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Effects of restrictive harvest regulations on rehabilitation of coaster brook trout in Minnesota's portion of Lake Superior

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ABSTRACT

Adfluvial brook trout in Lake Superior, commonly referred to as coasters, were once widely distributed among tributaries and supported trophy fisheries. The Minnesota Department of Natural Resources recently enhanced efforts to rehabilitate brook trout in Minnesota waters by imposing restrictive harvest regulations intended to produce more large individuals adopting a coaster life-history. The agency evaluated effects of the regulation changes by conducting electrofishing stream surveys concurrently with changes and three additional times over the next 16 years. Catch per unit effort of brook trout across all streams was similar among sampling periods. Generalized linear mixed models indicated a greater proportional size structure (number ≥ 330 mm/number ≥ 200 mm) and proportion of older fish (≥ age 3) after the regulation change. Genetic analyses indicated that individuals from coaster hatchery strains, which were stocked in nearby jurisdictions, made up only 5.6% of all individuals in Minnesota streams and 12% of individuals ≥330 mm, although the two largest fish were hatchery strain. Our results indicated that conservative regulations can contribute to rehabilitation of coaster populations and that stocked coasters could not account for the improved size and age structure.

Introduction

Brook trout *Salvelinus fontinalis* are the only native salmonines to inhabit both tributary streams and the waters of Lake Superior in Minnesota. An adfluvial life history form of brook trout in Lake Superior, referred to as "coaster" brook trout, was renowned for achieving large size (MacCrimmon and Gots, 1980; Roosevelt, 1865). Coasters were once widely distributed among Lake Superior tributaries (Newman and DuBois, 1996), although their distribution in most Minnesota tributaries is restricted by natural barrier falls within a short distance of the lake. Anecdotal angling reports indicate that large coasters were frequently caught at stream mouths in Minnesota in the mid to late 1800s, prior to the establishment of railways and roads (Roosevelt, 1865; Smith and Moyle, 1944). Soon thereafter, coaster populations experienced precipitous declines due to overfishing, habitat degradation, barriers to migration, and competition with other salmonines (Horns et al., 2003; Newman et al., 2003; Schreiner et al., 2008). Despite adversities over the past 150 years, small numbers of coasters are still present in the Minnesota waters of Lake Superior and utilize spawning and nursery habitat in tributaries.

Early attempts to rehabilitate coasters in Minnesota consisted of stocking various life stages of brook trout from the mid to late 1900s (Schreiner et al., 2006). These efforts were unsuccessful, as were similar attempts by other Lake Superior fisheries management agencies (Newman et al., 2003; Schreiner et al., 2008). In the early 1990s, the Minnesota Department of Natural Resources (MNDNR) began taking a stepwise approach to coaster rehabilitation. In 1992, the agency, after a series of public meetings, developed recommendations for coaster rehabilitation in Minnesota waters. Many of these recommendations were included in the 1995 *Fisheries Management Plan for the Minnesota Waters of Lake Superior* (Schreiner, 1995). The stated goal for coasters in the 1995 plan was to determine if rehabilitation of self-sustaining coaster stocks was feasible in Minnesota's portion of Lake Superior. Recommendations included conducting a genetic assessment to determine the ancestry of existing brook trout before any stocking was to be

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considered. In 1997, an initial shore-wide survey was conducted to determine the distribution, relative abundance and ancestry of brook trout present along the Minnesota shore of Lake Superior (Tilma et al., 1999). The survey was conducted by electrofishing streams below barriers during the spawning period and found a number of streams with low brook trout abundance.

Given the encouraging results of the initial survey, and the desire to protect these stocks (Burnham-Curtis, 2000), the MNDNR responded by implementing conservative regulations in 1997 for the entire 240 km of Minnesota's portion of Lake Superior and the area in streams below barrier falls accessible to migratory fish from Lake Superior. The regulations included a change from a continuous season to a closed season from the day after Labor Day (early September) to mid-April, a reduction in possession limit from five fish in combination with brown trout *Salmo trutta* to only one brook trout, and a change in size limits from a minimum size of 10 in (254 mm) with no more than three fish over 16 in (406 mm) to a minimum size of 20 in (508 mm).

Management for coaster brook trout is complicated by the range of life histories the species exhibits, from lacustrine and lacustrine-adfluvial types to stream residents that may make occasional use of lake habitat, and by the uncertainty as to which factors lead individuals to adopt the different life histories (Huckins et al., 2008; Kusnierz et al., 2009; Robillard et al., 2011b). The MNDNR describes its management of brook trout below barriers in Lake Superior tributaries as management for coaster brook trout (Schreiner et al., 2006). This stems, in part, from Becker's (1983) broad definition of coasters as brook trout that spend part of their life in Lake Superior. The lifetime use of Lake Superior by Minnesota brook trout is unknown, but they must make use of the lake because conditions within streams are often unsuitable for parts of the year. A narrower definition of a coaster includes only the lacustrine and lacustrine-adfluvial life histories (Huckins et al., 2008). Regardless of the definition of a coaster, management actions targeting streams will necessarily affect adfluvial and resident brook trout, if present. The implementation of conservative regulations to enhance coaster brook trout populations and fisheries relies on two premises: 1) minimal exploitation of all brook trout will help maintain robust populations that may have a better chance of producing coasters, and 2) minimal exploitation of large coasters will provide them the chance to reproduce and to be captured multiple times to enhance recreational fishing.

