STUDY FINAL REPORT

State: Michigan **Project No.:** F-81-R-7

Study No.: 230646 **Title:** Inland creel surveys

Period Covered: October 1, 1999 to September 30, 2006

Study Objective: To provide a consistent series of guidelines, data collection methods, and timely analysis to fisheries managers and research biologists for conducting access point and roving creel surveys on inland waters.

Summary: Seventy-nine angler surveys were conducted, between spring 2000 and fall 2006 on the inland waters of Michigan (Table 1). Fifty-eight surveys were conducted on inland lakes and twenty-one surveys were conducted on inland rivers. Both open water and winter surveys were conducted on eighteen large inland lakes. Most sites were in the western end of the Upper Peninsula, and the northern part of the Lower Peninsula.

Angler surveys were conducted for a variety of reasons. Thirty-nine angler surveys were part of a new, statewide program designed to improve assessment and monitoring of fish communities and fisheries in Michigan's largest inland lakes, known as the Large Lakes Program (Clark et al. 2004). All the other surveys were conducted based on local management needs to evaluate fish stocking, obtain catch or harvest estimates of specific species of interest, and characterize the fisheries.

Roving (or aerial) count and roving interview design was implemented for most (99%) of the inland lake creel surveys (Table 2). Whereas roving count and access point interview design was deployed for most (90%) of the river creel surveys. Aerial surveys were conducted to make angling boat counts for 16 of the 18 open water surveys for the Large Lakes Program. Roving-roving surveys were conducted for 22 winter surveys for the Large Lakes Program.

For the open water surveys, fishing boats were the most frequent unit counted (43%), followed by counts of anglers (45%), and counts of trailers-vehicles (10%), which are indirect counts of angling parties. Shanties and open ice anglers were counted in all the 22 winter surveys (Table 2).

Our surveys have achieved desirable precision for fishing effort and catch estimates for the large lakes surveys. The average coefficient of variations (CVs) across lakes for the open water surveys for effort, catch, catch rate, harvest, and harvest rate are 6.7%, 7.1%, 9.9%, 9.7%, and 12.0%, respectively (Table 3). The average winter survey CVs for the same estimates are almost doubled, 13.7%, 13.6%, 19.3%, 17.9%, and 22.9% (Table 4). Therefore, open water survey estimates are much more precise than winter survey estimates. This may be largely caused by doubled sampling effort directed to the open water surveys, where one creel clerk was deployed to collect interviews only and counts were made separately by an airplane for each lake; whereas, for a winter survey, one creel clerk was deployed both to collect interviews and make counts for each lake. Also notice that total effort and catch estimates are more precise than those of catch rate, harvest, and harvest rate.

The river surveys on average are less precise than the lake surveys. The average coefficient of variations (CVs) across rivers for effort, harvest, and catch estimates are 13.5%, 17.9%, and 26.3% respectively (Table 5).

In the following, we summarized our findings from the angler surveys conducted in the current period for the inland fisheries based on water body types: lake or river.

Findings: Jobs 1-9 were scheduled for 2005-06 and progress is reported below. This report is formatted as a final report rather than the scheduled annual progress report because the inland creel survey study (230646) and the Great Lakes creel survey study (230427) have both been amended to combine them into an umbrella creel survey study (230499) that begins in 2006-07.

Job 1. Title: <u>Examine creel survey sites.</u>

1. Characteristics of the large inland lake fisheries

There are 92 inland lakes that are 1,000 acres or more in size (Clark et al. 2004). Combined, these lakes total about 360,000 acres and provide a significant proportion of the total fishing activity in the state. We have surveyed 20 of these lakes in the last 5 years. Based on the results of 18 lakes with both open water and winter angler surveys (Table 6), the average fishing effort per acre (hours fished per acre) across lakes is 16.95 hours per acre. The average number of fish harvested and caught per acre are 13 .69 and 27.49 per acre, respectively. Assuming the 18 lakes are representative of the other large lakes, then the combined annual fishing effort on all 92 lakes is probably about 6.0 million angler hours per year (16.95 times 360,000). By comparison, the combined annual fishing effort for all Michigan waters of the Great Lakes was 4.4 million angler hours in 2004 (Thayer 2005). The combined annual catch and harvest from large inland lakes are thus estimated to be approximately 9.9 million and 4.9 million fish, respectively.

Open water survey seasons for these lakes are from the end of April in the Lower Peninsula or May 15 in the Upper Peninsula (coincides with the walleye opening date each year) to the end of September, or October (Table 6). The majority of the winter surveys covered the period from January through March each year (Table 6). This targets open ice and shanty fisheries on these lakes.

The largest amounts of fishing effort occur during the months of July and August for the open water fisheries and during January for the winter fisheries (Tables 7, 8). On average, winter fisheries of the 18 inland lakes make up of 26% of the total annual effort, 30% of the total harvest, and 24% of the total catch. On 16 of the 18 lakes, about 63% of the fish caught were released by the anglers (Table 6). The exceptions are Higgins Lake and Houghton Lake, where only 13.3% and 1.1% of the fish caught were released, respectively (Figure 1). Yellow perch, walleye, and bluegill are the predominant species caught in both the open water and winter fisheries (Tables 7, 8).

The top three fisheries based on fishing effort are Houghton Lake (357,122 angler-hours), Higgins Lake (250,962 angler-hours), and Manistique Lakes (228,788 angler-hours) (Table 6). The top three fisheries based on total harvest are Higgins Lake (692,254 fish), Houghton Lake (375,098 fish), and Cisco-Thousand Island Lake Chain (207,010 fish) (Table 6). The top three fisheries in terms of total catch are Higgins Lake (798,719 fish), Fletcher Floodwater (753,780 fish), and Cisco-Thousand Island Lake Chain (493,410 fish) (Table 6).

Among these 18 lakes, Cisco-Thousand Island Chain Lakes and Muskegon Lake are the most intensively fished lakes. Fishing effort per acre was 45.5 and 42.0 hours per acre, respectively (Figure 2). Cisco-Thousand Island Chain Lakes, Fletcher Floodwater, Higgins Lake, and Muskegon Lake have the highest number of fish caught per acre, 124, 84, 83 and 69, respectively (Figure 3).

Hours fished per acre were strongly related to fish harvested per acre Figure 4). This may imply that lakes with higher fish density (or higher catch rates) attracted more fishing effort.

2. The open water fisheries of the large inland lakes

Open water survey seasons spanned the period from May through September for most lakes (Table 7). Fishing effort and catch was usually highest during the months of June, July and August (Table 7). On 16 of the 18 lakes, about 67% of the fish caught were released by the anglers. The exceptions were Higgins Lake and Houghton Lake, where almost all the fish caught were kept (only 1.1% and 1.3% of the fish caught were released, respectively).

The top three fisheries based on fishing effort are Houghton Lake (278,214 angler-hours), Manistique Lakes (203,041 angler-hours), and Cisco-Thousand Island Lake Chain (171,310 angler-hours) (Table 7). The top three fisheries in terms of harvest are Houghton Lake (325,148 fish), Fletcher Floodwater (121,064 fish), and Cisco-Thousand Island Lake Chain (113,135 fish) (Table 7). The top three fisheries in terms of total catch are Fletcher Floodwater (554,337 fish), Cisco-Thousand Island Lake Chain (351,040 fish), and Houghton Lake (329,274 angler-hours) (Table 7). The predominant species harvested were yellow perch, bluegill, walleye, and pumpkinseed in these lakes.

