STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-2

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

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

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 two reaches in each of the Mainstem, North, and South branches Au Sable River, and in reaches of eleven other Lower Michigan rivers. Scale samples collected from subsamples of trout were read to determine trout ages and used to derive age-specific population estimates in all reaches. Habitat data were obtained and summarized for sampled reaches in eleven rivers (most having historic water quality and/or historic trout population estimates) and three reaches in the Au Sable River system. 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. Spawning redd counts were obtained for the Mainstem and South Branch Au Sable River in fall 2000. These data showed that brown trout spawning activity generally peaked in early November. As in 1999, peak redd counts occurred roughly 7-10 days earlier in the South Branch than in the Mainstem. Preliminary findings of experiments in rearing brown trout eggs and fry at temperatures typical of Michigan trout streams suggested that existing models predict when brown trout eggs hatch to within roughly 10 days. Further experiments are needed to determine how accurately swim-up time can be predicted.

Job 1. Title: Estimate trout populations and age scales

Findings: 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 2000. Management unit personnel determined the 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, habitat, and water quality from eleven additional rivers were collected to help in assessing changes in nutrient levels and brown trout abundance in Michigan rivers since the mid-1970's. 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 abundance and might be enriched by human activities. Data were entered, scales aged, and population estimates computed for surveys conducted in summer 2000 (Table 1). Surveys were conducted again in

2001, but data entry and scale aging will need to be completed before population estimates can be made. Water quality data were collected on these rivers in summer 2001 by the Michigan Department of Environmental Quality, Surface Water Quality Division, and should be available in the near future. We summarized habitat survey data from all fourteen rivers sampled during the summers of 2000 and 2001 for this study (Table 2).

Job 2. Title: <u>Monitor water temperatures and summarize data</u>

Findings: 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 major spawning periods, winter stream temperatures, and egg and fry rearing rates under ambient winter temperature conditions were obtained under this job.

We counted active brown trout redds in the Au Sable River on a weekly basis from October 18 to December 7, 2000. Redds were defined as distinct polished areas on the streambed, with an obvious egg pocket, and clean gravel washed downstream by fish activity. We only counted redds >0.5 m in diameter to minimize the potential for including brook trout redds in the count. Counts were made from a canoe in three river reaches: 3.81 km on the South Branch Au Sable River from Chase Bridge downstream to Marlabar; 3.88 km on the South Branch Au Sable River from Canoe Harbor State Forest Campground downstream to the former Truettner property; and 10.04 km on the Mainstem Au Sable River from Thendara Road downstream to the Wakeley Bridge public access site. Count data showed that brown trout spawning activity generally peaked in early November (Figure 1). As in 1999 (Zorn and Nuhfer 2000), peak redd counts occurred roughly 7-10 days earlier in the South Branch than in the Mainstem. Extreme cold weather events coincided with sharp declines in active redd counts on the Mainstem in mid-November and early December (Figure 1). These conditions prevented November 22 and December 7 redd counts on the South Branch Au Sable River.

We reared brown trout eggs and fry in the laboratory to determine the effect of water temperatures comparable to those seen in Michigan trout streams on trout development rates. Our intent was to assess whether predictions from published models (e.g., Crisp 1988), based mostly on warmer water temperatures, would apply to Michigan trout streams, which typically have much ($<5^{o}$ C) colder winter temperatures. We obtained fertilized eggs on December 14, 2000 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 hatch, and transferred by hatchery staff to warmer (10^{o} C) rearing tanks shortly after hatch was complete. 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 date from Crisp's (1988) model were within roughly 10 days of when we estimated that 50% hatch had occurred (Table 3). Rearing of fry from fertilization to swim-up at colder temperatures (rather than hatchery temperatures) is needed to determine if his model accurately predicts swim-up time. Our findings suggest occurrence of a compensatory relationship between development rate of brown trout and rearing temperature. Therefore, reports (e.g., Elliott 1994) indicating a specific number of degree days to hatch or swim-up should be interpreted within the thermal context of the rearing environment.

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 obtain July temperatures. Thermometers were deployed at or near river reaches where we estimate trout populations. Temperatures were typically recorded hourly throughout the year. Data were recovered from electronic thermometers each spring and fall. Data were summarized to facilitate comparisons of rivers (Table 2) and analyses such as effects of temperature on incubation time and growth rates of trout.

Job 3. Title: Analyze data

Findings: Some preliminary data analysis has begun and is reported under jobs 1 and 2. Further analysis will occur after scale samples are aged and additional data are processed and available.

Literature Cited:

Crisp, D.T. 1988. Prediction, from temperature, of eyeing, hatching and 'swim-up' times for salmonid embryos. Freshwater Biology 19:41-48.

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.

