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Impacts of Predator Management on Bluegill Fishing at Loon Lake, Indiana

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Photo above: *Brad Fink and Chad Griggs of the Indiana Division of Fish and Wildlife measure a Loon Lake muskie they caught during sampling in spring 2004.*

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EXECUTIVE SUMMARY

Loon Lake, a 222-acre natural lake located north of Columbia City with a history of supporting relatively small bluegills, was stocked with over 26,000 muskellunge fingerlings from 1978 through 2003 at a typical rate of 5/acre/year to increase predation on bluegills. A 12-inch minimum size limit on largemouth bass went into effect in October 1990 and was increased to 14 inches in July 1998. A 30-inch size limit on muskies was increased to 36 inches in 1999. Several surveys were conducted in 2004 to examine the long-term effects of muskie and bass predator management on the fish community at the lake.

Based on trapping from March 23 to April 15, Loon Lake contained an estimated 280 adult muskies (1.3/ac) ranging in size from 31-50 inches. Based on electrofishing from April 28 - May 12, the lake contained 2,931 largemouth bass (13.2/ac) that were 8-inch or larger. Of these, 1,302 were 8-11_ inches, 534 were 12-13_ inches, 1,007 were 14-17_ inches, and 88 were 18-inch or larger. The largest bass was 20 inches and 38% were legal size (≥14-in). The mean nightly catch rate was 113/hour. Catch rates for each of the four size groups were 50, 21, 39 and 3.5/hour. Muskie and bass growth rates were normal compared to other lakes in the area.

During a July fish community survey, 2,358 fish representing 18 species were collected. Total weight of the catch was 422 pounds. Bluegills dominated the catch by number (77%) and accounted for 40% of the weight. Black crappie ranked second numerically (9%) and by weight (10%). Redear ranked third numerically (5%), followed by largemouth bass (3%) and yellow perch (2%). Spotted gar were third in weight (10%), followed by largemouth bass (9%) and carp (8%). Two muskies captured during the survey accounted for only 6% of the weight. Altogether, sport fish made up 98% of the number and 79% of the weight.

Bluegills ranged in size from 1_-8 inches and were very abundant. Most (73%) were 4-5_ inches and were age-3, although some age-3 bluegills reached 7 inches. The electrofishing catch rate (508/15-min) was five times greater than the average bluegill catch rate for Indiana natural lakes. Although the percentage of 7-inch and larger bluegills was low (<2%), growth of smaller bluegills was normal with age-3 bluegills averaging 4_ inches long.

Anglers fished 14,476 hours at Loon Lake from April 7 - October 30. The estimate represented 65 hours/acre (0.3 hr/ac/day) and was 38% below average for lakes of similar size. Boat anglers accounted for 90% of the effort and shore anglers accounted for 10%. Anglers fished primarily for bass (36%) and bluegills (26%). Fewer fished for crappies (13%), muskies (12%), perch (<1%), or expressed no preference (12%). Fishermen took home 4,921 fish and removed 2,573 bluegills that were 4_-8_ inches long. Average size was slightly over 6 inches. Those 7-inch or larger made up 27% of the catch and those 8-inch and larger made up 2%. Fishermen removed 264 largemouth bass and released 4,864. They also took home nine muskies, only 6% of the estimated number of legal-size muskies present in the spring (150). They released 29 sub-legal muskies and released 79 that were 36-inch or larger. When asked to rate fishing, 49% of bluegill anglers in boats and 37% of bluegill shore anglers rated fishing as poor. Boat anglers thought crappie fishing was good (62%), as did bass (50%) and muskie (50%) anglers.

Stocking muskie fingerlings and imposing largemouth bass size limits failed to produce any significant improvement in bluegill fishing quality at Loon Lake. The most notable changes as a result of predator management efforts included the creation of muskie fishing opportunities and increases in density and size structure of largemouth bass.

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BACKGROUND

Bluegill *Lepomis macrochirus* populations dominated by small individual fish that are too small to interest anglers are present in several natural lakes throughout northern Indiana. Where these populations exist, anglers complain of poor fishing and expect managers to take corrective measures to increase fish size. Isolating and addressing the cause or causes of the problem, however, can be difficult.

Small bluegill size can occur where habitat features limit bluegill production or predators cannot control bluegill recruitment. In both cases, bluegill growth is usually slow because competition exceeds available food resources. Where growth is good, small bluegill size can also occur when fishing and natural mortality limit survival of older bluegills. Adding to the complexity of the problem is the possibility these factors may operate at the same time or at different times over a range of sizes and ages.

A lack of understanding of the problem has led to a fundamental debate among Indiana fish managers and anglers. At issue is whether the state's natural lakes contain sufficient numbers and sizes of predators to limit recruitment of young bluegills in highly-productive, "forage-rich" systems or whether the lakes contain too many predators that limit densities of older, larger bluegills in "forage-poor" systems. The debate continues.

The notion that Indiana natural lakes are forage-rich is centered on farm-pond theory rooted in the 1970s. The premise is that bluegills are highly prolific and their excessive recruitment leads to slow growth and small size due to competition, especially where other forage species are present or dense vegetation provides too much cover from predators. The typical approach to address the problem involved the use of fish toxicants to reduce forage abundance and weed control. The approach later included application of various size limits on angler-caught largemouth bass *Micropterus salmoides* to increase predator densities. At the same time, other species, such as northern pike *Esox lucius* and muskellunge *Esox masquinongy*, became available for stocking and were released in hopes of boosting predator numbers. Although simplistic in rationale, imposing limits on bass and stocking predators were seen as measures that could garner public support in lieu of more drastic and costly renovations.

The notion that Indiana natural lakes are forage-poor also goes back to the 1970s when studies indicated large year classes of bluegills produced better bluegill fishing than small year classes. Large year classes were not always inherently troublesome, so attempts to limit bluegill recruitment through predation were thought to be counterproductive. It was also theorized that the failure of some fish stocking programs in Indiana lakes, especially small walleyes *Zander stizostedion* and small hybrid muskies *E. lucius x E. masquinongy*, may have been due to a widespread scarcity of forage and that fry and small fingerlings may have succumbed to an already-dense predator population. Other studies indicated largemouth bass growth slowed, bass size structure deteriorated, and bass fishing declined at some lakes as bass numbers increased under tighter restrictions, indicating forage populations were not sufficient to sustain greater bass densities. And finally, anglers complained that fishing success for bluegills and other species declined at some lakes following introductions of muskies.

Although little research has been conducted to understand the theoretical dynamics of predator-prey relationships in Indiana natural lakes, case studies over the years have provided information on how some lakes responded to various management initiatives. Loon Lake is one example. Prompted by complaints from anglers of poor bluegill and a request from the local lake association to add northern pike to feed on small bluegills, the Division of Fish and Wildlife began annual hybrid muskie stockings in Loon Lake in 1978. Northern pike were not available at the time. The stocking program was later switched to purebred muskies in 1997 due to hatchery production changes. A 30-inch size limit was initially imposed on muskies but increased to 36 inches in 1998. In addition, a 12-inch minimum size limit on largemouth bass was imposed In October 1990 and increased to 14 inches in July 1998, along with a reduction in the daily catch limit from six to five bass as part of a region-wide regulatory change.

The purpose of this report is to summarize how Loon Lake's fish community responded to predator management. Emphasis is placed on bluegill fishing. Although anecdotal, the information sheds light on the complex nature of fish communities in Indiana natural lakes.

LOON LAKE

Loon Lake is a 222-acre natural lake located about 2 miles west of SR 109 and 7 miles north of Columbia City. It lies within the upper reaches of the Tippecanoe River watershed and drains 6,910 acres. Watershed use is primarily agriculture (61%), pasture (16%) and forest (12%). Hydraulic retention time is 289 days. Most of its shoreline is residential but some natural shoreline and significant wetlands are present on the east and southeast sides. Public access is available at a state-owned boat ramp in the southeast corner along Friskney Ditch, the lake's main inlet. Boating speeds are limited to 10 mph except during 1-4 pm daily.

Maximum depth of Loon Lake is 92 feet and average depth is 26 feet. Water clarity averages 5 feet. Oxygen levels during summer are adequate for fish only in the top 10 feet of water. Habitat conditions were worse in 2004 (*Table 1*). The bottom is mainly sand and muck. Water lilies, spatterdock and cattails are the major emergent plants while eel grass and coontail are the dominant submersed plants. They typically grow in water less than 8 feet deep and cover about 40% of the littoral area. Lake residents routinely hire a commercial pesticide applicator each summer to chemically control Eurasian water milfoil and curly-leaf pondweed in shoreline areas covering 5-6 acres.

Loon Lake's fish management history dates back to an initial survey in 1971 (*see references*). Surveys were also done in July 1977, 1982, 1986, 1988 and June 2000. Angler effort and catches were surveyed in 1983 and water clarity was monitored in 1988. The 1983 work also included estimates of bluegill and crappie density, size structure, and exploitation. Much of this historical information on the lake was later summarized in a report by the Division of Fish and Wildlife issued in 1989. The status report included numerous recommendations for watershed, shoreline, and recreation management, fish and wildlife management, water quality monitoring, and environmental education.

Since 1978, over 26,000 muskies have been stocked at a typical rate of 5/acre/year (*Table 2*). Fish sizes ranged from 3-17 inches and were reared in state hatchery raceways and production ponds. At first, small hybrid muskies that were reared solely on food pellets were stocked. From 1981 through 1996, they were initially fed pellets and then live minnows for 90 days before release. Only purebred fingerlings were released after 1996 and those stocked since 1998 were fed minnows for 30 days prior to stocking.

