Upper Long Lake

Noble County

Fish management report

with emphasis on muskie management

Jed Pearson, fisheries biologist

Fisheries Section
Indiana Department of Natural Resources
Division of Fish and Wildlife
I.G.C.-South, Room W273
402 W. Washington Street
Indianapolis, IN 46204

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EXECUTIVE SUMMARY

Although muskies have been stocked in Upper Long Lake since 1996, opposition to continuing the stocking program reached a crescendo in 2009. To address concerns expressed by some lake residents, the DFW conducted a series of surveys in 2010 to document the status of the fish community and fishing at the lake. This report summarizes the results of the surveys.

Upper Long Lake is an 86-acre natural lake with a history of producing small, slow-growing bluegills. Consequently the local lake association began stocking muskies in 1996 to add to the predator population. In 2002 the Webster Lake Musky Club assumed costs of the program and increased the stocking rate. To date 4,279 muskies have been stocked over the past 14 years.

Anglers fished 4,330 hours from May 11 through August 31 at the lake. Their effort represented 0.45 hours per acre per day. Lake residents accounted for 64% of the total anglers. Of all anglers, 33% fished solely for muskies. Boat anglers made 542 trips to fish for muskies that generated $34,688 of economic benefit. Anglers kept nine muskies. They caught and released another 136 of which 128 were less than 36 inches long and eight were 36 inches or larger. Based on the total hours fished and the fraction directed at catching muskies, anglers caught an average of one muskie per 10 hours of fishing. About 65% of all anglers favored the stocking program.

No major shifts occurred in species composition after muskies were stocked but species diversity declined. Bluegills accounted for 70% of a June survey catch by number and 35% by weight. Bluegills ranged from 1.5 to 7.5 inches long but only very few were 6 inches or longer. Bluegills and crappies apparently increased after muskie stockings, perch stayed about the same, and bass declined. The number of 8- to 12-inch bass dropped from 745 in May 1995 to 307 in May 2010 but increased from 186 to 276 among 12- to 14-inch bass and from 100 to 281 among 14- to 18-inch bass.

No muskies small enough to have originated from natural reproduction were observed.

Although muskies were originally stocked in Upper Long Lake to prey on small bluegills and increase numbers of large bluegills, this did not happen. Catch rates of 6- to 7-inch bluegills decreased from 37 per hour in 1991 to less than 3 per hour in 2010. Catch rates of 7-inch and larger bluegills decreased from 4 per hour to less than 2 per hour.

Based on gill net catches only, the catch rate of 10 muskies in four gill nets (2.5/net) was over three times the average (0.7/net) at other lakes. Given the number, size and weight of muskies in the lake, there is no reason to think that they were not abundant enough in theory to exert ample predation on bluegills. Therefore, no amount of muskie density is likely to improve bluegill size.

In contrast, muskie stockings now attract a substantial number of anglers who enjoy the opportunity to catch muskies and are willing to invest time and money into fishing for them without creating problems of excessive use at the lake or detracting from other fishing opportunities. While the current level of muskie fishing interest and catches might be sustained with a reduced stocking rate, it is unlikely that the loss of socioeconomic benefits would be off-set if the program is discontinued. In light of the DFW's mission to manage a diverse array of fishing opportunities, it is recommended that requests to stock additional muskies be permitted.

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INTRODUCTION

Stocking muskellunge *Esox masquinongy* to provide quality muskie fishing is an important component of Indiana's fish management program. Until the 1970s muskies were present only in the Ohio River and a nearby tributary. At the time the DFW of Fish and Wildlife ("DFW") began stocking muskies in various public waters with fish obtained from out of state sources. Since the mid-1990s broodfish captured at Lake Webster have provided an in-state egg source to expand the program. About 18,000 muskie fingerlings (8-10 inch) are now reared in state hatcheries annually. The DFW currently stocks muskies in seven natural lakes totaling 3,372 acres in the north half of the state and six impoundments totaling 6,431 acres in the south half.

As the muskie stocking program grew, so too did angler interest but mainly at a local level. From 1994 to 2005 the percentage of natural lake anglers who fished for muskies increased slightly from 0.7% to 1.3% (from Shipman 1996; Broussard 2005). Estimates of annual muskie fishing activity rose from 14,300 to 15,600 angler-days (from Pearson 2010 unpublished). In contrast, the percentage of boat anglers who targeted muskies at Lake Webster increased from 7% in 1987 and 6% in 1990 to 24% in 1998 and 60% in 2005 (Pearson 2005). About 55% of all anglers at Webster targeted muskies in 2005. At Skinner Lake, muskies interested 10-16% of its anglers in the 1990s but increased to 26% in 2008 (Thomas 2008). Muskies attracted 4-18% of anglers at Ball Lake, including 11% who fished solely for muskies (Koza 2008 unpublished). Although initial interest at Loon Lake was comparable to other lakes, muskie interest dropped from 12% in 2004 to only 6% in 2009 (Pearson 2004, Pearson et. al 2009).

While Indiana's muskie stocking program attracts some anglers, not all muskie stockings are popular with other anglers or lake residents. Opposition centers on concerns over the potential impacts muskies may have as predators on other sport fish and concerns that stockings may lead to problems associated with increased lake use. Some opposition comes from anglers who simply prefer that a different species (e.g. walleyes) be stocked or from traditional anglers who have never experienced muskie fishing. In the initial years of the program at Lake Webster, 24% of anglers opposed stocking and 64% favored it (Pearson 1987). Nearly twice as many lake resident anglers (29%) opposed muskie stocking than did visiting anglers (17%). Opposition there seems to have subsided but to what extent has not been measured. More recently, only 9% of anglers opposed muskie stocking at Skinner Lake and 91% favored it (Thomas 2008). At Ball Lake only 1% of interviewed anglers opposed muskie stockings (Koza 2008 unpublished).

While these figures indicate support for muskie stocking can be locally strong, opposition to a stocking program at Upper Long Lake reached a crescendo in 2009. Some lake residents expressed outrage over the DFW's continued issuance of a stocking permit to the Webster Lake Musky Club for purchase and release of 430 fingerling muskies (5/acre) each year in the lake. In Indiana, individuals and groups interested in stocking fish into public waters must obtain a permit. Although hearings are not usually held before issuing a permit, the DFW is interested in public comments on stocking proposals. Therefore, to address concerns expressed by Upper Long Lake residents, the DFW facilitated a meeting in March 2010 between representatives from the association and the muskie club to discuss the history, status, and goals of the stocking program. Out of the meeting came a consensus to continue stocking but also an agreement to a one-year reduction in the stocking rate (2/acre) and a call for a series of surveys to be done in 2010 to document the status of the fish community and fishing at the lake. These surveys focused on five questions of special interest and will be addressed in this report:

1. How many anglers fish for muskies at the lake and how many muskies are caught?
2. What are the levels of support and opposition toward the muskie stocking program?
3. Have changes occurred among native species that may be associated with muskies?
4. Has muskie predation on small bluegills resulted in more large bluegills?
5. Are muskies reproducing and adding to the muskie population?

UPPER LONG LAKE

Upper Long Lake is an 86-acre natural lake with a history of producing small, slow-growing bluegills. Angler satisfaction with bluegill fishing has been low. During an initial survey in 1980, only five bluegills from a sample of 302 were 7-inch or larger (Pearson 1980). Back-calculated lengths at age-4 averaged only 4.6 inches. In contrast, age-4 bluegills in Indiana natural lakes typically average 6.1 inches (Pearson 1996). Assuming the population exceeded its food supply, biologists applied antimycin to the lake in 1981 to reduce bluegill numbers and stimulate growth. Largemouth bass fingerlings and sub-adults were also stocked to boost predation on bluegills. After six years, there was no evidence of any change in bluegill size (Pearson 1987, 1991). Consequently, the association began stocking muskies in 1996 to add to the predator population. In 2002 the muskie club assumed costs of the program and increased the stocking rate. To date 4,279 muskies have been stocked over the past 14 years (Table 1).

Habitat features and the fish community at Upper Long Lake are similar to those of many Indiana natural lakes. Maximum depth is 54 feet and average depth is 22 feet. Its watershed is small (1,331 acre) and hydraulic retention time is long (512 days). A small outlet leaves the lake at the north end and eventually drains to the Elkhart River (Lake Michigan watershed). The bottom is mostly sand with some muck and marl. The lake thermally stratifies between 10 and 18 feet with adequate amounts of oxygen (≥3 ppm) usually present in the top 10 to 15 feet of water. There is some indication, however, that oxygen levels at 15 feet may have declined in the last 10 years (Table 2). Water clarity has ranged from 6 to 14.5 feet and averaged 9 feet. Coontail is the dominant submersed aquatic plant and covers 60% of the littoral area from 0 to 20 feet deep (see Appendix). Chara, nitella, Eurasian water milfoil, and large-leaf pondweed are present, although overall plant diversity is low. The shoreline is residential except along the north and northwest sides. Significant palustrine wetlands are located in these areas. A state-owned public boat ramp is available on the northeast side of the lake. Northern pike, although few in number, have been routinely captured during previous surveys at the lake (Pearson 2002).

METHODS

To evaluate the current status of fishing at Upper Long Lake, an angler creel survey was conducted from May 11 through August 31 according to DFW guidelines. Boat and shore anglers were counted at hourly intervals on five weekdays and two weekend days every two weeks during either an early (7:00-2:00 pm) or late (3:00-10:00 pm) period. Fishing effort was calculated for boat and shore anglers for weekends and weekdays each month by multiplying the average daily count of each group times 16 hours per day times the total number of weekend or weekdays per month. Angler catch was determined by interviewing as many anglers as possible during each sampling day. Total monthly catches of various species were then estimated by expanding the observed catch times the fraction of total effort represented by the accumulated interview hours. Harvested fish were also measured to assess size structure. During each interview a spokesperson for the party was asked which species they fished for, whether they were an Upper Long Lake resident, how they rated fishing quality (i.e. "good, fair, or poor"), and whether they favored the muskie stocking program. Anglers were also asked if they released any legal-size (≥36-inch) or sublegal (<36-inch) muskies, as well as any legal-size (≥14-inch) or sublegal (<14-inch) largemouth bass.

To determine if muskie stockings have affected the overall fish community and improved bluegill size, a fish population survey was conducted during June 21-23 according to standard sampling procedures adopted by the DFW. Sampling effort was similar to surveys in previous years and included 30 minutes of night DC electrofishing (504 V) using two dip-netters to capture stunned fish. Two gill nets and two trap nets were also set overnight for two nights. All captured fish were measured to the nearest 0.1-inch (total length) and released when possible. Weights were estimated for each species from standard length-weight formulas generated from data on file from other surveys at Indiana natural lakes. Bluegill lengths were grouped into "traditional" half-inch bins (e.g. 7.5=7.3-7.7 inch, 8.0=7.8-8.2 inch). Scales were taken from bluegills for age and growth analysis using a standard 0.8-inch body-length: scale-length intercept. Changes in bluegill numbers were evaluated based on electrofishing catch rates of various size groups. In addition to the June survey, electrofishing was conducted at weekly intervals on four nights from April 26 through May 17 to specifically target largemouth bass. The entire shoreline was covered each night, also using two dip-netters to capture stunned bass. Each bass was measured, marked by removing the right ventral fin, and released after scale samples were taken for age and growth analyses. Subsequent recaptures of marked bass were used to generate a Schnabel population estimate of 8-inch and larger bass. Mean nightly catch per hour was calculated for four size categories of bass (8-12 inch, 12-14 inch, 14-18 inch, ≥18 inch). The figures, along with the Schnabel estimate, were compared to data obtained in 1995 using identical procedures at the lake (Pearson 1997). Back-calculated growth rates of bass were also determined from scales using a 0.8-inch body-length to scale-length intercept. The creel clerks also recorded any marked bass observed in angler catches in an attempt to estimate bass fishing mortality.