Among these 18 lakes, Belleville Lake, Cisco-Thousand Island Chain Lakes, and Muskegon Lake are the most intensively fished lakes. Fishing effort per acre per year was 56 and 43 and 23 hours per acre, respectively (Table 7). Cisco-Thousand Island Chain Lakes, Muskegon Lake, and Houghton Lake have the highest number of fish harvested per acre, 28, 21, and 16, respectively (Table 7).

Hours fished per acre was related to fish harvested per acre if the latter is treated as an index of fish density (Figure 5).

An inverse relationship between harvest rates of yellow perch and walleye was observed in the open water fisheries (Figure 6).

3. The winter fisheries of the large inland lakes

Winter survey seasons were from January through March for most lakes (Table 8). Fishing effort and catch was usually highest in January (Table 8). On 16 of the 18 lakes, about 44% of the fish caught during winter were released by the anglers. The exception was Houghton Lake, where almost all the fish caught were kept (only 3.5% of the fish caught have been released) (Table 8).

The top three winter fisheries in terms of fishing effort are Houghton Lake (220,834 angler-hours), Higgins Lake (160,150 angler-hours), and Muskegon Lake (80,648 angler-hours) (Table 8). The top three fisheries in terms of harvest are Higgins Lake (583,399 fish), Muskegon Lake (93,875), and Houghton Lake (61,139 fish) (Table 8). The top three fisheries in terms of total catch are Higgins Lake (688,690 fish), Fletcher Floodwater (199,443 fish), and Muskegon Lake (142,370 fish) (Table 8). The predominant species harvested were yellow perch, bluegill, walleye, and pumpkinseed in these lakes.

Among these 18 lakes, Muskegon Lake, Crystal Lakes, and Higgins Lake are the most intensively fished lakes. Fishing effort per acre per year was 19.1 and 18.9 and 16.7 hours per acre, respectively (Table 8). Higgins Lake, Muskegon Lake, and Fletcher Floodwater have the highest number of fish harvested per acre, 3.6, 1.2, and 1.0, respectively (Table 8).

Hours fished per acre was positively related to fish harvested per acre if the latter is treated as an index of fish density (Figure 7).

A weak inverse relationship between harvest rates of yellow perch and walleye was evident (Figure 8).

4. The open water fisheries of the rivers

The river surveys are less comparable due to large differences in length of survey season and length of survey sections. Summary statistics for the major river surveys are listed in Table 9 for general reference.

Job 2. Title: Sampling intensity, techniques, and proposed level of statistical significance.– Error bounds (2 SE) were calculated for each estimate and provided a measure of uncertainty in the estimate. The error bounds can be used to calculate a crude 95% confidence interval by taking the estimate plus or minus error bound. Rates of precision (mean/2 SE) were not predetermined for any of the surveys. Unless otherwise noted, all estimates in this report were ±2 SE.

Design and estimation methods used for surveys given in this report followed the multiple-day period (Lockwood et al. 1999). Survey planning in each instance followed general funding and supervisory procedures given in Lockwood (2000a). Survey design naming conventions followed those given Lockwood (2000b).

Job 3. Title: Prepare stratified-random schedules.–Schedules were prepared and distributed to appropriate personnel. All survey schedules made since 2004 have been generated by the Creel Survey Designer program (MiCreel Designer; Su 2004), and those before 2004 were done manually.

General information, and work shifts and expansion values for surveys given in this report, are available in Angler Surveys on Michigan Inland Waters, 2000–06, available on the DNR Intranet (http://dnrintranet). Instructions and schedules for these surveys are available on separate documents.

Job 4. Title: Train creel clerks.–A two-day training session has been given annually to clerks since 2004. Written instructions were prepared for all surveys conducted in the current five year survey periods. Management unit personnel provided additional on-site training for clerks. Training descriptions for surveys conducted during previous survey season were given in Lockwood (2000a).

Job 5. Title: Survey inland waters.–Seventy-nine angler surveys were conducted, between spring 2000 and fall 2006 on the inland waters of Michigan (Table 1). Fifty-eight surveys were conducted on inland lakes and 21 surveys were conducted on inland rivers. Both open water and winter surveys were conducted on 18 large inland lakes. Most sites were in the western end of the Upper Peninsula, and the northern part of the Lower Peninsula.

Angler surveys were conducted for a variety of reasons. Thirty-nine angler surveys were part of a new, statewide program designed to improve assessment and monitoring of fish communities and fisheries in Michigan's largest inland lakes, known as the Large Lakes Program (Clark et al. 2004). All the other surveys were conducted based on local management needs to evaluate fish stocking, obtain catch or harvest estimates of specific species of interest, and characterize the fisheries.

Job 6. Title: Supervise count and interview data processing, and quality control.–Count and interview data from current five year survey periods were processed at the Institute for Fisheries Research. Additional range checking of all data was done at the Institute for Fisheries Research.

Job 7. Title: Calculate and distribute catch and pressure estimates.–Effort and catch estimates were calculated by the inland creel survey estimation program (MiCreel Estimator). This program is capable of reading in or querying creel survey data stored in plain text, Microsoft Excel (.xls), dbase (.dbf), and Microsoft Access database (.mdb) formats. The calculations of catch rate, effort, and catch estimates were based on Lockwood et al. (1999) multiple-day estimation methods.

Total effort and detailed catch estimates for each survey are given in Angler Surveys on Michigan Inland Waters, 2000–06, available on the DNR Intranet (http://dnrintranet).

Job 8. Title: Write annual performance report.–This report was prepared as a final report because this study has been ended ahead of schedule. Michigan's inland and Great Lakes creel survey programs have been rolled into an umbrella study encompassing all waters of Michigan (New study 230499 which commences in 2006-07).

Job 9. Title: Write study renewal for next 5 year cycle.−This study is not being renewed because Michigan's inland and Great Lakes creel survey programs have been incorporated into a new creel study encompassing all waters of Michigan (new study 230499).

Literature Cited:

Clark, R. D., P. A. Hanchin, and R. N. Lockwood. 2004. The fish community and fishery of Houghton Lake, Roscommon County, Michigan with emphasis on walleyes and northern pike. Michigan Department of Natural Resources, Fisheries Special Report 30, Ann Arbor.

Lockwood, R. N. 2000a. Conducting roving and access site angler surveys. Chapter 14 *in* Schneider, James C. (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Lockwood, R. N. 2000b. Sportfishing angler surveys on Michigan Inland waters, 1993-99. Michigan Department of Natural Resources, Fisheries Technical Report 2000-3, Ann Arbor.

Lockwood, R. N., D. M. Benjamin, and J. R. Bence. 1999. Estimating angling effort and catch from Michigan roving and access site angler survey data. Michigan Department of Natural Resources, Fisheries Research Report 2044, Ann Arbor.