Table 1. *Oxygen levels (ppm) and clarity (secchi readings) at various depths at Loon Lake from 1970-2004.*

Depth (ft)	7/70	7/71	7/77	7/82	7/86	7/87	7/88	6/00	7/04
0	9.2	8.3	10.0	8.0	11.0	10.0	12.0	10.5	9.1
5	9.7	9.3	10.0	7.5	10.0	9.0	13.0	10.0	8.8
10	7.7	8.6	10.0	7.0	8.0	8.0	9.0	8.5	4.3
15	---	2.4	4.0	3.0	1.0	1.5	2.5	3.6	0.5
20	0.4	0.2	3.0	1.0	0.6	1.0	1.5	0.5	0.3
25	0.2	0.2	0.5	tr	0.6	tr	1.0	0.5	0.2
30	0.1	0.1	0.0	tr	0.6	tr	1.6	0.4	0.2
35	0.1	0.1	0.0	tr	0.6	tr	—	0.6	0.2
40	---	---	0.0	tr	0.6	tr	1.0	1.1	0.2
50	---	---	---	tr	0.6	tr	0.6	0.2	0.1
60	---	---	---	---	tr	tr	0.8	0.2	0.1
70	---	---	---	---	tr	tr	0.6	0.2	0.1
80	---	---	---	---	tr	tr	-	0.1	0.1
90	---	0.0	---	---	0.0	tr	0.8	0.1	0.1
Secchi (ft)	5.5	6.0	5.0	8.5	5.0	5.0	4.0	4.8	2.3

*tr indicates trace amount

SAMPLING

To assess long-term changes in Loon Lake's fish community and fishing quality that may be associated with muskie stockings and bass regulations, the Division of Fish and Wildlife conducted a major study at the lake in 2004. The study included mark-recapture sampling to estimate the density and size structure of muskies and largemouth bass during the spring, a standard fish population survey in July, and an angler creel survey covering the period from April 7 through October 30. Some additional electrofishing was conducted in early spring and late fall to assess survival of young muskies. More specific details on sampling methods are presented within each section of the report.

Table 2. *Record of muskellunge stockings at Loon Lake from 1978-2003.*

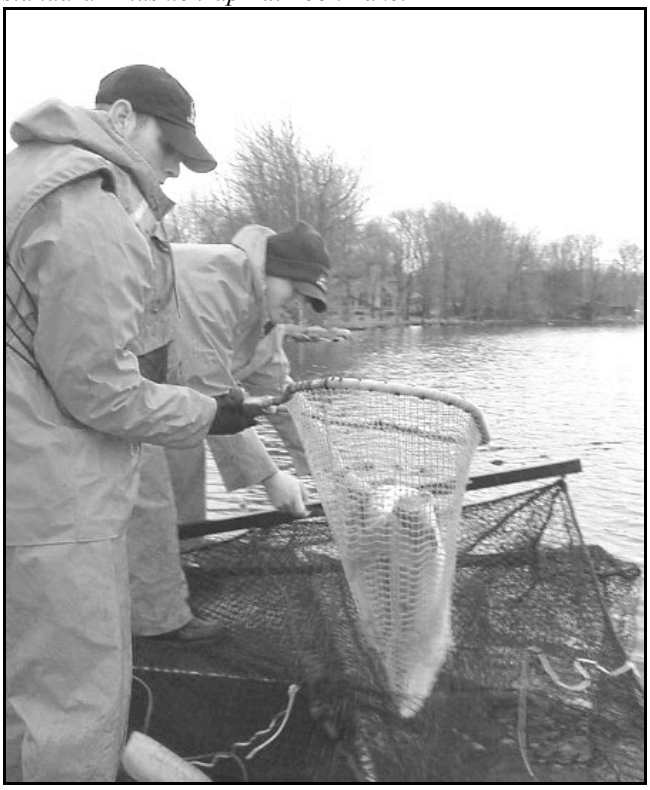
Year	Number	Inches	Diet	Source
1978	1,110	3-5	pellet	Cikana
1979	1,400	3-5	pellet	Cikana
1980	1,143	5	pellet	Fawn River
1981	1,200	6-16	fish	Tri-County
1983	1,280	8-13	fish	Tri-County
1985	1,200	9-10	fish	East Fork
1986	1,000	4-5	pellet	East Fork
1987	1,647	7-17	mixed	TC and EF
1988	482	6-17	fish	TC and FR
1989	446	8-17	fish	Tri-County
1990	1,236	7-17	fish	Tri-County
1991	1,050	9-13	fish	Fawn River
1992	1,200	10-12	fish	Fawn River
1993	1,050	9-11	fish	Fawn River
1994	825	8-13	fish	Fawn River
1995	900	8-11	fish	Fawn River
1996	1,200	8-11	fish	Fawn River
1997	1,110	7-9	fish	Fawn River
1998	1,110	9-13	fish	East Fork
1999	1,110	10-14	fish	East Fork
2000	1,100	11-12	pellet	East Fork
2001	1,100	10-13	fish	East Fork
2002	1,100	9-10	fish	East Fork
2003	1,100	9-11	fish	East Fork

MUSKIE POPULATION CHARACTERISTICS

Fifty-four adult muskies were caught in trap nets at Loon Lake between March 23 and April 15, measured, and marked with left pectoral fin clip before release (*Appendix 1*). They ranged from 31-40 inches long and averaged 36 inches. Twenty-nine were 36-inch or larger (legal size) and 25 were less than 36 inches. Four, measuring 34_-35_ inches, were subsequently recaptured during the trapping period. Based on the ratio of unmarked to marked fish caught daily, the population estimate of adult muskies was 280 (SE=125), or slightly more than 1/acre.

Three trap designs were tested during the project, of which only one proved useful. Only two muskies, including one recapture, were caught in "perch nets" set at eight locations over 12 nights (0.2/lift). None were caught in a larger "club net" set at two sites over three nights. The most successful design was a standard "muskie trap" used in state hatchery operations. Fourteen muskies were caught over 14 nights (1.0/lift) in one trap set off a point at the end of Redbud Lane. Thirty-five muskies, including two recaptures, were caught on the north side of an island on the lake's east side over 14 nights (8.8/lift). Fourteen of the muskies caught at this location were taken the first day (3/30) and eight were caught on the second day (3/31). Four were caught at three sites around a peninsula on the east side of the lake over 11 nights, while three, including one recaptured fish, were caught over nine nights (0.3/lift) in the bay near the access site. Water temperatures during trapping increased from 39F to 53F and averaged 45F. Forty-seven muskies (81%) were trapped between March 29 and April 5 at water temperatures varying from 43F to 47F.

Photo below: *Chad Griggs hoists a muskie out of a standard "muskie trap" at Loon Lake.*

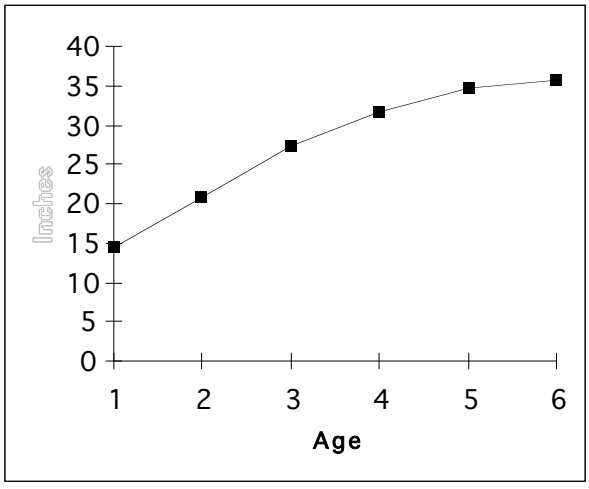


Twenty-one muskies were captured in two hours of electrofishing on the evening of March 29. Of these, 19 were age-1 muskies (9.5/hr) stocked in November 2003 and were 9-10_ inches long. One 19-inch muskie and a 39_-inch muskie were also captured. A second large muskie was observed but it avoided capture. In contrast, fall electrofishing was unsuccessful. During two hours of sampling on November 3, 2004, a single 13_-inch muskie was caught (0.5/hr).

Only two muskies were caught during the standard fish population survey in July. Both were taken in small trap nets (0.5/lift) and ranged in length from 34_-40_ inches. None were captured within one hour of electrofishing and none were caught in gill nets set at eight locations.

Muskie growth in Loon Lake is typical for Indiana lakes, based on a limited number of scale samples taken during trapping (*Figure 1*). However, aging muskies from scale samples can be very subjective. Apparently most muskies caught during the spring trapping were age-5 and age-6 fish. They appeared to reach 30 inches by age-4 and nearly 36 inches by age-6. The largest muskie, a 38_-inch fish, was estimated to be 6 years old.

Figure 1. *Estimated average growth rate of muskies in Loon Lake.*



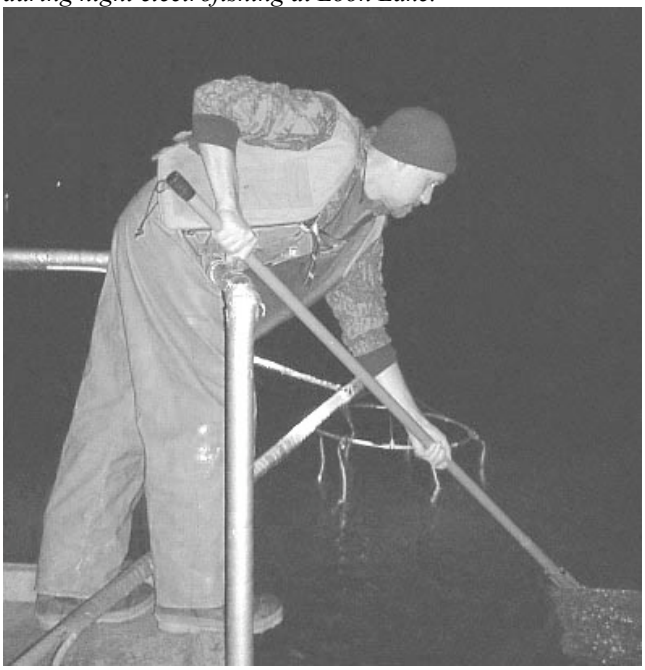
BASS POPULATION CHARACTERISTICS

To estimate density, size structure, and growth of largemouth bass, three nights of electrofishing were conducted from April 28 to May 12 along the entire lake shoreline. Each captured bass was measured and marked with a right ventral fin clip prior to release. Scale samples were taken for age and growth determinations. Water temperatures at the time of bass sampling were 56F, 60F and 73F. Altogether 1,146 bass were captured. Of these, 120 were recaptured fish. The catch included 1,048 adult bass (≥8-in), of which 117 were recaptured (*Appendix 2*).

