GREAT LAKES FISHERY COMMISSION

2004 Project Completion Report[1]

# Lake Superior Coaster Brook Trout Initiative

by:

Donald R. Schreiner[2], Ken Cullis[3], and Dr. Jeff Schuldt[4]

[2]Lake Superior Area Fisheries
Minnesota Department of Natural Resources

[3]Lake Superior Manager
Ontario Department of Natural Resources

[4]Department of Biology and Earth Science
University of Wisconsin - Superior University of Michgan

December 2004

# A Completion Report on the

# Lake Superior Coaster Brook Trout Initiative

Donald R. Schreiner
Lake Superior Area Fisheries
Minnesota Department of Natural Resources

Ken Cullis
Lake Superior Manager
Ontario Department of Natural Resources

Dr. Jeff Schuldt
Department of Biology and Earth Science
University of Wisconsin - Superior

## Table of Contents



## List of Appendices

## INTRODUCTION

A migratory strain of brook trout (*Salvelinus fontinalis*) was once common in the near shore waters of Lake Superior. These migratory brook trout, referred to as "coasters" provided a highly valued and productive sport fishery until the early 1900's. Today only a small number of remnant populations exist (Newman and DuBois, 1997). Excessive harvest and habitat degradation are thought to be the major cause of the decline. In 1999 the brook trout sub-committee of the Lake Superior Technical Committee, under the auspices of the Great Lakes Fishery Commission (GLFC), with guidance from the Fish Community Objectives for Lake Superior (Bushian 1990), published *A Brook Trout Rehabilitation Plan for Lake Superior (Newman, et al. 1999).* As stated in the plan, "*The rehabilitation goal for brook trout in Lake Superior is to maintain widely dispersed self-sustaining populations in as many of the original, native habitats as is practical."* Throughout the plan the need for more scientific information about coasters is emphasized. Since 1999, a variety of research and management projects have been conducted on coaster brook trout in Lake Superior. Various partners have expressed an interest in discussing this new information, and charting a shared direction for future research and management of brook trout in Lake Superior. The 2003 version of the Fish Community Objectives for Lake Superior (Horns et al. 2003) continues to place high value on the rehabilitation of brook trout in Lake Superior.

In 2002 we received a grant from the Great Lakes Restoration Act, administered through the Great Lakes Fishery Commission, to fund a conference and synthesize information on the restoration of coaster brook trout in Lake Superior. In partnership with a number of other organizations interested in coaster brook trout rehabilitation (Ontario Ministry of Natural Resources, Minnesota Sea Grant, Wisconsin Extension and Trout Unlimited) we formed a steering committee to coordinate a Coaster Brook Trout Initiative for Lake Superior. Our overall goal was to advance the scientific understanding of coaster brook trout rehabilitation in Lake Superior.

The steering committee defined five major objectives for the Coaster Brook Trout Initiative:

1. Share the results of management and research projects related to coaster brook trout rehabilitation in Lake Superior.
2. Convene a conference and synthesis session where lake-wide recommendations on future research and management initiatives are developed for coaster brook trout rehabilitation.
3. Promote collaboration among fishery biologists from various organizations by providing both formal and informal opportunities for interaction and networking among conference participants.
4. Publish conference and synthesis proceedings in a peer reviewed journal or a GLFC Special Publication.
5. Work with Minnesota Sea Grant, University of Wisconsin Extension and Trout Unlimited (US and Canada) to provide materials and a forum where other interested organizations and citizens can learn more about Lake Superior coaster brook trout rehabilitation, and ways in which they can become involved in supporting rehabilitation efforts.

## METHODS

The Coaster Brook Trout Initiative (CBTI) was coordinated by a steering committee composed of at least one representative from each of the major funding organizations. The steering committee included a representative from the Lake Superior Committee/Lake Superior Technical Committee (GLFC), Minnesota Sea Grant, Ontario Ministry of Natural Resources (OMNR), Wisconsin Department of Natural Resources (WIDNR) and Trout Unlimited (TU). Minnesota Sea Grant, WIDNR, OMNR and TU all contributed additional funding and staff time to the initiative. University of Wisconsin Extension and most of the other Lake Superior fish management agencies also contributed significant staff time to assist with the initiative.

The Coaster Brook Trout Conference and Synthesis was the focal point of the CBTI. Theme areas highlighted at the conference and in the synthesis papers include coaster brook trout genetics, stream habitat requirements, lake habitat requirements, population dynamics, and management techniques and perspectives. Other CBTI activities included two symposia on migratory brook trout that were sponsored at the 2003 and 2004 American Fisheries Society (AFS) national meetings in Quebec City, Quebec and Madison, Wisconsin. In addition, we have developed a multi-agency outreach program to transfer science-based information to the general public interested in coaster brook trout rehabilitation, and we anticipate peer-reviewed publication of the 2004 AFS coaster brook trout symposia proceedings.

## OUTCOMES

A number of outcomes have resulted from the CBTI. A time frame and the relationship among the major outcomes can be found in Figure 1. A brief description of the five major outcomes follows:

### Brook Trout Symposium at 2003 Annual AFS Meeting in Quebec City, Quebec

The steering committee felt that sponsoring a symposium on brook trout at the 2003 annual AFS meeting in Quebec City, Quebec was a great opportunity for researchers and managers to showcase new scientific information on brook trout research in the eastern US and Canada. The title of the symposium was *A multiple scale perspective on brook trout conservation and management.* Dr. Daniel Josephson and Dr. Clifford Kraft organized the symposium that was sponsored by the OMNR, WIDNR, TU and the GLFC. It was the intent of the steering committee to concentrate most of the presentations on the migratory nature of brook trout and the behaviors and factors that influenced migration over a wide range of spatial scales. Twenty-two presentations and fifteen posters were presented at the symposium (Appendix 1), including a presentation by Dr. Jeff Schuldt and a poster assembled by the steering committee that highlighted the Coaster Brook Trout Initiative in Lake Superior. Abstracts of both presentations and posters can be accessed on line at http://portaltools.fisheries.org/2003Abs/afsform.cfm. Scientific information was exchanged and a number of contacts were made that have the potential to influence coaster brook trout rehabilitation efforts in Lake Superior. Particular researchers were identified by the steering committee and invited to participate in both the Coaster Brook Trout Conference and Synthesis and the coaster brook trout symposium being planned for the 2004 annual AFS meeting in Madison WI.