Su, Z. 2004. Inland creel surveys, Study 230646, Project F-81-R-5. Annual performance report of Michigan Department of Natural Resources to U.S. Fish and Wildlife Service, Federal Aid in Sport Fish Restoration, Twin Cities, Minnesota.

Thayer, S. 2005. Measurement of sport fishing harvest in the Michigan waters of lakes Michigan, Huron, Erie and Superior, Study 230427, Project F-81-R-6. Annual performance report of Michigan Department of Natural Resources to U.S. Fish and Wildlife Service, Federal Aid in Sport Fish Restoration, Twin Cities, Minnesota.

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Date: September 30, 2006

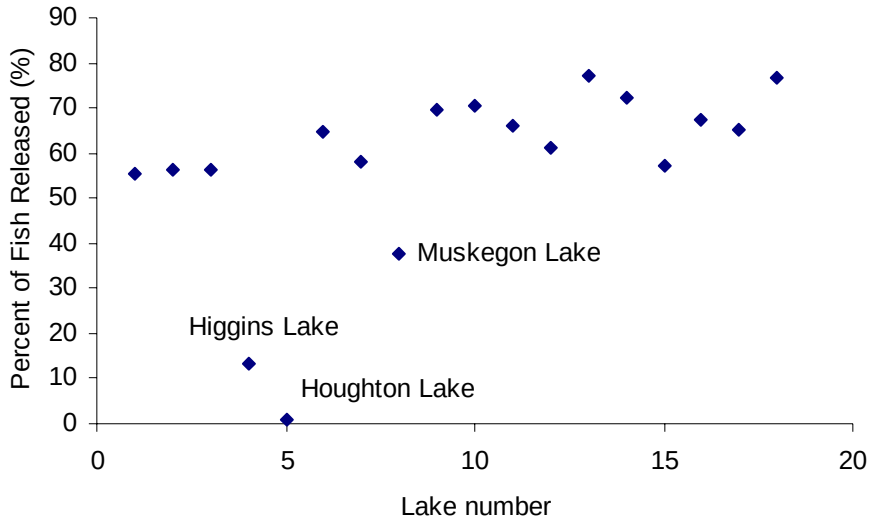

Figure 1.–Percent of fish released in annual total catch. Source data are from Table 6.

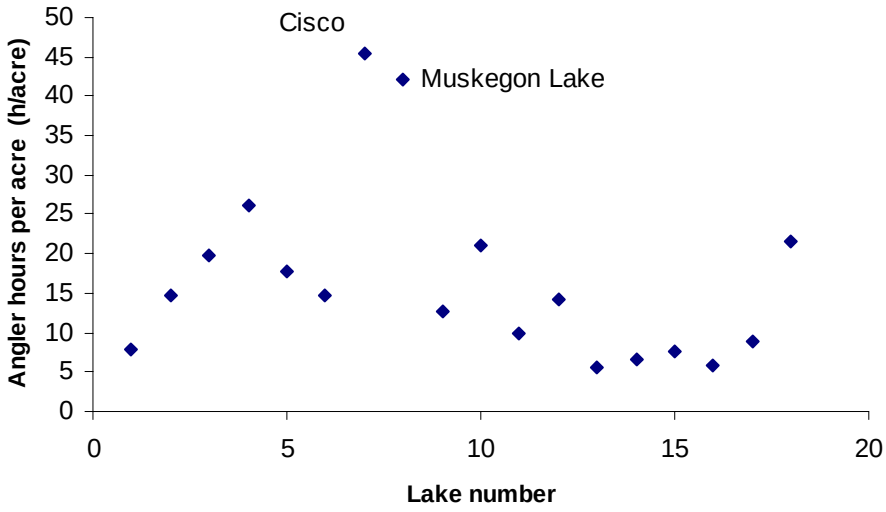

Figure 2.–Angler hours fished per acre for 18 lakes listed in Table 6.

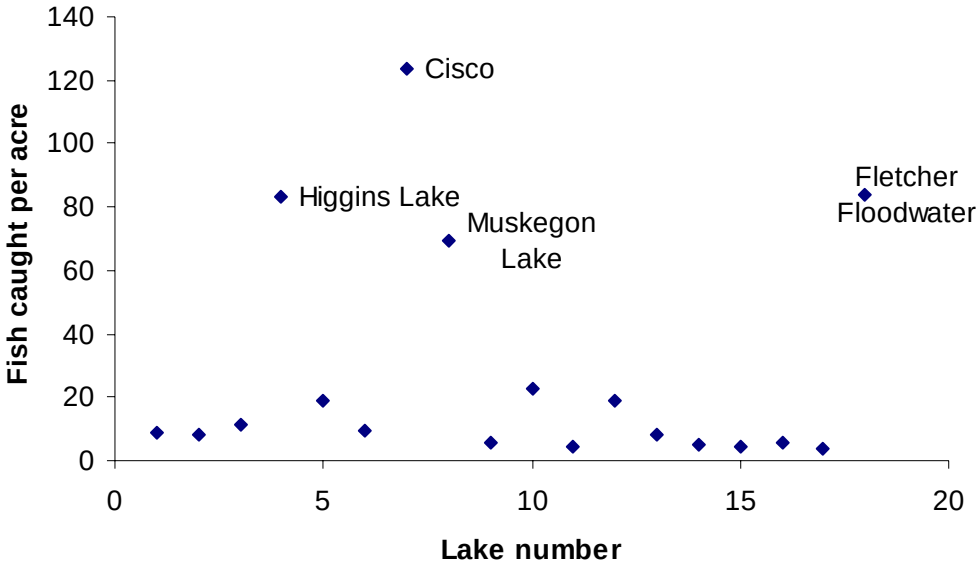

Figure 3.–Fish caught per acre for the 18 lakes listed in Table 6.

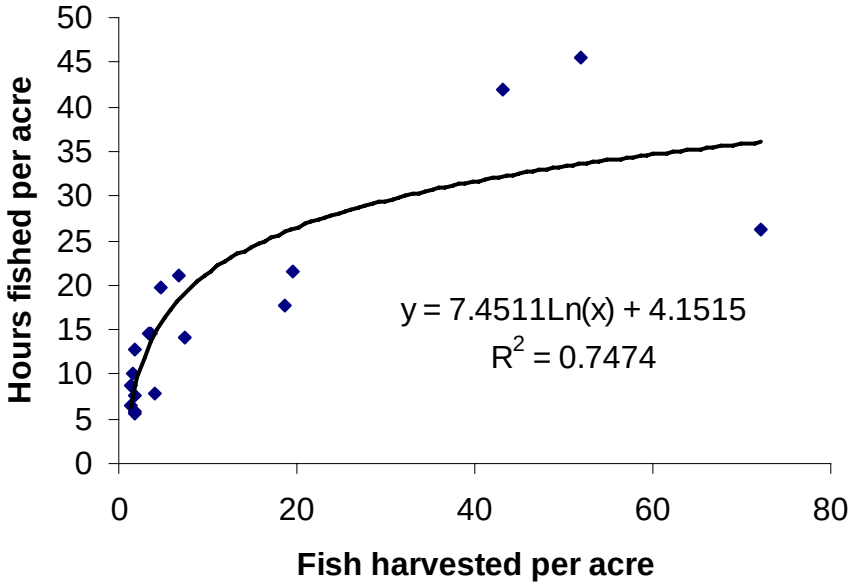

Figure 4.–Relation of fish harvested per acre and hours fished per acre for the 18 lakes listed in Table 6.

