STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-80-R-1

Study No.: 665

Title: Investigation of causes of declines in Au Sable River brown trout populations

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

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: We estimated trout populations in two reaches in each of the Mainstem Au Sable River, and its North and South branches. Scale samples collected from subsamples of trout were read to determine trout ages and used to derive age-specific population estimates in all reaches. Eleven rivers, most having historic water quality and/or historic trout population estimates, were selected for surveys in 2000-1. We used electronic thermometers to collect water temperature data in all three branches of the Au Sable River where trout populations were estimated. Instream habitat data, continuous July temperature measurements, and trout population estimates were obtained in the summer of 2000 for one reach on nearly all of the eleven rivers. Spawning redd count data, collected for the Mainstem and South Branch Au Sable River, showed that brown trout spawning activity peaked roughly 7-10 days earlier in the South Branch than in the Mainstem. Preliminary findings from egg and fry rearing experiments suggested that larval development rates vary with temperature in a compensatory manner, and are not strictly regulated by simple thermal measures such as degree days.

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 river reaches distributed among three branches of the Au Sable River during late summer and early fall 1999. District fisheries personnel determined the ages of trout from scale samples from subsamples of the trout collected. We used these data to compute both size- and age-specific trout population estimates for each river reach. Estimated numbers of fish per hectare by age for fall 1999 are reported for brown trout (Table 1) and brook trout (Table 2).

We identified eleven additional rivers to be sampled during the summers of 2000 and 2001 (Table 3). Eight of these were selected because they had historic (pre-1975) trout population estimate and water quality data. Locations historically sampled on these rivers were re-visited. Three other rivers (South Branch Boardman, Spring Brook, and Silver Creek) were selected because survey data showed that they still had relatively high brown trout abundance and were thought to be enriched by human activities. Instream habitat data, continuous July temperature measurements, and trout population estimates were obtained in the summer of 2000 for one reach on each of the eleven rivers. Instream habitat data were not collected during the past summer on Spring Brook and Silver Creek, but will be collected in summer 2001. These data have not yet been entered into a computer database nor analyzed. Water quality data will be collected on these rivers in summer 2001 with cooperation from the Michigan Department of Environmental Quality, Surface Water Quality Division. These data and similar information for the Au Sable River will be used to determine if there has been a general decline in nutrient levels and brown trout abundance in Michigan rivers since the mid-1970's.

Job 2. Title: Monitor water temperatures and summarize data

Findings: We collected 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 14 to December 2, 1999. 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. Redd locations were mapped using GPS on October 22 and November 1. Count data obtained indicated that peak spawning activity occurred 10 days earlier on the South Branch Au Sable River (Figure 1). Similar data will be collected in fall 2000.

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 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 so as to facilitate analyses such as effects of temperature on incubation time and growth rates of trout.

We reared brown trout under three different thermal regimes to determine the effect of water temperatures on egg and fry rearing 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 7, 1999 from the Oden State Fish Hatchery and transferred them to the Wolf Lake State Fish Hatchery where they were reared by hatchery staff. Preliminary findings from these experiments suggested that development rates vary with water temperature in a compensatory manner, and are not strictly regulated by simple thermal measures such as degree days. For example, Elliott's (1994) finding that spawned brown trout eggs in British streams require 444 degree-days to hatch may not directly apply to naturally-reproducing brown trout in Michigan streams (Table 4).

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.

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Table 1.–Estimated[a] number (±2 SE) of brown trout per hectare (by age) for fall 1999 populations in the Mainstem, North Branch, and South Branch Au Sable River.

