STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-3

Study No.: 665 **Title:** Investigation of causes of declines in Au Sable River brown trout populations

Period Covered: October 1, 2001 to September 30, 2002

Study Objective: To continue to conduct annual trout population surveys at index stations on the Au Sable River. These data will be used to determine effects of changes in channel habitats and water quality on the abundance of larger trout in the river. They will also be used to evaluate the effectiveness of instream structure rehabilitation efforts in the Mainstem and North Branch Au Sable River.

Summary: Fisheries Management Unit and Hunt Creek Fisheries Research Station personnel estimated trout populations in reaches of the Mainstem, North, and South branches Au Sable River, and eleven other Lower Michigan rivers. We summarized water quality data collected for these reaches in fall 2001 and compared contemporary nutrient concentrations to historic values. Preliminary comparisons between current and historic total phosphorus concentrations suggests phosphorus levels may be 1.5 to 4 times lower than in the early 1970s. We used electronic thermometers to collect water temperature data in the three branches of the Au Sable River and eleven rivers where trout populations were estimated. We continued to test predictive models that use water temperature to predict time to hatch and swim-up of brown trout. Preliminary findings from rearing brown trout eggs and fry at temperatures typical of Michigan trout streams suggested that existing models can predict median hatch and swim-up times of brown trout to within about 2 weeks.

Findings: Jobs 1, 2, and 3 were scheduled for 2001-02, and progress is reported below.

Job 1. Title: Estimate trout populations and age scales.–Fisheries management unit biologists and technicians conducted mark-and-recapture estimates of trout populations in six reaches distributed among three branches of the Au Sable River during late summer and early fall 2001. Trout populations were estimated in 2002 for one reach in each of the mainstem Au Sable and South Branch Au Sable rivers. Management unit personnel determined ages of trout from scales collected from subsamples of the trout at each site. We used these data to compute both size- and age-specific trout population estimates for each river reach.

Information on fish populations and water quality from eleven additional rivers was collected to help in assessing changes in nutrient levels and brown trout abundance in Michigan rivers since the mid-1970s. Eight rivers were sampled at sites having historic data on (pre-1975) trout populations and water quality. We also sampled three rivers (South Branch Boardman, Spring Brook, and Silver Creek) that had relatively high brown trout abundances and might be enriched by human activities. Data were entered and population estimates computed for surveys conducted in summers of 1999 to 2002 (Table 1). Scale aging will need to be completed for 2002 surveys (and some 2001 surveys) before population estimates can be made for each age group. Historic population estimates need to be compiled and summarized for comparison with contemporary population levels.

Water quality data were collected on these rivers in late summer 2001 by the Michigan Department of Environmental Quality, Surface Water Quality Division for comparison with historic data (Table 2). Preliminary comparisons between current and historic total phosphorus concentration mean values suggests phosphorus levels may be 1.5 to 4 times lower than historic levels in many rivers.

Job 2. Title: Monitor water temperatures and summarize data.–We collected water temperature data to better understand the influence of spawning time and winter rearing temperatures on brown trout recruitment dynamics in the Au Sable River. Trout fry are most vulnerable to high flows shortly after they swim up from the gravel and begin exogenous feeding (Nuhfer et al. 1994). Data describing ambient stream temperatures and egg and fry development rates under near-ambient winter temperature conditions were obtained under this job.

We reared brown trout eggs and fry in the laboratory to determine the effect of cold water temperatures (i.e., similar to those in Michigan trout streams) on development rates. Our intent was to assess whether predictions from published models (Crisp 1981; Crisp 1988), based mostly on warmer water temperatures, would apply to Michigan trout streams, which typically have much colder winter temperatures (<5 ^{o}C). We obtained fertilized eggs on December 13, 2001 from the Oden State Fish Hatchery and transferred them to the Wolf Lake State Fish Hatchery where they were reared by hatchery staff. Fish were reared under cold temperatures until April 14, 2002 when the chiller was shut off due to competing electrical needs of other hatchery operations. Median hatch and swim-up dates were interpolated from notes made by hatchery staff on the developmental progress of each batch of eggs and fry reared. Preliminary analysis indicated that predictions of median hatch and swim-up dates from Crisp's (1981; 1988) models were within roughly 2 weeks of predicted values (Table 3). Our findings concur with those of Wallace and Heggberget (1988) who found that Crisp's (1981) model accurately predicted hatch times for Atlantic salmon reared at or below 1 ^{o}C. Further rearing of fry from fertilization to completion of swim-up at ambient temperatures is still desirable for testing Crisp's (1988) model, because we could not maintain such temperatures throughout the swim-up period. Nevertheless, our findings suggest that these models may suffice for predicting hatch and swim-up times of brown trout in Michigan streams.

We have used electronic thermometers to record water temperatures at a minimum of one location at each of the three branches of the Au Sable River every year since 1989. Thermometers were also deployed in the eleven other study rivers to record hourly stream temperatures throughout the year. Data were recovered from electronic thermometers each spring and fall. Data will be used to facilitate analyses, such as effects of temperature on incubation time and growth rates of trout.

Job 3. Title: Analyze data.–Some preliminary data analysis has begun and is reported under Jobs 1 and 2. Further analysis will occur once remaining scale samples are aged, and as additional data are processed and become available.

Literature Cited:

Crisp, D. T. 1981. A desk study of the relationship between temperature and hatching time for the eggs of five species of salmonid fishes. Freshwater Biology 11:361-368.

