STUDY PERFORMANCE REPORT

State: Michigan   **Project No.:**   F-35-R-22

Study No.: 668   **Title:** Guidelines for the interpretation of lake
                                                    surveys

Period Covered: April 1, 1996 to March 31, 1997

Study Objective: Relative to sampling fish in lake surveys, to: (1) evaluate gear selectivity and
    provide guidelines for the interpretation of fish catches; (2) develop standards for interpreting
    population and community attributes such as length-frequency, age-frequency, percent
    legal/acceptable size, CPE, percent species composition, etc.; (3) develop concepts and databases
    to facilitate comparison of key attributes among lakes statewide and among lakes of the same
    type; (4) develop, in conjunction with (2) and (3), guidelines for diagnosing fishery problems;
    (5) develop, if feasible, and IBI or a similar system for evaluating Michigan lakes which will
    serve as an indicator of environmental quality and change; and (6) guide application of the above
    as an interactive computer tool.

Summary: Gear selectivity by species and size was analyzed by selecting data sets from lakes with
    intensive population studies culminating in mark-recapture population estimates stratified by
    size groups. Catches for several gear types could then be compared to these "known" statistics
    to determine bias in estimating species composition of the community (% by number and
    weight) and length-frequency distribution. Most gear types tended to underestimate bluegill and
    yellow perch and to over-estimate pumpkinseed. Electrofishing (three types), seine, and
    toxicants obtained samples of the smallest fish but usually had peak efficiency at intermediate or
    large sizes. Trap nets with 1.5" mesh were strongly biased towards larger bluegill and
    pumpkinseed even though they could retain both intermediate and large sizes. Some seasonal
    variation in electrofishing catch was documented. Tentative guideline/recommendations were
    developed for the best times, gear, and locations to sample each species.

Job 1. Title: Gear selectivity.

Findings: Selectivity of fishing gear has both advantages and disadvantages. Advantages include
    concentrating relatively rare species or sizes so one can confirm their presence (note: absence is
    never confirmed). Disadvantages include a distorted view of true proportions—either by species
    or by size. The latter effects our perception of populations and communities and our ability to
    measure quantitative statistics such as predator-prey ratios and fraction of the population above
    legal size. Gear bias varies with gear type, season, and lake type.

Factors affecting catch

(a) Mesh size, which allows smaller fish to escape.

(b) Fish movement, which is essential for passive gear such as trap nets and gill nets.

(c) Fish abundance in the habitat and location being sampled. All gear types except gillnets sample the littoral zone best.

(d) Fish behavior around the gear.   Are they prone to enter nets ("structure") or avoid electric fields? Also, rate of escape from nets.

(e) Impediments to the gear, such as snags (seine), soft bottoms (trap and fyke nets), water conductivity (electrofishing).

(f) Design variations within a gear type, such as net dimensions, or AC versus DC electrofishing and power output.

(g) Time of day (night usually more effective), season (spawning concentrations) and temperature (influences activity).

(h) Operator skill or bias. Nets not set in the best site or orientation, or scappers on electrofishing boat either not seeing or collecting small fish which are stunned. However this can be an advantage when targeting certain species or sizes.

Data selection

Because no one gear–including toxicants–is completely unbiased, one of the best measures of the actual proportions of species and sizes in natural lakes (which cannot be drained and censused) is a mark-recapture estimate stratified by species and size group.

Consequently, I selected from my pre-existing data sets (Schneider 1971, 1973, 1990, 1991, 1995 and unpublished) those surveys which contained mark-recapture estimates and samples taken by several gear types. All the lakes were relatively small (<136 acres) and shallow (<33 feet). All but one (Jewett) contained typical communities dominated by bluegill and largemouth bass, but the bluegill populations ranged from stunted to excellent. The most intensive sampling was conducted in spring and fall.

Gear types considered

Standard trap nets.–As described in the survey manual (Merna et al. 1980), these nets have pots with 1.5-inch hearts and 2.5-inch stretched mesh. Pots are 3 feet by 5 feet. Nets are usually fished with a lead and are effective to a depth of about 20 feet. These nets will be abbreviated in this report as "1.5" T".

Small-mesh trap nets.–Nets as described above, but with ¾-inch stretched-mesh pots and 1.5-inch hearts. These were special-made for studies by Schneider. These nets are abbreviated in this report as "0.7" T".

Fyke nets.–Basically, these nets are as described by Merna et al (1980), but they have many variations in mesh size and dimensions. The one referred to here has a 1-inch stretched mesh in the pot, "1" F".

Small-mesh fyke nets.–Nets as described above with 3/8"-inch stretch mesh in pot, "0.4" F".

Seine.–In the late 1950's to mid-1960's, large, winch-drawn seines were used extensively. The one discussed in this report was 800 feet long, 15-20 feet deep, with 1-inch stretched mesh in the bag. Use was restricted to areas adjacent to a firm beach. It is abbreviated in this reports as "seine".

AC electrofishing gear.–This gear consisted of a 220-V AC, 3-phase generator, regulated to put out about 10 amps in hard water while mounted in a "boom shocker" boat. One or two people on the bow pick up individual stunned fish with scap nets. May be operated either day or night, but visibility is usually better at night.

DC electrofishing gear.–This gear consisted of a 240-V DC generator, regulated to put out variable power and pulse frequency while mounted in a "boom shocker' boat. Scap netters picked up individual stunned fish; used either day or night.

Rotenone.–One lake, Cassidy, was treated with sufficient rotenone to kill all fish after it had been sampled with traditional gear. The pick-up of dead fish was intensive, but even so, there was a tendency to recover a higher proportion of the large fish.

Antimycin A.–Several lakes were treated to "thin out" stunted bluegills. Relatively small samples of dead fish were picked up, and can be compared to samples by other gear types.

Bias in community composition

When sampling communities it is important to discover the presence/absence of all species and to obtain a snapshot of the proportion each species comprises of the total community. The proportions can be expressed on either a number or a weight basis. However, composition by number can be greatly distorted by sporadic catches of very abundant small fish, such as small bluegills. Since small fish have little biomass, community composition by weight is a more stable and meaningful statistic. Schneider (1981) gives guidelines for interpreting community quality on a weight basis.

Data on community composition have been compiled for 11 lakes to date (Appendices 1-6 and 11). Gear bias by species is summarized in Tables 1-7. Note that since the data are presented as a percentage of the total catch or estimate, gear selection for (or against) one species can influence the percentage of another species. The bluegill, the predominant species, has the dominant effect on relative percentage.

1.5″ T.–Catches from these trap nets tend to over-represent the numerical proportion of black crappie, bulkheads (especially yellow), northern pike (especially in early spring), and often pumpkinseed (Table 1). Bluegill, yellow perch, and all the small-bodied species (darters, minnows, pickerel) are usually under-represented. The picture on a weight basis is the same, with the addition of bowfin as oversampled (Table 2).

0.7″ T.–Small-mesh trap and fyke nets under-sampled bluegill, pumpkinseed and other sunfishes, and minnows (Table 3). Bullheads (especially yellow) were the only species over-sampled by either number or weight. Yellow perch (most of which are small-bodied) were sampled better in 0.7″ than in 1.5″ trapnets. Overall, the small mesh nets take fewer fish and are less efficient.

1″ seine.–Catches by the large seine had relatively low bias (Table 4). Bluegill were over-represented, the only gear with that bias. Yellow perch and minnows were undersampled

because many are small-sized. Bullheads were undersampled on a weight basis, probably because the seine passed over them.

Day AC.–Night catches were low for bluegill and high for pumpkinseed and largemouth bass (Table 5). But overall, night electrofishing gave a good picture of the fish community. Day AC electrofishing also under-sampled bluegill (especially on a weight basis) and over-sampled pumpkinseed, grass pickerel, bowfin and chubsucker (Table 6). Table 7 directly compares fish community composition for day and night AC shocker and shows CPUE was about twice as high during the night as during the day.

Electrofishing.–Catches by electrofishing were stratified according to night DC, night AC and day AC. Night catches were low for bluegill and high for pumpkinseed and largemouth bass (Table 5). But overall, night electrofishing gave a good picture of the fish community. Day AC electrofishing also under-sampled bluegill (especially on a weight basis) and over-sampled pumpkinseed, grass pickerel, bowfin and chubsucker (Table 6). Table 7 directly compares fish community composition for day and night AC shocker and shows CPUE was about twice as high during the night as during the day.

Toxicants.–Rotenone was used as a sampling tool at Cassidy Lake (Appendix 2). While all fish were killed, and extensive effort was made to recover as many fish as possible, there was still some bias in the community picture relative to the mark-recapture estimates. Bluegill and yellow perch were under-represented by both number and weight. Pumpkinseed, largemouth bass, bowfin and bullhead were slightly over-represented. Antimycin A was applied to six lakes in 1990. It was supposed to target small bluegills, yet the composition of the kill samples (relatively meager) indicates little species selection relative to electrofishing or trapnets (Tables 1 and 5).

Seasonal variation in species composition

Seasonal shifts in fish distribution and behavior could effect catches and the proportions of species in samples. One lake, Blueberry, was sampled frequently from April 27 to October 15, 1987 with day AC electrofishing (Table 8). The goal was to obtain fish for diet analysis, so sample sizes were relatively small. Catches may be compared to mark-recapture estimates made that spring. Bluegill were consistently under-sampled by both number and weight, especially during April and May. Yellow bullhead were often under-sampled. Pumpkinseed and chubsucker were consistently over-represented. Grass pickerel were over-represented during April. Catches of largemouth bass fluctuated daily with no clear pattern.

