STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-53-R-14

Study No.: 484 **Title:** Population dynamics of yellow perch stocks in Michigan waters of Lake Michigan.

Period Covered: April 1, 1997 to March 31, 1998

Study Objectives: (1) To summarize pertinent existing data from state, federal, commercial, sport, university, and private sources; (2) to conduct assessment netting to establish baseline data and determine whether lack of recruitment and declining yellow perch numbers are problems in Michigan waters; (3) to determine whether factors of fish health might be affecting abundance or recruitment of yellow perch; (4) to reestablish a program of biological data collection for sport-caught yellow perch; (5) to investigate discreteness of yellow perch populations in Lake Michigan; and (6) to develop information and mathematical models from these data that will allow managers to predict, with some predetermined level of certainty, the outcome of various yellow perch management strategies.

Summary: Yellow perch are an important component of Michigan's sport fishery in Lake Michigan. Between 1985 and 1994, an estimated 2,330,888 yellow perch have been caught by anglers annually, more than any of the other species tabulated by the Michigan Department of Natural Resources creel census (Rakoczy and Svoboda 1998). Since 1990, yellow perch population density in Lake Michigan has declined, and the age structure has shifted toward older fish due to an almost complete lack of recruitment (Great Lakes Fishery Commission 1996). These trends have been documented in southern Lake Michigan by various agencies (Indiana Department of Natural Resources, Illinois Natural History Survey, Illinois Department of Natural Resources, Wisconsin Department of Natural Resources, University of Wisconsin, University of Michigan, Ball State University, and USGS-BRD) using a variety of assessment gear (graded-mesh gill nets, seines, trawls, fyke nets, larvae nets). Other evidence for the decline has come from monitoring sport and commercial fisheries for yellow perch. Although the trends have been described, current data sets do not seem sufficient to identify the causes of the decline or to suggest possible management solutions to the problem. Furthermore, it is not clear if yellow perch density has declined in Michigan waters of Lake Michigan because the Michigan Department of Natural Resources has not conducted assessment netting aimed at evaluating yellow perch populations since the late 1970s. This study was initiated with the above objectives, as part of an interagency task group to address current questions concerning Lake Michigan yellow perch populations.

Gillnet catch-per-unit-effort at four southern Lake Michigan ports combined averaged 177 yellow perch per 1,000 feet of gill net per 24 h in 1996 and 94 yellow perch per net night in 1997. Catch rates were higher in both years at Grand Haven and South Haven than at Saugatuck and St. Joseph. Overall sex ratio (F:M, all ports and years combined) was 1.1:1. Their were no apparent differences in length-at-age of yellow perch among the four southern Lake Michigan ports sampled. Additional species collected in yellow perch assessment nets include alewife, rainbow smelt, spottail shiner, salmonines, whitefish (lake and round), and sucker (white and longnose).

Trawling was conducted in July and August/September at Muskegon, Grand Haven, South Haven, and St. Joseph. Overall catch-per-unit-effort was higher in July (138 yellow perch per trawl hour in 1996, 33 yellow perch per trawl hour in 1997) than in August (19 and 5 yellow perch per hour). The majority of yellow perch collected in both years were from the 1995 year class. While the collection of significant numbers of fish indicates that some measurable level of reproduction occurred in 1995, catch rates are still at levels indicative of a "extremely weak" year class. Spottail shiner were the most abundant fish in trawl samples at southern Lake Michigan ports in both 1996 and 1997.

Overall recreational catch of Lake Michigan yellow perch has declined in recent years, from 3.2 million fish in 1988 to 0.6 million fish in 1997. In southern Lake Michigan, yellow perch catch varies significantly across ports, and a general decline has not been observed at every port. Average total length of yellow perch in the recreational catch was approximately 9.5 inches, and did not vary significantly by mode of angling, although yellow perch from Grand Traverse Bay and in the South Haven charter catch in 1997 were significantly shorter than those from other locations.

