

STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-1

Study No.: 465

Title: Assessment of lake whitefish populations
in Michigan waters of Lake Superior

Period Covered: October 1, 1999 to September 30, 2000

Study Objectives: (1) To specify what areal, and size or age, segments of the lake whitefish stocks are harvested by trap-net, gill-net, and hook-and-line fisheries. (2) To gather trap-net data needed to determine total allowable catches.

Summary: Samples were collected as scheduled during 2000. Data from these samples will be processed, analyzed, and summarized in future reports. During 1999 in Lake Superior, only 267 lake whitefish were estimated as harvested by sport anglers in MS-3 and 6,744 were harvested in MS-4. Estimated lake whitefish sport harvest was 4,913 in Lake Michigan management zone MM-4. In Michigan waters of Lake Superior between Ontonagon and Munising, state-licensed commercial trap-net fishers harvested 179,221 kg of lake whitefish during 1999 and tribal commercial gill-net fishers harvested 195,857 kg (not including harvests from 1836 treaty waters). Lake whitefish total annual mortality, calculated using pooled commercial trap-net data from 1997 through 1999 ranged from 34% at Marquette to 76% at Keweenaw Bay. Mean lengths, weights, and ages were calculated for lake whitefish harvested during 1999 by state-licensed commercial trap nets in Upper Entry, Keweenaw Bay, Big Bay, Marquette, and Munising. Mean lengths per fish were significantly different for fish in each area ranging from 485 mm at Keweenaw Bay to 549 mm at Marquette. Mean weights per fish were relatively low at Upper Entry (1,048 g) and Keweenaw Bay (1,024 g), and were significantly higher at other locations. Highest mean weight calculated for 1999 lake whitefish was in Marquette (1,462 g). Mean age was lowest at Keweenaw Bay (6.3) and highest at Munising (8.1).

Job 1. Title: Summarize creel survey data.

Findings: Lake whitefish harvest data were collected in 1999 sport fishery creel surveys conducted under Study 427. Sport harvest of lake whitefish was estimated for Lake Superior management zones MS-3 (Keweenaw Bay) and MS-4 (Marquette and Munising), and for Lake Michigan management zone MM-4 (Grand Traverse Bay). A small estimated sport harvest of lake whitefish in MS-3 (267 fish) followed two years in a row during which no lake whitefish were recorded the MS-3 creel survey (Table 1). Estimated sport harvest in MS-4 was 6,744, up 17% from 1998 (Table 1). In MM-4, estimated sport harvest during 1999 was 4,913, down 11% from the 1998 estimate (Table 1).

Job 2. Title: Summarize tribal data.

Findings: Commercial gill-net fisheries data are reported by the Chippewa Ottawa Resource Authority (formerly the Chippewa/Ottawa Treaty Fisheries Management Authority) for the Munising area (1836 Treaty Ceded waters) and by the Great Lakes Indian Fish and Wildlife

Commission for Lake Superior waters near Marquette, Big Bay, Keweenaw Bay, Upper Entry, and Ontonagon (1842 Treaty Ceded waters). Native American commercial gill-net fishers harvested 195,857 kg of lake whitefish from 1842 treaty waters of Lake Superior during 1999. Compared to 1998 gill net catch statistics, 1999 harvest was down 15%, effort was down 19%, but catch-per-unit effort (CPE) was up 2% in 1842 waters. This report does not include 1999 tribal harvest statistics from 1836 treaty waters because these data have not yet been appended to the data base shared by member tribes and the State of Michigan.

Job 3. Title: Collect trap-net lake whitefish data.

Findings: State-licensed commercial fishers harvested lake whitefish with trap nets and submitted harvest and effort data, summarized in Table 2, to the Michigan Department of Natural Resources. Marquette Fisheries Research Station personnel collected lake whitefish data dock-side at Upper Entry, Bete Grise, Big Bay, Marquette, and Munising between June 3 and August 3, 1999. No state-licensed fishing was done at Ontonagon or Grand Marais during 1999. All sampled lake whitefish (N=2,701) were measured (total length to the nearest mm) and weighed (round weight to the nearest g). Scales were taken from each fish for age determination.

