Ministry of Natural Resources

Ontario

Natural. Valued. Protected.

Update on brook trout rehabilitation in the Ontario waters of Lake Superior, Lake Nipigon, and the Nipigon River: *Public Workshop Proceedings*

Upper Great Lakes Management Unit – Lake Superior

Technical Report 11-02 (November 2011)

AUTHORS

Russell Bobrowski[1], Marilee Chase[1]*, Rob Swainson[2], Albertine van Ogtrop[3], Steve Bobrowicz[1], Ken Cullis [1], Mark Sobchuk[4]

1. Upper Great Lakes Management Unit – Lake Superior, Ontario Ministry of Natural Resources (OMNR), Thunder Bay, ON

2. Nipigon District, OMNR, Nipigon, ON

3. Lake Nipigon Fisheries Assessment Unit, OMNR, Nipigon, ON

4. Northwest Region, OMNR, Thunder Bay, ON

* Author to whom correspondence should be addressed:

Ontario Ministry of Natural Resources, Upper Great Lakes Management Unit, Lake Superior. 435 James Street South, Suite 221e, Thunder Bay, Ontario, Canada, P7E 6S8

Marilee.Chase@Ontario.ca

Phone: (807) 475-1371

Cover photo credit: Gord Ellis

CITATION:

Bobrowski, R.J., M. Chase, R. Swainson, A. van Ogtrop, S. Bobrowicz, K. Cullis and M. Sobchuk. 2011. Update on brook trout rehabilitation in the Ontario waters of Lake Superior, Lake Nipigon, and the Nipigon River, *Public Workshop Proceedings*. Upper Great Lakes Management Unit Technical Report 11-02. Ontario Ministry of Natural Resources, Thunder Bay, ON. 31 pp. plus appendices.

Table of Contents

List of Figures

List of Tables

Executive Summary

Brook trout populations have declined from historic highs in the Ontario waters of Lake Superior, Lake Nipigon, and the Nipigon River. In an effort to enhance populations, a protective sport fishing regulation was applied in 2005, allowing the possession of 1 brook trout greater than 56 cm (22 in) in length. Associated with the new regulation was a public recommendation to review the status of brook trout after a five year period. As a result, in March 2011 the Ontario Ministry of Natural Resources (OMNR) hosted a workshop to present information collected from 2005 to 2010, review the progress of brook trout rehabilitation, and to discuss future actions.

Brook trout populations and fisheries in Lake Nipigon showed substantial change after the sport fishing regulation was amended. Brook trout numbers and average size increased in two Lake Nipigon spawning populations, although numbers remain at a fraction of 1930's levels. Catch rates of the average angler have improved but remain below management objectives. Declines were observed in the total number of brook trout caught by anglers and also in the proportion of anglers targeting brook trout. However, both measures returned to pre-2005 levels. Catch rates by co-operative anglers exceeded management goals for Lake Nipigon. The proportion of spawning brook trout protected from angler harvest increased by 43% and 59% in two Lake Nipigon populations.

Co-operative anglers in Lake Nipigon and the Nipigon River captured 15% to 33% of tagged brook trout at least twice. High recapture rates reveal the effectiveness of catch and release but also high vulnerability to angling. Catch rates by co-operative anglers generally increased after 2004 in Lake Nipigon, the Nipigon River and Lake Superior. After the new sport fishing regulation was in place brook trout were caught in previously undocumented areas. The proportion of brook trout protected from angler harvest increased by 22% in the Nipigon River and 17% in Nipigon Bay.

Brook trout in Lake Superior are not a unique sub-species and both stream-resident and migratory brook trout occur in the Nipigon Bay watershed. Movement studies indicate brook trout frequent specific habitats but can move long distances. Similar large scale movements occur in Lake Nipigon.

U.S. efforts to restore Lake Superior brook trout include stocking, habitat improvement, public outreach, and protective angling regulations. Wisconsin and Michigan still allow significant harvest opportunities in streams. Wild brook trout remain rare in most of the American waters of Lake Superior.

Although protective sport fishing regulations have been in place for a short period (five years or approximately one brook trout generation), signs of rehabilitation are encouraging and the current regulation is recommended to remain in place.

Background

Brook trout (*Salvelinus fontinalis*) occur naturally only in eastern North America (MacCrimmon and Campbell 1969), and were once common throughout much of Lake Superior, Lake Nipigon, and the Nipigon River. This area was renowned for its large brook trout and supported a legendary sport fishery dating back to the 1850's (Thunder Bay Historical Society 1923; Newman and Dubois 1997; Kelso and Demers 1993; Ritchie and Black 1988). In 1915 the current angling world record brook trout, weighing 6.6 kg (14.5 lb) and measuring 88 cm (34.5 in), was caught on the Nipigon River; Wright (1892) documented brook trout weighing 7.7 kg (17 lbs) in the river.

Brook trout populations throughout this region have declined from historic highs due to a number of anthropogenic factors including construction of roads and railways, log driving, land clearing, introduction of exotic species, and overfishing (Ritchie and Black 1985; Kelso and Demers 1993; Schreiner et al. 2008). Currently, remnant stocks of brook trout in Lake Superior are only known to exist near Isle Royale, Nipigon Bay, and the Salmon Trout River (Figure 1), and have been largely replaced by non-native species of trout and salmon. Populations of brook trout still persist throughout the Nipigon River and Lake Nipigon but at a fraction of their former abundance (See Lake Nipigon Spawner Surveys, Kelso and Demers 1993).

Since their original decline a number of different approaches have been used in an effort to restore brook trout populations.

From the 1920's to the 1980's more than four million brook trout were stocked in many locations along the Ontario shoreline of Lake Superior, throughout the Nipigon River, and in southern Lake Nipigon. However, stocking programs were largely unsuccessful and have been discontinued. The most recent stocking occurred from 1994 to 1997, when fingerlings were released over lakeshore springs in Thunder Bay and the surrounding area.

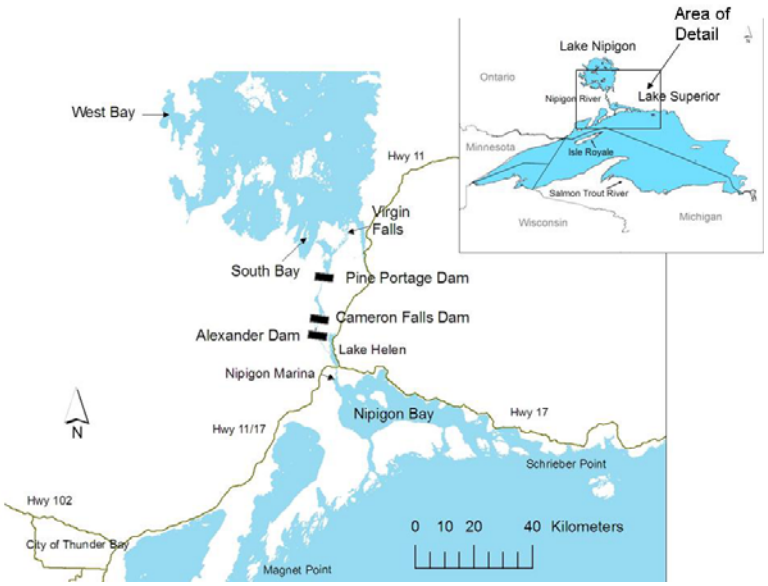


Figure 1: Location of areas within the Ontario waters of Lake Superior, Lake Nipigon and the Nipigon River discussed in this review.

Angling regulations became increasingly protective over time. Prior to 1885, harvest was unrestricted and anglers in the Nipigon area could reportedly harvest barrels of trout each day (Kelso and Demers 1993); in 1887 Ontario first regulated a province-wide fishing season for brook trout, (May 1 – September 15), though it was acknowledged that poaching was a problem on the Nipigon River (Roland 1887; Ontario

Game and Fish Commission 1892). Province-wide possession limits were in place by 1926 (Ontario Department of Game and Fisheries 1926). As recently as 1979, brook trout regulations allowed each angler to possess fifteen fish or ten pounds plus one fish from the Ontario waters of Lake Superior. However, concern was raised over the status of brook trout in Lake Nipigon and the Nipigon River, and possession limits were reduced to 2 brook trout longer than 46 cm (18.1in) in 1990. Limits were further reduced on the Nipigon River in 1997 to one brook trout longer than 50 cm (20 in) and this regulation was extended to Nipigon Bay in 2000. Around the same time (in 1999 & 2000), opening day for brook trout fishing on Nipigon Bay, Lake Nipigon, and the Nipigon River was changed from January 1 to the last Saturday in April, which effectively eliminated the ice fishing season (See Appendix 1).

Habitat protection and creation were important in efforts to rehabilitate the Nipigon River during the 1990's. Artificial spawning sites were created and plans were developed to regulate fluctuating water levels caused by hydroelectric generation. In 2006, hydroelectric development was avoided on the Steel River, a tributary located approximately 20km east of Terrace Bay with a strong history of brook trout production (Alexander 1911).

