Fish Population Survey and Shoreline Fish Community at Lake Wawasee

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Abstract

Lake Wawasee was sampled on July 12-16, 2004 to determine the status of the fish population. Sampling included two hours of electrofishing, eight gill net lifts and twelve trap net lifts. Sampling sites for electrofishing were also selected to assess fish assemblage along bulkhead seawalls, natural shorelines, channels and mixed (50% bulkhead / 50% natural) habitats. We found significantly more fish (x^2=344.96; df=3; P<0.001) and fish species (x^2=12.74; df=3; P<0.005) along natural shorelines than along bulkhead seawalls. The channel and mixed habitats had close to the expected number of fish and fish species. Submersed aquatic plants were sampled at 214 sites on August 2, 2004. Data was stratified from 0-10 feet in depth and mean rake scores were compared between natural shorelines and the rest of the lake. No significant differences (F=1.85; df=2; P=0.16) were evident between mean rake scores or species present. However, many sample sites were over 50 feet from shore. Trap nets were set each year from 2002-2004 to monitor changes in the fish community following establishment of ecozones in Johnson and Conklin Bays. Traps were also set in the Southeast Bay as a control. We compared catch at each location by year and found no significant change over three years and no significant difference in trap net catches by location. The fish community at Lake Wawasee has experienced a few changes since past surveys. Electrofishing catch rate of bluegill (472/hr) is higher now than ever before. Growth has declined slightly and there are now fewer bluegill greater than nine inches. The electrofishing catch rate of largemouth bass over 12-inches increased to its highest rate ever. This increase is possibly a response to the size limits implemented in 1990's. Yellow bullhead relative abundance has increased to its highest point so far. White bass are now present and could potentially affect the fish community.

Introduction

For nearly a century, Lake Wawasee - Indiana's largest natural lake - has been a popular fishing and boating site. Its 3,410 acres offer many types recreation and its 35 miles of shoreline provide areas for residential development. Most of lake Wawasee is residentially developed. Extensive channel systems have been dug along portions of the shoreline to increase the amount of lakefront property. The only significant remaining areas of undeveloped shoreline are located in Johnson Bay (0.48 mi) and Conklin Bay (0.89 mi).

For lake access and aesthetic reasons residents often remove aquatic vegetation along the shore. This can lead to significant erosion and water quality problems since plants help reduce wake action from wind and boats. In turn, residents construct bulkhead seawalls to reduce erosion of their property. The majority of Lake Wawasee is now lined with bulkhead seawalls that have exacerbated wave energy and changed the physical nature of the near-shore habitat. These structures can affect the lake by altering littoral habitat critical for fish, invertebrates, plants and wildlife (Engel and Pederson 1998). Minnesota Department of Natural Resources reported that floating and emergent vegetation is typically reduced by 66% along developed shorelines (Radomski 2001). Another study in Minnesota found that property values decrease as water clarity decreases (Krysel 2003).

Figure 1. *Bulkhead Seawall with no Vegetation*

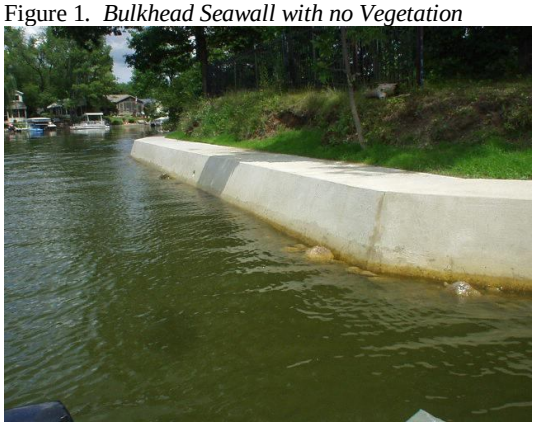

Figure 2. *Natural shoreline with vegetation.*

During a 2004 fish population survey conducted by the Indiana Department of Natural Resources (IDNR) at Lake Wawasee, electrofishing sites were purposefully selected to sample various shorelines. The objective of this sampling was to compare species diversity and total catch rate of fish adjacent to bulkhead seawalls, natural shorelines and manmade channels.

Recently ecological regions (ecozones) were established in Johnson and Conklin bays of Lake Wawasee to minimize the degradation of wetlands and natural shoreline by boating. Boat speeds are restricted to idle within the ecozones. Multiple traps nets were set from 2002-2004 to determine the differences in species diversity and trap net catch rate before and after ecozone implementation.

A vegetation survey was also conducted to determine species presence and relative density within the lake. Additionally, the data was used to compared differences in submersed aquatic macrophyte species diversity and relative density between natural and developed shorelines.

Study Site

Lake Wawasee is located in northeastern Indiana along State Road 13 southeast of the town of Syracuse. Maximum depth is 77 feet and average depth is 22 feet (Table 1). A state-owned public boat ramp is available at the southeast side of the lake at the Wawasee fishing area. The watershed is

Table 1. *Physical-chemical features of Lake Wawasee*

Surface acres	3,410	
Maximum depth (ft)	77	
Mean depth (ft)	22	
Volume (ac-ft)	67,337	
Clarity (secchi ft)		
	Jul-75	9.5
	Jul-85	11.0
	Jul-97	5.5
	Jul-04	6.6
Oxygen (ppm) at 10 feet		
	Jul-75	7.8
	Jul-85	8.0
	Jul-97	9.0
	Jul-04	7.5
Oxygen (ppm) at 20 feet		
	Jul-75	9.2
	Jul-85	7.0
	Jul-97	6.0
	Jul-04	5.6
Oxygen (ppm) at 30 feet		
	Jul-75	4.4
	Jul-85	5.0
	Jul-97	2.0
	Jul-04	0.2

mainly agriculture (63%) and forest land (12%) (Choi 2005).

Lake Wawasee is a moderately fertile lake (IDEM 2002). Enough oxygen (5 mg/l) is present for fish down to 20 feet. However, oxygen has declined in the past 30 years in the 20-30 foot range. Water clarity varies from 5½-11 feet (Table 1).

Although Lake Wawasee is natural in origin, a concrete control structure currently maintains the water level at 858.89 feet (msl). The outlet, Turkey Creek, has a combined drainage area of 22,944 acres and flows to the Elkhart River (Lake Michigan watershed).

Shoreline Electrofishing

Methods

To assess the fish assemblage along different shoreline types, nighttime electrofishing (Smith Root Type VIA, 530-707v DC) was conducted during a fish population survey on July 12, 2004. Eight sites were sampled: two with bulkhead concrete seawalls, two with natural shoreline, two in channel habitat and two with mixed (50% bulkhead seawall / 50% natural shoreline) habitats. Each site was electrofished for 900 seconds; all fish were netted using two dip netters and measured to the nearest 0.1 inch. Due to the presence of multiple piers the boat was maneuvered into shore where possible. At that time one hour was spent sampling two 10-minute stations along concrete seawalls, two stations in manmade channels, and two stations along cattails in Johnson Bay.