Some additional data was collected in 2010, part of which has already been alluded to in the description of oxygen levels and the plant community. Upper Long Lake is one of several randomly-selected lakes in a DFW project to assess the long-term status and trends of habitat conditions and fish communities in Indiana natural lakes (Donabauer, unpublished). For this project, temperature and oxygen profiles were measured in June and August. Submersed aquatic plants and zooplankton were sampled in August. And in addition to the fish sampling procedures described previously, weights were recorded for a subset of captured fish captured, but this additional information will not be presented or discussed within this report.

RESULTS

Angler creel survey results

Anglers fished an estimated total of 4,330 hours from May 11 through August 31 (Table 3). Boat anglers accounted for 3,965 hours (92%) and shore anglers accounted for 365 hours (8%). Anglers fishing on weekends made up 66% of the total and anglers fishing on weekdays made up 34%. Fishing effort by boat anglers was about twice as much on weekends (2,628 hours) than weekdays (1,337 hours). Overall effort represented 50 hours per acre and 38 hours per day for an average of 0.45 hours per acre per day. May was the peak fishing month for boat and shore anglers, even though the first 10 days were not included. June had the lowest monthly amount of effort by boat anglers and August had the lowest monthly amount by shore anglers. Weekends in May experienced the most fishing effort. Lake residents accounted for 64% and visiting anglers 36% of the total anglers. Among boat anglers, residents made up 59% of the group and visitors made 41%. Even on weekends, when opportunities may be greater for visitors to fish, resident anglers made up a larger share of boat anglers (54%) than visiting anglers (46%).

Anglers fished for four species, as well as three combinations of species (Table 4). About 12% expressed no particular preference ("anything"). Of 222 angler parties interviewed during the survey, 33% fished solely for muskies and 2% fished for muskies in combination with bass and bluegills. Muskies made up 33% of the 228 responses. Bass were sought solely by 36% of the parties and another 3% in combination with other species. Only 15% of the parties fished solely for bluegills and another 2% fished for bluegills in combination with other species. Less than 1% fished for crappies. Among boat anglers, muskies and bass were each mentioned 39% of the time, followed by bass bluegills (10%) and crappies (1%). In contrast, shore anglers fished mainly for bluegills (47%) and bass (33%). Based on interviews of parties who had completed their fishing trip, boat anglers spent an average of 2.72 hours fishing per trip. Bass anglers fished 2.88 hours per trip and muskie anglers fished 2.86 hours per trip. Bluegill anglers fish slightly less per trip (2.43 hours) as did crappie anglers (2.25 hours). Therefore, of the 3,965 total hours fished by boat anglers (including 39.1% for muskies and 38.5% for bass), boat anglers made 542 trips to fish for muskies, 530 trips for bass, 170 trips for bluegills, 18 trips for crappies, and 159 trips for any species. Assuming an average fishing trip generates $64 of economic value (Department of Interior 2008), total worth of boat fishing activity at the lake is $90,816. Muskie fishing generated $34,688 of this economic benefit during the period covered by the survey.

Anglers caught and kept 848 fish during the creel survey period, including nine muskies (Table 5). They caught and released another 136 muskies, of which 128 were less than 36 inches long and eight were 36 inches or larger. The total muskie catch, therefore, was 145. The nine muskies taken by anglers were based on two muskies actually observed by the clerks. One measured 36 inches long and the other 42 inches long. Boat anglers kept the nine harvested muskies and caught 125 of the muskies that were released. Shore anglers kept no muskies but caught and released 11. Among boat anglers, muskie catches were about equally split between weekends (71) and weekdays (63).

In addition to muskies, anglers caught and kept four other species during the survey. They kept only 786 bluegills as well as 42 bass, six sunfish, and five perch. They also caught and released 586 bass, of which 314 were less than 14 inches long and 272 that were 14 inches or larger. Boat anglers took 54% of the bluegills and all of the bass, sunfish and perch. Boat anglers also caught 95% of the bass that were released. Harvested bluegills were very small, ranging in size from 3.0 to 6.5 inches (Table 6). Only 107 of the 786 bluegills were 6-inch or larger. Half were less than 5 inches long. All harvested bass were 14 to 16 inches long. The only sunfish observed by the clerks was 5.5 inches long and the only observed perch was 8 inches long. Among interviewed boat anglers who specifically targeted only muskies, their catch rate was one muskie per 22 hours of fishing (*Note: see discussion later*). The rate was higher in June (1/12 hours) and lower in May (1/53 hours). Boat anglers targeting only bass caught one per 2.6 hours of fishing, including bass that were released. Their catch rate was higher in August (1/1.6 hours). Bluegill anglers fishing from boats caught and kept bluegills at the rate of one per 1.4 hours.

Support for the muskie stocking program differed among boat and shore anglers as well as resident and visiting anglers (Table 7). Boat anglers were more likely to favor muskie stocking (67%) than shore anglers (56%), but more boat anglers were also likely to oppose stocking (22%) than shore anglers (12%). Shore anglers were more likely to have no opinion (32%). Among all anglers, 65% favored the stocking program, 20% opposed the stocking program, and 15% had no opinion. Resident boat anglers were more likely to oppose stocking (26%) than visiting boat anglers (16%) but both groups were much more supportive of stocking than opposed to stocking. Visiting boat anglers favored muskie stocking over opposing muskie stocking by a ratio of 4.3:1 while resident boat anglers favored muskie stocking over opposing muskie stocking by a ratio of 2.5:1.

Among all boat anglers contacted during the survey, 48% rated fishing good, 32% rated fishing fair, and 20% rated fishing poor (Table 8). There were, however, differences between anglers based on species preferences but fewer differences between visiting and resident anglers. Each interviewed person was asked to respond to the question: "How do you rate fishing at this lake - good, fair, or poor?" Nearly 75% of boat anglers who fished solely for muskies rated fishing good. In contrast, only 35% who fished solely for bass and only 6% who fished solely for bluegills rated fishing good. Only 4% of muskie anglers rated fishing poor but 32% of bass anglers and 25% of bluegill anglers rated fishing poor. Resident boat anglers who fished for muskies, bass and bluegills all had a slightly higher perception of fishing quality than visiting anglers. As many as 77% of resident muskie anglers thought fishing quality was good compared to 72% of visiting muskie anglers. More resident bass anglers also thought fishing was good (38%) compared to visiting bass anglers (30%). Among resident bluegill anglers, 13% considered fishing good but no visiting bluegill anglers did.

Fish population survey results

During the June fish survey, 1,266 fish weighing an estimated 156 pounds were collected (see Appendices). Fourteen species were noted. Bluegills accounted for 70% of the catch by number and 35% by weight. Black crappies ranked second numerically (15%) and third by weight (13%). Largemouth bass ranked third in number with redear sunfish and accounted for 13% of the weight. Ten muskies were captured but they ranked second overall in weight (18%). Altogether, sport fish accounted for 98% of the total number of fish and 89% of the total weight.

Bluegills ranged in length from 1.5 to 7.5 inches, but of the 889 bluegills captured during the survey, only 26 were 6.0 inches or longer and only six (<1%) were 7.0 inches of longer. Over half (53%) were 4.0 to 4.5 inches. At other Indiana natural lakes, 7-inch and larger bluegills typically account for 15% of the population. Bluegills at Upper Long Lake were captured by electrofishing at the rate of 352 per 15 minutes of sampling, a figure more than three times greater than the average rate of 100 per 15 minutes observed at Indiana natural lakes. Most of the bluegills were age-2 and age-3. Their growth rate after age-2 was below normal compared to other lakes, averaging 1.7, 2.8, 4.2, 5.6, and 6.5 inches at age-1 through age-5. Typical back-calculated sizes for bluegills at these same ages in other Indiana natural lakes are 1.7, 3.0, 4.7, 6.2, and 7.1 inches respectively.

Other sport fish collected during the survey were also small. Crappies ranged in length from 5.0 to 8.0 inches, most of which (95%) were less than 7.0 inches. Gill nets captured all but three at the rate of 47 per lift. Fifty-six largemouth bass were caught, ranging from 4.0 to 18.0 inches long. Only 11 bass were legal-size (≥14 inches). The number of bass captured by electrofishing (24/15-minutes) was average compared to other lakes in the area. Their growth rate was also average, with age-4 bass reaching 12.5 inches and age-5 bass reaching 13.7 inches. The 10 muskies were 22.0 to 30.0 inches long. Six were less than 24 inches and four were 24-inch and larger. All were caught in gill nets at the rate of 2.5 per lift. Their estimated mean weight was 2.9 pounds. Other sport fish included 56 redear sunfish measuring up to 7.5 inches long, 21 yellow perch up to 8.5 inches, 10 warmouth, seven yellow bullheads, and one 8-inch brown bullhead. Non-sport fish included 10 lake chubsuckers, seven brook silversides, four spotted gar, three redfin pickerel that were 7.5-11.0 inches long, and two golden shiners.

Largemouth bass spring sampling results

During the four nights of electrofishing in April and May, 506 largemouth bass, 8-inch and larger, were captured. Of these, 94 were marked and recaptured while 412 were captured only once. Using these figures, the Schnabel population estimate was 889, or 10 bass per acre. The mean nightly catch rate of 8-inch and larger bass was 83 per hour, including a mean nightly catch rate of 29 per hour of legal-size bass (≥14-inch). Mean nightly catch rates of 8- to 12-inch bass, 12- to 14-inch bass, 14- to 18-inch bass, and 18-inch and larger bass were 28/hour, 26/hour, 27/hour, and 2/hour, respectively. Based on the proportions of the four size groups, estimates were that the lake contained 305 bass that were 8 to 12 inches, 276 that were 12 to 14 inches, 281 that were 14 to 18 inches, and 25 that were 18-inch or larger. The 42 legal-size bass removed by anglers, therefore, represented only 14% of the number of legal-size bass estimated to be in the lake. At the end of bass sampling in the spring, 46% of the population had been marked but only one of nine harvested bass (11%) observed by the creel clerks was marked. Although the number of bass observed by the creel clerks was very small (9), the difference in the percentage of harvested marked bass (11%) compared to the percentage of marked bass at large (46%) indicated that the actual population may have been under-estimated. The one observed marked bass (15.5-inch) expanded to an estimate of five, which represented only 4% of the estimated number of marked 14- to 18-inch bass in the population (4% = 5/(281*46%)).