Based on the ratio of marked to unmarked adult fish caught each night (*Schnabel estimate*), the lake contained 2,931 bass, or 13/acre. Of these, 1,302 were 8-11_ inches, 534 were 12-13_ inches, 1,007 were 14-17_ inches, and 88 were 18-inch or larger. The largest bass was 20 inches and 38% were legal size (≥14-in). The mean nightly catch rate was 113/hour. Catch rates for each of the four size groups were 50, 21, 39 and 3.5/hour.

During the July fish population survey, 77 largemouth bass ranging in size from 2-17_ inches were caught. Sixty-eight were captured in 45 minutes by electrofishing (23/15-min). Six were caught in gill nets and three were caught in traps. The electrofishing catch included 20 that were 8-11_ inches, six that were 12-13_ inches, and the remaining seven (12%) were legal size at 14-17_ inches.

Photo below: *John Edmonds dips a largemouth bass during night electrofishing at Loon Lake.*



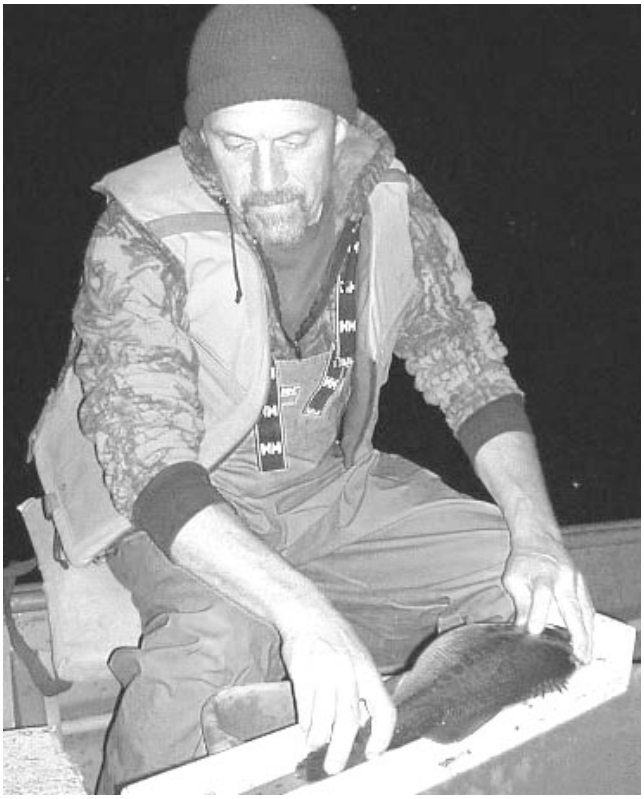
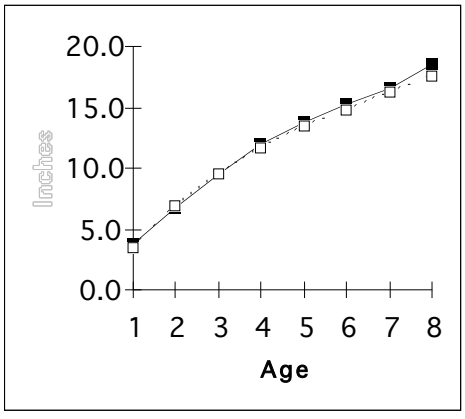


Photo above: *John Edmonds measures one of several large bass captured by electrofishing at Loon Lake.*

Largemouth bass growth was normal compared to other natural lakes in northern Indiana, although growth tended to slow slightly at age-2 and age-3 and then increase among age-5 and older bass. By age-6, bass in Loon Lake averaged 15_ inches long. They were 16_ inches at age-7 and 18_ inches at age-8 (*Figure 2*). Bass in most area lakes average 16_ inches at age-7 and 17_ inches at age 8.

Figure 2. *Estimated average growth rate of largemouth bass in Loon Lake (solid line) compared to other lakes in the area (dotted line).*



FISH COMMUNITY CHARACTERISTICS

To obtain information on the status of the fish community and evaluate the impacts of predator fish management at Loon Lake, a standard fish population survey was conducted from July 19-22 (*Appendix 6-17*). The time period corresponded to most previous surveys conducted at the lake. Sampling effort consisted of 45 minutes of electrofishing, eight standard gill net lifts and four trap net lifts.

During the survey, 2,358 fish representing 18 species were collected. Total weight of the survey catch was estimated to be 422 pounds. Bluegills dominated the catch by number (77%) and accounted for 40% of the weight. Black crappie ranked second numerically (9%) and by weight (10%). Redear ranked third numerically (5%), followed by largemouth bass (3%) and yellow perch (2%). Spotted gar were third in weight (10%), followed by largemouth bass (9%) and carp (8%). The two muskies captured during the survey accounted for only 6% of the weight. Altogether, sport fish made up 98% of the number and 79% of the weight.

Bluegills ranged in size from 1_-8 inches and were very abundant. Most (73%) were 4-5_ inches and were age-3, although some age-3 bluegills reached 7 inches. The electrofishing catch rate (508/15-min) was five times greater than the average bluegill catch rate for Indiana natural lakes. Although the percentage of catchable-size bluegills (≥7-in) was low (<2%), growth of smaller bluegills was normal with age-3 bluegills averaging 4_ inches long.

Black crappies ranged from 1_-12_ inches long. Most (96%) were 6_-8_ inches and were also age-3. Only four were 10-inch or larger. Although crappie growth was within normal ranges compared to other lakes, age-3 crappies were slightly more than _ inch smaller than the mean at other lakes.

Several miscellaneous sunfish species were collected, including 119 redear ranging from 3-7 inches long. Most redear were 5_-6_ inches long and, like bluegills and crappies, were age-3. Five warmouth and three pumpkinseeds were also caught.

Other sport fish included 53 yellow perch ranging in size from 5-10 inches. Most perch were 6-6_ inches and were also age-3. Also collected were 25 yellow bullheads up to 13_ inches, eight brown bullheads up to 15_ inches, and three channel catfish measuring 15-17_ inches. Non-sport fish included 21 spotted gar that were 18-20 inches long, nine carp 16-22 inches long, four lake chubsuckers, three bowfin, two brook silversides, a golden shiner and a spotted sucker.

Photos above and below: *Chad Griggs and Brad Fink display some fish caught during spring trapping in Loon Lake, including a large channel catfish and walleye.*

FISHING SURVEY RESULTS

Anglers fished 14,476 hours at Loon Lake from April 7 through October 30 (*Table 3*). The estimate represented 65 hours/acre (0.3 hr/ac/day) and was 38% below average for area lakes of similar size. It was based on 7-8 hourly counts of boat and shore anglers per day on 103 survey days, split between morning and afternoons and covering two weekend days and five weekdays every two weeks. Boat anglers accounted for 90% of the effort and shore anglers accounted for 10%. Weekend fishing by boat anglers made up 50% of the effort and weekday boat fishing made up 41%.

Table 3. *Average daily hourly counts of anglers and fishing effort (hours) on weekends and weekdays at Loon Lake from April 7 through October 30, 2004.*

		Counts		Effort	
Month	Strata	Boat	Shore	Boat	Shore
April	Weekend	9.43	0.21	792.1	17.6
April	Weekday	1.82	0.14	458.6	35.3
May	Weekend	6.81	0.91	1048.7	140.1
May	Weekday	2.81	0.65	786.8	182.0
June	Weekend	15.53	1.00	1731.8	128.0
June	Weekday	3.89	0.63	1369.3	221.8
July	Weekend	7.53	1.19	1204.8	190.4
July	Weekday	3.53	0.54	1186.1	181.4
August	Weekend	5.94	0.50	855.4	72.0
August	Weekday	2.45	0.27	823.2	90.7
September	Weekend	8.69	0.31	1094.9	39.1
September	Weekday	2.95	0.17	826.0	47.6
October	Weekend	3.89	0.21	490.1	26.5
October	Weekday	1.42	0.06	417.5	17.6

Loon Lake anglers fished mostly for bass (36%) and bluegills (26%) (*Appendix 3*). Fewer fished for crappies (13%), muskies (12%), perch (<1%), or expressed no preference (12%). Boat anglers fished more for bass (40%) than bluegills (24%), but shore anglers preferred bluegills (38%) or anything (28%). There was no difference in preference for bass among weekend and weekday boat anglers (40%). Crappie preference was also similar between both groups (13%). Bluegills however were more popular among weekday boat anglers (27%) than weekend boat anglers (20%), while muskies were less popular among weekday boat anglers (13%) than weekend boat anglers (17%). Among boat anglers, bluegill preference peaked in July (31%) and was lowest in April (4%). In contrast, crappie interest was greatest in April (33%) and lowest in October (2%). Bass interest varied from 35% in April and May to 51% in August. Muskie interest was greatest in October (31%) and varied from 9% in August to 17% in May during the other months.

Fishermen took home 4,921 fish during the survey period (*Table 4*), of which 80% were taken by boat anglers. Anglers removed 2,573 bluegills that were 4_-8_ inches long (*Appendix 4*). Average size was slightly over 6 inches. Those 7-inch or larger made up 27% of the catch and those 8-inch and larger made up 2%. Anglers also took home 1,686 crappies ranging from 5-13 inches but averaging only 7 inches, 249 sunfish (mostly redear) averaging 8 inches, and 140 perch. Crappies that were 10-inch or larger made up only 8% of the crappie catch.

Fishermen removed 264 largemouth bass and released 4,864. Bass taken home were 14-18 inches long and averaged 16 inches. Fifteen bass (6%) were 18 inches long. Based on the number of bass present in the spring, anglers removed 24% of the 14-17_ inch bass (246/1007) and 17% of the 18-inch and larger bass (15/88). Actual percentages may have been slightly lower since some bass grew into legal size during the summer. However, fishermen took home an estimated 93 legal-size bass out of 294 (32%) that had been marked in the spring. The ratio of legal-size marked to unmarked bass observed by the creel clerks was 13:22. The ratio in the population after spring sampling was estimated to be 294:801.

