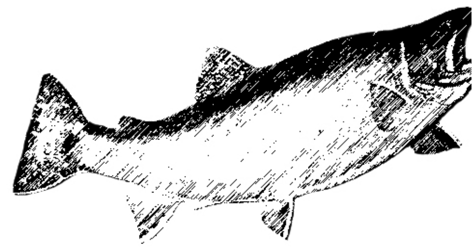
A BROOK TROUT REHABILITATION PLAN FOR LAKE SUPERIOR



Great Lakes Fishery Commission

Miscellaneous Publication 2003-03

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Citation: Newman, L.E., R.B. DuBois, and T. N. Halpern (EDS.). 2003. A brook trout rehabilitation plan for Lake Superior. Great Lakes Fish. Comm. Misc. Publ. 2003-03.

Great Lakes Fishery Commission
2100 Commonwealth Blvd., Suite 100
Ann Arbor, MI 48105-1563

May 2003

Printed on recycled paper.
Miscellaneous Publication 2003-01
May 2003/600

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ABSTRACT

The goal for brook trout *(Salvelinus fontinalis)* rehabilitation in Lake Superior is to maintain widely distributed, self-sustaining populations throughout their original habitats. Reaching the goal will require, singly or in combination, actions to restore tributary habitat, regulate harvest, and introduce genetically appropriate strains through stocking. Progress toward the goal should be measured by increased robustness of existing populations and successful reestablishment of new populations in areas containing sufficient or restored habitat. Management should concentrate on maintaining populations that contain six or more age-classes of brook

trout and have at least two age-classes of spawning females. Existing habitats should be protected, and impaired habitats should be restored. Only strains of brook trout originating within the Lake Superior basin should be considered for stocking or reintroduction. Gamete collections must be designed to limit the risk of weakening the donor populations. Hatchery-reared eggs, fry, or older fish should be stocked to reestablish populations where they have been extirpated. Routine assessment should include monitoring abundance, growth, recruitment, and harvest from each population. Public information can play a key role in building support and appreciation for brook trout rehabilitation. Future research should focus on the barriers to rehabilitation, identification of critical habitats for each life stage, genetic, behavioral, and morphological studies, and ecological interactions.

INTRODUCTION

A migratory form of lake-dwelling brook trout *(Salvelinus fontinalis)* was historically widespread and common in the nearshore waters of Lake Superior. The lake trout provided a highly valued and productive sport fishery along suitable shoreline areas of the lake and in tributary streams with spawning populations (Smith and Moyle 1944; Shiras 1935; Roosevelt 1865). Local residents called these brook trout “coasters” or “rock trout” in reference to their preference for rocky, nearshore lake habitat. Becker (1983) described coaster brook trout as “those spending part of their life in the Great Lakes.” This definition includes the full range of complex life strategies exhibited by brook trout populations in Lake Superior and is the definition used in this plan.

Historical literature provides limited evidence of the number and locations of stream-spawning populations of coasters. Several recent sources, as summarized in Newman and DuBois 1996, mention the occurrence of lake-run brook trout in 106 streams tributary to Lake Superior. Since that report, agencies have added 12 additional streams. However, in some cases it cannot be positively determined whether these fish were from native stocks or hatchery stocks—or if, in fact, they were actually reproducing in the streams named.

Coaster stocks are known to be highly susceptible to exploitation, particularly by angling (Roosevelt 1865; Newman and DuBois 1996). Populations throughout the lake were exploited rapidly during the 1800s and the most accessible populations were probably extirpated at an early date. For example, Roosevelt (1865) reported that "streams within thirty miles of Marquette [Michigan] were fished out." By the end of the 1930s, habitat loss and degradation caused by logging activities had resulted in further declines in coaster abundance. In some areas, habitat loss may have been the major factor in the extirpation of stocks. By the mid-1900s, coaster brook trout were reduced to the few viable populations that have persisted to the present (Hansen 1996).

Agencies have made repeated attempts to restore coaster stocks in Lake Superior by stocking a variety of cultured strains of brook trout. From approximately 1900 to 1995, these attempts produced some returns of large brook trout. However, the number of recaptures has been low, and they are not known to have resulted in the establishment of any naturally reproducing stocks (Newman and DuBois 1996). This lack of success may have been due to:

- The use of unsuitable strains
- Inadequate protection
- Poor fitness of stocked fish
- Suboptimal size or age at stocking

- Inappropriate stocking locations

- Competition from naturalized salmonines

- Stream habitats near the areas stocked being too degraded to support coaster rehabilitation

More recently, Newman (2000) reported that Nipigon-strain brook trout stocked in Grand Portage, Minnesota, streams as fertilized eggs or as 38-mm fry were emigrating to Lake Superior then returning as adults to streams where they were stocked and reproducing successfully. The initial success noted here may be due to either the strain used, the stocking of an early life stage, the protection from overharvest provided by Grand Portage, or all of these factors combined.