Job 1. Title: <u>Review literature and summarize existing data.</u>

Findings: **Historic Commercial Yellow Perch Production:** Data on commercial landings comprise the longest Lake Michigan data set on yellow perch. I reviewed lakewide commercial catch data from 1889-1969 (Baldwin and Saalfeld 1962, Keller et al. 1973). A fluctuation in yellow perch abundance is apparent in this data, with an average period of approximately 15 years. This agrees with existing ecological theory concerning animal population fluctuations; the period of population oscillation should correspond to the maximum lifespan of an organism (Ricklefs 1976, Nicholson 1958). The amplitude of these oscillations probably varies across the lake; future work will separate this data by region and attempt to model perch abundance based on this pattern of fluctuation (see Job 6).

Michigan Dept. of Natural Resources Assessment Netting: Yellow perch were collected in MDNR assessment netting throughout Lake Michigan between 1968-86. From 300-3,000 yellow perch were collected and aged per year. These data are currently being summarized, along with information on alewife abundance in these same assessments (see Job 2). Results of these analyses will be presented in future reports.

Literature Review: A review of yellow perch literature has been conducted, focusing on the following subjects; yellow perch disease, sampling techniques, interactions with alewife, reproduction and early life history, population fluctuations, age and growth, regulations, stock assessment, foraging, and energetics. This review is ongoing and will be used in planning and completing other jobs within this study.

Job 2. Title: <u>Conduct standardized assessment sampling.</u>

Findings: **Spring Assessment Netting:** Gill-net assessments were conducted at four southern Lake Michigan ports (Grand Haven, Saugatuck, South Haven, and St. Joseph) in April, 1997. Four nets (1,000 feet long, 1.5 to 3.5" stretched nylon mesh, 0.5" intervals) were fished overnight at each port. In addition, yellow perch were collected near Ludington, Michigan by Barnes-Williams Environmental Consultants, Inc. and Tim Robbins (Independent Observer) of The Wyatt Group, Inc., as part of the Ludington Pumped Storage Project Barrier Net Study. Subsamples of fish from MDNR assessments and from the Ludington study were returned to the Charlevoix Great Lakes Station (MDNR) for analysis of age and growth, fecundity, body composition (percent water, gonadosomatic index), and diet.

Catch-per-unit-effort at the four southern Lake Michigan ports combined averaged 177 yellow perch per 1,000 feet of gill net per 24 h in 1996 and 94 yellow perch per net night in 1997 (Table 1). Catch rates were higher in both years at Grand Haven and South Haven. Overall sex ratio (F:M, all ports and years combined) was 1.1:1. A higher percentage of fish collected in Grand Haven were females (1.8:1); sex ratio was lowest at Saugatuck (0.9:1) and at St. Joseph (0.3:1). Yellow perch catch rates were typically higher in deep (60-70 feet) net sets when compared with shallow (30-40 feet) sets at the four southern Lake Michigan ports we sampled.

Aging of yellow perch collected in April 1997 has not yet been completed. In 1996, 90% of yellow perch collected in southeastern Lake Michigan were six years old and older. There were no apparent differences in length-at-age of yellow perch among the four southern Lake Michigan ports sampled (Table 2). Estimates of mortality rate and relative year-class strength will be completed when ages of yellow perch collected in 1997 have been determined.

Additional species collected in yellow perch assessment nets include alewife, rainbow smelt, spottail shiner, salmonines, whitefish (lake and round), and sucker (white and longnose). Of these, alewife probably have the greatest potential to influence yellow perch populations (GLFC 1996, Brandt et al. 1987). Alewife ranged from 30-90% of the catch, by number; catch increased from north to south (Table 3). In 1996, a higher percentage of young alewife (<150 mm) were collected at South Haven (1%) and St. Joseph (36%) than at Grand Haven and Saugatuck (0% at each port).

Yellow perch were collected from gill nets at the Ludington Pumped Storage Plant during the months of April and May in 1996 (N=155 fish) and 1997 (N=289 fish). Catch rates at the Ludington facility are not directly comparable to those from the southern Lake Michigan assessment because net types and effort varied signicantly. Sex ratio at Ludington was 0.3 females for every male yellow perch collected in both 1996 and 1997. Eighty-six percent of yellow perch collected near Ludington were six years old and older. Male yellow perch collected at Ludington were slightly longer at a given age than male perch collected in southern Lake Michigan; there were no apparent differences in growth between female perch collected at Ludington and those collected at other ports (Table 2).

