STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-4

Study No.: 703 **Title:** Lakewide assessment of the contribution of natural recruitment to the chinook salmon population of Lake Huron. Huron

Period Covered: October 1, 2002 to September 30, 2003

Study Objective:

(1) To estimate annual natural recruitment of chinook salmon to Lake Huron for the 2000 to 2003 year classes;
(2) To determine contributions from natural reproduction to the spawning populations of selected tributaries to Lake Huron;
(3) To refine recruitment modules of Lake Huron's bioenergetics and catch-at-age models, which will, in turn, be used to prescribe stocking levels for Lake Huron.

Summary: This was the second year of funding for this project. All chinook salmon stocked in lakes Huron and Michigan, except those stocked by Ontario, were marked using oxytetracycline administered in feed. All chinook salmon stocked in Ontario waters of Lake Huron were fin clipped. Quality control samples of vertebrae were received during May and June 2003 from Michigan, Illinois, Indiana, and Wisconsin hatcheries. All quality control samples from spring 2002 were checked for quality of the oxytetracycline mark. The Alpena Fisheries Research Station invested in ultraviolet microscope equipment and imaging software, using nonfederal funding, to enhance reproducibility and specimen processing speed. Vertebrae images can now be electronically archived. A database for storage of oxytetracycline mark and fin clip results was designed, as were field data sheets and field collection methods. These products were shared with other cooperating agencies on the Lake Huron Technical Committee. This year was the second year of field collections and creel clerks and coded-wire tag recovery personnel were trained in gathering vertebrae for the recruitment study. Alpena Fisheries Research Station provided staff to collect vertebrae at fishing tournaments at Alpena, Cheboygan, St. Ignace, and Rogers City. Volunteer groups assisted in many collections. The "Thumb Steelheaders", in particular, collected nearly 100 vertebrae each year (2002 and 2003) using the prescribed methodology. Lake Superior State University collected over 400 vertebrae each year from the St. Marys River. Ontario Ministry of Natural Resources collected vertebrae from Georgian Bay and the south-east main basin of Lake Huron. The 2003 vertebrae samples were still being received by the Alpena Fisheries Research Station at the time of this report. Mark composition of age 1 and age 2 chinook from 2002 suggested close to 80% of these year classes originated from natural reproduction. If sustained, this level of chinook salmon reproduction would represent a sharp increase since the early 1990s. Chinook salmon at two stocking sites, on the other hand, were approximately 97% of hatchery origin. Size and condition of chinook salmon at the two stocking sites were relatively low in 2002. Sea lamprey wounding rates were the lowest since the beginning of the time series.

Findings: Jobs 1, 2, 3, 4, and 5 were scheduled for 2002-03 and progress is reported below.

Job 1. Title: **Quality control on fish marking.**–In 2000 - 2003, all chinook salmon stocked in U.S. waters of lakes Michigan and Huron and their tributaries were marked with oxytetracycline (OTC) by administering the antibiotic shortly prior to stocking. In the case of Ontario, all chinook salmon stocked into Lake Huron were marked by fin clipping. Quality control samples from OTC marked chinook salmon were sent to Alpena for analysis. All quality control samples from 2001 and 2002 were analyzed and are summarized in Table 1. Mark quality varied between hatcheries and the two years. Only 11% of Wisconsin's chinook salmon had "good" or "excellent" marks in 2001. Wisconsin's "good" and "excellent" marks rose to 67% the next year. All hatcheries except Wisconsin's Keewanee Hatchery had satisfactory mark quality in 2002. The rise in mark quality in 2002 is likely the result of better implementation of marking protocols. In addition, some of the 2001 samples and the Keewanee samples taken in 2002 were probably taken too soon after marking. The mark requires about 3 weeks to become readily detectable, consequently some of the marks were probably better than our quality control data suggest. In 2002 and 2003 most quality control samples from hatcheries were taken at least 3 weeks after marking. Another measure of mark quality is by sampling known-marked fish at Swan Weir. This weir is located on a limestone quarry outlet where natural reproduction is highly unlikely; thus, most fish in the run should be hatchery fish imprinted on the site at planting. In 2002 we sampled 245 mature chinook salmon at the weir, including 185 age-1 and age-2 fish which should have had marks. Of the 185 fish from marked year classes, 97.5% had detectable marks (Table 2).

In 2001, samples were collected from all hatchery lots. In 2002, we failed to collect samples from Wolf Lake Hatchery. In 2003 there were no departures from the study plan with respect to Job 1.