Despite efforts at rehabilitation, the status of brook trout stocks and their associated fisheries continued to cause concern among anglers and fisheries managers in the early 2000's, prompting numerous actions. A lake-wide rehabilitation plan for Lake Superior brook trout was developed in 2003 (Newman et al. 2003), and a similar lake-wide policy was developed for Lake Nipigon (OMNR 2004). Included in these efforts were goals for rehabilitation (Table 1). From 2002 to 2005 the OMNR worked with a public advisory committee to explore options for rehabilitating brook trout stocks throughout the Ontario waters of Lake Nipigon, the Nipigon River, and Lake Superior including the lower reaches of tributary streams. After reviewing available information, the committee recommended reducing the daily possession limit to 1 brook trout with a minimum length of 56 cm (22 in). Following public consultation, this regulation came into effect January 2005, replacing a variety of regulations across a large geographical area (Appendix 1).

Table 1: Goals for brook trout management in Lake Superior and Lake Nipigon.

Lake Superior (Newman et al. 2003)	Lake Nipigon (OMNR 2004)
Populations will be geographically widespread, inhabiting areas which historically held viable populations	Restore to 1930's levels of abundance and structure
Populations will be comprised of six or more age classes (ages 0-5), including at least two age classes of spawning females	Restore to allow angler catch rates of 1 brook trout every 2 hours of fishing
Populations will exhibit genetic profiles consistent with those of populations currently existing in the Lake Superior basin	Restore to provide angler catch rates of 1 brook trout longer than 56 cm (22in) for every eight hours of fishing

The committee proposed the status of brook trout should be reviewed after five years. In response, the OMNR hosted a workshop in Thunder Bay in March 2011 to present information collected from 2005 to 2010, to review the progress of brook trout rehabilitation, and to discuss future actions.

Forty-eight participants attended the 2011 workshop, including members of the original public advisory committee, First Nations, Métis, recreational anglers, commercial fishermen, members of the Fisheries Management Zone 9 Advisory Council, OMNR staff, and select fisheries managers from the United States (Appendix 2).

This report is a companion to the 2011 workshop and provides current information on the status of brook trout populations and sport fisheries in the Ontario waters of Lake Superior, Lake Nipigon, and the Nipigon River. Updates from each of the American states bordering Lake Superior are also provided. Key pieces of information are described in the main body of the document and full details of previously unpublished studies are provided in appendices. The workshop presentations and agenda are included on a CD attached to the document cover (Appendix 3). Recommendations are provided to guide future efforts to rehabilitate brook trout populations and sport fisheries in Lake Superior, Lake Nipigon, the Nipigon River, and their tributary streams.

Angler with a large brook trout from the Nipigon area. Photo: Gord Ellis.

Lake Nipigon Spawning Shoal Surveys

Tagging studies and egg collection programs provide information on the number and size of brook trout that spawn on shoals in South Bay and West Bay of Lake Nipigon (See Appendix 4). Historical estimates of population size are based on spawn collection records from 1924 to 1984. An OMNR live-release tagging program provides more recent information on the size and number of brook trout spawning in South Bay and West Bay.

Historical and recent estimates of the number of spawning brook trout are illustrated in Figure 2. Changes in the size of brook trout after sport fishing regulations were modified in 2005 are illustrated in Figure 3.

Data interpretation

Number of Spawning Brook Trout

- Numbers of spawning brook trout reached low points during the 1980's in both South Bay and West Bay (Figure 2).
- After protective sport fishing regulations were implemented in 1990 (possession change from 4 brook trout of any size to 2 larger than 51cm (18 in)), numbers of spawning brook trout increased by 67% and 94 % in South Bay and West Bay respectively (Figure 2).
- After regulations became more protective in 2005 (possession changed to one brook trout greater than 56 cm (22 in)) population size increased by 66% and 42% in South Bay and West Bay respectively (Figure 2).
- In 2007 the number of brook trout estimated to be spawning in South Bay was at 25% of the management objective (1930's levels).
- In 2009 the number of brook trout estimated to be spawning in West Bay was at 4.5% of the management objective.

Size Structure of Spawning Population:

- The portion of the spawning population protected from angler harvest increased after 2005 in South Bay from 29% to 88%, and in West Bay from 28% to 71% (Figure 3).
- After 2005 the average size of brook trout spawning increased from 489 mm (19.3 in) to 502 (19.8 in) and from 497 (19.6 in) to 516 (20.3 in) in South Bay and West Bay, respectively (Figure 3).

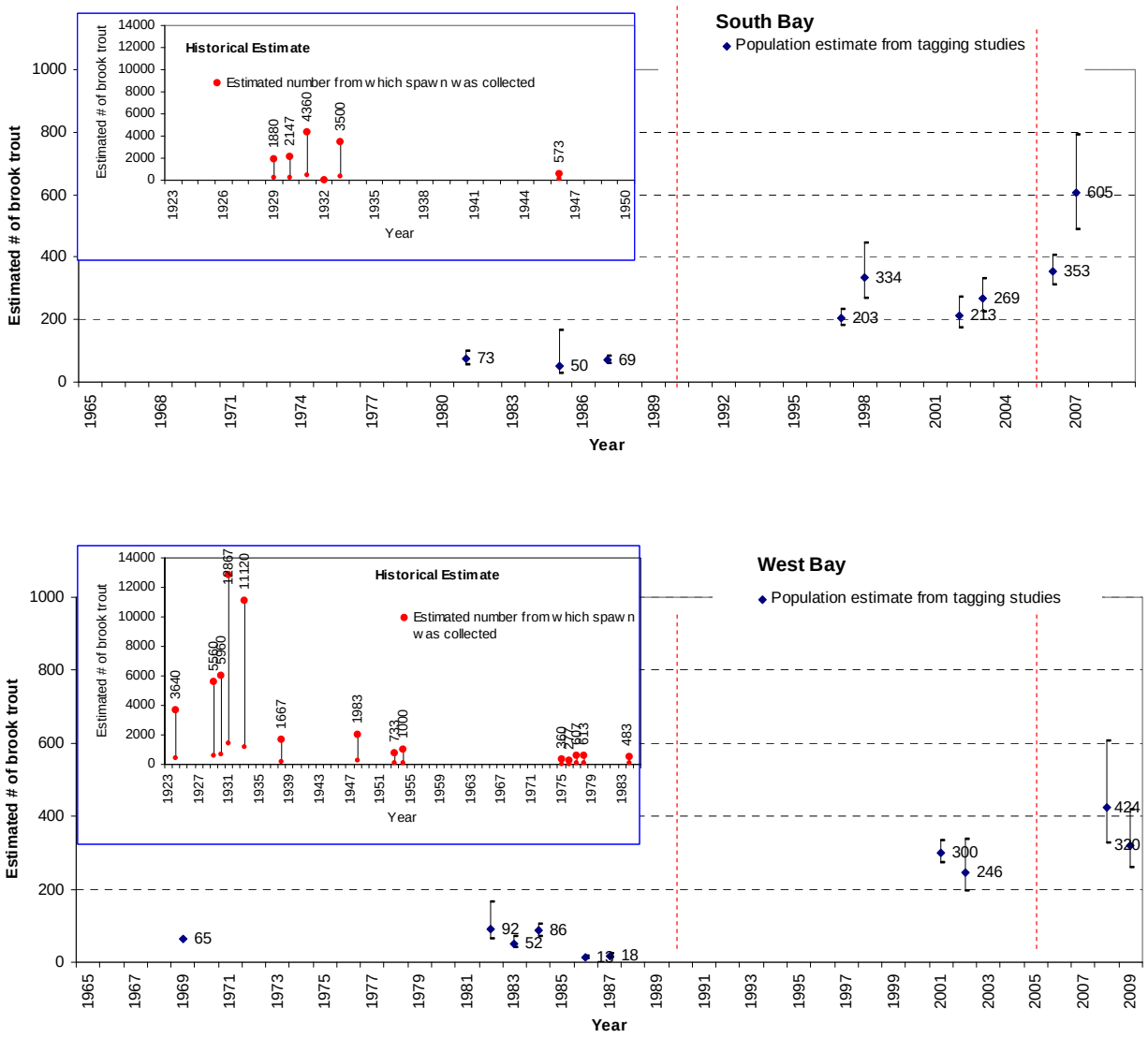


Figure 2: Annual estimated number of brook trout spawning on shoals in West Bay and South Bay of Lake Nipigon. Red dotted lines represent recent years when sport fishing regulations were changed. Population estimates from tagging studies are calculated using the Schumacher-Eschmeyer method and include 95% Confidence limits. Estimated numbers of brook trout from which spawn was collected are based on historical records from 1923 to 1984 and assume fecundity ranging from 300 - 2800 eggs per female and a 1:1 sex ratio (Appendix 4). It is thought that most spawning brook trout present were captured during spawn collection programs.