Summer Trawl Assessments: Trawling was conducted in July and August/September at Muskegon, Grand Haven, South Haven, and St. Joseph. Samples consisted of 12, 10-minute trawls at each port during each month. Six trawls were conducted prior to sunset and six were conducted after dark. Overall catch-per-unit-effort was higher in July (138 yellow perch per trawl hour in 1996, 33 yellow perch per trawl hour in 1997) than in August (19 and 5 yellow perch per hour; Table 4). Catch-per-unit-effort in July was highest at Muskegon (234 fish per trawl hour) and Grand Haven (193 fish per h) in 1996 and at South Haven (72 fish per h) in 1997. The majority of yellow perch collected in both years were from the 1995 year class. While the collection of significant numbers of fish indicates that some measurable level of reproduction occurred in 1995, catch rates are still at levels indicative of a “extremely weak” year class, based on long-term sampling in Indiana waters of Lake Michigan.

Several species have the potential to predate or compete with just-hatched yellow perch. Other species collected in trawl samples included spottail shiner, alewife, rainbow smelt, and johnny darter. Spottail shiner were the most abundant fish in trawl samples at southern Lake Michigan ports in both 1996 and 1997 (Table 5). There were no distinct patterns in abundance of predators or competitors across ports in southern Lake Michigan. Preliminary sampling was conducted at Empire and Onekema in northern Lake Michigan in 1997; at these ports the most abundant species was johnny darter (Table 5; “other”).

Job 3. Title: Investigate the potential impacts of disease on yellow perch populations.

Findings: Early Mortality Syndrome (EMS) has been found to be very detrimental to fry survival in coho salmon, rainbow trout, and other species. Survival has increased dramatically when these fry were treated with thiamine. EMS (or other facets of fish health) could potentially influence recruitment of yellow perch as well. To investigate these possibilities, Fish Quality Laboratory personnel collected mature male and female yellow perch from Lake Michigan. Experiments were conducted in 1996 to compare survival of Lake Michigan yellow perch fry to those from Lake Huron (Saginaw Bay). Parameters compared were percent eye-up, percent hatch, percent feeding, and percent survival to pond stocking. Forty-four female and 20 male yellow perch collected in Lake Michigan were transferred to Bayport Aquaculture Station for these experiments. Eggs could only be obtained from two female perch from the Lake Michigan group. Hatch from these egg strands was 20%, while hatch from the Saginaw Bay group averaged 40%. After hatch, fish went into tanks and were fed brine shrimp. After 14 days, no feeding on brine shrimp was observed in the Lake Michigan fry, while 4-5% feeding was seen in Saginaw Bay fish. Swimbladder inflation was also lower in Lake Michigan fish than in Saginaw Bay fish. The Lake Michigan fry averaged 5.2 mm in length, while the Saginaw Bay fry were 5.8 mm long at hatch. Size of forage (brine shrimp) may have contributed to the lower feeding success of Lake Michigan perch fry (i.e., forage items were too large for yellow perch fry from Lake Michigan to consume).

Additional tests were attempted in hopes of directly investigating the possibility that thiamine deficiency may be influencing yellow perch survival. Six female yellow perch were spawned in the Fish Quality Lab (Wolf Lake Hatchery) between May 30 and June 3. Eggs from four females were considered 100% dead by eye-up and were discarded. The remaining two strands of eggs were transferred to an earthen pond at Wolf Lake Hatchery on June 14 when hatch was first observed. On June 17, all of these remaining eggs were dead and little or no hatch had occurred. Temperature shock is suspected as the cause of mortality. Due to personnel changes at Wolf Lake Hatchery, continuation of these tests has been postponed for the foreseeable future.

Parasites may also influence yellow perch populations in Lake Michigan; a complete parasite survey of Lake Michigan yellow perch has not been conducted. Samples from summer trawling were provided to Dr. Pat Muzzall at Michigan State University to assess parasite load in yearling yellow perch. These data are currently being analyzed; results will be presented in future reports.