Information specific to Lake Superior coasters is extremely limited due to the rapid depletion of the original populations. No information exists about annual catches, yields, or mortality rates. Fish-community objectives for Lake Superior (Busiahn 1990; Horns et al., 2003) call for reestablishment of depleted native fish stocks such as sturgeon, walleye, and brook trout through:

- Management of habitat for spawning and rearing

- Protection from overharvest

- Replacement and/or enhancement by stocking early life stages

Since the development of the fish-community objectives, agencies have shown interest in rehabilitation of brook trout in Lake Superior; and since 1992, several research and adaptive management projects have been started to provide baseline information on the species (Quinlan 1999; Newman 2000).

This rehabilitation plan for brook trout in Lake Superior recognizes the profound need for more scientific information about coasters. Research into some areas of coaster biology and their habitat requirements may be a prerequisite for successfully implementing brook trout rehabilitation in particular habitats or portions of the lake. In other situations, rehabilitation may only require stocking appropriate life stages of fish and then providing adequate protection from harvest, as demonstrated at Grand Portage, Minnesota (Newman and Johnson 1996).

In the Nipigon area, populations of existing native stocks are apparently responding well to restrictive harvest regulations and protection of spawning habitat (K. Cullis, Ontario Ministry of Natural Resources, 5 Wadsworth, Nipigon, Ontario, P0T 2J0, personal communication). However, conservation and enhancement of coaster populations on a broad scale in the Lake Superior watershed will require coordination and implementation of a comprehensive approach that must include simultaneous efforts such as:

- Biologically based management and control of the fisheries to prevent overexploitation
- Research into habitat requirements of existing populations
- Rehabilitation of degraded stream habitats
- Location of suitable rehabilitation sites
- Reintroduction and establishment of reproducing populations of genetically appropriate stocks in suitable areas

GOALS FOR REHABILITATION

The rehabilitation goal for brook trout in Lake Superior is to maintain widely distributed, self-sustaining populations in as many of the original, native habitats as is practical.

Objectives for Brook Trout Populations

Changes in tributary habitat conditions in some streams and in the Lake Superior fish community (Lawrie and Rahrer 1972; MacCallum and Selgeby 1987) over the last 150 years may prevent achievement of predepletion population characteristics of brook trout. Despite these uncertainties, however, rehabilitation of brook trout in Lake Superior can be successful if the following objectives are met:

- Populations will be self-sustaining and capable of co-existing with populations of naturalized salmonines in the existing fish community

- Populations will be geographically widespread, inhabiting the areas that historically held viable populations, provided that tributary and lake habitat conditions in these areas are still suitable, or that they can be restored

- Populations will be comprised of six or more age-groups (ages 0-5), including at least two spawning year-classes of females; spawning populations will exhibit densities sufficient to ensure viable gene pools

- Populations will exhibit genetic profiles consistent with those of populations currently existing in the Lake Superior basin

- Essential habitat in tributaries will be protected and, where necessary, rehabilitated on a lakewide basis

- Fully rehabilitated native or reintroduced stocks will be capable of supporting managed fisheries

Achieving Rehabilitation Goals

The extent to which the rehabilitation goals for brook trout in Lake Superior will be achieved may depend upon conditions that include but are not limited to the following:

Tributary Habitat

Suitable tributary habitat for spawning and rearing must be maintained and, where necessary, rehabilitated. These actions will include:

- Maintaining healthy riparian forest conditions

- Ameliorating the effects of man-made obstructions to migration

The actions may further include:

- Reducing sand bedload

- Reestablishing large woody debris volumes

- Controlling beaver activity in key stream sections

These habitat objectives are achievable only to the extent that continued research focuses on identifying those habitats that are critical for all life stages.

Brood stock

Brood stocks with appropriate genetic makeup for areas targeted for reintroduction must be available. This does not discount the possibility that appropriate genetic stocks may already exist as small remnant stocks. Research that will help to define appropriate genetic stocks is ongoing (M. Curtis, National Forensic Laboratory, 1490 E. Main St., Ashland, OR, personal communication) and should continue.

Exploitation

Exploitation by sport, subsistence, and commercial fisheries must be effectively managed. Because brook trout are known to be highly vulnerable to anglers, newly established or developing populations must be managed conservatively to allow development of adequate spawning stocks.

Competition

Competition with other salmonines may inhibit rehabilitation of coasters in some habitats. Coasters have demonstrated some ability to compete successfully in Ontario waters (e.g., Nipigon and Cypress Rivers) and in the Salmon Trout River in Michigan. However, many unanswered questions remain about the extent to which coasters can co-exist with different salmonine species at various densities and in smaller systems where habitat availability may be a strongly limiting factor. It is unlikely that agencies will undertake wholesale removals of naturalized salmonines from tributaries, although they may experiment with excluding them from localized areas to gain understanding about competitive interactions.

Agency Efforts

Agencies must exhibit sufficient resolve to follow through with brook trout rehabilitation. Most agencies have already attempted to restore brook trout in Lake Superior without much success. However, these efforts probably did not provide sufficient protection for rehabilitation to occur; and the strains, life stages, sizes, and locations stocked may have been inappropriate.

Financial Resources

Financial resources for research on brook trout biology, ecology, genetics, stocking techniques, and habitat requirements must be available. Current knowledge is insufficient to ensure a successful rehabilitation effort.

Productive Capacity of Habitats

The productive capacity of habitats supporting nearshore Lake Superior fisheries must be maintained. This includes protecting the groundwater discharge areas that may provide critical spawning habitat in the lake and maintaining healthy populations of nearshore forage fishes, macroinvertebrates, and their habitats.