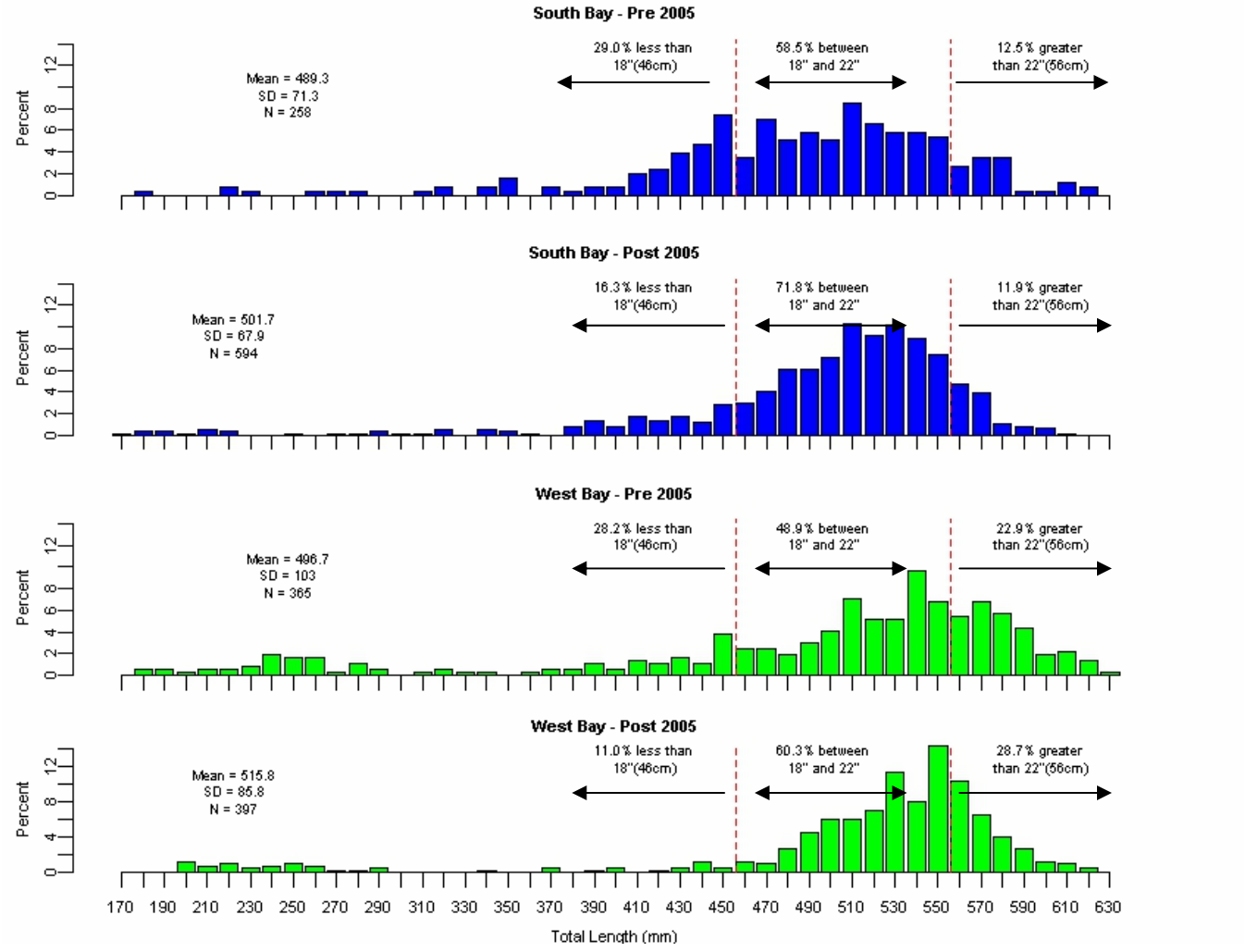


Figure 3: Size structure of brook trout captured during spawning shoal surveys in South Bay and West Bay of Lake Nipigon. Each column represents the portion of the total population belonging to that particular 10mm size bin. To illustrate changes in the size of brook trout after the regulation was modified in 2005, data collected in South Bay was combined during 2002 & 2003 (Pre-2005), and 2006 & 2007 (Post-2005). Data from West Bay was combined during 2001 & 2002 (Pre-2005), and 2008 & 2009 (Post 2005).

Lake Nipigon and Nipigon River Angler Surveys

The OMNR periodically conducts angler surveys on the Nipigon River and at the South Bay boat launch on Lake Nipigon (Appendix 5). These surveys provide estimates of the following fishery characteristics: angler effort for all species; angler effort directed at brook trout; brook trout catch rate; brook trout catch, and; brook trout harvest. Estimates of fishery characteristics are illustrated for the Nipigon River (Figure 4), and South Bay (Figure 5).

Data Interpretation

Nipigon River:

- After 2005, substantial differences were not found in total fishing effort for all species, fishing effort for brook trout, brook trout catch rate, and total brook trout catch (Figure 4). These results are not surprising considering the change in regulation was minor compared to that on Lake Nipigon (Appendix 1).
- The Jessie Lake area has become increasingly popular for brook trout angling over time. Highest values occurred in 2010 when 83% of anglers which target brook trout on the Nipigon River fished in the Jessie Lake area (Appendix 5).
- Brook trout harvest declined dramatically when sport fishing regulations were modified in 1997 (reduction of 4 brook trout of any size to 1 greater than 51cm (20 in). After 2005, harvest levels remained low, near 1997 – 2004 levels (Figure 4).

South Bay:

- Fishing effort for all species began to decline in 2004 and has remained below pre-2005 levels (Figure 5).
- The proportion of anglers targeting brook trout declined during 2005-2006, but has recently increased to pre-2005 levels (Figure 5).
- Brook trout catch declined in 2005, but has recently increased to pre-2005 levels (Figure 5).
- Brook trout catch rate increased after 2005 and values are approaching rehabilitation goals set for Lake Nipigon (one brook trout of any size caught per hour, see Table 1, Figure 5).
- Brook trout harvest declined dramatically beginning in 2005 (Figure 5).

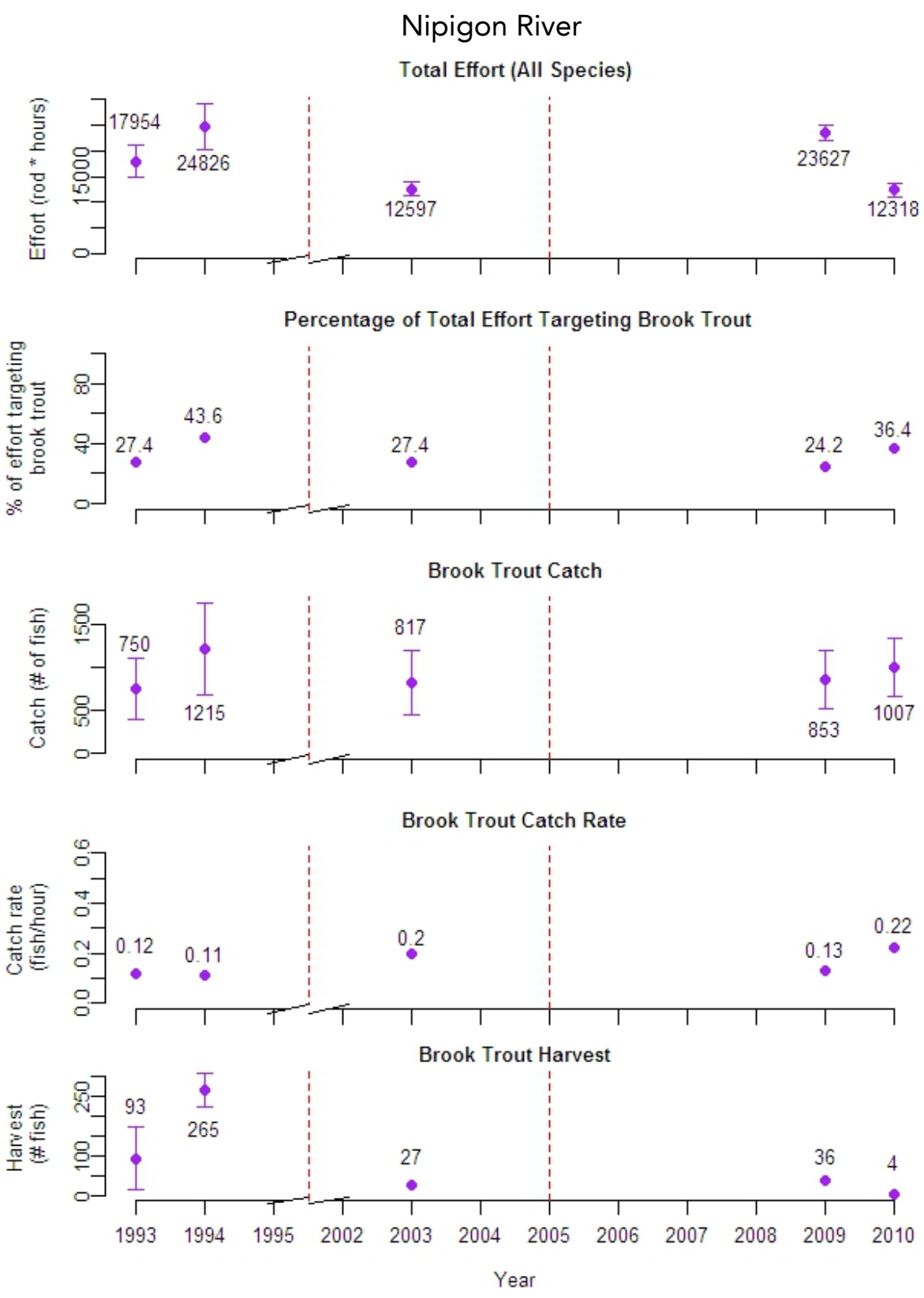


Figure 4: Results from OMNR angler surveys on the Nipigon River from 1993 to 2010. Error bars represent ±1 standard error. Estimates are for the time period of late May – early September (refer to Appendix 5 for exact dates). Red dotted lines indicate years when sport fishing regulations were modified (1997 and 2005).