Results

In 1997 nearly three times as many fish were captured in channels and along the natural cattail stands than along concrete seawalls (Table 2). More species were also noted in channels (15) and along cattails (14) than seawalls (11). Seawall areas held more brook silversides, logperch, longnose gar and smallmouth bass than channels or cattails. Seawall areas also held more largemouth bass than natural areas. Channels were more likely to contain bowfin, golden shiners, grass pickerel, largemouth bass, longear and pumpkinseeds. Natural cattail areas held more black crappies, bluegills, redear, spotted gar, warmouth, yellow bullheads and yellow perch. They also held more golden shiners and grass pickerel than seawall areas.

Table 2. *Numbers of fish collected by electrofishing in three types of habitat within Lake Wawasee during July 1997.*

Species	Seawall	Channel	Ecozone
Black crappie	0	0	4
Bluegill	17	54	62
Bluntnose minnow	1	0	1
Bowfin	0	4	1
Brook silverside	4	0	0
Brown bullhead	0	1	0
Golden shiner	0	5	3
Grass pickerel	0	15	6
Green sunfish	0	0	1
Hybrid sunfish	0	2	0
Lake chubsucker	0	2	0
Largemouth bass	14	17	7
Logperch	4	0	0
Longear	2	28	5
Longnose gar	2	1	0
Pumpkinseed	0	2	0
Redear	2	2	4
Smallmouth bass	2	0	0
Spotted gar	1	0	4
Warmouth	0	5	8
Yellow bullhead	0	6	17
Yellow perch	7	5	21

Table 3. *Numbers of fish collected by electrofishing in three types of habitat within Lake Wawasee during July 2004.*

Species	Seawall	Channel	Ecozone
Black crappie	0	0	2
Bluegill	52	172	486
Bluntnose minnow	5	1	3
Bowfin	0	2	2
Brook silverside	33	1	0
Brown bullhead	0	1	1
Carp	0	10	2
Central mudminnow	0	0	1
Golden shiner	0	0	3
Grass pickerel	0	0	0
Green sunfish	0	1	0
Hybrid sunfish	0	1	4
Lake chubsucker	14	26	26
Largemouth bass	14	0	0
Logperch	14	0	0
Longear	0	0	0
Longnose gar	0	1	3
Pumpkinseed	0	1	4
Redear	1	0	0
Rock bass	0	0	1
Smallmouth bass	0	3	8
Spotted gar	1	5	5
Warmouth	0	4	22
White bass	0	1	2
Yellow bullhead	1	1	0
Yellow perch	1	0	0

During 2004 electrofishing a total catch of 1,295 fish along four different habitats. As expected, natural shorelines had the highest total catch rate of fish (1154/hr) and bulkhead seawalls had the lowest (242/hr). The catch rate within the channel habitat (498/hr) was slightly below expected (646/hr). A Chi-square test indicated significantly fewer fish (x^2=344.96; df=3; P<0.001) were collected adjacent to bulkhead seawalls than natural shorelines.

A total of 18 species were captured along natural shorelines. Only nine species were observed adjacent to bulkhead seawalls. The mixed and channel habitat catches were similar to the ecozone habitat catch with both having 17 species present. A Chi-square test indicated significantly fewer fish species (x^2=12.74; df=3; P=0.005) adjacent to bulkhead seawalls when compared to other habitats.

Brook silversides, largemouth bass and logperch were more prominent along bulkhead seawalls than any other habitat. Carp where mostly found in channel habitats. Bluegill, pumpkinseed, warmouth, golden shiner and smallmouth bass were typically located along natural shorelines. Bluegill was also the top species by number in each electrofishing stations.

Ecozone Trap nets

Methods

Nine trap-nets were set during July of each year from 2002-2004 to examine any change in fish community after ecozone implementation. Three nets were set in each of the two ecozones and three were set along bulkhead seawalls in the southeast bay. Nets were set in the morning and retrieved the following morning allowing for a 24 hour set. All fish species were counted and measured to the nearest 0.1 inch.

Results

A total of 4,606 fish were collected from 2002-2004 with trap nets. Nets placed in Johnson Bay collected 1,354 fish from 2002 to 2004. A one-way ANOVA found no significant difference (F=1.2; df=2; P=0.36;) in mean catch among years, possibly indicating no response yet in fish density at the ecozones. The number of species collected each year was also examined using a Chi-square test. The test showed no significant difference (x^2=1.3; df=2; P=0.52).

Conklin Bay trap nets collected 1,275 fish from 2002-2004. Similar to Johnson Bay, Conklin showed no significant difference in mean catch among years (F=4.8; df=2 P=0.07). Additionally, there were no significant differences in number of species collected (x^2=1.3; df=2; P=0.52).

The shoreline of the Southeast Bay is mostly bulkhead seawalls and was the location of three traps for use as a control. The traps collected 1,977 fish. However, they also showed no significant differences in mean catch (F=0.5; df=2; P=0.51) or number of species (x^2=4.1; df=2; P=0.13) collected among years. The lack of change in all three bays indicates no short-term changes in the fish community associated with ecozones.

Vegetation Sampling

Methods

A submersed aquatic vegetation survey was conducted on August 2, 2004 during maximum seed production, which aided in species identification. Vegetation sampling was conducted following the Indiana protocol (Pearson 2004). Ecozone vegetation was compared to vegetation around the rest of the lake. Comparisons were based on depths less than 10 feet to limit the offshore bias.

Results

During the submersed vegetation survey chara was observed at 63% of the sampling sites at a moderate density (2.0 on a scale of 1-5). Variable pondweed was found at 27% of the sites at low densities (1.2). Northern water milfoil and eel grass were also present at 23% and 18% of the sites, respectively. Coontail was observed at 15% of the sites. Exotic species Eurasian water milfoil and curly-leaf pondweed only showed up in 2% of all sampling sites. A total of 17 species were present during sampling.

Vegetation sampled along bulkhead seawalls did not differ in mean rake score to vegetation samples collected within ecozones (F=1.85; df=2; P=0.16). The mean rake score of vegetation between 0-10 feet deep in Johnson bay was 2.75 on a scale on 1-5. In Conklin bay the mean rake score was 1.5, and outside of the ecozones it was 2.1. Additionally, plant species diversity did not differ among habitats.

Fish Survey

Methods

Sampling during the fish population survey consisted of two hours electrofishing, eight-gill nets and 12 trap-nets. Nighttime electrofishing (Smith Root Type VIA, 530-707v DC) was conducted along multiple shoreline types. Both trap nets and gill nets were set in the morning and lifted the following morning for a 24-hour set. Nets were placed in different habitats to focus on collecting as many species as possible and cover as much habitat as possible. All fish were measured to the nearest 0.1-inch. Water chemistry was examined on July 12, 2004.

Results

During the July survey at Lake Wawasee, 2,822 fish weighing 608 pounds were collected. A total of 28 species were sampled. Bluegill comprised over half of the number (68%) and ranked second in weight (17%) after northern pike (20%). Largemouth bass were second in number (5%), followed by yellow bullhead (4%). By weight, yellow bullhead ranked third (16%). Sportfish accounted for 94% of the total catch by number and 85% of the weight.

The 1,919 bluegill collected during the survey were 2-9 inches long, but only 14 were 7-inch or larger. The majority (82%) were less than 5 inches. The number captured by electrofishing (472/hr) was normal compared to other northern Indiana natural lakes. Bluegill growth was normal.