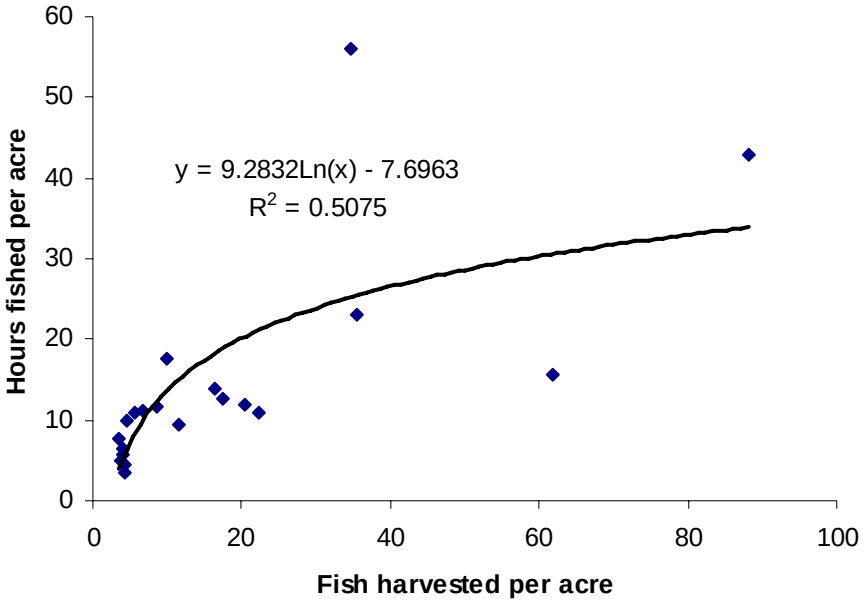

Figure 5.–Relation of fish harvested per acre and hours fished per acre for the 18 lakes listed in Table 7 (open water fisheries).

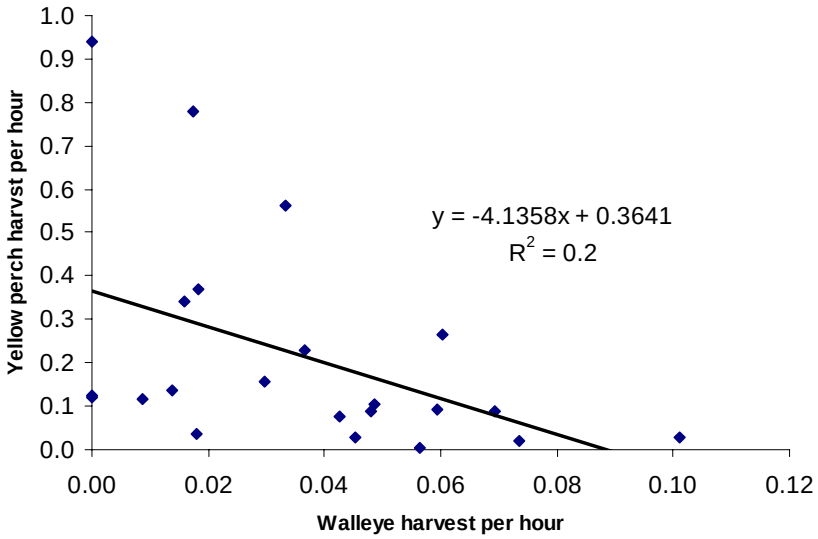

Figure 6.–Relation of yellow perch and walleye in their harvest rates (harvest per hour for open water fisheries). Source data are from Table 7.

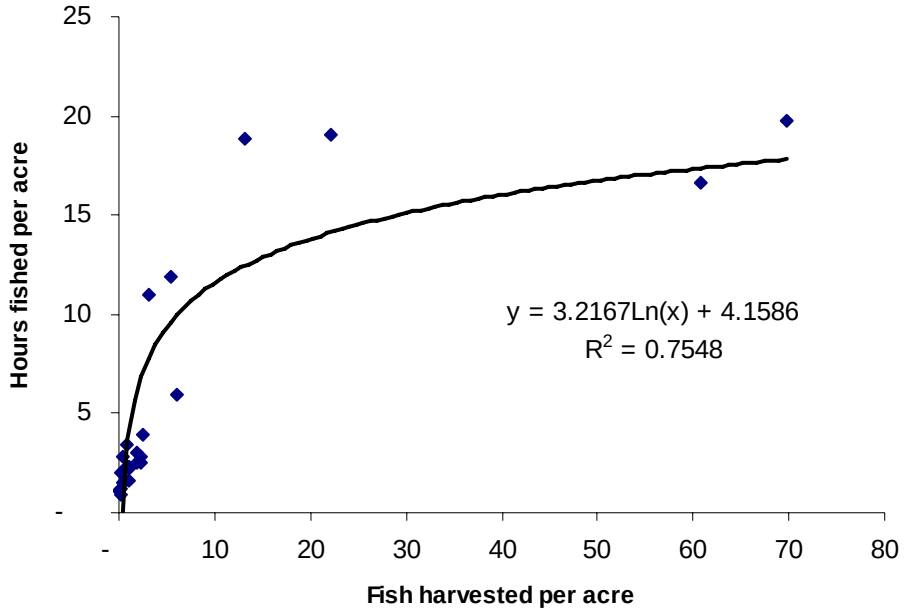

Figure 7.–Relation of fish harvested per acre and hours fished per acre for the 18 lakes listed in Table 8 (winter fisheries).

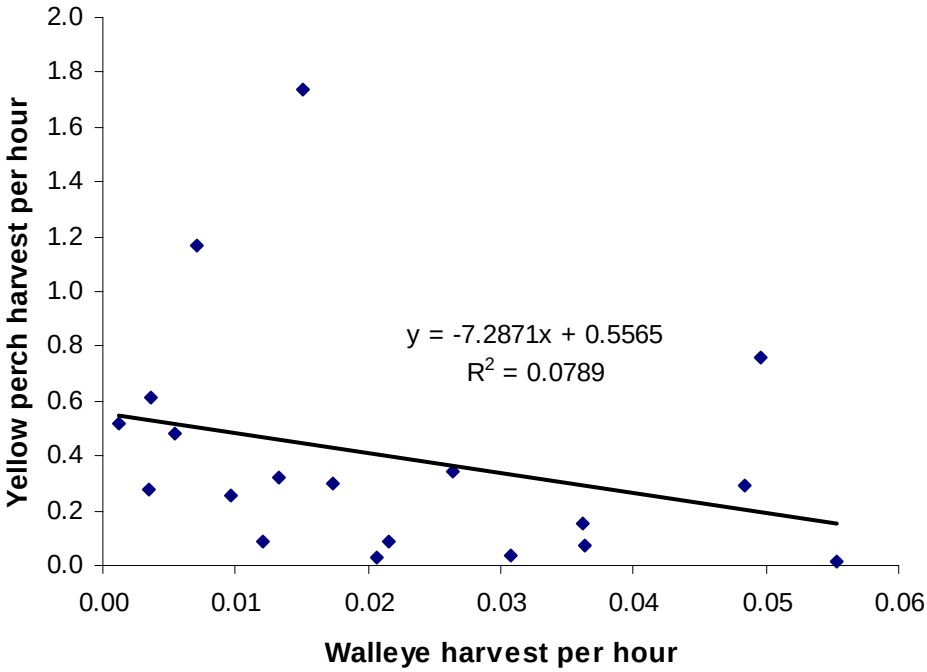

Figure 8.–Relation of yellow perch and walleye harvest per hour for the 18 lakes listed in Table 8 (winter fisheries).

