

Seasonal Habitat Use and Survival of Brook Trout (*Salvelinus fontinalis*)
in the Pilgrim River, Houghton County, Michigan

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Research Plan

Rationale

The rehabilitation of Coaster Brook Trout is limited by a lack of understanding of habitat use, particularly in Michigan where few remnant populations exist. This study aims to gain information on seasonal movement patterns and survival of Brook Trout in the Pilgrim River, a Lake Superior tributary in Houghton County, Michigan. The Pilgrim River is one of eight Lake Superior tributaries in which the Michigan Department of Natural Resources implemented restrictive harvest regulations on downstream reaches to protect and enhance cryptic Coaster populations (one Brook Trout over 20 inches may be obtained). While these streams are suspected to historically support Coaster populations, their current presence has not been confirmed due to limited scientific information. Findings from this study will help to determine if a Coaster population is present in the Pilgrim River and understand how existing habitat being utilized throughout the year. Being able to document the Coaster life history in the Pilgrim River and obtain data on movement patterns is critical to justify continuation or alteration the harvest restriction and to inform potential habitat restoration efforts.

Objectives

The objectives of this study are to 1) determine if Coaster Brook Trout are present in the Pilgrim River, 2) describe the timing and extent of movements with the river, particularly among protected and unprotected reaches, and into the Keweenaw waterway, and 3) evaluate seasonal survival in those three locations. These objectives will be address by evaluating watershed-scale movements of individually tagged Brook Trout for multiple years.

Methods

The primary tool for evaluating Brook Trout movements are passive integrated transponder (PIT) tags and in-stream antenna stations which record detections of the individually tagged fish. Brook Trout are collected via backpack electrofishing and anesthetized using clove oil. PIT tags (23mm HDX) are implanted surgically into the body cavity through an incision made in the abdomen of the fish. Biological data including length, weight, sex, and scale and tissue samples are collected from all tagged fish. The first Brook Trout were PIT tagged in the Pilgrim River in 2014, and to date 803 have been tagged. This has included fish from locations ranging from the river mouth to 15 kilometers upstream.

PIT tag detection stations consist of a power source (12 volt batteries and solar panel), custom built data logging unit, and instream passive antennas. For stream locations, these are constructed with a three square meter wire loop housed in PVC pipe attached support posts to stand upright perpendicular to stream current. At the stream/lake interface, antennas are constructed with wire to form a circular coil, which is laid flat on the bottom, and detect fish as they pass over. This innovative deployment technique has allowed the continued operation of stations throughout the winter and under ice cover, providing movement data that would be unobtainable with traditional sampling techniques. Tag detection data is stored on an SD card and downloaded periodically. Antenna stations have been installed at four locations: RKM 0 (river mouth), RKM 1, RKM 6 (upstream limit of protective harvest regulation), and RKM 14 (Figure 1).

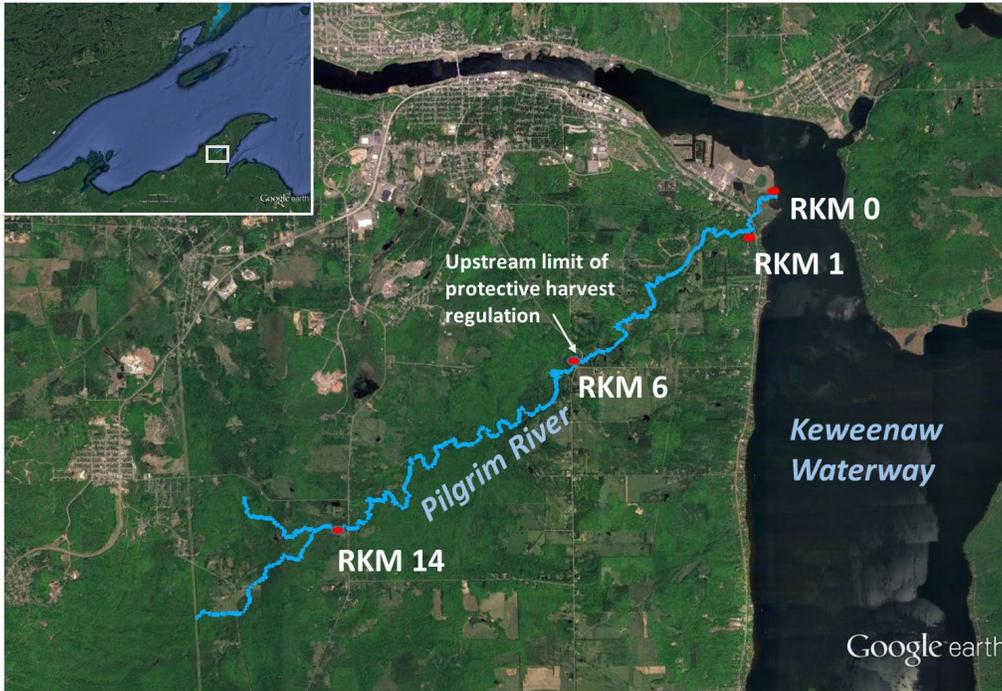


Figure 1. Map of Pilgrim River in Houghton County, Michigan. Red dots indicate locations where PIT tag antenna stations have been installed.

