STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-35-R-22

Study No.: 654

Title: Evaluation of brown trout and steelhead competitive interactions in Hunt Creek, Michigan.

Period Covered: April 1, 1996 to March 31, 1997

Study Objective: To determine if the introduction of steelhead into a stream where they presently do not exist will affect the abundance, survival, growth, or disease status of resident trout species.

Summary: We collected pretreatment data on trout populations and physical habitat in treatment and reference zones located on Hunt and Gilchrist Creeks for the second consecutive year. Adult steelhead will be stocked into a treatment zone of Hunt Creek each spring during 1998-2002. Effects of steelhead introductions on resident trout populations will be evaluated via a before/after and treatment/control study design. We installed an electronic river stage height recorder on Hunt Creek to obtain continuous stream stage records at the upstream end of the Hunt Creek reference zone. Periodic discharge estimates were made at this site to determine the relationship between stage height and stream discharge. Relationships between stage height and discharge in the treatment zone and the Gilchrist Creek reference zone are being determined using staff gauges and periodic discharge measurements. Water temperature is recorded in all zones using electronic thermometers.

We used modifications of methods described in Platts et al. (1983) to characterize in stream habitat conditions in each 100-m segment of the 3.2 km treatment zone during June and July 1996. I derived dependent variables reflecting trout abundance in each 100-m stream segment from population estimates made during September 1996. I used regression analysis to determine if fall brown trout abundance in 100-m sections of the 3.2 km treatment zone was significantly related to the habitat variables measured in these sections. Independent variables reflecting pool quality and quantity of large woody debris (LWD) were most strongly linked to abundance of brown trout $\geq$ 203 mm total length. Abundance of LWD and mean cross sectional area per station accounted for 65% of the variation in biomass of legal-sized brown trout ($\geq$ 203 mm total length) among the 32 contiguous sections.

We used mark-and-recapture methods to estimate brown and brook trout populations in treatment and reference zones during September 1996. Scale samples were collected from subsamples of trout to determine their ages. Subsamples of fish were measured and weighed to determine relationships between total length and weight. We monitored spawning activity by periodically counting trout redds. Most spawning took place between mid-October and mid-November.

We collected 60 brown trout during July 1996 and had them inspected for the presence of selected bacterial and viral diseases or the whirling disease parasite. No diseases or parasites of concern were detected.

Job 2. Title: <u>Monitor water temperature in treatment and reference zones.</u>

Findings: We recorded water temperatures hourly using electronic thermometers maintained at 5 sites. One thermometer is located near the upstream boundary of the Hunt Creek reference zone and the other four thermometers were located near the upstream and downstream boundaries of the treatment zone on Hunt Creek and the reference zone on Gilchrist Creek.

Job 3. Title: <u>Monitor water stage and discharge.</u>

Findings: We installed a Sutron electronic stage height recorder in Hunt Creek on 12-August 1996 to obtain hourly measurements of water stage height near the upstream end of the Hunt Creek reference zone. We made periodic discharge measurements to establish the relationship between stage height and stream discharge at this site. We also placed staff gauges at the downstream ends of the Hunt Creek treatment zone and the Gilchrist Creek reference zone during June 1996. Staff gauges were read periodically to establish relationships between stage height at all three locations. Beginning in April 1997, stream discharge will be periodically measured at both staff gauge locations. After one year these data will be analyzed to determine if discharge at all staff gauge locations can be reliably predicted from data recorded by the Sutron stage height recorder.

Job 4. Title: <u>Characterize physical habitat in treatment and reference zones.</u>

Findings: We used modifications of methods described in Platts et al. (1983) to characterize in stream and riparian habitat in the treatment zone during June and July 1996. Habitat parameters were measured along 160 transects spaced 20-m apart within the 3.2 km treatment zone. Habitat data collected included stream widths and depths, frequency of occurrence of different substrate types, amount of undercut bank cover and bank stability, amount of rooted aquatic plant growth, abundance of woody debris, and primary riparian vegetation types adjacent to each 100-m segment. We measured stream discharge each day before habitat was measured to confirm that discharge was similar (± 3 cfs) on days that habitat parameters were measured. Mean stream discharge at the downstream boundary of the treatment zone on days when habitat measurements were made was 30.3 cfs. Physical habitat in the reference zones will be measured during the summer of 1997 when stream discharge is near baseflow.