Bias in size structure

Each type of gear exhibited some size selectivity. None gave a completely representative picture of the size structure of a species population. Number of fish caught per size group per gear type were divided by the mark-recapture estimate for the size group, then multiplied by a constant (10,000) to give a whole number. Thus, the largest numbers in each column reflect relatively high catchability of size groups (and species). The data are in Appendices 7-10 and 12-13, and have been condensed in Tables 8-14 for the important species. Summarized there are the minimum size (inch group) likely to be captured at all, the peak size (if any) and the shape of the relationship: flat with no clear trend, increasing or decreasing catchability with increasing size, and dome shaped (low catchability within smallest and largest sizes).

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Bluegill.–Trap nets with 1.5" mesh catch some bluegill as small as 4 inches but have a strong selection towards larger sizes up through 8 inches (Table 9). Latta (1959) and Laarman and Ryckman (1980) had previously reported that bias. The advantage of this selectivity is it efficiently concentrates large bluegill so that their presence can be determined without sorting through thousands of small fish. This selectivity cannot be solely attributed to mesh size. Measurements indicate nets retain bluegill whose maximum body depth exceeds 90% of the stretched-mesh size. Converted to approximate lengths, the following stretched mesh sizes retain bluegills longer than lengths given: 1.25" > 3.5 inches; 1.5" > 4.0 inches; 2" >5.0 inches; and 2.5" > 6.0 inches. A bluegill size index (Schneider 1990) was developed to aid in interpreting the selectivity of 1.5" trap nets and two other types of gear. Field data indicate trap nets with 0.7" pots take bluegills as small as 2 inches and appear to be unbiased above 4 inches. Electrofishing can effectively sample bluegills as small as 1 inch and are relatively unbiased over 4 inches. Bias is most likely caused by personnel not collecting all of the smallest sizes and by larger bluegill being offshore in midsummer. Fyke nets with 1" mesh may catch a few small bluegill, but the peak catch seems to be about 7 inches. Fyke nets with 0.4" mesh are effective for 1-2 inch bluegills (but not larger sizes) based on results at one lake. The large seine took bluegill as small as 2 inches and was unbiased over a broad size range, 3-7 inches. The rotenone sample took all sizes but was biased toward larger bluegill.

Pumpkinseed.–Trap nets with 1.5" mesh have a size selectivity towards pumpkinseed like that of bluegill (Table 10). The minimum is 4 inches and efficiency increases with size through 8 inches. Trap nets with 0.7" mesh catch smaller pumpkinseeds but still have an upward bias. Electrofishing catches some small fish, and is relatively unbiased from 3-6 inches. Fyke nets and seines with 1" mesh, and rotenone, have an increasing bias above 3 inches in length.

Yellow perch.–Trap nets with 1.5" mesh are strongly biased towards large size and fail to sample small perch (Table 11). The traps with small mesh are less bias and extend the minimum size down to 4 inches, but in most lakes 2-3 inches (YOY) is the predominant size for perch. Electrofishing samples all sizes, but 5-7 inch fish are usually the peak. Samples by seine and rotenone contain small fish but there still seems to be an upward bias.

Black crappie.–Trap nets are a very effective gear for crappie generally, and for larger fish in particular (Table 12). Few crappie smaller than 5 inches (yearlings) are caught in either trap net mesh or by electrofishing or seine. However, electrofishing and seine have less size selectivity.

Largemouth bass.–Trapnets with 1.5" mesh catch bass as small as 7 inches and are relatively unbiased for bass over 10 inches (Table 13). Fyke nets with 1" mesh have a similar catch. The small-mesh trap and fyke nets are ineffective for bass generally, but catch the smallest sizes (2-4 inches) present. Electrofishing, seine, and rotenone catch the full range of sizes with minor bias. However, day electrofishing favors smaller fish (2-5 inches) than night electrofishing (6-14 inches).

Northern pike.–Trap nets catch a relatively unbiased sample of pike over about 14 inches (Table 14). The small mesh nets are less productive, however. The other gear types are capable of taking smaller pike, but generally the medium sizes predominate.

Walleye.–Walleye data for one lake were examined (Table 15). Trap nets with 1.5" mesh catch walleye as small as 8 inches, but are strongly selective for larger fish. Laarman and Ryckman (1980) noticed that in Manistee Lake also. Night electrofishing had a similar pattern in Jewett Lake, but would have taken smaller walleye if they had been present.

Best times and gear

A questionnaire was distributed to nine management biologists with considerable field experience in lake fish sampling. It asked for them to critique a set of tentative guidelines I had developed as to the best times, seasons, locations, and gear to sample each species of sport fish. The revised guidelines are in Table 16.

Job 2. Title: Develop standards.

Findings: Standards are needed for evaluating species populations and communities. As a first step, the important population and community indications, and their significance, were outlined (Table 17).

Job 3. Title: Develop IBI.

Findings: Some pertinent life history information and a tentative organizational scheme were developed. Results will be presented in the next report.

Job 4. Title: Prepare reports.

Findings: This progress report was prepared.

Literature Cited:

Laarman, Percy W. and J. R. Ryckman. 1980. Size selectivity of trapnets for eight species of fish. Michigan Department of Natural Resources Fisheries Research Report 1880.

Latta, William C. 1959. Significance of trap-net selectivity in estimating fish population statistics. Papers Michigan Academy of Science, Arts and Letters 44:123-138.

Merna, J. W. et al. 1980. A manual of fishery survey methods. Michigan Department of Natural Resources Fish Management Report No. 9.

Schneider, James C. 1995. Dynamics of a bluegill, walleyes, and yellow perch community Michigan Department of Natural Resources Fisheries Research Report 2020.

Schneider, James C. 1991. Dynamics of good bluegill populations in two lakes with dense vegetation. Michigan Department of Natural Resources Fisheries Research Report 1991.

Schneider, James C. 1990. Classifying bluegill populations from lake survey data. Michigan Department of Natural Resources Technical Report 90-10.

Schneider, James C. 1971. Characteristics of a population of warmwater fish in a southern Michigan Lake, 1964-1969. Michigan Department of Natural Resources Fisheries Research Report 1777.

Schneider, James C. 1973. The fish population of Casey Lake, Washtenaw County. Michigan Department of Natural Resources Fisheries Research Report 1792.

Schneider, James C. 1981. Fish communities in warmwater lakes. Michigan Department of Natural Resources Fisheries Research Report 1890.

Table 1.–Summary of species selectivity of 1.5" trap net, based on percent by number, relative to the best reference data. ok = within 5% of reference; low = <5% or tr; high = >5%; 0 = not caught but present; -o = taken by gear but not antimycin.

| Species | Reference: mark-recapture and known presence | | | | | Reference: antimycin partials in 1990 | | | | | | |
	Blueberry s1987	Cassidy s1964	Dead s1984	Dead s1985	**Pattern**	Williams	Lake 14	Island	Myers	Big	Horseshoe	**Pattern**
Bluegill	ok	high	high	v. low	**varies**	low	low	low	ok	low	low	**low**
Pumpkinseed	low	high	low	low	**varies**	high	ok	high	high	ok	low	**high**
Yellow perch	ok	v. low	v. low	v. low	**low**	0	0		0	0	0	**0**
Rock bass		ok			**ok**			-o	0	-o		**ok**
Black crappie		ok	high	high	**high**	low	high	high	high		high	**high**
Largemouth bass	ok	ok	ok	ok	**ok**	ok	-o	-o	-o	ok	ok	**ok**
Northern pike			ok	high	**high**		-o			-o	-o	**high**
Muskellunge										-o		**high**
Brown bullhead [a]		ok	ok	high	**ok**		0	-o	-o	high	high	**high**
Yellow bullhead	high	ok	high	high	**high**							
Warmouth			ok	ok	**ok**	low	ok	0		0	ok	**ok**
Green sunfish	0	ok	0	0	**0**		0	0	0	0	0	**low**
Longear sunfish			0	0	**0**						0	**low**
Grass pickerel	ok	0	ok	0	**low**	0	0	-o		0		**low**
Chubsucker	low	ok	low	ok	**ok**	ok	-o		-o	0	-o	**ok**
Bowfin		ok	ok	ok	**ok**	-o	-o			high	-o	**high**
Carp							-o			high	0	**ok**
Golden shiner	ok	0	0	0	**low**	0	low				0	**low**
White sucker		0			**low**			-o		-o	-o	**ok**
Iowa darter	0		0	0	**0**				0			**0**
Johnny darter								0				**0**
Banded killifish		0			**0**							
Brook silverside			0	0	**0**							
Bluntnose minnow	0	0	0	0	**0**			0		0		**0**
Fathead minnow	0		0	0	**0**				0			**0**
Blackchin shiner	0	0	0	0	**0**				0			**0**
Blacknose shiner		0			**0**							
Mudminnow							0			0	0	**0**

[a] Includes all species of bullhead for antimycin lakes.

Table 2.–Summary of species selectivity of 1.5" trap net, based on percent by weight, relative to mark-recapture estimates and known presence.

ok = within 5% of reference; low = <5% or tr; high = >5%; 0 = not caught but present.

Species	Blueberry s1987	Cassidy s1964	Dead s1984	Dead s1985	Mill f1964	**Pattern**
Bluegill	low	ok	low	v. low	v. low	**low**
Pumpkinseed	ok	high	low	low	ok	**varies**
Yellow perch	ok	low	ok	low	low	**low**
Rock bass		ok			ok	**ok**
Black crappie		ok	ok	high	high	**high**
Largemouth bass	low	ok	ok	ok	high	**ok**
Northern pike			high	high	high	**high**
Brown bullhead		ok	high	ok	ok	**ok**
Yellow bullhead	v. high	ok	high	high	ok	**high**
Warmouth			ok	ok	ok	**ok**
Green sunfish	0	ok	0	0	0	**low**
Longear sunfish			0	0		**low**
Grass pickerel	ok	0	ok	0	0	**low**
Chubsucker	ok	ok	ok	ok	ok	**ok**
Bowfin		high	low	high	v. high	**high**
Golden shiner	ok	ok	0	0	0	**low**
White sucker		ok			ok	**ok**
Iowa darter	0		0	0		**0**
Banded killifish		0				**0**
Brook silverside			0	0		**0**
Bluntnose minnow	0	0	0	0		**0**
Fathead minnow	0		0	0		**0**
Blackchin shiner	0	0				**0**
Blacknose shiner		0				**0**

Table 3.–Summary of species selectivity (%) of 0.7" mesh trap nets[a] relative to mark-recapture estimate and known presence.

ok = within 5% of reference; low = <5% or tr; high = >5%; 0 = not caught but present.