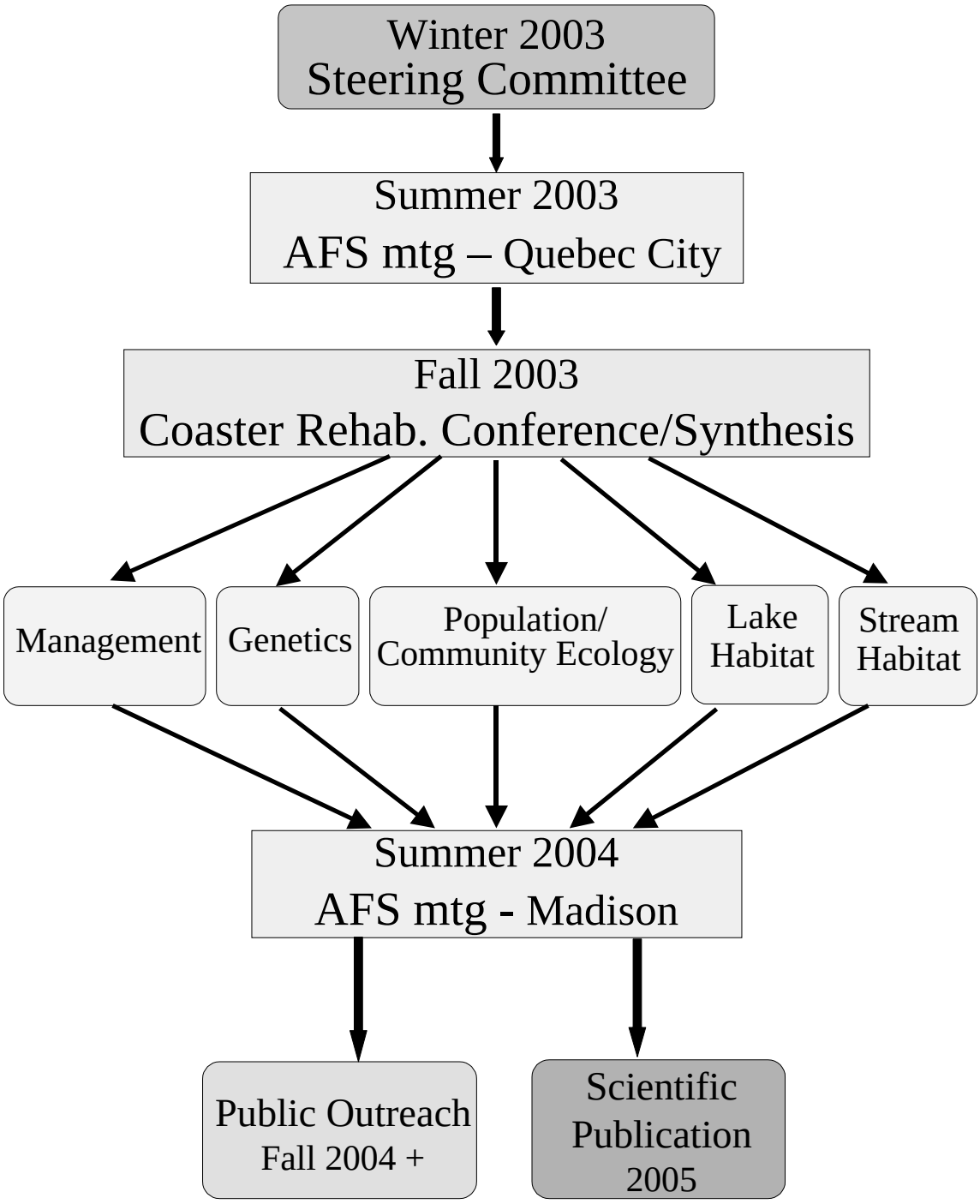


Figure 1. Flow chart of activities, relationships and time frames associated with Coaster Brook Trout Initiative for Lake Superior.

## Coaster Brook Trout Conference and Synthesis

The scientific foundations of coaster brook trout rehabilitation were discussed and debated during a Coaster Brook Trout Conference and Synthesis held at the University of Minnesota Forestry Station on October 16-18, 2003. Thirty nine fisheries professionals (Appendix 2) from across North America gathered to review recent coaster brook trout research findings and make suggestions for future coaster brook trout rehabilitation efforts.

The 1999 document, "*A Brook Trout Rehabilitation Plan for Lake Superior*" published by the GLFC, formed a general framework for brook trout rehabilitation efforts by management agencies in Lake Superior and identified numerous research needs. The 2003 Coaster Brook Trout Rehabilitation Science Conference and Synthesis represented an opportunity to assess ongoing rehabilitation efforts and current research results.

The bulk of the conference consisted of participants working in teams to address one of five important topics associated with coaster brook trout rehabilitation efforts in Lake Superior: 1) coaster genetics, 2) stream habitat requirements, 3) lake habitat requirements, 4) population dynamics, 5) management techniques and perspectives. Each team began assembling a manuscript that synthesized all of the available scientific information pertaining to a topic, identified critical research needs, and provided Lake Superior-wide management suggestions. Synthesis papers were developed and presented during a Coaster Brook Trout Rehabilitation Symposium at the 2004 AFS annual meeting in Madison, WI. Information gathered during the conference and presented in the synthesis papers was summarized and used to develop an outreach program that will be presented in a series of regional meetings targeted at citizens interested in coaster brook trout rehabilitation.

The Coaster Brook Trout Conference and Synthesis was organized and conducted by Jeff Schuldt and Ed Iwachewski (Co-chairs), Don Schreiner, Ken Cullis, Casey Huckins, Martin Jennings, Rob Mackereth, and Chris Wilson. The Great Lakes Fishery Commission, Minnesota Sea Grant, Ontario Ministry of Natural Resources, and Trout Unlimited provided funding for the workshop. All of the participating agencies and institutions contributed staff time and effort to make the conference a success.

## Coaster Brook Trout Symposium at 2004 Annual AFS Meeting in Madison, WI

The purpose of the coaster brook trout symposium at the 2004 Annual AFS meeting in Madison, WI was to transfer the results of the synthesis papers developed at the coaster brook trout conference and other recent findings on coaster rehabilitation to the scientific community. The title of the symposium was *Coaster Brook Trout Management, Biology and Rehabilitation*. Each of the theme chairs presented their group's synthesis paper with contributed papers grouped under one of the five major theme areas. Martin Jennings, WIDNR, organized the symposium that was funded by OMNR, WIDNR, TU, and the GLFC. Twenty-six presentations, ten posters and a panel discussion took place over the 1 ½ day symposium (Appendix 3). Abstracts from the five synthesis papers along with key messages and research/management recommendations can be found in Appendix 4. All abstracts from the symposium can be found at http://portaltools.fisheries.org/2004Abs/afssearch.cfm. It is anticipated that the proceedings of the 2004 coaster brook trout symposium will be published by the AFS in the future.