Table 1.–Angler surveys conducted from 2000 to 2006 on the inland waters of Michigan. SUM – summer, WIN – winter.

Year	Water body	Basin	Season	Type
2000	Au Sable River	Huron	SUM	management
	Monocle Lake and Tahquamenon River (Ebr)	Superior	SUM	management
2001	Burt Lake	Huron	WIN	large lake
	Crooked Lake	Michigan	WIN	large lake
	Pickerel Lake	Michigan	WIN	large lake
	Higgins Lake	Michigan	WIN	large lake
	Houghton Lake	Michigan	WIN	large lake
	Burt Lake	Huron	SUM	large lake
	Crooked Lake	Michigan	SUM	large lake
	Pickerel Lake	Michigan	SUM	large lake
	Higgins Lake	Michigan	SUM	large lake
	Houghton Lake	Michigan	SUM	large lake
	Michigamme Reservoir	Superior	SUM	large lake
2002	Burt Lake	Michigan	WIN	large lake
	Crooked Lake	Michigan	WIN	large lake
	Pickerel Lake	Michigan	WIN	large lake
	Higgins Lake	Michigan	WIN	large lake
	Houghton Lake	Michigan	WIN	large lake
	Michigamme Reservoir	Superior	WIN	large lake
	Cisco-Thousand Island Lake Chain	Superior	SUM	large lake
	Muskegon Lake	Michigan	SUM	large lake
	Leelanau Lake	Michigan	SUM	large lake
	Au Sable River	Huron	SUM	management
	Buck Creek and Coldwater River	Michigan	SUM	management
	Grand River - lower and Rogue River	Michigan	SUM	management
	Grand River - upper	Michigan	SUM	management
	Gull Lake	Michigan	SUM	management
	Manistee River	Michigan	SUM	management
	Sucker River	Superior	SUM	management
	Muskallonge Lake			
2003	Cisco-Thousand Island Lake Chain	Superior	WIN	large lake
	Muskegon Lake	Michigan	WIN	large lake
	Leelanau Lake	Michigan	WIN	large lake
	Crystal Lake	Michigan	SUM	large lake
	Green Lake	Michigan	SUM	large lake
	Bond Falls Flowage	Superior	SUM	large lake
	Manistique Lakes	Michigan	SUM	large lake
	Crockery, Half, Lime, Clear	Michigan	SUM	management
	Grand River-lower and Rogue River	Michigan	SUM	management
	Grand River-upper	Michigan	SUM	management
	Manistee River	Michigan	SUM	management

Table 1.–Continued.

Year	Water body	Basin	Season	Type
2004	Green Lake	Michigan	WIN	large lake
	Crystal Lake	Michigan	WIN	large lake
	Manistique Lakes	Michigan	WIN	large lake
	Grand Lake	Huron	SUM	large lake
	Long Lake	Huron	SUM	large lake
	Peavy Pond	Superior	SUM	large lake
	Escanaba River	Michigan	SUM	management
	Grand River Lower and Rogue River	Michigan	SUM	management
	Grand River Upper	Michigan	SUM	management
	Kalamazoo River	Michigan	SUM	management
	Tahquamenon River	Michigan	SUM	management
	Little Manistee River	Michigan	SUM	management
2005	Grand Lake	Huron	WIN	large lake
	Long Lake	Huron	WIN	large lake
	Peavy Pond	Superior	WIN	large lake
	Black Lake	Huron	SUM	large lake
	Lake Gogebic	Superior	SUM	large lake
	Fletcher Floodwater	Huron	SUM	management
	Campau Lake and Murray Lake	Michigan	SUM	management
	Paw Paw Lake	Michigan	SUM	management
	Boardman River	Michigan	SUM	management
	Menominee River	Michigan	SUM	management
	Belleville Lake	Erie	SUM	management
	Maceday and Lotus Lakes	Erie	SUM	management
	Clinton River	Erie	SUM	management
	Tahquamenon River	Superior	SUM	management
	Sucker River	Superior	SUM	management
2006	Black Lake	Huron	WIN	large lake
	Lake Gogebic	Superior	WIN	large lake
	Fletcher Floodwater	Huron	WIN	management
	Lake Charlevoix	Michigan	SUM	large lake
	Lake Michigamme	Superior	SUM	large lake
	Hardy Pond	Michigan	SUM	management
	Gun Lake	Michigan	SUM	management
	Lake Cadillac and Mitchell	Michigan	SUM	management
	Dowagiac Creek	Michigan	SUM	management
	Hubbard Lake	Huron	SUM	management
	Ford Lake	Erie	SUM	management

Table 2.–Interview and count methods (roving and/or access point interviews, ground or aerial counts) deployed and types of interviews of counts in terms of fishing modes. 1–fishing boats, 2–shore anglers, 4–open ice anglers, 5–dock/pier anglers, 6–shanties, 7–trailers representing fishing boats, 8–cars representing anglers. SUM – summer, WIN – winter.

			Interview modes							
			Roving		Access		Ground count mode			Aerial count
Year	Water body	Season	Party	Angler	Party	Angler	Party	Angler	trailer, car	Boat
2000	Au Sable River	SUM			1	2				
	Monocle Lake and Tahquamenon (Ebr)	SUM			1	2	1	2		
2001	Burt Lake	WIN	6	4			6	4		
	Crooked Lake	WIN	6	4			6	4		
	Pickerel Lake	WIN	6	4			6	4		
	Higgins Lake	WIN	6	4			6	4		
	Houghton Lake	WIN	6	4			6	4		
	Burt Lake	SUM	1							1
	Crooked Lake	SUM	1							1
	Pickerel Lake	SUM	1							1
	Higgins Lake	SUM	1							1
	Houghton Lake	SUM	1							1
	Michigamme Reservoir	SUM	1							1
2002	Burt Lake	WIN	6	4			6	4		
	Crooked Lake	WIN	6	4			6	4		
	Pickerel Lake	WIN	6	4			6	4		
	Higgins Lake	WIN	6	4			6	4		
	Houghton Lake	WIN	6	4			6	4		
	Michigamme Reservoir	WIN	6	4			6	4		
	Cisco-Thousand Island Lake Chain	SUM	1							1
	Muskegon Lake	SUM	1		1	2				1
	Leelanau Lake	SUM	1							1
	Au Sable River	SUM			1	2	1	2		
	Buck and Coldwater rivers	SUM	1			2		2	8	
	Grand River-lower and Rogue River	SUM				2		2	8	
	Grand River-upper	SUM		2		2	1	2		
	Gull Lake	SUM	1		1		1			
	Manistee River	SUM	1	2				2	8	
	Sucker River	SUM		2		2			8	
	Muskallonge Lake									
2003	Cisco-Thousand Island Lake Chain	WIN	6	4			6	4		
	Muskegon Lake	WIN			6	4	6	4		
	Leelanau Lake	WIN	6	4			6	4		
	Crystal Lake	SUM	1							1
	Green Lake	SUM	1							1
	Bond Falls Flowage	SUM	1							1
	Manistique Lakes	SUM	1							1
	Crockery, Half, Lime, Clear	SUM			1	2	1	2	8	
	Grand River-lower and Rogue	SUM			1	2		2	8	
	Grand River-upper	SUM		2		2	1	2		
	Manistee River	SUM	1	2	1	2	1	2		

Table 2.–Continued.