Species	By number				By weight					
	Blueberry s1987	Dead s1984	Dead s1985	**Pattern**	Blueberry s1987	Dead s1984	Dead s1985	Wakeley[a] s1987	Jewett 1992	**Pattern**
Bluegill	v. low	ok	v. low	**low**	v. low	v. low	v. low	v. low	ok	**v. low**
Pumpkinseed	low	low	low	**low**	low	low	ok	ok		**low+**
Yellow perch	ok	low	high	**varies**	ok	ok	ok	ok	ok	**ok**
Rock bass								ok		
Black crappie		ok	ok	**ok**		ok	ok			**ok**
Largemouth bass	low	ok	ok	**ok**	low	low	ok	low		**low**
Northern pike		ok	ok	**ok**		low	ok	low		**low**
Walleye									low	**low**
Brown bullhead		ok	ok	**ok**		high	ok	v. high		**high**
Yellow bullhead	v. high	v. high	high	**v. high**	v. high	v. high	high	high		**v. high**
Warmouth		ok	ok	**ok**		ok	ok			**ok**
Green sunfish	ok	0	0	**low**	ok	0	0			**low**
Longear sunfish		0	0	**low**		ok	0			**low**
Grass pickerel	ok	0	0	**low**	ok	0	0			**low**
Chubsucker	ok	ok	ok	**ok**	ok	ok	ok			**ok**
Bowfin		ok	ok	**ok**		low	high			**ok?**
Golden shiner	0	ok	ok	**low**	0	ok	ok	ok		**ok**
Iowa darter	0	0	ok	**low**	0	0	ok			**low**
Brook silverside		0	0	**0**		0	0			**0**
Bluntnose minnow	0	0	0	**0**	0	0	0			**0**
Fathead minnow	0	0	0	**0**	0	0	0			**0**
Blackchin shiner	0			**0**	0					**0**

[a] Wakeley data for 0.4" fyke nets.

Table 4.–Summary of species selectivity (%) of 1" mesh seine relative to mark-recapture estimates and known presence.

ok = within 5% of reference; low = <5% or tr; high = >5%; 0 = not caught but present.

Species	By number		By weight		
	Cassidy s1964	**Pattern**	Mill f1964	Cassidy s1964	**Pattern**
Bluegill	high	**high**	high	high	**high**
Pumpkinseed	ok	**ok**	ok	ok	**ok**
Yellow perch	low	**low**	ok	low	**low+**
Rock bass	ok	**ok**	0	ok	**ok**
Black crappie	ok	**ok**	ok	ok	**ok**
Largemouth bass	ok	**ok**	ok	high	**ok**
Northern pike			ok		**ok**
Brown bullhead	ok	**ok**	0	low	**low**
Yellow bullhead	ok	**ok**	0	low	**low**
Warmouth			ok		**ok**
Green sunfish	ok	**ok**	ok	ok	**ok**
Grass pickerel	ok	**ok**	ok	ok	**ok**
Chubsucker	ok	**ok**	ok	ok	**ok**
Bowfin	ok	**ok**	0	ok	**low**
Golden shiner	0	**0**	0	0	**0**
White sucker	0	**0**	0	0	**low**
Banded killifish	0	**0**		0	**0**
Bluntnose minnow	0	**0**		0	**0**
Blacknose shiner	0	**0**		0	**0**
Blackchin shiner	0	**0**		0	**0**

Table 5.–Summary of species selectivity of night electrofishing (AC or DC), based on percent by number, relative to the best reference data. ok = within 5% of reference; low = <5% or tr; high = >5%; 0 = not caught but present; -o = taken by gear but not antimycin.

| | Reference: mark-recapture and known presence | | | | | | Reference: antimycin partials in 1990 | | | | | | |
Species	Blueberry s1987	Dead s1984	Dead s1985	Mill f1964	Wakeley 1987	**Pattern**	Williams	Lake 14	Island	Myers	Big	Horseshoe	**Pattern**
Bluegill	low	low	low	low	low	**low**	low	low	low	high	low	low	**low**
Pumpkinseed	high	high	high	ok	high	**high**	ok	ok	high	low	high	high	**high**
Yellow perch	ok	low	ok	ok	ok	**ok**	-o	high			ok	ok	**ok**
Rock bass				ok	ok	**ok**			-o	0			**ok**
Black crappie		ok	ok	ok		**ok**	low	-o	0	-o	-o	-o	**ok**
Largemouth bass	high	ok	ok	high	high	**high**	ok	-o	-o	-o	ok	ok	**ok**
Northern pike		ok	ok	ok	ok	**ok**				-o	-o		**ok**
Brown bullhead [a]		0	ok	ok	ok	**ok**		high		-o	ok	-o	**ok**
Yellow bullhead	ok	ok	ok	ok	ok	**ok**							
Warmouth		ok	ok	ok		**ok**	low	ok	ok		0	ok	**ok**
Green sunfish	ok	ok	ok	ok		**ok**		0	ok	0	ok	0	**ok**
Longear sunfish		ok	ok			**ok**					-o		
Grass pickerel	ok	ok	ok	ok		**ok**	ok	ok	-o		ok	0	**ok**
Chubsucker	high	ok	ok	ok		**ok**	high	-o		-o	ok		**ok**
Bowfin		ok	ok	ok		**ok**	-o	-o			-o		**ok**
Carp								-o			-o	0	**ok**
Longnose gar							-o						**ok**
Golden shiner	ok	ok	ok	ok	ok	**ok**	0	ok			-o	0	**ok**
White sucker				0						-o			**ok**
Iowa darter	0	ok	0			**ok**				0			**low**
Johnny darter									0				**low**
Brook silverside		ok	0			**ok**							
Bluntnose minnow	0	ok	ok			**ok**			ok		ok		**ok**
Fathead minnow	0	ok	0			**ok**				0			**low**
Blackchin shiner	0					**ok**				0			**low**
Blacknose shiner											-o		**low**
Mudminnow								0			0	0	**low**

[a] Includes all species of bullhead for antimycin lakes.

Table 6.–Summary of species selectivity (%) of day electrofishing (AC) relative to mark-recapture and known presence.

ok = within 5% of reference; low = <5% or tr; high = >5%; 0 = not caught but present.

| | By number | | | By weight | | | |
Species	Blueberry s1987	Dead s1985	**Pattern**	Blueberry s1987	Dead s1985	Mill f1964	**Pattern**
Bluegill	v. low	low	**low**	low	v. low	v. low	**v. low**
Pumpkinseed	high	high	**high**	high	high	high	**high**
Yellow perch	ok	low	**ok**	ok	ok	low	**ok**
Rock bass						ok	**ok**
Black crappie		ok	**ok**		ok	ok	**ok**
Largemouth bass	ok	ok	**ok**	ok	ok	ok	**ok**
Northern pike		ok	**ok**		ok	0	**low**
Brown bullhead		ok	**ok**		low	low	**low**
Yellow bullhead	ok	ok	**ok**	ok	ok	0	**ok**
Warmouth		ok	**ok**		ok	ok	**ok**
Green sunfish	0	ok	**ok**	ok	ok	0	**ok**
Longear sunfish		ok	**ok**		ok		**ok**
Grass pickerel	high	ok	**high**	high	ok	ok	**ok+**
Chubsucker	high	ok	**ok+**	high	ok	high	**high**
Bowfin		ok	**ok**		high	v. high	**high**
Golden shiner	ok	ok	**ok**	ok	ok	ok	**ok**
White sucker						ok	**ok**
Iowa darter	0	0	**low**	0	0		**low**
Brook silverside		0	**low**		0		**low**
Bluntnose minnow	0	ok	**low**	0	ok		**low**
Fathead minnow	0	0	**low**	0	0		**low**
Blackchin shiner	ok	0	**low**	0			**low**
Blacknose shiner		ok	**low**				

Table 7.–Comparison of fish community composition (% by number) of day (DAC) and night (NAC) electrofishing samples at three lakes.

Species	Dead, May 1985		Mill, September 1964		Blueberry, April-May 1987	
	NAC	DAC	NAC	DAC	NAC	DAC
Bluegill	43	51	61	46	20	17
Pumpkinseed	26	30	8	21	35	35
Yellow perch	18	9	16	5	4	3
Largemouth bass	5	2	6	13	14	8
Northern pike	tr	+	tr	*		
Black crappie	tr	tr	3	2		
Yellow bullhead	tr	+	1	*	2	tr
Brown bullhead	*	*	1	tr		
Warmouth	1	1	2	tr		
Grass pickerel	tr	tr	tr	1	10	15
Bowfin	1	1	tr	2		
Lake chubsucker	4	3	3	9	15	20
Golden shiner	1	tr	*	*	tr	1
Bluntnose minnow	tr	tr	*	*	*	*
Brook silverside	*	*				
Mudminnow	*	*	*	*		
Longear sunfish	tr	1	*			
Green sunfish	1	tr		*	1	tr
Iowa darter	*	*	*	*		
Fathead minnow		*				
Rock bass			tr	tr		
White sucker			*	tr		
Number of fish	2900	2905	6402	813	1159	1594
Catch/hour		145	297	108		73

* Not collected but known or believed to be present in lake.

Table 8.–Daily and monthly variation in species composition (%) by daylight electrofishing at Blueberry Lake during 1987 compared to mark-recapture (M-R) estimates for spring 1987 and electrofishing average. tr = trace = <0.5%. + = present.