## Outreach Efforts

A workshop template entitled "Hooked on Coasters: Lake Superior Coaster Brook Trout Rehabilitation" was developed to present current scientific information pertaining to coaster brook trout status and rehabilitation efforts, and to engage stakeholders on the topic of coaster brook trout rehabilitation. Jeff Schuldt, Jeff Gunderson, Laura Hewitt, Todd Breiby, Sylvia Damelio, and Jack Imhoff developed the workshop template. Workshops will be held in a series of regional meetings around the Lake Superior Basin with at least one workshop held within each management jurisdiction. The target audiences for these workshops are fishing and environmental organizations, community members, resource managers, and government officials. The workshop template includes: 1) Introduction (life history, historical and current status, and factors associated with historical population declines); 2) Summary of the five synthesis papers presented at the 2004 American Fisheries Society meeting (genetics, stream and lake habitat requirements, population ecology, and management strategies) (see Appendix 4); 3) the opportunity for local agencies to discuss two or three local management and/or research projects targeted at coaster brook trout rehabilitation.

To date workshops have been conducted in Duluth, MN (11/2/04), Grand Marais, MN (11/03/04), Ashland, WI (11/16/04), Houghton, MI (12/8/04), and Marquette, MI (12/9/04). Workshops are currently being scheduled for locations in Ontario early in 2005. Future workshops will be conducted as need and interest dictates.

## Publication of 2004 Coaster Brook Trout Symposium Proceedings

It is anticipated that the proceedings of the 2004 coaster brook trout symposium will be published by the AFS in the future. Martin Jennings, WIDNR, will take the lead in pursuing peer-reviewed publication. Options being considered are a book, a volume of *The Transactions of the American Fisheries Society*, a volume of the *North American Journal of Fisheries Management* or some combination of the above. If publication by the AFS does not occur, we will proceed with publishing the five synthesis papers in the GLFC publication series. We anticipate some form of publication to occur within a year.

## SUMMARY

The amount and quality of work accomplished by funding this grant far exceeded our initial expectations. As discussed in the outcomes section, many organizations contributed funding, staff time or both to what became known as the Coaster Brook Trout Initiative (Figure 1). The GLFC Restoration Grant of $10,000.00 provided the stimulus for this activity. A scientific conference and synthesis, two international symposium, a major citizen outreach program and anticipated peer reviewed publications have all resulted from this initial funding. Even more important, our understanding of the science and future needs for coaster brook trout restoration has advanced far beyond where it was even five years ago. The communication and interaction this initiative has fostered between organizations interested in coaster restoration will serve to enhance our future management efforts. Lastly, by providing sound science for the rehabilitation formula we have developed a realistic understanding on how to proceed and what might be expected from our future management efforts.

## REFERENCES

Busiahn, T.R. 1990. Fish community objectives for Lake Superior. Great Lakes Fish. Comm. Spec. Pub. 90-1.

Horns, W.H. and 10 co-authors. 2003. Fish-community objectives for Lake Superior. Great Lakes Fish. Comm. Spec. Pub. 03-01. 78 p.

Newman, L.E., R.B. DuBois, and T.N. Halpern. [eds.]. 1999. A brook trout rehabilitation plan for Lake Superior. Great Lakes Fishery Commission. Ann Arbor.

Newman, L.E. and R.B. DuBois. 1997. Status of brook trout in Lake Superior. Prepared for the Lake Superior Technical Committee by the Brook Trout Subcommittee. Great Lakes Fishery Commission. Ann Arbor.

## ACKNOWLEDGEMENTS

We would like to express our thanks to all the participants involved in the Coaster Brook Trout Initiative, the Conference and Synthesis, both AFS symposium and the outreach program. We would like to extend special thanks to Rob Mackereth, Chris Wilson and Casey Huckins for acting as group leaders and lead authors of their respective synthesis papers; Dan Josephson and Cliff Kraft for organizing the 2003 AFS symposium in Quebec City, Quebec; Martin Jennings for organizing the 2004 AFS symposium in Madison WI, and taking the lead in pursuing peer-reviewed publication; and Laura Hewitt, Jeff Gunderson, Todd Breiby, Sylvia Damelio and Jack Imhoff for their efforts in leading the outreach component. Joe Ostazeski and Marcia Neiman assisted in organizing the Coaster Brook Trout Conference and Synthesis in addition to assisting with the completion report. Mary Negus and Tim Goeman provided constructive comments that improved the quality of this report.

# Appendix 1

## Symposium at Quebec City 2003 Annual AFS Meeting

### *"A multiple scale perspective on brook trout conservation and management"*

**Oral Presentations – Titles and Authors**

**Brook trout conservation and management: the importance of spatial scales in defining the functional units.**
*Pierre Magnan. Groupe de recherche sur les écosystèmes aquatiques. Université du Québec à Trois-Rivières, C.P. 500, Trois-Rivières (Québec)

**Early life history and behavior of brook trout, *Salvelinus fontinalis***
*David L. G. Noakes, Zoology Department and Axelrod Institute of Ichthyology, University of uelph, Guelph, Ontario

**Adaptive life history variation within and among unexploited populations of brook trout in southeastern Newfoundland.**
*Jeffrey A. Hutchings, Department of Biology, Dalhousie University, Halifax, Nova

**Groundwater hydrology and its implications for brook trout habitat.**
***J.M. Buttle, Department of Geography, Trent University, Peterborough, Ontario

**Assessing GIS techniques and technology for the identification of brook trout habitat in central Ontario.**
*Scott C. Bates, Jason Borwick, Brent Wootton, James M. Buttle, Mark Ridgway, and David O. Evans. Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario

**Lake size and the availability of young-of-year brook trout habitat in the land/lake ecotone.**
*Borwick, J., Ridgway, M.S and Buttle, J.M.. (Harkness Laboratory of Fisheries Research, Ontario Ministry of Natural Resources), (De artment of Geography, Trent University, Peterborough, Ontario

**The Distribution and Population Characteristics of Brook Trout in Headwater Stream Catchments in Ontario's Boreal Forest.**
*Mackereth, R.W. and K. Armstrong. Centre for Northern Forest Ecosystem Research and Northwest Science and Information, Ontario Ministry of Natural Resources, Thunder Bay, Ontario