Job 2. Title: **Monitoring of composition of open-water chinook harvest.**–A database for storage of chinook salmon biological data and laboratory results of vertebrae analysis was designed in 2001 and refined in 2002, as were field data sheets and instructions for field collections. These products were shared with other cooperating agencies on the Lake Huron Technical Committee. This was the second year of field collections. Coded-wire tag recovery personnel and volunteers from organized recreational fishing groups were trained in gathering vertebrae for the recruitment study. Alpena Fisheries Research Station provided staff to collect vertebrae at fishing tournaments at Alpena, Rogers City, Cheboygan, and St. Ignace. Volunteer groups assisted in some collections. The "Thumb Steelheaders", in particular, collected approximately 100 vertebrae in each year, 2002 and 2003, using the prescribed methodology. Ontario Ministry of Natural Resources collected vertebrae from Georgian Bay and the south-east main basin of Lake Huron. Lake Superior State University (LSSU) collected 463 chinook salmon from the upper St. Marys River in 2002 and conducted age and OTC detection in their own lab. LSSU is prepared to do the same in fall 2003. A summary of vertebrae collections is given in Table 3. Vertebrae samples from 2003 were still being received by the Alpena Fisheries Research Station at the time of this report. Sample size quotas were met in 2003 for north-central Lake Huron, but as with 2002, collections fell short in southern Lake Huron and in Ontario waters. Sample size targets and staffing requirements for meeting sample quotas in 2004 will be taken up by the Lake Huron Technical Committee at its January 2004 meeting. Incidence of unmarked (wild origin) chinook salmon has been higher (see Job 4) than anticipated in the study design, thus it may prove that sample size targets in the study plan were higher than necessary.

Job 3. Title: **Monitoring of composition of spawning escapement chinook salmon on selected spawning tributaries.**–Escapement was sampled in the Au sable River in October 2002 by electrofishing. Biological samples of escaping chinook salmon were also taken at Swan River in October 2002 by sampling at the harvest weir. Both of these efforts were conducted according to the study plan. In addition, Lake Superior State University sampled the St. Marys River and

Ontario Ministry of Natural Resources sampled Milldam River in Owen Sound. Sample sizes are given in Table 3.

Job 4. Title: **Laboratory analysis.**–In September 2002 Alpena upgraded its oxytetracycline detection equipment by acquiring a florescence dissecting stereoscope and imaging software using nonfederal funds. The new equipment was configured and used for the first time in mark detection during 2003. The new technology allowed archiving and peer review of our image analysis, using electronically saved images. OTC mark composition and ages were determined for all 1,786 vertebrae samples received (Table 3) from May 2002-March 2003. In addition, all quality control samples from 2001 and 2002 were inspected.

Job 5. Title: **Data analysis, preparation of annual and final reports, report layout and publication, and presentation of findings at technical and public meetings.**–During the period 1991-1994, the last time all chinook salmon were OTC marked, approximately 85% of vertebrae displayed a mark, suggesting recruitment from natural reproduction was no more than 15% at that time. Surprisingly, the opposite was true for the 2000 and 2001 year classes as represented by vertebrae samples from the recreational fishery. Marks or fin clips were detected on only 22.3% of these samples (Table 4). Two thirds or more of vertebrae collected from the various sites were evidently of wild origin. By contrast, OTC marks were detected on 96.8% of samples from two stocking sites, Swan Weir and Au sable River, where reproduction is known to be minimal or nonexistent, indicating the OTC marks were detectable. Thus, the low incidence of marks in the recreational fisheries is indicative of high contributions from reproduction to the 2000 and 2001 year classes. With the exception of Georgian Bay and St. Marys River, the recreational fisheries were sampled during mid-summer when chinook salmon were presumably of mixed origin. Thus, chinook salmon from a variety of stocking and reproduction sites should have been represented in each of these samples. Evidently, reproduction was substantial for at least the 2000 and 2001 year classes.

Fall sampling of chinook salmon escapement to the Swan Weir and Au sable River provided the opportunity to continue collecting growth and condition information that had been collected by Study 482 and previous studies. Size-at-age data from the two sites are presented in Table 5. Size and Ktl for age-2, -3, and -4 salmon were lowest at both sites in 1997 and 1998, years of low adult alewife abundance. Size and Ktl recovered in 1999 but Ktl showed indications of decline from 2000 to 2002. In Table 6, growth and condition of age-3 chinook salmon from the Au sable River are compared with data collected there from 1973-1981. Length, weight, and Ktl were lower in the latter period ($P < 0.01$), suggesting density effects may be affecting these parameters in recent years. Lamprey wounding is given in Table 7 for both sampling sites. Type A-1, A-2, and A-3 wounds, which in fall represent wounds of the current year, were lowest of the 1996-2002 time series in 2002.