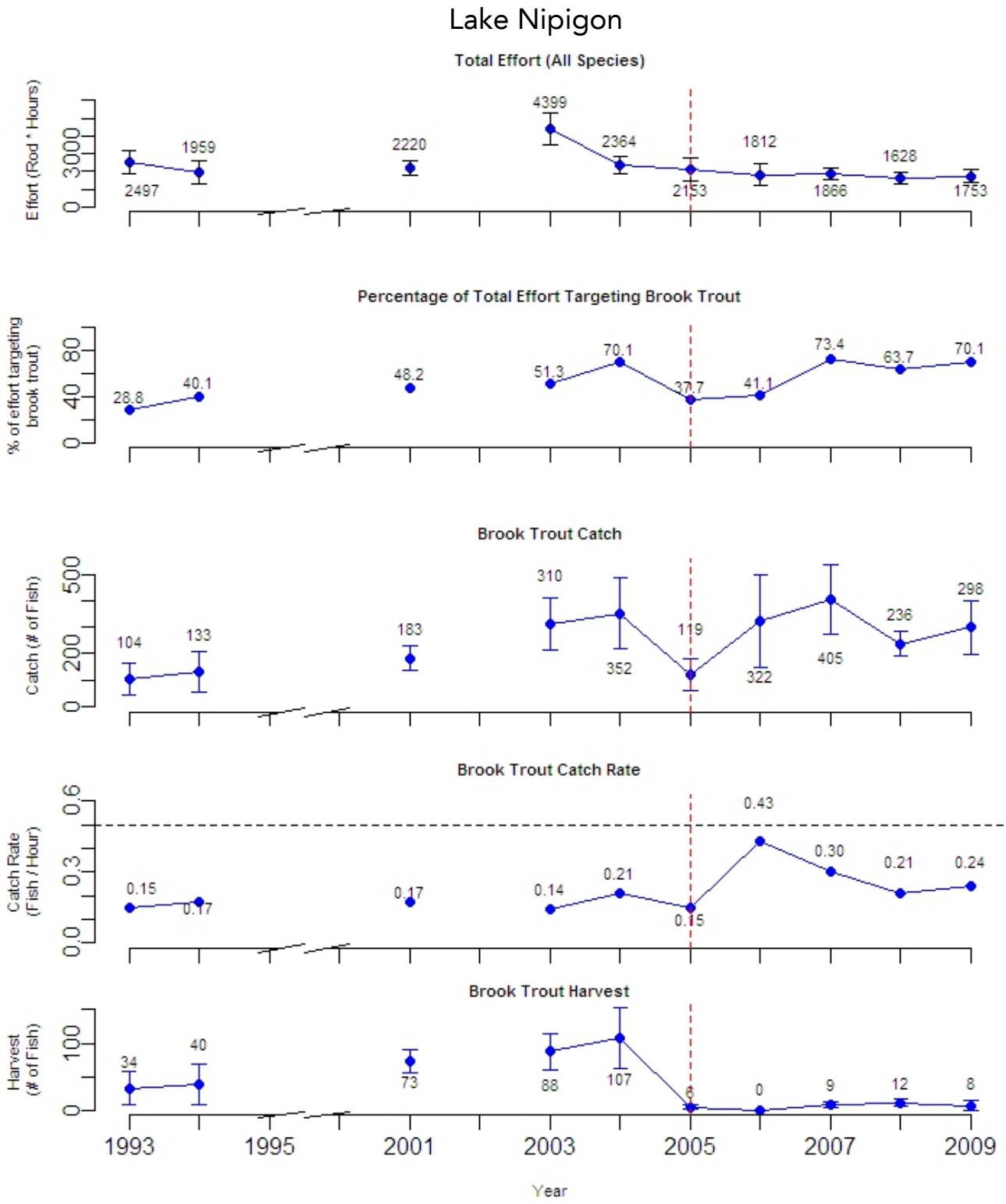


Figure 5: Results from OMNR angler surveys at the South Bay access point on Lake Nipigon from 1993 to 2009. Error bars represent ±1 standard error. Estimates are for the time period of approximately mid-May to June 30 (refer to Appendix 5 for exact dates). The red dotted line illustrates when sport fishing regulations were modified (2005). The black dotted line represents the objective for angling quality on Lake Nipigon (0.5 brook trout per rod hour, See Table 1).

Habitat use and movement patterns of brook trout in Nipigon Bay, Lake Superior

In co-operation with Lakehead University, OMNR studied the habitat use and movement of brook trout in Nipigon Bay, Lake Superior from 1998 to 2000 using radio telemetry. Brook trout that spend a part of their life in Lake Superior are known as "coasters" (Becker 1983). Prior to this study, habitat use and movement patterns of coasters were based on tag returns from co-operative anglers which showed long distance dispersal but also affinity for certain areas.

Over the course of the study, 40 coasters were implanted with radio transmitters and their movements were documented using mobile tracking systems. Information from 20 individuals has been described in Mucha (2004) and Mucha and Mackereth (2008).

Coaster brook trout implanted with a radio transmitter. (Photo credit: Rob Swainson)

Twenty brook trout captured within Nipigon Bay were surgically implanted with radio transmitters and located from June 1999 to October 2000. A total of 638 locations were obtained during the tracking period with 483 locations within Nipigon Bay and the remaining 155 within tributary streams. Brook trout were located almost exclusively within the shallow nearshore areas of Nipigon Bay with 92% of locations in areas less than 7 m deep, and 94% less than 400 m from shore. Brook trout inhabited deeper areas with steeper shoreline slopes during July and August when the water temperature of shallow nearshore areas became higher than their tolerable limit. Following selected individuals for 24 hours revealed brook trout utilized deeper areas during daylight hours and moved to extremely shallow nearshore areas during the night. Tagged brook trout began ascending streams during late summer in both 1999 and 2000. The mean residency time for brook trout in spawning tributary streams in 1999 was 46 days. Spawning occurred in early October with most tagged brook trout returning to Lake Superior by mid-October. Four different streams were used by tagged brook trout, with all brook trout entering streams exhibiting strong spawning site fidelity. Watershed size of spawning streams varied from 8.38 sq. km to 288.04 sq. km, but stream reach characteristics of spawning areas were similar, exhibiting a moderate gradient, riffle-pool complexes, coarse sands and gravels, and groundwater input. These results suggest that brook trout in Nipigon Bay utilize specific areas depending upon the time of year. Protection of these identified areas is critical to maintain or enhance these remnant natural stocks.

From Mucha and Mackereth (2008).

Movement of brook trout between Lake Superior and Nipigon Bay tributaries

Brook trout movement between Lake Superior and Nipigon Bay tributary streams was studied using Passive Integrated Transponders (PIT tags) from 2004 to 2009. The study was a co-operative effort between OMNR and the Department of Fisheries and Oceans Canada.

Brook trout were tagged in seven tributaries (Dublin, MacInnes, Little Cypress, Cypress, Gravel, Jackpine, Clearwater) and movement between the lake and tributaries was monitored by stationary antennas situated near the mouths of five streams (MacInnes, Cypress, Little Cypress, Jackpine, Clearwater) (Figure 6). Lake-stream movement was typically monitored 24 hours per day between May and October. 956 brook trout were tagged (mean fork length 173 mm (6.9 in), mean weight 86 g), and 165 brook trout (mean fork length 170 mm (6.7 in), mean weight 78g) were recorded at the various antennas. Preliminary findings from the project include:

Figure 6: A simplified diagram of PIT antennas used to study movement of brook trout between Lake Superior and Nipigon Bay tributaries

- Brook trout which moved between streams and Lake Superior varied in size from 109 mm (4.3 in) to 391 mm (15 in).
- There was no significant difference between the size of brook trout which moved between stream and lake environments, and those fish that did not move.
- Twenty-five brook trout were recorded in tributaries in which they were not tagged.
- The vast majority of recorded movement occurred at dawn, dusk or night (Figure 7).

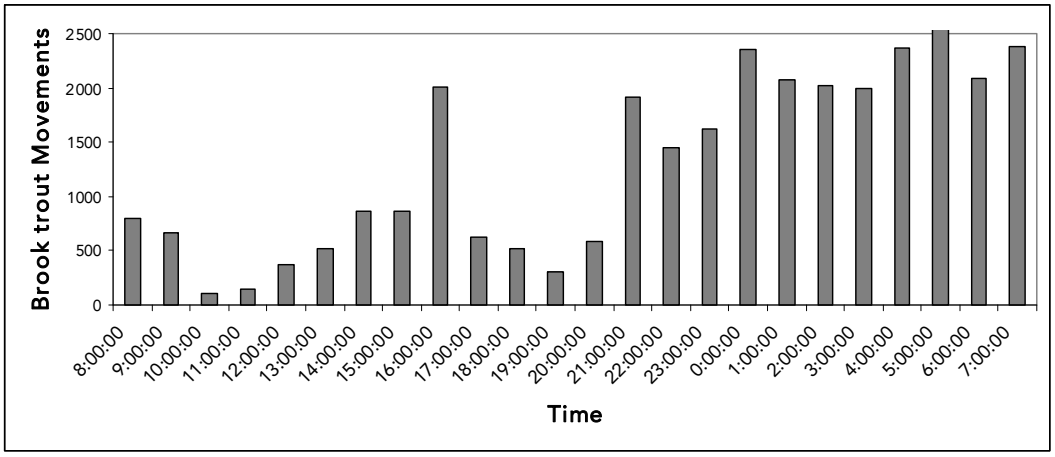


Figure 7: Time of brook trout movements recorded at PIT antennas situated near the mouth of tributary streams in Nipigon Bay, Lake Superior.