Species	M-R	Average	27-Apr	29-Apr	30-Apr	1-May	11-May	12-May	13-May	14-May	15-Jun	16-Jul	19-Aug	16-Sep	15-Oct
Percent by number															
Bluegill	58	24	16	19	19	11	17	16	17	20	47	40	25	30	35
Pumpkinseed	16	31	36	34	34	25	42	40	35	43	19	15	29	29	22
Lake chubsucker	9	17	21	20	18	30	15	17	24	14	4	22	14	16	10
Grass pickerel	5	11	21	16	21	14	6	14	10	7	6	5	7	5	5
Largemouth bass	5	9	5	9	8	11	14	7	10	4	11	9	11	11	9
Yellow perch	4	5	0	2	tr	7	4	4	5	7	11	3	8	4	6
Yellow bullhead	3	1	0	0	1	1	1	0	0	1	2	4	2	0	0
Green sunfish	1	tr	0	0	0	1	0	tr	0	4	0	0	0	0	0
Golden shiner	tr	2	1	1	0	0	1	1	tr	1	0	3	5	5	5
Blackchin shiner	+	1	0	0	0	0	0	0	0	0	0	0	0	0	9
Iowa darter	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bluntnose minnow	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number in sample	16,118	–	180	315	258	177	79	256	243	86	47	78	134	98	116
Percent by weight															
Bluegill	59	18	1	4	4	6	11	14	9	24	45	40	21	16	34
Pumpkinseed	12	27	34	34	25	16	24	41	33	38	9	10	27	36	27
Lake chubsucker	7	26	43	25	39	49	15	25	32	17	1	30	20	23	15
Grass pickerel	3	8	18	13	19	12	5	10	3	4	5	2	4	5	6
Largemouth bass	9	12	3	20	12	5	40	4	19	6	11	1	16	12	10
Yellow perch	6	5	0	5	0	7	2	4	4	5	21	4	7	8	6
Yellow bullhead	5	2	0	0	1	1	2	0	0	2	8	13	4	0	0
Green sunfish	tr	1	0	0	0	3	0	1	0	4	0	0	0	0	0
Golden shiner	tr	tr	tr	tr	0	0	2	tr	tr	tr	0	tr	1	1	1
Blackchin shiner	+	0	0	0	0	0	0	0	0	0	0	0	0	0	tr
Iowa darter	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bluntnose minnow	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9.–Summary of gear size selectivity (inches) for bluegill.

Lake	Charac-teristic	1.5" T [a]	0.7" T [b]	NAC [c]	DAC [d]	NDC [e]	1"F [f]	0.4"F [g]	Seine [h]	Rotenone [i]
Blueberry s1987	Min	4	3	1	1					
	Peak	7+	4	4	3					
	Shape	increase	dome	dome	dome					
Cassidy s1964	Min	4							2	1
	Peak	8+							8+	8+
	Shape	increase							flat 4-7	increase
Dead s1984	Min	5	2	2						
	Peak	9+	9-Jul	4						
	Shape	increase	increase	dome						
Dead s1985	Min	5	2	2						
	Peak	7	5-6	4-6						
	Shape	dome	dome	sl dome						
Jewett f1992	Min	3	2	2						
	Peak	7	4	5						
	Shape	sl dome	sl dome	dome						
Mill f1964	Min	4		2	2				2	
	Peak	7+		6-7	5				7	
	Shape	increase		increase	dome				flat 3-7	
Wakeley s1987	Min					1	2	1		
	Peak					3-4	7	2		
	Shape					?	?	?		
Summary	Min	4-5	2-3	1-2	1-2	1	2	1	2	1
	Peak	7+	4+	4-6	4+	3-4	7	2	7+	8+
	Shape	increase	flat	dome	dome	?	?	?	flat 3-7	increase

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.
[d] Day electrofishing with 220-V AC boom shocker.
[e] Night electrofishing with 240-V DC boom shocker.
[f] Fyke nets with 1.0" stretched-mesh pots.
[g] Fyke nets with 0.4" stretched-mesh pots.
[h] Seine 800 feet long with bag of 1" stretched mesh.
[i] Total rotenone treatment followed by pickup.

Table 10.–Summary of gear size selectivity (inches) for pumpkinseed.

Lake	Charac-teristic	1.5" T [a]	0.7" T [b]	NAC [c]	DAC [d]	NDC [e]	1"F [f]	0.4"F [g]	Seine [h]	Rotenone [i]
Blueberry	Min	5	3	2	2					
s1987	Peak	8+	7	2	4-5					
	Shape	increase	increase	decrease	dome					
Cassidy	Min	4							3	3
s1964	Peak	8+							8+	8+
	Shape	increase							increase	increase
Dead	Min	5	4	2						
s1984	Peak	7+	7+	4-8						
	Shape	increase	increase	flat						
Dead	Min	5	2	2	2					
s1985	Peak	7+	7+	4-6	3-5					
	Shape	increase	flat?	dome	dome					
Mill	Min	4		2	2					
f1964	Peak	7+		6+	5					
	Shape	increase		increase	dome					
Wakeley	Min					2	3	2		
s1987	Peak					3 & 7	8	3 & 7		
	Shape					?	increase	?		
Summary	Min	4-5	2-3	2	2	2	3	2	3	3
	Peak	7+	7+	4-6	3-5	3 & 7	8	3 & 7	8+	8+
	Shape	increase	sl increase	dome	dome	?	increase	?	increase	increase

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.
[d] Day electrofishing with 220-V AC boom shocker.
[e] Night electrofishing with 240-V DC boom shocker.
[f] Fyke nets with 1.0" stretched-mesh pots.
[g] Fyke nets with 0.4" stretched-mesh pots.
[h] Seine 800 feet long with bag of 1" stretched mesh.
[i] Total rotenone treatment followed by pickup (biased towards most visible fish).

Table 11.–Summary of gear size selectivity (inches) for yellow perch.

Lake	Charac-teristic	1.5" T [a]	0.7" T [b]	NAC [c]	DAC [d]	Seine [h]	Rotenone [i]
Blueberry	Min	5-7	5-7	5-7	5-7		
s1987	Peak	10+	5-7	5-7	5-7		
	Shape	increase	flat	flat	flat		
Cassidy	Min	7				3	3
s1964	Peak	10+				7	8+
	Shape	increase				increase	increase
Dead	Min	–	7+	2			
s1984	Peak	–	–	7+			
	Shape	–	?	increase			
Dead	Min	7	3	2	2		
s1985	Peak	–	7+	7+	7+		
	Shape	?	increase	increase	flat		
Jewett	Min	5	4	2			
f1992	Peak	8+	4-8	4			
	Shape	increase	flat	?			
Jewett	Min	6	4	2			
f1983	Peak	9+	4	5			
	Shape	increase	decrease	dome			
Mill	Min	7		4	4	4	
f1964	Peak	7-8		8+	6	4 & 7+	
	Shape	flat		increase	incre ?	?	
Summary	Min	5-7	4	2	2-4	3	3
	Peak	7+	4-8	5-7	5-7	4-7	8+
	Shape	increase	?	increase	flat	increase	increase

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.
[d] Day electrofishing with 220-V AC boom shocker.
[h] Seine 800 feet long with bag of 1" stretched mesh.
[i] Total rotenone treatment followed by pickup (biased towards most visible fish).

Table 12.–Summary of gear size selectivity (inches) for black crappie.

Lake	Characteristic	1.5" T [a]	0.7" T [b]	NAC [c]	DAC [d]	Seine [h]
Dead s1984	Min	5	5	5		
	Peak	11	–	–		
	Shape	increase	–	–		
Dead s1985	Min	5	5	–	5	
	Peak	10-12	8-9	–	8-9	
	Shape	increase	–	–	–	
Mill f1964	Min	5		5	5	5
	Peak	6		7-8	9	7
	Shape	dome		flat	flat?	flat?
Summary	Min	5	5	5	5	5
	Peak	6+	8-9	7-8	9	7
	Shape	increase ?	?	flat	flat?	flat?

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.
[d] Day electrofishing with 220-V AC boom shocker.
[h] Seine 800 feet long with bag of 1" stretched mesh.

Table 13.–Summary of gear size selectivity (inches) for largemouth bass.

Lake	Charac-teristic	1.5" T [a]	0.7" T [b]	NAC [c]	DAC [d]	NDC [e]	1" F [f]	0.4" F [g]	Seine [h]	Rotenone [i]
Blueberry	Min	6-9	2-5	2-5	2-5					
s1987	Peak	10+	–	6-11	2-5					
	Shape	dome?	–	sl. dome	flat?					
Cassidy	Min	7							3	3
s1964	Peak	10+							3	3-9
	Shape	increase							flat	flat
Dead	Min	10	–	2-4						
s1984	Peak	10+	–	5-14						
	Shape	flat	–	sl dome						
Dead	Min	5-9	2-4	2-4	2-4					
s1985	Peak	15+	–	5-11	2-4					
	Shape	increase	–	dome	flat?					
Mill	Min	6-9		2	2				3	
f1964	Peak	12+		6-11	2-5				6-11	
	Shape	increase		sl dome	decrease				flat	
Wakeley	Min					3	10	3		
s1987	Peak					12-14	12-15	–		
	Shape					sl dome	dome	flat?		
Summary	Min	7-10	2-4	2	2	3	10	3	3	3
	Peak	10+	–	6-11	2-5	12-14	12-15	–	6-11	3-9
	Shape	sl incre	–	sl dome	flat?	sl dome	dome	flat?	flat	flat

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.
[d] Day electrofishing with 220-V AC boom shocker.
[e] Night electrofishing with 240-V DC boom shocker.
[f] Fyke nets with 1.0" stretched-mesh pots.
[g] Fyke nets with 0.4" stretched-mesh pots.
[h] Seine 800 feet long with bag of 1" stretched mesh.
[i] Total rotenone treatment followed by pickup (biased towards most visible fish).