The number of bass caught and released (4,864) was 66% greater than the spring estimate of 8-inch and larger bass (2,931), indicating many individual bass were probably caught several times. Based on the reported size of released bass, 33% were 14-inch and larger (1,589). This number was 45% greater than the number of legal-size bass present in the spring (1,095). The number of released sublegal bass (3,275) was 78% greater than the number present (1,836).

Table 4. *Number of bluegills (BG), crappies (CR), sunfish (SF), perch (YP), bass (LB), and muskies (MU) removed and the number of bass (RLB) and muskies (RMU) released on weekends (WE) and weekdays (WD) per month by anglers at Loon Lake.*

Strata	BG	CR	SF	YP	LB	MU	RLB	RMU
Apr WE	0	120	18	0	9	0	83	0
Apr WD	0	179	0	0	0	0	81	0
May WE	70	84	0	0	22	0	211	14
May WD	155	365	16	0	57	0	605	22
Jun WE	174	9	0	9	59	0	842	8
Jun WD	568	278	0	0	45	0	699	13
Jul WE	193	182	81	0	30	0	352	0
Jul WD	326	329	46	50	7	0	579	20
Aug WE	359	47	14	43	9	0	312	9
Aug WD	88	11	22	11	11	0	307	5
Sep WE	126	82	38	6	0	0	352	6
Sep WD	161	0	6	20	6	0	299	0
Oct WE	301	0	9	0	9	9	18	0
Oct WD	53	0	0	0	0	0	127	11
TOTAL	2573	1686	249	140	264	9	4864	108

Two fishing tournaments were monitored during the survey to obtain additional information on the number and size of bass caught at Loon Lake. Twenty-five anglers fished a total of 150 hours on Saturday, June 12, from 2 pm-8 pm and brought 36 bass to the weigh-in (0.24/hr). They were 14-18 inches long but most (75%) were 14-15_ inches. Sixteen anglers fished 48 hours on Wednesday, August 4, from 5 pm-8 pm and brought 19 bass in to weigh (0.40/hr). The fish were 14-18_ inches long, but 68% were 14-15_ inches. The ratio of marked to unmarked bass in the June tournament was 20:16, while the ratio in the August tournament was 6:13. The combined percentage of marked bass (47%) was greater than percentage marked in the spring (27%).

Anglers took home nine muskies, although the estimate was based on a single 44_-inch fish caught by a weekend boat angler in October. The nine fish represented 6% of the estimated number of legal-size muskies present in the spring (150). However, based on reported releases, anglers caught and released 29 sublegal muskies and an additional 79 that were 36-inch or larger.

Boat anglers who specifically fished for bluegills caught and kept them at the rate of 0.84/hour. Those who fished solely for crappies caught and kept them at the rate of 0.88/hour. Boat anglers who fished for bluegills in combination with other fish (excluding those with no preference) caught and kept bluegills at a rate of 0.65/hour, while crappies were caught and kept at a rate of 0.66/hour by boat anglers who fished

for crappies and other species. Boat anglers who targeted only bass caught them at a rate of 0.78/hour, including anglers who kept bass (0.04/hour). Those who fished for bass in combination with other species caught them at 0.63/hour. Muskie anglers in boats caught muskies at a rate of 0.08/hour (1/12_ hrs), while those who fished for muskies in combination with other species caught them at 0.04/hour.

Of 497 boat anglers interviewed during the survey, four caught and released a sublegal muskie and 13 caught and released a legal-size muskie on the day they were interviewed. Seventy-one anglers (14%) said they had caught at least one muskie previously during the year.

Bluegill anglers were dissatisfied with fishing quality, but anglers who fished for crappies, bass or muskies were generally satisfied (*Appendix 5*). When asked to rate fishing, 49% of bluegill anglers in boats and 37% of bluegill shore anglers rated fishing poor. Only 11% of bluegill boat anglers and 23% of shore anglers rated fishing good. The rest considered fishing fair. Boat anglers thought crappie fishing was good (62%), as did bass (50%) and muskie (50%) anglers. Only 4% of boat anglers targeting crappies rated fishing poor, 9% who sought bass rated bass fishing poor, and 5% of muskies anglers rated muskie fishing poor. Among all interviewed anglers, whether fishing from boat or shore, on weekends or weekdays, 38% rated fishing good, 42% fair, and 21% poor.

COMPARISONS TO PREVIOUS SURVEYS

More fish were caught during the 2004 fish population survey than any previous survey (*Table* 5). Although some of the increases over earlier surveys reflect changes in sampling gear and effort, similar sampling has been conducted since 1986. Bluegills consistently ranked first and increased four-fold in number from 1986 to 2004, despite efforts to boost the predator population by stocking muskies and restricting bass harvest. At the same time, crappies, redear and carp apparently increased, while lake chubsuckers, pumpkinseeds, warmouth, yellow bullheads, and yellow perch decreased.

Largemouth bass catches increased in 1988 and 2000 before declining in 2004. Most bass are caught by electrofishing and AC gear is about three times more effective than DC gear, so even though the number caught was lowest in 1982, the catch rate (35/hr) was similar to 1971 (29/hr), 1977 (32/hr), 1986 (96/hrDC) and 2004 (91/hrDC). Catch rates in 1988 (195/hr) and 2000 (278/hr) were two and three times greater. Muskie catches decreased after 1982.

Table 5. *Number of fish collected during fish population surveys at Loon Lake from 1971-2004.*

Species	1971	1977	1982	1986	1988	2000	2004
Black bullhead	2	--	--	--	--	--	--
Black crappie	36	12	5	33	31	154	203
Bluegill	440	672	554	426	694	1,243	1,819
Bluntnose minnow	--	--	--	--	2	4	--
Bowfin	6	8	4	3	2	8	3
Brook silverside	57	*	--	2	3	*	2
Brown bullhead	32	28	20	29	20	22	8
Carp	--	*	2	1	2	11	9
Channel catfish	--	1	--	--	--	–	3
Grass pickerel	5	18	3	--	1	–	--
Green sunfish	--	1	2	1	--	–	--
Golden shiner	--	24	--	7	6	9	1
Hybrid sunfish	13	--	--	--	--	5	--
Lake chubsucker	68	62	82	64	37	5	4
Largemouth bass	132	100	47	100	154	288	77
Muskellunge	--	--	34	7	9	2	2
Pumpkinseed	40	91	42	114	58	41	3
Pugnose shiner	1	--	--	--	--	–	--
Redear	27	152	12	12	40	109	119
Smallmouth bass	--	--	--	--	1	–	--
Spotted gar	6	12	7	5	8	20	21
Spotted sucker	--	2	--	--	--	3	1
Warmouth	77	123	58	16	23	10	5
White sucker	--	5	4	--	--	--	--
Yellow bullhead	79	100	67	83	44	23	25
Yellow perch	235	160	146	73	134	82	53
TOTAL	1,256	1,571	1,089	976	1,269	2,039	2,358
Sampling effort							
Electro- hrs	4_ ac	3ac	1_ac	1dc	_dc	1dc	_dc
Gill nets lifts	16	12	7	8	8	8	8
Trap net lifts	0	12	8	8	8	4	4

*denotes observed but not collected.

Based on electrofishing catch rates (*Table 6*), the bluegill population expanded more than the actual survey number indicated. The catch rate increased five-fold from 1986 to 2004 from 391/hour to over 2,000/hour. The catch rate of crappies caught in gill nets also increased, up seven-fold from an average of 0.5/lift in 1977 and 1982 to 3.8/lift in 1986 and 1988, then up three-fold to 11/lift in 2000 and 2004. Perch gill net catch rates showed no consistent trend with highs in 1982 and 1988 and lows in 1986 and 2004. Muskie gill net catch rates decreased 16-fold from four muskies per lift in 1982 to one muskie per four lifts in 2000 and 2004.

Table 6. *Number of major sport fish collected per unit of sampling effort at Loon Lake from 1971-2004.*

Species	1971	1977	1982	1986	1988	2000	2004
Number per electrofishing hour*							
Bluegills	--	75	131	391	588	753	2,033
Bass	29	32	35	96	195	278	91
Number per gill-net lift							
Crappies	--	0.9	0.1	3.6	3.9	11	11
Perch	--	10	15	0.3	11	9.1	0.4
Muskies	--	--	4.14	0.88	1.13	0.25	0.25

*AC gear used in 1977 and 1982, DC gear used in 1986 and after.

Table 7. *Number and size of bluegills collected at Loon Lake from 1971-2004.*

Inches	1971	1977	1982	1986	1988	2000	2004
1-1_	2	4	0	1	1	7	1
2-2_	42	58	9	39	71	445	25
3-3_	143	176	133	27	44	185	81
4-4_	76	271	165	172	87	190	684
5-5_	67	63	50	88	132	224	799
6-6_	60	57	61	79	159	128	200
7-7_	48	36	113	19	188	52	27
8-8_	2	7	21	1	12	11	2
9-9_	0	0	2	0	0	1	0
Mean length	4.5	4.3	5.1	4.7	5.5	3.9	4.9
% ≥6-in/≥3-in	27.8	16.4	36.1	25.6	57.7	24.3	12.8
% ≥7-in/≥3-in	12.6	7.0	25.0	5.2	32.2	8.1	1.6
% ≥8-in/≥3-in	0.5	1.1	4.2	0.3	1.9	1.5	0.1

Bluegill size has been generally small at Loon Lake over the past 33 years (*Table 7*). Mean bluegill length varied from 4-5_ and averaged 4_ inches. The percentage of 6-inch and larger bluegills of all 3-inch and larger bluegills, defined as proportional stock density (PSD), was highest in 1988 (58%) and lowest in 2004 (13%). The percentage of 7-inch and larger bluegills was also greatest in 1988 (32%) and lowest in 2004 (<2%), while the highest percentage of 8-inch and larger bluegills was greatest in 1982 (4%) and lowest in 1971, 1986 and 2004 (<1%). Only 59 bluegills out of 5,848 (1%) caught during all surveys at the lake were 8-inch or larger.