Kidney swabs were taken from 66 Lake Superior lake whitefish in 1999. Swabs were sent to Wolf Lake State Fish Hatchery, Mattawan, MI, to test for *Renibacterium salmoninarum*, the bacterium that causes bacterial kidney disease in trout and salmon. *Renibacterium salmoninarum* was detected in lake whitefish for the first time in fish from Lake Michigan during 1997 (Jonas et al. in press). Monitoring was expanded and continues to include Lake Superior lake whitefish, though to date, none have tested positive for the bacterium. Results from 1999 testing were not yet available.

Job 4. Title: Analyze lake whitefish data.

Findings: I have not yet examined sport-fishery biological data gathered during 1999 for lake whitefish. I suspect that pooling of 3-4 yr of data will be necessary to use for comparisons of size and age between areas or among years. Schorfhaar and Schneeberger (1997) analyzed and compared size-at-age, age composition, and mortality rates of lake whitefish caught by sport anglers between 1985 and 1996.

Catch, effort, and CPE statistics for state-licensed trap-net fisheries (Table 2) showed that overall 1999 harvests increased 62%, effort increased 14%, and CPE increased 41% compared to 1998 values. Harvest was lowest at Marquette (17,765 kg) and highest at Upper Entry (69,935 kg) during 1999. Effort ranged from 133 lifts at Keweenaw Bay to 718 lifts at Munising. CPE varied considerably from 68 kg/lift at Munising to 260 kg/lift at Upper Entry.

Lake whitefish total annual mortality rates were derived from estimates of survival using coded age frequencies (Robson and Chapman 1961) pooled from 1997-1999 data (when available). The Tripartite Technical Fisheries Review Committee recommended that total annual mortality rate not exceed 50-55% (depending on area) to adequately protect Lake Superior lake whitefish stocks. Since at least the mid-1990s, mortality has consistently exceeded the target maximum rate at Upper Entry, Keweenaw Bay, and Big Bay, but has consistently been below target maximum rates at Marquette and Munising (Table 3).

Weight-length relationships and von Bertalanffy growth coefficients were calculated using 3-yr pooled data as available. Parameters have fluctuated for lake whitefish in each fishing area during the 1990s, but trends in values have not been evident (Table 4).

Mean length, mean weight, and to a lesser extent, mean age of lake whitefish in commercial trap-net catches generally increased in fishing areas from west to east (Table 5). During 1999, mean length and weight of fish ranged from 485 mm and 1,024 g in Keweenaw Bay to 549 mm and 1,462 g in Marquette; mean age ranged from 6.3 years at Keweenaw Bay to 8.1 years at Munising. Mean lengths were significantly different in each fishing area. Significant differences of mean weight and mean age occurred among some, but not all, fishing areas. During 1993-99, mean length, mean weight, and mean age have generally fluctuated without trend throughout Michigan waters of Lake Superior.

Fishery and biological data from 1986 through 1998 were used to construct age-structured stock-assessment models for lake whitefish in management zones MS-4 and MS-5. These models were important during recently concluded re-negotiation of the 1985 Consent Decree which expired in May 2000 and governed commercial fishing in 1836 treaty waters. Data from 1999 fisheries and assessments will be appended to models to generate harvest quotas for 2001.

Job 5. Title: Prepare reports.

Findings: A report for annual Lake Committee Meetings, sponsored by the Great Lakes Fishery Commission, and this 1999-2000 Study Performance Report (F-81-R-1) were prepared during this study segment.

References:

- Jonas, J., P. Schneeberger, D. Clapp, M. Wolgamood, G. Wright, and B. Lasee. (in press). Presence of the BKD-causing bacterium *Renibacterium salmoninarum* in lake whitefish and bloaters in the Great Lakes. Archiv fur Hydrobiologie.
- Robson, D. S., and D. G. Chapman. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society 90:181-189.
- Schorfhaar, R.G. and P.J. Schneeberger. 1997. Commercial and sport fisheries for lake whitefish in Michigan waters of Lake Superior, 1983-1996. Michigan Department of Natural Resources, Fisheries Research Report 2034, Ann Arbor.

Prepared by: P.J. Schneeberger

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Table 1.—Creel survey estimate data for lake whitefish in Lake Michigan and Lake Superior, 1985-99. Estimated harvest in numbers of fish, round weight in kg, and effort in non-targeted angler hours.