Assessment of Progress Towards Rehabilitation Goals

Progress toward the rehabilitation goal should be measured by:

- Evidence of increased abundance and range of existing brook trout populations

- Successful reestablishment of new populations in areas containing sufficient existing or restored habitat

This progress should be evaluated on a location-specific basis using assessment procedures that are standardized among the management agencies to the greatest extent feasible. These procedures will include but are not limited to:

- Lake and estuary surveys using trawls and trapnets

- Stream electrofishing surveys

- Assessments of sport catches through creel surveys

Specific techniques are described in more detail in the Routine Assessment section of this publication. Further knowledge will be gained as agencies use adaptive management techniques to experimentally reestablish brook trout in areas containing suitable habitat either through introductions of genetically appropriate strains (known to be either anadromous or lake-spawning stocks) or by encouraging establishment of anadromous stocks from existing stream populations. We expect the results of these experiments to shed light on factors affecting brook trout rehabilitation and to give further indication of progress being made toward the goal.

ISSUES AND STRATEGIES

Control Fishery Exploitation

Agencies should enact conservative harvest regulations for both existing and developing populations of brook trout. The vulnerability of brook trout stocks to overharvest in a variety of habitats has been documented by many researchers. Lake Superior stocks were not an exception to this rule—their decline was clearly linked to overharvest, primarily by sport fishing (Newman and DuBois 1996). Regulations and management techniques in use during the period of depletion were inadequate to maintain populations. Lake-dwelling populations appear to be distinct from stream populations in some aspects of their biology and life history. Therefore, different management techniques and regulations will likely be required to maintain the populations.

Contemporary populations of brook trout from the north shore of Lake Superior—whether anadromous or lake-dwelling—share some common characteristics of age and size composition. Spawning populations are primarily composed of individuals ranging from age 3+ to 8+ (R. Swainson, Ontario Ministry of Natural Resources, 5 Wadsworth, Nipigon, Ontario, P0T 2J0, personal communication). With the exception of a small number of precocious age-1+ and age-2+ males, total lengths are usually larger than 45 cm (18 in). These data suggest that maturation (particularly of females) does not occur until age 3+ and at lengths of approximately 45 cm. However, brook trout reared in hatcheries and rfrom south shore streams may grow faster and mature earlier. Many cases of local population extirpations may be attributable to overharvest reducing the number of spawning adults to the point where reproduction failed.

Management efforts should concentrate on maintaining adequate numbers of spawning adults and an appropriate age structure in each brook trout population. Some jurisdictions (e.g., Grand Portage Tribe, the state of Minnesota, and the province of Ontario) have already enacted daily bag limits of one fish and minimum length limits of 46-50 cm (18-20 in.) for all or most of the Lake Superior waters within their jurisdiction. The goal of these regulations is to protect brook trout (particularly females) until they have had the opportunity to spawn at least twice. We recommend that other agency management plans be designed to achieve this goal. An alternative approach is to manage harvest to maintain a minimum of six year-classes (ages 0-5) in each population.

Potential Regulatory Tools

It is expected that fisheries managers will consider regulations that best fit the needs of their own particular fisheries and will have the support of the relevant agencies and the public. In many areas, regulatory protection can be provided for brook trout in Lake Superior and in tributaries below barriers to upstream migration without having much impact on existing fisheries. By contrast, circumstances where potential coaster stream habitat overlaps with existing resident stream populations that support productive fisheries are more problematic. Each agency will need to determine appropriate regulatory strategies to deal with such situations. The range of potential regulatory tools for protecting brook trout in Lake Superior includes the following:

- Year-round closed seasons on streams and lake waters supporting intensive rehabilitation or reintroduction efforts

- Seasonal closure (spawning through the fry emergence period) of key lake waters and tributary spawning areas to protect spawning adults and their habitats from destruction by wading fishermen (for example, the seasonal refuge areas on the Nipigon River established by the Ontario Ministry of Natural Resources)

- Creation of seasonal fish sanctuaries by protecting known staging areas and locations below migration barriers

- Annual bag limits verified by the use of tags or punch cards for each fish kept

- Minimum size limits, such as the 50-cm limit now used by several agencies

- Catch-and-release regulations for all brook trout in particular areas, or for all unclipped (native) brook trout

- Gear limit regulations (e.g., fly fishing only, barbless hooks) designed to increase post-release survival

Habitat Rehabilitation Initiatives

Coaster brook trout require spawning and nursery habitat in tributaries and along the shore of the lake. Tributary habitat quality has been severely altered by various forms of development since the mid-1800s (Greene 1935), which likely contributed to the decline of brook trout in Lake Superior. Many questions remain about the mechanisms by which habitat degradation may have affected historical populations because there are no thorough descriptions of the original habitats in and surrounding Lake Superior. Habitat disturbances certainly included forest cutover (Curtis 1959) and related logging activities, such as clearing stream channels of obstructions and driving logs down streams to the lake (Larson 1949; Rector 1951; Bassett 1987; Harmon et al. 1986). Wildfires in the period following the major logging era burned the portions of the watershed (Holbrook 1943). Agriculture, road building, dam construction, and increasing beaver populations (Brasch et al. 1982) have negatively impacted stream habitat and, in some cases, may still continue to limit remaining stocks. Climate changes (Eaton and Scheller 1996) may also influence rehabilitation attempts. The following lakewide habitat rehabilitation initiatives should be conducted:

