STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-35-R-24

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

Period Covered: April 1, 1998 to September 30, 1999

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, catch-per-effort (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, an index of biotic integrity (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: This study was amended to extend for another year; consequently, this is a progress report rather than a final report. Progress focused on additional analysis of the selectivity of several types of lake fish sampling gear relative to each other, and on computation of state average catch per-unit-effort (CPE) rates for those gear types. Two of the most popular gear types, 1.5" trap nets and 1.5" fyke nets, collected samples with similar species proportions and size structures. Relative to 1.5" trap and fyke nets, samples collected by gill nets tended to over-represent northern pike (and often walleye, yellow perch and white sucker) and to under-represent bluegill and rock bass (and other centrarchids). Average size of fish caught in inland gill nets tended to be slightly smaller than fish in trap nets. Samples collected by electrofishing contained relatively high proportions of largemouth bass (and probably smallmouth bass), high species diversity, and the smallest fish. The practical interpretation of these analyses and a review of related information on lake fish population and communities are being incorporated into a revision of the Manual of Fisheries Survey Methods.

Job 1. Title: Gear selectivity.

Findings: The 1996-97 report discussed selectivity of nine types of fishing gear for seven species of warmwater and coolwater fishes relative to "known" abundance indicated by mark-and-recapture population estimates. All types of gear were found to cause some bias in our perceptions of community composition and population size structure. Unfortunately, there was insufficient comparable information for gill nets and fyke nets, two important types of gear.

This year, sixteen data sets were examined for which fish populations were not known, but for which relatively large catches were made at the same lake on the same date with two to four types of gear. These data sets included catches in gill nets and fyke nets. Relative catches could be compared between pairs of gear types to tease out patterns in species selectivity and size selectivity. These data had been collected during routine surveys by managers around the state.

Gear types were: trap nets with pots of 1.5" stretched mesh (a primary gear in the prior analysis and widely used in southern Michigan); fyke nets with mesh of either 0.7", 1.5", or 2" stretched mesh (widely used in northern areas); 250-v DC boom shocker used at night; experimental inland gill nets (125' long with mesh of 1.5", 2", 2.5", 3" and 4" stretched mesh); and Great Lakes gill nets (500 or 1000' long, of 1.5", 2", 2.5", 3", 3.5", 4', 4.5", 5", 5.5", and 6" stretched mesh).

As in the prior analysis, the data were examined to determine patterns in gear selectivity with respect to species composition (community structure) and length-frequency distribution (size structure). Species composition was expressed as percent of catch on a weight basis. For some analyses of community species composition, catches from the two types of gill nets were pooled to increase replicates in the analysis because the four largest mesh sizes in the Great Lakes nets rarely catch anything unique in inland lakes. Similarly, catches for 1.5' and 2" fyke nets were pooled. Note that a difficulty in interpreting percent composition is that selectivity for one species tends to mathematically depress the percentages of other species, and conversely, avoidance by one species can increase the percentage of another species. For analyses of size selectivity; average length, minimum length, and maximum length were compared for important species of fish which had been adequately sampled with two types of gear at the same lake on the same date. In those paired comparisons, size selectivity would be indicated if size statistics were consistently higher or lower. For a final summary analysis, comparisons of the three size statistics were tabulated across species to bring out any overall pattern.

An additional analysis compared the number of fish caught per lift (CPE) of 1.5" fyke nets to 1.5" trap nets. These two gear types are the most popular nets in use and each has its advocates. They are rarely fished concurrently. However, their catch rates could be directly compared based on surveys conducted at three large lakes in the Upper Peninsula (Manistique, S. Manistique, and Indian).

Community composition

Standard 1.5" trap net compared to 1.5" fyke net.–The species percentages were quite similar, usually within 5% of each other (Table 1). This result suggests these gear types give similar snapshots of the fish community in most relatively shallow lakes. However, there can be slightly differences in how these nets are used which may affect catch. Fyke nets are almost always deployed out from the shoreline at shallow depths, whereas trap nets can be fished in slightly deeper water. In certain seasons and circumstances, trap nets may be slightly more effective than fyke nets when fish such as bluegill, black crappie, walleye, and northern pike are located offshore. Note that both types of gear do not sample small-bodied species (such as minnows), so they under-represent community diversity. The previous comparison of trap net community composition data to known population data had indicated trap nets (and now by inference large-mesh fyke nets) tend to slightly over-represent bullheads, black crappie, northern pike, pumpkinseed, and bowfin, and to slightly under-sample bluegill, yellow perch, and all the small-bodied species. The proportion of top predators in the community based on trap net samples is believed to be fairly accurate, but experience has shown that largemouth bass are sometimes difficult to net.