**Metapopulation structure of brook trout in streams on the Precambrian Shield in south-central Ontario, Canada.**
*Brent C. Wootton, Chris Wilson, and David O. Evans. Watershed Ecosystems Graduate Program Trent University, Peterborough, Ontario

**Role of small tributaries as refugia for brook trout populations in environmentally stressed Adirondack lakes and rivers.**
*Daniel Josephson, Clifford Kraft, and Brian Weidel. Adirondack Fishery Research Program, Department of Natural Resources, Cornell University, Ithaca, NY

**Relative growth and stress tolerance of native southern Appalachian versus naturalized northern strain brook trout.**
*P. F. Galbreath*, L. W. Sherrill III, B. S. Marbert and M. S. Avis. Mountain Aquaculture Research Center, Western Carolina University, Cullowhee

**Heterogeneity in movement behavior of stream fish: Quantitative estimation of displacemtn distances for stationary and mobile indivuals.**
*Rodríguez, Marco A. and Claudia Cossette. Département de chimie-biologie, Université du Québec à Trois-Rivières, Trois-Rivières, Québec

**Pitfalls and PIT-tagging – capture of brook trout during successive recapture events in a Virginia mountain stream**
*Craig Roghair, USDA Forest Service, Southern Research Station Center for Aquatic Technology Transfer 1650 Ramble Road, Blacksburg, VA

**Brook trout utilization, movement and growth within lacustrine and fluvial habitats of a small headwater system in Newfoundland, Canada: A case of optimizing resources.**
*Keith D. Clarke, David A. Scruton, and James H. McCarthy. Fisheries and Oceans Canada, Science Oceans and Environment Branch, P.O. Box 5667, St. Johns, NL

**The impact of barriers on the occurrence of anadromy in salmonids**
*Geneviève R. Morinville and Joseph B. Rasmussen. Department of Biology, McGill University, 1205 Dr. Penfield Ave., Montréal, Québec

**Variable life histories tactics among anadromous brook charr populations.**
*R. Allen Curry, Jacob vandeSande , David Courtemanche , Fred Whoriskey , Celine Audet , and Louis Bernatchez. Canadian Rivers Institute, New Brunswick Cooperative Fish and Wildlife Research Unit, Biology Department, University of New Brunswick, Fredericton, NB

**Local and regional perspectives on the dispersal of stocked brook trout between Lake Superior Tributaries**
*Carlson, A.J. and C.J Huckins, Biological Sciences, Michigan Technological University, 1400 Townsend Drive, Houghton MI

**The role of land-use, in stream habitat, and environmental variability in structuring brook trout populations in Appalachian headwater streams.**
*Kyle J. Hartman, John A. Sweka, James P. Hakala, and M. Keith Cox. West Virginia University, Wildlife & Fisheries Resources Program, Morgantown, WV

**Influences of Landscape-Scale Factors on Brook Trout Populations in Pennsylvania, USA**
*Patrick M. Kocovsky and Robert F. Carline. The Pennsylvania State University, 113 Merkle Lab, University Park, PA

**Range of conditions: Eastern USDA Forest Service watersheds in relation to biotic integrity of brook trout.**
*Mark Hudy and J.Keith Whalen. USDA Forest Service, National Aquatic Ecologist-East, MSC 7801, 225 Burruss Hall, James Madison University, Harrisonburg

**Where have all the (Maryland) brook trout gone?**
*Dr. Raymond P. Morgan II and Mr. Scott A. Stranko. University of Maryland Center for Environmental Science, Appalachian Laboratory, 301 Braddock Road, Frostburg,

**Presenting a habitat-based framework**
*Seth Moore, Dr. Carl Richards, and Dr. Lucinda Johnson. USGS, Lake Superior Biological Station

**Coordination of Coaster Brook Trout Restoration Efforts.**
*Schuldt, J.A., E. Iwachewski, D. Schreiner, K. Cullis, R.W. Mackereth, C. Huckins, and M. Jennings, C. Wilson. Department of Biology and Earth Science, University of Wisconsin Superior, Superior, WI

## Posters – Titles and Authors

**Brook trout population declines in small Canadian Shield lakes: potential impact of beaver activity.**
*Andrea Bertolo, Pierre Magnan and Michel Plante. Département de chimie-biologie, Université du Québec à TroisRivières, C.P.500, Trois-Rivières (Québec) Canada

**Diffusion in the littoral zone: scoping emergence times and movement to essential habitat for young-of-year brook trout in lakes.**
*Matthew F. Coombs and Mark S. Ridgway. Watershed Ecosystems Graduate Program, Trent University, Symons Campus, 1600 West Bank Drive, Peterborough, Ontario

**Natural Spawning and Population Response by Brook Trout in Adirondack Lakes with Outlet Barriers.**
*Daniel Josephson, Clifford Kraft, Charles Krueger, and Stephen Sebestyen. Adirondack Fishery Research Program, Department of Natural Resources, Cornell University, Ithaca, NY.

**Habitat suitability under varying flow regimes and subsequent risks to brook trout in Pennsylvania streams.**
*Cara A. Campbell, Robert M. Ross, and Randy M. Bennett, USGS-BRD, Northern Appalachian Research Laboratory, RR #4, Box 63, Wellsboro, PA

**Alternative spawning strategies utilised by brook trout in a single species, headwater system.**
*Keith D. Clarke, David A. Scruton, R. Allen Curry and James H. McCarthy. Fisheries and Oceans Canada, Science Oceans and Environment Branch, P.O. Box 5667, St. Johns, NL.

**Brook Trout and Associated Fish Species as Indicators of Episodic Stream Acidification**
*Emily E. Phillips and William E. Sharpe. Penn State Institutes of the Environment and School of Forest Resources, The Pennsylvania State University, University Park, PA

**Temperature as a directive and lethal factor in the distribution of brook trout in headwater tributaries of the Precambrian Shield**
*David O. Evans and Brent C. Wootton. Watershed Ecosystem Graduate Program, Trent University, Peterborough, Ontario

**Status of Wild Brook Trout in Adirondack Ponds**
*William H. Gordon, Leo Demong, Patrick J. Festa, and Daniel C. Josephson. New York State Department of Environmental Conservation, Bureau of Fisheries, Region 6, 317 Washington Street, Watertown, NY

**Spatial and Temporal Patterns of Small Stream Habitat Use by Brook Trout, *Salvelinus fontinalis*, in Northwestern Ontario**
*Lawrie, M.K. and R.W. Mackereth. Department of Biology and Centre for Northern Forest Ecosystem Research (OMNR), Lakehead University, Thunder Bay, ON

**Landscape Scale Characteristics Influencing the Presence and Relative Abundance of Brook Trout (*Salvelinus fontinalis*) in Beaver Ponds in Northwestern Ontario**
Parker, S. A. and R. W. Mackereth, Lakehead University, Department of Biology and the Centre for Northern Forest Ecosystem Research (OMNR), Thunder Bay, ON.