The annual progress report for October 2002-September 2003 was prepared. Data from the first year of this study were presented at the Upper Lakes Meeting of the Great Lakes Fishery Commission, the Lake Huron Technical Committee, the Michigan DNR Lake Huron Basin Team meeting, a staff meeting of Platte River State Fish Hatchery personnel, and other forums during 2003. Coordination was carried out with the Lake Huron Technical Committee on chinook salmon data collection.

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Table 1.–Summary of quality control data by hatchery, 2001 and 2002.

					Numbers					Percent				
Station	State	Year	Lot	Sample size	Excellent	Good	Poor	Very poor	Negative	Excellent	Good	Poor	Very poor	Negative
Keewanee	Wisconsin	2001		25	0	4	13	5	3	0	16	52	20	12
Manitowac	Wisconsin	2001		25	0	7	15	1	2	0	28	60	4	8
Westfield	Wisconsin	2001		25	0	0	10	13	2	0	0	40	52	8
Wild Rose	Wisconsin	2001		25	0	0	14	6	5	0	0	56	24	20
Jake Wolf	Illinois	2001		50	37	13	0	0	0	74	26	0	0	0
Thompson	Michigan	2001		50	50	0	0	0	0	100	0	0	0	0
Wolf Lake	Michigan	2001		100	61	28	11	0	0	61	28	11	0	0
Platte	Michigan	2001		40	34	4	1	0	1	85	10	2.5	0	2.5
Bodine	Indiana	2001		50	7	17	22	4		14	34	44	8	0
Mixsaubaw	Indiana	2001		50	1	11	33	5	0	2	22	66	10	0
Keewanee	Wisconsin	2002	1	65	8	8	22	-	27	12	12	34	-	42
Westfield	Wisconsin	2002	2	74	55	10	6	-	3	74	14	8	-	4
Wild Rose	Wisconsin	2002	1	51	43	5	2	-	1	84	10	4	-	2
Jake Wolf	Illinois	2002	1	48	28	18	2	-	0	58	38	4	-	0
Jake Wolf	Illinois	2002	2	52	47	5	0	-	0	90	10	0	-	0
Thompson	Michigan	2002	1	101	81	16	4	-	0	80	16	4	-	0
Platte	Michigan	2002	LM	19	8	10	1		0	42	53	5	-	0
Keewanee	Michigan	2002	Sable Pen	19	12	5	2		0	63	26	11	-	0
Westfield	Indiana	2002	1	59	50	6	2	-	1	85	10	3	-	2

Table 2.–Oxytetracycline mark quality on chinook salmon returning to Swan Weir (site with no reproduction), 2002.

			Mark quality counts				Mark quality percent			
Age	Year class	Sample	Excellent	Good	Poor	No mark	Excellent	Good	Poor	No mark
1	2001	46	16	25	4	1	34.8	54.3	8.7	2.2
2	2000	138	21	70	43	4	15.2	50.7	31.2	2.9
3	1999	61	year class not marked			61	0.0	0.0	0.0	100.0

Table 3.–Numbers of chinook salmon vertebrae collected by basin or lake area, 2002, for Jobs 2 and 3 (summer and fall collections).

Area	Targeted	All Ages	< Age-3
Swan Weir	200	245	184
Au sable River (fall)	200	255	187
N. Central Basin	500	279	243
Thumb	500	188	144
St. Marys (LSSU, fall)	200	463	419
Ontario Main Basin	1,000	256	193
Georgian Bay	250	100	98
Total		1,786	1,468

Table 4.–Incidence of OTC in vertebrae sampled from Lake Huron chinnook salmon by capture location. Escapement sampling was from two stocking sites with no prior evidence of reproduction. St. Marys River and Georgian Bay samples included escapement, and were in proximity to stocking sites and locations thought to be reproduction sites.