Despite a scarcity of large fish, bluegill growth has been fairly typical of most natural lakes in the area (*Table 8*). However, mean lengths of age-4 through age-6 bluegills averaged _ inch smaller after 1994 compared to earlier years.

Photo below: *Biologist Jed Pearson (left) and aide Bob Angyal measure bluegills and take scale samples for age and growth determinations at Loon Lake back in 1983.*

Table 8. *Mean length in inches of bluegills at Loon Lake of various year classes.*

Inches	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6
2003	1.6					
2002	1.7	2.4				
2001	1.7	2.9	4.4			
2000	1.7	2.9	4.4	6.0		
1999	1.6	2.8	4.7	6.5	7.3	
1998	1.7	2.6				
1997	1.7	2.8	4.2			
1996	1.8	2.9	4.3	5.8		
1995	1.8	3.1	4.4	5.6	6.8	
1994	1.8	3.0	4.8	5.8	6.8	7.4
(data not available for 1988 – 1993)						
1987	1.7					
1986	1.7	3.0				
1985	1.6	3.0	4.4			
1984	1.7	3.2	5.1	6.7		
1983	1.7	3.1	4.8	6.6	7.4	
1982	1.6	3.0	4.7	6.5	7.4	7.8
1981	1.6					
1980	1.5	2.8				
1979	1.3	2.6	4.6			
1978	1.4	2.6	4.9	6.6		
1977		2.6	4.8	6.5	7.5	
1976	1.4	2.8	5.0	6.6	7.5	8.0
1975	1.4	2.7				
1974	1.4	2.6	4.5			
1973	1.6	2.9	5.0	6.5		
1972	1.7	3.0	5.1	6.3	7.2	
Mean	1.6	2.8	4.7	6.3	7.2	7.7
Area mean	1.7	3.1	4.7	6.1	6.9	7.4

The percentage of larger bass has apparently increased in recent years compared to previous years (*Table 9*). From 1971 through 1988, the percentage of 12-inch and larger bass of all 8-inch and larger bass varied from 10-19% and averaged 13%. The percentage increased to 41% in 2000 and 2004. Likewise, the percentage of 14-inch and larger bass increased from an average of 6% to 22% over the same time period. The percentage of 18-inch and larger bass did not increase however. From 1971 through 1988, 18-inch and larger bass accounted for 1-5% and averaged 2% of all 8-inch and larger bass. In the two most recent surveys, they accounted for 0-3% and averaged 1_%.

Table 9. *Number of largemouth bass collected during summer surveys* at Loon Lake from 1971-2004.*

Inches	1971	1977	1982	1986	1988	2000	20004
<8	84	42	12	43	46	108	38
8-11_	39	49	29	49	97	107	23
12-13_	5	5	4	3	5	41	6
14-17_	3	1	1	4	5	27	10
□18	1	3	1	1	1	5	0
% ≥12-in/≥8-in	18.8	15.5	17.1	14.0	10.2	40.6	41.0
% ≥14-in/≥8-in	8.3	6.9	5.7	8.8	5.6	17.8	25.6
% ≥18-in/≥8-in	2.1	5.2	2.9	1.8	0.9	2.8	0.0

*effort shown in Table 5.

Fishing effort from April through October 2004 at Loon Lake was less than effort reported from mid-May through September 1983 (79 hrs/ac). Excluding April and October, effort by boat anglers (49 hrs/ac) was 24% less in 2004 compared to 1983 (65 hrs/ac). The percentage of anglers who fished for bluegills decreased from 74% to 30% and the number of bluegills taken home declined 83% from 14,856 to 2,573. The proportion of 7-inch and larger bluegills decreased from 72% to 27%. Based on a spring estimate of 35,379 adult bluegills (≥6 in) in Loon Lake in 1983, anglers removed 34% of the population.

Although bluegill catches were down in 2004, crappie and bass catches increased over 1983 estimates. Muskie catches were similar. The percentage of crappie anglers rose from 2% to 15% and the crappie catch increased from only 252 in 1983 to 1,686 in 2004. The number of bass taken home was less in 2004 (264) compared to 1983 (682) but the number caught and released increased 15-fold from 397 to 4,864. Less than 3% of Loon Lake anglers fished for muskies in 1983 compared to 14% in 2004. One muskie was observed by the survey clerk in 2004 and none were observed in 1983. Anglers released 144 in 1983 and 108 in 2004.

MANAGEMENT IMPLICATIONS

Stocking muskie fingerlings and imposing largemouth bass size limits failed to produce any significant improvement in bluegill fishing quality at Loon Lake. The lake continues to be dominated by bluegills too small to interest most bluegill anglers. Bluegill numbers are greater than ever. In addition, crappies are now more abundant but are also generally small. Similar results were noted at Skinner Lake where muskies were stocked at four times the usual rate (20/ac) and a 14-inch bass size limit was imposed (Pearson 1995). Apparently the inherent stability of fish communities within Indiana natural lakes, despite variations in year class strength among species, coupled with a diverse array of potential forage fish, buffer the ability of predator fish to impact bluegill populations.

In contrast, the most notable changes as a result of predator management efforts at Loon Lake include the creation of muskie fishing opportunities and increases in density and size structure of largemouth bass. Although overall fishing effort is down and fewer anglers now fish for bluegills, more than half of Loon Lake anglers are drawn to bass (41%) or muskie (14%) fishing.

Photo above: *An angler displays a large muskie caught at Loon Lake.*

The density of adult muskies in Loon Lake (1.3/ac) was similar to an estimate at Lake Webster (1.5/ac) and met the original goal of establishing at least one adult per acre (Pearson 1999). Muskie anglers typically fished 3 hours per trip at Loon compared to 8 hours per trip at Webster but they caught muskies at an identical rate (1/25 hrs). On an acre basis, muskie fishing effort was about half at Loon (8 hrs/ac) compared to Webster (19 hrs/ac) and less than the target objective of 10 hours/acre. However, 95% of Loon Lake muskie anglers rated fishing fair or good, well above the goal of 65% satisfaction. Since 12% of the total fishing effort was directed at muskies, that figure translates to 1,795 hours of muskie fishing, or 598 trips. Assuming muskie anglers spend $50 per trip (American Sportfishing Association), the economic value of muskie fishing at Loon Lake was estimated to be $29,917 in 2004. The commercial value of 1,100 fingerlings (10-in) stocked each year is estimated to be $7,700 for a benefit:cost ratio of 4:1.

Although muskies have not improved bluegill fishing, there is little evidence to suggest muskies have had any adverse effects on the overall fish community at Loon Lake. Sport fish that may have declined since muskies were stocked (e.g. bullheads, perch, pumpkinseeds) are of little interest to most area anglers. Furthermore, stocking alternative predator species, (e.g. channel catfish, walleye, pike) would probably not improve bluegill size since maximum size, mouth gape, and food requirements of these fish are less than muskies.

Muskies have not adversely affected largemouth bass fishing at Loon Lake either. The density of 8-inch and larger bass (13/ac) is currently 27% below average for similar-sized lakes with a 14-inch size limit (18/ac), but size structure is much better. Density of 14-17_ inch bass (4.5/ac) is more than double the average number in other lakes (1.7/ac) and the density of 18-inch and larger bass (0.40/ac) is 54% above average (0.26/ac).

Like bluegills, bass undergo wide variations in recruitment. The greater density of older bass in Loon Lake probably reflects development of strong year classes in the late 1990s, effects of size limits, and popularity of catch-and-release fishing. Even so, bass fishing may decline after these older fish die out until another strong year class occurs. To protect quality bass fishing in lakes like Loon Lake, extend survival of older bass, and possibly mitigate the impacts of variable recruitment, more studies are needed to better understand bass population dynamics.

While disappointing, the lack of improvement in bluegill fishing in response to increased predator densities is not surprising. Other authors have concluded that the utility of stocking muskies as a bluegill management tool is limited (Graff 1986, Storck and Newman 1992). Likewise, Shroyer et. al. (2003) found no evidence to suggest prohibiting harvest of largemouth bass had any beneficial effect on bluegill abundance, size or fishing quality at two Minnesota lakes, although study design was compromised by changes in plant communities. Dense plants can impair predator foraging and optimum bluegill habitat should include dense patches surrounded by sparsely distributed plants (Harrel et. al. 2001). At Loon Lake, no submersed plants were found at 29% of littoral sites sampled in July 2004 and density (1.6 mean rake score on a 1-5 scale) was generally low, so vegetation probably does not limit the ability of predator fish to find and capture bluegills.

Although the current scarcity of larger bluegills in Loon Lake is due to the low number of fish older than age-3, the key to long-term improvements in bluegill fishing may rest more with habitat management than predator management. The lake is 92 feet deep, yet poor water clarity during summer limits sunlight penetration to water less than 10-15 feet (3 times secchi depth). As a result, much of the water column lacks enough oxygen to support fish. This forces them into the top layer of water where temperatures are warmer, energy requirements are greater, and competition for food is more intense.

Loon Lake will never be as clear as some lakes due to its large watershed and greater nutrients, but steps have been taken to protect water quality from further declines. These include land management practices in the watershed, wetland restoration, construction of a sediment basin on Friskney Ditch, and installation of a sewer. Other steps that could increase water clarity and improve fish habitat, such as reducing turbulence created by boating, limiting shoreline alterations, maintaining greater plant densities, aeration, or nutrient inactivation, are more controversial or costly.

Even though muskies have not improved bluegill fishing at Loon Lake as originally hoped, the program should be continued on the basis that it adds diversity to fishing opportunities at the lake without affecting fishing for other species. It also generates enough interest and satisfaction among anglers to offset the program's cost. In the meantime, bluegill fishing is expected to improve slightly in the near future as the large 2001 year-class ages.