Small-mesh (0.7") fyke net compared to large-mesh (2") fyke net.–The species percentages were quite different (Table 2). The small-mesh nets tended to over-represent rock bass and bluegill (small littoral species) and under-represent large fish such as piscivores and suckers. The proportion of top predators was decidedly lower in the small-mesh fyke net. The prior analysis of known communities had already indicated small-mesh trap and fyke nets tend to over-sample

bullheads, causing problems in interpretation of the proportions of other species. Small-mesh nets tend to under-sample small minnows.

Gill nets (inland or Great Lakes) compared to trap or fyke nets (1.5" or 2").–The species percentages between gears were quite different, and depended on lake type and species present. For deep lakes containing a mixture of cold and warmwater species (Table 3), gill nets were an essential tool for sampling deep waters and associated pelagic or cold water species. This is a large habitat that it is not feasible to sample with other nets, and associated fishes may only be vulnerable to other nets set in the littoral habitat during cold seasons. Within those deep lakes, gill nets tended to over-sample northern pike and under-sample rock bass, but caught about the same proportions of other warmwater and coolwater species as trap/fyke nets. All minnows except the largest-bodied species were missed.

For lakes not containing cold-water species (Table 4), gill nets markedly over-sampled northern pike, and tended to be high for walleye, yellow perch, and white sucker. Bluegill, pumpkinseed, black crappie, and rock bass were usually under-represented, and largemouth and smallmouth bass were often under-represented. Again, smaller minnows were missed. Estimates of the proportion of predators tended to be very high (as much as 96% of the total weight), in gill nets relative to trap/fyke nets, because strong selection for walleye and pike was only partially offset by selection against bass.

DC electrofishing compared to 1.5" trap nets.–The percentage of largemouth bass was markedly higher by electrofishing than by trap netting (Table 5). The same may be true for smallmouth bass as well. Bluegill tended to be under-sampled. These biases were noted in the previous analysis of known communities. Northern pike, carp, and suckers tend to avoid the electric field. Many species of minnows—especially the medium to large sizes—may be collected by electrofishing if crews look for them, but additional species may usually be found by seining.

Length-frequency

1.5" fyke net compared to 1.5" trap net.–Out of 10 possible paired comparisons, the size distributions of fish captured by fykes were quite similar to those of fish captured in standard trap nets (Table 6). These fykes caught smaller minimum sizes (9/10 comparisons), but similar maximum sizes (3 lower, 5 same, 2 higher), and average size was slightly more likely to be lower (6 lower, 1 same, 3 higher). That is, fykes tended to catch a broader size range (due to smaller fish) but average size was not consistently lower.

Inland gill net compared to 1.5" trap net.–Average length of fish caught in these gill nets were slightly smaller in 7/9 comparisons (Table 6). Minimum sizes were similar, but traps tended to catch the largest fish.

Great Lake gill net compared to 1.5" trap net.–Out of 10 comparisons, these larger mesh gill nets caught similar size fish as trap nets (Table 6).

Night DC electrofishing compared to 1.5" trap net.–All electrofishing samples consistently contained much smaller fish than 1.5" trap or fyke nets (Table 6). Average size was markedly smaller also, but some large specimens were taken by electrofishing. In these surveys a strong effort was made to pick up all sizes that had been stunned. The previous analysis of known populations had indicated electrofishing is one of the least biased gear types, but still under-samples small sizes relative to their true abundance. Samples can be strongly biased in situations where small fish are located inshore and large fish are in water too deep to electrofish.

Great Lakes gill net compared to 1.5" fyke net.–Out of 6 comparisons, average and minimum lengths were higher for Great Lakes gill nets (Table 6). Maximum length showed no trend. This result is consistent with the selectivity ranking inferred above.

Data for the other comparisons in Table 6 are meager but were generally in line with expectations and analyses made 2 years ago.

Catch rates

1.5" fyke compared to 1.5" trap net.–Fyke nets had higher CPEs than trap nets for 21/30 (70%) of paired comparisons. This was for fish of all sizes. Since fyke nets tend to catch slightly smaller sizes (see above), CPEs of "legal-sized" sport fish also were calculated. Fyke nets still held a slight advantage in that average CPE across the four surveys for each species was higher; however in the revised paired comparisons fyke CPEs were higher for only 14/26 (54%). A fairly consistent exception was that trap nets caught northern pike at an average rate four times that of fyke nets. Based on these limited data, which may depend on exactly how nets were deployed, it appears that 1.5" fyke nets are slightly more effective than 1.5" trap nets for capturing many species and sizes.