Year	MM-4 Grand Traverse Bay			MS-3 Keweenaw Bay			MS-4 Marquette and Munising		
	Harvest	Weight	Effort	Harvest	Weight	Effort	Harvest	Weight	Effort
1985	89,866	126,365	466,505						
1986	53,875	75,757	335,002						
1987	20,011	21,784	284,478	1,184	1,558	29,365	9,587	3,479	157,697
1988	13,636	11,752	262,402	5,160	6,085	102,597	8,023	4,003	138,865
1989	13,806	13,151	251,561	5,421	4,180	107,951			
1990	12,102	10,430	191,901	121	137	32,551	698	380	69,777
1991 ^a	10,746	11,698	233,139	212	240	57,647	4,082	1,481	168,410
1992	4,978	5,419	191,459	364	479	67,137	1,192	433	150,663
1993	2,480	3,375	179,805	471	620	94,709	2,536	805	152,316
1994	4,152	4,897	184,550	408	518	125,975	1,102	550	116,497
1995	4,428	4,619	196,525	10	12	69,297	4,225	1,533	94,848
1996	10,490	11,420	191,401	97	119	86,569	2,515	1,141	118,204
1997 ^b	21,932	~23,029	278,426	0	0	48,386	2,729	990	134,001
1998	5,259	~5,522	304,638	0	0	40,553	5,773	2,357	103,097
1999	4,430	4,913	227,978	267	317	39,144	6,744	2,781	103,165

^a Only month of May was surveyed at Keweenaw Bay.

^b Winter ice fishery was not surveyed at Keweenaw Bay and Munising.

Table 2.—Lake whitefish harvest (kg), effort (trap-net lifts, 305 m of gill net), and catch per unit effort (CPE - kg per trap-net lift, kg per 305 m of gill net) in Lake Superior commercial fisheries, 1997-99.

Fishing area (stat. district)	Year	Trap net ^a			Gill net ^b			Total catch
		Catch	Effort	CPE	Catch	Effort	CPE	
Ontonagon (MS-2)	1997				10,356	201	51	10,356
	1998				5,440	85	64	5,440
	1999				16,700	170	98	16,700
Upper Entry (MS-3)	1997				72,692	^{1,872}	39	72,692
	1998	27,202	200	136	141,917	2,566	55	169,119
	1999	69,935	269	260	95,785	1,722	56	165,720
Keweenaw Bay/Bete Grise (MS-3)	1997	14,292	135	106	65,239	2,328	28	79,531
	1998				66,121	2,253	29	66,121
	1999	24,342	133	183	68,353	2,172	31	92,695
Big Bay (MS-4)	1997	24,043	136	177	9,222	164	56	33,265
	1998	20,370	144	141	15,264	482	32	35,634
	1999	18,366	182	101	9,913	258	38	28,279
Marquette (MS-4)	1997	13,414	151	89	4,048	48	84	17,462
	1998	13,957	204	68	5,564	110	50	19,521
	1999	17,765	230	77	5,106	134	38	22,871
Munising (MS-4)	1997	29,839	337	88	13,925	657	21	43,764
	1998	49,090	791	62	17,938	607	30	67,028
	1999	48,812	718	68	^c	^c	^c	48,812 ^c
All the above	1997	81,588	759	107	175,482	5,270	33	257,070
	1998	110,619	1,339	83	252,244	6,103	41	362,863
	1999	179,221	1,532	117	195,857	4,456 ^c	44 ^c	375,078 ^c

^a Large-mesh trap nets used by state-licensed fishers.

^b Large-mesh gill nets used by tribal fishers. Gill-net catch statistics are from Great Lakes Indian Fish & Wildlife Commission (GLIFWC) for Upper Entry, Keweenaw Bay, Big Bay, and Marquette. Statistics from Chippewa-Ottawa Resource Authority (formerly Chippewa-Ottawa Treaty Fishery Management Authority) for Munising.

^c Does not include statistics from 1836 treaty waters.

Table 3.—Total annual mortality rates of lake whitefish in state-licensed commercial trap-net catches, 1991-99, with 2 SE and ages included in calculations. When possible, data from each Lake Superior fishing area were pooled over 3-year intervals.