Table 14.-- Summary of gear size selectivity (inches) for northern pike.

Lake	Charac-teristic	1.5" T [a]	0.7" T [b]	NAC [c]	DAC [d]	NDC [e]	1" F [f]	0.4" F [g]
Dead s1984	Min	13-15	16-19	16-19				
	Peak	20-23	–	24+				
	Shape	dome	–	?				
Dead s1985	Min	16-19	16-19	16-19	20-23			
	Peak	16-24+	–	24+	–			
	Shape	flat	–	increase	–			
Wakeley s1987	Min					6-12	16-19	6-12
	Peak					20-23	20-23	13-24+
	Shape					dome	dome	flat
Summary	Min	13-15	16-19	16-19	20-23	6-12	16-19	6-12
	Peak	16-24+	–	24+	–	20-23	20-23	13-24+
	Shape	flat?	–	increase	–	dome	dome	flat

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.
[d] Day electrofishing with 220-V AC boom shocker.
[e] Night electrofishing with 240-V DC boom shocker.
[f] Fyke nets with 1.0" stretched-mesh pots.
[g] Fyke nets with 0.4" stretched-mesh pots.

Table 15.–Summary of gear size selectivity (inches) for walleye.

Lake	Characteristic	1.5" T [a]	0.7" T [b]	NAC [c]
Jewett	Min	8-9	12-13	10-11
f1992	Peak	18+	–	16+
	Shape	increase	–	increase

[a] Trap nets with 1.5" stretched-mesh pots.
[b] Trap nets with 0.7" stretched-mesh pots.
[c] Night electrofishing with 220-V AC boom shocker.

Table 16.–Summary of results of questionnaire to management biologists giving generally good times (best in bold), locations, and gear to sample lake fish populations.

T = trap net; F = fyke net; sm = smallmesh; G = gillnet; EN = electroshocker,night; ED = electroshocker, day; HL = hook & line; S = seine; Lit = littoral; shoal = hard substrates; ther = thermocline; veg = macrophytes

Species, Size	Season and approximate temperature (F)							
	Ice-out 32-40°	After ice-out 40-50°	Spring,early 55-65°	Spring,late 65-75°	Summer 75-62°	Fall,early 62-50°	Fall,late 50-40°	Winter 39-32°
Northern Pike								
Adult	**spawn marsh,inlet T,F**,G,EN	lit T,F,G				lit T,F	lit T,F,G	under ice G
Juvenile	[1]	lit G				veg EN		
White sucker								
Adult		**spawn shoal, inlet,outlet T,F**,G	sublit G,T	sublit G,T		lit, sublit T,F,G,EN		
Juvenile	[1]			lit EN,S	lit S	lit EN		
Walleye								
Adult		**spawn shoal,inlet T,F,EN**,G,ED	lit, sublit T,F,G	lit, sublit T,F,G		lit, sublit T,F,G		
Juvenile	[1]		shoal EN		shoal S,EN	**shoal** [2] **EN**,S,smF		
Smelt								
Adult		**spawn inlet,shoal S**,EN						pelagic HL
Juvenile								
Musky								
Adult		**spawn veg,inlet T,F**,G	lit T,F			lit T,F,EN		
Juvenile	[1]						**woody debris EN**	
Yellow perch								
Adult		**pre & spawn veg,shoal T,F,G,EN**	lit, sublit G,T,F		ther G	lit, sublit G,T,F,EN		
Juvenile	[1]		lit EN	lit EN,S	lit S	**lit EN**,smF		

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Table 16.–Continued.

Species, Size	Ice-out 32-40°	After ice-out 40-50°	Spring,early 55-65°	Spring,late 65-75°	Summer 75-62°	Fall,early 62-50°	Fall,late 50-40°	Winter 39-32°
Chubsucker								
Adult			**spawn** **lit** **T,F,G,ED,EN**	lit T,F,G,ED,EN		lit ED,EN		
Juvenile			lit ED,EN			lit ED,EN		
Bowfin								
Adult		lit T,F	**spawn** **lit** **T,F**	lit T,F				
Juvenile					lit ?EN			
Sturgeon								
Adult			**spawn** **river,shoal** **ED,T,F,G**	postspawn river ED	sublit G			
Juvenile			[1]	sublit smG	sublit smG			
Smallmouth bass								
Adult		lit T,F	**prespawn** **lit** **EN,T,F**	sublit G,T,F,HL		lit, sublit T,F,EN,G,ED	sublit G	
Juvenile			lit EN	lit EN	lit EN,S	**lit** **EN,ED**		
Largemouth bass								
Adult	warm bays T,F		**prespawn** **lit** **EN,T,F**	lit EN,T,F,HL	lit EN,HL	lit EN,T,F	lit T,F	
Juvenile			lit EN,ED	lit EN	lit EN,S	**lit** **EN,ED**		
Black crappie								
Adult		lit sublit T,F	**prespawn** **sublit** **T,F,G**			lit sublit T,F,G		
Juvenile			sublit smF,T,G			lit EN		
Carp								
Adult			prespawn lit T,EN,F,G	spawn lit F,T,G,ED				
Juvenile				lit EN,S		lit smF		

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Table 16.–Continued.

Species, Size	Ice-out 32-40°	After ice-out 40-50°	Spring,early 55-65°	Spring,late 65-75°	Summer 75-62°	Fall,early 62-50°	Fall,late 50-40°	Winter 39-32°
				Season and approximate temperature (F)				
Gar								
Adult			**prespawn** **lit** **T,G**	spawn lit,inlet T,G,ED				
Juvenile								
Redear								
Adult			**prespawn** **lit,sublit** **T,F**	**spawn** lit T,F,EN				
Juvenile								
Bullhead, brown & yellow								
Adult		**lit** [2] **T,F**	**lit,** **sublit** **T,F**	**spawn** **lit** **T,F**	lit,sublit T,F,G	lit, sublit T,F		
Juvenile								
Warmouth								
Adult			lit T,F,EN	spawn lit T,F,EN		lit EN		
Juvenile			lit EN,ED	lit EN,ED		lit EN		
Rock bass								
Adult			lit T,F	spawn lit T,F	lit,sublit T,F	lit T,F,EN		
Juvenile					lit S	lit smF,EN		
Bluegill								
Adult		**lit** [3] **T,F**	lit, sublit T,F	**spawn** **lit** **T,F,EN**,ED,HL		lit sublit T,F,EN		
Juvenile			lit S,EN,ED	lit **S,EN,ED,smF**	lit S,EN	lit EN,smF,S		
Pumpkinseed								
Adult		**lit** [3] **T,F**	lit T,F,EN	**spawn** **lit** **T,F,EN,ED**		lit T,F,EN		
Juvenile			lit S,EN,ED	lit S,EN,ED,smF	lit S,EN	lit EN,ED,smF		

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Table 16.–Continued.

Species, Size	Season and approximate temperature (F)							
	Ice-out 32-40º	After ice-out 40-50º	Spring,early 55-65º	Spring,late 65-75º	Summer 75-62º	Fall,early 62-50º	Fall,late 50-40º	Winter 39-32º
Grass pickerel								
Adult		spawn marsh,inlet **ED**,EN	lit **ED**,EN	lit **ED**,EN		lit ED,EN		
Juvenile			lit ED,EN	lit ED,EN	lit S	lit ED,EN		
Minnows								
Adult				lit S,ED,smF	lit S,ED,smF	lit EN		
Juvenile				lit S	lit S	lit EN		
Rainbow trout								
Adult		**spawn,springs, inlet,outlet G,F,T,ED**	lit G		ther G,HL	**lit G,EN**,F,T	lit G,EN,F,T	
Juvenile		[1]			inlet,outlet ED	**inlet,outlet ED**		
Brown trout								
Adult		lit G,T,F	lit G			**spawn,springs, inlet,outlet G,T,F,ED,EN**	lit G,T,F	
Juvenile					inlet,outlet ED	**inlet,outlet ED**		
Brook trout								
Adult		lit G,T,F			ther G,HL	**spawn,springs, inlet,outlet G,T,F,ED,EN**	lit G,EN,T,F	
Juvenile					inlet,outlet ED	**inlet,outlet ED**		
Whitefish								
Adult			sublit G,T	ther,bottom G	ther,bottom G	sublit G,T	**spawn shoal T,G**	
Juvenile							[1]	

Table 16.–Continued.

Species, Size	Season and approximate temperature (F)							
	Ice-out 32-40º	After ice-out 40-50º	Spring,early 55-65º	Spring,late 65-75º	Summer 75-62º	Fall,early 62-50º	Fall,late 50-40º	Winter 39-32º
Lake herring								
Adult							**spawn shoal**	
	pelagic G,T				ther G		**G,T**	
Juvenile	pelagic smG				ther smG		[1]	
Lake trout								
Adult						lit, sublit	**spawn shoal**	
		sublit G,T	sublit G,T	ther,bottom G	ther,bottom G	sublit G,T,F	**T,F,G**	
Juvenile							[1]	
						?smG		

[1] Some large juveniles (subadults) may accompany the spawning run.
[2] Juvenile walleye may be effectively sampled at temperatures as high as 70ºF.
[3] Especially lakes in southern Michigan.

Table 17.–Possible indicators of important characteristics of fish populations and communities and their interpretation.

A. Population level:

1. Individual size range–Can be detected with high bias gear and small sample size.
   Big fish present–Fishable; growth and total mortality not high.
   Medium fish present–Recruits for fishery, even reproduction.
   Small fish present–Recent reproduction.

   In combination, all three indicate uniformity of reproduction/recruitment.

2. Size frequency–Requires large sample and unbiased or corrected distribution, or standard gear plus expectations. A better measure of recruitment and potential fishing quality.
   Large predominate–Potential fishing quality is high.
   Small predominate–Possible stunting, over-fishing, community imbalance, food
       limitation.