Seasonal movement and survival probabilities will be estimated using a multi-state mark-recapture model. Three states (reaches) are defined as upstream unprotected reach, downstream protected reach, and Keweenaw Waterway. Tagged fish will be assigned to one of those reaches based on their encounter at a detection station or physical recapture during each season (Figure 2). The resulting capture history matrix will be inputted into Program Mark to build a multi-state mark-recapture model that uses maximum likelihood methods to estimate the probability of movement between reaches and survival in each reach during each season. Akaike’s Information Criterion will be used to compare models where survival and movement parameters are constrained across time intervals and/or locations to select the most parsimonious model to be used for parameter estimation.



Figure 2. Schematic of Pilgrim River PIT tag detection stations and defined reaches (left). Hypothetical “capture history matrix” for three individually tagged Brook Trout (right).

Preliminary Results

To date, we have detected 107 Brook Trout that were tagged in the Pilgrim River moving downstream and entering the Keweenaw Waterway. About half of these individuals have also been detected re-entering the Pilgrim River, with a few individuals being documented making this migration several times throughout the course of this study. Thus, it is likely that the Pilgrim River is supporting a Coaster Brook Trout population. Outmigration typically occurs in November and December, after spawning but before much of the stream freezes over. Seasonal movements within the Pilgrim River have been observed consistently throughout the study. This includes mid-summer movements between the downstream protective regulation reach and the upstream reach where harvest. This finding may be very important for evaluating the effectiveness of the regulation.

A flood event that occurred in June 2017 caused severe damage to the antenna stations, completely destroying or displacing two of them. Generous funding assistance by the Copper Country Chapter of Trout Unlimited has allowed the redeployment of three of the stations, at RKM 0, 1 and 6. Funding from this grant would allow re-deployment of the station at RKM 14. Detections of tagged fish in 2019 will constitute the final encounter event for the multi-state mark-recapture model. By maximizing detection efficiency during this last encounter event, movement and survival parameter estimations for preceding seasons will be strengthened

Financial Plan

Funding from this grant will be used to purchase equipment for redeployment of the fourth antenna station at RKM 14, which was lost during the flood in June 2019. This is an important location since detection there confirms movement into the reach without protective harvest regulations. Increasing detection effort in the final segment of this study will strengthen movement and survival parameter efforts by increasing the number of individuals whose location and survival is known. While the data collected for analysis in my dissertation will conclude in the summer of 2019, it is likely that the monitoring effort will continue, and the antenna station purchased with these funds will continue to collect valuable movement data to be utilized in future analyses.

Completion of work on this project to date has been the result of a collaborative effort by the United States Fish and Wildlife, Ashland office and Michigan Department of Natural Resources, Marquette Office, who have provided equipment and labor for deploying antenna stations and electrofishing to tag Brook Trout. Grants from the Copper Country, Fred Waara, and Kalamazoo Chapters of Trout Unlimited have provided funding to purchase equipment and PIT tags, as have research grants from the Ecological Sciences Center and Great Lakes Research Center here at Michigan Tech. Funding for conference travel to share preliminary results of this study have been provided by The Greater Lake Superior Foundation and the Michigan Tech Graduate School. Academic support has been provided by the Michigan Tech Department of Biological Sciences through teaching assistantships in Introductory Biology and Botany laboratory courses.

Timetable

	2014	2015	2016	2017	2018	2019
PIT Tagging	59 Tagged at RKM 1	53 Tagged at RKM 1 and 6	74 Tagged at RKM 1, 2, 6	292 Tagged at RKM 1,2,3,5,6,14,15	284 Tagged at RKM 1,2,3,5,6,12,13,14,15	40 Tagged at RKM 0
Antenna Station Operation	None	Installed stations at RKM 1 and 6	Installed station at RKM 0, operation at RKM 1 and 6	Installed station at RKM 14, operation at RKM 0, 1, 7	All stations damaged in June flood, re-installed RKM 0, 1, 6	Operation at RKM 0, 1, 6. This grant would allow re-installation at RKM 14
Results		Movments between RKM 1 and 6	Outmigration from Pilgrim River into Keweenaw Waterway	Return of Brook Trout that had out-migrated. Movement to RKM 14.	Increased numbers documented displaying Coaster life history	Conclude data collection for dissertation in summer. Analyze data and prepare manuscript for publication in fall
Data Sharing			Presentation at Copper Country Trout Unlimited Mtg	Presentation at MI AFS, Copper Country Trout Unlimited Banquet	Presentation at MI AFS meeting, Charr Symposium, Socitey for Freshwater Science, State of Lake Superior, Michigan Coldwater Resources Steering Comitte	Conclude data collection for dissertation in summer. Analyze data with multi-state mark-recapture model. Prepare manuscript for publication and dissertation defense in Fall