictalurus punctatus*).

The quality of angling in Iowa's farm ponds varies widely. Each year, fish are intentionally and completely eradicated from a small percentage of the ponds not providing adequate sized fish of popular game species. Some of these ponds show rather complex fish communities consisting of several game and non-game species at different trophic levels (Fessler 1950; Carlander 1952). After eradication, these ponds are then restocked with recommended numbers of popular species of game fishes so that within one to three years, anglers may catch desirable sized fish. The renovated pond thus often has fewer species and a simpler trophic structure but is intended to provide better angling than before the renovation.

Swingle (1950), Anderson (1980), and other investigators have developed and applied several different empirical indices that can be used to interpret whether or not a pond is in *balance*, i.e., is likely to provide sustained quality angling. To calculate and apply these indices, data on length, weight, and abundance of fishes must be collected. Because most small ponds in Iowa are of low unit value as fishery resources, seldom can fishery managers afford detailed surveys of the fishes inhabiting these ponds. For the same reason, follow-up studies are rarely done to assess fish community changes resulting from restocking (But see Hill 1978). In this paper, I report the changes in fish community and population structure associated with a fish renovation (eradication and restocking) project on a small pond. The objectives of the paper are to assess if the eradication was justified and if the restocking was successful in providing better opportunities for angling.

STUDY SITE

McHose Pond is a 0.25 ha impoundment located within McHose Park, in the city of Boone, Boone County, Iowa. The pond was constructed in the 1960s and has served as a recreational angling pond for fishing contests and as a local angling spot for youths only. Unlike most Iowa ponds, which are on or closely adjacent to agricultural lands, this pond is located in a small clearing amid a mixed deciduous forest. Land adjacent to the pond is hilly and unsuited for agriculture. By 1984, the pond had filled in with sediment to a depth of 1.4 m, so it was dredged out to a maximum depth of about 2.7 m. In September 1985, the pond was highly turbid, but by 1987, after renovation, water clarity had improved substantially. Aquatic macrophytes exist around the perimeter, and by autumn 1987, a heavy growth of filamentous algae was found along the shores. Bullfrog tadpoles were abundant in the pond during sampling for fish in both 1985 and 1987. Historically, the pond had been stocked with bluegills, black bullheads (*Ictalurus melas*) and other species. Anglers may keep all fish that they catch. No harvest statistics are available.

MATERIALS AND METHODS

Fish eradication (1985)

On 9 September 1985, the fish toxicant rotenone was applied to the pond in liquid form at a concentration of 2-3 mg/l of water and mixed into the water with the propeller of a small motorboat. Fish that subsequently swam or floated to the surface were collected from shore with long-handled dipnets. All dead fish seen were collected from the pond for 3 hours that day, and again the next morning. All fish collected were measured for total length, and subsamples were weighed. Large bigmouth buffalo (*Ictiobus cyprinellus*), carp (*Cyprinus carpio*) and channel catfish were too heavy to be weighed with equipment on hand, so weights for these fish were estimated from mean weights for fishes of comparable length reported by Carlander (1969). Although the mortality appeared to be total and recovery of dead fish appeared to be high, no fish were marked before introduction of the toxicant, so population estimates are unavailable. Thus, it is assumed that the catch was a minimum estimate of the actual population in the pond.

Fish stocking (1985-86)

Restocking was accomplished with the "split stocking" method described by Hill (1978). In October 1985, the pond was stocked with 500 bluegills less than 2.5 cm long and 50 channel catfish 5 to 7.5 cm long. The next June, the pond was stocked with 35 largemouth bass with a mean length of 2.5 cm.

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Table 1. Criteria used to calculate fish community indices in McHose Pond.