- Protect and restore riverine and lake habitats that support the remaining coaster populations

- Survey and quantify reach-scale, watershed scale, and lake-scale habitat requirements of these populations

- Describe pre-disturbance conditions in order to gain additional insight into the habitat requirements of coasters—by combining this information with the characteristics of the contemporary conditions where coasters exist, describe the range of conditions where coasters can exist

- Identify potential reestablishment sites where suitable coaster habitat exists and protect and restore these habitats

In habitats that presently have coaster populations or where suitable habitat conditions for coasters still exist, more specific recommendations should be included.

- Protect critical habitats, such as spawning areas, riparian zones, headwater reaches, estuaries, nearshore areas, and other critical habitats, as identified in the habitat survey initiative

- Identify both immediate and long-term threats (such as land-use patterns or the presence of contaminants) to existing habitat, and develop strategies to limit long-term damage

- Restore watershed-scale habitat by developing and implementing watershed management strategies that maintain and improve riverine habitat

- Educate the public and landowners about best watershed management practices

Species Interactions

Populations of naturalized salmonines and domestic salmonines stocked by management agencies may represent impediments to achieving brook trout rehabilitation in Lake Superior. Competition for food and space and loss of genetic integrity through interbreeding are two processes that could be involved. Wholesale removals of naturalized salmonine populations would be neither feasible nor popular with the angling public. Rehabilitation efforts must therefore proceed under the assumption that rehabilitated brook trout populations can develop and sustain themselves in the presence of naturalized salmonine populations. Domestic strains of brook trout, brook trout hybrids, and other domestic salmonines pose similar threats. Hansen (1994) recommended that hatchery-reared salmonines not be planted in streams or areas of Lake Superior where wild populations are at carrying capacity. Areas of the lake that are targeted for coaster rehabilitation should be afforded similar consideration.

Several agencies have stocked splake (male brook trout x female lake trout hybrid) *(Salvelinus fontinalis* x *S. namaycush)* into Lake Superior for many years. Splake habitat and ranges may overlap with those of existing brook trout populations or with areas targeted for reintroduction of brook trout, which creates the potential for competition between the two forms. Furthermore, splake are so similar to brook trout in appearance that the two cannot be easily distinguished by untrained individuals. This similarity represents a potential problem in regulating brook trout harvest. Because some splake products have demonstrated a degree of fertility, there may be some danger of interbreeding between splake and wild brook trout (or lake trout) with a resulting loss of genetic integrity of the native species. Agencies should weigh these potential threats to brook trout rehabilitation against the benefits of maintaining a splake fishery. Additionally, genetic research has provided some indication that brook trout and brown trout hybridization may be occurring in the wild and that Fl generation offspring have reproduced (Burnham-Curtis 1996).

Stocking

Reestablishing coaster brook trout populations in habitats where they have been extirpated may require stocking hatchery-produced eggs, fry, or older fish. The most appropriate life stage and optimal density of fish to stock has yet to be determined. Initially, the use of various sizes and strains may be necessary to establish guidelines for future reintroduction programs. Reintroduction sites should be selected by appropriate management authorities that may consult with the Lake Superior Committee or the Lake Superior Technical Committee. All stocked hatchery fish should be marked. Techniques such as heat-marking, oxytetracycline treatment, freeze-branding, and fin clipping could be used. If fertilized eggs are stocked, genetic "fingerprinting" of parent stocks will serve as a substitute for direct marking.

Brood stocks and Strains

The genetic relationship of Lake Superior coasters to other regional strains is currently being described. Substantial genetic variability is still present among wild stocks, and some can be identified to their source using recently developed genetic markers (M. Curtis, National Forensic Laboratory, 1490 E. Main St., Ashland, OR, personal communication). To preserve the genetic integrity of wild Lake Superior coasters, we recommend that only strains of brook trout originating within the Lake Superior basin, including Lake Nipigon, be considered for stocking and/or reintroduction. Genetic profiles of all hatchery stocks should be established and maintained for reference. Inland lakes with no water access to Lake Superior could be stocked with other strains of brook trout.

Only a few wild populations that exhibit either the migratory or lake-dwelling life history are sufficiently large to serve as source populations for brood stock. These may include populations in the vicinity of Nipigon Bay, Lake Nipigon, Isle Royale, and the Salmon Trout River. As of 2002, there are three strains of Lake Superior brook trout brood stock being reared and made available for stocking. They are the Tobin Harbor and Siskiwit Bay strains from Isle Royale, Michigan, and the Lake Nipigon strain from Lake Nipigon, Ontario.