Job 4. Title: Collect and analyze biological data from sport-caught yellow perch.

Findings: Yellow Perch Catch: Yellow perch recreational catch information for the period 1985-97 were summarized in coordination with Studies 427 and 462. Overall Lake Michigan yellow perch catch has declined in recent years, from 3.2 million fish in 1988 to 0.6 million fish in 1997. In southern Lake Michigan, yellow perch catch varies significantly across ports, and a general decline has not been observed at every port. Catch was highest at St. Joseph (greater than 600,000 yellow perch) and Grand Haven (greater than 200,000 fish) in the mid- to late-1980s, whereas catch peaked at South Haven in 1994 (approximately 1.5 million yellow perch; Table 6). Recreational catch statistics generally parallel fishery independent assessments of adult yellow perch in southern Lake Michigan (see Table 1 and Table 6).

Biological data collection: Yellow perch length and age data were collected in 1985-92 as part of the Lake Michigan creel survey program (Study 427). Beginning in 1996, data were again collected from the recreational creel at four sites for which fisheries-independent assessment data

are available. In 1997, this data collection program was expanded to include all standard creel sites between New Buffalo and Grand Traverse Bay. At a given site, data are collected from up to 100 angler-caught yellow perch per month. Length and sex are determined for each fish. Similar data are solicited from yellow perch charter captains, with assistance from District 9 and 12 personnel.

Average total length of yellow perch in the recreational catch was approximately 9.5 inches, and did not vary significantly by mode of angling (Table 7). However, in 1997 yellow perch from Grand Traverse Bay and in the South Haven charter catch were significantly shorter than those from other locations (Table 7). Age composition of the recreational catch will be determined in the future, using a length-age key based on gillnet assessment samples.

Job 5. Title: Investigate discreteness of yellow perch populations in Lake Michigan.

Findings: Tagging study: Tagging of yellow perch was conducted during spring 1997, in coordination with other Lake Michigan management agencies through the Great Lakes Fishery Commission Yellow Perch Task Group. In this first year of the study, yellow perch tagged by MDNR personnel were released near Bridgman and St. Joseph (Table 8). In 1998, tagging operations will be expanded to include sites at Grand Haven/Muskegon and Onekema, providing much needed information on fish movements, growth, exploitation rates, and mixing of stocks.

Physiological parameters: Physiological parameters have often been used as measures of discreteness of fish populations (Ihssen et al. 1981). As part of our spring assessment sampling, we examined various physiological and biological parameters (percent water, gonadosomatic index, growth rate, diet) for differences among populations (ports). In 1996, percent water in somatic and gonadal tissue averaged 75% and 79% across ports (Table 9). Gonadosomatic index (GSI - weight of reproductive tissue as a percentage of yellow perch total weight) averaged 14% for female yellow perch and 5% for male perch (Table 10). This initial examination showed no apparent differences in these parameters among perch populations at southern Lake Michigan ports. Analyses of fecundity and diet of yellow perch collected in spring assessment netting are still being conducted. In the future, we will examine correlations between yellow perch reproductive success and these various physiological parameters using data collected over a number of years.

Job 6. Title: Develop information and mathematical models related to yellow perch management strategies.

Findings: Successful modeling of Lake Michigan yellow perch populations will require collection of information on length, weight, age, sex, maturity, egg production, diet, movement, harvest rates, and predation. These data are currently being collected in Jobs 1-5 (see above). Initial modeling efforts will be aimed at investigating predictability of yellow perch population fluctuations (see Job 1), and the influence of commercial and recreational harvest on yellow perch populations. Results of these efforts will be presented in future reports.

Job 7. Title: Evaluate results, write reports, and develop future study plans for Michigan waters of Lake Michigan south of the 45th parallel.

Findings: Results of research were summarized for this report, as well as for summaries to various MDNR and external committees. Proposals were prepared for the Great Lakes Fishery Commission Yellow Perch Task Group and the Great Lakes Protection Fund. Presentations were given at the 1997 Midwest Fish and Wildlife Conference, and to numerous Michigan State University Fisheries Extension Workshops.