3. CPUE–Requires standard effort, index sites and season. Indicates both abundance and catchability.

4. Age Frequency–Requires unbiased or corrected distribution. Indicates recruitment and mortality patterns.

5. Growth–Requires relatively unbiased sampling. Growth rate, and to a lesser extent mortality, shape size frequency. Populations with average or better growth will have large fish unless mortality is unusual.

B. Community level:

1. Presence/absence–Requires targeted gear suitable for all species likely to be present.
2. Species–
       Types available to fishery.
       Suggests food chains.
       Indicates habitat types present (temperature, oxygen, pH, etc.).
3. Rare species–need protection.
4. Diversity–
       Complex interactions are likely.
       Variety of habitats are available.
       Stability implied.
       Total productivity relatively high.
5. Relative composition–Requires unbiased or corrected gear, or standard gear plus expectation.
   Measures are percent by number or weight.
       a. Predator/prey ratio (desire >20% by weight)
       b. % panfish (desire <78% by weight)
       c. % sucker and carp (desire <50%)
       d. % chubsucker and golden shiner (desire <15%)
       e. Winterkill indicators

Appendix 1.–Fish community species composition (%) for four types of gear fished in Blueberry Lake, spring 1987, as compared to mark-recapture estimates.

Species	M-R [a]	1.5" Trap [b]	0.7" Trap [c]	DAC [d]	NAC [e]
Percent by number					
Bluegill	58	53	9	17	20
Pumpkinseed	16	9	10	35	35
Lake chubsucker	9	2	11	20	15
Grass pickerel	5	1	8	15	10
Largemouth bass	5	1	tr	8	14
Yellow perch	4	7	4	3	4
Yellow bullhead	3	26	58	tr	2
Green sunfish	1	0	1	0	1
Golden shiner	tr	1	0	1	tr
Blackchin shiner	+	0	0	0	0
Iowa darter	+	0	0	0	0
Bluntnose minnow	+	0	0	0	0
Fathead minnow	+	0	0	0	0
Number in sample	16118	4239	395	1594	1159
Percent by weight					
Bluegill	59	46	5	9	8
Pumpkinseed	12	7	6	32	23
Lake chubsucker	7	2	11	31	18
Grass pickerel	3	0	3	11	7
Largemouth bass	9	2	tr	14	33
Yellow perch	6	8	3	3	5
Yellow bullhead	5	34	73	1	4
Green sunfish	tr	0	tr	1	1
Golden shiner	tr	1	0	tr	tr
Blackchin shiner	+	0	0	0	0
Iowa darter	+	0	0	0	0
Bluntnose minnow	+	0	0	0	0
Fathead minnow	+	0	0	0	0

[a] M-R are mark-recapture population estimates which were calculated by size groups, then summed.
[b] 1.5" TN are trap nets with 1.5" stretched-mesh pots. March 24-April 10, 32 net lifts over 7 nights.
[c] 0.7" TN are trap nets with 0.7" stretched-mesh pots. March 24-April 10, 14 net lifts over 7 nights.
[d] DAC is daytime electrofishing with 220-v AC. April 27-May 14, 8 trips.
[e] NAC is night time electrofishing with 220-v AC. April 27May 13, 7 trips.

Appendix 2.–Community composition (% by number and weight) for 3 collection methods compared to best estimate (mark-recapture). Cassidy Lake, May-June 1964.

Species	Number (%)				Weight (%)			
	M-R [a]	Seine [b]	1.5" T [c]	Roten [d]	M-R [a]	Seine [b]	1.5" T [c]	Roten [d]
Bluegill	51.6	65.2	62.8	44.5	46.8	59.1	44.1	34
Pumpkinseed	7.8	11.1	24.9	16.8	9.9	12.1	18.3	12.4
Rock bass	…	0.2	0.1	0.1	0.03	0.1	0.04	0.1
Perch	32.8	17.6	0.4	18.5	15.6	5.5	0.6	5.5
Black crappie	0.1	tr	1.8	0.2	0.3	tr	1.9	0.3
Largemouth bass	0.8	3.9	0.8	5.3	6.8	17.9	2.6	11.2
Chubsucker	0.4	0.3	1.1	0.8	1.7	1.1	1.9	1.5
Green sunfish	3.4	0.7	0.1	3.6	2	0.4	0.1	1.6
Pickerel	0.4	0.5	0	1.9	0.6	0.8	0	1.9
Brown bullhead	0.9	0.2	2.3	3.5	8.6	1.2	8.1	15.3
Yellow bullhead	1.7	0.2	2.6	3.3	3.9	0.7	6.4	4.8
Bowfin	0.1	0.1	2.9	1.3	3.7	1	14.3	11.1
Golden shiner	…	0	0.1	…	…	0	tr	…
Killifish	+	0	0	…	+	0	0	…
Blackchin shiner	+	0	0	…	+	0	0	…
Blacknose shiner	+	0	0	…	+	0	0	…
Bluntnose minnow	+	0	0	…	+	0	0	…
Sucker spp	…	0	0.1	0.01	…	0	1.7	0.4
Total no.	100843	5145	1549	5161	6658		423	906

+ Minnows not recorded. These species reported in 1936,1944, and 1964.

[a] Mark-recapture population estimates, stratified by size groups.

[b] Large seine, 800' long by 1" stretched mesh in bag.

[c] Trap nets with 1.5" stretched mesh in pot.

[d] Complete rotenone treatment followed by intensive fish pickup.

Appendix 3.–Fish community composition (%) for four types of gear fished in Dead Lake in spring, 1984 and 1985, as compared to mark-recapture (M-R) estimates.

Species	March-May, 1984 M-R [a]	1.5"Trap [b]	0.7"Trap [c]	NAC [e]	Spring 1985 M-R [a]	April, 1985 1.5"Trap [b]	0.7"Trap [c]	NAC [e]	May, 1985 DAC [d]
Percent by number									
Bluegill	46	57	52	40	66	42	30	43	51
Pumpkinseed	17	5	4	27	10	2	5	26	30
Largemouth bass	1	2	tr	4	1	2	1	5	2
Yellow perch	26	tr	tr	19	18	1	42	18	9
Northern pike	1	5	tr	tr	tr	13	1	tr	+
Black crappie	tr	5	2	tr	tr	14	3	tr	tr
Yellow bullhead	2	18	32	tr	1	15	12	tr	+
Brown bullhead	tr	4	3	0	1	6	1	+	tr
Lake chubsucker	7	2	4	7	3	1	1	4	3
Grass pickerel	tr	tr	0	tr	tr	0	0	tr	tr
Warmouth	tr	tr	1	tr	tr	tr	1	1	1
Bowfin	1	tr	1	1	tr	5	2	1	1
Longear sunfish	tr	0	0	1	tr	0	0	tr	1
Green sunfish	tr	0	0	tr	tr	0	0	1	tr
Golden shiner	+	0	tr	1	tr	0	2	1	tr
lowa darter	+	0	0	tr	+	0	tr	0	0
Brook silverside	+	0	0	tr	+	0	0	0	0
Bluntnose minnow	+	0	0	tr	+	0	0	tr	tr
Fathead minnow	+	0	0	tr	+	0	0	0	0
Number in sample		1144	301	4739		735	365	2900	2905
Percent by weight									
Bluegill	43	33	20	24	49	16	17	22	27
Pumpkinseed	10	3	2	25	8	1	4	17	19
Largemouth bass	6	4	1	12	6	6	4	13	5
Yellow perch	4	tr	tr	5	6	tr	8	4	2
Northern pike	8	14	1	3	5	32	2	6	1
Black crappie	1	5	2	tr	2	9	5	1	tr
Yellow bullhead	2	20	52	1	4	11	26	tr	tr
Brown bullhead	tr	8	9	tr	7	6	4	tr	1
Lake chubsucker	6	2	7	9	2	1	3	3	5
Grass pickerel	tr	tr	0	tr	tr	0	0	tr	tr
Warmouth	tr	tr	1	tr	tr	tr	2	1	1
Bowfin	17	10	6	20	12	20	24	33	39
Longear sunfish	tr	0	0	tr	tr	0	0	tr	tr
Green sunfish	tr	0	0	tr	tr	0	0	tr	tr
Golden shiner	tr	0	tr	1	tr	0	2	tr	tr
lowa carter	+	0	0	tr	tr	0	tr	0	0
Brook silverside	+	0	0	tr	+	0	0	0	0
Bluntnose minnow	+	0	0	tr	tr	0	0	tr	tr
Fathead minnow	+	0	0	tr	+	0	0	0	0

[a] M-R are mark-recapture population estimates which were calculates by size groups, then summed.

[b] 1.5" TN are trap nets with 1.5" stretched mesh pots. March 24-April 10, 1987, 32 net lifts over 7 nights.

[c] 0.7" TN are trap nets trap nets with 0.7" stretched-mesh pots. March 24-April 10, 1987, 14 net lifts over 7 nights.

[c] DAC is daytime electrofishing with 220-v AC. April 27-May 14, 1987, 8 trips.

[e] NAC is night time electrofishing with 220-v AC. April 27 May 13, 1987, 7 trips.

Appendix 4.–Fish community composition (% by weight) of Mill Lake, fall 1964, based on four types of fishing gear, as compared to mark-recapture population estmates.

Species	M-R	1.5" trap	1" Seine	NAC [a]	DAC [b]
Bluegill	57	9	68	34	17
Pumpkinseed	3	5	3	8	13
Yellow perch	9	tr	7	10	2
Rock bass	1	1	0	1	1
Black crappie	3	13	4	8	4
Largemouth bass	13	23	11	19	9
Northern pike	4	21	7	4	0
Brown bullhead	5	9	0	6	1
Yellow bullhead	1	3	0	2	0
Warmouth	2	tr	tr	2	tr
Green sunfish	tr	0	tr	tr	0
Grass pickerel	tr	0	tr	tr	1
Chubsucker	1	tr	tr	3	8
Bowfin	2	16	0	3	46
Golden shiner	tr	0	0	tr	tr
White sucker	tr	tr	0	0	tr
	100	100	100	100	100

[a] Night electrofishing with 220-V AC boom shocker.
[b] Day electrofishing with 220-V AC boom shocker.