Fishing area	Years pooled	Mortality	2 SE	Ages included
Ontonagon	1995	0.47	0.04	6-14
Upper Entry	1992-93	0.59	0.04	7-12
	1992-94	0.63	0.03	7-12
	1993-95	0.78	0.03	7-11
	1994-95	0.77	0.04	7-11
	1998	0.76	0.10	9-11
	1998-99	0.63	0.04	8-12
Keweenaw Bay	1993-94	0.71	0.04	7-12
	1994 & 1996	0.62	0.03	6-14
	1996-97	0.65	0.04	7-14
	1997-99	0.76	0.04	7-14
Big Bay	1991-93	0.38	0.02	7-16
	1992-94	0.37	0.02	6-16
	1993-94	0.53	0.03	6-16
	1994 & 1996	0.58	0.05	7-12
	1996-97	0.64	0.05	7-12
	1996-98	0.69	0.06	8-14
	1997-99	0.66	0.05	8-14
Marquette	1991-93	0.42	0.03	8-17
	1992-94	0.41	0.03	9-17
	1993-95	0.49	0.06	13-17
	1994-96	0.30	0.02	8-17
	1995-97	0.32	0.02	7-17
	1996-98	0.44	0.02	7-19
	1997-99	0.34	0.05	10-19
	Munising	1991-93	0.54	0.07
1992-94		0.55	0.06	12-17
1993-95		0.51	0.05	12-17
1994-96		0.40	0.03	10-17
1995-97		0.35	0.02	7-20
1996-98		0.47	0.02	7-18
1997-99		0.36	0.03	10-19
Grand Marais		1997	0.35	0.06

Table 4.—Vital statistics from state-licensed commercial trap-net data sets (pooled over 3 yr period when possible) used to generate lake whitefish total allowable catches for Lake Superior stocks.

Fishing area	Years pooled	Instantaneous fishing mortality ^a (F)	Weight-length coefficients ^b		Von Bertalanffy coefficients			Mean dressed weight of fish In catch (kg)	Catch (dressed kg) ^c
			Intercept	Slope	K	L _∞ (mm)	t ₀		
Ontonagon	1995	0.38	-13.00	3.22	0.115	894	-0.108	1.5	13,260
Upper Entry	1992-93	0.65	-12.67	3.17	0.314	552	-0.004	1.0	102,911
	1992-94	0.75	-12.05	3.07	0.314	551	-0.005	1.0	92,697
	1993-95	1.26	-12.02	3.07	0.362	531	-0.002	0.9	76,325
	1994-95	1.21	-10.74	2.86	0.496	507	-0.001	0.9	69,404
	1998	1.18	-11.88	3.04	0.429	515	-0.000	1.1	70,393
	1998-99	0.75	-11.88	3.04	0.325	551	-0.001	1.1	48,568
Keweenaw Bay	1993-94	1.00	-13.26	3.27	0.020	800	-0.500	1.0	72,644
	1994 & 96	0.73	-12.69	3.18	0.129	809	-0.164	1.1	62,474
	1996-97	0.80	-12.98	3.22	0.149	746	-0.276	1.0	74,984
	1997 & 99	1.19	-11.54	2.98	0.460	507	-0.005	1.0	19,317
Big Bay	1991-93	0.23	-12.92	3.20	0.358	596	-0.007	1.4	33,479
	1992-94	0.22	-12.25	3.09	0.365	590	-0.006	1.4	26,477
	1993-94	0.50	-12.70	3.17	0.272	662	-0.018	1.5	23,414
	1994 & 96	0.61	-12.52	3.14	0.225	680	-0.008	1.4	14,012
	1996-97	0.78	-13.72	3.34	0.279	627	0.015	1.3	17,899
	1996-98	0.92	-9.12	2.60	0.252	656	-0.057	1.3	18,723
	1997-99	0.82	-10.40	2.80	0.212	678	-0.035	1.2	21,380
Marquette	1991-93	0.30	-14.67	3.48	0.176	790	-0.040	1.9	30,739
	1992-94	0.28	-14.44	3.45	0.178	792	-0.026	1.9	22,048
	1993-95	0.43	-13.59	3.31	0.183	786	-0.020	2.1	17,193
	1994-96	0.11	-13.51	3.30	0.168	801	-0.022	2.0	18,356
	1995-97	0.14	-13.84	3.35	0.159	805	-0.036	1.9	19,917
	1996-98	0.34	-11.25	2.94	0.202	718	0.015	1.5	22,942
	1997-99	0.16	-11.18	2.92	0.155	800	-0.072	1.5	15,062
Munising	1991-93	0.52	-11.94	3.05	0.202	731	-0.111	1.8	68,981
	1992-94	0.56	-13.03	3.23	0.212	727	-0.080	2.0	48,691
	1993-95	0.46	-12.23	3.11	0.219	733	-0.016	2.5	37,388
	1994-96	0.27	-14.50	3.46	0.201	740	-0.035	2.2	31,716
	1995-97	0.18	-13.66	3.33	0.196	734	-0.085	1.8	30,913
	1996-98	0.39	-13.92	3.36	0.182	753	-0.178	1.5	38,069
	1997-99	0.20	-13.56	3.30	0.163	767	-0.292	1.4	42,757

