

STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-2

Study No.: 465

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

Period Covered: October 1, 2000 to September 30, 2001

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 2001. Data from these samples will be processed, analyzed, and summarized in future reports. During 2000 in Lake Superior, an estimated 159 lake whitefish were harvested by sport anglers in MS-3, and 6,500 were harvested in MS-4. Estimated lake whitefish sport harvest was 13,233 in Lake Michigan management zone MM-4. In Michigan waters of Lake Superior between Ontonagon and Munising, state-licensed commercial trap-net fishers harvested 193,703 kg of lake whitefish during 2000 and tribal commercial gill-net fishers harvested 222,553 kg (not including harvests from 1836 treaty waters). Lake whitefish total annual mortality, calculated using pooled commercial trap-net data from 1998 through 2000, ranged from 32% at Munising to 70% at Keweenaw Bay. Mean lengths, weights, and ages were calculated for lake whitefish harvested during 2000 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 470 mm at Keweenaw Bay to 540 mm at Marquette. Mean weights per fish were relatively low at Upper Entry (1,092 g) and Keweenaw Bay (934 g), and were significantly higher at other locations. Highest mean weight calculated for 2000 lake whitefish was at Marquette (1,451 g). Mean age was lowest at Keweenaw Bay (6.3) and highest at Upper Entry (8.3).

Job 1. Title: Summarize creel survey data.

Findings: Lake whitefish harvest data were collected in 2000 sport fishery creel surveys conducted under F-81-R 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 (159 fish) continued a trend of low or non-existent catches since 1995 (Table 1). Estimated sport harvest in MS-4 was 6,500, roughly the same as the estimate for 1999 (Table 1). In MM-4, estimated sport harvest during 2000 was 13,233, up almost threefold from 1999 and higher than any estimate since 1997 (Table 1).

Job 2. Title: Summarize tribal data.

Findings: Commercial gill-net fisheries data are reported by the Chippewa Ottawa Resource Authority (CORA, 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 (GLIFWC) for Lake Superior waters near Marquette, Big Bay, Keweenaw Bay, Upper Entry, and Ontonagon (1842 Treaty Ceded waters). Harvest and effort figures from CORA were not available for this report, but GLIFWC commercial gill-net fishers harvested 222,553 kg of lake whitefish from 1842 treaty waters of Lake Superior during 2000 (Table 2). Compared to 1999 gill net catch statistics, 2000 harvest was up 14%, effort was up 1%, and catch-per-unit effort (CPE) was up 14% in 1842 waters.

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 13 and August 9, 2000. No state-licensed fishing was done at Ontonagon or Grand Marais during 2000. All sampled lake whitefish (N=2,570) 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 67 Lake Superior lake whitefish during 2000. 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 (including those collected in 2000) have tested positive for the bacterium.

Job 4. Title: Analyze lake whitefish data.

Findings: Sport-fishery biological data gathered during 2000 for lake whitefish have not yet been examined. Because of relatively low catches and sample sizes, 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 2000 harvests increased 8%, effort increased 12%, and CPE decreased 3% compared to 1999 values. Harvest was lowest at Keweenaw Bay (16,408 kg) and highest at Munising (69,422 kg) during 2000. Effort ranged from 149 lifts at Big Bay to 930 lifts at Munising. CPE varied from 75 kg/lift at Munising to 217 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 data for 1998-2000. 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. Parameters have fluctuated for lake whitefish in each fishing area during the study, but trends in values have not been evident (Table 4).

Mean length and mean weight of lake whitefish in commercial trap-net catches have generally been greatest for Marquette and least for Upper Entry or Keweenaw Bay (Table 5). Mean age has been highest for fish at Munising and lowest for fish at Keweenaw Bay, with fair consistency (Table 5). During 2000, mean length and weight of fish ranged from 470 mm and 934 g in Keweenaw Bay to 540 mm and 1,451 g in Marquette; mean age ranged from 6.3 years at Keweenaw Bay to 8.3 years at Upper Entry. Mean lengths were not significantly different for Big Bay, Marquette, and Munising. Significant differences of mean weight and mean age occurred among some, but not all, fishing areas. During 1993-2000, mean length, mean weight, and mean age have generally fluctuated without trend for fish in each management zone throughout Michigan waters of Lake Superior.