Appendix 5.–Composition of the fish community (% by weight) in Wakeley Lake, 1987 for three types of gear and partial mark-recapture estimates.

Species	M-R [a]	1.0" Fyke [b]	0.4" Fyke [c]	NDC [d]
Bluegill	54	7	16	20
Pumpkinseed	3	7	8	13
Yellow perch	…	0	tr	tr
Rock bass	…	tr	1	tr
Largemouth bass	11	35	6	38
Northern pike	23	30	12	23
Brown bullhead	7	18	44	4
Yellow bullhead	2	3	13	3
Golden shiner	…	0	tr	tr
Total	100	100	100	99

[a] M-R are mark-recapture population estimates for large and common fish. Total weights are approximate for all fish.
[b] Fyke nets with 1"" stretched mesh."
[c] Fyke nets with 3/8"" stretched mesh."
[d] Night electrofishing with 240-V pulse DC boom shocker.

Appendix 6.–Comparison of species relative abundance (% by number) from small samples (1 trip) with 3 types of gear at six stunted bluegill lakes in southern Michigan, 1990. Gear: TN = 1.5" trap net; DCD = pulse 220v DC boom shocker (daylight); AA = partial poison with antimycin (target small bluegill).

Species	Williams			Lake 14			Island			Myers [1]			Big			Horseshoe		
	TN	DCD	AA	TN	DCD	AA	TN	DCD	AA	TN	DCD	AA	TN	DCD	AA	TN	DCD	AA
Bluegill	68	76	84	61	48	78	46	73	82	52	69	56	27	72	94	27	72	83
Pumpkinseed	17	9	6	5	10	5	18	12	4	36	21	29	2	8	2	1	17	11
Yellow perch	0	0	1	0	17	5	0	0	0	0	1	3	0	tr	tr	0	tr	1
Black crappie	2	1	8	19	1	0	15	0	tr	6	1	0	0	1	0	54	1	0
Largemouth bass	2	1	tr	2	4	0	2	1	0	1	3	0	4	5	tr	1	6	tr
Smallmouth bass	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	0	2	1	0	0	0	tr	tr	0	0	0	0	0
Warmouth	0	2	8	1	1	3	0	1	1	0	0	0	0	0	tr	tr	2	2
Green sunfish	0	0	0	0	0	1	0	5	2	0	0	6	0	tr	2	0	0	2
Longear sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	0
Northern pike	0	0	0	1	0	0	0	0	0	0	1	0	tr	0	0	1	0	0
Tiger musky	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Yellow bullhead	0	0	0	0	0	0	0	0	0	2	tr	0	0	0	tr	2	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0	0	19	2	tr	4	1	0
Black bullhead	0	0	0	0	0	0	0	0	0	tr	0	0	1	0	0	1	0	0
All bullhead	7	0	0	0	10	2	13	0	0	2	tr	0	20	2	tr	7	1	0
Pickerel	0	2	tr	0	1	tr	tr	1	0	0	0	0	0	3	tr	0	0	tr
White sucker	0	0	0	0	0	0	4	0	0	0	tr	0	1	tr	0	1	tr	0
Longnose gar	0	tr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bowfin	3	tr	0	4	1	0	0	0	0	0	0	0	5	tr	0	1	0	0
Carp	0	0	0	6	1	0	0	0	0	0	0	0	20	1	0	0	0	tr
Chubsucker	2	8	1	1	4	0	0	0	0	tr	tr	0	0	2	tr	tr	0	0
Golden shiner	0	0	1	1	2	7	0	0	0	0	0	0	0	tr	0	0	0	tr
Bluntnose minnow	0	0	0	0	0	0	0	7	10	0	0	0	0	1	tr	0	0	0
Mudminnow	0	0	0	0	0	tr	0	0	0	0	0	0	0	0	tr	0	0	tr
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0
Blacknose shiner	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
Blackchin shiner	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Iowa darter	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0
Johnny darter	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0	0	0	0
Number caught	302	468	1266	156	398	1023	233	376	326	1057	395	497	461	452	1112	794	495	1106

[1] Meyers Lake net and shock samples from 1989.

Appendix 7.–Selectivity (catch per effort divided by estmated population in inch group) for four types of gear which sampled Blueberry Lake during April-May, 1987, as compared to mark-recapture estimates. N = number of fish sampled.

| Species | Inch group | M-R [a] | CPUE/M-R*10000 | | | |
			1.5" T [b]	0.7" T [c]	DAC [d]	NAC [e]
Bluegill	1	1151	0	0	5	14
	2	829	0	0	26	15
	3	590	0	2	43	38
	4	234	4	11	52	29
	5	306	52	3	3	8
	6	933	58	3	3	2
	7	1494	135	1	2	2
	8	3624	136	1	3	2
	9	173	143	0	0	0
	N	9334	2533	36	267	230
Pumpkinseed	1	…	0	0	…	…
	2	117	0	0	43	120
	3	354	0	3	66	70
	4	372	0	3	104	46
	5	479	19	5	104	42
	6	620	84	5	44	37
	7	580	120	9	40	24
	8	31	212	0	10	20
	N	2553	438	38	562	401
Yellow perch	2-4	…	0	0	..	…
	5-7	173	45	13	42	31
	8	154	140	8	8	12
	9	199	157	2	6	16
	10-11	174	284	5	9	13
	N	700	352	15	52	47
Largemouth bass	2-5	265	0	1	118	41
	6-9	52	12	0	12	72
	10-11	371	26	0	19	85
	12+	103	30	0	21	24
	N	791	43	1	131	156
Lake chubsucker	2-3	…	…	…	…	…
	4-6	637	4	3	73	42
	7+	608	53	20	84	42
	N	1245	111	45	312	168

Appendix 7.–Continued.

Species	Inch group	M-R [a]	CPUE/M-R*10000			
			1.5" T [b]	0.7" T [c]	DAC [d]	NAC [e]
Yellow bullhead	4-7	53	442	88	0	12
	8	109	765	149	11	23
	9	144	892	193	0	17
	10	132	1016	149	0	12
	11-13	18	1198	139	0	0
	N	456	1251	227	4	23
Golden shiner	2-10	460	37	0	7	3
Green sunfish	1-8	82	11	8	23	34
Grass pickerel	4-11	840	9	12	88	43

[a] M-R are mark-recapture population estimates calculated by size groups. Data for bluegill and pumpkinseed are unpublished: other data from Schneider (1993).

[b] 1.5" T are trap nets with 1.5" stretched mesh pots. March 24-April 10, 1987, 32 net lifts over 7 nights.

[c] 0.7" TN are trap nets with 0.7" stretched-mesh pots. March 24-April 10, 1987, 14 net lifts over 7 nights.

[d] DAC is daytime electrofishing with 220-v AC. April 27-May 14, 1987, 8 trips.

[e] NAC is night time electrofishing with 220-v AC. April 27May 13, 1987, 7 trips.

Appendix 8.–Selectivity (catch divided by mark-recapture estimate per inch group) for three types of gear in Cassidy Lake, May-June 1964, as compared to mark-recapture estimates (M-R). N = number of fish sampled.

| | Inch group | M-R [a] | Catch/M-R*1000 | | |
			Seine [b]	1.5" Trap [c]	Rotenone [d]
Bluegill	1	…	0	0	…
	2	…	…	0	…
	3	33603	14	0	7
	4	7418	122	10	60
	5	5398	163	41	132
	6	4537	195	89	144
	7	1082	193	233	217
	8	16	313	938	375
	N	52054	3353	973	2297
Pumpkinseed	1	0	0	0	0
	2	…	…	0	…
	3	3416	18	1	32
	4	2115	45	23	114
	5	1648	170	88	210
	6	489	192	217	227
	7	175	194	463	246
	8	32	125	125	344
	N	7875	570	386	868
Yellow perch	2	…	…	0	…
	3	14364	16	0	12
	4	14665	36	0	34
	5	3448	23	0	50
	6	416	50	0	139
	7	134	231	7	209
	8	12	333	0	667
	9	9	111	111	556
	10+	15	133	267	467
	N	33063	906	6	955
Largemouth bass	2-3	36	583	0	417
	4	13	154	0	846
	5	3	333	0	667
	6	81	210	0	173
	7	111	225	9	459
	8	62	468	16	629
	9	79	228	0	532
	10+	394	218	25	251
	N	779	199	12	273

Appendix 8.–Continued.

	Inch group	M-R [a]	Catch/M-R*1000		
			Seine [b]	1.5" Trap [c]	Rotenone [d]
Rock bass	2-7	30	333	33	233
Black crappie	3-13	125	8	224	72
Chubsucker	2-13	450	40	38	93
Green sunfish	2-8	3400	11	0	55
Pickerel	6-12	356	70	0	278
Brown bullhead	7-14	900	11	40	202
Yellow bullhead	4-13	1730	6	23	99
Bowfin	10-28	81	62	556	852

[a] Mark-recapture population estimates by species and size group.
[b] Large seine 800' long x 1" stretched mesh in bag.
[c] Trap nets with 1.5" stretched mesh in pot.
[d] Total rotenone treatment followed by intensive pickup.

Appendix 9.–Selectivity (catch per effort divided by estimated population in inch group) for four types of gear which sampled Dead Lake fish during April-May, 1984 and 1985, as compared to mark-recapture estimates (M-R). N = number of fish sampled.