DISCUSSION

How many anglers fish for muskies and how many muskies are caught?

Muskie fishing interest was higher than average at Upper Long Lake compared to other northern Indiana muskie lakes (Table 9). The percentage of anglers who preferred to fish for muskies (34%) was more than double the average (16%) and ranked second only to Lake Webster (55%). Interest in muskie fishing, however, has not sparked a major increase in fishing effort at the lake, contrary to a concern of some residents that muskies stockings are causing over-crowding at the lake. The total number of hours fished per acre per day (0.45) was higher than average (0.35) but less than early estimates at Skinner Lake and similar to Ball Lake. Overall fffort was also less than a previous estimate at the lake based on an angler survey in June 1991 (Pearson 1991). The average numbers of boat anglers observed per hour on weekends (7.2) and weekdays (1.6) in June 1991 were twice as high compared to June 2010 (3.7 and 0.7). While effort may be less, there has been a shift in angler preference. Most anglers in 1991 fished for bluegills (56%), bass (22%), and crappies (22%). In contrast, non-muskie anglers in 2010 fished mainly for bass (78%) and much less for bluegills (20%) and crappies (2%). Even though 34% of Upper Long Lake anglers now fish for muskies, their 542 angler fishing trips in 2010 translated to 13.1 hours of muskie fishing per day and was less than the mean (20.5 hours/day) compared to other lakes, similar to an estimate at Skinner and two estimates at Webster, but well below the 2005 estimate at Webster (160 hours/day). Because of the lake's small size, however, the number of muskie fishing hours per acre per day (0.15) was second only to Webster (0.21).

Like most muskie lakes in Indiana and elsewhere (Thomas et. al. draft), very few muskies were removed by anglers at Upper Long. Muskie anglers consider muskies a "trophy" fish and release most of their catch in hopes that released muskies will grow larger. Catch comparisons, therefore, are best based on total catch (harvest and releases). Numbers of muskies caught during 16 angler surveys in ranged from four at Ball in 2001 to 2,215 at Webster in 2005 (Table 9). The catch rate at Upper Long (1/10 hours) was five times faster than average (1/49 hours), nearly double the catch rate at Webster in 2005 (1/18 hours), and exceeded the average (1/31 hours) in Wisconsin (Simonson 2003). This catch rate (1/10 hours) differed from the previously reported rate (1/22 hours – *see page 11*) because it was calculated from total angler effort and percentage who fished for muskies: 145 muskies/(4330 hours x 0.34). Calculating catch rate in this manner, albeit simplistic and subject to bias, allows for standardized comparisons with other surveys.

What are the levels of support and opposition toward the muskie stocking program?

Muskie stockings are moderately popular among natural lake anglers in Indiana compared to other species (Broussard 2005). Walleyes are twice as popular and are currently stocked by the DFW of Fish and Wildlife in 10 lakes totaling 6,211 acres. Striped bass rank second in popularity but are stocked in two natural lakes totaling 885 acres. Rainbow trout and brown trout stockings are similar in popularity to muskies but channel catfish and flathead catfish rank lower. At the local level however, muskie fishing can be as popular as walleye fishing. The percentage of anglers who fished for muskies at Upper Long (34%), as well as Skinner (26%) and Webster (55%), exceeded or matched the average percentage of anglers who fished for walleyes (26%) at 11 lakes (Pearson 2010, unpublished) and exceeded the 9% who fished for walleyes at nearby Sylvan Lake (Pearson 2007) and the 16% at nearby Winona Lake (Braun and Edgell 2008).

Muskie anglers also have a good impression of fishing quality and anglers in general favor muskie stockings at the local level (Table 9). The percentage of muskie anglers who described fishing as good at Upper Long (75%) was greater than at Loon (50-57%) or Skinner (60%) but less than Webster (80-89%). The percentage of muskie anglers who described fishing as poor at Upper Long was very low (4%) and was similar to the other lakes (5%). Among all anglers at Upper Long, 65% favored the muskie stocking program and 20% opposed it. These figures are similar to the average percentages who favor stockings (74%) and oppose stockings (16%) observed at other Indiana muskie lakes.

Have changes occurred among native species that may be associated with muskies?

Although no major shifts have occurred in the species composition at Upper Long Lake since muskies have been stocked, species diversity has declined (Table 10). The number of native species collected during five surveys from 1980 through 1991 varied from 15 to 18 and averaged 17. Since 2002, the number of native species in three surveys varied from 13 to 18 and averaged 15. Some species not collected in the latest survey were more prevalent in earlier years, including sunfish (green, pumpkinseeds, and hybrid sunfish). Likewise, fewer northern pike and bullheads (brown and yellow) have been captured since muskies were stocked. No significant decreases were apparent among other sport fish species, including redear, warmouth and black crappies, or among other potential forage species available to muskies (e.g. silversides, shiners, chubsuckers, or suckers).

Native species diversity (Simpson Index), an overall measure of the relative abundance of various species, varied from 0.62 to 0.82 and averaged 0.71 prior to muskie stocking but only 0.33 to 0.47 with an average of 0.38 since muskie stocking. However, the change in diversity most likely reflects a greater number of bluegills in the survey catches since 2002 rather than decreases in numbers of fish among less-abundant species. For example, had the 2002 catch included the previous 5-year average number of bluegills (366), diversity would have been 0.74. Some of the differences were also likely due to inherent variations based on changes in sampling gear, sampling personnel, weather conditions, and timing of the surveys. All of the surveys conducted prior to 2004 were done during the month of July. The 2004 and 2010 surveys were conducted in June, although the surface water temperatures in 2004 (77F) and 2010 (81F) were similar to previous surveys in July (77-82F).

While bluegills, as well as crappies, have apparently increased since muskie stockings, yellow perch have stayed about the same and numbers of largemouth bass have declined in recent years. Nearly all bass collected during the fish population surveys were captured by electrofishing. The catch rate, therefore, from 1987 through 2002 ranged from about 36 to 39 bass per 15 minutes of sampling and averaged 38. Since then the catch rate has declined 26% to 33 in 2004 and 28 in 2010. Prior to 1987 bass were captured with less-effective AC electrofishing gear. Even then bass catch rates in 1982 and 1984 (20/15-minutes) were not much lower than the DC catch rate in 2010 (28/15-minutes).

Results of the spring sampling for largemouth bass also suggested largemouth bass abundance has declined since the muskie stocking program began (Table 11). The estimated number of 8-inch and larger bass decreased 17% from 1,067 (12/acre) in 1995 to 889 (10/acre) in 2010. Meanwhile, bass densities in Indiana natural lakes generally increased from an average of 13/acre in 1980 to 24/acre in 2007 in response to imposition of a 12-inch and then 14-inch minimum size limit coupled with voluntary releases by anglers (Pearson 2008). Likewise, the mean nightly electrofishing catch rate of 8-inch and larger bass at Upper Long also decreased 17% from 101 per hour in 1995 to 83 per hour in 2010. The decrease, however, occurred only among 8- to 12-inch bass, down from 71 to 28 per hour. Catch rates of 12- to 14-inch bass increased after muskie stockings from 17 to 26 per hour and from 10 to 27 per hour among 14- to 18-inch bass. The catch rate of 18-inch and larger bass stayed about the same at 3.9 per hour in 1995 to 2.3 in 2010. The proportion of 8- to 12-inch bass decreased from 70% in 1995 to 35% in

2010. In contrast, the proportion of 12- to 14-inch bass increased from 17% to 31% and the proportion of 14- to 18-inch bass increased from 9% to 32%, while the proportion of 18-inch and larger bass stayed the same at 3%. Based on these figures, the estimated number of 8- to 12-inch bass dropped from 745 to 307 but increased from 186 to 276 among 12- to 14-inch bass and from 100 to 281 among 14- to 18-inch bass. The estimated number of 18-inch and larger bass decreased from 35 to 25.

Similar decreases in overall bass abundance, coupled with increases in numbers of larger bass, have been observed at other Indiana muskie lakes (Table 12), although bass are not commonly preyed upon by muskies where ample forage is available (Hanson 1986). Electrofishing catch rates of 8-inch and larger bass during spring sampling are similar are lakes stocked with muskies (110/hour) compared to lakes not stocked with muskies (108/hour), but catch rates of 8- to 12-inch bass are lower where muskies are stocked. Catch rates are similar among 12- to 14-inch bass, but greater among 14- to 18-inch bass and among 18-inch and larger bass at lakes where muskies are stocked. Densities of 8-inch and larger bass are double at lakes without muskies (19/acre) compared to lakes with muskies (9/acre) and densities are also greater among all size groups at lakes without muskies, even though proportions of 12-inch and larger bass are greater in lakes with muskies. Bass growth rates are also slightly faster in lakes where muskies are stocked. While muskie stockings may play a role in determining bass abundance and size, other factors (e.g. stocking site selection, habitat features, and forage) may also explain many of the differences. For example, overall electrofishing catch rates and densities of bass did not decline at Ball or Loon, were similar at Skinner, but did decline at Upper Long and Webster.

Has muskie predation on small bluegills resulted in more large bluegills?

Although muskies were originally stocked into Upper Long Lake to prey on small bluegills and thereby increase numbers of large bluegills, this has not happened. Bluegills are apparently more abundant now and comprise a greater percentage of the fish community. The 2010 electrofishing catch rate (351/hour) was the highest ever recorded (Table 13). The catch rate of 3- to 6-inch bluegills, the intended target size for muskie predation, increased from a pre-stocking mean of 191 per hour, then dropped to 89 per hour in 2002 but increased to 341 per hour in 2010. Catches rates of 6- to 7-inch bluegills decreased from 37 per hour in 1991 to less than 3 per hour in 2010. The catch rate of 7-inch and larger bluegills decreased from 4 per hour

to less than 2 per hour. Mean length of 6-inch and larger bluegills (i.e. "harvestable size") stayed about the same, varying from 6.1 to 6.3 inches before muskie stockings to 6.1 and 6.4 inches after stocking. The proportion of 3- to 6-inch bluegills (RSD) increased to 99% by 2010 while the proportion of 6-inch and larger bluegills decreased to 1%. The growth rate of bluegills may have increased slightly since muskies were stocked but remains below average compared to other Indiana natural lakes. Mean bluegill length at age-2 was 2.4 to 2.5 inches before muskies and 2.9 to 3.0 inches after. Mean length at age-4 was 4.2 to 5.4 before muskies and 4.9 to 5.5 after. Bluegills in other natural lakes typically reach 6.1 inches by age-4. Likewise, muskie stockings failed to increase the size of bluegills taken by anglers. Only 9% of the bluegills observed by the creel clerks in 1991 were 7 inches or larger but none were seen in 2010.