Zorn, T.G., and A.J. Nuhfer. 2000. Investigation of causes of declines in Au Sable River brown trout populations. Michigan Department of Natural Resources, Fisheries Division, Sport Fish Restoration Performance Report, Study 665, Project Number F-80-R-1, Ann Arbor.

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Table 1.–Estimated biomass density of salmonids for two reaches in each of the Mainstem, North, and South branches Au Sable River and for reaches in eleven additional rivers.

River Branch	Location	Population estimates (kg/ha) Brown trout	Brook trout	Rainbow trout	Chinook salmon	Coho salmon	All salmonids
Au Sable River							
Mainstem	Stephan Bridge	120.9	9.6	16.9	0.0	0.0	147.4
	Thendara Road	47.5	17.8	0.0	0.0	0.0	65.3
North Branch	Dam Four	39.0	24.4	0.0	0.0	0.0	63.4
	Eamons Landing	21.6	26.6	0.0	0.0	0.0	48.2
South Branch	Chase Bridge	74.2	8.0	0.0	0.0	0.0	82.1
	Smith Bridge	32.5	16.0	0.0	0.0	0.0	48.5
Baldwin River	Bray Creek Campground	96.7	0.0	10.9	0.0	0.0	107.6
Boardman River							
North Branch	near Broomhead Road	42.4	11.6	0.0	0.0	0.0	54.0
South Branch	Broomhead Road	110.6	3.6	0.0	0.0	0.0	114.2
Hersey River	Patterson Road	136.3	0.0	0.0	0.0	0.0	136.3
Houghton Creek	Flynn Road	193.2	0.0	7.6	0.4	0.0	201.2
Pere Marquette River	mouth of Baldwin River	n/a	n/a	n/a	n/a	n/a	n/a
Little South Branch	Taylor Bridge	42.2	0.0	17.7	0.3	0.2	60.4
Manistee River	Cameron Bridge	88.3	9.0	0.0	0.0	0.0	97.3
Platte River	Haze Road	91.5	0.0	19.3	0.1	13.7	124.5
Silver Creek	Fourth Street	120.7	0.8	0.0	0.0	0.0	121.5
Spring Brook	DE Avenue	99.6	0.0	0.0	0.0	0.0	99.6

Table 2.–Summary of habitat data obtained from fourteen river reaches included in this study. Data unavailable at present are indicated by "n/a".

Habitat variable	River													
	Au Sable River, Mainstem-Stephan Bridge	Au Sable River, North Branch- Dam Four	Au Sable River, South Branch-Chase Bridge	Baldwin River	Boardman River, North Branch	Boardman River, South Branch	Hersey River	Houghton Creek	Pere Marquette River	Pere Marquette River, Little South Branch	Manistee River	Platte River	Silver Creek	Spring Brook
Sample area (ha)	0.57	1.24	0.57	n/a	0.31	0.31	0.30	0.23	0.60	0.34	0.55	0.41	0.15	0.16
July 2000 mean temp. (C)	16.0	17.8	16.0	n/a	15.8	13.6	15.0	14.9	16.4	16.0	12.4	17.0	16.3	15.0
Mean depth (cm)	31	21	48	n/a	31	32	36	43	37	47	47	25	19	22
Mesohabitat (proportion)														
Riffle	0.7	0.4	0.1	n/a	0.2	0.0	0.2	0.1	0.6	0.0	0.0	0.2	0.3	0.1
Run	0.3	0.6	0.9	n/a	0.8	1.0	0.8	0.9	0.4	0.9	1.0	0.8	0.6	0.7
Pool	0.0	0.0	0.0	n/a	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.1
Substrate composition (%)														
Clay	0	0	<1	n/a	0	0	0	30	0	5	0	0	1	0
Silt or Detritus	13	21	14	n/a	6	14	11	8	20	13	12	5	9	9
Sand	47	19	25	n/a	35	48	36	37	18	51	21	31	17	20
Gravel	38	59	30	n/a	47	30	38	11	58	28	56	59	56	62
Small cobble	0	1	24	n/a	6	1	11	0	1	3	8	4	11	2
Large cobble	0	0	<1	n/a	1	4	<1	2	0	0	<1	1	2	<1
Boulder	0	0	0	n/a	0	0	2	1	0	<1	<1	0	3	2
Wood	1	<1	1	n/a	1	1	1	12	2	0	<1	1	1	5
Other	1	<1	5	n/a	4	1	<1	<1	<1	<1	1	<1	<1	1
Percent of reach with rooted plants	46	57	10	n/a	14	47	7	1	33	15	19	26	19	12
Large Woody Debris Density														
Meters of logs >15 cm	93	13	436	n/a	176	276	189	794	55	147	359	257	95	45
Meters of logs >30 cm	38	9	141	n/a	18	65	73	187	31	33	92	137	36	0
Log jam area (m^2)	98	0	224	n/a	499	135	279	586	36	19	139	544	22	119
Artificial structure area (m^2)	916	16	0	n/a	0	7	0	14	368	27	362	232	259	0
Total lineal density (m/ha)	131	22	577	n/a	194	340	262	981	86	180	452	394	131	45
Total areal density (m^2/ha)	1014	16	224	n/a	499	142	279	600	403	45	501	776	281	119

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 2001. 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 made from interpolations of observational notes recorded for each treatment.