Job 2. Title: <u>Develop standards.</u>

Findings: Average catch-per-unit-effort (CPE) indices were computed by species and gear type from representative state-wide lake surveys. These data had been collected by management crews in recent years and entered in the computerized Fish Collection System. The analysis is based on a relatively modest amount of data in the system as of mid-September 1999, and should be updated in a few years after more data have accumulated. For now, the averages are considered to be state-wide standards for evaluating how catches from any survey compare to average expectations. These averages have been incorporated into Chapter 21 of the Manual of Fisheries Survey Methods II. Other material included in that chapter are representative survival rates for fish populations and a summary of fish standing crops.

Job 3. Title: <u>Develop IBI.</u>

Findings: Current literature on the application of Indices of Biological Integrity (IBI) to lake classification were reviewed. Few applications have been attempted to date, and results have not been very useful nor as widely applicable as parallel IBIs developed for streams. Problems with the lake applications include:

- Some areas (e.g., Northeast) have few native species, and therefore a limited potential for developing useful of metrics (Whittier 1999);
- Degraded sites tend to be selected for study based on prior knowledge of severe water quality problems, then the metrics made to fit—not an unbiased approach (Minns et al. 1993; Thoma 1999);
- The stream paradigm and metrics don't seem to adapt to lake systems (Thoma 1999; Minns et al. 1994);
- Unlike stream ecosystems, the fish fauna of Michigan lakes seems to lack species that are sensitive indicators of habitat and perturbations;
- It is difficult to standardize methods and gear for sampling lakes to obtain consistent data (Weaver and Magnuson 1993; Jennings et. al. 1999).

Job 4. Title: Prepare reports.

Findings: This progress report was prepared.

Literature Cited:

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Minns, C. K., V. W. Cairns, R. G. Randall, and J. E. Moore. 1994. An index of biological integrity (IBI) for fish assemblages in the littoral zone of Great Lakes' areas of concern. Canadian Journal of Fisheries and Aquatic Sciences 51:1804-1822.

Thoma, R. 1999. Biological monitoring and an index of biological integrity for Lake Erie's nearshore waters. Chapter 16 *in* T. P. Simon (Ed) Assessing the sustainability and biological integrity of water resources using fish communities, p417-462. CRC Press LLC, New York.

Weaver, M. J., and J. J. Magnuson. 1993. Analyses for differentiating littoral fish assemblages with catch data from multiple sampling gears. Transactions of the American Fisheries Society 122:1111-1119.

Whittier, T. R. 1999. Development of IBI metrics for lakes in southern New England. Chapter 22 *in* T. P. Simon (Ed) Assessing the sustainability and biological integrity of water resources using fish communities, p563-582. CRC Press LLC, New York.

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Table 1.–Comparison of fish community composition, based on percentage of total catch by weight, between 1.5" fyke net and 1.5" trap net (reference).

ok = within 5% of reference; low = <5% or trace; high=>5%;+ = not caught in reference gear;
0 = not caught in 1.5" fyke but other gear; blank = not caught by any gear.

	Lake and survey date				
Species	Indian 6/96	Manistique 6/97	S. Manistique 9/88	S. Manistique 8/95	**Pattern**
Walleye	low	low	ok	low	**sl. low**
Smallmouth bass	high	ok	ok	ok	**ok**
Largemouth bass			ok	ok	**ok**
N. pike	low	low	ok	ok	**sl low**
Musky				0	
Yellow perch	high	high	ok	ok	**sl high**
Bluegill	ok	ok	ok	high	**ok**
Pumpkinseed		ok	ok	high	**ok**
Black crappie	ok				**ok**
Rock bass	high	ok	ok	ok	**ok**
Warmouth					
Hybrid sunfish					
Green sunfish					
Channel catfish					
Bullhead spp	+	ok	high	low	**ok**
Carp					
Redhorse	ok	ok	+	ok	**ok**
White sucker	low	ok	ok	ok	**ok**
Bowfin					
Gar spp					
Golden shiner					
Common shiner					
Forage>3"			0		
Brown trout	0				
Lake trout					
Splake					
Rainbow trout					
Brook trout		0			
Cisco	0	0	0	0	**0**
Smelt					
Burbot					
% top predators*	ok	low	ok	low	**sl low**
% bluegill trap	1.1	0.3	5.6	27	

*Top predators defined as top five species

Table 2.–Comparison of fish community composition, based on percentage of total catch by weight, between 0.7" fyke net and 2.0" fyke net (reference).

ok = within 5% of reference; low = <5% or trace; high=>5%;+ = not caught in reference gear;
0 = not caught in 1.5" fyke but other gear; blank = not caught by any gear.

