F-80-R-7, Michigan
Study 230519 **New Study: 2005-06**

Name of Study: Colonization of a brook trout stream by introduced brown trout.

A. Problem: Brook trout have been extensively studied in Hunt Creek within the boundaries of the Hunt Creek Fisheries Research Area from 1939 to the present time. A broad array of fisheries management experiments have been conducted, ranging from evaluation of regulations, stocking evaluations, restoration and enhancement of habitat, and an evaluation of the effects of water withdrawal on brook trout and invertebrate populations. Prior to about the 1970s the brook trout populations within the research area waters were representative of many small headwater trout streams in the northern lower peninsula of Michigan. Since that time, naturalized brown trout populations have become well established in most small headwater streams in the Lower Peninsula and are now the dominant inland salmonid species. Thus, most contemporary inland trout management questions and knowledge gaps for streams relate to brown trout. Establishment of an experimental brown trout population in Hunt Creek within the research area will provide a site to conduct experiments and research on brown trout in a controlled, yet natural environment. It will also provide insights into species colonization dynamics related to fish passage and removal of artificial barriers to free within-stream movement. Long-term research plans include evaluation of the effects of passing Pacific salmon species into streams presently occupied by brown trout. Such experiments can be conducted in Hunt Creek under relatively controlled conditions without causing the social conflicts that often occur in waters that are open to angling.

B. Objectives: To establish a stable, naturally reproducing population of brown trout in the headwaters of Hunt Creek to use as an experimental population for future management experiments and evaluations. A long term goal is to build a brown trout population that can be used to study interactions with potamodromous salmonid species found in the Great Lakes. To monitor population dynamics of all trout species as brown trout colonize reaches of Hunt Creek presently occupied primarily by brook trout.

C. Justification: Brown trout are the dominant inland salmonid species in most coldwater streams within the Lower Peninsula of Michigan. They supply significant recreational opportunities for both resident and nonresident anglers. Management actions taken to protect or restore habitat in Lower Peninsula trout streams are usually conducted with the objective of increasing brown trout abundance or improving the size structure of the populations. Evaluations of the effectiveness of management are often hindered by uncontrolled or unmonitored variables such as angler harvest or other activities in the watershed. An experimental population of brown trout within the Hunt Creek Research Area will be used to study relevant fisheries management questions without these confounding effects because the study stream reach is closed to angling and land use activities in the undeveloped upper watershed are controlled by the state. The experimental brown trout population will set the stage for future research studies related to removal of barriers to upstream passage of salmonid species from the Great Lakes. This study is also expected to document dynamics of the partial displacement of the present brook trout population by introduced brown trout.

D. Expected Results and Benefits: This study will result in the establishment of a brown trout population within the Hunt Creek Fisheries Research area that can be used to study management activities and habitat relationships relevant to the dominant salmonid species found in most coldwater streams in the Lower Peninsula of Michigan. It will set the stage for future studies of effects of removing barriers to upstream passage of fishes from the Great Lakes.

E. Background: The Hunt Creek Fisheries Research Station was established in 1939 for the purpose of studying methods to increase brook trout abundance and angler catches (Shetter 1948). This site was selected because of the high-quality trout habitat present and because the state owned the frontage along several miles of the mainstem of Hunt Creek, seven tributary streams and four lakes, all within a one-mile radius of an office site. In addition, the variety of habitat types in the mainstem and tributaries were considered to be quite typical of high-quality Michigan headwater trout streams (Hazzard 1940). At that time, the only salmonid species known to occur in Hunt Creek was the brook trout. Early studies focused on basic management questions such as the numbers and sizes of trout caught, the effectiveness of stocking brook trout of various sizes, effects of angling restrictions, and the value of stream improvement devices. In addition, researchers investigated population dynamics and basic biology of the brook trout.

Hunt Creek and its tributaries were closed to angling after the 1965 fishing season. This set the stage for long-term evaluations of the effects of sand sediment on stream morphology and brook trout populations (Alexander and Hansen 1986, 1988). During the 1990s effects of summer water withdrawals on brook trout populations were investigated (Baker and Coon 1995; Nuhfer and Baker 2004). During these studies brown trout were excluded from the research waters of Hunt Creek by a low-head barrier at the downstream end of the study reach. Any brown trout that traversed the barrier were captured and removed when fish populations were estimated each spring and fall.

During the 1950s and 1960s brown trout established small naturally reproducing populations in all reaches of Hunt Creek downstream of the research area. These populations presumably originated from brown trout stocked elsewhere in the Thunder Bay River watershed prior to 1965 because there are no records of any brown trout plantings in Hunt Creek. By the 1990's brown trout had largely displaced brook trout from Hunt Creek waters downstream from the low-head barrier. Brown trout in a 3.4-km section of Hunt Creek downstream of the research area have been nearly thirty times more abundant than brook trout during recent years (Nuhfer 2004a). Similar displacement of brook trout by brown trout occurred in many trout streams in the Lower Peninsula of Michigan during the same time period. Hence, fisheries managers in the Lower Peninsula have shifted most management and evaluation effort in coldwater streams toward brown trout. In general, brown trout are more highly regarded by anglers than brook trout because they live longer and grow to larger sizes than brook trout in Lower Peninsula streams.

In 2001, adult brown trout were intentionally stocked into downstream reaches of Hunt Creek within the research area. Parental fish were transferred from multiple naturalized stocks of stream brown trout. Additional adults were stocked in 2003 and 2004. The objectives of the plantings were to begin the process of establishing a genetically fit stock of brown trout in research waters of Hunt Creek that could be used as a study population to answer questions related to management and protection of stream brown trout and their habitat (e.g. genetics studies, early life history studies, species interaction investigations, and studies of brown trout/habitat relationships). Genetic analysis of offspring generations showed that a high level of heterozygosity was achieved (Stanchek 2004).