Year	Water body	Season	Interview modes: Roving Party	Roving Angler	Access Party	Access Angler	Ground count mode: Party	Ground count mode: Angler	Ground count mode: trailer, car	Aerial count: Boat
2004	Green Lake	WIN	6	4			6	4		
	Crystal Lake	WIN	6	4			6	4		
	Manistique Lakes	WIN	6	4			6	4		
	Grand Lake	SUM	1				1			
	Long Lake	SUM	1				1			
	Peavy Pond	SUM	1				1			
	Escanaba River	SUM			1	2	1	2	7, 8	
	Grand River-lower and Rogue River	SUM			1	2, 5		2, 5	7, 8	
	Grand River-upper	SUM			1	2	1	2		
	Kalamazoo River	SUM			1	2	1	2		
	Tahquamenon River	SUM	1	2	1	2	1	2		
	Little Manistee River	SUM		2				2	8	
2005	Grand Lake	WIN	6	4			6	4		
	Long Lake	WIN	6	4			6	4		
	Peavy Pond	WIN	6	4			6	4		
	Black Lake	SUM	1							1
	Lake Gogebic	SUM	1							1
	Fletcher Floodwater	SUM	1	2	1	2	1	2		
	Campau and Murray lakes	SUM	1	2	1	2	1	2		
	Paw Paw Lake	SUM	1	2	1	2	1	2		
	Boardman River	SUM	1	2	1	2	1	2		
	Menominee River	SUM			1	2	1	2	7, 8	
	Belleville Lake	SUM	1	2	1	2	1	2		
	Maceday and Lotus lakes	SUM	1	2	1	2	1	2		
	Clinton River	SUM			1	2	1	2		
	Tahquamenon River	SUM	1	2	1	2	1	2	7, 8	
	Sucker River	SUM								
2006	Black Lake	WIN	6	4			6	4		
	Lake Gogebic	WIN	6	4			6	4		
	Fletcher Floodwater	WIN	6	4			6	4		
	Lake Charlevoix	SUM	1							1
	Lake Michigamme	SUM	1							1
	Hardy Pond	SUM	1	2	1	2	1	2		
	Gun Lake	SUM	1	2	1	2	1	2		
	lakes Cadillac and Mitchell	SUM	1	2	1	2	1	2		
	Dowagiac Creek	SUM	1	2	1	2	1	2	7, 8	
	Hubbard Lake	SUM	1	2	1	2	1	2		
	Ford Lake	SUM	1	2	1	2	1	2		

Table 3.–Coefficients of variations (CVs) of fishing effort (angler-hours), catch, catch rate (catch/h), harvest, and harvest rate (harvest/h) estimates for open water large inland lake surveys. Cisco - Cisco-Thousand Island Lake Chain.

		CV (%)				
Year	Water body	Effort	Catch	Catch rate	Harvest	Harvest rate
2001	Burt Lake	4.3	10.2	11.1	13.9	14.6
	Crooked Lake	6.4	7.5	9.9	12.2	13.8
	Pickerel Lake	8.8	9.5	13.0	13.4	16.1
	Higgins Lake	5.0	7.0	8.6	7.1	8.7
	Houghton Lake	4.8	7.5	8.9	7.6	9.0
	Michigamme Reservoir	5.4	4.3	6.9	6.4	8.4
2002	Cisco	2.9	3.4	4.5	4.8	5.6
	Muskegon Lake	9.6	6.1	11.4	8.6	12.9
	Leelanau Lake	6.9	5.8	9.0	8.7	11.1
2003	Green Lake	8.0	5.4	9.7	8.0	11.3
	Bond Falls Flowage	7.8	13.6	15.6	11.4	13.8
	Manistique Lakes	4.8	4.8	6.8	8.9	10.1
2004	Grand Lake	9.1	10.0	13.5	13.1	15.9
	Long Lake	11.1	9.4	14.5	13.1	17.2
	Peavy Pond	8.5	5.6	10.2	9.2	12.5
2005	Black Lake	6.0	8.5	10.4	13.1	14.4
	Lake Gogebic	6.9	5.7	9.0	8.1	10.7
	Fletcher Floodwater	6.1	3.6	7.1	5.1	8.0
	Belleville Lake	5.1	7.2	8.8	12.0	13.0
Average		6.7	7.1	9.9	9.7	12.0

Table 4.–Coefficients of variations (CVs) of fishing effort (angler-hours), catch, catch rate (catch/h), harvest, and harvest rate (harvest/h) estimates for winter large inland lake surveys. Cisco -- Cisco-Thousand Island Lake Chain.

		CV (%)				
Year	Water body	Effort	Catch	Catch rate	Harvest	Harvest rate
2002	Burt Lake	10.6	9	14	12.2	16.1
	Crooked Lake	19.5	17	26	20.1	28.0
	Pickerel Lake	22.6	27	39	50.0	54.9
	Higgins Lake	11.7	9	22	10.2	15.6
	Houghton Lake	9.6	11	0	10.9	14.5
	Michigamme Reservoir	9.5	7	12	8.5	12.7
2003	Cisco	28.4	23	36	31.8	42.6
	Muskegon Lake	10.0	9	13	11.0	14.8
	Leelanau Lake	12.7	23	26	26.8	29.7
2004	Green Lake	12.1	15	19	20.5	23.8
	Crystal Lake	8.5	7	11	8.4	12.0
	Manistique Lakes	8.7	12	14	15.0	17.3
2005	Grand Lake	18.0	12	22	16.6	24.5
	Long Lake	11.0	18	21	23.2	25.7
	Peavy Pond	19.9	18	27	18.8	27.4
2006	Black Lake	10.6	11	15	15.7	19.0
	Lake Gogebic	13.1	12	18	15.3	20.2
	Fletcher Floodwater	10.9	5	12	6.6	12.7
Average		13.7	13.6	19.3	17.9	22.9

Table 5.–Coefficients of variations (CVs) of fishing effort (angler-hours), harvest, and catch estimates for inland river surveys

Year	Water body	CV (%)		
		Effort	Harvest	Catch
2002	Buck Creek and Coldwater River	16.0	41.0	38.2
	Grand River (lower) and Rogue River	6.3	11.5	10.2
	Grand River (upper)	6.7	28.4	12.9
	Manistee River	81.9	47.6	40.2
2003	Grand River (lower) and Rogue River	5.9	8.7	7.0
	Grand River (upper)	6.4	24.2	12.8
	Manistee River	8.0	18.6	11.8
2004	Escanaba River	16.6	49.5	28.8
	Grand River (lower) and Rogue River	4.3	18.6	10.3
	Grand River (upper)	4.7	17.3	10.5
	Kalamazoo River	5.2	12.3	8.7
	Tahquamenon River (upper)	11.7	30.5	17.1
	Little Manistee River	11.0	31.0	30.6
2005	Boardman River	11.8	29.5	12.9
	Menominee River	6.4	16.0	15.4
	Tahquamenon River (lower)	12.5	35.6	19.3

Table 6.–Comparison of recreational fishing effort, harvest and catch among 18 large inland lakes surveyed from 2001 to 2006.