- Movement was greatest during the months of August and September (Figure 8).
- Brook trout were found moving between Lake Superior and each of the seven study streams with the exception of Dublin Creek and the Gravel River.

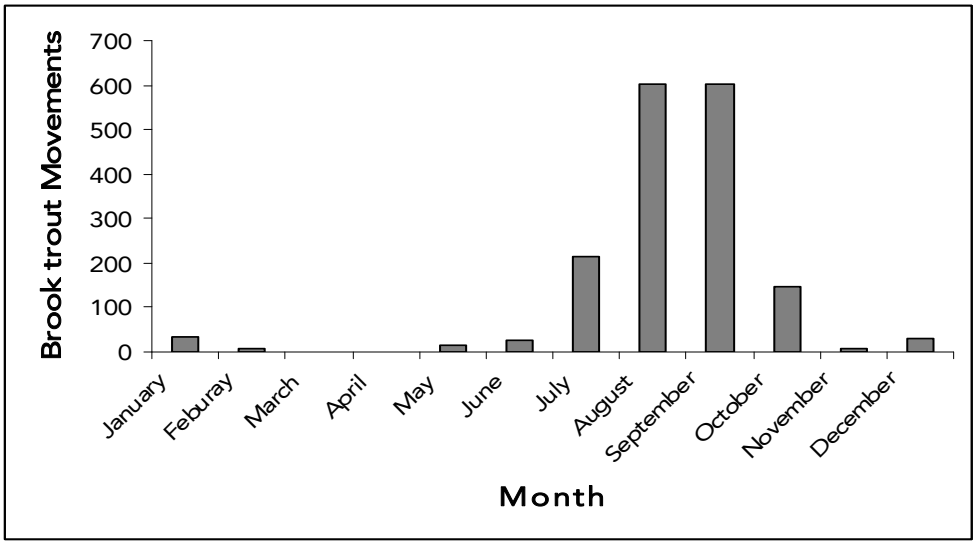


Figure 8: Date of brook trout movements recorded at PIT antennas situated near the mouth of tributary streams in Nipigon Bay, Lake Superior

This study provides clarification that small brook trout residing in streams may move into Lake Superior and become coasters. In addition this study illustrates the importance of including both stream and lake habitats in efforts to restore coaster brook trout populations.

Co-operative Brook Trout Angler Program

Since 1997, the OMNR has been working with a group of dedicated anglers to learn more about brook trout in Lake Superior, Lake Nipigon, and the Nipigon River. Anglers provide information by participating in a tagging program or by logging information of their fishing trips (Appendix 6). In most cases the same anglers have participated in the program each year. Changes in angler catch rates should indicate trends in general angling quality which can be used to gauge progress of rehabilitation efforts (See Table 1).

Information was collected from a large geographical area. For ease of discussion, the area has been divided into several study areas (Figure 1):

- *Lake Nipigon* refers to the lake proper, including waters upstream of Pine Portage dam.
- *Jessie Lake* refers to the waters of the Nipigon River between Cameron Falls and Pine Portage dams.
- *Cameron Falls* refers to waters between Alexander and Cameron Falls dams.
- *Lower Nipigon River* refers to waters of the Nipigon River downstream of Alexander dam.
- *Nipigon Bay* refers to waters of Lake Superior east to Schreiber Point and west to Magnet Point.

From 1997 to 2010 a total of 1,953 brook trout were tagged, and 200 tagged brook trout were subsequently re-captured by anglers participating in the tagging program. Anglers not participating in the program reported an additional 81 tagged brook trout.

Various sizes of brook trout were caught in Lake Superior, Lake Nipigon, and the Nipigon River (Appendix 6; Figure 9; Figure 11). The largest brook trout caught in Lake Superior, Lake Nipigon, and the Nipigon River were 675 mm (26.5 in), 647mm (25.5 in), and 657 mm (25.8 in), respectively. The proportion of brook trout protected from harvest increased after 2005 in Nipigon Bay from 80% to 97% and in the Nipigon River (Jessie Lake) from 72% to 95%. Large numbers of small fish (approximately 30 – 40 cm (12 – 16 in) were caught in Jessie Lake in 2006 (Figure 9). This group of fish was observed each year as they grew, reaching approximately 56 cm (22 in) in 2009. Few fish from this size class were caught in 2010; however, a new group of small fish entered the fishery in 2010. A similar pattern was observed in Nipigon Bay over the same time period (Appendix 6).

Catch rates by co-operative anglers generally increased from 2005 to 2010, with the exception of Lake Nipigon (Figure 10). The anglers fishing Lake Nipigon modified their behaviour, trying new locations in search of larger brook trout when catch rates increased after 2005. Highest catch rates were recorded in the Nipigon River (Figure 10). Brook trout were also caught in new areas by co-operative anglers in Nipigon Bay, Lake Nipigon, and the Nipigon River after the sport fishing regulation was

changed (Dave Nuttall, Randy Beamish, and Gord Ellis, co-operative anglers, personal communications).

Results from tagging support catch and release angling as a management tool. In certain years, between 15% to 33% of tagged brook trout were caught at least twice by co-operative anglers in Lake Superior, Lake Nipigon and the Nipigon River (Appendix 6). Reported recapture rates are minimum estimates, as only brook trout captured by co-operative anglers were considered, although many other anglers fish in these areas. Further illustrating the effectiveness of catch and release was that 10% of tagged brook trout in Jessie Lake were captured at least three times. In just over two years one brook trout was captured five times, and another was captured four times. High recapture rates reveal brook trout in these areas survive catch and release multiple times, and are highly vulnerable to angling. Because brook trout respond well to catch and release in these areas, a single brook trout can provide a memorable catch for many anglers.

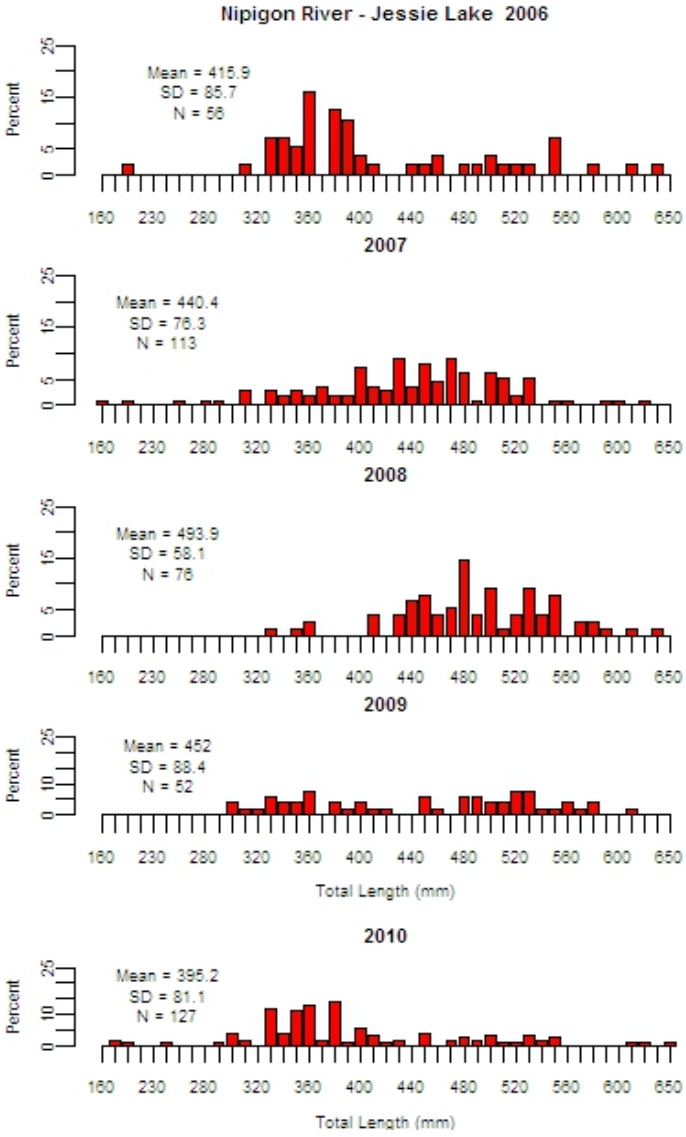


Figure 9: Size structure of brook trout captured by co-operative anglers in the Jessie Lake area of the Nipigon River from 2006 to 2010. Note the group of fish between 30 cm and 40 cm in 2006. This group of fish was present each year as they grew up until 2010.