River branch	Age						
River reach	0	1	2	3	4	5	6
Mainstem							
Stephan Bridge	1715	393	306	106	20	2	0
	(±148)	(±73)	(±40)	(±26)	(±14)	(±4)	
Wa Wa Sum	492	152	149	51	2	0	0
	(±67)	(±21)	(±25)	(±17)	(±3)		
North Branch							
Eamons Landing	505	118	17	3	0	0	0
	(±54)	(±12)	(±6)	(±2)			
Dam – 4	1121	156	55	13	1	0	0
	(±86)	(±16)	(±9)	(±5)	(±0)		
South Branch							
Chase Bridge	1420	169	83	37	6	0	0
	(±177)	(±38)	(±20)	(±14)	(±8)		
Smith Bridge	771	69	35	9	2	0	0
	(±119)	(±18)	(±9)	(±5)	(±0)		

[a] Petersen (Bailey modification) single-census, mark-and-recapture population estimate.

Table 2.–Estimated[a] number (±2 SE) of brook trout per hectare (by age) for fall 1999 populations in the Mainstem, North Branch, and South Branch Au Sable River.

River branch	Age			
River reach	0	1	2	3
Mainstem				
Stephan Bridge	1010	212	36	6
	(±94)	(±48)	(±15)	(±5)
Wa Wa Sum	769	179	115	0
	(±67)	(±35)	(±29)	
North Branch				
Eamons Landing	2027	309	54	3
	(±100)	(±37)	(±21)	(±2)
Dam – 4	2532	479	60	1
	(±101)	(±43)	(±25)	(±0)
South Branch				
Chase Bridge	654	94	11	0
	(±97)	(±35)	(±2)	
Smith Bridge	1471	110	17	1
	(±108)	(±29)	(±10)	(±2)

[a] Petersen (Bailey modification) single-census, mark-and-recapture population estimate.

Table 3.–Sampling locations for eleven additional rivers being sampled in the summers of 2000-1 under the present study. Occurrences of historic water quality or trout population estimate data are indicated by “Y”.

River	Major receiving water	Fish sampling Location (road crossing)	Water quality location, if different	Historic water quality data	Historic trout estimates
N Br Boardman	Lake Michigan	Approx. 1.2 miles downstream of Broomhead Rd	US131 near Kalkaska	Y	Y
S Br Boardman	Lake Michigan	Broomhead Rd			Y
Manistee	Lake Michigan	Cameron Br	County Rd 612	Y	Y
Platte	Lake Michigan	Haze Rd		Y	
Baldwin	Pere Marquette River	Bray Creek State Forest Campground	US10	Y	Y
Hersey	Muskegon River	Patterson Rd		Y	
Little South Branch Pere Marquette River	Pere Marquette River	Taylor Bridge (Star Lake Rd)		Y	Y
Pere Marquette River	Lake Michigan	Mouth of Baldwin River	M37	Y	Y
Houghton Creek	Rifle River	Flynn Rd	Beechwood Rd	Y	Y
Silver Creek	Kalamazoo River	19th St			
Spring Brook	Kalamazoo River	DE Ave			

Table 4.–Timing of hatch and swim-up for brown trout reared under three thermal regimes at the Wolf Lake State Fish Hatchery from December 1999 to May 2000. Average January temperatures are shown to depict relative differences among treatments. Temperatures were adjusted monthly to mimic seasonal patterns. An equipment malfunction resulted in loss of all fish in the 8.5 C treatment. Percents indicate percent completion of hatch in treatment.

Average January temperature (C)	Degree-days to hatch	Hatch Date	Degree-days to 1st swim-up	1st Swim-up Date
2.2	316 (90%)	06-Mar	653	22-May
4.5	400 (100%)	29-Feb	619	27-Mar
8.5	-----	-----		
10.3	537 (100%)	18-Jan	846	17-Feb