Captive brood stock and production fish are reared at the:

- Ontario Ministry of Natural Resources Dorion Fish Culture Station (Lake Nipigon strain)

- Red Cliff Tribal Hatchery (Lake Nipigon strain)

- U.S. Fish and Wildlife Service Iron River National Fish Hatchery (Tobin Harbor and Siskiwit Bay strains)

A joint project is being conducted by geneticists at the University of Minnesota, U.S. Geological Survey Great Lakes Science Center, and Ontario Ministry of Natural Resources. Analysis of micro-satellite DNA will be performed on the source populations of each strain and hatchery brood stock. A brief description of the strains follows:

Lake Nipigon Strain

This strain is derived from gametes collected in three separate years (1976, 1977, and 1978) from a shoal-spawning population. A total of 66 males and 62 females mated at a ratio of 2:1 are founding parents of the brood stock maintained at the Dorian Fish Culture Station. Infusion of wild gametes crossed with existing brood stock will occur in 2002, 2003, and 2004. The brood stock maintained at the Red Cliff Tribal Hatchery was developed from a total of 148 pairings mated at a 1:1 ratio of Dorian Fish Culture Station brood stock in 1994, 1995, and 1996.

Tobin Harbor Strain

This strain is derived from gametes collected in three separate years (1996, 1998, and 2001) from a shoreline/shoal spawning population. A total of 51 males and 48 females mated at ratios of 2:1 (1996) and 1:1 (1998 and 2001) are founding parents for the brood stock. Infusion of wild gametes is scheduled for 2004, 2007, and 2013.

Siskiwit Bay Strain

This strain is derived from gametes collected over two years (1995 and 1999) from a migratory population spawning in the Big and Little Siskiwit Rivers. A total of 8 males and 11 females contributed to this brood stock. Efforts to collect additional year-classes were unsuccessful in 1998 and 2000.

The need for additional brood stocks may become necessary if genetic, behavioral, or performance differences are found among stocks. For example, if the habitat of anadromy, as opposed to lake shoal spawning, is found to be genetically controlled, a river-spawning stock would become preferable for riverine use.

Gamete collections must be designed to limit the risk of weakening the donor population. A sufficient number of founding individuals should be collected to ensure the representation of low-frequency gene alleles that may exist in the wild population. All brood stocks should be developed and maintained with a properly designed management program, as recommended for lake trout (Hansen 1996). Lake Superior brook trout brood stocks should be maintained in more than one hatchery system to minimize the chance of catastrophic loss.

The selection of brood stock strains for reestablishing populations should be based on the proximity of the source to the reintroduction site or on the performance and behavioral traits of each strain and its suitability for the local habitat. To determine these traits, research must be conducted on the available strains.

ROUTINE ASSESSMENT

Brook trout abundance, growth, recruitment, harvest, and mortality should be monitored annually at locations where brook trout rehabilitation projects are undertaken. These data can then be used to track the viability of existing populations and the progress of rehabilitation projects in order to help develop management strategies. Where possible, the collection, analysis, and reporting of these data should be standardized among agencies. Because most brook trout populations in Lake Superior are small, sampling should be designed to minimize mortality.

Abundance

The number of adults in each spawning population (stream or lake) should be estimated so that progress toward goals can be monitored. Abundance of adults should be monitored in the fall by trapnetting or electrofishing. Trapnetting should be used wherever possible. To reduce injuries to the fish, electrofishing operators should explore new technologies, such as the use of unpulsed DC current and Quadra Pulse-type systems.

Growth and Life History Information

Age and growth rate may be determined from scales taken from adults returning to spawn in the fall. Marking or tagging should be used to provide additional information on:

- Growth rates
- Frequency of spawning
- Occurrence of straying
- Patterns of movement

Although information on diet is useful for understanding habitat needs and determining the extent of diet overlap and competition with other species, it should be collected only with nonlethal methods.

Recruitment

Juvenile abundance can be monitored by electroshocking streams and possibly nearshore areas, for young-of-the-year (YOY) brook trout and juveniles. Shocking should be conducted from mid-June through July when stream water levels are low enough to use the equipment efficiently but before out migration to Lake Superior has begun. Out migration of YOY brook trout may begin as early as August.

Harvest

Harvest of brook trout should be determined from creel survey data. Streams with coaster brook trout populations and sites where rehabilitation projects are under way should be included in ongoing surveys where possible. If the cost of including coaster sites in a creel survey is prohibitive, an angler diary program or voluntary creel survey should be conducted at streams where coasters exist or where rehabilitation is being attempted.

Mortality

Differentiating natural mortality from that caused by fishing will be necessary to assess the effectiveness of regulations in protecting populations. Analysis of catch curves can be used to estimate mortality.

PUBLIC EDUCATION

Brook trout rehabilitation in Lake Superior will likely require regulatory changes, habitat rehabilitation, and reintroduction by stocking. The success of such efforts will be partly dependent on the public's appreciation of the value of brook trout rehabilitation. Providing information to and consulting with the public can play a key role in building support and appreciation for rehabilitation. Brook trout are well known as stream fish in the region surrounding Lake Superior, but they are not well known as anadromous members of the native Lake Superior fish community. Posters, pamphlets, videos, and other resources that inform the public of the historical status of brook trout in Lake Superior may help the public understand and support rehabilitation efforts.

All management agencies involved in Lake Superior brook trout rehabilitation should develop, either alone or in cooperation, informational and educational materials that can be used to inform the public about these efforts. Materials should be developed that can be distributed at management-agency offices, sporting clubs, schools, and meetings of other concerned groups.