Information on brook trout growth in the Nipigon River (Jessie Lake) was provided from the recapture of 32 tagged brook trout (Table 2). In general, brook trout grew approximately 7.5 cm (3 in) and 450g (1 lb) per year and growth reduced as fish became longer. Too few fish were recaptured in Lake Nipigon and Nipigon Bay to accurately calculate growth rates. An equation was developed to predict the weight of Nipigon River brook trout when length is known (See Appendix 6).

Table 2: Annual growth of brook trout in the Jessie Lake section of the Nipigon River.

Brook trout size	Annual Growth	
	Length	Weight
Less than 355.6mm (14.0 in)	129 mm (5.1 in)	957g (1.9 lbs)
Between 355.7mm (14.0 in) and 457.2mm (18.0 in)	83mm (3.3 in)	590g (1.3lbs)
Between 457.3mm (18.0 in) and 485.0mm (19.0 in)	54mm (2.1 in)	685g (1.5 lbs)
Greater than 485.1 mm (19.0 in)	21mm (0.8 in)	241g (0.5 lbs)

Tagging also provided information on brook trout movement in Lake Superior, Lake Nipigon, and the Nipigon River. Early information from tag returns in Lake Nipigon is presented in Ritchie and Black (1988). In Lake Superior the average distance between capture and recapture was 17.2 km (SD=12.85) per year. Maximum distance between capture and recapture was displayed by a brook trout tagged outside of Nipigon Bay (Blind Channel) and recaptured downstream of Alexander Dam on the Nipigon River. Tagged brook trout were also recaptured within Nipigon Bay tributaries.

Two brook trout tagged in Lake Nipigon were recaptured downstream of Pine Portage dam. Although other explanations are possible, these fish may have passed over the dam or over the falls when water was spilled. All other brook trout tagged in the landlocked sections of the Nipigon River were captured in the same area they were tagged in.

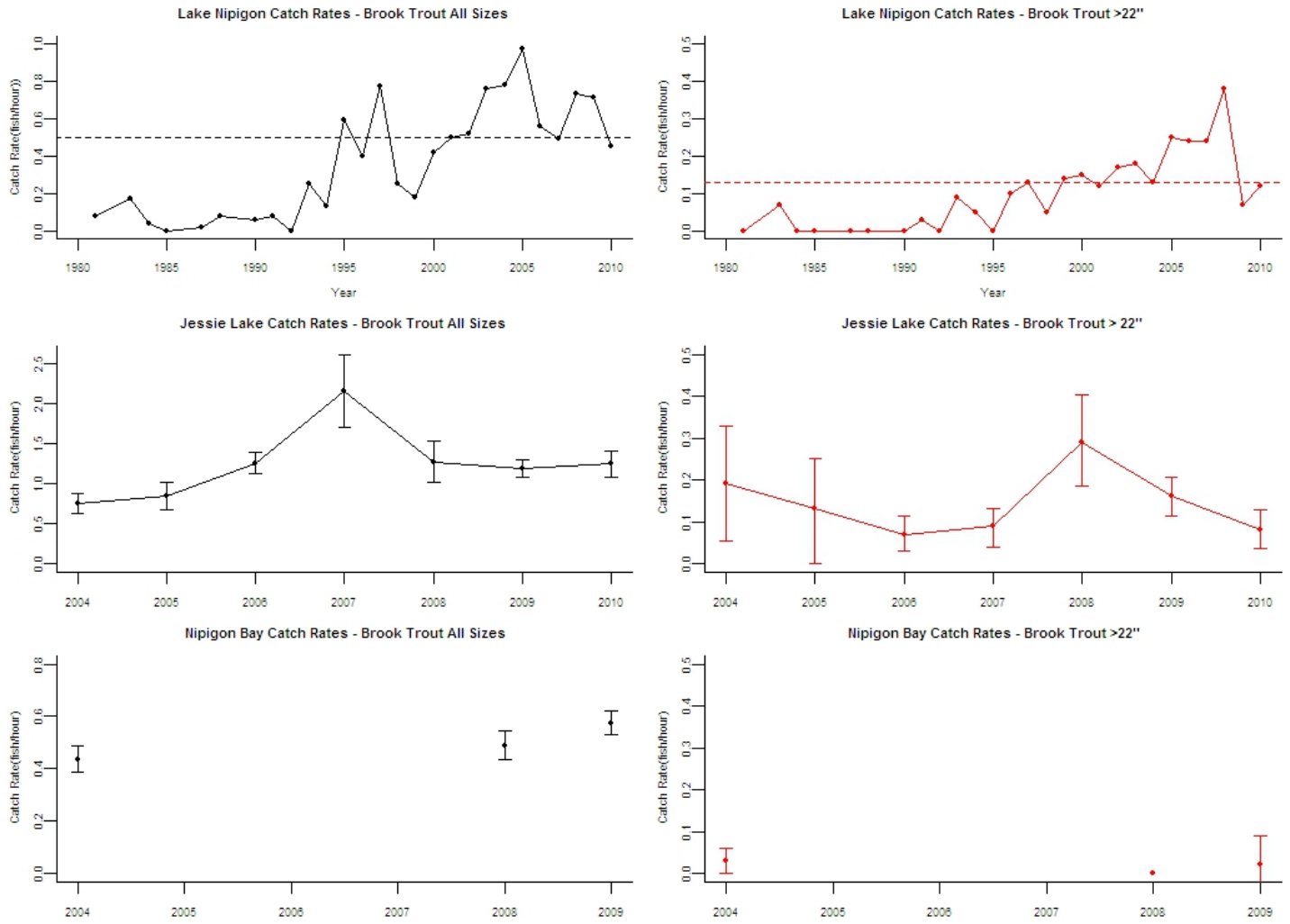


Figure 10: Co-operative angler catch rates on Lake Nipigon (top), the Jessie Lake area of the Nipigon River (middle), and Nipigon Bay (bottom). Catch rates for brook trout of all sizes are illustrated on the left, and catch rates for brook trout larger than 56 cm (22 in) are illustrated on the right. The dotted line represents the management objective for angling quality in Lake Nipigon (Table 1). Error bars represent ± 1 standard error.

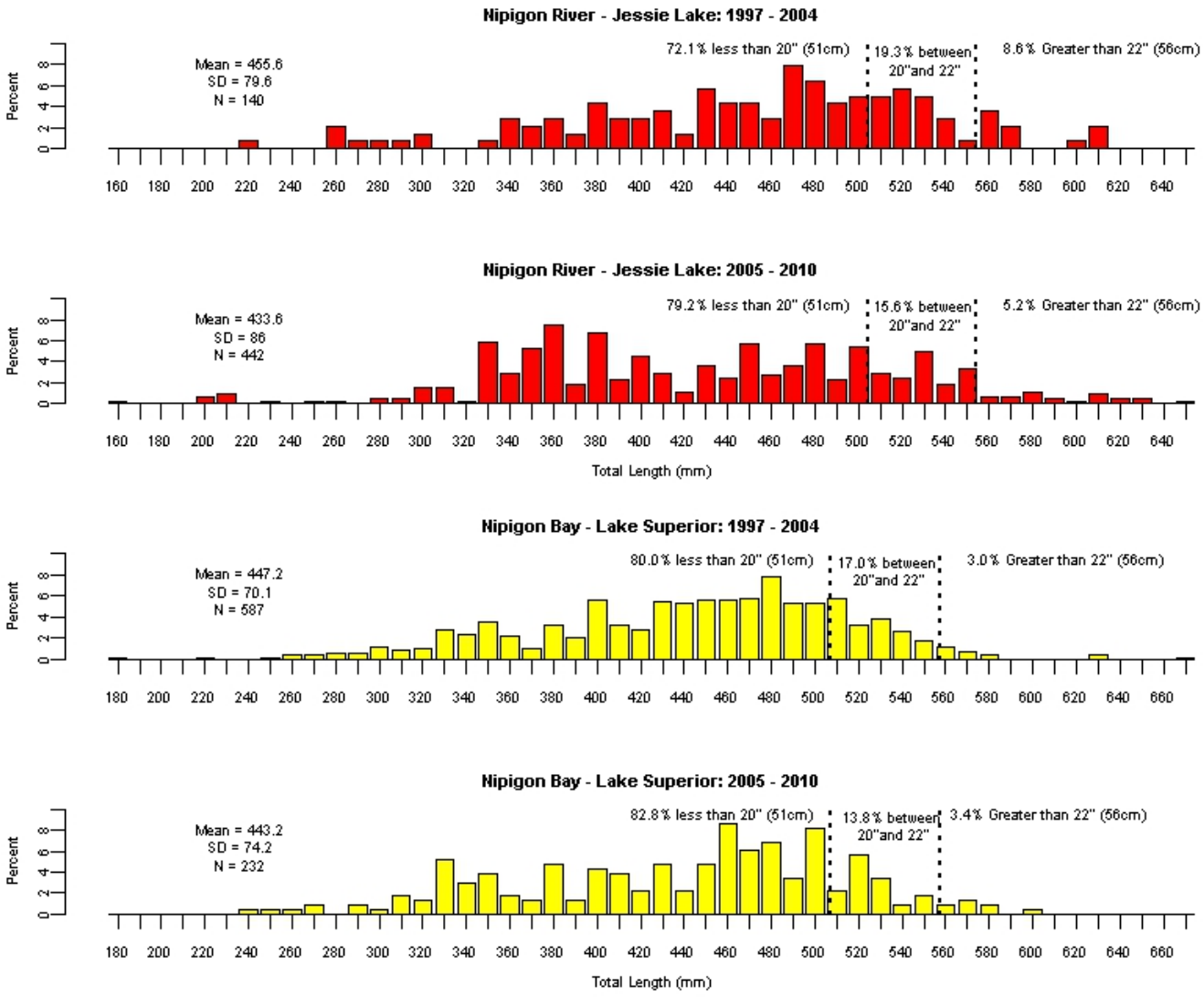


Figure 11: Size structure of brook trout caught by Co-operative anglers in the Jessie Lake Area of the Nipigon River (red), and the Nipigon Bay area of the Lake Superior (yellow) before and after the regulation change in 2005.