A total of 142 largemouth bass were collected during the July survey. They measured 1½-18½ inches long. Sixteen bass were 14-inch or larger, three of which were greater than 18 inches. The electrofishing catch rate (41/hr) was about one quarter the normal catch rate of bass in other natural lakes. Their growth rate was average with age-5 bass reaching 14 inches.

Yellow bullhead catch increased significantly from past surveys (Table 6). The gill net catch rate increased from 0.8/lift in 1997 to 4.1/lift in 2004 and trap net catch rate increased from 2.0/lift in 1997 to 5.8/lift in 2004. Yellow bullheads measured 6½-13½ inches.

Table 4. *Mean lengths of bluegills and largemouth bass from age-1 through age-6 at Lake Wawasee in 1975, 1985, 1997 and 2004.*

Bluegill length at age

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6
1975[1]	1.3	2.7	4	5.9	7.4	8.5
1985	1.7	2.9	4.4	6.1	8.0	8.7
1997	1.7	3.0	4.4	6.1	7.8	8.8
2004	1.5	2.4	3.7	5.1	6.5	7.6

Largemouth bass length at age

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6
1975[1]	2.6	6.8	9.0	11.2	14.3	16.1
1985	2.9	6.7	9.6	11.7	13.4	
1997	3.1	6.7	9.6	12.2	14.1	14.9
2004	3.5	7.2	9.6	11.5	13.3	14.8

[1]no body-scale intercept used in back-calculations.

Table 5. *Number of bluegill collected at age in Lake Wawasee in 2004.*

Age	Length	Num.
Age-1 fish	1.8 - 2.7	154
Age-2 fish	2.8 - 4.1	934
Age-3 fish	3.4 - 6.6	746
Age-4 fish	4.9 - 7.6	40
Age-5 fish	6.0 - 8.2	31
Age-6 fish	6.9 - 9.1	11
Age-7 fish	8.3 - 9.1	3
All Ages	1.8 - 9.1	1919

Ninety-five yellow perch were collected. They measured 2-13 inches long, but most (80%) were less than eight inches. The gill net catch rate of yellow perch declined steadily over the years from 4.7/lift in 1975 to 2.7/lift in 1997. However, in 2004 the catch rebounded to 4.3/lift. Age-4 yellow perch are expected to reach eight inches.

Thirty-eight northern pike were collected, ranging in length from 18-34½ inches and weighing 122 pounds. Average weight of each fish was a little over three pounds. All but two pike were legal-size (20-in). Twenty percent were above the preferred angling size (>28 inch). Pike gill net catch rates increased from 0.8/lift in 1975 to above average at 4.7/lift in 1997 and have remained stable according to the 2004 catch (4.6/lift). By weight, the percentage of pike in the survey catches increased from 14% in 1975 to 20% in 2004. Their growth rate was normal for all ages.

Other sportfish included several sunfish, 36 rock bass up to 11½ inches long, black crappies up to 14 inches long, and six smallmouth bass. The smallmouth bass were 2-16 inches long.

Non game fish, including various suckers common to other lakes in the area, never made up much of the survey catches. White and spotted suckers, for instance, have never been collected at Wawasee by the DNR. In past surveys longnose gar were most abundant and dominated non game fish by weight. Numerous longnose and spotted gar were also collected in 2004 but the datasheet was lost following the survey.

Brook silversides dominated non game fish by number (2%). Other non game fish important for predator forage included 37 logperch, 36 bluntnose minnows and five lake chubsuckers. Thirteen golden shiners were also collected measuring 4½-7½ inches long.

Table 6. *Numbers of fish collected and sampling effort during fish population surveys at Lake Wawasee in July 1975, 1985, 1997 and 2004.*

Species	1975	1985	1997	2004
Bluegill	452	333	488	1919
Yellow perch	287	99	61	95
Largemouth bass	129	126	44	142
Longear	64	18	41	59
Yellow bullhead	41	25	38	115
Northern pike	31	34	28	38
Warmouth	39	17	22	32
Grass pickerel	11	4	21	3
Rock bass	36	3	15	40
Longnose gar	74	43	14	1*
Pumpkinseed	105	9	14	21
Redear	95	45	13	94
Black crappie	127	21	12	65
Brown bullhead	43	25	9	13
Golden shiner	15	14	9	13*
Spotted gar	38	7	8	15*
Bowfin	26	6	5	8*
Smallmouth bass	13	19	5	6
Brook silverside	44	na	4	47
Logperch	0	4	4	37
Hybrid sunfish	0	0	3	5
Bluntnose minnow	5	2	2	36
Lake chubsucker	70	11	2	5
Green sunfish	6	0	1	0
Walleye	0	9	0	0
Carp	2	4	0	7*
Banded killifish	4	1	0	0
Central mudminnow	0	0	0	1
White bass	0	0	0	3
Mimic shiner	0	0	0	2
TOTAL	1,757	879	863	2,822

EFFORT

		2½		
Electrofishing hours	5 (AC)	(AC/DC)	1 (DC)	2 (DC)
Gill net lifts	40	11	6	8
Trap net lifts	0	10	5	12

*GN data for these species not obtained

DISCUSSION

Shoreline Habitat

The data collected by electrofishing from 1997 and 2004 indicated a more suitable habitat for sunfish species along natural shorelines. It also indicated the number and diversity of fish along natural shorelines is greater than the number and diversity of fish adjacent to bulkhead

Table 7. *Number and size of bluegill and largemouth bass collected in Lake Wawasee from 1975 –2004.*

Bluegill		YEAR		
Length	1975	1985	1997	2004
1-1½	3	0	1	0
2-2½	26	11	160	154
3-3½	66	62	72	900
4-4½	87	123	133	514
5-5½	59	44	79	245
6-6½	94	46	27	74
7-7½	82	37	11	23
8-8½	24	2	0	5
9-9½	9	6	2	4
10-10½	2	2	3	0
Total	452	333	488	1919
Largemouth bass		YEAR		
Length	1975	1985	1997	2004
< 8 inches	57	13	11	39
8-11½	63	88	22	61
12-13½	4	14	9	26
14-17½	2	11	2	13
≥18	3	0	0	3
Total	129	126	44	142

seawalls. A study on Lake Conroe, Texas produced similar results with 3-4 times as many fish adjacent to natural shorelines than bulkhead seawalls (Webb 1995).

There were no significant differences in fish community at any location based on trap net catches. The data also indicated a lack of short term change to fish community after ecozone implementation. However, Minnesota DNR reported that night electrofishing captured more species than trap nets. Trap nets missed a lot of minnows and smaller fish (McInerny 2004).

Many Indiana natural lake shorelines have already been lined with bulkhead seawalls. A research project needs to be designed to further examine the effects on bulkhead seawalls on fish and plant communities. If future studies concur with the electrofishing results at Lake Wawasee, the DNR should consider adopting stricter regulations on seawall construction and refacing.

Vegetation

Although there were no significant differences in mean rake score between the ecozones and the rest of the lake, the data may not adequately represent the effect bulkhead seawalls have on near shore vegetation. Our sampling method collected data throughout the littoral zone, which in most cases extends past the effect a bulkhead seawall may have on vegetation. The majority of samples were collected more than 50 feet from the shore.