Muskie stockings in general seldom increase bluegill size (Graff 1986, Wahl and Stein 1988). More specifically, muskie stockings also failed to increase bluegill size at nearby Loon (Pearson et. al. 2009) and Skinner (Thomas 2008). On average, electrofishing catch rates of 3-inch and larger bluegills are nearly twice as high at lakes with muskies than at lakes without muskies (Table 13). Although this difference is also mainly a function of site selection (i.e. lakes with high bluegill densities are more likely to be stocked), muskie stockings apparently do not lead to lower overall catch rates of bluegills. Lakes stocked with muskies have higher catch rates of 6-inch and larger bluegills but percentages of 7-inch and larger bluegills are less in muskie lakes. The relative size distribution of 8-inch and larger bluegills is over four times greater in lakes without muskies (Table 13).

Are muskies reproducing and adding to the muskie population?

No muskies small enough to have originated from natural reproduction (<10 inches) were observed during any of the fish sampling or taken to creel clerks by interested anglers for verification. Representatives from the association who reported seeing numerous young-of-the year muskies previously at the lake were also encouraged to temporarily hold fish that they thought were age-0 muskies for verification. None were ever provided. In contrast, one representative who accompanied the electrofishing crew was shown redfin pickerel and indicated that local residents may have assumed pickerel were young muskies. Although sexually-mature adult muskies are present in Indiana lakes (e.g. Lake Webster), there is no evidence to date that naturally-produced muskies are contributing to its muskie population either (Pearson 1999).

Because mark-recapture techniques to estimate adult muskie density require a considerable investment in time, depend on large sample sizes, and may have inherent biases that are difficult to overcome (Pearson 2009), no attempt was made to estimate the number of muskies in Upper Long Lake. Nevertheless, the June survey catch provided a relative measure of muskie abundance compared to other Indiana muskie lakes. The 10 muskies captured at Upper Long was twice the average number (5) collected at four other muskie lakes on 16 occasions (Table 14). Their size range was slightly below average. The total weight (29 pounds) of muskies was also above average compared to other lakes (17 pounds) and their weight tied Ball Lake in 1996 as the highest percentage of the fish community (18%). These figures, however, do not account for differences in the amount of sampling effort using various types of gear. Most muskies are typically caught in gill nets. Therefore, based on gill net catches only (Table 14), the catch rate of 10 muskies in four gill nets (2.5/net) at Upper Long was over three times the average (0.7/net) and ranked second only to Skinner in 1994 (2.7/lift). Using these figures, muskies can be considered abundant in Upper Long Lake.

SUMMARY AND RECOMMENDATION

The muskie stocking program at Upper Long Lake had two original goals: (1) increase bluegill size through muskie predation, and (2) add diversity to the fishing opportunities at the lake. The first goal primarily dealt with the potential biological benefits of the program while the second goal dealt with potential socioeconomic benefits of the program. From a biological perspective, the stocking program failed to improve bluegill size. Given the number, size and weight of muskies in the lake, there is no reason to think that they were not abundant enough in theory to exert ample predation on bluegills. Therefore, no amount of muskie density is likely to improve bluegill size and continuing to stock muskies as a biological tool to improve bluegill fishing is not justified. In contrast, muskie stockings now attract a substantial number of anglers who enjoy the opportunity to catch muskies and are willing to invest time and money into fishing for them without creating problems of excessive use at the lake or detracting from other fishing opportunities. While the current level of muskie fishing interest and catches might be sustained with a reduced stocking rate, it is unlikely that the loss of socioeconomic benefits would be off-set if the program is discontinued. In light of the DFW's mission to manage a diverse array of fishing opportunities, it is recommended that requests to stock additional muskies be permitted.

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Table 1. *Year, organization, and number of muskies stocked in Upper Long Lake from 1996 through 2010.*

Year	Organization	Number
1996	Upper Long Lake Association	192
1999	Upper Long Lake Association	179
2001	Upper Long Lake Association	218
2002	Webster Lake Musky Club	400
2003	Webster Lake Musky Club	400
2004	Webster Lake Musky Club	430
2005		muskies unavailable
2006	Webster Lake Musky Club	1,000
2007	Webster Lake Musky Club	430
2008	Webster Lake Musky Club	430
2009	Webster Lake Musky Club	430
2010	Webster Lake Musky Club	170

Table 2. *Oxygen levels (ppm) in 5-foot intervals and water clarity (secchi depth) at Upper Long Lake from 1972 through 2010 (data from DFW of Fish and Wildlife files).*

Depth (ft)	8/72	7/80	7/82	7/84	7/87	7/91	7/02	7/04	8/04	6/10	8/10	Mean
0	10.0	7.0	8.0	7.0	10.0	10.0	8.9	7.2	8.4	8.3	7.7	8.4
5	10.0	7.0	7.0	7.0	9.0	10.0	8.9	7.4	8.4	7.1	7.0	8.1
10	10.0	7.0	8.0	7.0	9.0	9.0	10.7	6.7	8.1	7.7	6.8	8.2
15	9.0	6.0	5.0	6.0	6.0	5.0	2.9	1.1	2.1	0.0	0.0	3.9
20	0.8	0.6	0.6	1.5	0.5	1.5	0.3	0.8	0.6	0.0	0.0	0.7
25	---	0.0	0.4	trace	0.0	5.0	0.2	0.7	0.5	0.0	0.0	0.8
30	0.0	0.0	trace	trace	0.0	1.0	0.1	0.7	0.4	0.0	0.0	0.2
35	---	0.0	trace	trace	0.0	1.2	0.1	0.5	0.3	0.0	0.0	0.3
40	0.0	0.0	trace	trace	0.0	0.6	0.1	0.5	0.3	0.0	0.0	0.2
45	0.0	0.0	trace	—	0.0	0.0	0.1	0.5	0.2	0.0	0.0	0.1
50	0.0	0.0	trace	0.0	0.0	0.0	0.1	0.5	0.2	0.0	0.0	0.1
Secchi (ft)	6.0	8.5	14.5	10.0	9.5	8.5	8.5	7.0	11.0	6.0	9.5	9.0

Table 3. *Mean number of boat anglers present (MeanB) and mean number of shore anglers present (MeanS) per hour per weekend day and per weekday per month, standard deviations (StdevB and StdevS), length of a fishing day (Hrs/d), number of days, and estimated total number of fishing hours by boat anglers (BoatHrs) and shore anglers (ShoreHrs) at Upper Long Lake from May 11 through August 31, 2010.*

Month	Day	Count	MeanB	StdevB	MeanS	StdevS	Hrs/d	Days	BoatHrs	ShoreHrs	TotalHrs
May	Weekend	3	8.92	8.10	0.75	0.82	16	7	999	84	1083
May	Weekday	8	1.17	1.50	0.17	0.34	16	14	263	39	301
June	Weekend	4	3.72	1.64	0.47	0.12	16	8	476	60	536
June	Weekday	11	0.70	0.51	0.10	0.15	16	22	248	36	284
July	Weekend	5	3.78	1.73	0.28	0.48	16	10	604	44	648
July	Weekday	11	1.09	0.97	0.16	0.19	16	21	368	53	421
August	Weekend	4	3.81	1.93	0.28	0.16	16	9	549	41	590
August	Weekday	10	1.30	1.08	0.03	0.05	16	22	459	9	468
								Sum	3965	365	4330
								Weekend sum	2628	229	2856
								Weekday sum	1337	137	1474

Table 4. *Number of interviewed boat and shore anglers who fished for various species and species combinations (angler preference combinations) and the number of times a species was mentioned by interviewed anglers (angler preference responses) at Upper Long Lake from May 11 through August 31, 2010.*

Angler Preference Combinations						
Species	**Boat anglers**	**Percent**	**Shore anglers**	**Percent**	**Total**	**Percent**
Bass	69	36.9	11	31.4	80	36.0
Muskie	71	38.0	2	5.7	73	32.9
Bluegill	18	9.6	16	45.7	34	15.3
Anything	21	11.2	5	14.3	26	11.7
Bluegill-bass	2	1.1	1	2.9	3	1.4
Muskie-bass	3	1.6			3	1.4
Crappie	2	1.1			2	0.9
Bluegill-muskie	1	0.5			1	0.5
Grand Total	187		35		222	
Angler Preference Responses						
Species	**Boat anglers**	**Percent**	**Shore anglers**	**Percent**	**Total**	**Percent**
Bass	74	38.3	12	32.8	86	37.6
Muskie	75	38.9	2	5.5	77	33.6
Bluegill	21	10.9	18	48.0	38	16.6
Anything	21	10.9	5	13.7	26	11.4
Crappie	2	1.0			2	0.9
Grand total	193		37		229	

Table 5. *Number of fish harvested per species per period by boat and shore anglers and the number of legal and sub-legal muskies and largemouth bass released by boat and shore anglers at Upper Long Lake from May 11 through August 31, 2010.*

		HARVESTED FISH - Boat anglers						RELEASED FISH - Boat anglers			
Month	Days	Bluegill	Crappie	Sunfish	Perch	Bass	Muskie	Bass<14"	Bass>14"	Muskie<36"	Muskie>36"
May	Weekend	0	0	0	0	0	0	43	48	10	0
May	Weekday	0	0	0	0	0	0	6	0	3	0
June	Weekend	14	0	0	5	5	5	14	23	28	0
June	Weekday	0	0	0	0	5	0	41	27	5	0
July	Weekend	0	0	0	0	24	0	53	48	29	0
July	Weekday	153	0	0	0	0	0	16	16	16	0
August	Weekend	256	0	6	0	0	0	65	77	0	0
August	Weekday	0	0	0	0	9	4	62	13	31	4
	Sum	423	0	6	5	42	9	301	254	121	4

		HARVESTED FISH - Shore anglers						RELEASED FISH - Shore anglers			
Month	Days	Bluegill	Crappie	Sunfish	Perch	Bass	Muskie	Bass<14"	Bass>14"	Muskie<36"	Muskie>36"
May	Weekend	0	0	0	0	0	0	3	0	0	0
May	Weekday	29	0	0	0	0	0	0	0	0	0
June	Weekend	0	0	0	0	0	0	4	0	7	4
June	Weekday	0	0	0	0	0	0	0	0	0	0
July	Weekend	117	0	0	0	0	0	0	0	0	0
July	Weekday	0	0	0	0	0	0	6	19	0	0
August	Weekend	0	0	0	0	0	0	0	0	0	0
August	Weekday	216	0	0	0	0	0	0	0	0	0
	Sum	363	0	0	0	0	0	13	19	7	4
	Grand total	786	0	6	5	42	9	314	272	128	8

Table 6. *Size distribution of fish harvested by anglers that were observed by the creel clerks and the estimated total number (Expanded Total) of harvested fish per half-inch at Upper Long Lake from May 11 through August 31, 2010.*

Bluegill

Inches	5/28	6/5	6/10	6/12	6/20	7/18	7/27	7/31	8/7	8/8	8/20	8/24	8/28	Total	Percent	Expanded Total
3.0							6						1	7	6.8	53
3.5							2		1				2	5	4.9	38
4.0							9		7				5	21	20.4	160
4.5							3	1	11				3	18	17.5	137
5.0	2						8	3	7				2	22	21.4	168
5.5				2			1	2	4	5			2	16	15.5	122
6.0	2							1	4	4			1	12	11.7	92
6.5				1				1						2	1.9	15
													Sum	103		786