Inch group	1984 CPUE/M-R*10000				1985 CPUE/M-R*10000				
	M-R (no.)	1.5"T[a]	0.7"T[b]	NAC[c]	M-R (no.)	1.5"T[a]	0.7"T[b]	DAC[d]	NAC[c]
				Bluegill					
1	…	0	0	…	…	0	0	…	…
2	6358	0	6	56	25859	0	1	10	12
3	16919	0	2	30	26316	0	0	44	26
4	2432	0	2	73	7752	0	1	39	28
5	6732	5	2	42	3802	2	3	41	34
6	5970	16	2	39	3831	8	3	27	21
7	4973	35	6	26	7042	17	1	18	16
8	2178	32	3	13	923	3	1	28	21
9	287	43	6	7	…				
N	45849	656	157	1913	75525	311	110	1490	1249
				Pumpkinseed					
1-2	2059	0	0	50	1437	0	1	73	36
3	7898	0	0	26	5747	0	0	116	73
4	1548	0	1	158	1348	0	1	146	110
5	2062	2	2	193	1116	2	0	123	130
6	1429	11	2	174	1330	3	1	90	108
7-8	548	31	5	130	319	6	14	54	39
N	15544	62	13	1266	1197	13	15	869	735
				Yellow perch					
2-3	18716	0	0	27	12195	0	2	23	37
4-6	4779	0	0	80	8264	0	8	9	26
7+	141	0	6	170	46	82	27	31	109
N	23636	0	1	920	20505	7	154	251	536
				Black crappie					
3-4	…	0	0	0	…	0	0	…	…
5-7	291	42	11	24	206	33	9	21	12
8-9	37	143	0	27	281	171	20	5	40
10	42	280	40	0	9	625	0	0	0
11	13	362	0	0	9	278	0	0	0
12+	3	196	0	0	3	625	0	0	0
N	386	59	6	8	508	104	12	4	11
				Largemouth bass					
2-4	338	0	0	62	785	0	1	93	84
5-9	302	0	0	358	477	3	0	39	162
10-11	120	25	0	0	124	0	0	46	161
12-14	202	23	4	153	206	12	6	7	55
15+	82	29	0	37	49	102	0	58	51
N	1044	17	1	163	1641	14	3	71	142

Appendix 9.–Continued.

Inch group	1984 CPUE/M-R*10000				1985 CPUE/M-R*10000				
	M-R (no.)	1.5"T[a]	0.7"T[b]	NAC[c]	M-R (no.)	1.5"T[a]	0.7"T[b]	DAC[d]	NAC[c]
				Northern pike					
13-15	93	13	0	0	…	0	…	0	…
16-19	388	47	2	23	148	207	4	0	25
20-23	150	75	0	7	109	224	0	13	34
24+	19	31	0	53	17	294	0	0	147
N	650	53	1	11	274	96	2	1	10
				Lake chubsucker					
2-5	3653	0	0	29	2740	0	0	28	39
6-8	2158	2	2	59	348	5	4	168	101
9-11	148	44	34	149	71	26	26	40	35
N	5959	18	11	255	3159	6	5	96	115
				Brown bullhead					
6-10	127	79	13	8	144	95	4	10	0
11	32	147	26	0	92	27	7	16	0
12	101	70	50	0	96	26	7	15	0
13	107	66	8	0	204	18	3	0	0
14	9	196	0	0	57	55	0	0	0
N	376	52	10	1	593	41	4	3	0
				Bowfin					
14+	564	16	3	73	371	57	10	146	118
				Yellow bullhead					
5-7	139	25	30	22	202	19	12	0	0
8	112	200	112	27	122	82	72	0	0
9	167	229	130	18	214	70	20	0	0
10	131	202	172	15	185	135	24	8	7
11	110	187	114	9	89	119	63	0	14
12+	50	188	133	40	22	114	0	0	0
N	709	205	96	14	834	107	41	1	2

[a] 1.5" T are trap nets with 1.5" stretched mesh pots. April 24-27, 1984, effort was 17 net lifts over 3 nights. April 8-12, 1985 effort was 16 lifts over 4 nights.

[b] 0.7" TN are trap nets with 0.7" stretched mesh pots. April 24-27, 1984, was12 net lifts over 3 nights. April 9-12, 1985 effort was 16 net lifts over 4 nights.

[c] NAC is night time electrofishing with 220-v AC. May 7-23, 1984 effort was 10 trips. May 8-17,1985 effort was 8 trips.

[d] DAC is daytime electrofishing with 220-v AC. May 13-23, 1985 effort was 7 trips.

Appendix 10.–Selectivity of three types of fishing gear for yellow perch, bluegill, and walleye in Jewett Lake, fall 1992 and 1983 (perch). Catch per effort (0.7"- or 1.5"-mesh trap nets) or total catch (night AC shocker) was divided by the mark-recapture estimate (MR) and multiplied by 1000. N = number of fish sampled.

Inch group	M-R	CPUE/M-R*1000		Catch/M-R	Inch group	M-R	CPUE/M-R*1000		Catch/M-R
		0.7" T	1.5" T	NAC			0.7" T	1.5" T	NAC
Bluegill–1992					**Yellow perch–1992**				
1-2	34904	4	0	2	2-3	5375	0	0	4
3	17215	5	1	2	4	2253	14	0	4
4	1214	29	30	35	5	89	42	3	45
5	974	18	22	50	6	34	16	27	0
6	324	23	29	6	7	24	42	28	0
7	62	19	56	0	8	56	42	42	0
8+	54	0	31	0	9+	81	40	80	0
N	…	3258	1075	184	N	…	377	128	36
Walleye–1992					**Yellow perch–1983**				
1-7	0	…	…	…	2-3	2525	0	0	14
8-9	2	0	42	0	4	711	58	0	177
10-11	30	0	31	33	5	12	28	0	250
12-13	81	2	52	25	6	792	20	18	81
14-15	45	4	65	67	7	937	9	20	69
16-17	22	8	53	227	8	101	12	34	89
18-19	10	9	92	200	9+	29	11	73	69
20+	0	…	…	…	N	…	402	343	749
N	…	7	123	13					

Appendix 11.–Fish community composition (% biomass) for two types of trap nets compared to mark-recapture population estimates, Jewett Lake, fall 1992 (Schneider 1995 and unpublished).

	M-R	0.7" T	1.5" T
Walleye	17	7	49
Yellow perch	16	22	14
Bluegill	67	71	37
Total	100	100	100

Appendix 12.–Size selectivity (number caught divided by mark-recapture estimate for inch group times 10000) for four types of fishing gear for Mill Lake, fall 1964, as compared to mark-recapture (M-R) estimates. N = number of fish sampled.

	Inch group	M-R	DAC [a]	NAC [b]	Seine [c]	1.5" T [d]
Bluegill	2	98154	7	68	53	0
	3	59221	17	186	334	0
	4	36883	26	319	358	4
	5	17313	51	430	571	30
	6	2528	40	605	297	233
	7	901	22	577	1332	477
	8	…	0	0	0	0
	N	…	371	3896	5001	170
Pumpkinseed	2	1046	0	0	0	0
	3	3042	30	112	36	0
	4	1372	211	714	80	29
	5	2264	225	574	97	84
	6	702	954	2407	684	826
	7	352	284	1989	682	881
	N	…	167	520	118	114
Yellow perch	2	…	…	…	…	…
	3	…	…	…	..	..
	4	9756	14	301	438	0
	5	8628	19	519	87	0
	6	1573	45	877	89	0
	7	170	0	2059	235	235
	8	44	0	2727	455	227
	N	…	40	990	904	5
Black crappie	3	…	…	…	…	…
	4	…	…	…	…	…
	5	240	167	1083	625	292
	6	95	0	737	105	6316
	7	238	42	1513	840	4664
	8	581	120	1583	448	568
	9	158	253	1266	190	63
	10	…	…	…	…	…
	N	…	18	195	69	230
Largemouth bass	2-5	2406	387	794	141	0
	6-9	914	131	1149	328	44
	10-11	288	0	1076	347	278
	12+	534	19	562	262	674
	N	…	106	357	88	48

[a] day electrofishing with 220- V AC boom shocker.
[b] Night electrofishing with 220- V AC boom shocker.
[c] Seine 800 feet long with 1-inch, stretched-mesh bag.
[d] Trap net with 1.5-inch, stretched-mesh pot.

Appendix 13.–Size selectivity (% of species' catch within inch group) for three types of gear which sampled Wakeley Lake fish during May-June, 1987. N = number of fish sampled.

Species	Inch group	1.0" Fyke [a]	0.4" Fyke [b]	NDC [c]
Bluegill	1	0	14	1
	2	4	44	8
	3	13	20	30
	4	4	7	31
	5	2	2	18
	6	17	2	9
	7	31	0	3
	8	0	8	0
	9	19	2	1
	10+	10	1	0
	N	83	649	1539
Pumpkinseed	1	0	0	0
	2	0	18	3
	3	4	22	16
	4	1	6	15
	5	7	5	8
	6	1	5	9
	7	28	24	30
	8	45	21	18
	9	13	0	2
	N	69	105	292
Largemouth bass	2-4	0	36	15
	5-9	0	0	13
	10-11	4	7	10
	12-13	37	21	31
	14-15	44	7	21
	16-17	8	14	11
	18+	7	14	4
	N	90	14	195
Northern pike	6-12	0	5	23
	13-15	0	30	11
	16-19	20	15	18
	20-23	53	35	43
	24+	27	15	6
	N	45	20	80

Appendix 13.–Continued.

Species	Inch group	1.0" Fyke [a]	0.4" Fyke [b]	NDC [c]
Brown bullhead	5-10	1	28	59
	11	23	56	38
	12	60	15	3
	13	13	1	0
	14	3	0	0
	N	99	159	32
Yellow bullhead	5-7	4	3	20
	8	4	11	29
	9	33	42	17
	10	38	30	22
	11	21	14	12
	N	24	73	41

[a] Fyke nets with 1" str mesh.
[b] Fyke nets with 3/8" str mesh.
[c] Night time electrofishing with 240-v pulse DC.

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