Based on past observations samples must be obtained within 50 feet of the shoreline in order to determine the effect an ecozone or seawall may have on near shore rooted vegetation. Therefore, the data we collected may not be suitable for this comparison. However, it may indicate that boating or other offshore activities may not significantly affect offshore submersed vegetation.

Fish Population Survey

Historically bluegill, yellow perch and largemouth bass have ranked as the top three fish by number. However, during the 2004 survey yellow perch ranked fourth by number and yellow bullhead ranked third. This was a response to an increase in yellow bullhead and not a decrease in yellow perch.

Electrofishing catch rate of bluegill increased from 68/hour in 1985 to 235/hour in 1997 and 472/hr in 2004. Bluegill typically average 40% of the survey catch at Lake Wawasee. However, in 2004 they accounted for 68% of the catch. The increased relative abundance of bluegill (Table 6) is most likely due to strong age-2 and age-3 year classes (Table 5). Age-2 and age-3 bluegill made up 88% of the total bluegill catch.

Numbers of big bluegill have declined since 1975. Very large bluegill (≥10 in.) were not present in the 2004 survey. Additionally, the percentage of 8-inch and larger bluegill of all 3-inch and larger bluegills has steadily declined from 3% in 1985 to 1½% in 1997 and only ½% in 2004. The percentage of 7-inch and larger bluegills declined from 15% to 5% and 2%, respectively. The lack of larger bluegill may indicate greater exploitation by anglers.

In 1975, three 18-inch or larger largemouth bass were collected but none were caught in 1985 or 1997. The percentage of 14-inch and larger bass of all 8-inch and larger bass increased from 7% in

1975 to 10% in 1985 but decreased to 6% in 1997. The percentage of 12-inch and larger bass increased from 13% in 1975 to 22% in 1985 and 33% in 1997. In 2004 bass 14-inch and larger made up 16% of all bass over 8-inches. The percentage of 12-inch bass also increased to 42% in 2004. These percentages are higher now than before. Bass 18-inch or larger made up 2% of the catch, which is higher than 1985 and 1997. Additionally, the electrofishing catch rate of bass has increased from 26/hr in 1985 to 40/hr in 1997 and 41/hr in 2004. The increased percentage of 12-inch and larger bass may be in response to the 12-inch minimum size limit implemented in 1991 and 14-inch in 1998. Other lakes in the area have shown an increase in 12-inch and larger bass as well.

One troubling aspect of the 2004 survey results was the appearance of white bass. Although white bass are a popular sportfish they may impact some prey species such as yellow perch and shiners (Hartman 1998). However, white bass prefer to spawn in rivers in the spring during high flow (Guy 2002). Because Lake Wawasee has no major inlet, white bass reproduction may be limited.

Recommendations

Few studies have been conducted to determine the effects of shoreline development on fish communities and plant diversity at Indiana natural lakes. Although electrofishing at Wawasee provided some data on how fish communities may respond to shoreline alterations, further studies are needed to examine how bulkhead seawalls and shoreline alterations affect fish and plant communities and water quality. A better designed study is also needed to assess ecozones. Follow up fish population surveys should be conducted at Lake Wawasee to monitor any long-term effects white bass have on the fish community.

Although bluegill growth is average to other area lakes it is still slowly declining. Recently, area anglers have commented on the lack of large bluegill at Wawasee. Currently there are no regulations on bluegill in Indiana. If other area lakes show the same decline in larger and older bluegill possible size limit or bag limit regulations should be investigated.

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March 15, 2005

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APPENDIX 1

Lake Survey Report and Relative Abundance of Fish Species by Number and Weight

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)
Wawasee	Kosciusko	7/12/04 - 7/16/04
Biologist's name		**Date of approval (Month, day, year)**
Jed Pearson and Brad Fink		

LOCATION

Quadrangle name	Range	Section
Lake Wawasee	7E	8,9,10,11 12,13,14,15,16,17,22,23,24,25,26
Township	**Nearest town**	
34N	Syracuse	

ACCESSIBILITY

State owned public access site	Privately owned public access site	Other access site
Southeast Bay	Several marinas are available	

Surface acres	Maximum depth (ft)	Average depth (ft)	Acre feet	Water level (msl)	Extreme fluctuations (ft)
3410	77	22	75,020	858.89	

INLETS

Name	Location	Origin
Turkey Creek	Southeast corner	Indian Village Lake
Dillion Creek	Northeast corner	Runoff
Unnamed	S.W. corner	Runoff

OUTLET

Name	Location
Turkey Creek	Flows to Syracuse Lake

Water level control

Dam on Turkey Creek below Syracuse Lake

POOL	ELEVATION (Feet MSL)	ACRES
TOP OF DAM		
TOP OF FLOOD CONTROL POOL		
TOP OF CONSERVATION POOL		
TOP OF MINIMUM POOL		
STREAMBED		

Bottom type

Boulder	
Gravel	X
Sand	X
Muck	X
Clay	
Marl	

Watershed use

General farming with woodlots and residential areas

Development of shoreline

The shoreline is about 90% developed with only marsh areas in Johnson and Conklin Bays undeveloped

Previous surveys and investigations

Fishery survey, IDNR, 1975, 1985, 1997: Largemouth Bass Study, IDNR, 1997:

Relative Abundance, Size and Estimated Weight of Fish Collected at Lake Wawasee

Common Name*	Number	Percent	Minimum Length (in)	Maximum Length (in)	Weight (lb)**	Percent
Bluegill	1919	68.00	1.8	9.1	103.30	16.99
Largemouth bass	142	5.03	1.5	18.7	95.88	15.77
Yellow bullhead	115	4.08	6.3	14.7	98.53	16.21
Yellow perch	95	3.37	1.8	12.9	17.47	2.87
Redear sunfish	94	3.33	2.5	11.0	18.86	3.10
Black crappie	65	2.30	3.8	13.8	11.01	1.81
Longear sunfish	59	2.09	2.0	5.2	2.27	0.37
Brook silverside	47	1.67	2.9	3.8	NA	NA
Rock bass	40	1.42	2.3	11.3	9.01	1.48
Logperch	37	1.31	2.7	4.6	NA	NA
Northern pike	37	1.31	17.9	34.7	118.72	19.53
Bluntnose minnow	36	1.28	1.6	3.4	NA	NA
Warmouth	32	1.13	2.3	8.0	6.36	1.05
Pumpkinseed sunfish	21	0.74	3.0	7.9	2.98	0.49
Spotted gar	15	0.53	14.1	27.2	18.42	3.03
Brown bullhead	13	0.46	7.3	14.8	17.80	2.93
Golden shiner	13	0.46	4.3	7.3	0.69	0.11
Bowfin	8	0.28	17.0	27.5	30.75	5.06
Carp	7	0.25	10.8	30.4	37.35	6.14
Smallmouth bass	6	0.21	1.9	15.7	6.42	1.06
Lake chubsucker	5	0.18	7.2	8.7	1.25	0.21
Hybrid sunfish	5	0.18	4.7	7.5	1.23	0.20
White bass	3	0.11	12.9	13.5	3.24	0.53
Grass pickerel	3	0.11	6.5	7.6	0.26	0.04
Mimic shiner	2	0.07	2.1	2.4	NA	NA
Central mud minnow	1	0.04	3.9	3.9	NA	NA
Channel catfish	1	0.04	25.7	25.7	5.75	0.95
Longnose gar***	1	0.04	18.7	18.7	0.44	0.07
Total Number	2822			Weight	607.99	

*Common names of fishes recognized by the American Fisheries Society.