^a Instantaneous rate of natural mortality (M) was assumed to be 0.25 year⁻¹ (Rakoczy 1983) in all fishing areas.

^b $\log_e(\text{Weight}) = a + b(\log_e[\text{Length}])$

^c Computed from catch data in Table 1.

Table 5.—Mean length, weight, and age (with \pm factor for 95% confidence intervals) of Lake Superior lake whitefish in state-licensed commercial trap nets, 1993-97. Total length is in millimeters, round weight is in grams, and age is in years.

Fishing area	Year	Length		Weight		Age	
		Mean	\pm factor	Mean	\pm factor	Mean	\pm factor
Ontonagon	1995	496.4	6.5	1,536.4	209.9	7.0	0.2
Upper Entry	1993	473.6	2.5	987.4	44.1	6.4	0.1
	1994	465.2	2.3	919.1	29.7	6.5	0.1
	1995	470.8	3.5	910.9	29.5	6.7	0.1
	1998	494.4	3.9	1,066.0	29.4	7.5	0.1
	1999	499.6	3.2	1,048.0	23.3	7.5	0.1
Keweenaw Bay	1993	478.8	3.3	977.7	56.6	6.9	0.1
	1994	473.6	3.0	990.4	39.8	6.2	0.1
	1996	487.5	5.0	1,188.4	85.6	6.6	0.2
	1997	456.8	2.3	845.9	23.9	6.4	0.1
	1999	485.3	3.3	1,023.8	24.7	6.3	0.1
Big Bay	1993	542.6	6.5	1,472.6	128.4	6.3	0.2
	1994	519.6	5.4	1,464.5	65.0	6.5	0.1
	1996	515.9	5.7	1,298.9	72.1	6.6	0.2
	1997	522.3	4.9	1,258.2	51.8	6.8	0.1
	1998	523.7	4.6	1,263.1	39.7	6.8	0.1
	1999	514.5	4.6	1,241.6	39.8	7.0	0.1
Marquette	1993	587.7	7.2	1,771.8	158.1	8.0	0.2
	1994	585.0	7.9	1,695.0	163.3	7.8	0.2
	1995	639.7	5.8	2,841.7	168.1	9.9	0.2
	1996	524.3	6.6	1,474.8	136.8	7.2	0.2
	1997	532.1	4.9	1,453.5	139.6	7.1	0.1
	1998	552.5	6.6	1,578.3	81.1	7.9	0.2
	1999	548.8	4.5	1,461.9	40.5	7.5	0.1
Munising	1993	581.8	7.0	2,225.9	178.5	8.3	0.3
	1994	609.7	6.1	2,475.7	155.3	8.7	0.2
	1995	624.6	5.7	2,790.7	142.9	9.1	0.3
	1996	509.7	5.6	1,191.2	109.2	7.5	0.2
	1997	527.6	6.2	1,214.2	85.5	7.2	0.2
	1998	547.2	3.8	1,544.2	43.9	7.5	0.1
	1999	520.8	3.9	1,298.4	40.6	8.1	0.1