Species	Type (F = forage) (C = carnivore)	Stock size (cm)	Quality size (cm)
Bluegill	F	8	15
Green sunfish	F	8[1]	15[1]
Crappie	F or C[2]	13	20
Largemouth bass	C	20	30
Buffalo	F	28[3]	41[3]
Carp	F	28	41
Channel catfish	F or C[4]	28	41
Black bullhead	F	13	23

[1]Assumed to be the same as bluegill. (Anderson 1980)
[2]F species if < 115 g; C species otherwise. (Swingle 1950)
[3]Assumed to be the same as carp. (Anderson 1980)
[4]F species if < 908 g; C species otherwise. (Swingle 1950)

Evaluation of fish stocking (1987)

In autumn 1987, a follow-up survey of the stocked fish was conducted. Fish were sampled with boat-carried, Smith-Root 1.5-KV electrofishing gear and dip nets, a 30.5-m long, 6.35-mm mesh seine and two rectangular-framed trap nets with long leads. Electrofishing and seining were conducted on 28 September. Trap nets were set that afternoon and emptied the next morning. All fish captured by the three methods were measured for length and subsamples were weighed. Fish 80 mm or longer were marked by clipping the lower lobe of the caudal fin. All fish were then released.

On 5-6 October, 1987, fish were sampled with the same three gears. Marked fish were identified and enumerated. Lengths were measured and weights were sampled from all fishes caught. Population sizes and 95% confidence intervals were estimated for fish at least 80 mm long with Bailey's modification of the Peterson mark-recapture method (Ricker 1975). Assumptions of this method, outlined by Ricker (1975), were believed to be met reasonably well. Biomass estimates for bluegills > 80 mm, largemouth bass, and green sunfish were based upon these population estimates. Biomass estimates for bluegills less than 80 mm were based on the assumption that the ratio of biomass of these fish sampled to biomass of larger bluegills sampled was directly proportional to the ratios of their total population biomass estimates.

Community indices

Seven useful indices for analyzing fish community structure were calculated for the pre-eradication and stocked fish: F/C, where F is the weight of forage species and C is the weight of carnivorous species (Swingle 1950; Table 1); A_T, or the percentage of total weight of fish of harvestable weight (Swingle 1950); E values, or the percentage of the total weight of fish of individual species (Swingle 1950); Proportional Stock Density (PSD), or the ratio of the number of fish of a species of "stock size" to that of "quality size" times 100 (stock and quality sizes are defined for different species by Anderson 1980); Relative Stock Density (RSD_{36cm}), or the ratio of the number of a species at least 36 cm long (considered here to be a memorable catch) to the number of fish of "stock size" times 100 (Table 1; Anderson 1980); relative weight W_r, or the ratio of the weight of the fish to the weight of a "standard" fish of the same length times 100 ["standard" largemouth bass were defined by log (weight) $= -5.316 + 3.191$ log (length) by Wege and Anderson 1978]; and Young Adult Ratio (YAR), or the ratio of the number of fish at least 152 mm (6 inches) long to the number of fish at least 305 mm (12 inches) long (Reynolds and Babb 1978).

Statistical analyses

A Chi-square statistic was used to investigate differences in day 1 versus day 2 recovery rates of different species of fish killed by rotenone. A t-statistic was used to compare weights of fish killed by rotenone on day 1 versus day 2 and to compare relative weights of largemouth bass caught during the eradication with those caught after restocking.

RESULTS

Species composition of fish taken by rotenone in 1985

Before eradication, the fish community in McHose pond consisted of centrarchids [bluegills, largemouth bass, crappies (*Pomoxis* spp.) and green sunfish *Lepomis cyanellus*], two species of ictalurids — channel catfish and black bullheads, carp and bigmouth buffalo. Bluegills, green sunfish and crappies were by far the most common species, but 18 large buffalo and seven large carp accounted for 80% of the biomass in the pond (Table 2). Species composition of samples from day 1 differed significantly from that of day 2 (Chi-square, $P<0.01$). The major differences in catches between the two days were buffalo (18 caught on day 1 versus none on day 2) and crappies (96 versus 15). Young-of-the-year bass, evidently produced naturally, were caught much more frequently on day 2 than on day 1. There were no significant size differences in catch between days for bluegills, crappies, or green sunfish ($P>0.05$). The crappies exhibited emaciated bodies and large eyes relative to total length that are characteristic of stunted growth. The minimum biomass estimate of all species combined was 81.7 kg (Table 3).