**Summer use of a small tributary stream by fish and crayfish and exchanges with adjacent lentic macrohabitats**
*Cossette, Claudia and Marco A. Rodríguez. Département de chimie-biologie, Université du Québec à Trois-Rivières, Trois-Rivières, Québec

**Identification and protection of brook trout habitat - using basin topography to link forest management with critical groundwater recharge zones**
*H.T.A. Thompson1 and J.M. Buttle. Watershed Ecosystems Graduate Program, Trent University, Peterborough, ON

**Predicting the distribution of brook trout in small headwater catchments on the Precambrian Shield of south-central Ontario**
*B. C. Wootton, S. C. Bates, D. O. Evans, and P. C. Schleifenbaum. Watershed Ecosystems Graduate Program, Trent University, Peterborough, Ontario

**Coordination of Coaster Brook Trout Restoration Efforts.**
*Schuldt, J.A., E. Iwachewski, D. Schreiner, K. Cullis, R.W. Mackereth, C. Huckins, and M. Jennings, C. Wilson Department of Biology and Earth Science, University of Wisconsin Superior, Superior, WI

**Successful restoration of an acidified native brook trout stream through mitigation with limestone sand – Ten years later.**
*Mark Hudy, ; Daniel M. Downey, and J.Keith Whalen. USDA Forest Service, National Aquatic Ecologist-East, James Madison University, Harrisonburg, VA

* *Address of first author follows author string.*

# Appendix 2

# Participant List for Coaster Brook Trout Conference and Synthesis

## Genetics Group

Chris Wilson
Ontario Ministry of Natural Resources
(705) 755-2260
chris.wilson@mnr.gov.on.ca

Wendylee Stott
Great Lakes Science Center
(734) 214-7242
wstott@usgs.gov

Martin Jennings
Wisconsin Department of Natural Resources
(715) 635-4160
Martin.Jennings@dnr.state.wi.us

Loren Miller
University of Minnesota
(612) 624-3019
lmm@umn.edu
Genetics Group (Cont.)

Silvia D'Amelio
Trout Unlimited Canada
(519) 824-4120
Silvia.Damelio@NRDPFC.ca

Anne Cooper
University of Minnesota
(612) 624-3019
amcoop@umn.edu

## Stream Group

Rob Mackereth
Centre for Northern Forest Ecosystem Research
Ontario Ministry of Natural Resources
Lakehead University
955 Oliver Rd. Thunder Bay ON P7B 5E1
(807) 343 4009
rob.mackereth@mnr.gov.on.ca

Andy Carlson
Department of Zoology and Physiology
P.O. Box 3166
University of Wyoming
Laramie, WY 82071-3166
(307) 766-2426 lab
acarlson@uwyo.edu

Carl Richards
Minnesota Sea Grant College Program
Office of Vice President for Research and Dean of the Graduate School
2305 East Fifth Street
Duluth, MN 55812-1445
(218) 726-8710
crichard@umn.edu

Jack Imhof
Trout Unlimited Canada
c/o Rm. 114, Textiles Building
University of Guelph
Guelph, ON N1G 2W1
(519) 824-4120 Ext. 53608
jimhof@tucanada.org

Seth Moore
USGS
Lake Superior Biological Station
2800 Lakeshore Drive East
Ashland, WE 54806
(715) 682-6163
samoore@usgs.gov

Michelle Lawrie
Department of Biology, Lakehead University
955 Oliver Rd. Thunder Bay ON P7B 5E1
(807) 343 4020
michelle.lawrie@mnr.gov.on.ca

Scott Parker
Department of Biology, Lakehead University
955 Oliver Rd. Thunder Bay ON P7B 5E1
(807) 343 4024
scott.parker@mnr.gov.on.ca

## Lake Group

Jeff Schuldt
Department of Biology and Earth Sciences,
UW-Extension
University of Wisconsin Superior
Superior, WI 54880
(715) 394-8524
jschuldt@facstaff.uwsuper.edu

Owen Gorman
USGS
Lake Superior Biological Station
2800 Lakeshore Drive East
Ashland, WE 54806
(715)682-6163
owen_gorman@usgs.gov

Lee Newman
USFWS-Ashland FRO
Ashland, WI 54806
(715) 682-6185 Ext. 208
lee_newman@fws.gov

Marilee Chase
Upper Great Lakes Management Unit
Ontario Ministry of Natural Resources
Thunder Bay, ON P7E 6S8
(807) 475-1371
marilee.chase@mnr.gov.on.ca

Jammie Mucha
Thunder Bay District
Ontario Ministry of Natural Resources
Thunder Bay, ON P7E 6S8
(807) 939-3155
jamie.mucha@mnr.gov.on.ca

Cliff Kraft
Dept. of Natural Resources
Cornell University
Ithaca, NY 14853-3001
607-255-2775
cek7@cornell.edu

Rob Swainson
Nipigon District
Ontario Ministry of Natural Resources
Nipigon, ON P0T 2J0
(807)887-5029
rob.swainson@mnr.gov.on.ca

Terry Marshal
Northwest Science and Technology
Ontario Ministry of Natural Resources
Thunder Bay, ON P7C 4T9
(807) 939-3105
terry.marshall@mnr.gov.on.ca

John Sandberg
University of Minnesota Duluth
(218) 720-4260
jsandber@nrri.umn.edu

## Population and Community Ecology Group

Casey Huckins
Biological Sciences
Michigan Technological University
(906)487-2475
cjhuckin@mtu.edu

Ed Baker
Michigan Department of Natural Resources
(906) 249-1611 ext 309
bakerea@state.mi.us

Kurt Fausch
Fishery and Wildlife Biology
Colorado State University
(970) 491-6457
kurtf@cnr.colostate.edu

Jill Leonard
Department of Biology
Northern Michigan University
(906) 227-1619
jileonar@nmu.edu