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Elliott, J. M. 1994. Quantitative ecology and the brown trout. Oxford University Press, New York, New York.

Nuhfer, A. J., R. D. Clark, Jr., and G. R. Alexander. 1994. Recruitment of brown trout in the South Branch of the Au Sable River, Michigan in relation to stream flow and winter severity. Michigan Department of Natural Resources, Fisheries Research Report 2006, Ann Arbor.

Wallace, J. C., and T. G. Heggberget. 1988. Incubation of eggs of Atlantic salmon (Salmo salar) from different Norwegian streams at temperatures below 1°C. Canadian Journal of Fisheries and Aquatic Sciences 45:193-196.

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Table 1.–Average standing crops of salmonid populations in reaches of fourteen Lower Michigan rivers.

River	Location	Years	Population estimate (lbs/acre) Brook trout	Brown trout	Rainbow trout	Chinook salmon	Coho salmon	Total
Au Sable, Mainstem	Stephan Bridge	2000-2002	9.5	122.0	14.2	0	0	145.7
Au Sable, North Branch	Dam Four	2000-2002	22.0	34.2	0	0	0	56.2
Au Sable, South Branch	Smith Bridge	2000-2002	11.7	65.3	0	0	0	77.0
Baldwin	Bray Creek Campgd.	2000-2002	0	62.7	8.2	0.1	0.9	72.0
Boardman, North Branch	near Broomhead Rd.	2000-2002	9.9	32.3	0	0	0	42.2
Boardman, South Branch	Broomhead Road	2000-2002	4.1	74.6	0	0	0	78.7
Hersey	Patterson Road	2000-2002	0	73.3	0	0	0	73.3
Houghton Creek	Flynn Road	2000-2002	0	152.4	6.3	0.4	0	159.1
Manistee	Cameron Bridge	2000-2002	7.8	102.4	0	0	0	110.2
Pere Marquette	mouth of Baldwin R.	1999-2000	0	72.0	65.8	2.1	34.9	174.9
Pere Marquette, Little South Branch	Taylor Bridge	2000-2002	0	21.5	7.4	0.2	0.1	29.2
Platte	Haze Road	2000-2002	0	59.7	15.9	0.0	6.9	82.6
Silver Creek	Fourth Street	2000-2001	0.4	116.0	0	0	0	116.4
Spring Brook	DE Avenue	2000-2002	0	87.6	0	0	0	87.6

Table 2.–Historic (pre-1975) and recent total phosphorus concentrations for reaches of fourteen Lower Michigan rivers. Values shown are mean and standard deviation (in mg P/L) and the number of samples (N). Also shown, is the ratio of historic to current total phosphorus concentrations. Shown for Houghton Creek (highlighted by an asterisk) is historic soluble phosphorus concentration (a parameter comparable to orthophosphate), the current orthophosphate concentration, and the ratio between the two parameters.

River	Location	Total Phosphorus concentration (mg P/L) Historic Mean	Historic S. Dev.	Historic N	Current Mean	Current S. Dev.	Current N	Historic to current
Au Sable, Mainstem	Stephan Bridge	0.035	0.037	26	0.011	0.001	2	3.3
Au Sable, North Branch	Dam Four	0.015	0.007	2	0.015	0.004	2	1.0
Au Sable, South Branch	Chase Bridge	0.039	0.024	8	0.012	0.002	2	3.4
Baldwin	Bray Creek Camp.	0.037	0.017	14	0.020	0.001	2	1.9
Boardman, North Branch	near Broomhead Rd.	0.016	0.021	5	0.011	0.001	2	1.5
Boardman, South Branch	Broomhead Road				0.006	0.001	2	
Hersey	Patterson Road	0.183	0.257	3	0.033	0.006	2	5.6
Houghton Creek*	Flynn Road	0.019	0.021	4	0.006	n/a	1	3.1
Pere Marquette	mouth of Baldwin R.	0.038	0.027	16	0.019	0.004	2	2.1
Pere Marquette, Little South Branch	Taylor Bridge	0.034	0.029	15	0.020	0.007	2	1.7
Manistee	Cameron Bridge	0.011	0.012	7	0.009	0.005	2	1.3
Platte	Haze Road	0.040	0.031	33	0.010	0.003	2	4.0
Silver Creek	Fourth Street				0.011	0.003	2	
Spring Brook	DE Avenue				0.009	0.001	2	

Table 3.–Predicted and observed days to hatch and swim-up for brown trout reared under different thermal regimes at the Wolf Lake State Fish Hatchery from 1999 to 2002. Temperatures were adjusted monthly to mimic seasonal patterns. Predictions of days to median hatch and swim-up were made from equations developed by Crisp (1988). Observed days to 50% hatch and swim-up were based on interpolations of observational notes from each treatment.

	Mean rearing temperature (^{0}C) to predicted:		Predicted days to:		Observed days to:		Observed degree
Year	Hatch	Swim-up	Hatch	Swim-up	Hatch	Swim-up	days to hatch
1999-00	2.2	3.4	141	171	84	--	313
1999-00	4.9	6.1	92	123	80	--	369
1999-00	10.4	10.4	39	67	42	80	437
2000-01	2.9	4.2	128	157	123	159	355
2000-01	2.7	4.1	132	158	121	158	360
2000-01	3.2	4.2	115	154	105	154	347
2001-02	3.7	4.6	99	140	114	144	400
2001-02	3.6	4.8	100	135	106	135	398
2001-02	8.1	7.8	54	98	66	87	529
2001-02	7.4	--	60	--	83	--	614