RESEARCH NEEDS

Research into the life history of coaster populations, including habitat use by all life stages is especially needed. Particular emphasis should be placed on identifying the critical habitats and needs of coasters, such as groundwater upwellings for spawning, nursery areas, and forage bases. A habitat suitability index to identify potential reintroduction sites should be developed. Habitat improvement projects should be evaluated for their effectiveness in promoting anadromy of brook trout.

Genetic, morphologic and meristic analyses, and behavioral studies, should be conducted to describe existing coaster stocks such that comparisons with stream resident populations can be made. This information will shed light on the question whether anadromous brook trout are genetically distinct from existing stream resident populations or whether the genetic profile necessary for anadromy already exists within stream resident population but it is not being expressed. Research should involve:

- Describe more fully the competitive relationship between coaster brook trout and naturalized salmonines and their hybrids in spawning and nursery habitats and in the lake

- Determine the most appropriate life stages for stocking programs

- Determine the potential dangers for genetic degradation of native stocks of brook trout and lake trout through interbreeding with introduced splake. Also explore the potential for interbreeding between native brook trout and introduced brown trout

- Complete a genetic reference collection of genotypes of all brook trout stocks (including hatchery brood stocks) so that the source of all fish captured in the wild may be identified

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APPENDIX 1

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APPENDIX 2

COASTER STREAM HABITAT, TRIBUTARIES TO LAKE SUPERIOR

The following list describes the Lake Superior tributaries where lake-run brook trout may have occurred historically (Newman and DuBois 1996), and summarizes the quantity and condition of the existing habitats in these streams. The original sources for this list noted the presence of large, lake-run fish in these streams. However, it is not certain that lake-run brook trout were reproducing in any given tributary or that they were indeed wild fish. Recent research in Wisconsin has focused on documenting the mention of large brook trout in streams from newspaper clippings prior to the inception of widespread stocking programs in the early 20th century (Dennis Pratt, Wisconsin Department of Natural Resources, 1705 Tower Avenue, Superior, WI 54880, personal communication). Based on this research, Fish Creek and the Bois Brule, Cranberry, Flag, Sand, and Sioux Rivers in Wisconsin had large, wild brook trout that were probably lake-run. The absence of newspaper accounts of large anadromous brook trout in other streams does not preclude the possibility that coasters existed in them. The contents of data columns include:

Stream Name

The lists are derived from those reported in the status of the stock report on brook trout in Lake Superior (Newman and DuBois, 1996). Some streams have been added to this list at the request of management agencies since publication of this report. These streams are marked with an asterisk.

Stream Length

The total length of stream (including tributaries) from headwaters to point of entry into Lake Superior.

Barrier

The presence or absence of natural or manmade barriers to upstream migration of salmonids.

Anadromous Habitat

Stream distance from mouth of stream up to first impassable barrier to migration.

Anadromous Species

Salmonine species other than brook trout observed in surveys of the stream. Species symbols include:

STT	Steelhead or rainbow trout
COS	Coho salmon
CHS	Chinook salmon
PKS	Pink salmon
BNT	Brown trout
ATL	Atlantic salmon
SPL	Splake (hybrid)

Stressors

Habitat factors that may limit the use or function of a stream as habitat for coasters. Factors listed and symbols used include:

LF Low flow rates during summer or winter

LG Limited groundwater to maintain suitable stream temperatures and provide spawning habitat

UT Unsuitable temperatures

SS Spawning substrate limited

CH Cover habitat (woody debris, rock) limited

PC Pollutant contamination

Habitat Improvements

Habitat improvement projects completed or in progress for this stream.

U Unknown or no data available

ONTARIO STREAMS

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Pigeon	U	Y	2.9	20.6	STT, CHS, PKS	U	N
Current	69.25	U	U	3.94	STT	LF, UT	Y
Ishkibibble	U	U	U	U	U	U	N
Wild Goose	10.6	Y	0.5	U	STT, COS	LF, CH	N
Blind	5.75	Y	0.7	U	STT	LF	N
MacKenzie	60.0	Y	2.6	U	STT, PKS	SS	N
Blende	8.0	U	U	U	STT	LF	N
Pearl	U	Y	2.0	U	STT	U	N
Coldwater	34.14	U	U	U	STT	U	Y
Spring	U	U	U	U	STT	U	Y
Wolf	93.5	Y	11	6.8	STT, COS, PKS, CHS	U	Y
Black Sturgeon	90.0	Y	19	24.2	STT, COS, CHS, PKS	U	N
Stillwater	16.5	Y	2.4	U	STT	CH	N
Nipigon	50.0	Y	12.9	352	STT, COS, CHS, PKS	LF	N
Firehill	4.0	N	4.0	U	STT	LF, CH	N
Jackfish	U	Y	U	U	STT	U	N
Ozone	15.0	Y	U	U	STT	U	N
Mazykamah	U	U	U	U	STT	U	N
Jackpine	46.8	Y	1.6	U	STT	LF, UT	N
Dublin	12.4	Y	1.14	U	STT	LF, LG	N
MacInnes	8.5	N	8.5	U	STT	LF, LG	N
Cypress	37.0	Y	U	U	STT	LF	N
Little Cypress	6.2	Y	0.9	U	STT		Y