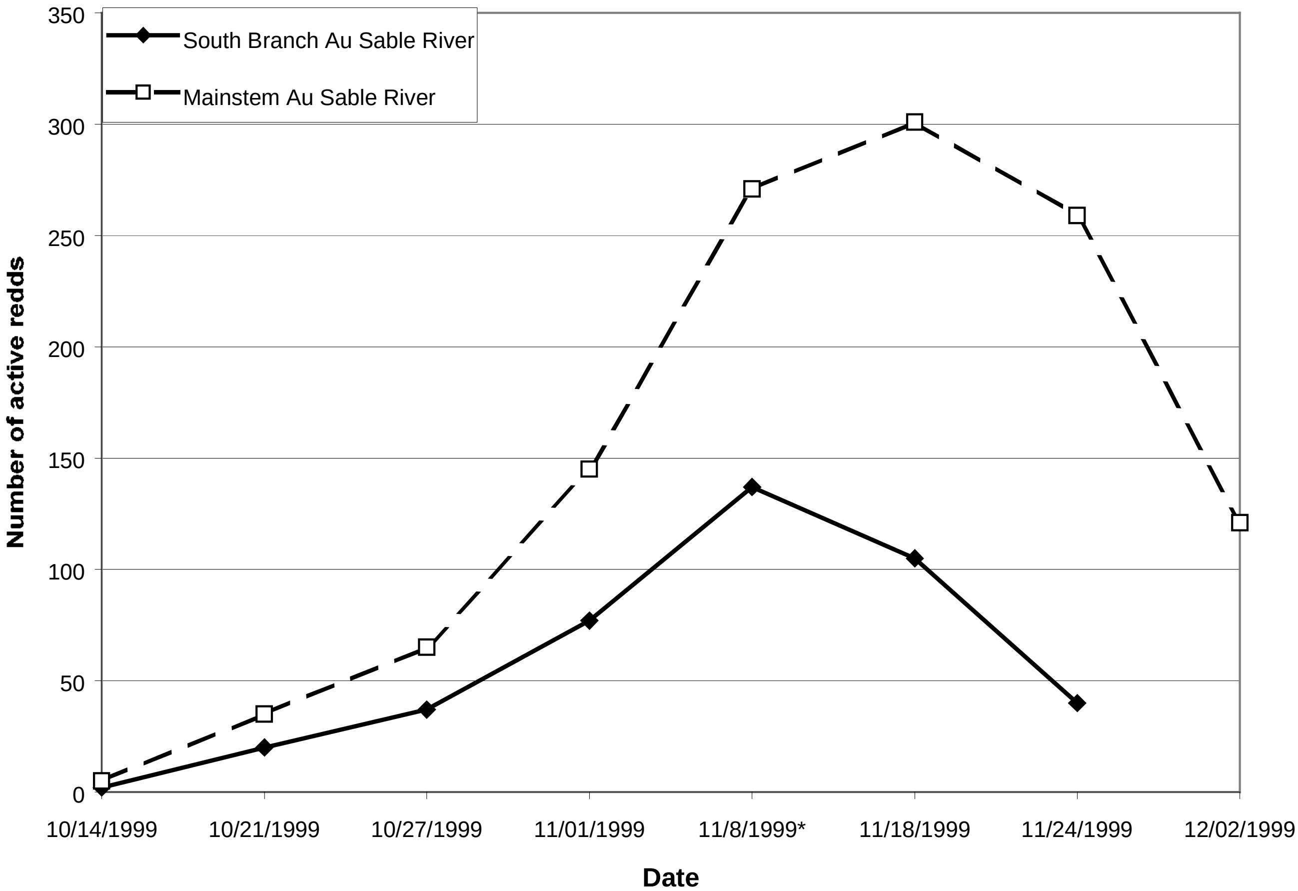

Figure 1.–Active redds counted in 7.7 km of the South Branch Au Sable River (3.8 km from Chase Bridge downstream to Marlabar and 3.9 km from Canoe Harbor State Forest Campground downstream to the former Truettner property) and in 10.0 km of the Mainstem Au Sable River from Thendara Road downstream to the Wakeley Bridge public access site. *All counts were made by Troy Zorn except for the November 8th count which was made by Tim Smigielski.