	Lake and survey date									
Species	Boardman 6/86	Bass 6/95	Bear 5/90	Fife 6/93	Green 7/89	Leelenau N. 6/88	Leelenau S. 5/94	Silver 6/82	Silver 6/94	**Pattern**
Walleye	low	0	0	0			ok	0	low	**low**
Smallmouth bass	+	+	high	low	ok	low	high	ok	0	**?**
Largemouth bass	0	v. low	0	0	ok	0	0	low	0	**v. low**
N. pike	ok	0	0	0	0		0	0	0	**v. low**
Musky										
Yellow perch	ok	0	0	ok	ok	+	ok	ok	0	**ok**
Bluegill	0	ok	high	ok	high	ok	0	ok	high	**ok-high**
Pumpkinseed	ok	high	0	ok	ok	ok	0	high	ok	**ok**
Black crappie			0	0						**low**
Rock bass	ok	v. high	high	v. high	high	low	high	ok	ok	**high**
Warmouth										
Hybrid sunfish										
Green sunfish								+	0	
Channel catfish										
Bullhead spp	high	ok	0	+	0	+	0	high	v. high	**varies**
Carp										
Redhorse										
White sucker	low		0	0	low	v. low	0	0	low	**low**
Bowfin			0		0	high	0			**low**
Gar spp					0	ok	low			**low**
Golden shiner										
Common shiner						+				**+**
Forage >3"						+	+			**+**
Brown trout						0	0			**0**
Lake trout					0	0				**0**
Splake					0	0				**0**
Rainbow trout										
Brook trout										
Cisco					0	0	0			**0**
Smelt						0				**0**
Burbot						0				**0**
% top predators*	low	v. low	low	v. low	low	low	sl. high	low	v. low	**low**
% bluegill, 2"fyke	1	27	13	2	17	1	1	12	3	

*Top five species defined as top predators.

Table 3.–Comparison of fish community composition in coldwater lakes, based on percentage of total catch by weight, between gill nets (either inland or Great Lakes) and either trap or fyke nets with 1.5" or 2" mesh (reference).

ok = within 5% of reference; low = <5% or trace; high=>5%;+ = not caught in reference gear;
0 = not caught in 1.5" fyke but other gear; blank = not caught by any gear.

	Two-story northern lakes							
Species	Leelenau S. 5/94	Leelenau N. 6/88	Green 7/89	Manistique N. 6/97	Indian 6/96	Independence 5/95	Manistique S. 9/88	**Pattern**
Walleye	high			low	high	v. low	low	**varies**
Smallmouth bass	low	low	high	0	0	0	0	**low**
Largemouth bass	0		0				0	**low**
N. pike	v. high	0	ok	v. high	high	v. high	ok	**high**
Musky								
Yellow perch	ok	+	ok	low	ok	v. high	ok	**ok**
Bluegill	0	0	0	0	0		0	**low**
Pumpkinseed	+	0	0	0			0	**low**
Black crappie					0			
Rock bass	v. low	low	v. low	0	0	0	0	**v. low**
Warmouth								
Hybrid sunfish								
Green sunfish								
Channel catfish								
Bullhead spp	0	0	ok	0	0			**low**
Carp								
Redhorse				0	0		0	
White sucker	high	ok	ok	low	low	low	ok	**varies**
Bowfin	0		low					**low**
Gar spp		ok	+					**ok**
Golden shiner								
Common shiner		0						
Forage spp<3”	0	0				0	0	**0**
Brown trout	+	+			ok			**+**
Lake trout		+	+					**+**
Splake		+	+					**+**
Rainbow trout								
Brook trout				0				
Cisco	+	+	+	high	high	+	+	**+**
Smelt		+						
Burbot		+				0		**+**
% top predators*	high	low	high	high	ok	low	low	**varies**
% bluegill, fyke/trap	1	1	17	1	1	0	7	

*Top predators defined as top five species

Table 4.–Comparison of fish community composition in warmwater lakes, based on percentage of total catch by weight, between gill nets (either inland or Great Lakes) and either trap or fyke nets with 1.5" or 2" mesh (reference).

ok = within 5% of reference; low = <5% or trace; high=>5%;+ = not caught in reference gear;
0 = not caught in 1.5" fyke but other gear; blank = not caught by any gear.