	Mean temperature (C) to predicted:		Predicted days to:		Observed days to:		Observed degree days to
Year	Hatch	Swim-up	Hatch	Swim-up	Hatch	Swim-up	Hatch
1999-2000	2.2	3.4	141	171	84	–	197
1999-2000	4.9	6.1	92	123	80	–	369
1999-2000	10.4	10.4	39	67	42	80	437
2000-1	2.9	4.2	128	157	123	159	355
2000-1	2.7	4.1	132	158	121	158	360
2000-1	3.2	4.2	115	154	105	154	347

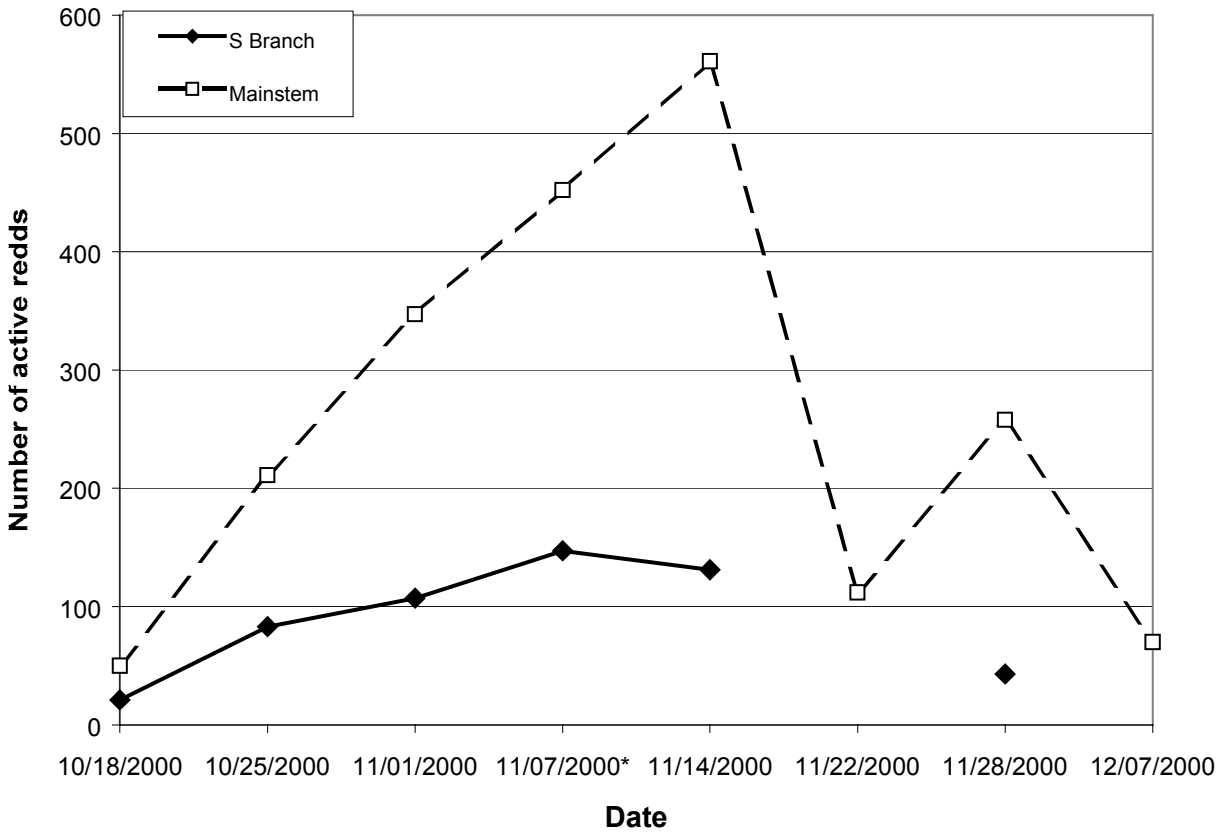

Figure 1.–Active redds counted in 7.7 km of the South Branch Au Sable River (3.8 km from Chase Bridge downstream to Marlabar and 3.9 km from Canoe Harbor State Forest Campground downstream to the former Truettner property) and in 10.0 km of the Mainstem Au Sable River from Thendara Road downstream to the Wakeley Bridge public access site. *All counts were made by Troy Zorn except for the November 7th count made by Tim Smigielski.