Species composition of stocked fish as of 1987

Electrofishing was effective for recovering adult bass, but neither the seines nor trap nets collected any bass. Seines were most effective for bluegills below about 60 mm; the traps were effective for larger bluegills and large green sunfish. Recovery rates of marked fish were high enough for reliable population estimates.

Population sizes of bluegills at least 80 mm long was estimated to be 110 fish (95% confidence limits 72,235). The bluegill was the only species for which juveniles were found. The largemouth bass were few (N = 25, 95% confidence limits 16, 61), but all were large (fish stocked at 25 mm in length in June 1986 ranged from 295 to 337 mm long by autumn 1987). No channel catfish were sampled. A few green sunfish of unknown origin also were present (N = 5; 95% confidence limits 3, 9). The minimum biomass of all species combined was estimated to be 18 kg (Table 3). The estimate is a minimum because no catfish were sampled, even though they had been stocked. In 1987, largemouth bass dominated biomass, accounting for 78% of the total (Table 2).

Table 2. Abundance and biomass of fishes in McHose Pond before eradication (1985) and after restocking (1987)[1].

Species	Pre-eradication Number	Pre-eradication biomass (g)	Post-restocking Number	Post-restocking biomass (g)
Bluegill	413	1921	NA	5720
Green sunfish	124	430	4	384
Crappie	111	5138		
Largemouth bass	47	5147	25	11850
Buffalo	18	48975		
Carp	7	16307		
Channel catfish	3	3538		
Black bullhead	2	242		

NA = Not available
[1]More detailed data on lengths and weights available from the author.

Biomass changes from 1985 to 1987

Total estimated biomass of centrarchids was 12.6 kg before renovation and 18 kg after renovation. This moderate increase in weight of these game fishes coincided with the removal of substantial biomass of buffalo and carp. Total biomass in 1987 was only 22% of that in 1985 (Table 3).

Comparison of fish community indices for pre- and post-eradication (1985 and 1987)

In 1985, E-values indicated that large buffalo and carp dominated the biomass (Table 3). The high F/C ratio (9.1) was misleading because most of the so-called forage was too large to be eaten by predators. Although the centrarchids dominated numerically that year, they constituted only 15% of total biomass. In addition, PSD values of zero for crappie, bluegills, and green sunfish indicated that these three species provided no quality angling. The only quality angling in the pond was provided by six large bass and three channel catfish.

By 1987, the pond had, at least temporarily, become too dominated by large bass; F/C ratios had dropped to 0.3. Biomass of bass was more than twice that of bluegills. The high PSD value for bass and the absence of young bass sampled (YAR = 0) indicated that bass reproduction, which was sporadic before renovation (YAR = 6.7), was not successful in 1987. RSD_{36cm} values for bass indicated that none of the stocked bass had yet reached 36 cm in length by October 1987, despite their rapid growth. Relative weights of bass in both years were above that for a "standard" bass, so bass were in good condition. However, bass in 1985 were in significantly better condition than in 1987 ($P<.05$). The PSD value for bluegills increased to 17 in 1987, which reflected the presence of quality-sized fish. The four green sunfish sampled were all large specimens (lengths from 127 to 168 mm) that may have survived the fish eradication in 1985.

Table 3. Summary of fish community indices for McHose Pond before eradication (1985) and after restocking (1987).[1]

Index	Pre-eradication (1985)	Post-restocking (1987)[2]
F/C	9.1	0.3
A_T	90	97
E		
bluegill	2	18
green sunfish	<1	3
crappie	6	—
largemouth bass	6	78
buffalo	60	—
carp	20	—
channel catfish	4	—[3]
black bullhead	<1	—
PSD		
bluegill	0	17
green sunfish	0	100
crappie	0	—
largemouth bass	86	86
RSD_{36cm}	57	0
Mean W_r (bass)	111.6	104.1
YAR	6.7	0
Total biomass (kg)	81.7[4]	18[4]

[1]See methods section for descriptions of indices.
[2]Indices for post-restocking based on sampling of 28-29 September, 1987 only.
[3]Channel catfish not sampled, but believed to be present.
[4]Minimum values.