I determined relationships between fall brown trout abundance in 100-m sections of the 3.2 km treatment zone and the habitat variables measured in these sections using regression analysis. Dependent variables reflecting trout abundance in each 100-m stream segment were derived from population estimates made during September 1996. A summary of habitat variables (independent variables) used for the analyses and results presented below are shown in Table 1. All statistical tests were performed at the 95% significance level ($P \leq 0.05$).

Biomass of brown trout ≥ 203 mm per station during September 1996 was most strongly and positively correlated with abundance of LWD ($r = 0.73$) (Table 2). Biomass of brown trout ≥ 203 mm per station was likewise significantly correlated with aggregate woody cover, i.e. the sum of LWD, small woody debris and rootwads. The stream morphology variable most highly correlated with abundance of trout ≥ 203 mm was mean cross sectional area ($r = 0.58$). Mean cross sectional area is equivalent to mean static water volume in a station. The related variables of mean and maximum water depth were also significantly and positively correlated with biomass of brown trout ≥ 203 mm because stream width was quite uniform among stations. A significant positive relationship between abundance of larger trout and abundance of sand, and a significant negative relationship with mean stream velocity suggests that larger trout were more abundant in stations having more pool habitat. Multiple regression analysis revealed that a model containing both the LWD and mean cross sectional area variables accounted for 65% of the variation in biomass of brown trout ≥ 203 mm among the 32 contiguous stations. Total brown trout biomass and abundance of other size groupings of larger brown trout (i.e. trout ≥ 305 mm and trout ≥ 406 mm) were generally significantly correlated with the same habitat variables as trout ≥ 203 mm. By contrast, abundance of young-of-the-year (YOY) brown trout was significantly correlated only with gravel abundance ($r = -0.385$). This negative relationship may indicate that stations having higher water velocities were less suitable for YOY trout because gravel abundance in stations was positively related to mean stream velocity. However, abundance of YOY trout was not significantly related to my estimates of mean stream velocity.

Job 5. Title: Locate and mark locations of trout redds and measure redd characteristics.

Findings: We counted trout redds in the treatment and reference zones on five occasions between 25-October and 5-December 1996. During the first count, redd locations were temporarily marked and their dimensions were measured using a steel tape. We could not determined if redds were used by more than one female. However, the large size of some redds suggested that they were used by multiple spawners. On subsequent counts, redds were classified as “active” if additional cleaned gravel was evident. Most spawning apparently occurred between mid-October and mid-November. Redd density near the middle of November was 34.4/km in the Hunt Creek treatment zone and 31.7/km in the Gilchrist Creek reference zone. By 5-December only 5 redds could be clearly identified in the 2.3-km reference zone on Gilchrist Creek. Previously visible redds were obscured by periphyton growth or sediment. This suggests that little spawning occurred after mid-November in the reference zone. More frequent redd counts will be made in both treatment and reference zones during 1997 to better define the period of peak spawning activity.

On 13-November 1996 we used numbered steel stakes to mark 21 redd locations in the Hunt Creek treatment zone for future excavation. Most of these redds were initially identified on 25-October. On 4-December we excavated 3 redds by using a spade to dig up and broadcast redd gravel upstream into the current so that liberated eggs could be captured with a 2 mm mesh seine held against the stream bottom approximately 0.5 meters downstream. The purpose of this initial excavation was to determine if the cleaned gravel areas we had identified as redds actually contained trout eggs. Approximately 100 viable eggs were excavated from one redd and 25 were recovered from a second redd (Table 3). We found approximately 100 dead eggs in the third redd. On 17-March we began excavating additional redds at approximately 1-week intervals to determine the developmental stage of eggs and alevins. The purpose of these excavations was to obtain qualitative information on the developmental stage of brown trout eggs or alevins during the time period that mature steelhead will be stocked into the treatment zone. Recoveries of eggs or alevins from redds excavated during March and April provided ambiguous information on probable emergence dates (Table 3). We found no eggs or alevins in half of the 14 redds excavated and only dead eggs were found in 28% of the redds. A lack of eggs or alevins in some redds could have multiple causes. Trout may have cleaned gravel without depositing eggs, fry may have emerged, eggs could die and decay, or our capture efficiency may have been low. During late winter and early spring 1998 we will attempt to trap fry emerging from redds to obtain more useful data. If this effort is successful we may be able to make reasonably accurate projections of future peak emergence periods based on weekly redd counts and water temperature.

Job 6. Title: Collect population and biological data.