Fishery and biological data from 1986 through 1999 were used to construct age-structured stock-assessment models for lake whitefish in management zones MFS-4 and MFS-5. These models were used to calculate harvest limits for the 2001 fishing season, as mandated by the 2000 Consent Decree that governs commercial fishing in 1836 treaty waters. Data from 2000 fisheries and assessments will be appended to models to generate harvest quotas for 2002.

Job 5. Title: Prepare reports.

Findings: The 2000-01 Study Performance Report (F-81-R-2) was 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.
- Rakoczy, G.P. 1983. Recommended harvest levels for commercially exploited stocks of lake whitefish in Michigan waters of Lake Superior. Michigan Department of Natural Resources, Fisheries Research Report 1912, Ann Arbor.
- 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.

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Table 1.—Creel survey estimate data for lake whitefish in Lake Michigan and Lake Superior, 1985-2000. Estimated harvest in numbers of fish, round weight in kg, and effort in non-targeted angler hours. Blanks correspond to years and areas when surveys were not conducted. Except where otherwise indicated, estimated values were calculated from surveys conducted only during the open water season at Grand Traverse Bay and during both open water and ice fishing seasons at Keweenaw Bay, Marquette, and Munising.

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 ^a	89,866	126,365	466,505						
1986 ^a	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 ^b	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 ^c	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
2000	13,233	~14,676	185,571	159	~189	28,887	6,500	~2,681	96,370

^a Winter ice fishery survey included in estimates for Grand Traverse Bay.

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

^c 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, 1997-2000.

Fishing area (stat. district)	Year	Trap net ^a			Gill net ^b			Total catch
		Catch	Effort	CPE	Catch	Effort	CPE	
Ontonagon (WFS-01)	1997				10,356	201	51	10,356
	1998				5,440	85	64	5,440
	1999				16,700	170	98	16,700
	2000				51,435	382	135	51,435
Upper Entry (WFS-02)	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
	2000	64,083	295	217	92,563	1,609	58	156,646
Keweenaw Bay/Bete Grise (WFS-03)	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
	2000	16,408	151	109	58,645	2,020	29	75,053
Big Bay (WFS-04)	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
	2000	26,612	149	179	13,431	235	57	40,043
Marquette (WFS-04)	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	6,800	209	32	24,565
	2000	17,178	194	88	6,479	249	26	23,657
Munising (WFS-05)	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	27,054	1,167	23	75,866
	2000	69,422	930	75	^c	^c	^c	69,422 ^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	224,605	5,698	39	403,826
	2000	193,703	1,719	113	222,553 ^c	4,495 ^c	50 ^c	416,256 ^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, 1992-2000, 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
	1998-2000	0.56	0.04	9-13
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
	1998-2000	0.70	0.04	7-14
Big Bay	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
	1998-2000	0.61	0.04	8-16
Marquette	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
	1998-2000	0.33	0.05	10-21
Munising	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
	1998-2000	0.32	0.03	11-19
Grand Marais	1997	0.35	0.06	8-17

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
	1998-2000	0.56	-11.20	2.93	0.360	532	-0.000	0.9	45,932
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
	1998-2000	0.95	-10.82	2.87	0.383	537	-0.009	0.8	16,510
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
	1998-2000	0.68	-13.51	3.35	0.199	697	-0.036	1.2	18,618
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
	1998-2000	0.15	-12.48	3.14	0.152	803	-0.081	1.2	13,932
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
	1998-2000	0.14	-12.70	3.17	0.169	757	-0.256	1.2	47,671

^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, 1993-2000. 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
	2000	492.7	3.4	1,092.1	26.1	8.3	0.2
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
	2000	470.9	2.7	934.2	20.0	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
	2000	532.9	4.7	1,416.2	44.4	7.5	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
	2000	540.1	5.6	1,450.9	54.3	7.5	0.2
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
	2000	532.9	4.9	1,448.1	48.2	8.1	0.1