**Weights estimated from standard length-weight regression models.

***Several spotted gar and additional longnose gar were collected in gill nets but the data sheet was lost

APPENDIX 2

Sampling Effort, Water Quality Parameters, and Relative Vegetation Abundance

SAMPLING EFFORT			
ELECTROFISHING	Day hours	Night hours	Total hours
	0	2	2
TRAPS	Number of traps	Days	Total lifts
	4	3	12
GILL NETS	Number of nets	Days	Total lifts
	4	2	8

PHYSICAL AND CHEMICAL CHARACTERISTICS			
Color	Turbidity		
Greenish-grey	6	Feet	6 Inches (Secchi disk)

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

Depth (ft)	Degrees F	Oxygen*
Surface	78.4	7.56
2	78.4	7.59
4	78.4	7.59
5	78.4	7.59
6	78.4	7.61
8	78.3	7.59
10	78.1	7.54
12	76.5	7.24
14	75.4	6.74
15	75.0	6.66
16	73.0	6.74
18	72.7	6.47
20	72.5	5.62
22	72.5	4.63
24	71.2	3.56
25	70.3	2.85
26	69.1	1.80
28	66.7	0.52
30	65.1	0.22
32	63.9	0.18
34	62.1	0.16
35	61.3	0.14
36	60.8	0.13
38	60.1	0.12
40	59.5	0.12
42	59.0	0.11
44	58.6	0.11
45	58.5	0.10
46	58.5	0.10
48	58.1	0.10
50	57.9	0.09
52	57.7	0.09
54	57.6	0.09

**ppm = parts per million*

Depth (ft)	Degrees F	Oxygen*
55	57.4	0.09
56	57.4	0.09
58	57.0	0.09
60	57.0	0.09
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: 7-12-2004

	Surface	Bottom
pH	9.0	7.5
Alkalinity*	119.7	171
Conductivity	330	350

N 41°24.190 W 85°42.553

Occurrence and Abundance of Submersed Aquatic Plants

Date:	8/3/04		Littoral sites with plants:		182	Species diversity:		0.83
Littoral depth (ft):	25.0		Number of species:		17	Native diversity:		0.82
Littoral sites:	214		Maximum species/site:		6	Rake diversity:		0.81
Total sites:	214		Mean number species/site:		1.91	Native rake diversity:		0.80
Secchi:	6.5		Mean native species/site:		1.86	Mean rake score:		2.18

Common Name	**Site frequency**	**Relative density**	**Mean density**	**Dominance**
Chara	62.6	1.28	2.04	25.6
Variable pondweed	26.6	0.31	1.18	6.3
Northern watermilfoil	22.9	0.43	1.90	8.7
Eel grass	18.2	0.29	1.62	5.9
Coontail	15.4	0.35	2.27	7.0
Bladderwort	11.7	0.17	1.44	3.4
Naiad sp	11.2	0.19	1.67	3.7
Sago pondweed	7.9	0.15	1.94	3.1
Floating-leaf pondweed	2.8	0.05	1.83	1.0
Clasping-leaf pondweed	2.3	0.04	1.80	0.8
Curly-leaf pondweed	2.3	0.03	1.20	0.6
Eurasian watermilfoil	1.9	0.02	1.00	0.4
Small pondweed	1.4	0.01	1.00	0.3
Nitella	0.9	0.03	3.50	0.7
Flat-stemmed pondweed	0.5	0.00	1.00	0.1
Whorled watermilfoil	0.5	0.00	1.00	0.1
Elodea sp	0.5	0.00	1.00	0.1
Other Observed Plants				
Arrow arum	Purple loosestrife			
Button bush	Spatterdock			
Cattails	Water willow			
Hibiscus	White water lily			
Illinois pondweed				

APPENDIX 3

Length Ranges for bluegill, largemouth bass, yellow bullhead, yellow perch, redear sunfish, black crappie, longear sunfish, rock bass, northern pike, and pumpkinseed sunfish for each gear type: Electrofishing (EF), Gill nets (GN), and Trap nets (TN).

Back calculated length at age for bluegill, largemouth bass, black crappie, yellow perch, and northern pike.

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

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5							
1.5								15.0							
2.0	20		19	39	2.0	0.01	1	15.5							
2.5	47		68	115	6.0	0.01	1	16.0							
3.0	101		175	276	14.4	0.02	2	16.5							
3.5	317		307	624	32.5	0.03	2,3	17.0							
4.0	154	8	98	260	13.5	0.05	2,3	17.5							
4.5	150	14	90	254	13.2	0.07	3	18.0							
5.0	92	35	35	162	8.4	0.09	3,4	18.5							
5.5	35	36	12	83	4.3	0.12	3,4	19.0							
6.0	20	20	9	49	2.6	0.16	3,4,5	19.5							
6.5	5	13	7	25	1.3	0.20	3,4,5	20.0							
7.0	1	5	7	13	0.7	0.26	4,5,6	20.5							
7.5	2	6	2	10	0.5	0.32	4,5,6	21.0							
8.0		1	2	3	0.2	0.39	5,6	21.5							
8.5			2	2	0.1	0.47	6,7	22.0							
9.0		3	1	4	0.2	0.55	6,7	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				1919		103.30	
Electrofishing catch:			944			Gill net catch:		141				Trap net catch:		834	

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

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5	1	1		2	1.4	1.53	5,6
1.5	2			2	1.4	0.00	0	15.0	1			1	0.7	1.70	6
2.0	2			2	1.4	0.00	0	15.5	1	1		2	1.4	1.88	6
2.5								16.0		1		1	0.7	2.07	6
3.0								16.5	1			1	0.7	2.28	6
3.5								17.0			1	1	0.7	2.49	6
4.0	3		5	8	5.6	0.03	1	17.5	1			1	0.7	2.73	7
4.5	4		9	13	9.2	0.04	1	18.0	1			1	0.7	2.97	8
5.0	4		3	7	4.9	0.06	1	18.5	1		1	2	1.4	3.24	8
5.5	1			1	0.7	0.08	1	19.0							
6.0			1	1	0.7	0.10	1	19.5							
6.5								20.0							
7.0								20.5							
7.5	3	2		5	3.5	0.20	2	21.0							
8.0	3	3		6	4.2	0.25	2	21.5							
8.5	2	2		4	2.8	0.30	2	22.0							
9.0	2	3		5	3.5	0.35	2	22.5							
9.5	5	3		8	5.6	0.42	2,3	23.0							
10.0	2	1	1	4	2.8	0.49	3	23.5							
10.5	4	6		10	7.0	0.57	3,4	24.0							
11.0	7	3		10	7.0	0.65	3,4,5	24.5							
11.5	11	2	1	14	9.9	0.75	3,4,5	25.0							
12.0	3			3	2.1	0.85	3,4,5								
12.5	3	2		5	3.5	0.97	3,4,5								
13.0	8	1	1	10	7.0	1.09	4,5								
13.5	5	2	1	8	5.6	1.23	5,6								
14.0	1	2	1	4	2.8	1.37	5,6	Total				142		95.88	
Electrofishing catch:			82			Gill net catch:		35				Trap net catch:		25	