Genetics of Lake Superior Brook Trout

The genetic status of coaster brook trout has puzzled fisheries managers for decades. Coasters have been variously treated as a unique species, a sub-species, or no different than other brook trout. Studies conducted from 1999 to 2001 in Nipigon Bay concluded that coasters are not genetically distinguishable from other populations of brook trout and therefore are not a candidate for protection as a species-at-risk (D'Amelio 2002; D'Amelio and Wilson 2008).

More recent studies found remnant coaster populations form several genetic stocks. Discrete populations occur at Isle Royale, Salmon Trout River, Nipigon Bay, Thunder Bay, Black Bay, and north-eastern Lake Superior (east of Nipigon Bay to Sault Ste. Marie) (Stott et al. 2010; Wilson et al. 2010; Addison and Wilson 2011). Populations along the north shore of Minnesota are distinct from each other as well as from other coaster populations (Stott et al. 2010). These results suggest long-distance migration and spawning in non-natal streams is uncommon; however, some straying does occur between streams which are in close vicinity to each other. Low levels of straying may allow natural re-colonization if a stream population is lost; large scale dispersal is unlikely. In addition, this shows geographic populations throughout Lake Superior are genetically discrete, and should be managed accordingly.

Genetic analyses also suggest remnant stocks of coasters in Nipigon Bay are supported by a number of local tributaries (D'Amelio 2002). Small numbers of brook trout from Black Bay, Thunder Bay, and eastern Lake Superior are also present in Nipigon Bay during the spring and summer (Addison and Wilson 2011). It should also be noted that other unidentified streams or possibly shoals in Ontario waters may produce coasters. These results suggest that maintaining stream populations is essential for supporting remnant stocks of coasters in Nipigon Bay.

Hatchery populations used in stocking programs throughout Lake Superior are also genetically distinct from each other. Wilson et al. (2008) found the Lake Nipigon, and Tobin Harbor (Isle Royale) hatchery strains are significantly different from each other, but very similar to their respective wild sources. Wild brook trout in Nipigon Bay are genetically distinct from the Lake Nipigon hatchery strain which was used in early stocking, although a minor contribution from historical stocking was evident (Wilson et al. 2010; Addison and Wilson 2011). Wilson et al. (2008) also determined that the introduced brook trout population in Grand Portage Creek (MN) was successfully established from stocking the Lake Nipigon hatchery strain. These results suggest local or ecologically similar stocks are best suited for restoration efforts using stocking.

Coaster brook trout research in Nipigon Bay and tributary streams

Like many species of trout and salmon, some populations of brook trout are known to move from streams into lakes or oceans. These migratory fish typically grow larger than fish that reside only in streams. Juvenile Pacific and Atlantic salmon typically reside in streams and migrate into lakes or oceans, returning to streams as adults for spawning. This cycle represents complete migration, where all juveniles leave nursery streams to grow and mature in lakes or oceans.

Coaster brook trout in Nipigon Bay are thought to be migratory; however, it is unknown whether all juveniles migrate into Lake Superior (complete migration), or if some reside in streams for their entire life (partial migration).

Research by the University of Guelph addressed this question and found that two types of brook trout occur in Nipigon Bay and connected tributary streams. One type is migratory and moves from streams into Lake Superior, resides in the lake throughout the summer, grows fast, and is long-lived (Robillard et al. 2011a; 2011b; Coppaway 2011). The second type spends most of its life in streams, although some individuals may move into Lake Superior for short periods of time (Coppaway 2011). These stream residents grow slower, are shorter-lived, and approach sexual maturity in streams (Robillard et al. 2011a; 2011b, M. Robillard unpublished data).

The identification and description of two types of brook trout allows future research to investigate causes of these differences, which would provide important information to guide recovery efforts. Specifically, future studies may evaluate why some brook trout migrate into Lake Superior, while others reside only in streams. If migration is associated with a genetic trait, then rehabilitation efforts using stocking may be improved by releasing only strains predisposed to migrate from streams into Lake Superior. However, if migration is not hereditary, restoration efforts should focus on improving stream-resident populations to allow surplus brook trout to move into Lake Superior.

Coaster brook trout management in other jurisdictions

Efforts to restore coasters have been ongoing in each of the American states bordering Lake Superior. An overview of assessment and management activities in each state is provided below. This information is useful when evaluating the rehabilitation approach used in Ontario, and in planning future actions.

Minnesota

The Minnesota Department of Natural Resources (MNDNR) has been carrying out monitoring and restoration activities for coaster brook trout. Similar to Ontario, protective angling regulations were implemented in 1997, allowing the possession of only one brook trout greater than 508mm (20 in). The protective regulation was implemented on Lake Superior as well as tributary streams downstream of a posted landmark. A closed season for brook trout angling was also introduced, from Labour Day to mid-April.

The MNDNR has been monitoring the size and number of brook trout which return to spawn in Lake Superior tributaries every 5 years since the protective regulations were implemented (Figure 12). Fish were captured using backpack electrofishing and live released. The average size of brook trout captured in this study has increased since the protective regulation was implemented. Most anglers have welcomed the opportunity to catch larger fish, even though most must be released. In addition to protective angling regulations, the MNDNR has been working to protect, improve and restore brook trout habitat by increasing fish passage, documenting groundwater sources, and protecting riparian areas. Additional information on coaster brook trout management in Minnesota can be found in the *Fisheries Management Plan for the Minnesota Waters of Lake Superior* (MNDNR 2007).

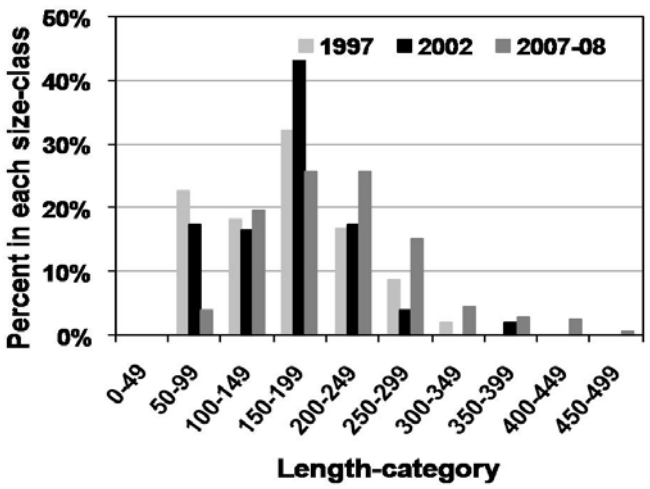


Figure 12: The size of spawning brook trout captured in Minnesota tributaries before and after protective sport fishing regulations were implemented in 1997

Wisconsin

Coasters were once common in Wisconsin, but have been lost in many historic habitats and are currently extremely rare. Compared to Ontario and Minnesota, the Wisconsin Department of Natural Resources (WIDNR) uses a different approach to restore coaster populations. Stream angling regulations are much less restrictive in most areas and stringent regulations were implemented in three select areas. Their management actions have mainly focused on habitat improvement projects. More information can be found in the *Wisconsin Lake Superior Basin Brook Trout Plan* (WIDNR and USFWS 2005).

A daily possession limit of one fish greater than 50.8 cm (20 in) has been applied to Lake Superior with a continuous open season. In tributary streams the angling season is open from early May to late September and five brook trout can be harvested with a minimum size limit of 20.3 cm (8 in).

Catch-and-release only regulations for brook trout were effected on the Bark River, Whittlesey Creek and Graveyard Creek. On a section of the Brule River the size limit was increased from 20.3 cm (8 in) to 25.4 cm (10 in) and the possession limit was decreased from 5 to 3 fish per day.

The Red Cliff Tribal Fish Hatchery stocks coaster strain brook trout in Lake Superior waters along the Red Cliff Indian reservation shoreline.

Supplemental stocking and subsequent monitoring has occurred in Whittlesey Creek. PIT antennas have been installed near the stream mouth to monitor brook trout movement between steam and lake environments. Results have shown:

- Stocked and unmarked yearling brook trout exhibit similar seasonal emigration patterns, with peak periods of movement occurring in either the fall (October/November) or spring (April/May).
- Unmarked and stocked yearling brook trout exhibit a similar diurnal pattern of movement with the majority of movements both within and out of the stream occurring between 20:00 and 02:00.
- In the fall of 2010, three fish PIT tagged in 2008 as yearlings that left Whittlesey Creek, returned as sexually mature adults.