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Little Gravel	U	Y	1.6	0.5	STT, COS	CH	N
Gravel	U	Y	1.6	U	STT	U	N
Steel	149.0	Y	10.4	U	STT, COS, BNT	U	N
Prairie	U	U	U	U	U	U	N
Ripple	U	Y	1.6	U	U	U	N
Deadhorse	19.4	Y	1.6	U	STT, COS	CH, UT	N
Little Pic	157.9	Y	1.6	15.8	STT	U	N
Mink	11.1	Y	1.6	U	STT, COS	UT	N
Pic	U	Y	4.8	52.0	STT	U	N
Willow	40.0	U	U	U	U	U	
Nicol Cove	5.3	Y	1.5	U	STT, COS	U	N
White Gravel	20.0	Y	1.8	U	STT	U	N
Simons Harbor	3.7	Y	0.6	U	STT, COS	U	N
North Swallow	17.0	Y	0.2	U	STT, COS	U	N
Swallow	33.8	Y	1.2	U	STT	U	N
Cascades	U	U	U	U	U	U	N
Tagouche	23.6	Y	1.4	U	STT, COS	CH	N
Imogene	8.5	Y	1.4	U	STT, COS	CH	N
Pukaskwa	81.8	Y	0.7	U	STT	U	N
Pipe	U	Y	1.6	U	STT	U	N
Dog	82.4	Y	2.5	U	STT	U	N
Makwa	U	U	U	U	U	N	N
Floating Heart	U	U	U	U	U	N	N
Dore	U	Y	1.6	U	STT	U	N

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Michipicoten	127.5	Y	16.6	35.9	STT, COS, CHS, PKS	LF	N
Noisey	U	U	U	U	U	U	
Old Woman	U	Y	3.2	U	STT, COS	U	N
Unnamed	U	U	U	U	U	U	N
Sand	U	Y	3.2	U	STT	U	N
Agawa	U	Y	3.2	U	STT	U	N
Montreal	U	Y	1.6	U	STT	LF	N
Pancake	U	Y	8.0	U	STT, COS	U	N
Carp	17.9	Y	6.9	U	STT, COS,	U	N
Batchawana	U	Y	9.7	U	STT, COS, CHS	U	N
Chippewa	U	Y	1.6	U	STT, COS	SS	N
Harmony	U	Y	1.6	U	STT	U	N
McLeans	U	U	U	U	STT	U	N
St. Marys	70	U	U	U	STT, COS, CHS, BRN, ATL	U	Y

MICHIGAN STREAMS

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Pendils	4.6	Y	<1	0.85	STT, COS, PKS	PC	N
Halfaday	4.6	N	4.6	U	STT COS, PKS		N
Little Two Hearted	16	N	16	1.98	STT, COS, PKS		N
Hurricane	11.2	N	11.2	U	COS, STT, SPL		N
Seven Mile	6.4	N	6.4	0.48	STT, COS, PKS		N
Mosquito	8.0	Y	1.6	1.13	STT, COS, SPL		N
Miners*	30.6	Y	3.1	U	STT, COS, PKS, SPL	UT	N
Bay Furnace	8.0	N	8.0	.99	STT, COS, PKS, CHS		N
Au Train	24	Y(MM)	16	3.40	STT, COS, PKS, CHS		N
Rock	16	Y(MM)	0.06	1.27	STT, COS, PKS, CHS		N
Sand	16	N	16	1.42	COS, STT, CHS		N

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Chocolay	>32	N	>32	5.10	STT, COS, PKS, CHS	SL	N
Campeau	3.2	N	3.2	.14	COS, STT	LF, PC	N
Big Garlic	24	N	24	2.80	STT, COS, PKS, CHS	SL	N
Salmon Trout	24	Y	8.0	1.13	STT, COS, PKS CHS	SL	N
Gratiot*	24	Y	4.8	.28	BNT, COS, STT	LF, LG	Y
Montreal*	24	Y	.8	.56	COS, STT	SS	N
Traverse*	16	N	16	.48	COS, STT		N
Tobacco*	9.7	N	9.7	.42	COS, STT	LF	N
Pilgrim*	21	N	21	.28	COS, STT, BNT,PKS	LF, CH	Y
Schot*	8	N	8	.28	COS, STT	LF	N
Boston*	8	N	8	.14	COS, STT	LF, PC	N
Little Huron	16	N	16	U		LF	N
Big Huron	32	Y	9.6	6.37	STT, COS	LF	N
Silver River	24	Y	4.8	5.24	STT, COS		N
Eagle	1.2	Y	<.8	U			N
Ohman's	4.8	N	4.8	U	BNT		N
Montreal	32		<.8	9.19	STT		N
Big	9.6	N	9.6	U	STT		N

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Siskiwit							
Little Siskiwit	11.2	N	11.2	U	STT		N
Washing-ton	8.0	N	8.0	0.47	STT		N
Grace	11.2	N	11.2	U	STT		N