Water body	Season (months, year) Open water	Winter	Area (acres)	Effort (h)	Harvest (number)	Catch (number)	Fish released (%)	Catch per hour	Harvest per hour	Catch per acre	Harvest per acre	Hours fished per acre
Burt Lake	5–9, 2001	1–3, 2002	17,120	134,748	68,216	152,999	55.4	1.14	0.51	8.94	3.98	7.87
Crooked Lake	5–9, 2001	1–3, 2002	2,351	34,469	8,227	18,763	56.2	0.54	0.24	7.98	3.50	14.66
Pickerel Lake	5–9, 2001	1–3, 2002	1,080	21,415	5,204	11,941	56.4	0.56	0.24	11.06	4.82	19.83
Higgins Lake	5–9, 2001	1–3, 2002	9,600	250,962	692,254	798,719	13.3	3.18	2.76	83.20	72.11	26.14
Houghton Lake	5–9, 2001	1–3, 2002	20,075	357,122	375,098	379,224	1.1	1.06	1.05	18.89	18.68	17.79
Michigamme Reservoir	5–10, 2001	1–2, 2002	6,400	93,543	21,623	60,971	64.5	0.65	0.23	9.53	3.38	14.62
Cisco	5–10, 2002	12–2, 2003	3,987	181,392	207,010	493,410	58.0	2.72	1.14	123.75	51.92	45.50
Muskegon Lake	5–11, 2002	1–3, 2003	4,232	177,819	182,458	292,625	37.6	1.65	1.03	69.15	43.11	42.02
Leelanau Lake	5–9, 2002	12–3, 2003	8,607	110,118	15,316	50,506	69.7	0.46	0.14	5.87	1.78	12.79
Green Lake	4–9, 2003	1–3, 2004	1,994	41,976	13,298	45,044	70.5	1.07	0.32	22.59	6.67	21.05
Bond Falls Flowage	5–10, 2003	–	2,100	20,991	3,200	9,452	66.1	0.45	0.15	4.50	1.52	10.00
Manistique Lakes	5–10, 2003	1–3, 2004	16,187	228,788	119,350	307,048	61.1	1.34	0.52	18.97	7.37	14.13
Grand Lake	5–10, 2004	1–3, 2005	5,822	33,082	10,622	46,552	77.2	1.41	0.32	8.00	1.82	5.68
Long Lake	5–10, 2004	1–3, 2005	5,341	34,950	7,026	25,417	72.4	0.73	0.20	4.76	1.32	6.54
Peavy Pond	5–10, 2004	1–3, 2005	3,500	26,447	6,299	14,765	57.3	0.56	0.24	4.22	1.80	7.56
Black Lake	5–9, 2005	1–3, 2006	10,130	59,861	18,747	57,392	67.3	0.96	0.31	5.67	1.85	5.91
Lake Gogebic	5–9, 2005	1–3, 2006	13,380	117,244	17,650	50,651	65.2	0.43	0.15	3.79	1.32	8.76
Fletcher Floodwater	5–9, 2005	1–3, 2006	8,970	193,763	174,782	753,780	76.8	3.89	0.90	84.03	19.49	21.60

Table 7.–Summary statistics for open water large inland lake surveys.

Year	Water body	Season	Dominant fishing months	Area (acres)	Effort (h)	Harvest (number)	Catch (number)	Fish released (%)	Catch rate	Harvest rate	Catch per acre	Harvest per acre	Hours fished per acre	Dominant species
2001	Burt Lake	5–9	7–8	17,120	86,113	28,750	64,875	55.7	0.75	0.33	3.79	1.68	5.03	Yellow perch Walleye
	Crooked Lake	5–9	7–8	2,351	26,442	6,095	15,954	61.8	0.60	0.23	6.79	2.59	11.25	Yellow perch Walleye
	Pickerel Lake	5–9	7–8	1,080	18,946	4,095	10,640	61.5	0.56	0.22	9.85	3.79	17.54	Bluegill Yellow perch
	Higgins Lake	5–9	7–8	9,600	90,812	108,855	110,029	1.1	1.21	1.20	11.46	11.34	9.46	Yellow perch Rock bass
	Houghton Lake	5–9	6–8	20,075	278,214	325,148	329,274	1.3	1.18	1.17	16.40	16.20	13.86	Bluegill Pumpkinseed
	Michigamme Reservoir	5–10	7–8	6,400	75,240	19,584	55,675	64.8	0.74	0.26	8.70	3.06	11.76	Yellow perch Walleye Bluegill
2002	Cisco	5–10	6–8	3,987	171,310	113,135	351,040	67.8	2.05	0.66	88.05	28.38	42.97	Yellow perch Bluegill Walleye
	Muskegon Lake	5–11	6–9	4,232	97,171	88,583	150,255	41.0	1.55	0.91	35.50	20.93	22.96	Yellow perch Bluegill Pumpkinseed
	Leelanau Lake	5–9	6–7	8,607	93,135	12,916	47,577	72.9	0.51	0.14	5.53	1.50	10.82	Walleye Yellow perch
	Gull Lake	5–8	6, 8	2,046	22,359	15,147	45,917	67.0	2.05	0.68	22.44	7.40	10.93	Bluegill
2003	Green Lake	4–9	6–8	1994	23,697	11,030	40,608	72.8	1.71	0.47	20.37	5.53	11.88	Bluegill Yellow perch Rock bass
	Bond Falls Flowage	5–10	5–8	2,100	20,991	3,200	9,452	66.1	0.45	0.15	4.50	1.52	10.00	Walleye Yellow perch
	Manistique Lakes	5–10	6–8	16,187	203,041	103,166	284,185	63.7	1.40	0.51	17.56	6.37	12.54	Yellow perch Bluegill Walleye

Table 7.–Continued.