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Table 1.–Average assessment gillnet catch (fish / 1,000' of gillnet / 24 hours) of yellow perch at four southern Lake Michigan ports, 1996-97. Four nets were set at each port in each year, except three nets were set at Grand Haven in 1997. Two standard errors are shown in parentheses.

Sample year	Port							
	Grand Haven		Saugatuck		South Haven		St. Joseph	
1996	315	(326)	20	(4)	338	(584)	33	(14)
1997	155	(104)	59	(62)	153	(200)	25	(10)

Table 2.–Average total length-at-age (mm) for male and female yellow perch collected in assessment gillnets at five Lake Michigan ports in 1996. Values in parentheses are two standard errors.

	Port									
	Ludington		Grand Haven		Saugatuck		South Haven		St. Joseph	
Age	N	Length	N	Length	N	Length	N	Length	N	Length
					Male					
5	12	211 (8)	3	217 (8)	4	205 (12)	10	208 (8)	10	198 (8)
6	18	220 (12)	16	205 (6)	9	208 (8)	19	207 (8)	24	199 (4)
7	38	225 (8)	27	214 (8)	10	212 (8)	26	214 (8)	18	204 (6)
8	27	250 (10)	25	219 (8)	7	211 (8)	14	224 (8)	9	218 (12)
9	9	249 (18)	11	221 (10)	4	207 (8)	4	223 (32)	4	205 (4)
10	3	270 (4)	2	258 (60)	2	221 (40)	1	200 (--)	0	----- (--)
					Female					
5	4	283 (6)	7	257 (20)	2	240 (6)	5	262 (18)	0	----- (--)
6	4	265 (18)	29	269 (8)	9	248 (14)	13	257 (12)	4	242 (16)
7	8	284 (10)	45	277 (6)	7	261 (20)	14	270 (8)	4	255 (16)
8	8	287 (12)	44	286 (6)	9	263 (22)	23	276 (8)	4	274 (32)
9	2	307 (46)	19	282 (14)	2	270 (8)	16	288 (8)	1	260 (--)
10	2	332 (4)	3	295 (24)	2	300 (12)	5	307 (26)	1	305 (--)

Table 3.–Alewife catch (percent by number) in yellow perch assessment gillnets, 1996-97.

	Year	
Port	1996	1997
Grand Haven	43	35
Saugatuck	31	30
South Haven	80	69
St. Joseph	81	90

Table 4.–Yellow perch catch-per-unit-effort (number per trawl hour) at four Lake Michigan ports (Muskegon, Grand Haven, South Haven, and St. Joseph); values are for samples from the four ports combined. Percent of sample composed of Age 0 and Age 1 and older yellow perch is shown in parentheses. Samples were not collected at St. Joseph in September 1996 or at Muskegon in July 1997. Age class determinations are based on length frequency analysis.

	Year					
	1996			1997		
Age class	July	September	Combined	July	August	Combined
Age 0	0	2	1	2	2	2
	(--)	(9)	(1)	(6)	(40)	(12)
Age 1 and older	138	17	84	31	3	15
	(100)	(91)	(99)	(94)	(60)	(88)
Combined	138	19	85	33	5	17
	(100)	(100)	(100)	(100)	(100)	(100)

Table 5.–Composition of summer (July-September) trawl catch at six Lake Michigan ports, 1996-97. Data are percent (by number) of trawl catch made up of each species. Other species include (primarily) Johnny darter, 3-spine stickleback, 9-spine stickleback, rainbow smelt, trout perch, slimy sculpin, longnose sucker, and gizzard shad. Empire and Onekema were not sampled in 1996.

	Port					
Species	Empire	Onekema	Muskegon	Grand Haven	South Haven	St. Joseph
			1996			
Alewife	---	---	14	7	3	21
Spottail shiner	---	---	51	79	91	47
Yellow perch	---	---	18	12	1	8
Other	---	---	17	2	5	24
			1997			
Alewife	0	1	1	1	7	21
Spottail shiner	30	1	93	77	87	76
Yellow perch	0	0	0	1	3	1
Other	70	98	6	21	3	2

Table 6.–Yellow perch recreational catch at four southern Lake Michigan ports, 1985-97. Estimates of charter catch were not obtained prior to 1990. Creel estimates were not obtained at Holland and South Haven in 1989-91.