Rick Salmon
Lake Nipigon Fisheries Assessment Unit
Ontario Ministry of Natural Resources
(807) 887-5062
rick.salmon@mnr.gov.on.ca

## Management Group


Donald R. Schreiner
MN DNR-Lake Superior Fisheries
5351 North Shore Drive
Duluth, MN 55804
(218) 525-0853
don.schreiner@dnr.state.mn.us

Ken Cullis
OMNR
Thunder Bay, ON, Canada P7C 5G6
(807) 475-1375
ken.cullis@mnr.gov.on.ca

Steve Scott
Michigan DNR-Newberry
Newberry, MI 49868
(906) 293-5131
scottsj@mi.gov

Dennis Pratt
WI DNR-Superior
Superior, WI 54880
(715) 392-7990
Dennis.Pratt@dnr.state.wi.us

Henry Quinlan
USFWS-Ashland FRO
Ashland, WI 54806
(715) 682-6186
henry_quinlan@FWS.gov

Karen Mumford
Carl Vinson Institute of Gov.
University of Georgia
Athens, GA 30602
(706) 542-6202
mumford@cviog.uga.edu

Laura Hewitt
Trout Unlimited
222 South Hamilton St., #3
Madison, WI 53703
(608) 250-3534
lhewitt@tu.org

Greg Fischer
UWS – Aquatic Facility
P. O. Box 165
Bayfield, WI 54814
(715) 373-1047
gfischer@uwsuper.edu

Michael Donofrio
Keweenaw Bay Natural Res, Dep
HCR01 Box 120
L'Anse, MI 49946
(906)-524-5757 ext. 13
mdonofri@up.net

Joe Ostazeski
MN DNR-Lake Superior Fisheries
5351 North Shore Drive
Duluth, MN 55804
(218)-525-0853
joseph.ostazeski@dnr.state.mn.us

# Appendix 3

## Symposium at Madison 2004 Annual AFS Meeting

### *"Coaster brook trout management, biology and rehabilitation"*

**Oral Presentations – Titles and Authors**

**A roadmap for coasters: landscapes, life histories and the conservation of brook trout**.
Ridgeway, M. - keynote address

**Conservation genetics of Lake Superior brook trout: issues, questions, and directions.**
Wilson, C., et al.

**Applying evolutionary theory to the conservation of lake migratory brook trout: lessons from the pre-exploitation era' in northern Quebec populations.** Fraser, D. and L. Bernatchez.

**Population genetics of sympatric migratory and resident life history rainbow trout (*Oncorhynchus mykiss*) in British Columbia.** Heath, D.D., et al.

**Metapopulation structure and the influence of stocking on resident and migratory brook trout in coastal tributaries of southern Lake Superior.** Scribner, K., C. Huckins and E. Baker.

**Metapopulation structure among source populations for coaster book trout in Nipigon Bay.**
D'Amelio, S. and C. Wilson.

**Are splake reproducing in Lake Superior?** Stott, W., L. Newman, and E. Ruthorford .

**Genetic characteristics of brook trout in Lake Superior South Shore streams.**
Sloss, B., M. Jennings, and D. Pratt.

**Stream habitat of Lake Superior coaster brook trout: a multi-scale review of features critical to protection and enhancement.** Mackereth, R. et al.

**Does flow change elicit a predictable response from brook trout? An examination of relative activity in response to flow in a regulated and an unregulated river.** Smokorowski, K.E., and K.J. Murchie

**Basin-wide habitat associations of young-of-year brook trout.** Carlson, A. and S. Moore.

**Seasonal patterns of tributary stream use by coaster brook trout in Nipigon Bay, Lake Superior.** MacIntosh, K. and R. Mackereth.

**The role of lake habitat in coaster brook trout rehabilitation.** J.A. Schuldt, M. Chase, R. Swainson, T. Marshal, J. Mucha, C. Kraft, O.Gorman, L. Newman.

**Habitat use, movement patterns and home ranges of Coaster Brook trout in Nipigon Bay, Lake Superior.** Mucha, J. and R. Mackereth,

**Habitat associations of coaster brook trout in Isle Royale, Lake Superior.** Gorman, O. S. Moore, H. Quinlan, and A. Carlson.

**Macrobenthic communities of nearshore habitats in eastern Nipigon Bay, Lake Superior.** Sandberg, J., J.A. Schuldt, L.B. Johnson.

**Brook trout landscapes, a fish community perspective of Lake Superior brook trout populations.** Moore, S.

**Ecology, life history and rehabilitation of Lake Superior coaster brook trout.** Huckins, C. et al.

**Using TIRFID to monitor migratory activity of brook trout (Salvelinus fontinalis) in three rivers within Pictured Rocks National Lakeshore, MI.** Stimmell, S. and J. Leonard.

**Ecology and status of a remnant south shore population of Lake Superior coaster brook trout.** Huckins, C. J, D. Kramer and E. Baker.

**Comparison of growth parameters between Tobin Harbor "coaster" strain and stream-resident brook trout.** Sreenivasan, A. and J. Leonard.

**Overview of management issues affecting rehabilitation of coaster brook trout.** Schreiner, D., et al.

**History of coaster brook trout fisheries in Lake Superior.** Pratt, D. and R. Swainson.

**Status and population structure of coaster brook trout at Isle Royale National Park, Michigan.** Quinlan, H.

**Human dimensions considerations for coaster brook trout rehabilitation.** Mumford, K., G. Fisher, and L. Hewitt.

**Keeping the ball rolling: outreach to engage and educate user groups about Lake Superior coaster brook trout rehabilitation.** Gunderson, J., J. Schuldt, L. Hewitt, S. Damelio, J. Imhoff, T. Breiby.

## Posters - Titles and Authors:

**Identification of key habitat features associated with coaster brook trout production.** D'Amelio, S. and J. Imhof.

**Tracking the origins of coaster brook trout: combining telemetry and genetic profiles to determine source populations.** D'Amelio, S., J. Mucha, R. Mackereth, and C. Wilson.

**Migratory brook charr and metapopulations: an evolutionary perspective for conservation.** Fraser, D. and L. Bernatchez.

**Monitoring salmonid abundance in Lake Superior South Shore streams: implications for brook trout rehabilitation.** Jennings, M., et al.

**Habitat use by Brook in tributary streams of Nipigon Bay, Lake Superior, still used by coaster brook trout.** MacIntosh, K. and R. Mackereth,

**Use of thermal infrared imaging to identify ground water resources for coaster brook trout along the Minnesota shoreline of Lake Superior.** Ostazeski, J. and D. Schreiner.