DISCUSSION AND CONCLUSIONS

Has the quality of angling been improved?

The abundance of large bass increased about fivefold after crappies were removed, consistent with reports by Swingle and Smith (1950) and Hill and Schwartz (undated) that crappies in small ponds often compete directly with bass. The adequate numbers, large size, rapid growth, and good condition of bass in 1987 indicate that the original eradication and stocking resulted in a bass population able to provide both an adequate quantity and quality of angling. However, as the bass reach desirable lengths in such a small pond, the population may be quickly depleted by effective anglers unless harvest is restricted. If most bass are caught and those remaining are unable to reproduce fairly consistently, bass may have to be restocked to sustain the fishery for both bass and bluegills. Conversely, since bass biomass as of 1987 is too high relative to bluegills (which the F/C ratio indicates), bass could become forage limited. However, the large number of young bluegills, their high reproductive capacity, and the abundance of tadpoles, all of which would result in more forage for bass, make this prospect much less likely than the former one.

Similarly, the increase in PSD for bluegills from 0 in 1985 to 17 in 1987 indicated that the restocking has resulted in a bluegill population able to provide both quality angling as well as forage for the bass. From a condition in 1985 where most centrarchids exhibited stunted growth and little quality angling existed, a quality fishery had developed by 1987. Total biomass of game species had also increased. In addition, increased clarity of the water was observed in 1987 compared to 1985, after the carp and buffalo had been removed. And as of 1987, aquatic macrophytes, which are a nuisance in many areas (Swingle and Smith 1950), had not yet become a serious problem. Thus, from the perspective of the manager's goal of improving opportunities for bass and bluegill angling, the renovation was a success.

What are the trade-offs to improved angling?

Improved angling has been provided by substituting an ecologically simpler game fish assemblage for a more complex, multitrophic level fish assemblage (Fig. 1). From an energetics standpoint, the buffalo and carp served as effective benthic detritivores and omnivores in the pond, even if they were a nuisance to anglers. Becker (1983) and Cross (1967) described the carp as omnivorous, consuming both animal and plant material, as well as bottom ooze. The buffalo has been classified as feeding on benthic organisms (Becker 1983). These niches evidently were not exploited as effectively by the stocked fishes; the reduced species diversity after restocking resulted in only about one-fifth as much biomass in the pond in 1987 as in 1985. The result that only 20% of total biomass in 1985 was game fishes agrees closely with studies by Jenkins (1976), who found that total sport fish production in 20 Oklahoma reservoirs was only 25% of total fish production. Clearly, the bottom feeding fishes such as carp and buffalo, along with the other species, exploit food energy resources much more effectively overall in the pond than does the simple game fish assemblage. Channel catfish were stocked to utilize this benthic food supply, but it is not clear if they have suffered high mortality (natural or angling) in the pond or simply were not vulnerable to the electrofishing, seining, or trap netting. Catfish are difficult to sample from Iowa's small ponds, even when a variety of gears is used (T. Putnam, Iowa Department of Natural Resources, Personal Communication). However, anglers have reported catching them in McHose pond within the last year. Even assuming that catfish are present, it is unlikely that their biomass would compensate for the biomass reduction observed in 1987. In protein-rich areas such as Iowa, management is not concerned with the biomass loss, but rather with the recreational benefits of a quality angling experience.

Inasmuch as fish populations in small ponds are often unstable

(Regier 1963), the pond should be sampled with different gear types in the future to assess the balance between bass and bluegills. In future years, the pond may require additional stocking of bass, vegetation control (Swingle and Smith 1950), or any of several other management actions prescribed for small ponds.