Number, catch by gear, percentage, estimated weight and age of yellow bullhead

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5		1	1	2	1.7	1.52	
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								18.5							
5.5								19.0							
6.0								19.5							
6.5	1	1		2	1.7	0.13		20.0							
7.0	1		1	2	1.7	0.16		20.5							
7.5								21.0							
8.0			1	1	0.9	0.24		21.5							
8.5	1			1	0.9	0.29		22.0							
9.0	2		2	4	3.5	0.35		22.5							
9.5	1			1	0.9	0.41		23.0							
10.0	2		2	4	3.5	0.48		23.5							
10.5	1	2	8	11	9.6	0.56		24.0							
11.0		3	9	12	10.4	0.65		24.5							
11.5	1	1	9	11	9.6	0.74		25.0							
12.0	2	2	11	15	13.0	0.85									
12.5		4	9	13	11.3	0.96									
13.0		4	8	12	10.4	1.08									
13.5		10	7	17	14.8	1.22									
14.0		5	2	7	6.1	1.36		Total				115		98.53	
Electrofishing catch:			12			Gill net catch:		33				Trap net catch:		70	

Number, catch by gear, percentage, estimated weight and age of yellow perch

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5							
1.5								15.0							
2.0	1			1	1.1	0.00	0	15.5							
2.5								16.0							
3.0								16.5							
3.5	3		1	4	4.2	0.02	1	17.0							
4.0	6		3	9	9.5	0.03	1	17.5							
4.5	13		5	18	18.9	0.04	1,2	18.0							
5.0	5		3	8	8.4	0.06	2,3	18.5							
5.5	6		1	7	7.4	0.08	2,3	19.0							
6.0	3	4	1	8	8.4	0.10	2,3	19.5							
6.5	2	7	1	10	10.5	0.13	2,3,4	20.0							
7.0	1	3		4	4.2	0.17	3,4	20.5							
7.5		4	2	6	6.3	0.21	3,4,6	21.0							
8.0	1	4	1	6	6.3	0.25	3,4	21.5							
8.5		1	1	2	2.1	0.31	5	22.0							
9.0		1		1	1.1	0.37	6	22.5							
9.5		2		2	2.1	0.44	4,6	23.0							
10.0								23.5							
10.5								24.0							
11.0		2	1	3	3.2	0.71	4	24.5							
11.5		1		1	1.1	0.82	6	25.0							
12.0		3		3	3.2	0.94	5,6								
12.5		1		1	1.1	1.07	5								
13.0		1		1	1.1	1.21	7								
13.5															
14.0								Total				95		17.47	

Electrofishing catch:	41			Gill net catch:	34				Trap net catch:	20		

Number, catch by gear, percentage, estimated weight and age of redear sunfish

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5							
1.5								15.0							
2.0								15.5							
2.5	1		1	2	2.1	0.01		16.0							
3.0	2			2	2.1	0.02		16.5							
3.5			1	1	1.1	0.03		17.0							
4.0			4	4	4.3	0.05		17.5							
4.5	1		9	10	10.6	0.07		18.0							
5.0			9	9	9.6	0.09		18.5							
5.5			5	5	5.3	0.12		19.0							
6.0			12	12	12.8	0.16		19.5							
6.5			14	14	14.9	0.20		20.0							
7.0	1		15	16	17.0	0.25		20.5							
7.5			10	10	10.6	0.31		21.0							
8.0		1	4	5	5.3	0.38		21.5							
8.5			1	1	1.1	0.45		22.0							
9.0			1	1	1.1	0.54		22.5							
9.5			1	1	1.1	0.64		23.0							
10.0								23.5							
10.5								24.0							
11.0			1	1	1.1	0.99		24.5							
11.5								25.0							
12.0															
12.5															
13.0															
13.5															
14.0								Total				94		18.86	

Electrofishing catch:	5			Gill net catch:	1				Trap net catch:	88			

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

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (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	1	1	6	8	12.3	0.03	1	17.5							
4.5	1	6	2	9	13.8	0.05	1	18.0							
5.0		3		3	4.6	0.07	1	18.5							
5.5			1	1	1.5	0.09	2	19.0							
6.0			4	4	6.2	0.11	2	19.5							
6.5		4	6	10	15.4	0.15	2	20.0							
7.0		5	4	9	13.8	0.18	2	20.5							
7.5		7	5	12	18.5	0.22	2,3	21.0							
8.0		7		7	10.8	0.27	2	21.5							
8.5								22.0							
9.0			1	1	1.5	0.39	3	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		1		1	1.5	1.47	5	Total				65		11.01	

Electrofishing catch:	2			Gill net catch:	34				Trap net catch:	29			

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

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5							
1.5								15.0							
2.0	6			6	10.2	0.01		15.5							
2.5	5			5	8.5	0.01		16.0							
3.0	2		3	5	8.5	0.02		16.5							
3.5	5		14	19	32.2	0.03		17.0							
4.0	6		7	13	22.0	0.05		17.5							
4.5	3		3	6	10.2	0.07		18.0							
5.0	5			5	8.5	0.09		18.5							
5.5								19.0							
6.0								19.5							
6.5								20.0							
7.0								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				59		2.27	

Electrofishing catch:		32			Gill net catch:	0				Trap net catch:		27	

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

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5							
1.5								15.0							
2.0								15.5							
2.5	2		6	8	20.0	0.01		16.0							
3.0	1			1	2.5	0.02		16.5							
3.5	2		7	9	22.5	0.03		17.0							
4.0	3		3	6	15.0	0.05		17.5							
4.5		1		1	2.5	0.07		18.0							
5.0								18.5							
5.5								19.0							
6.0								19.5							
6.5		1	2	3	7.5	0.22		20.0							
7.0			1	1	2.5	0.27		20.5							
7.5			1	1	2.5	0.34		21.0							
8.0		1		1	2.5	0.41		21.5							
8.5			3	3	7.5	0.49		22.0							
9.0			1	1	2.5	0.59		22.5							
9.5			1	1	2.5	0.70		23.0							
10.0		2		2	5.0	0.81		23.5							
10.5			1	1	2.5	0.95		24.0							
11.0								24.5							
11.5		1		1	2.5	1.25		25.0							
12.0															
12.5															
13.0															
13.5															
14.0								Total				40		9.01	