Findings: We made mark-and-recapture estimates of brook and brown trout populations during September 1996 in a 3.2 kilometer treatment zone on Hunt Creek, a 0.7 kilometer reference zone on Hunt Creek, and a 2.3 kilometer reference zone on Gilchrist Creek (Tables 4 and 5). Total lengths of all trout collected on the marking run were recorded. Data were segregated for each 100-m section within each zone. Scale samples were collected from subsamples of trout > 9.9 cm long to determine their ages. We weighed all individual fish that were scale sampled to determine length/weight relationships for each zone. When sufficient numbers of fish were captured, we weighed and measured (but did not collect scales from) 60 trout ≤ 9.9 cm per zone for each species. Past scale reading indicated that all trout of this size were age-0 in all three zones. Brown trout comprised approximately 97% of the total trout population in the treatment zone of Hunt Creek and the reference zone on Gilchrist Creek. By contrast, over 80% of the trout in the Hunt Creek reference zone were brook trout. Total brown trout numbers were lower in 1996 than in 1995 in all zones. Percent reductions in brown trout abundance ranged from 24% in Gilchrist Creek to 40% in the Hunt Creek reference zone. From 1995-96 total brook trout abundance in the Hunt Creek reference zone declined 23% whereas it increased 18% in Gilchrist Creek and 44% in the Hunt Creek treatment zone. Brown and brook trout population data will be collected for an additional year (fall 1997) before adult steelhead are stocked into the Hunt Creek treatment zone during spring 1998.

Job 7. Title: Test fish for BKD.

Findings: No diseases were detected in sixty brown trout collected from Hunt Creek during July 1996. In addition to testing for the presence of the Salmonid kidney disease bacterium, trout were also examined for the presence of *Aeromonas salmonica*, *Myxosoma cerebralis*, the enteric redmouth bacterium, the viral hemorrhagic septicemia virus, the infectious pancreatic necrosis virus, and the *Onchohynchus masou* virus.

Job 10: Title: Analyze data and write progress report.

Findings: This progress report was prepared.

Literature Cited:

Platts, W.S., W.F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. United States Department of Agriculture, Forest Service General Technical Report INT-138.

Table 1.–Habitat variables measured or visually estimated along 160 transects (5 per 100-m station) on Hunt Creek during 1996. Habitat was measured or estimated at 0.5-m intervals along transects perpendicular to stream flow.

Variable	Description
Stream morphology	
Mean stream width (m)	Mean horizontal distance along transects from bank to bank at existing water surface, to nearest 0.1 m
Mean stream depth (cm)	Mean of all depth measurements taken along transects in each station, to nearest 0.5 cm
Maximum stream depth (cm)	Maximum depth measured along any transect in each station, to nearest 0.5 cm
Width to depth ratio	Mean stream width (m) divided by mean stream depth (m) in each station
Mean cross sectional area (m^2)	Product of mean stream width and mean depth in each station
Mean stream velocity (m/s)	Stream discharge (m^3/s) divided by mean cross sectional area in a station
Undercut bank (cm)	Sum of undercut bank measurements (Platts et al. 1983) made along 5 transects per station
Average shore depth (cm)	Mean of shore depth measurements (Platts et al. 1983) made along 5 transects per station
Variance of depth measurements	The variance of all depth measurements made in a station
Cover	Values for cover types (defined below) were determined by summing the percentages of each 0.5-m transect segment in a station composed of partially or completely submerged cover capable of providing shelter for trout
Large woody debris (LWD)	Logs > 25-cm in diameter and ≥ 2 m long
Small woody debris (SWD)	Wood 10-24 cm in diameter and ≥ 2 m long
Rootwads (RW)	Bases of trees and root structure
Brush	Accumulations of brush of sufficient density to provide overhead cover for fall fingerling or larger trout
Rooted plants	Plant beds dense enough to provide overhead cover for fall fingerling or larger trout
Aggregate woody cover	Sum of values for LWD, SWD, and RW
Substrate	Primary substrate type (defined below) was determined for each 0.5-m transect segment in a station. Values for substrate types used in regression analyses were defined as the frequency of occurrence of a substrate type in a station
Detritus/organics	Deposits of fine flocculent organic particles or coarser organics such as leaves or needles
Clay	Particle diameter ≤ 0.004 mm
Sand	Particle diameters > 0.004 mm and < 2 mm
Gravel	Particle diameters 2-64 mm
Cobble	Particle diameters 65-250 mm
Boulder	Particle diameters > 250 mm

Table 2.–Correlations between September 1996 biomass of trout ≥ 203 mm in 100-m stations on Hunt Creek and habitat variables measured during June-July 1996. Asterisks indicate statistically significant correlation coefficients.