Year	Water body	Season	Dominant fishing months	Area (acres)	Effort (h)	Harvest (number)	Catch (number)	Fish released (%)	Catch rate	Harvest rate	Catch per acre	Harvest per acre	Hours fished per acre	Dominant species
2004	Grand Lake	5–10	7–8	5,822	19,928	4,245	25,079	83.1	1.26	0.21	4.31	0.73	3.42	Yellow perch Smallmouth bass
	Long Lake	5–10	7–8	5,341	29,950	5,673	21,717	73.9	0.73	0.19	4.07	1.06	5.61	Yellow perch Smallmouth bass
	Peavy Pond	5–10	7–9	3,500	22,527	5,972	14,063	57.5	0.62	0.27	4.02	1.71	6.44	Yellow perch Walleye
2005	Black Lake	5–9	7–8	10,130	44,298	13,590	43,766	68.9	0.99	0.31	4.32	1.34	4.37	Yellow perch Walleye
	Lake Gogebic	5–9	6–7	13,380	101,372	15,689	47,242	66.8	0.47	0.15	3.53	1.17	7.58	Yellow perch Walleye
	Fletcher Floodwater	5–9	6–7	8,970	140,331	121,064	554,337	78.2	3.95	0.86	61.80	13.50	15.64	Bluegill Pumpkinseed Yellow perch
	Belleville Lake	4–10	5–7	1,253	70,284	11,018	43,517	74.7	0.62	0.16	34.73	8.79	56.09	Walleye Bluegill

Table 8.–Summary statistics for winter large inland lake surveys.

Year	Water body	Season	Dominant months	Effort (h)	Harvest (number)	Catch	Fish released (%)	Catch per hour	Harvest per hour	Harvest per acre	Hours fished per acre	Dominant species
2001	Burt Lake	1–3	1–2	42,391	38,483	–	–	–	0.9	2.2	2.5	Yellow perch Walleye Brown trout
	Crooked Lake	1–3	1, 2	5,503	2,201	–	–	–	0.4	0.9	2.3	Yellow perch Walleye
	Pickerel Lake	1–3	1, 2	3,258	2,051	–	–	–	0.6	1.9	3.0	Yellow perch
	Higgins Lake	1–3	3	189,479	669,269	–	–	–	3.5	69.7	19.7	Yellow perch Lake trout Rainbow trout
	Houghton Lake	1–3	1, 2	78,908	49,950	–	–	–	0.6	2.5	3.9	Bluegill Black crappie Yellow perch
2002	Burt Lake	1–3	1–2	48,635	39,466	88,124	55	1.8	0.8	2.3	2.8	Yellow perch Walleye Brown trout
	Crooked Lake	1–3	1, 2	8,027	2,132	2,809	24	0.3	0.3	0.9	3.4	Yellow perch Walleye
	Pickerel Lake	1–3	1, 2	2,469	1,109	1,301	15	0.5	0.4	1.0	2.3	Yellow perch
	Higgins Lake	1–3	3	160,150	583,399	688,690	15	4.3	3.6	60.8	16.7	Yellow perch Lake trout Rainbow trout
	Houghton Lake	1–3	1, 2	220,834	61,139	63,384	3.5	0.3	0.3	3.0	11.0	Bluegill Black crappie Yellow perch
	Michigamme Reservoir	1–2	2	18,303	2,039	5,296	61	0.3	0.1	0.3	2.9	Walleye Black crappie Yellow perch

Table 8.–Continued.

Year	Water body	Season	Dominant months	Effort (h)	Harvest (number)	Catch	Fish released (%)	Catch per hour	Harvest per hour	Harvest per acre	Hours fished per acre	Dominant species
2003	Cisco–Thousand Island Lake Chain	12–2	1	10,082	7,220	11,006	34	1.1	0.7	1.8	2.5	Yellow perch Bluegill
	Muskegon Lake	1–3	2	80,648	93,875	142,370	34	1.8	1.2	22.2	19.1	Yellow perch Bluegill
	Leelanau Lake	12–3	2–3	16,983	2,400	2,929	18	0.2	0.1	0.3	2.0	Yellow perch Walleye
2004	Green Lake	1–3	1–2	23,697	11,030	40,608	73	1.7	0.5	5.5	11.9	Yellow perch Northern pike
	Crystal Lake	1–3	2	39,604	27,543	36,958	25	0.9	0.7	13.1	18.9	Yellow perch Lake trout
	Manistique Lakes	1–3	1–2	25,747	16,184	22,863	29	0.9	0.6	1.0	1.6	Yellow perch Walleye
2005	Grand Lake	1–3	1–2	13,154	6,377	21,473	70	1.6	0.5	1.1	2.3	Yellow perch
	Long Lake	1–3	1–2	5,000	1,353	3,700	63	0.7	0.3	0.3	0.9	Yellow perch
	Peavy Pond	1–3	3	3,920	327	702	53	0.2	0.1	0.1	1.1	Yellow perch Walleye
2006	Black Lake	1–3	1	15,563	5,157	13,626	62	0.9	0.3	0.5	1.5	Yellow perch Walleye
	Lake Gogebic	1–3	1	15,872	1,961	3,409	42	0.2	0.1	0.1	1.2	Yellow perch Walleye
	Fletcher Floodwater	1–3	1–2	53,432	53,718	199,443	73	3.7	1.0	6.0	6.0	Bluegill Yellow perch Pumpkinseed

Table 9.–Summary statistics for river surveys.

Year	Water body	Season	Dominant months	Effort	Harvest	Catch	Dominant species
2002	Buck and Coldwater rivers	5–8	5	6,087	450	9,459	Brown trout (8,575)
	Grand River (lower) and Rogue River	3, 4, 9–11	3, 4, 10	113,358	7,776	26,136	Rainbow trout (4,698) Chinook salmon (2,116)
	Grand River (upper)	3, 4, 9–11	3, 4, 10	21,786	1,583	9,537	Bluegill (603) Coho salmon (403) Rainbow trout (206)
	Manistee River	5–8	6	59,019	839	1,228	Walleye (763)
2003	Grand River (lower) and Rogue River	3, 4, 9–11	3, 4, 9, 10	96,423	8,876	19,949	Rainbow trout (5,344) Walleye (798) Coho salmon (561)
	Grand River (upper)	3, 4, 9, 10	10	17,996	2,396	10,522	Bluegill (1,346) Smallmouth bass (228) Chinook salmon (226)
	Manistee River	5–8	7, 8	27,267	1,699	8,104	Rainbow trout (473) Bluegill (301) Walleye (281)
2004	Escanaba River	4–10	5, 6	5,468	101	764	Brown trout (55)
	Grand River (lower) and Rogue River	3–11	3, 4, 7-10	115,190	20,035	54,459	Bluegill (7,019) Rainbow trout (4,273) Rock bass (4,123)
	Grand River (upper)	3–11	6–8	64,143	19,076	67,374	Bluegill (10,987) Channel catfish (2,812) Walleye (1,990)
	Kalamazoo River	4–10	8–10	75,317	13,902	22,958	Bluegill (6,274) Channel catfish (1,908) Rainbow trout (1,480) Walleye (1,205)
	Tahquamenon River (upper)	5–9	7	17,253	3,136	6,517	Yellow perch (1,785) Walleye (1,242)
	Little Manistee River	6–8	7, 8	20,551	827	2,630	Chinook salmon (640) Brook trout (187)
2005	Boardman River	5–9	5–7	16,724	1,236	11,292	Rock bass (422) Smallmouth bass (221)
	Menominee River	4–10	5–7	29,181	3,537	11,628	Smallmouth bass (981) Yellow perch (666) Bluegill (628)
	Tahquamenon River (lower)	5–10	7	16,874	1,035	7,526	Yellow perch (494) Walleye (297)