Electrofishing catch:	8			Gill net catch:	6				Trap net catch:	26			

Number, catch by gear, percentage, estimated weight and age of northern pike

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
10.0								23.5		2		2	5.3	2.87	3,4
10.5								24.0		3		3	7.9	3.06	5,6
11.0								24.5							
11.5								25.0			1	1	2.6	3.48	4
12.0								25.5		2		2	5.3	3.70	4,5
12.5								26.0							
13.0								26.5							
13.5								27.0							
14.0								27.5		1		1	2.6	4.70	4
14.5								28.0		2		2	5.3	4.97	4,5
15.0								28.5							
15.5								29.0							
16.0								29.5							
16.5								30.0							
17.0								30.5		1		1	2.6	6.50	6
17.5								31.0							
18.0		1		1	2.6	1.24	3	31.5							
18.5								32.0		1		1	2.6	7.56	6
19.0		1		1	2.6	1.47	2	32.5							
19.5								33.0							
20.0		1		1	2.6	1.73	2	33.5		1		1	2.6	8.73	5
20.5		2		2	5.3	1.87	2,5	34.0							
21.0		4		4	10.5	2.01	3,4,5	34.5		1		1	2.6	9.57	10
21.5		4		4	10.5	2.17	4,5	35.0							
22.0		4		4	10.5	2.33	3,4,5								
22.5		5		5	13.2	2.50	2,3,4,5								
23.0		1		1	2.6	2.68	5	Total				38		122.20	
Electrofishing catch:			0				Gill net catch:	37				Trap net catch:		1	

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

Length	Catch by gear			Total	Percent	Estimated	Age	Length	Catch by gear			Total	Percent	Estimated	Age
(in)	EF	GN	TN	Number		Weight (lb)		(in)	EF	GN	TN	Number		Weight (lb)	
1.0								14.5							
1.5								15.0							
2.0								15.5							
2.5								16.0							
3.0	1			1	4.8	0.02		16.5							
3.5								17.0							
4.0	1			1	4.8	0.05		17.5							
4.5	5			5	23.8	0.07		18.0							
5.0	2			2	9.5	0.09		18.5							
5.5	1			1	4.8	0.12		19.0							
6.0	6			6	28.6	0.16		19.5							
6.5	3			3	14.3	0.20		20.0							
7.0								20.5							
7.5	1			1	4.8	0.31		21.0							
8.0	1			1	4.8	0.38		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				21		2.98	

Electrofishing catch:	21			Gill net catch:	0				Trap net catch:	0		

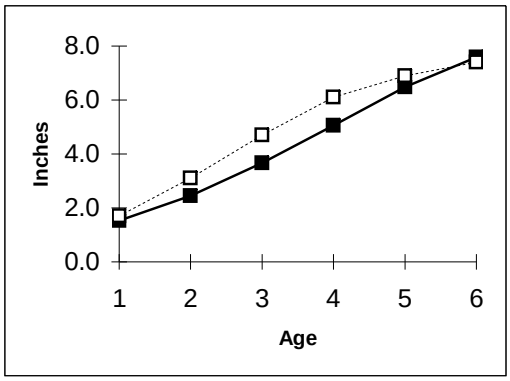
Bluegill
Intercept: 0.8 inch

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Year Class	Count	I	II	III	IV	V	VI
2003	26	1.7					
	stdev	0.23					
2002	44	1.6	2.6				
	stdev	0.18	0.29				
2001	77	1.5	2.6	4.0			
	stdev	0.18	0.33	0.63			
2000	13	1.5	2.5	3.6	5.3		
	stdev	0.14	0.20	0.41	0.71		
1999	22	1.5	2.3	3.5	4.8	6.3	
	stdev	0.18	0.27	0.41	0.68	0.66	
1998	12	1.4	2.3	3.6	5.1	6.7	7.5
	stdev	0.15	0.33	0.59	0.70	0.76	0.77
Mean*		1.5	2.4	3.7	5.1	6.5	7.6
SD		0.13	0.15	0.23	0.21	0.07	
Count		194	168	124	47	34	6

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

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



AGE	This Lake	Other Lakes
1	1.5	1.7
2	2.4	3.1
3	3.7	4.7
4	5.1	6.1
5	6.5	6.9
6	7.6	7.4

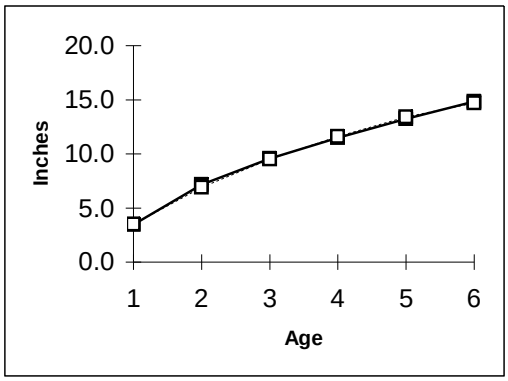
Largemouth bass
Intercept: 0.8 inch

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Year Class	Count	I	II	III	IV	V	VI
2003	14	2.9					
	stdev	0.24					
2002	21	3.5	7.2				
	stdev	0.69	0.95				
2001	25	3.3	6.9	9.6			
	stdev	0.90	1.19	1.11			
2000	22	3.5	7.1	8.8	10.9		
	stdev	0.65	1.14	1.83	0.66		
1999	12	3.9	7.1	9.7	11.4	12.7	
	stdev	0.95	1.58	1.28	1.22	1.07	
1998	8	3.5	7.5	10.2	12.2	13.8	14.8
	stdev	0.82	1.00	1.00	0.79	1.18	1.29
Mean*		3.5	7.2	9.6	11.5	13.3	14.8
SD		0.30	0.24	0.57	0.64	0.08	
Count		102	88	67	42	20	8

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

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



AGE	This Lake	Other Lakes
1	3.5	3.5
2	7.2	6.9
3	9.6	9.5
4	11.5	11.6
5	13.3	13.4
6	14.8	14.7

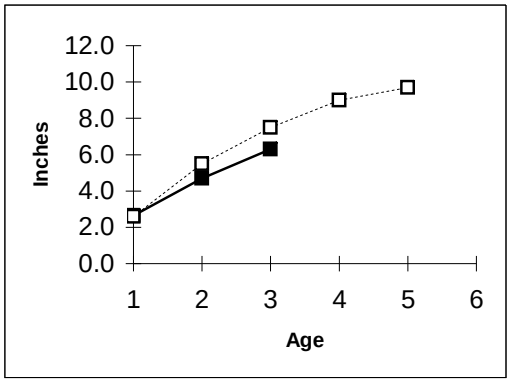
Black crappie
Intercept: 1.4 inch

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Year Class	Count	I	II	III	IV	V	VI
2003	14	2.7					
	stdev	0.11					
2002	33	2.6	5.3				
	stdev	0.23	0.53				
2001	3	2.6	4.1	6.3			
	stdev	0.24	0.29	1.38			
2000							
	stdev						
1999	1	2.7	6.1	9.2	11.9	13.2	
	stdev						
1998							
	stdev						
Mean*		2.6	4.7	6.3			
SD		0.07	1.05				
Count		51	37	4			