Habitat variable	r	*P*
Stream morphology		
Mean stream width (m)	0.189	0.301
Mean stream depth (cm)	0.542	0.001*
Maximum stream depth (cm)	0.456	0.008*
Width to depth ratio	-0.272	0.132
Mean cross sectional area (m^2)	0.583	<0.001*
Mean stream velocity (m/s)	-0.469	0.007*
Undercut bank (cm)	-0.105	0.568
Average shore depth (cm)	-0.011	0.953
Variance of depth measurements	0.423	0.016*
Cover		
Large woody debris (LWD)	0.731	<0.001*
Small woody debris (SWD)	0.254	0.160
Rootwads (RW)	0.311	0.083
Brush	0.270	0.135
Rooted plants	-0.157	0.390
Aggregate woody cover	0.604	<0.001*
Substrate		
Detritus/organics	0.112	0.540
Clay	0.205	0.260
Sand	0.366	0.039*
Gravel	-0.240	0.185
Cobble	-0.146	0.424
Boulder	-0.182	0.318

Table 3.–Numbers of eggs and alevins recovered from redds in the Hunt Creek treatment zone that were excavated between 4-December 1996 and 10-April 1997.

	Number of			Alevin
Date Excavated	Live eggs	Dead eggs	Live alevins	mean length (mm)
December 4	95	0	–	–
	25	0	–	–
	0	98	–	–
March 17	46	0	4	11
	0	0	9	16
	0	0	0	–
March 25	0	0	0	–
	0	4	0	–
	0	0	0	–
April 1	0	0	10	19
	0	24	0	–
	0	24	0	–
	0	0	0	–
April 10	0	0	0	–
	0	0	0	–
	0	0	0	–
	0	12	0	–

Table 4.–Fall 1996 numbers of brown trout per hectare (± 2 standard errors) in a treatment zone and 2 reference zones.

	Treatment Zone		Reference Zones			
Inch Group	Hunt Creek		Gilchrist Creek		Hunt Creek	
2	73.7	±31.7	793.3	±118.7	97.6	±86.5
3	816.0	±47.0	1073.5	±101.0	138.1	±48.1
4	104.8	±19.2	29.9	±7.2	0.0	
5	103.2	±10.6	218.0	±25.8	19.7	±8.4
6	268.7	±13.0	189.4	±23.1	61.2	±19.3
7	135.2	±9.1	63.1	±14.5	41.0	±13.2
8	56.4	±4.7	64.1	±12.2	53.5	±7.8
9	62.4	±4.9	31.4	±6.4	54.4	±22.5
10	28.5	±2.5	19.6	±5.9	51.3	±8.9
11	22.3	±4.2	14.4	±3.1	26.4	±14.3
12	9.9	±2.3	9.6	±2.9	10.5	±0.0
13	5.6	±1.1	5.3	±1.8	6.3	±4.2
14	2.3	±0.0	4.0	±1.3	10.5	±4.2
15	2.8	±0.9	2.2	±0.0	4.2	±0.0
16+	4.1	±0.8	1.6	±0.0	8.4	±0.0
Totals	1695.9	±63.4	2519.3	±161.3	582.8	±106.3

Table 5.–Fall 1996 numbers of brook trout per hectare (± 2 standard errors) in a treatment zone and 2 reference zones.

	Treatment Zone		Reference Zones			
Inch Group	Hunt Creek		Gilchrist Creek		Hunt Creek	
2	0.5	±0.0	12.7	±5.3	464.8	±123.5
3	11.6	±4.9	8.1	±4.1	1690.9	±229.5
4	4.8	±2.5			147.1	±44.2
5	14.8	±5.1	15.3	±7.3	149.2	±31.8
6	9.6	±3.5	12.4	±3.5	47.8	±13.5
7	3.3	±1.1	5.9	±2.9	8.4	0.0
8	0.5	±0.0	0.0		6.3	0.0
9	0.0		0.5	±0.0	0.0	
10	0.0		0.5	±0.0	0.0	
Totals	45.1	±8.4	55.4	10.9	2514.4	±266.6

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