	Port							
	Grand Haven		Holland		South Haven		St. Joseph	
Sample year	Creel	Charter	Creel	Charter	Creel	Charter	Creel	Charter
1985	110,084	---	105,398	---	292,225	---	664,671	---
1986	79,972	---	27,382	---	307,847	---	590,044	---
1987	213,199	---	126,910	---	313,800	---	448,285	---
1988	156,496	---	119,128	---	618,933	---	575,937	---
1989	121,713	---	---	---	---	---	313,084	---
1990	74,151	1,755	---	74	---	2,107	348,313	16,099
1991	133,783	154	---	2	---	39,870	253,873	6,076
1992	58,126	791	47,610	12	348,138	19,906	430,828	8,293
1993	78,364	1,532	62,585	176	732,128	40,452	384,416	17,822
1994	119,106	1,344	63,588	504	1,414,005	48,756	152,108	11,232
1995	11,490	363	68,882	85	981,999	92,074	74,063	3,528
1996	75,553	608	40,704	0	148,115	35,372	64,113	2,327
1997	84,774	304	16,899	0	209663	41771	11891	800

Table 7.–Average total length (inches) of yellow perch in recreational catch, 1996-97. Data are presented for boat and shore angling modes; fish caught by charter anglers at South Haven are presented separately. Values in parentheses are two standard errors.

	Year			
	1996		1997	
Port	Boat	Shore	Boat	Shore
Arcadia – Onekema	-----	-----	10.2 (0.4)	-----
Elk Rapids	-----	-----	-----	9.3 (0.4)
Grand Traverse Bay	-----	-----	8.2 (0.2)	7.0 (0.2)
Grand Haven – Muskegon	10.1 (0.2)	9.4 (0.2)	10.4 (0.2)	9.5 (0.2)
Holland	9.4 (0.4)	9.6 (0.2)	10.3 (0.2)	9.4 (0.4)
South Haven	9.3 (0.2)	10.2 (0.4)	9.3 (0.2)	10.4 (1.4)
South Haven (Charter)	9.3 (0.2)	-----	8.7 (0.2)	-----
St. Joseph - New Buffalo	9.8 (0.2)	9.8 (0.2)	10.2 (0.2)	10.2 (0.4)
Combined	9.7 (0.2)	9.7 (0.2)	9.9 (0.2)	9.2 (0.2)

Table 8.–Number of perch tagged, and number and percent of participant (>24-h at liberty), sport, and commercial recaptures from Lake Michigan tagging locations, 1997 (from GLFC 1997).

Tagging location	Perch tagged	Participant recaptures	Sport recaptures	Commercial recaptures
Illinois	8,482	344 (4.1%)	55 (0.6%)	0
Indiana	2,950	65 (2.2%)	32 (1.1%)	0
Grand Traverse Bay	32	0	0	0
Green Bay	1,844	39 (2.1%)	10 (0.5%)	21 (1.1%)
Michigan	3,292	49 (1.5%)	35 (1.1%)	0
Wisconsin	5,563	327 (5.9%)	13 (0.2%)	0
All sites	21,753	824 (3.8%)	145 (0.6%)	21 (<0.1%)

Table 9.–Average percent water in somatic and gonadal tissue of male and female yellow perch collected at four Lake Michigan ports, 1996. Percent water was not measured for male yellow perch gonadal tissue.

		Sex	
Port	Tissue type	Male	Female
Grand Haven	Somatic	75.4	75.0
	Gonadal	----	78.8
Saugatuck	Somatic	75.1	74.6
	Gonadal	----	79.1
South Haven	Somatic	74.9	74.5
	Gonadal	----	79.2
St. Joseph	Somatic	74.8	74.6
	Gonadal	----	80.2

Table 10.–Average gonadosomatic index (GSI) of male and female yellow perch collected at four Lake Michigan ports.

	Sex	
Port	Male	Female
Grand Haven	4.7	14.4
Saugatuck	5.4	13.2
South Haven	5.0	14.4
St. Joseph	4.6	15.8

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