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

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



AGE	This Lake	Other Lakes
1	2.6	2.6
2	4.7	5.5
3	6.3	7.5
4		9.0
5		9.7
6		

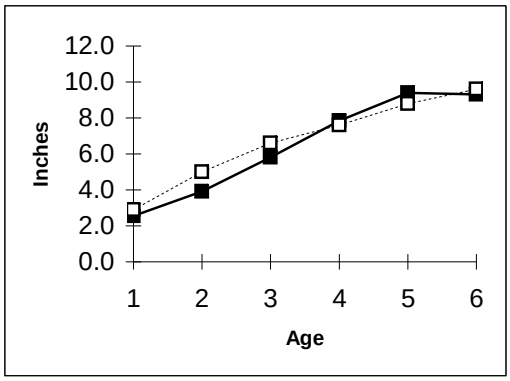
Yellow perch
Intercept: 1.2 inch

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Year Class	Count	I	II	III	IV	V	VI
2003	11	2.8					
	stdev	0.34					
2002	20	2.3	3.8				
	stdev	0.27	0.64				
2001	14	2.4	3.9	5.2			
	stdev	0.26	0.33	0.73			
2000	10	2.6	3.7	5.4	7.2		
	stdev	0.17	0.43	1.08	1.41		
1999	3	2.9	4.7	7.1	9.3	10.7	
	stdev	0.10	0.56	1.28	1.79	2.19	
1998	5	2.4	3.5	5.5	7.0	8.1	9.3
	stdev	0.29	0.64	1.72	2.52	2.48	2.04
Mean*		2.6	3.9	5.8	7.8	9.4	9.3
SD		0.25	0.47	0.85	1.27	0.20	
Count		63	52	32	18	8	5

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

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



AGE	This Lake	Other Lakes
1	2.6	2.9
2	3.9	5.0
3	5.8	6.6
4	7.8	7.6
5	9.4	8.8
6	9.3	9.6

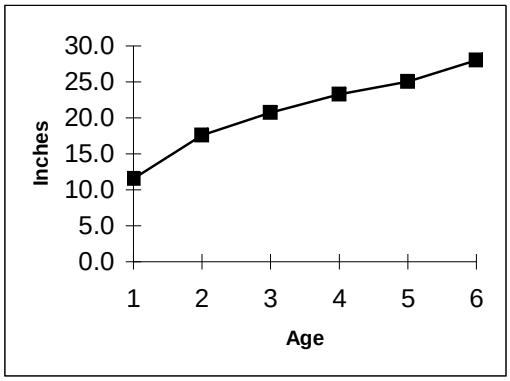
Northern pike
Intercept: 1.2 inch

BACK-CALCULATED LENGTH (inches) AT EACH AGE

Year Class	Count	I	II	III	IV	V	VI
2003							
	stdev						
2002	4	9.1	18.2				
	stdev	1.52	1.51				
2001	7	12.3	17.5	20.2			
	stdev	0.64	2.14	1.96			
2000	10	11.8	17.0	20.3	22.4		
	stdev	1.57	1.89	2.00	2.39		
1999	12	11.8	17.2	20.3	22.2	23.5	
	stdev	1.25	1.76	2.29	2.77	3.33	
1998	3	12.8	18.1	22.1	25.2	26.6	28.0
	stdev	1.11	0.82	0.80	2.25	2.70	3.67
Mean*		11.6	17.6	20.7	23.3	25.0	28.0
SD		1.42	0.56	0.91	1.70	0.44	
Count		36	36	32	25	15	3

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

Northern pike growth (solid line) compared to other lakes (dotted line).



AGE	This Lake	Other Lakes
1	11.6	
2	17.6	
3	20.7	
4	23.3	
5	25.0	
6	28.0	

APPENDIX 4

Number of fish collected in trap nets at three locations within Lake Wawasee 2002-2004.

JOHNSON BAY	Trap #1			Trap #2			Trap #3		
Species	2002	2003	2004	2002	2003	2004	2002	2003	2004
Black crappie	0	0	0	0	2	6	4	1	0
Bluegill	7	93	33	70	442	124	132	83	18
Bowfin	0	0	0	0	0	0	1	0	0
Brown bullhead	0	0	0	0	1	0	0	2	0
Carp	0	1	0	0	0	0	0	0	0
Hybrid sunfish	0	4	2	0	1	2	1	2	1
Largemouth bass	1	0	0	1	6	6	3	1	3
Longear	0	0	5	3	0	1	2	1	2
Northern pike	0	1	0	1	0	0	0	0	0
Pumpkinseed	1	1	3	2	1	0	3	1	0
Redear	4	12	9	17	22	7	45	24	3
Rock bass	0	2	3	0	4	1	3	2	2
Spotted gar	0	0	0	2	2	1	1	0	0
Warmouth	0	1	3	1	1	0	3	6	0
Yellow bullhead	3	6	10	5	10	6	8	13	7
Yellow perch	0	0	3	2	7	4	5	2	0
TOTAL	16	121	71	104	499	158	211	138	36
Number of species	5	9	9	10	12	10	13	12	7
Diversity index	0.59	0.43		0.51	0.25		0.55	0.59	

CONKLIN BAY	Trap #4			Trap #5			Trap #6		
Species	2002	2003	2004	2002	2003	2004	2002	2003	2004
Black crappie	0	0	9	2	na	3	2	2	0
Bluegill	86	190	99	135	na	154	51	255	33
Brown bu1lhead	1	0	6	0	na	3	1	1	0
Carp	1	0	1	0	na	0	0	2	0
Hybrid sunfish	0	0	0	0	na	0	1	0	1
Lake chubsucker	0	0	0	0	na	0	1	0	0
Largemouth bass	4	0	0	1	na	0	1	0	1
Longear	0	2	0	1	na	2	0	0	0
Pumpkinseed	1	1	2	0	na	1	3	4	0
Redear	12	2	14	2	na	3	8	13	26
Rock bass	2	0	3	0	na	0	0	3	0
Spotted gar	0	0	0	2	na	3	4	4	0
Warmouth	0	1	3	4	na	1	5	7	5
Yellow bullhead	7	9	7	8	na	5	7	11	5
Yellow perch	1	0	1	3	na	0	1	19	0
TOTAL	115	205	145	158	na	175	85	321	71
Number of species	9	6	10	9	na	9	12	11	6
Diversity index	0.42	0.15		0.3	na		0.66	0.4	

SOUTHEAST BAY	Trap #7			Trap #8			Trap #9		
Species	2002	2003	2004	2002	2003	2004	2002	2003	2004
Black crappie	3	0	9	0	na	0	1	0	1
Bluegill	25	175	220	139	na	4	832	284	51
Bowfin	0	0	0	0	na	0	1	1	0
Carp	4	0	1	0	na	0	0	0	0
Hybrid sunfish	0	0	0	0	na	0	1	0	0
Largemouth bass	0	0	5	0	na	0	2	0	2
Longear	0	4	3	0	na	1	1	17	0
Pumpkinseed	1	3	0	0	na	0	0	5	0
Redear	9	4	10	2	na	0	6	22	5
Rock bass	3	2	0	2	na	0	0	3	1
Spotted gar	2	0	1	0	na	0	1	1	2
Warmouth	1	4	2	0	na	0	5	4	3
Yellow bullhead	13	3	5	2	na	0	6	11	25
Yellow perch	1	0	1	3	na	0	10	5	1
TOTAL	62	195	257	148	na	5	866	353	91
Number of species	10	7	10	5	na	2	11	10	9
Diversity index	0.76	0.22		0.14	na		0.11	0.37	

APPENDIX 5

Map of gear location of fish population survey at Lake Wawasee July 2004.

Lake Wawasee sampling effort and location of gear July 12, 2004..