Bass

Inches	5/28	6/5	6/10	6/12	6/20	7/18	7/27	7/31	8/7	8/8	8/20	8/24	8/28	Total	Percent	Expanded Total
14.0						2								2	22.2	9
14.5				1		1								2	22.2	9
15.0											2			2	22.2	9
15.5			1											1	11.1	6
16.0						2								2	22.2	9
													Sum	9		42

Perch

Inches	5/28	6/5	6/10	6/12	6/20	7/18	7/27	7/31	8/7	8/8	8/20	8/24	8/28	Total	Percent	Expanded Total
8.0					1									1	100.0	5
													Sum	1		5

Sunfish

Inches	5/28	6/5	6/10	6/12	6/20	7/18	7/27	7/31	8/7	8/8	8/20	8/24	8/28	Total	Percent	Expanded Total
5.5									1					1	100.0	6
													Sum	1		6

Muskie

Inches	5/28	6/5	6/10	6/12	6/20	7/18	7/27	7/31	8/7	8/8	8/20	8/24	8/28	Total	Percent	Expanded Total
36.0												1		1	50.0	5
42.0		1												1	50.0	4
													Sum	2		9

Table 7. *Support for and against muskie stockings among boat and shore anglers and between resident and visiting anglers at Upper Long Lake from May 11 through August 31, 2010.*

Boat anglers

Support	Visitors	Percent	Residents	Percent	Total	Percent
Favor	52	69.3	70	64.8	122	66.7
Oppose	12	16.0	28	25.9	40	21.9
No opinion	11	14.7	10	9.3	21	11.5
Total	75		108		183	

Shore anglers

Support	Visitors	Percent	Residents	Percent	Total	Percent
Favor	3	75.0	16	53.3	19	55.9
Oppose	0	0.0	4	13.3	4	11.8
No opinion	1	25.0	10	33.3	11	32.4
Total	4		30		34	

All anglers

Support	Visitors	Percent	Residents	Percent	Total	Percent
Favor	55	69.6	86	62.3	141	65.0
Oppose	12	15.2	32	23.2	44	20.3
No opinion	12	15.2	20	14.5	32	14.7
Total	79		138		217	

Table 8. *Perceptions of fishing quality based on their species of preference among visiting boat anglers and lake resident boat anglers at Upper Long Lake from May 11, through August 31, 2010.*

Visiting angler number					**Visiting angler percentage**		
Species	**Good**	**Fair**	**Poor**	**Total**	**Good**	**Fair**	**Poor**
Anything		6	2	8		75.0	25.0
Bluegill		6	2	8		75.0	25.0
Bluegill-bass	1			1	100.0		
Bluegill-muskie		1		1		100.0	
Crappie			1	1			100.0
Bass	7	8	8	23	30.4	34.8	34.8
Muskie	23	7	2	32	71.9	21.9	6.3
Muskie-bass	1			1	100.0		
Total	32	28	15	75	42.7	37.3	20.0

Resident angler number					**Resident angler percentage**		
Species	**Good**	**Fair**	**Poor**	**Total**	**Good**	**Fair**	**Poor**
Anything	6	1	5	12	50.0	8.3	41.7
Bluegill	1	5	2	8	12.5	62.5	25.0
Bluegill-bass		1		1		100.0	
Bluegill-muskie				0			
Crappie	1			1	100.0		
Bass	17	14	14	45	37.8	31.1	31.1
Muskie	30	8	1	39	76.9	20.5	2.6
Muskie-bass	1	1		2	50.0	50.0	0.0
Total	56	30	22	108	51.9	27.8	20.4

All anglers					**All angler percentage**		
Species	**Good**	**Fair**	**Poor**	**Total**	**Good**	**Fair**	**Poor**
Anything	6	7	7	20	30.0	35.0	35.0
Bluegill	1	11	4	16	6.3	68.8	25.0
Bluegill-bass	1	1		2	50.0	50.0	
Bluegill-muskie		1		1		100.0	
Crappie	1		1	2	50.0		50.0
Bass	24	22	22	68	35.3	32.4	32.4
Muskie	53	15	3	71	74.6	21.1	4.2
Muskie-bass	2	1		3	66.7	33.3	
Total	88	58	37	183	48.1	31.7	20.2

Table 9. *Overall fishing effort (Hr/ac and Hr/ac/d), angler preference (pref), muskie fishing effort (Hr, Hr/d, Hr/ac/d), muskie catches, muskie catch per acre (C/ac) and catch per hour (C/hr), average number of hours required to catch a muskie, perceptions of fishing quality (good, fair, poor) among muskie anglers, and angler support for (favor) or against (oppose) muskie stockings at seven northern Indiana natural lakes. NOTE: figures presented in this table may differ from reported values based on the application of a standard method to calculate muskie fishing effort from overall fishing hours times angler preference percentages.*

		Total		Total		Muskie	Muskie	Muskie	Muskie	Muskie	Muskie	Hours/	Fishing quality			Angler support	
LAKE	**Year**	**Hr/ac**	**Days**	**Hr/ac/d**	**Pref**	**Hr**	**Hr/d**	**Hr/ac/d**	**Catch**	**C/ac**	**C/hr**	**muskie**	**Good**	**Fair**	**Poor**	**Favor**	**Oppose**
Adams	1992	36.9	146	0.25	11	1249	8.56	0.03	92	0.30	0.07	13.58				49	29
Ball*	1996	14.7	168	0.09	16	204	1.22	0.01	52	0.60	0.25	3.93					
Ball*	2001	78.8	152	0.52	9	617	4.06	0.05	4	0.05	0.01	154.31					
Ball*	2002	82.4	183	0.45	21	1506	8.23	0.09	6	0.07	0.00	251.02					
Ball	2008	36.1	187	0.19	17	535	2.86	0.03	6	0.07	0.01	89.11				99	1
Bruce	2005	43.7	219	0.20	10	1070	4.89	0.02	41	0.17	0.04	26.11				62	19
Loon	2004	65.2	206	0.32	12	1737	8.43	0.04	117	0.53	0.07	14.85	50	45	5		
Loon	2009	35.0	112	0.31	6	466	4.16	0.02	22	0.10	0.05	21.19	57	43	0		
Skinner	1991	87.3	111	0.79	16	1746	15.73	0.13	130	1.04	0.07	13.43				76	18
Skinner	1994	76.1	107	0.71	10	951	8.89	0.07	264	2.11	0.28	3.60				74	13
Skinner	2008	43.1	199	0.22	26	1401	7.04	0.06	82	0.66	0.06	17.09	60	28	12	91	9
Upper Long	***2010***	***50.3***	***112***	***0.45***	***34***	***1472***	***13.14***	***0.15***	***145***	***1.69***	***0.10***	***10.15***	***75***	***21***	***4***	***65***	***20***
Webster	1990	68.5	229	0.30	6	3183	13.90	0.02	90	0.12	0.03	35.37					
Webster**	1987	24.5	89	0.28	7	1327	14.91	0.02			0.00					64	24
Webster	1998	56.8	230	0.25	23	10104	43.93	0.06	528	0.68	0.05	19.14	89	10	1		
Webster	2005	91.5	243	0.38	55	38956	160.31	0.21	2215	2.86	0.06	17.59	80	15	5		
	Mean* **	**56.0**	**172**	**0.35**	**16**	**4337**	**20.47**	**0.06**	**261**	**0.67**	**0.07**	**48.59**	**67**	**28**	**5**	**74**	**16**

*Pressure and catch estimates were doubled at Ball Lake for 1996 through 2002 to reflect weekend and weekday results.

**Based on boat anglers interviews only.

***Mean values do not include Upper Long Lake data.

Table 10. *Number of fish, number of native species, and native species diversity at Upper Long Lake based on fish population surveys conducted from 1980 through 2010.*

Species	**1980**	**1982**	**1984**	**1987**	**1991**	**2002**	**2004**	**2010**
Black crappie	23	9	6	1	9	34	29	190
Bluegill	302	33	409	542	529	2512	1356	889
Bowfin	2	1	4		1	1	1	
Brook silverside			1				1	7
Brown bullhead	14	7	9	9	30	8	9	1
Carp		1	4	1			1	
Central mudminnow							2	
Darter spp.							1	
Golden shiner	14		4	1	7		7	2
Green sunfish	7	1	2	13	12	5		
Hybrid sunfish	4	9	2	2	20	20		
Killifish							4	
Lake chubsucker	34	5	38	35	5	22	2	10
Largemouth bass	39	95	78	113	109	77	66	56
Muskellunge								10
Northern pike	1	3	7	4	5			
Pumpkinseed	58	60	27	25	35	4	8	
Redear	42	51	68	56	111	326	120	56
Redfin pickerel	2	2	2	2	6	1		3
Spotted gar	3		4	8	4	3	7	4
Spotted sucker					1			
Walleye					1			
Warmouth	27	11	28	14	40	58	25	10
White sucker	1	5	8	5	7	2	5	
Yellow bullhead	43	36	27	62	90	29	15	7
Yellow perch	27	1	10	19	36	43	12	21
TOTAL	643	330	738	912	1058	3145	1671	1266
NATIVE SPECIES*	17	15	18	16	18	15	18	13
DIVERSITY*	0.75	0.82	0.66	0.62	0.70	0.34	0.33	0.47
SAMPLING EFFORT								
Electrofishing minutes	60ac	70ac	60ac	45dc**	45dc**	30dc	30dc	30dc
Gill net lifts	6	4	8	6	6	4	3	4
Trap net lifts	6	4	6	8	8	4	3	4

*does not include carp, hybrid sunfish, muskellunge, or walleye

**includes 15 minutes of sampling for largemouth bass only.

Note: brown bullheads were omitted from a similar table in the 2002 report.