	Age group							
	0		1		2		Ages 0-2	
Basin	Sample size	% marked	Sample size	% marked	Sample size	% marked	Sample size	% marked
Georgian Bay	6	0.0	50	10.0	137	8.8	193	8.8
South-Central Basin, Ont.	66	22.7	13	69.3	20	30.0	99	30.3
South Basin, Mich.	0	-	36	22.2	108	13.0	144	15.3
North-Central, Mich.	0	-	13	23.1	211	15.2	224	15.6
North, Mich.	0	-	17	5.9	2	50.0	19	10.5
St. Marys River	0	-	118	41.5	301	29.9	419	33.2
All sites	72	20.8	247	30.4	779	19.9	1098	22.3
Escapement to stocking sites:								
Au sable River	0	-	78	98.7	109	94.5	187	96.3
Swan Weir	0	-	46	97.8	138	97.1	184	97.3
Both sites combined	0	-	124	98.4	247	96.0	371	96.8

Table 5.–Lengths (mm), weights (gm), and condition factors for chinook spawning runs in Swan and Au sable rivers, September-October, 1996-2002.

		Swan River				Au sable River			
Age group	Sample year	Length	Weight	Condition*	Sample size	Length	Weight	Condition*	Sample size
1	1996	569	1,773	0.95	10	543	1,727	1.05	126
	1997	507	1,372	1.05	6	528	1,580	1.08	34
	1998	509	1,470	1.13	7	561	1,970	1.06	11
	1999	629	2,468	0.98	46	608	2,464	1.07	40
	2000	593	2,250	1.06	58	572	2,003	1.09	186
	2001	591	2,120	1.01	68	594	2,160	1.02	40
	2002	563	1,812	0.98	44	535	1,564	1.00	76
2	1996	776	4,414	0.93	52	766	4,590	1.00	124
	1997	840	4,040	0.74	3	724	3,730	0.97	190
	1998	691	3,150	0.95	61	710	3,300	0.92	95
	1999	789	5,025	0.99	52	771	4,627	0.99	56
	2000	824	5,705	1.00	37	786	4,799	0.97	96
	2001	820	5,592	1.00	86	775	4,538	0.96	55
	2002	806	4,893	0.92	143	763	4,161	0.91	110
3	1996	852	5,769	0.92	25	857	6,246	0.98	149
	1997	822	4,973	0.89	40	827	5,260	0.92	239
	1998	846	5,610	0.90	86	783	4,490	0.92	310
	1999	864	6,365	0.97	91	847	6,092	0.99	278
	2000	915	7,577	0.98	89	875	6,545	0.96	114
	2001	917	7,399	0.95	37	839	5,567	0.93	41
	2002	891	6,823	0.95	61	855	5,798	0.91	66
4	1996	967	8,886	0.97	13	911	7,513	0.98	27
	1997	860	5,706	0.88	16	858	5,830	0.91	92
	1998	866	5,860	0.88	56	825	4,840	0.85	33
	1999	864	6,257	0.96	10	863	6,233	0.96	136
	2000	921	7,182	0.91	16	899	6,862	0.94	38
	2001	865	6,051	0.91	9	917	6,775	0.87	2
	2002	-	-	-	0	815	4,960	0.92	1

* Condition = $(\text{Weight}/\text{Length}^3) \times 10^5$

Table 6.–Summary of lengths, weights, and condition factors of age-3 chinook salmon, Au sable River, 1973-2002.

Year	Length (mm) Mean	Length (mm) Std. dev.	Weight (g) Mean	Weight (kg) Std. dev.	Condition Mean	Condition Std. dev.
1973	886	54	8,685	1,540	1.24	0.09
1974	909	53	9,276	1,554	1.23	0.11
1975	952	50	10,719	1,265	1.25	0.14
1976	904	48	8,850	1,382	1.19	0.09
1977	888	51	8,298	1,421	1.18	0.08
1978	887	50	8,424	1,442	1.20	0.10
1979	899	34	8,785	1,401	1.20	0.10
1980	882	52	7,946	1,386	1.15	0.10
1981	897	47	8,425	835	1.17	0.11
1996	857	63	6,246	1,529	0.99	0.11
1997	827	60	5,265	1,320	0.92	0.13
1998	783	72	4,492	1,304	0.92	0.17
1999	847	61	6,092	1,449	0.99	0.12
2000	875	63	6,545	1,537	0.96	0.12
2001	840	60	5,567	1,336	0.93	0.10
2002	855	61	5,798	1,516	0.91	0.10

Table 7.–Number of A1-A3 (fresh) wounds per 100 chinook salmon >=700 mm total length, Au sable and Swan Rivers, combined fall spawning escapement collections.

Year	Wound rate	Sample size
1996	8.0	375
1997	3.4	523
1998	2.4	544
1999	5.5	605
2000	3.2	381
2001	5.3	225
2002	1.9	362