The MNDNR has chosen to forego stocking in its current coaster rehabilitation efforts; yet, Minnesota populations may be affected by coasters originating outside of its jurisdiction. The Grand Portage Band of Chippewa stocks streams and in Lake Superior within reservation waters on the northernmost portion of Minnesota's Lake Superior shore (GLFC stocking database, www.glfc.org/fishstocking/; accessed May 14, 2015; Moore et al., 2006). Other agencies in Wisconsin and Michigan also stock brook trout in Lake Superior (GLFC stocking database, www.glfc.org/fishstocking/; accessed May 14, 2015; WIDNR and USFWS, 2005). Recently, these agencies have primarily stocked coaster hatchery strains derived from populations whose individuals achieve large size (Huckins et al., 2008). Wild coasters also can move long distances (e.g., an individual recaptured over 300 km from its tagging site; H. Quinlan, unpublished data). Thus, larger brook trout captured in Minnesota may result from straying hatchery-reared or wild fish as well as the response of local Minnesota populations to regulation changes.

In this paper, we present the results of stream surveys conducted to assess the status of brook trout along the Minnesota shore of Lake Superior. Our objectives are to: 1) describe the distribution of brook trout in streams below barriers during the spawning season, 2) determine if size and age distributions have increased following regulation changes, and 3) determine the extent to which stocked coasters from other management agencies contribute to Minnesota populations. Results presented in this paper may influence the decisions of management agencies with regard to management actions, e.g., restrictive harvest regulations or stocking programs, to rehabilitate self-sustaining coaster populations.

Methods

MNDNR field collections

The study area consisted of sections below barriers in 28 streams and a seasonal barrier on the Knife River along the Minnesota shore of Lake Superior between Duluth and the Grand Portage Reservation (Fig. 1, Electronic Supplementary material (ESM) Table S1). Fall electrofishing surveys were conducted in 1997, 2002, 2007, 2008, and 2013. Not all streams were sampled each of these years. In particular, several larger streams could not be sampled in 2007 due to high sustained flows and were instead sampled in 2008. Also, only 10 streams were sampled in 2002 due to limited staff availability. The sample in 1997 was concurrent with regulation changes and was considered pre-regulation for comparison to post-regulation samples. Data from 2007 and 2008 were combined and treated as one sample year for analysis. Streams were sampled from late-September through early-November. Multiple trips were made to the same stream in some years, resulting in 1–6 sampling events per stream. Sampling occurred from the lake to the first barrier falls, to the extent possible, on all streams (ESM Table S1). A single individual in 1997 was sampled in an adult trap 0.1 km from the lake on the French River. Water temperature was measured near the stream mouth on each sampling date.

Fish were sampled using a Smith Root model 11-A backpack electrofishing unit (300–400 V, 60 Hz) or an ETS Electrofishing ABP-3 unit. Sample crews consisted of 3–6 individuals depending on stream width. A splitter was placed on the electrofishing unit to allow two anodes, or for some larger streams, two units were used. Multiple passes were conducted if all brook trout observed on the first pass were not netted, and time allowed. Gear configurations, crew members and sampling intensity (time electroshocked per stream distance) varied across years. In contrast, station length of each stream did not change

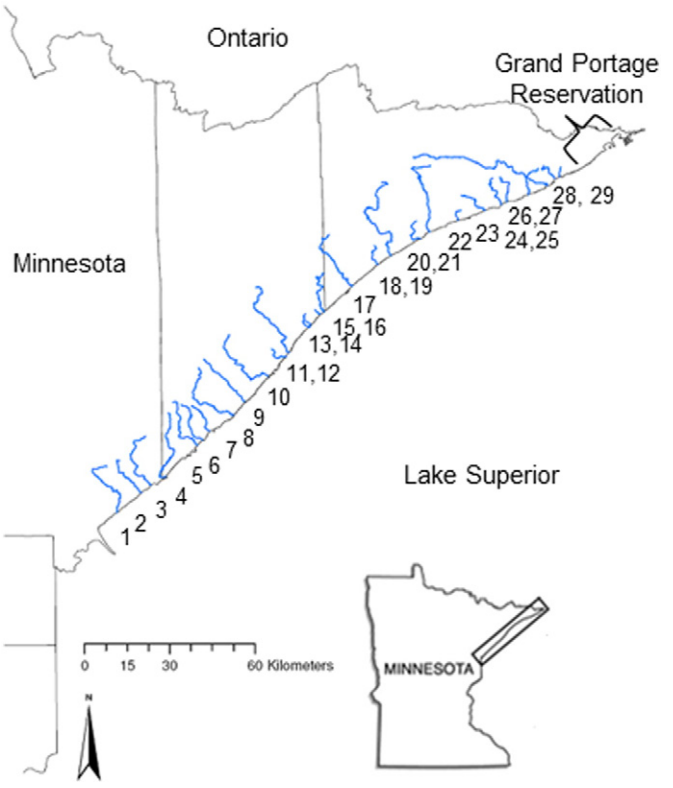

Fig. 1. Locations of streams sampled on the Minnesota shore of Lake Superior. Stream names are indicated in ESM Table S1.