WISCONSIN STREAMS

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Grave-yard*	8.8	N	8.8	0.1	STT, COS, BNT		N
Fish	33.9	N	33.9	1.90	STT, BNT, COS, PKS	SS, CH	N
Whittlesey	6.4	N	6.4	0.50	STT, BNT, COS, PKS, CHS	SS, CH	N
Bono	4.0	N	4.0	0.005		SS, CH, LF	N
Thomp-son	5.5	N	5.5	0.03	STT, BNT	SS, CH	N
Sioux	29	N	29	0.81	STT, BNT, COS, PKS	SS, CH	N
Onion*	6.4	N	6.4	U	STT, BNT, COS, PKS		N
Pike's	12.4	N	12.4	0.15	STT, BNT, COS	SS, CH, LF	Y
Birch Run	1.2	N	1.2	0.014		SS, CH	N
Saxine	3.8	N	3.8	0.017	STT,	LF, SS,	N

Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
					COS	CH	
Sand *	6.4	N	6.4	U	STT, BNT		
Bark	9.0	N	9.0	0.308	STT, COS, BNT	SS, CH	N
Cran-berry*	24.6	N	24.6	U	STT, COS, BNT		N
Flag*	26.7	N	26.7	U	STT, COS, CHS, BNT		
Brule	70.8	N	70.8	4.25	STT, BNT, COS, PKS, CHS	SS, CH	Y

MINNESOTA STREAMS

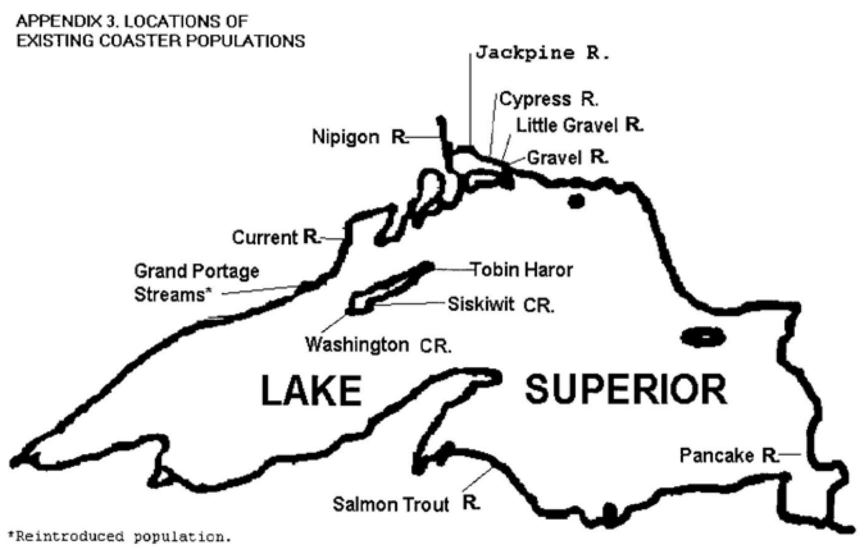
Stream Name	Stream Length (km)	Barrier Y/N	Anad. Habitat (km)	Mean Flow (m^3/s)	Anad. Species	Stressors	Habitat Improv.
Knife	224	N	113	U	STT, BNT, COS	UT, LG, CH, LF	Y
Stewart	69	Y	2.4	U	STT, COS	LG, LF	Y
Split Rock	95	Y	1.1	U	STT	LG, SS, CH	N
Baptism	221	Y	1.4	U	STT, CHS, COS	LG, SS, CH	N
Little Marais	10	Y	.2	U	STT	LF, LG, CH, UT	N
Manitou	147	Y	U	U	STT	CH, SS	N
Brule	276	Y	2.4	U	STT	UT, SS, LG, CH, LF	N
Reserva-tion	29	Y	9.3	U	STT, COS,	UT, LG	N
Hollow Rock	15	Y	.4	U	STT, COS	LF, LG	N
Grand Portage	11	Y	1.4*	U	STT, COS	LF, LG	Y

* Streams added to list since publication of status report (1997)

** The barrier in Grand Portage Creek is a box culvert under Highway 61. A fish-passage tube in the culvert allows steelhead to ascend and reproduce above the barrier in some years.

APPENDIX 3.

Locations of Existing Coaster Populations



MISCELLANEOUS PUBLICATIONS

February 1993	What's next? the prediction and management of exotic species in the Great Lakes (report of the 1991 workshop). E.L. Mills, J.H. Leach, C.L. Secor, and J.T. Carlton. 22 p.
August 1993	A survey of fish-community and habitat goals/objectives/targets and status in Great Lakes areas of concern. J.H. Hartig. 95 p.
August 1993	Toward integrating remedial-action and fishery-management planning in Great Lakes areas of concern. J.H. Hartig. 34 p.
September 1994	Walleye-rehabilitation guidelines for the Great Lakes area. P.J. Colby, C.A. Lewis, R.L. Eshenroder, R.C. Haas, L.J. Hushak. 112 p.
April 1996	A lake trout restoration plan for Lake Superior. M.J. Hansen [ED.]. 34 p.
August 1998	A lake trout rehabilitation guide for Lake Huron. M.P. Ebener [ED.]. 48 p.
May 2003-01	A rehabilitation plan for walleye populations and habitats in Lake Superior. M.H. Hoff [ED.]. 22 p.
May 2003-02	A lake sturgeon rehabilitation plan for Lake Superior. N.A. Auer [ED.]. 28 p.