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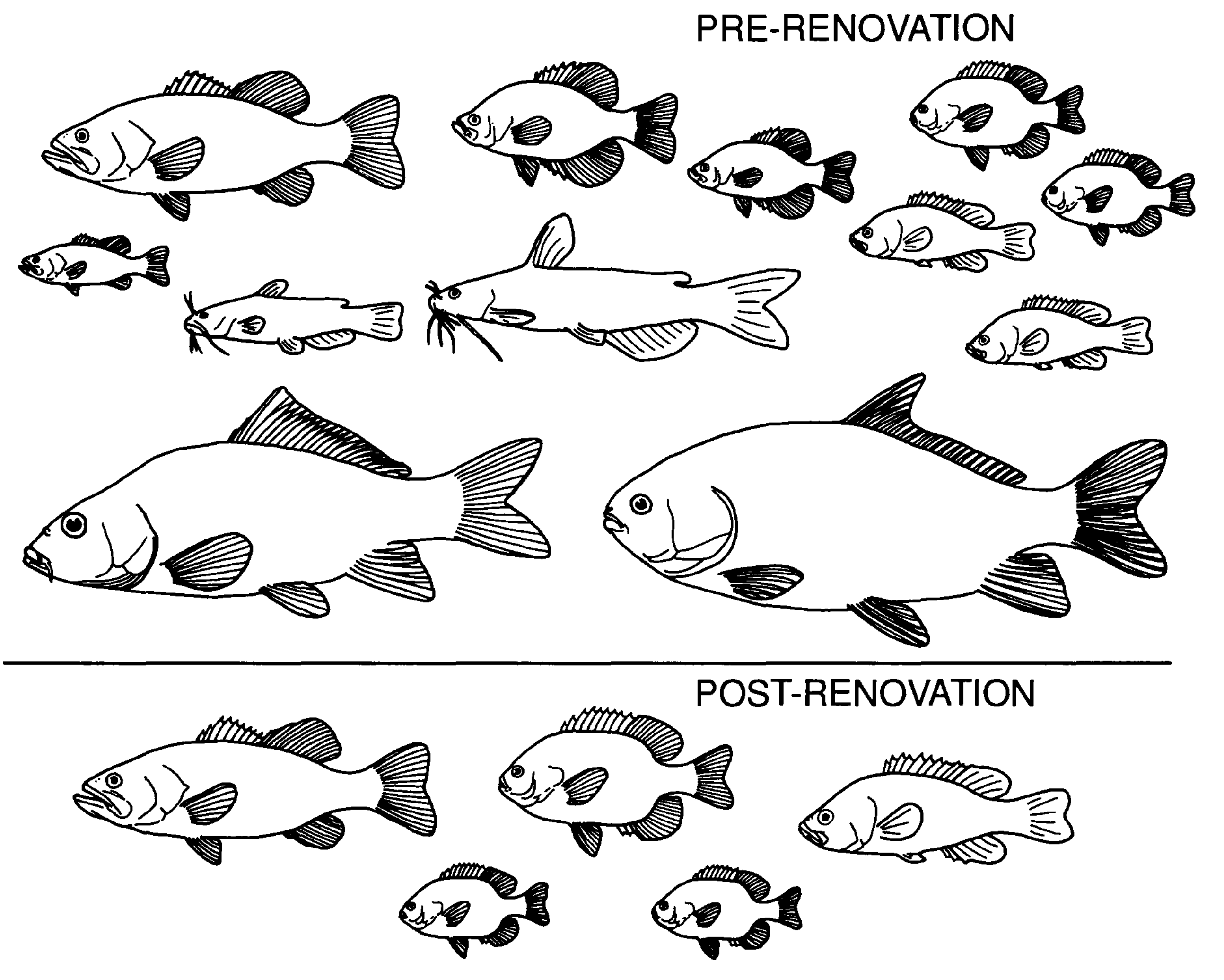

Figure 1. Fish assemblages in McHose pond before eradication (1985) and after restocking (1987). Channel catfish probably were also present in the post-renovation community but were not sampled.

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