**Objectives, strategies, and progress of ongoing coaster brook trout stocking projects in the Lake Superior basin.** Quinlan, H. and G. Fisher.

**Mitochondrial and microsatellite DNA variation among brook trout populations from Lake Superior.** Stott, W., D. Schreiner, H. Quinlan, and M.K. Burnham-Curtis.

**Genetics of Lake Nipigon brook trout.** Wilson, C. and S. D'Amelio.

**Standardization of genetic markers and databases for coaster brook trout in Lake Superior.** Wilson, C. et al.

# Appendix 4

## Abstracts from synthesis papers with key messages and research/management recommendations

**Conservation Genetics of Lake Superior Brook Trout: Issues, Questions, and Directions.**

Wilson, C., W. Stott, M. Jennings, L. Miller, S. D'Amelio, and A. Cooper

Parallel efforts by several genetic research groups tackled common themes relating to management concerns and recent rehabilitation opportunities for coaster brook trout in Lake Superior. Some of the questions that have been addressed include resolving the evolutionary and genetic status of coaster brook trout, relatedness among coasters and their relationship to riverine tributary brook trout populations, and the role and effectiveness of stocking in maintaining and restoring coasters to Lake Superior. Congruent genetic results indicate that coasters are an ecotype (life history variant) rather than an ESU or genetically distinct strain. Regional structure exists among brook trout stocks, with coasters being produced from local populations. Introgression of hatchery genes into wild populations appears to vary among regions, and may relate to local population sizes, habitat integrity and anthropogenic pressures. Tracking the genetic diversity and integrity of captive breeding programs is helping to ensure that fish for stocking are representative of their source populations and appropriate for rehabilitation efforts. Comparative analysis of shared samples among the collaborating labs is enabling standardization of genotype scoring and interpretation, as well as developing a shared toolkit for assessing genetic structure and diversity. This effort has been complemented by the development of a lake-wide genetic database for data sharing among labs, greatly enhancing the resolving power of localized studies. Together, these multifaceted efforts provide comprehensive insights into the biology of coaster brook trout, as well as enhancing restoration options. Incorporation of genetic data into rehabilitation projects will facilitate monitoring efforts and subsequent adaptive management.

Key Messages:

- Genetic results indicate that coasters are an ecotype (life history variant) rather than an ESU or genetically distinct strain, although some structuring may exist within rivers;
- Regional structure exists among brook trout stocks, with coasters being produced from local populations;
- Evidence from lake-wide metadata suggests at least five regional stocks within Lake Superior;
- Genetic (long-term) contribution of hatchery fish appears to vary among regions, and may relate to local population sizes, habitat integrity and anthropogenic pressures (currently unknown)

Research and Management Recommendations:

- Fill in sampling gaps for assessing lake-wide genetic structure of brook trout (assess regional structure and identify remaining genetic resources);
- Use genetic monitoring as an integral component of population restoration and monitoring efforts;
- Encourage data standardization among participating genetic laboratories;
- Use regional metapopulations twinned with habitat rehabilitation as primary tools for coaster recovery;
- Test effectiveness of stocking versus transplantation to re-establish populations;
- Assess local adaptation/fitness differences of hatchery versus wild fish

**Stream Habitat of Lake Superior Coaster Brook Trout: A Multi-Scale Review of Features Critical to Protection and Enhancement.**

Mackereth, R., S. Moore, J. Imhof, A. Carlson and C. Richards

Over the past century, due to habitat loss and exploitation, brook trout that live in Lake Superior and utilize tributary streams for spawning and nursery habitat ('Coasters') have gone from being common throughout the lake to having their distribution reduced to a few areas. Research and management efforts to protect and enhance remaining stream habitat require the identification of the key habitat features for brook trout and an improved understanding of the spatial scale at which these features should be assessed. We reviewed existing information on coaster stream habitat focusing on nested spatial scales of reach, segment, catchment and basin. Available stream survey information focuses on the reach to segment scale; however, brook trout require groundwater which is associated features of the catchment and basin. The Lake Superior basin is dominated by bedrock and clay and generally lacks the type of material associated with groundwater. Catchments within the basin that support coasters often contain permeable superficial deposits (e.g. eskers, moraines, lacustrine deposits) and may provide higher groundwater inputs than other streams. An improvement in spatial analysis capabilities and basin-wide cooperation among research and management agencies has begun to improve our ability to analyses brook trout habitat features at broad spatial scales.

Key Messages:

- Unique geology of Lake Superior basin may be linked to coaster life history, mainly through patterns of groundwater discharge
- Current research and management of coaster stream habitat may be focused at too small a spatial scale (incorporate work at catchment and basin scales)
- Coaster stream habitat is extremely variable both among streams (e.g. in stream size and channel form) and within streams (e.g. high seasonal variability in discharge and temperature)
- In many streams, brook trout are less abundant than other salmonids (i.e. rainbow, coho) suggesting the potential for competition

Research and Management Recommendations:

- Consider stream habitat requirements at the appropriate spatial scale (e.g. basin, catchment, segment reach)
- Improve the integration of spatial data for entire basin
- Update and consolidate basin-wide information on distribution and abundance of coasters
- Research on: a) the influence of hydrology on coaster distribution and abundance and b) the impact of land-use practices on hydrology
- Research on the role of competition stream systems (mainly with other salmonids) on coaster distribution and abundance

**The Role of Lake Habitat in Coaster Brook Trout Rehabilitation**

J. Schuldt, L. Newman, R. Swainson, O. Gorman, M. Chase, J. Mucha, C. Kraft, T. Marshall.

Coaster brook trout are characterized as spending part of their life history in Lake Superior. The degree of lake utilization by coasters varies from adult use in potamodromous populations to use by all life stages in lake spawning populations. Understanding the lake habitat requirements of coasters, identification of conditions that may hinder rehabilitation, and identification of research needs is important to rehabilitation efforts. We reviewed existing information from Lakes Superior and Nipigon, as well as studies of anadromous and lake dwelling forms throughout the native range of brook trout. Lake spawning by brook trout has been documented at Isle Royale and is prevalent in Lake Nipigon. Adult brook trout utilize shallow (less than 10 m), near shore areas (within 400 m of shore) in Lake Superior and are often associated with habitat elements that provide cover. Food availability and predation risk has likely changed because of changes to near shore fish communities since brook trout were abundant in Lake Superior. Near shore areas are also particularly susceptible to anthropogenic impacts; the degree of habitat alteration in the near shore zone is largely unknown for Lake Superior.