Table 11. *Numbers of 8-inch and larger largemouth bass captured during four nights of electrofishing, sampling effort (seconds), catch per night including recaptures (C), marked bass placed in the population (M), recaptured bass (R), Schnabel population estimate, and standard error at Upper Long in 1995 and 2010.*

DATE	SECONDS	CATCH C	MARKED M	RECAPTURES R	C*M	POPULATION	ST ERR
04/24/95	4366	136	0	0			
05/01/95	4914	80	136	12	10880	837	232
05/10/95	4891	135	204	31	27540	873	132
05/17/95	4779	187	308	46	57596	1067	112

DATE	SECONDS	CATCH C	MARKED M	RECAPTURES R	C*M	POPULATION	ST ERR
04/26/10	5524	104	0	0			
05/03/10	5544	122	104	19	12688	634	142
05/10/10	5445	112	207	30	23184	717	101
05/17/10	5404	168	289	45	48552	889	91

Table 12. *Electrofishing catch per hour (CPH) and estimated densities (N/acre) of five size groups of largemouth bass, as well as relative size distributions (RSD) and mean back-calculated length at age (L-1 through 8), at seven Indiana natural lakes stocked with muskies.*

LAKE	YEAR	ACRES	HOURS	CPH>=8	CPH8-12	CPH12-14	CPH14-18	CPH>=18	P8-12	P12-14	P14-18	P>=18	P8+
Adams	1992	308	10.1	112.61	46.60	42.14	19.39	4.47	2.86	2.57	1.18	0.27	6.88
Ball	1995	87	6.0	45.83	12.67	15.67	16.00	1.50	1.06	1.30	1.34	0.13	3.82
Ball	1996	87	4.5	60.89	52.22	4.67	3.56	0.44	3.21	0.31	0.20	0.02	3.75
Ball	2001	87	4.3	211.06	140.47	17.41	49.41	3.76	10.26	1.33	3.74	0.25	15.59
Ball	2002	87	5.8	159.07	104.31	32.89	19.12	2.74	10.65	3.29	1.95	0.28	16.16
Ball	2007	87	2.6	164.48	45.80	54.88	61.10	2.70					
Ball	2008	87	4.5	179.78	73.33	41.33	62.89	2.22	4.70	2.64	4.03	0.15	11.52
Bruce	2005	245	8.1	119.55	70.92	33.91	12.99	1.73	9.27	4.43	1.70	0.23	15.64
Loon	2004	222	9.2	113.49	50.02	20.61	39.33	3.52	5.86	2.41	4.54	0.40	13.20
Loon	2009	222	4.2	192.26	116.47	58.88	15.22	1.69					
Skinner	***1986***	***125***	***6.6***	***71.21***	***51.61***	***8.69***	***8.07***	***2.83***	***9.49***	***1.65***	***1.54***	***0.54***	***13.22***
Skinner	***1987***	***125***	***5.7***	***60.68***	***30.32***	***18.84***	***8.75***	***2.77***	***2.98***	***1.81***	***0.88***	***0.26***	***5.93***
Skinner	1990	125	3.1	116.79	55.21	38.81	20.21	2.56					
Skinner	1991	125	5.1	83.28	40.90	21.73	18.47	2.18	5.09	2.68	2.35	0.25	10.37
Skinner	1994	125	5.7	65.57	29.55	14.86	16.63	4.53	2.51	1.29	1.43	0.40	5.62
Skinner	2008	125	5.1	76.90	43.09	8.34	19.99	5.48	3.82	0.72	1.77	0.52	6.82
Upper Long	***1995***	***86***	***5.3***	***101.11***	***70.53***	***16.74***	***9.91***	***3.93***	***8.66***	***2.17***	***1.16***	***0.41***	***12.41***
Upper Long	2010	86	6.1	83.24	28.45	25.98	26.51	2.30	3.57	3.21	3.27	0.29	10.34
Webster	1990	774	11.8	92.22	72.27	10.47	7.88	1.59	8.17	1.16	0.86	0.18	10.37
Webster	2005	774	25.8	43.97	28.06	4.92	8.40	2.60	3.17	0.56	0.94	0.30	4.97
Webster	2006	774	25.2	56.53	41.06	8.51	4.39	2.58	4.75	0.96	0.50	0.29	6.51
	Lakes with muskies			109.86	58.41	25.33	23.41	2.70	5.26	1.92	1.99	0.26	9.44
	Lakes without muskies			107.71	71.03	21.89	12.32	2.45	12.34	3.66	2.50	0.57	19.07

**Data in italics not included in mean calculations.*

LAKE	YEAR	ACRES	HOURS	RSD12-14	RSD 14-18	RSD>=18	L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8
Adams	1992	308	10.1	37.38	17.13	3.97	3.1	7.2	9.8	11.7	13.1	14.4		
Ball	1995	87	6.0	33.99	34.99	3.30	5.5	9.4	12.0	13.8	15.5	16.8		
Ball	1996	87	4.5	8.24	5.46	0.62	5.3	8.9	12.3	13.6	15.2	16.5		
Ball	2001	87	4.3	8.56	23.97	1.63	4.1	7.6	11.1	13.8	15.2	16.4	17.3	
Ball	2002	87	5.8	20.34	12.05	1.70	4.9	8.1	11.7	14.0	15.7	17.3	18.4	19.8
Ball	2007	87	2.6	32.85	37.30	1.64	5.7	8.9	11.1	12.7	14.4	15.5	17.2	
Ball	2008	87	4.5	22.96	34.98	1.26	3.6	8.3	11.0	13.1	14.0	15.6	17.0	
Bruce	2005	245	8.1	28.36	10.90	1.44	3.1	7.0	9.4	11.6	13.6	15.3	17.8	18.8
Loon	2004	222	9.2	18.22	34.35	3.01	3.6	5.7	8.7	11.7	13.7	15.3	16.5	18.5
Loon	2009	222	4.2	30.63	7.92	0.88	4.2	7.6	10.1	12.0	13.5	15.9		
Skinner	***1986***	***125***	***6.6***	***12.49***	***11.65***	***4.10***	***3.5***	***6.2***	***8.3***	***10.5***	***12.1***			
Skinner	***1987***	***125***	***5.7***	***30.52***	***14.84***	***4.42***	***3.3***	***6.0***	***9.3***	***10.6***	***14.3***			
Skinner	1990	125	3.1	33.07	17.25	2.06	2.4	6.1	9.4	11.6	12.8	14.2		
Skinner	1991	125	5.1	25.82	22.64	2.44	3.0	6.0	7.7	10.8	13.8	15.0		
Skinner	1994	125	5.7	22.91	25.40	7.14	5.0	7.7	10.8	12.2	13.8	15.4		
Skinner	2008	125	5.1	10.48	25.89	7.60	3.6	6.8	8.8	11.4	13.4	14.4	16.4	17.4
Upper Long	***1995***	***86***	***5.3***	***17.47***	***9.39***	***3.32***	***3.3***	***6.1***	***8.1***	***10.4***	***12.1***	***14.2***		
Upper Long	2010	86	6.1	31.06	31.60	2.81	3.6	6.3	8.8	13.3	13.5	15.1		
Webster	1990	774	11.8	11.15	8.34	1.73	2.8	5.9	8.7	10.7	12.5	14.4		
Webster	2005	774	25.8	11.24	18.99	5.96	4.9	7.6	9.7	11.7	14.0	15.8	18.0	19.2
Webster	2006	774	25.2	14.77	7.71	4.53	5.1	8.2	10.0	11.8	13.4	15.9	17.7	20.9
	Lakes with muskies			22.33	20.94	2.98	4.1	7.4	10.1	12.3	14.0	15.5	17.4	19.1
	Lakes without muskies			19.34	12.50	2.88	4.1	7.1	9.4	11.5	13.3	15.1	16.2	17.6

**Data in italics not included in mean calculations.*

Table 13. *Electrofishing catch per 15-minutes (N/EF) of seven size groups and mean length of 6-inch and larger bluegills (Harv Size), as well as relative size distributions (RSD), mean back-calculated length in inches at age (L-1 through 6)) and un-weighted length among year classes at each age (Y-1 through 6) of bluegills at eight Indiana natural lakes stocked with muskies.*

LAKE	ACRES	Year	SEC	N/EF15	N>3/15	N<3/15	N3-6/15	N6-7/15	N7-8/15	N>=8/15	Harv Size
Adams	308	2005	3600	7.75	6.50	1.25	5.25	0.00	0.75	0.50	7.4
Ball	87	1995	7200	14.63	14.00	0.63	7.13	4.50	1.88	0.50	6.4
Ball	87	2001	2700	11.33	11.33	0.00	5.33	5.00	1.00	0.00	6.2
Ball	87	2004	3600	30.25	29.75	0.50	18.00	9.75	2.00	0.00	6.2
Ball	87	2008	2700	12.33	12.00	0.33	8.00	1.00	2.67	0.33	6.8
Bruce	245	2000	3600	29.75	29.75	0.00	20.00	5.00	4.00	0.75	6.6
Loon	222	2000	3600	188.25	112.75	75.50	92.00	15.25	5.00	0.50	6.3
Loon	222	2009	5400	55.50	48.33	7.17	23.83	13.83	10.67	0.00	6.4
Skinner	***125***	***1988***	***1800***	***126.00***	***113.00***	***13.00***	***96.00***	***14.50***	***2.50***	***0.00***	***6.1***
Skinner	***125***	***1989***	***1800***	***183.00***	***136.50***	***46.50***	***101.00***	***33.50***	***2.00***	***0.00***	***6.1***
Skinner	125	1990	1800	365.00	343.00	22.00	279.00	48.00	16.00	0.00	6.3
Skinner	125	1991	1800	385.00	380.00	5.00	286.50	87.00	6.00	0.50	6.1
Skinner	125	1993	2700	72.67	64.33	8.33	44.67	11.67	7.67	0.33	6.4
Skinner	125	1994	7860	127.79	106.60	21.18	80.84	18.09	7.56	0.11	6.3
Skinner	125	1998	2700	163.00	148.00	15.00	95.00	47.67	5.33	0.00	6.1
Skinner	125	2001	2700	93.67	92.67	1.00	50.33	34.33	8.00	0.00	6.2
Skinner	125	2002	2700	88.00	81.67	6.33	34.33	28.67	18.67	0.00	6.4
Skinner	125	2008	2700	261.00	258.67	2.33	126.33	130.00	2.33	0.00	6.0
Tippecanoe	768	2006	4500	16.00	16.00	0.00	5.40	3.60	6.00	1.00	6.8
Upper Long	***86***	***1991***	***2700***	***307.67***	***271.00***	***36.67***	***230.33***	***37.00***	***3.67***	***0.00***	***6.1***
Upper Long	***86***	***1995***	***5400***	***256.83***	***170.17***	***86.67***	***151.00***	***14.33***	***4.83***	***0.00***	***6.3***
Upper Long	86	2002	1800	211.50	118.50	93.00	89.00	25.50	4.00	0.00	6.1
Upper Long	86	2010	1800	350.50	345.00	5.50	341.00	2.50	1.50	0.00	6.4
Webster	774	1990	3600	190.00	188.75	1.25	111.00	75.00	2.75	0.00	6.0
	Lakes with muskies			133.70	120.38	13.32	86.15	28.32	5.69	0.23	6.4
	Lakes without muskies			78.73	65.74	13.06	46.97	10.24	6.38	2.14	6.6