	Warmwater northern lakes							Warmwater southern			
Species	Boardm. 6/86	Silver 6/94	Silver 6/82	Fife 6/93	Bear 5/90	Bass 6/95	Manistiq. S. 8/95	Portage 6/98	Miner 5/98	Gun 5/99	**Pattern**
Walleye	high	high	high	high	ok	+	v. high			ok	**high**
Smallmouth bass	+	low	ok	low	ok	0	0	+		ok	**low-ok**
Largemouth bass	0	low	ok	0	v. low	0	0	ok	ok	low	**low-ok**
N. pike	v. high	+	+	0	v. high	v. high	0	v. high	++	v. high	**v. high**
Musky							0			0	
Yellow perch	high	ok	v. high	high	ok	+	ok	ok	+	ok	**ok-high**
Bluegill	ok	ok	low	low	0	0	v. low	v. low	v. low	low	**low**
Pumpkinseed	ok	0	low	0	0	0	0	ok	0	0	**low**
Black crappie				0	0			low	ok	ok	**low-ok**
Rock bass	ok	0	v. low	low	0	0	0	ok	ok	low	**low-ok**
Warmouth								0	ok	ok	**low**
Hybrid sunfish								low	0	0	**low**
Green sunfish		0	0					0	0		**low**
Channel catfish									+	0	**ok?**
Bullhead spp	low	0	ok	+	0		0	0	ok	low	**low**
Carp								+	ok	0	**ok**
Redhorse							0	ok	ok	0	**ok**
White sucker	low	high	high	+	v. high		v. high	high	++	0	**high**
Bowfin					0			0	low	low	**low**
Gar spp								ok	0	ok	**ok**
Golden shiner								0	ok	+	**ok**
Common shiner								0			**0**
Forage spp<3"								0	0	0	**0**
Brown trout											
Lake trout											
Splake											
Rainbow trout											
Brook trout											
Cisco											
Smelt											
Burbot											
% top predators*	high	high	high	ok	ok	high	high	v. high	v. high	v. high	**v. high**
% bluegill, f/trap	1	2	12	8	13	27	32	19	26	34	

*Top predators defined as top five species

Table 5.–Comparison of fish community composition, based on percentage of total catch by weight, between night electrofishing and 1.5" trap net (reference). Also used for reference for Gun and Miner lakes were catches of small forage species by small seine.

ok = within 5% of reference; low = <5% or trace; high=>5%;+ = not caught in reference gear; 0 = not caught in 1.5" trap net but other gear; blank = not caught by any gear.

Species	Gun Lake 5/99	Miner Lake 5/99	Portage Lake 6/98	**Pattern**
Walleye	ok		+	**ok?**
Smallmouth bass	high		+	**high?**
Largemouth bass	v. high	v. high	v. high	**v. high**
N. pike	low	0	0	**low**
Musky	0			
Yellow perch	high	+	high	**high**
Bluegill	ok	low	low	**low**
Pumpkinseed	ok	ok	ok	**ok**
Black crappie	ok	0	low	**low?**
Rock bass	high	ok	ok	**ok**
Warmouth	ok	ok	ok	**ok**
Hybrid sunfish	0	ok	ok	**ok**
Green sunfish		ok	0	**ok**
Channel catfish	0	+		**ok?**
Bullhead spp	low	ok	ok	**ok**
Carp	0	0	0	**low**
Redhorse	0	0	0	**low**
White sucker	0	+	0	**low**
Bowfin	0	0	high	**none?**
Gar spp	0	low	0	**low**
Golden shiner	+	ok	ok	**ok**
Common shiner			+	**ok**
Spottail shiner			+	**ok**
Sand shiner	0	0		**low?**
Brook silverside	0		+	**low?**
Bluntnose minnow	0	0	+	**low?**
Johnny darter	0	0		**low**
Log perch			+	**low?**
Killifish		0		**low?**
% top predators*	high	v. high	v. high	
% bluegill, trap net	8	27	19	

*Top predators defined as top five species

Table 6.–Comparison of size selectivity statistics (average, minimum, and maximum lengths) between pairs of gear types. The numbers in the cells are the number of paired data comparisons (species x gear x survey). For example in the first row, for 6 out of 10 paired comparisons, average length of the species was lower in 1.5" fyke nets than in 1.5" trap nets.

	Number	Average length			Minimum length			Maximum length		
Gear	of pairs	lower	same	higher	lower	same	higher	lower	same	higher
Relative to 1.5" trap net										
1.5" fyke	10	6	1	3	9	1		3	5	2
0.7" fyke	1	1			1			1		
Inland gill	9	7		2	2	4	3	4	5	
Great Lake gill	10	5		5	4	2	4	5	2	3
Night DC shocker	11	11			11			8	2	1
Relative to 1.5" fyke net										
Inland gill	2			2			2	1		1
Great Lake gill	6	1		5			6	3	1	2
Relative to 2" fyke net										
Great Lake gill	2		1	1		1	1		2	