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Appendix 1. *Length-frequency distribution of unmarked (Unmark) and recaptured (Recap) muskellunge captured by trap nets during spring 2004 at Loon Lake.*

Inches	Unmark	Recap	Total	Age
31.0	1		1	
31.5				
32.0				
32.5	3		3	6
33.0	3		3	
33.5	3		3	
34.0	4		4	4
34.5	5	1	6	5
35.0	5	1	6	
35.5	1	2	3	5
36.0	8		8	4,5,6
36.5	1		1	
37.0	5		5	5
37.5	4		4	
38.0	5		5	
38.5	2		2	6
39.0	1		1	
39.5	2		2	
40.0	1		1	
Total	54	4	58	

Appendix 2. *Length-frequency distribution of unmarked (Unmark) and recaptured (Recap) largemouth bass captured by electrofishing (seconds) during spring 2004 at Loon Lake.*

Inches	4/28/2004 Unmark	4/28/2004 Recap	5/5/2004 Unmark	5/5/2004 Recap	5/12/2004 Unmark	5/12/2004 Recap	Total Unmark	Total Recap	Grand Total	Age
4.5	4		3	0	1	0	8	0	8	2
5	3		6	0	3	0	12	0	12	2
5.5	9		5	0	6	0	20	0	20	2
6	8		8	0	1	0	17	0	17	2
6.5	5		5	0	5	1	15	1	16	2,3
7	5		3	1	4	0	12	1	13	2,3
7.5	4		5	0	2	1	11	1	12	2,3
8	6		6	1	10	0	22	1	23	3
8.5	17		13	3	7	0	37	3	40	3
9	15		14	1	7	3	36	4	40	3
9.5	24		17	5	12	4	53	9	62	3
10	29		22	2	15	2	66	4	70	3,4
10.5	32		28	6	20	9	80	15	95	3,4
11	18		25	1	21	1	64	2	66	4
11.5	17		23	4	14	6	54	10	64	4,5
12	17		8	5	11	7	36	12	48	4
12.5	15		21	1	11	1	47	2	49	4
13	13		18	2	13	4	44	6	50	4,5
13.5	9		14	2	12	6	35	8	43	4,5,6,7
14	13		15	3	8	4	36	7	43	4,5,6,7
14.5	12		20	2	21	3	53	5	58	5,6
15	14		26	5	18	2	58	7	65	5,6
15.5	13		20	1	20	4	53	5	58	5,6
16	10		30	1	17	3	57	4	61	6,7
16.5	12		18	1	18	4	48	5	53	6,7
17	6		7	3	2	1	15	4	19	7
17.5	2		5	0	1	0	8	0	8	7,8
18	3		6	1	4	0	13	1	14	7,8
18.5	2		4	0	0	2	6	2	8	8
19	0		3	0	2	1	5	1	6	8,9
19.5	1		2	0	0	0	3	0	3	8,9
20	0		2	0	0	0	2	0	2	10
Total	338		402	51	286	69	1026	120	1146	
Seconds	10470		11780		10845					

Appendix 3. *Number of times various species were mentioned as fishing preferences among weekend or weekday, boat or shore, anglers who were interviewed at Loon Lake during 2004.*

All anglers

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	16	40	58	44	41	43	20	262	36.4
Bluegill	4	25	41	44	26	32	16	188	26.1
Crappie	16	24	16	20	7	12	1	96	13.3
Muskie	6	18	15	11	7	16	16	89	12.4
Perch	0	0	0	0	0	1	0	1	0.1
Any	9	19	24	13	10	9	0	84	11.7
Total	51	126	154	132	91	113	53	720	100.0

Boat anglers - weekends

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	6	17	30	12	16	21	7	109	39.8
Bluegill	1	8	9	13	7	11	7	56	20.4
Crappie	5	9	6	7	3	7	1	38	13.9
Muskie	4	6	12	5	5	8	6	46	16.8
Perch	0	0	0	0	0	1	0	1	0.4
Any	5	5	5	2	5	2	0	24	8.8
Total	21	45	62	39	36	50	21	274	100.0

Boat anglers - weekdays

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	10	16	24	22	23	22	13	130	40.1
Bluegill	1	9	22	18	12	17	7	86	26.5
Crappie	10	7	9	9	2	4	0	41	12.7
Muskie	2	10	3	6	2	8	10	41	12.7
Perch	0	0	0	0	0	0	0	0	0.0
Any	2	8	8	5	1	2	0	26	8.0
Total	25	50	66	60	40	53	30	324	100.0

Shore anglers - weekends

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	0	5	1	5	0	0	0	11	21.6
Bluegill	1	6	3	5	3	0	1	19	37.3
Crappie	0	1	0	1	1	0	0	3	5.9
Muskie	0	2	0	0	0	0	0	2	3.9
Perch	0	0	0	0	0	0	0	0	0.0
Any	1	0	7	2	2	4	0	16	31.4
Total	2	14	11	13	6	4	1	51	100.0

Shore anglers - weekdays

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	0	2	3	5	2	0	0	12	16.9
Bluegill	1	2	7	8	4	4	1	27	38.0
Crappie	1	7	1	3	1	1	0	14	19.7
Muskie	0	0	0	0	0	0	0	0	0.0
Perch	0	0	0	0	0	0	0	0	0.0
Any	1	6	4	4	2	1	0	18	25.4
Total	3	17	15	20	9	6	1	71	100.0

Appendix 3. *Continued.*

All boat anglers

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	16	33	54	34	39	43	20	239	40.0
Bluegill	2	17	31	31	19	28	14	142	23.7
Crappie	15	16	15	16	5	11	1	79	13.2
Muskie	6	16	15	11	7	16	16	87	14.5
Perch	0	0	0	0	0	1	0	1	0.2
Any	7	13	13	7	6	4	0	50	8.4
Total	46	95	128	99	76	103	51	598	100.0

All shore anglers

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	0	7	4	10	2	0	0	23	18.9
Bluegill	2	8	10	13	7	4	2	46	37.7
Crappie	1	8	1	4	2	1	0	17	13.9
Muskie	0	2	0	0	0	0	0	2	1.6
Perch	0	0	0	0	0	0	0	0	0.0
Any	2	6	11	6	4	5	0	34	27.9
Total	5	31	26	33	15	10	2	122	100.0

Weekend anglers

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	0	5	1	5	0	0	0	11	21.6
Bluegill	1	6	3	5	3	0	1	19	37.3
Crappie	0	1	0	1	1	0	0	3	5.9
Muskie	0	2	0	0	0	0	0	2	3.9
Perch	0	0	0	0	0	0	0	0	0.0
Any	1	0	7	2	2	4	0	16	31.4
Total	2	14	11	13	6	4	1	51	100.0

Weekday anglers

	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent
Bass	10	18	27	27	25	22	13	142	35.9
Bluegill	2	11	29	26	16	21	8	113	28.6
Crappie	11	14	10	12	3	5	0	55	13.9
Muskie	2	10	3	6	2	8	10	41	10.4
Perch	0	0	0	0	0	0	0	0	0.0
Any	3	14	12	9	3	3	0	44	11.1
Total	28	67	81	80	49	59	31	395	100.0

Appendix 4. *Size distribution of angler-caught fish measured by creel clerks at Loon Lake during 2004.*

Inches	Bluegill	Crappie	Sunfish	Bass	Perch
4.5	4				
5.0	22	5	3		
5.5	45	3	7		
6.0	100	27	9		2
6.5	85	29	7		1
7.0	71	61	3		5
7.5	16	64	2		2
8.0	6	24			1
8.5	1	10			2
9.0		4			0
9.5		1			1
10.0		1			1
10.5		4			
11.0		4			
11.5		6			
12.0		1			
12.5		0			
13.0		3			
13.5					
14.0				4	
14.5				1	
15.0				6	
15.5				5	
16.0				3	
16.5				4	
17.0				9	
17.5				1	
18.0				1	

Appendix 5. *Angler ratings of fishing quality (number of responses) based on various species sought at Loon Lake in 2004*

Group	"Good"	"Fair"	"Poor"	Total
All anglers	229	252	125	606
Boat anglers	200	198	92	490
Bluegill-only	9	35	42	86
Bass-only	82	67	15	164
Crappie-only	28	15	2	45
Muskie-only	21	19	2	42
Anything	16	23	11	50
Shore anglers	29	54	27	110
Bluegill-only	8	14	13	35
Bass-only	11	7	4	22
Crappie-only	1	6	0	7
Muskie-only	1	0	0	1
Anything	4	24	6	34

Appendix 6-17: *Standard Division of Fish and Wildlife fish population survey pages.*

FISH SURVEY REPORT

Indiana Division of Fish and Wildlife

Type of survey
Initial: Re-survey: X

Lake name	County	Date of survey (Month, day, year)
Loon Lake	Noble and Whitley	7/19-7/22/04
Biologist's name		Date of approval (Month, day, year)
Jed Pearson		

LOCATION

Quadrangle name	Range	Section
Ormas	8E, 9E	1,25,36,31,6
Township	Nearest town	
32N, 33N	Etna	

ACCESSIBILITY

State owned public access site	Privately owned public access site	Other access site
Located in southeast corner		

Surface acres	Maximum depth (ft)	Average depth (ft)	Acre feet	Water level (msl)	Extreme fluctuations (ft)
222	92	25.9		895.14	none

INLETS

Name	Location	Origin
Friskney Ditch	Southeast corner	runoff
Winters Drain	South shore	Goose Lake
Unnamed stream	West shore	Old Lake

OUTLET

Name	Location
Schaefer Drain	North end, flows to Stangland Ditch (Tippecanoe watershed)

Water level control
Concrete sill

POOL	ELEVATION (Feet MSL)	ACRES	Bottom type
TOP OF DAM			Boulder
TOP OF FLOOD CONTROL POOL			Gravel
TOP OF CONSERVATION POOL			Sand X
TOP OF MINIMUM POOL			Muck X
STREAMBED			Clay
			Marl X

Watershed use
Agricultural and residential development with small woodlots, wetlands and lakes.

Development of shoreline
Approximately 90% of the shoreline is residentially-developed.