**Data in italics not included in mean calculations.*

LAKE	ACRES	Year	SEC	RSD3-6	RSD6-7	RSD7-8	RSD8	L-1	L-2	L-3	L-4	L-5	L-6	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6
Adams	308	2005	3600	80.77	0.00	11.54	7.69		3.0	4.8	7.4	8.4	9.5	1.5	2.9	5.1	7.5	8.5	9.1
Ball	87	1995	7200	50.89	32.14	13.39	3.57	1.5	3.5	5.0	6.4	7.0		1.5	3.2	4.7	6.2	7.0	
Ball	87	2001	2700	47.06	44.12	8.82	0.00	1.8	3.4	4.9	5.6	6.5		1.7	3.1	4.7	5.8	6.5	
Ball	87	2004	3600	60.50	32.77	6.72	0.00	2.2	3.4	5.0	6.3	6.5	7.2	1.8	3.3	4.9	6.0	6.5	7.2
Ball	87	2008	2700	66.67	8.33	22.22	2.78	2.2	3.2	4.6	5.1	6.7	7.4	1.7	3.0	4.4	5.6	6.7	7.4
Bruce	245	2000	3600	67.23	16.81	13.45	2.52	2.9	4.5	6.5	7.6	8.2		2.5	4.6	6.5	7.6	8.2	
Loon	222	2000	3600	81.60	13.53	4.43	0.44	1.5	2.6	4.2	5.8	6.8	7.4	1.7	2.9	4.4	5.8	6.8	7.4
Loon	222	2009	5400	49.31	28.62	22.07	0.00	1.5	2.4	3.8	5.7	6.6		1.6	2.7	4.4	5.9	6.6	
Skinner	***125***	***1988***	***1800***	***84.96***	***12.83***	***2.21***	***0.00***	***1.6***	***2.6***	***3.6***	***5.5***	***6.6***	***7.1***	***1.6***	***2.8***	***4.2***	***5.9***	***6.7***	***7.1***
Skinner	***125***	***1989***	***1800***	***73.99***	***24.54***	***1.47***	***0.00***	***1.7***	***2.8***	***4.1***	***5.2***	***6.5***	***6.9***	***1.7***	***2.9***	***4.2***	***5.5***	***6.4***	***6.9***
Skinner	125	1990	1800	81.34	13.99	4.66	0.00	1.5	2.6	4.2	5.9	6.7	7.0	1.6	2.9	4.5	5.8	6.5	6.9
Skinner	125	1991	1800	75.39	22.89	1.58	0.13	1.7	2.5	4.0	5.5	6.6	6.6	1.6	2.8	4.4	5.8	6.4	6.9
Skinner	125	1993	2700	69.43	18.13	11.92	0.52	1.7	3.4	5.0	5.1	6.2	6.7	1.6	2.7	3.9	5.1	6.2	6.7
Skinner	125	1994	7860	75.83	16.97	7.09	0.11	1.8	3.3	5.2	6.0	6.7	7.3	1.7	3.2	4.8	5.8	6.7	7.3
Skinner	125	1998	2700	64.19	32.21	3.60	0.00	1.6	3.2	4.9	6.0	6.8		1.7	3.3	4.9	6.1	6.8	
Skinner	125	2001	2700	54.32	37.05	8.63	0.00	1.7	2.9	4.6	6.5	6.9		1.6	3.3	5.0	6.4	6.9	
Skinner	125	2002	2700	42.04	35.10	22.86	0.00	1.9	3.3	4.8	6.0	7.0	7.6	1.8	3.4	5.0	6.4	7.1	7.6
Skinner	125	2008	2700	48.84	50.26	0.90	0.00	1.9	2.8	4.4	6.0	7.2	8.3	1.7	2.9	4.7	6.4	7.5	8.3
Tippecanoe	768	2006	4500	33.75	22.50	37.50	6.25	2.0	3.3	4.7	6.3	7.1	7.5	1.7	3.1	4.8	5.9	7.0	7.5
Upper Long	***86***	***1991***	***2700***	***84.99***	***13.65***	***1.35***	***0.00***	***1.6***	***2.5***	***3.6***	***5.4***	***6.4***	***6.1***	***1.6***	***2.6***	***3.8***	***5.2***	***6.0***	***6.1***
Upper Long	***86***	***1995***	***5400***	***88.74***	***8.42***	***2.84***	***0.00***	***1.5***	***2.4***	***3.4***	***4.2***	***5.8***	***6.2***	***1.6***	***2.6***	***3.6***	***4.8***	***5.8***	***6.2***
Upper Long	86	2002	1800	75.11	21.52	3.38	0.00	1.7	2.9	3.8	4.9	6.2	6.9	1.6	2.5	3.7	5.0	6.1	6.9
Upper Long	86	2010	1800	98.84	0.72	0.43	0.00	1.7	3.0	4.2	5.5	6.5		1.7	2.8	4.2	5.6	6.5	
Webster	774	1990	3600	58.81	39.74	1.46	0.00	1.5	2.9	4.3	5.5	6.2		1.7	3.0	4.4	5.5	6.2	
	Lakes with muskies			64.10	24.37	10.33	1.2	1.8	3.1	4.6	6.0	6.8	7.5	1.7	3.1	4.7	6.0	6.8	7.4
	Lakes without muskies			67.04	15.80	12.06	5.10	1.7	3.0	4.6	6.2	7.2	7.6	1.7	3.0	4.7	6.3	7.2	7.8

**Data in italics not included in mean calculations.*

Table 14. *Number of muskies, percentage of the total catch of all fish by number, minimum and maximum muskie size in inches, pounds of muskies, percentage of the total fish weight, gill net lifts, number of netted muskies, and the number of muskie captured per net during various fish population surveys at Indiana muskie lakes.*

LAKE	Month	Year	Muskie Total	%N	Minimum Size	Maximum Size	Pounds	%LB	Gill nets	Netted Muskies	N/net
Ball	7	1996	15	1.4			30.9	18.5	6	12	2.0
Ball		2001	4	0.4	21.6	22.4	10.6	4.1	4	2	0.5
Ball		2004	4	0.4	17.9	19.9	6.1	2.1	6	4	0.7
Ball	6	2008	2	0.4	23.6	30.6	9.5	3.8	6	2	0.3
Loon	7	1988	9	0.7	14.5	34.1	12.6	4.2	8	9	1.1
Loon	6	2000	2	0.1	27.6	34.5	13.0	2.4	8	1	0.1
Loon	7	2004	2	0.1	34.7	40.5	24.0	5.7	8	0	0.0
Loon	6	2009	0	0.0			0.0	0.0	6	0	0.0
Skinner	6	1994	17	1.8	12.6	28.2	29.6	11.3	6	16	2.7
Skinner	6	1998	4	0.2	21.3	31.2	15.2	2.6	5	4	0.8
Skinner	6	2001	1	0.1	36.5	36.5	10.6	2.7	6	0	0.0
Skinner	6	2002	13	0.8	12.2	41.5	42.0	12.4	6	11	1.8
Skinner	6	2008	0				0.0		6	0	0.0
Upper Long	***6***	***2010***	***10***	***0.8***	***21.8***	***30.0***	***28.6***	***18.3***	***4***	***10***	***2.5***
Webster	7	1995	6	0.4	24.0	34.1	27.0	7.9	6	6	1.0
Webster	7	1998	0				0.0	0.0	6	0	0.0
Webster	7	2005	5	0.2	29.7	35.3	38.7	10.1	8	5	0.6
		Mean*	5	0.5	23.0	32.4	16.9	5.8	6.3		0.7

**Mean values do not include Upper Long Lake.*

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)
Upper Long Lake	Noble	6/21 - 6/23/10
Biologist's name		**Date of approval (Month, day, year)**
Jed Pearson		

LOCATION

Quadrangle name	Range	Section
Merriam	9E	4,33
Township	**Nearest town**	
33N, 34N	Wolf Lake	

ACCESSIBILITY

State owned public access site	Privately owned public access site	Other access site
Located on northeast shore		

Surface acres	Maximum depth (ft)	Average depth (ft)	Acre feet	Water level (msl)	Extreme fluctuations (ft)
86	54	22.1	1,902	890.9	None

INLETS

Name	Location	Origin
Unnamed ditch	East side	Runoff and Pleasant Lake

OUTLET

Name	Location
Unnamed ditch	North end, flows to Dollar Lake and Lower Long Lake

Water level control

Concrete sill dam

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

Watershed use

General farming with scattered woodlots and wetlands

Development of shoreline

About 2/3 of the shoreline is residential, except for the north and northwest shores.

Previous surveys and investigations

Water quality: 1972, Fish surveys: 1980, 1982-84, 1987, 1991, 2002, 2004 (unpublished),

Bass and bluegill sampling 1995, Diagnostic study 1998, Plant sampling 2004. Bluegill diet 2010

SAMPLING EFFORT			
ELECTROFISHING	Day hours	Night hours	Total hours
		0.50	0.5
TRAPS	Number of traps	Days	Total lifts
	2	2	4
GILL NETS	Number of nets	Days	Total lifts
	2	2	4

PHYSICAL AND CHEMICAL CHARACTERISTICS			
Color	Turbidity		
Blue-green	6	Feet 0	Inches (Secchi disk)

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

Depth (ft)	Degrees °F	Oxygen*
Surface	80.9	8.3
2	81.0	8.1
4	81.0	8.0
5	81.0	7.1
6	80.0	7.5
8	76.1	8.0
10	69.7	7.7
12	64.8	3.5
14	60.7	0.5
15	59.7	0.0
16		
18		
20	52.0	0.0
22		
24		
25	47.2	0.0
26		
28		
30	45.0	0.00
32		
34		
35		
36		
38		
40	43.9	0.00
42		
44		
45		
46		
48		
50	43.4	0.00
52		
54		

ppm = parts per million

Depth (ft)	Degrees °F	Oxygen*
55		
56		
58		
60		
62		
64		
65		
66		
68		
70		
72		
74		
75		
76		
78		
80		
82		
84		
85		
86		
88		
90		
92		
94		
95		
96		
98		
100		

Sampling date: 6/21/10

	Surface	Bottom
pH	8.7	7.1
Alkalinity*		
Conductivity	0.386	0.500

SAMPLING EFFORT			
ELECTROFISHING	Day hours	Night hours	Total hours
TRAPS	Number of traps	Days	Total lifts
GILL NETS	Number of nets	Days	Total lifts

PHYSICAL AND CHEMICAL CHARACTERISTICS			
Color	Turbidity		
Blue-green	9	Feet	6 Inches (Secchi disk)

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

Depth (ft)	Degrees °F	Oxygen*
Surface	80.6	7.7
2	80.7	7.0
4	80.7	7.0
5	80.7	7.0
6	80.7	6.9
8	80.7	6.7
10	80.7	6.8
12	75.3	6.5
14	68.4	0.4
15	66.0	0.0
16		
18		
20	51.4	0.0
22		
24		
25	47.3	0.0
26		
28		
30	45.8	0.00
32		
34		
35	45.3	0.00
36		
38		
40	45.0	0.00
42		
44		
45	44.7	0.00
46		
48		
50	44.4	0.00
52		
54		

**ppm = parts per million*

Depth (ft)	Degrees °F	Oxygen*
55		
56		
58		
60		
62		
64		
65		
66		
68		
70		
72		
74		
75		
76		
78		
80		
82		
84		
85		
86		
88		
90		
92		
94		
95		
96		
98		
100		

Sampling date: 8/6/10		
	Surface	Bottom
pH	8.9	7.5
Alkalinity*		
Conductivity	0.395	0.515

Occurrence and abundance of submersed aquatic plants in Upper Long Lake

County:	Noble			Sites with plants:	37		Mean species/site:	1.10				
Date:	8/6/10			Sites with native plants:	37		Standard error (ms/s):	0.09				
Secchi (ft):	9.5			Vegetated sites (%)	92.5		Mean native species/site:	1.03				
Maximum plant depth (ft):	19.5			Number of species:	5		Standard error (mns/s):	0.08				
Trophic status:	Meso			Number of native species:	4		Species diversity:	0.39				
Total sites:	40			Maximum species/site:	3		Native species diversity:	0.30				