To date, brown trout have been confined to the downstream 2.1 km of the 3.4 km study reach by a low head barrier used to control water levels for a previous study. Coarse substrates suitable for brown trout spawning are relatively sparse in this zone (Nuhfer 2004b). Consequently, brown trout reproductive levels have been much lower than those observed in sections of Hunt Creek downstream of the research area where coarser substrates predominate. Removing or reducing the height of four low head barriers to upstream fish movement will provide access for spawning brown trout to 0.75 km of high-gradient (8.5m/km), high-quality spawning substrate. Thus, I propose to gradually remove or lower these barriers to upstream movement. One upstream barrier will be

maintained to provide a reference reach occupied only by brook trout. Any adult brown trout that traverse the barrier will be removed from the reference zone when populations are estimated in late summer.

Adult brown trout stocked in 2001-04 exhibited a strong tendency to emigrate downstream out of the study zone. I hypothesize that emigration was triggered, in part, by a lack of LWD cover for larger fish. The entire watershed was heavily logged during the late 1800s and the stream was used to transport logs toward downstream mills and markets. Second-growth forests now predominate in the riparian zone but there have been few natural inputs of LWD during the last century. Thus, I propose to restore more natural levels of LWD in portions of the study reach to increase retention of adult brown trout. The chronology of proposed treatments to create a viable experimental population of brown trout in the research waters of Hunt Creek is shown in the matrix below. Stream reaches are numbered from the most downstream reach (1) to the most upstream reach (5).

<table>
<tr><th>Stream Reach</th><th>Brown trout colonization history (Years)</th><th>Treatments</th><th>Trout species composition (time period)</th></tr>
<tr><td>1</td><td rowspan="3">Adults stocked 2001, 2003, 2004</td><td>Add LWD 2006-07</td><td rowspan="3">Brook trout only (1939-2000) Brook and brown trout (2001-2005+)</td></tr>
<tr><td>2</td><td>Add LWD 2006-07</td></tr>
<tr><td>3</td><td>None</td></tr>
<tr><td>4</td><td>Natural upstream movement</td><td>Remove 4 barriers 2006-07</td><td>Brook trout only (1939-2004) Brook and brown trout (2005+)</td></tr>
<tr><td>5</td><td></td><td>Maintain downstream barrier</td><td>Brook trout (1939-2005+)</td></tr>
</table>

F. Procedure: Trout populations will be estimated by mark and recapture methods at least once a year in a 3.4-km stream reach of Hunt Creek. Downstream emigration of trout out of the study reach will be determined by counting and measuring fish caught in inclined-screen traps located at the downstream end of the study reach. Growth and survival rates will be determined by aging scales or other structures from a subsample of trout collected when populations are estimated. Water temperature will be measured hourly with electronic thermometers deployed at the upstream, downstream, and midpoint of the study reach. A Sutron stage height recorder will be used to record stream stage at the downstream end of the reach. The relation between stage height and discharge will be determined from periodic discharge estimates made across the range of stage heights observed. These data will provide hourly estimates of mean stream discharge. Four low-head barriers to upstream fish passage located in the upper 0.6 km of the study reach will be partially or completely removed gradually over a period of several years. These barriers were constructed for purposes relevant to past studies, but are no longer needed. Sediment that has accumulated upstream of the barriers will be captured in a sediment trap. LWD in the form of whole trees with trimmed branches will be anchored along shore in downstream reaches of the study zone where LWD cover is presently lacking.

Job 1. Estimate trout populations and emigration

Job 2. Estimate growth and survival rates for each species

Job 3. Monitor water temperature and stream discharge

Job 4. Remove barriers to upstream migration of spawning trout

Job 5. Anchor LWD in areas where cover is lacking

Job 6. Write annual performance report.

Job 7. Write research manuscript (MDNR Fisheries Division Research or Technical report)

Job 8. Publish report through the Fisheries Division's editing and finishing process for Research and Technical reports.

Job 9. Write final report

G. Schedule:

Year		Work planned
2005-06	Job 1.	Estimate trout populations
	Job 2.	Estimate growth and survival.
	Job 3	Monitor temperature and discharge
	Job 6.	Write annual performance report
2006-07	Job 1.	Estimate trout populations
	Job 2.	Estimate growth and survival.
	Job 3	Monitor temperature and discharge
	Job 4	Remove barriers
	Job 5	Add LWD
	Job 6	Write annual performance report
2007-08	Job 1.	Estimate trout populations
	Job 2.	Estimate growth and survival.
	Job 3	Monitor temperature and discharge
	Job 4	Remove barriers
	Job 5	Add LWD
	Job 6	Write annual performance report
2008-09	Job 1.	Estimate trout populations
	Job 2.	Estimate growth and survival.
	Job 3	Monitor temperature and discharge
	Job 6	Write annual performance report
2009-10	Job 1.	Estimate trout populations
	Job 2	Estimate growth and survival.
	Job 3	Monitor temperature and discharge
	Job 7	Write research manuscript
2010-11	Job 8	Publish report
	Job 9	Write final report

H. Geographical Location: Hunt Creek Fisheries Research Station, Lewiston, Michigan.

I. Personnel: Andrew J. Nuhfer and Todd C. Wills, Fisheries Research Biologists; and Thomas Adams, Fisheries Technician, Hunt Creek Fisheries Research Station. Research Administrative personnel, and contract editor.

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