Previous surveys and investigations
Mapping, USGS, 1956: Fishery surveys, IDNR, 1971, 1977, 1982, 1986, 1988, 2000:
Creel survey, IDNR, 1983: Water clarity, IDNR, 1988: Feasibility Study, LARE, 1992

SAMPLING EFFORT			
ELECTROFISHING	Day hours	Night hours	Total hours
		0.75	0.75
TRAPS	Number of traps	Days	Total lifts
	2	2	4
GILL NETS	Number of nets	Days	Total lifts
	3		8

PHYSICAL AND CHEMICAL CHARACTERISTICS	
Color	Turbidity
green	2 Feet 4 Inches (Secchi disk)

TEMPERATURE, DISSOLVED OXYGEN (ppm), TOTAL ALKALINITY (ppm), pH

Depth (ft)	Degrees F	Oxygen*		Depth (ft)	Degrees F	Oxygen*	
Surface	76.8	9.1		60	43.2	0.1	
2	77.0	9.1		62			
4	77.0	8.9		64			
6	77.0	8.6		66			
8	76.3	6.5		68			
10	75.0	4.3		70	42.1	0.1	
12	73.9	1.4		72			
14	75.6	0.5		74			
16	63.1	0.4		76			
18	61.7	0.3		78			
20	56.8	0.3		80	41.5	0.1	
22	54.5	0.3		82			
24	52.9	0.3		84			
26	50.4	0.2		86			
28	49.6	0.2		88			
30	49.3	0.2		90	41.5	0.1	
32	48.7	0.2		92			
34	48.4	0.2		94			
36	47.7	0.2		96			
38	47.3	0.2		98			
40	46.4	0.2		100			
42	45.7	0.1					
44	45.3	0.1					
46	45.0	0.1					
48	44.4	0.1					
50	44.1	0.1					
52	43.9	0.1					
54	43.9	0.1					
56	43.7	0.1					
58	43.5	0.1					

Sampling date: 6/7/2000

	Surface	Bottom
pH	9.0	7.5
Alkalinity*	171	
Conductivity	350	400
TDS		

**ppm = parts per million*

Occurrence and abundance of submersed aquatic plants in Loon Lake.

Date:	7/30/04	Littoral sites with plants:	44	Species diversity:	0.73
Littoral depth (ft):	7.5	Number of species:	7	Native diversity:	0.71
Littoral sites:	62	Maximum species/site:	3	Rake diversity:	0.71
Total sites:	66	Mean number species/site:	1.13	Native rake diversity:	0.70
Secchi:	2.5	Mean native species/site:	1.10	Mean rake score:	1.63

Common Name	Site frequency	Relative density	Mean density	Dominance
Eel grass	41.9	0.58	1.38	11.6
Coontail	37.1	0.56	1.52	11.3
Naiad species	16.1	0.18	1.10	3.5
Small pondweed	8.1	0.11	1.40	2.3
Sago pondweed	4.8	0.08	1.67	1.6
Curly-leaf pondweed	3.2	0.03	1.00	0.6
Chara	1.6	0.02	1.00	0.3
Filamentous algae	50.0			
Other Observed Plants				
Arrowhead				
Buttonbush				
Cattail				
Duckweed				
Purple loosestrife				
Smartweed				
Soft-stem bulrush				
Spatterdock				
Swamp loosestrife				
Water lily				

Relative Abundance, Size and Estimated Weight of Fish Collected at Loon Lake						
			Minimum	Maximum		
Common Name*	Number	Percent	Length (in)	Length (in)	Weight (lb)**	Percent
Bluegill	1819	77.1	1.6	8.2	169.18	40.1
Black crappie	203	8.6	1.7	12.3	45.73	10.8
Redear	119	5.0	2.9	7.1	17.33	4.1
Largemouth bass	77	3.3	2.1	17.6	39.83	9.4
Yellow perch	53	2.2	4.9	10.0	8.29	2.0
Yellow bullhead	25	1.1	6.7	13.5	15.32	3.6
Spotted gar	21	0.9	17.8	30.2	40.37	9.6
Carp	9	0.4	15.9	22.1	32.94	7.8
Brown bullhead	8	0.3	9.0	15.7	8.42	2.0
Warmouth	5	0.2	4.6	6.9	0.83	0.2
Lake chubsucker	4	0.2	8.8	9.4	1.60	0.4
Bowfin	3	0.1	10.8	25.7	10.92	2.6
Channel catfish	3	0.1	15.1	17.3	4.34	1.0
Pumpkinseed	3	0.1	4.5	5.1	0.26	0.1
Brook silverside	2	0.1	3.5	4.0	0.02	0.0
Muskellunge	2	0.1	34.7	40.5	23.98	5.7
Golden shiner	1	0.0	7.0		0.13	0.0
Spotted sucker	1	0.0	17.5		2.30	0.5
	2358				421.79	

Number, catch by gear, percentage, estimated weight and age of blueg															
Length	Catch by gear			Total	Percent	Weight*	Age	Length	Catch by gear			Total	Percent	Weight*	Age
(in)	EF	GN	TN			(lb)		(in)	EF	GN	TN			(lb)	
1.0								14.5							
1.5	1			1	0.1	0.00	1	15.0							
2.0	2			2	0.1	0.01	1	15.5							
2.5	23			23	1.3	0.01	1	16.0							
3.0	11		1	12	0.7	0.02	1,2	16.5							
3.5	65		4	69	3.8	0.03	2,3	17.0							
4.0	256	1	15	272	15.0	0.05	2,3	17.5							
4.5	383	2	27	412	22.6	0.07	3	18.0							
5.0	396	1	42	439	24.1	0.09	3,4	18.5							
5.5	291	3	66	360	19.8	0.12	3	19.0							
6.0	73	1	70	144	7.9	0.16	3,4	19.5							
6.5	16		40	56	3.1	0.20	3	20.0							
7.0	6		13	19	1.0	0.26	3,4,5	20.5							
7.5	2		6	8	0.4	0.32	4,5	21.0							
8.0			2	2	0.1	0.39	4,5	21.5							
8.5								22.0							
9.0								22.5							
9.5								23.0							
10.0								23.5							
10.5								24.0							
11.0								24.5							
11.5								25.0							
12.0															
12.5															
13.0															
13.5															
14.0								Total				1819		169.18	
Electrofishing catc			1525			Gill net catch:		8				Trap net catch:		286	

Number, catch by gear, percentage, estimated weight and age of black crappie															
Length	Catch by gear			Total	Percent	Weight	Age	Length	Catch by gear			Total	Percent	Weight	Age
(in)	EF	GN	TN			(lb)		(in)	EF	GN	TN			(lb)	
1.0								14.5							
1.5			1	1	0.5	0.00		15.0							
2.0			3	3	1.5	0.00		15.5							
2.5								16.0							
3.0								16.5							
3.5								17.0							
4.0								17.5							
4.5								18.0							
5.0								18.5							
5.5								19.0							
6.0								19.5							
6.5	1	7		8	3.9	0.15	3	20.0							
7.0	22	22	10	54	26.6	0.18	3	20.5							
7.5	32	51	26	109	53.7	0.22	3	21.0							
8.0	7	4	10	21	10.3	0.27	3	21.5							
8.5			3	3	1.5	0.33	3	22.0							
9.0								22.5							
9.5								23.0							
10.0			1	1	0.5	0.53	4	23.5							
10.5								24.0							
11.0								24.5							
11.5								25.0							
12.0	1			1	0.5	0.92	6								
12.5			2	2	1.0	1.04	6								
13.0															
13.5															
14.0								Total				203		45.73	
Electrofishing catch:			63			Gill net catch:		84				Trap net catch:		56	

Number, catch by gear, percentage, estimated weight and age of redear															
Length	Catch by gear			Total	Percent	Weight	Age	Length	Catch by gear			Total	Percent	Weight	Age
(in)	EF	GN	TN			(lb)		(in)	EF	GN	TN			(lb)	
1.0								14.5							
1.5								15.0							
2.0								15.5							
2.5								16.0							
3.0	2			2	1.7	0.02	1	16.5							
3.5	4		1	5	4.2	0.03	2	17.0							
4.0	2			2	1.7	0.05	2	17.5							
4.5	3			3	2.5	0.07	2	18.0							
5.0	3		3	6	5.0	0.09	3	18.5							
5.5	9		19	28	23.5	0.12	2,3	19.0							
6.0	12		35	47	39.5	0.16	3	19.5							
6.5	4	1	20	25	21.0	0.20	3,4	20.0							
7.0			1	1	0.8	0.25	3	20.5							
7.5								21.0							
8.0								21.5							
8.5								22.0							
9.0								22.5							
9.5								23.0							
10.0								23.5							
10.5								24.0							
11.0								24.5							
11.5								25.0							
12.0															
12.5															
13.0															
13.5															
14.0								Total				119		17.33	
Electrofishing catch:			39			Gill net catch:		1				Trap net catch:		79	

Number, catch by gear, percentage, estimated weight and age of largemouth bass

Length	Catch by gear			Total	Percent	Weight	Age	Length	Catch by gear			Total	Percent	Weight	Age
(in)	EF	GN	TN			(lb)		(in)	EF	GN	TN			(lb)	
1.0								14.5	2			2	2.6	1.53	
1.5								15.0		1		1	1.3	1.70	
2.0	8		1	9	11.7	0.00		15.5	1	1		2	2.6	1.88	
2.5	8		1	9	11.7	0.01		16.0	1			1	1.3	2.07	
3.0								16.5	2			2	2.6	2.28	
3.5								17.0							
4.0								17.5	1			1	1.3	2.73	
4.5								18.0							
5.0	1			1	1.3	0.06		18.5							
5.5								19.0							
6.0	1			1	1.3	0.10		19.5							
6.5	9			9	11.7	0.13		20.0							
7.0	4	1		5	6.5	0.16		20.5							
7.5	4			4	5.2	0.20		21.0							
8.0	2			2	2.6	0.25		21.5							
8.5	1			1	1.3	0.30		22.0							
9.0	1	1		2	2.6	0.35		22.5							
9.5	7			7	9.1	0.42		23.0							
10.0	2			2	2.6	0.49		23.5							
10.5	3			3	3.9	0.57		24.0							
11.0	1	1		2	2.6	0.65		24.5							
11.5	3	1		4	5.2	0.75		25.0							
12.0	1			1	1.3	0.85									
12.5	2			2	2.6	0.97									
13.0	2			2	2.6	1.09									
13.5	1			1	1.3	1.23			*ages not determined from July samples						
14.0			1	1	1.3	1.37		Total				77		39.83	