Depth (0 to 20 ft)	Occurrence		Rake score observations (N,%) per species									Plant
Common Name	Frequency (%)		0	%	1	%	3	%	5	%		Dominance
Coontail	24	60.0	6	15.0	3	7.5	4	10.0	17	42.5		50.0
Chara	4	10.0	36	90.0	2	5.0	1	2.5	1	2.5		5.0
Nitella	2	5.0	38	95.0	0	0.0	2	5.0	0	0.0		3.0
Eurasian water milfoil	3	7.5	37	92.5	3	7.5	0	0.0	0	0.0		1.5
Large-leaf pondweed	0	0.0	39	97.5	0	0.0	0	0.0	0	0.0		0.0
Filamentous algae	2	5.0										

Relative Abundance, Size and Estimated Weight of Fish Collected at Upper Long Lake						
			Minimum	Maximum		
Common Name*	Number	Percent	Length (in)	Length (in)	Weight (lb)**	Percent
Bluegill	889	70.2	1.6	7.7	54.32	34.8
Black crappie	190	15.0	4.8	7.8	20.47	13.1
Largemouth bass	56	4.4	3.8	18.0	19.92	12.8
Redear	56	4.4	2.2	7.4	8.64	5.5
Yellow perch	21	1.7	5.7	8.3	3.02	1.9
Muskellunge	10	0.8	21.8	30.0	28.59	18.3
Lake chubsucker	10	0.8	3.8	8.9	1.71	1.1
Warmouth	10	0.8	3.6	5.3	0.58	0.4
Yellow bullhead	7	0.6	7.1	10.8	2.99	1.9
Brook silverside	7	0.6	3.7	4.1	0.07	0.0
Spotted gar	4	0.3	27.0	30.8	15.05	9.6
Redfin pickerel	3	0.2	6.4	10.9	0.42	0.3
Golden shiner	2	0.2	2.0	2.3	0.01	0.0
Brown bullhead	1	0.1	8.2		0.22	0.1
TOTAL	1266				156.01	
*Common names of fishes recognized by the American Fisheries Society.						
**Weights estimated from standard length-weight regression models.						

Number, catch by gear, percentage, estimated weight and age of bluegill

Length	Catch by gear			Total	%	Estimated	Age analysis (scales/half-inch)						Age Composition (number/age)					
(in)	EF	GN	TN	Number		Weight (lb)	1	2	3	4	5	6+	1	2	3	4	5	6+
0.5																		
1.0																		
1.5	2			2	0.2	0.00	2						2	0	0	0	0	0
2.0	4		1	5	0.6	0.01	4						5	0	0	0	0	0
2.5	7		2	9	1.0	0.01	2						9	0	0	0	0	0
3.0	55		9	64	7.2	0.02	1	4					13	51	0	0	0	0
3.5	133	2	1	136	15.3	0.03		5					0	136	0	0	0	0
4.0	239	7	22	268	30.2	0.05		5					0	268	0	0	0	0
4.5	155	15	37	207	23.4	0.07		1	4				0	41	166	0	0	0
5.0	77	4	36	117	13.2	0.09			4				0	0	117	0	0	0
5.5	23	6	28	57	6.4	0.12			1	5			0	0	10	48	0	0
6.0	4	2	11	17	1.9	0.16				1	3		0	0	0	4	13	0
6.5	1			1	0.1	0.20				2	2		0	0	0	1	1	0
7.0	1			1	0.1	0.26				1	1		0	0	0	1	1	0
7.5	2			2	0.2	0.32					4		0	0	0	0	2	0
8.0																		
8.5																		
9.0																		
9.5																		
10.0																		
10.5																		
11.0																		
11.5																		
12.0																		
12.5																		
13.0																		
13.5																		
14.0																		
14.5																		
15.0																		
15.5																		
16.0																		
16.5																		
17.0																		
17.5																		
18.0																		
Totals:	703	36	147	886		53.02	9	15	9	9	10	0	29	497	292	53	16	0
											Mean length (in):		2.6	3.8	4.7	5.6	6.2	
											Variance:		0.23	0.15	0.08	0.05	0.29	

Number, catch by gear, percentage, estimated weight and age of black crappie

Length	Catch by gear			Total	%	Estimated	Age analysis (scales/half-inch)						Age Composition (number/age)					
(in)	EF	GN	TN	Number		Weight (lb)	1	2	3	4	5	6+	1	2	3	4	5	6+
0.5																		
1.0																		
1.5																		
2.0																		
2.5																		
3.0																		
3.5																		
4.0																		
4.5																		
5.0		30		30	15.8	0.07												
5.5		61		61	32.1	0.09												
6.0		63		63	33.2	0.11												
6.5	1	26		27	14.2	0.15												
7.0	1	3		4	2.1	0.18												
7.5		2	1	3	1.6	0.22												
8.0		2		2	1.1	0.27												
8.5																		
9.0																		
9.5																		
10.0																		
10.5																		
11.0																		
11.5																		
12.0																		
12.5																		
13.0																		
13.5																		
14.0																		
14.5																		
15.0																		
15.5																		
16.0																		
16.5																		
17.0																		
17.5																		
18.0																		
Totals:	2	187	1	190		20.47												
										Mean length (in):								
											Variance:							

Number, catch by gear, percentage, estimated weight and age of largemouth bass																		
Length	Catch by gear			Total	%	Estimated	Age analysis (scales/half-inch)						Age Composition (number/age)					
(in)	EF	GN	TN	Number		Weight (lb)	1	2	3	4	5	6+	1	2	3	4	5	6+
0.5																		
1.0																		
1.5																		
2.0																		
2.5																		
3.0																		
3.5																		
4.0	2			2	3.6	0.03	2						2	0	0	0	0	0
4.5	1			1	1.8	0.04	1						1	0	0	0	0	0
5.0																		
5.5	1			1	1.8	0.08		1					0	1	0	0	0	0
6.0																		
6.5	4			4	7.1	0.13		3					0	4	0	0	0	0
7.0	1			1	1.8	0.16		1					0	1	0	0	0	0
7.5																		
8.0																		
8.5	1			1	1.8	0.30		1					0	1	0	0	0	0
9.0																		
9.5	5			5	8.9	0.42		4					0	5	0	0	0	0
10.0	4	1		5	8.9	0.49		3					0	5	0	0	0	0
10.5	6	1		7	12.5	0.57		2	4				0	2	5	0	0	0
11.0	4			4	7.1	0.65		2	2	1			0	2	2	1	0	0
11.5	1			1	1.8	0.75				1			0	0	0	1	0	0
12.0	3			3	5.4	0.85				5			0	0	0	3	0	0
12.5	3	1	1	5	8.9	0.97												
13.0	1			1	1.8	1.09												
13.5	4			4	7.1	1.23												
14.0	1	1		2	3.6	1.37												
14.5	1			1	1.8	1.53												
15.0	2	1		3	5.4	1.70												
15.5		2		2	3.6	1.88												
16.0																		
16.5																		
17.0																		
17.5	1			1	1.8	2.73												
18.0	2			2	3.6	2.97												
Totals:	48	7	1	56		19.92	3	17	6	7			3	21	6	5		
												Mean length (in):	4.2	8.9	10.6	11.7		
												Variance:	0.08	2.97	0.06	0.18		

Number, catch by gear, percentage, estimated weight and age of muskellunge

Length	Catch by gear			Total	%	Estimated	Age analysis (scales/half-inch)						Age Composition (number/age)					
(in)	EF	GN	TN	Number		Weight (lb)	1	2	3	4	5	6+	1	2	3	4	5	6+
20.0																		
20.5																		
21.0																		
21.5																		
22.0		2		2	20.0	1.99												
22.5		2		2	20.0	2.14												
23.0																		
23.5		2		2	20.0	2.47												
24.0		1		1	10.0	2.65												
24.5																		
25.0		1		1	10.0	3.03												
25.5																		
26.0																		
26.5																		
27.0																		
27.5		1		1	10.0	4.16												
28.0																		
28.5																		
29.0																		
29.5																		
30.0		1		1	10.0	5.55												
30.5																		
31.0																		
31.5																		
32.0																		
32.5																		
33.0																		
33.5																		
34.0																		
34.5																		
35.0																		
35.5																		
36.0																		
36.5																		
37.0																		
37.5																		
Totals:	0	10	0	10		28.59												
										Mean length (in):								
											Variance:							

Bluegill

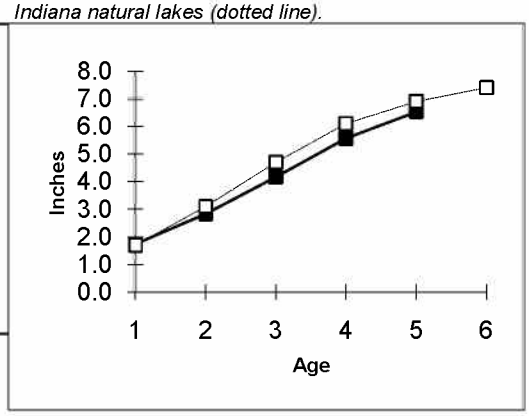
Intercept: 0.8 inch

BACK-CALCULATED LENGTHS (inches) AT EACH AGE

Year Class	Count	Mean L	I	II	III	IV	V	VI
2009	9	2.2	1.7					
	stdev	0.42	0.34					
2008	15	3.6	1.8	3.0				
	stdev	0.45	0.28	0.48				
2007	10	4.8	1.9	3.0	4.2			
	stdev	0.37	0.18	0.33	0.36			
2006	9	5.9	1.6	2.7	4.2	5.5		
	stdev	0.59	0.17	0.18	0.47	0.67		
2005	10	6.8	1.7	2.7	4.1	5.6	6.5	
	stdev	0.68	0.29	0.34	0.74	0.83	0.65	
2004								
Mean*			1.7	2.8	4.2	5.6	6.5	
SD			0.13	0.18	0.07	0.11		
Count			53	44	29	19	10	

**Does not include age groups with less than three samples.*

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



Largemouth bass (Scales taken from bass collected in Spring 2010)

Intercept: 0.8 inch

BACK-CALCULATED LENGTHS (inches) AT EACH AGE

Year Class	Count	Mean L	I	II	III	IV	V	VI
2009								
2008	22	6.4	3.6	6.3				
	stdev	0.74	0.75	0.78				
2007	24	8.9	2.7	6.4	8.8			
	stdev	0.87	0.59	0.62	0.89			
2006	24	11.7	4.7	8.3	11.0	13.3		
	stdev	0.83	5.65	7.58	8.08	8.69		
2005	12	13.6	3.9	7.2	9.8	11.7	13.5	
	stdev	0.98	0.96	0.94	1.00	1.26	1.09	
2004	4	15.1	3.7	6.7	9.6	12.5	13.8	15.1
	stdev	1.84	0.97	0.89	1.01	1.03	1.31	1.84
Mean*			3.7	7.0	9.8	12.5	13.7	15.1
SD			0.71	0.82	0.91	0.78	0.22	
Count			86	86	64	40	16	4

**Does not include age groups with less than three samples.*

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