Key Messages:

- Limited information is available on lake use by coaster brook trout
- Coaster brook trout are normally found near shore in less than 10m of water
- Lake spawning by coaster brook trout has been documented in Lake Nipigon and in the Isle Royale area of Lake Superior
- Remnant coaster brook trout stocks appear to utilize relatively shallow estuaries and embayments (Nipigon Bay, Tobin Harbor, etc)
- Diet information and food availability for coaster brook trout in the lake is not will know

Research and Management Recommendations:

- Further investigation into the prevalence of lake spawning in Lake Superior
- Coordinate efforts of independent groups assessing near shore habitat to describe existing conditions and monitor future changes with respect to brook trout
- Obtain more information for all life stages utilizing Lake Superior habitats
- Investigate the potential of biotic interactions between brook trout and other salmonids in the near shore area utilized by brook trout

- Investigate the importance of ground water as a thermal refuge in Lake Superior
- Focus rehabilitation efforts in areas where stream and lake habitat conditions are appropriate (expansive shallow near shore areas, mixed substrata, few other salmonid species)
- Protect near shore habitats as well as important upland linkages including shoreline vegetation, watershed conditions, and ground water recharge areas.

**Ecology, Life History and Rehabilitation of Lake Superior Coaster Brook Trout.**

Huckins, C. J., E. Baker, K. Fausch, J. Leonard and R. Salmon.

Although once a prominent member of the native fish assemblage of Lake Superior, lake-dwelling brook trout *Salvelinus fontinalis*, referred to as coasters for their use of coastal habitat, were dramatically reduced in abundance by the early 1900s. Scattered populations persist in Ontario, around Isle Royale and within and near one south shore tributary of Lake Superior. Their early decline prior to scientific study resulted in their ecology and life-history being poorly understood. In this project we synthesize available information on the ecology and life history of these remnant populations within the context of their potential rehabilitation. Coasters display either shoal spawning or adfluvial life histories with peaks of reproductive migrations of fish in at least their third year of life occurring mid-fall. Limitations on existing populations likely involve biotic interactions and angling mortality although habitat loss may also be important. Populations around the Lake Superior basin are showing either weak signs of recovery or they appear to be critically low in abundance. No published studies have investigated biotic interactions between coasters and nonnative fishes in Great Lakes watersheds but literature on stream resident brook trout suggest the likelihood for size-structured interactions to limit coaster populations. Adult mortality from recreational angling was likely one of the key factors that contributed to the coaster brook trout decline in Lake Superior and angling mortality may continue to impede coaster population recovery and expansion.

Key Messages**:**

- The relative roles that genetics and environment play in determining variation in Lake Superior brook trout life histories is unclear.
- Substantial variation in individual length at age and size-frequency distributions exist among brook trout populations in the Lake Superior basin.
    - Not all coaster populations (defined by their use of the lake habitat) display the trait of large body size.
    - Data suggests that coaster brook trout in the Nipigon region grow faster and get longer than coasters from Isle Royale or the Salmon Trout River.
    - Variation in length frequencies among the coaster populations appears to vary with the minimum legal length limits in the regional fishing regulations.
- All the known populations of coaster brook trout appear to be at critically low abundances with all of the studied populations currently in the low 100s of individuals.
- No known studies have addressed biotic interactions with coaster brook trout. We predict that coho salmon, rainbow trout and splake are the most likely species to strongly interact with coaster brook trout.

Research and Management Recommendations**:**

- Based on their complex and variable life histories, we need think broadly and conservatively about coasters and their needs for successful rehabilitation.
- Research at the appropriate scales is needed, for example:
    - large scale studies on the effects of biotic interactions with introduced salmonids
    - research on relative coaster recruitment bottlenecks (e.g., juvenile rearing habitat, competition at juvenile and adult stages, predation, exploitation by fishery).
- Fishery caused mortality appears to be high but basin-wide momentum toward adopting longer minimum length limits will reduce exploitation and enhance the potential for initial coaster recovery.

**Overview of Management Issues Affecting Rehabilitation of Coaster Brook Trout in Lake Superior**

D. Schreiner, K. Cullis, M. Donofrio, G. Fisher, L. Hewitt, K. Mumford, D. Pratt, H. Quinlan, and S. Scott.

Coasters are a migratory form of brook trout that spend part of their life in streams and part of their life in lakes. Over the last century coaster brook trout abundance in Lake Superior has declined dramatically and only remnant stocks remain. Recently, rehabilitation of coaster brook trout in Lake Superior has become a goal of fish management agencies. The Fish Community Objectives for Lake Superior states the coaster brook trout objective is to "maintain widely distributed, self-sustaining populations in as many of the historical habitats as practical". This paper describes the progress that has taken place since development of a coaster rehabilitation plan in 1998. We discuss realistic expectations for rehabilitation and emphasize the need for management agencies, academia and angling organizations to work cooperatively for rehabilitation to be successful. Key management themes include: a brief history of coaster brook trout in Lake Superior; habitat requirements and protection; species interactions; the role of stocking; assessment strategies, regulations required for rehabilitation; and the role of human dimensions in rehabilitation. Paramount for successful rehabilitation is a paradigm shift from harvest to existence, where fishing opportunity and harvest may be restricted or eliminated in the Lake Superior basin.

Key Messages:

- Management of coasters may be controversial in some areas of Lake Superior as required changes to accommodate coater rehabilitation may affect anglers targeting other species, and may divert agency resources toward coasters and away from other programs.
- Coasters may never support a "harvest" type of fishery, but have the potential to create a "Trophy or Memorable Experience" type of fishery.
- Restrictive regulations will have to be implemented for rehabilitation to occur.
- Stocking is a management tool that might be considered for coaster rehabilitation, but habitat, presence of remnant stocks and gamete source should all be critically reviewed before a stocking program begins.

- Restoration of coaster brook trout will take time (10-100 years) and will proceed at different rates based on the presence of remnant stocks, quality of habitat, angling pressure and political will.

Research and Management Recommendations:

- Determine impacts of other species on coaster rehabilitation
- Take an adaptive management approach to rehabilitation
- Increase biological surveys of coaster populations
- Monitor success or failure of stocking experiments
- Establish restrictive regulations for coasters in all jurisdictions
- Identify and protect ground water sources used by spawning coaster brook trout
- Restore impacted watersheds where coaster rehabilitation is desired