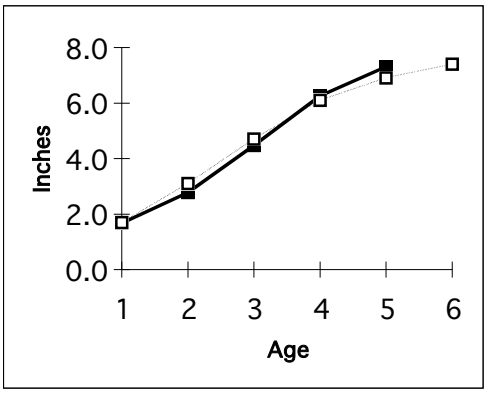
Electrofishing catch:	68	Gill net catch:	6	Trap net catch:	3

Number, catch by gear, percentage, estimated weight and age of yellow perch															
Length	Catch by gear			Total	Percent	Weight	Age	Length	Catch by gear			Total	Percent	Weight	Age
(in)	EF	GN	TN			(lb)		(in)	EF	GN	TN			(lb)	
1.0								14.5							
1.5								15.0							
2.0								15.5							
2.5								16.0							
3.0								16.5							
3.5								17.0							
4.0								17.5							
4.5								18.0							
5.0	2			2	3.8	0.06	1,2	18.5							
5.5	8			8	15.1	0.08	2,3	19.0							
6.0	12	1	2	15	28.3	0.10	3	19.5							
6.5	10		1	11	20.8	0.13	3	20.0							
7.0	5	1		6	11.3	0.17	3	20.5							
7.5	2			2	3.8	0.21	3	21.0							
8.0	1		1	2	3.8	0.25	4,5	21.5							
8.5	3			3	5.7	0.31	4,5	22.0							
9.0	1	1		2	3.8	0.37	6	22.5							
9.5								23.0							
10.0			2	2	3.8	0.52		23.5							
10.5								24.0							
11.0								24.5							
11.5								25.0							
12.0															
12.5															
13.0															
13.5															
14.0								Total				53		8.29	
Electrofishing catch			44			Gill net catch:		3				Trap net catch:		6	

Bluegill
Intercept: 0.8 inch

Year Class	Count	BACK-CALCULATED LENGTH (inches) AT EACH AGE I	II	III	IV	V	VI
2003	9	1.6					
	stdev	0.20					
2002	6	1.7	2.4				
	stdev	0.05	0.14				
2001	35	1.7	2.9	4.4			
	stdev	0.22	0.63	1.20			
2000	7	1.7	2.9	4.4	6.0		
	stdev	0.20	0.37	0.52	1.16		
1999	5	1.7	2.8	4.7	6.5	7.3	
	stdev	0.28	0.29	0.75	0.56	0.43	
1998							
	stdev						
Mean*		1.7	2.8	4.5	6.3	7.3	
SD		0.04	0.23	0.18	0.35	0.00	
Count		62	53	47	12	5	

Bluegill growth (solid line) compared to other lakes (dotted line).

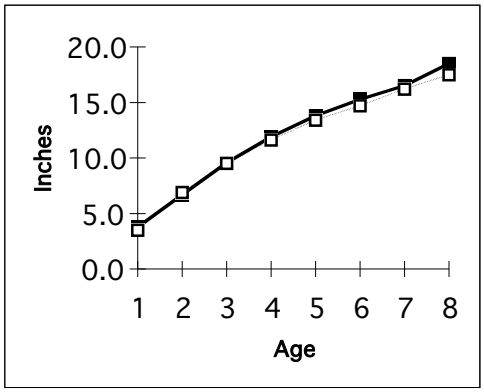


** Age groups with less than three samples not included in year class averages*

Largemouth bass
Intercept: 0.8 inch

Year Class	Count	BACK-CALCULATED LENGTH (inches) AT EACH AGE I	II	III	IV	V	VI		
2003	0								
	stdev								
2002	48	3.6	5.7						
	stdev	0.78	0.76						
2001	64	4.0	6.8	8.7					
	stdev	0.62	0.81	1.05					
2000	52	4.4	7.7	10.2	11.7				
	stdev	0.82	1.37	1.01	0.91				
1999	32	3.8	7.2	9.8	12.3	13.7			
	stdev	0.63	1.02	1.62	0.76	0.95			
1998	36	3.5	6.5	9.7	11.8	13.9	15.3		
	stdev	0.55	0.88	1.13	2.08	0.93	0.84		
1997	23	3.35	6.34	9.52	11.88	13.78	15.30		
	stdev	0.61	0.88	1.33	1.25	1.20	1.24		
1996									
Mean*		3.8	6.7	9.6	11.9	13.8	15.3	16.5	18.5
SD		0.39	0.70	0.56	0.29	0.09	0.02		
Count		319	271	207	143	91	59	23	na

Largemouth bass growth (solid line) compared to other lakes (dotted line).

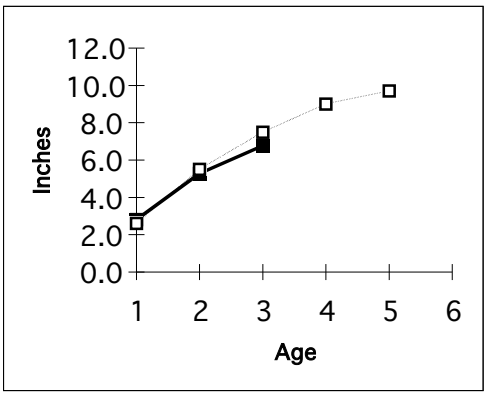


** Age groups with less than three samples not included in year class averages*

Black crappie
Intercept: 1.4 inch

Year Class	Count	BACK-CALCULATED LENGTH (inches) AT EACH AGE I	II	III	IV	V	VI
2003	0						
	stdev						
2002	0						
	stdev						
2001	23	2.8	5.3	6.8			
	stdev	0.37	0.61	0.73			
2000	0						
	stdev						
1999	0						
	stdev						
1998							
	stdev						
Mean*		2.8	5.3	6.8			
SD							
Count		23	23	23			

Black crappie growth (solid line) compared to other lakes (dotted line).



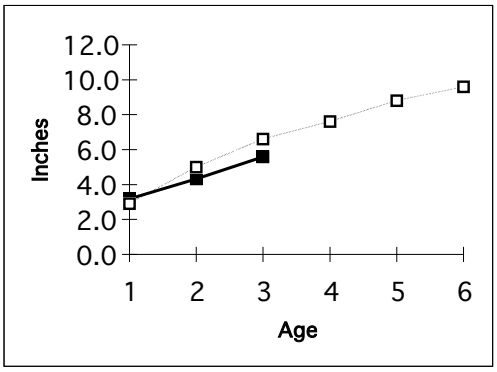
** Age groups with less than three samples not included in year class averages*

Yellow perch
Intercept: 1.2 inch

Year Class	Count	I	II	III	IV	V	VI
2003	1	3.4					
	stdev						
2002	3	3.2	4.3				
	stdev	0.54	0.24				
2001	17	3.0	4.4	5.6			
	stdev	0.24	0.34	0.60			
2000							
	stdev						
1999							
	stdev						
1998							
	stdev						
Mean*		3.2	4.3	5.6			
SD		0.20	0.09				
Count		21	20	17			

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Yellow perch growth (solid line) compared to other lakes (dotted line).



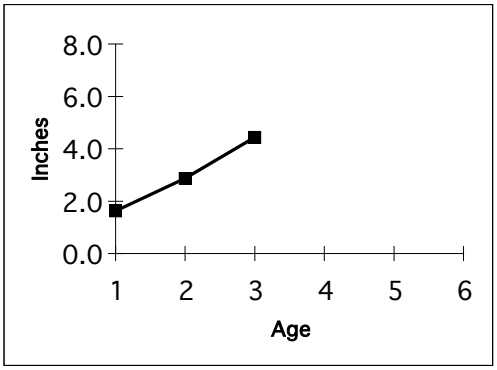
** Age groups with less than three samples not included in year class averages*

Redear
Intercept: 0.6 inch

Year Class	Count	I	II	III	IV	V	VI
2003	2	1.8					
	stdev	0.29					
2002	10	1.7	2.7				
	stdev	0.19	0.40				
2001	18	1.6	3.1	4.4			
	stdev	0.33	0.46	0.54			
2000	1	1.4	3.3	4.9	6.2		
	stdev						
1999							
	stdev						
1998							
	stdev						
Mean*		1.6	2.9	4.4			
SD		0.04	0.31				
Count		28	28	18			

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Redear growth (solid line).



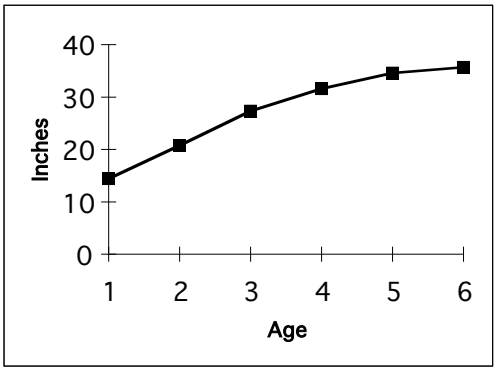
** Age groups with less than three samples not included in year class averages*

Muskellunge
Intercept: 2.1 inch

Year Class	Count	I	II	III	IV	V	VI
2003	1	16.4					
	stdev						
2002							
	stdev						
2001							
	stdev						
2000	2	12.3	23.6	31.2	34.5		
	stdev	1.05	1.86	1.18	0.75		
1999	4	14.4	21.2	27.5	32.4	35.3	
	stdev	0.55	1.82	2.12	1.44	1.41	
1998	3	14.4	20.3	27.1	30.8	33.9	35.7
	stdev	3.31	2.51	3.04	2.15	2.10	3.01
Mean*		14.4	20.7	27.3	31.6	34.6	35.7
SD		0.01	0.61	0.29	1.08	1.05	
Count		7	7	7	7	7	3

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Muskie growth (solid line).



** Age groups with less than three samples not included in year class averages*