Habitat restoration projects were implemented in numerous watersheds. The Wisconsin DNR is removing beaver dams and tag alder to increase water velocity, move sand downstream and expose coarse substrate on the Bark River and numerous other Wisconsin tributaries (Figure 13). Gravel has been added to the Brule River and Graveyard Creek to improve spawning habitat. Culvert replacements, tree planting, beaver removal, and placement of large woody debris have taken place in many watersheds.

Despite the efforts of WIDNR and other natural resource agencies and organizations, few coaster brook trout have been documented in the Wisconsin waters of Lake Superior or associated tributary streams to date. Future work will involve habitat improvement and stocking programs. Angling regulations are not scheduled to be modified.

Figure 13 A: Before habitat was improved on the Bark River, Wisconsin

Figure 13B: After habitat was improved in the Bark River, Wisconsin

Michigan

Remnant brook trout populations are known to exist in two general areas in the Michigan waters of Lake Superior: Isle Royale and the Salmon Trout River. Experimental reintroductions were also attempted in three watersheds along the Pictured Rocks National Shoreline and in two streams in the western Upper Peninsula but have been abandoned.

Similar to Wisconsin, angling regulations in the Michigan waters of Lake Superior allow possession of one brook trout longer than 508 mm (20 in), and the season is open year round. In tributaries, five brook trout can be harvested, although none can be longer than 178 mm (7 in).

In 2005, catch-and-release only regulations were applied for coasters in the waters surrounding Isle Royale, including tributary streams.

Isle Royale

Three coaster populations persist at Isle Royale: Tobin Harbor, Siskiwit Bay, and Washington Harbor. The size of the adult populations in these locations ranges from

several hundred individuals in Tobin Harbor to less than one hundred in the other locations.

The U.S. Fish and Wildlife Service has surveyed coaster stocks since the early 1990s. Spring index surveys using shoreline electrofishing show an upward trend in coaster abundance in Tobin Harbor. Boat electrofishing catch rates have increased by 17 times from 2001 to 2010.

Salmon Trout River

Brook trout returning to the Salmon Trout River have been monitored by Michigan Technical University and Michigan DNR. A temporary weir is installed annually at a location approximately 6 km upstream from Lake Superior and fish movement through the weir is recorded with a 24 hour video recorder. The weir is typically installed in July and removed when the river begins to freeze (late November). Since 2005 numbers have fluctuated around 300 individuals. Angler harvest was apparently high historically and may be a factor keeping the population small.

Pictured Rocks National Shoreline

Restoration efforts have been ongoing in three tributaries along the Pictured Rocks National Lakeshore in Michigan since 1999: Hurricane Creek, Mosquito Creek and Seven-Mile Creek.

Over 100,000 fingerlings from the Tobin Harbour (Isle Royale) strain were stocked from 1999 to 2003. Beginning in 2004 both yearlings and fingerlings were planted in the spring in an effort to increase adult returns.

Stocking was suspended in 2005 at the request of the National Park Service when potentially wild coaster brook trout were discovered. Research was initiated to assess the whether these fish were a result of the stocking program, or if stream-resident brook trout were moving into Lake Superior (See Kusnierz et al. 2009). Related research is also examining whether brook trout respond when non-native trout and salmon are removed (research efforts were concluded in 2011).

Conclusions

Brook trout populations and fisheries in Lake Nipigon showed substantial change after the sport fishing regulation was modified in 2005. The estimated number of spawning brook trout in South Bay increased by 2.2 times from 2003 to 2007, however estimates are 25% of management goals (1930's levels). Similarly, in West Bay numbers of spawning brook trout increased by 1.7 times from 2002 to 2008 but are 4.5% of 1930's levels. Many changes have occurred in the Lake Nipigon brook trout fishery. Brook trout catch rates improved as harvest declined. However, catch rates of the average brook trout angler on Lake Nipigon in 2009 remain below the management objective of one brook trout for every two hours of fishing. Declines occurred in the proportion of anglers targeting brook trout as well as the total number of brook trout caught by anglers, however both variables returned to pre-2005 levels. Tagging studies on Lake Nipigon showed the portion of the spawning population protected from angler harvest increased in South Bay from 29% to 88%, and in West Bay from 28% to 71%.

In many years 15% to 33% of tagged brook trout were caught at least twice by co-operative anglers on the Nipigon River and Lake Nipigon. High recapture rates show brook trout in these areas are vulnerable to angling, but also indicates that these fish respond well to catch and release. Catch rates by co-operative anglers generally increased from 2004 to 2010 in Lake Nipigon, Lake Superior, and the Nipigon River. Brook trout were also caught in previously undocumented areas. Co-operative anglers experienced catch rates exceeding management objectives for Lake Nipigon. Similar angling-based targets were not set for Lake Superior or the Nipigon River. The co-operative angler program showed the proportion of brook trout caught by anglers which are protected from harvest increased in Nipigon Bay from 80% to 97% and in the Nipigon River from 72% to 95%.

Research has been a focus on Lake Superior. Genetic studies suggest that brook trout in Lake Superior do not qualify as a species-at-risk. Genetics also show coaster brook trout can stray into non-natal streams for spawning, allowing natural re-colonization if a stream population is lost.

Movement studies suggest that brook trout in Lake Superior use specific areas during certain times. Tag returns from the Co-operative Angler Program indicated some fish frequent certain areas, while others move long distances. Similar large scale movements were reported in Lake Nipigon prior to 1990.

U.S. efforts to restore coaster brook trout populations have used stocking, habitat improvement, public outreach, and protective angling regulations. Wisconsin and Michigan still allow significant harvest opportunities in streams, and wild coasters remain rare in most of the American waters of Lake Superior.

Recommendations

Although current protective sport fishing regulations have been in place for a short period of time (five years, or approximately one brook trout generation), signs of rehabilitation are encouraging and the current restoration strategy is recommended to remain in place.

Participants at the OMNR workshop provided a number of recommendations to continue brook trout rehabilitation in Lake Superior, Lake Nipigon, and the Nipigon River (Appendices 6 & 7). Many recommendations were similar and are summarized below.

Monitoring and Assessment:

- Refine and expand the Co-operative Brook Trout Angler Program. This program has relied on a core group of anglers to provide important information on the brook trout fisheries and populations in the Nipigon Bay area of Lake Superior, Lake Nipigon, and the Nipigon River. OMNR should determine pertinent information to be collected in the future and efforts should be made to expand the number of participating anglers, particularly in Lake Superior. Findings should be regularly communicated by OMNR to participants.

- OMNR assessment of brook trout populations in Lake Superior. OMNR monitoring has provided important information on the status of brook trout populations and fisheries in Lake Nipigon and the Nipigon River. Similar efforts are recommended for Lake Superior, including areas outside of Nipigon Bay. Methods should include those used by the United States Fish and Wildlife Service to assess the status of brook trout in the nearshore waters of Lake Superior using boat electrofishing. This will allow populations throughout Lake Superior to be compared.

- Improve knowledge of brook trout distribution in Lake Superior and Lake Nipigon. Brook trout are known to spawn in West Bay, South Bay, and McIntyre Bay of Lake Nipigon; Lake Superior tributaries in Nipigon Bay, and throughout the Nipigon River. Spawning sites may also exist in other areas. Protecting spawning areas may aid restoration efforts. Significant information gaps exist along the eastern shoreline of Lake Superior (east of Nipigon Bay to Sault Ste. Marie), and also in areas of northern Lake Nipigon, including tributary streams. Methods may include those used by the Minnesota Department of Natural Resources to monitor spawning populations of coaster brook trout in tributary streams using backpack electrofishing. PIT tagging and antennas may also be a suitable method.

- Continue ongoing OMNR assessment of brook trout populations and fisheries in Lake Nipigon and the Nipigon River. Creel studies and tagging programs have provided important information and should be continued in the future.

Research:

Many research projects were recommended by attendees at the 2011 workshop including:

- Brook trout habitat use and movement in Lake Superior and tributary streams, particularly in areas outside of Nipigon Bay.
- Determining if migratory behavior in Lake Superior brook trout is a genetic trait.
- Determining the physical requirements for streams to produce coaster brook trout.
- Evaluate the effectiveness of stocking to reintroduce brook trout populations in Lake Superior tributaries.
- Human dimensions study to identify groups hindering rehabilitation efforts.
- A formal research plan should be developed. Prior research should be evaluated, and a list of research priorities should be produced co-operatively by management agencies and researchers. This exercise could advocate projects most helpful to the rehabilitation of brook trout populations and fisheries.

Management:

- Education to reduce harvest. Although progress is being made towards rehabilitation, overharvest may still be an issue. Illegal harvest may be occurring by anglers on Lake Nipigon and Lake Superior, and also in Lake Superior tributaries. The magnitude and effects of First Nations subsistence harvest in Lake Superior, Lake Nipigon, the Nipigon River, or tributary streams is currently unassessed. Education may assist the public in understanding the importance/value of brook trout in this region. Options include signs at popular fishing areas, OMNR presence at derbies, and including more anglers in the co-op angler program.

- Incorporate more user groups in rehabilitation efforts. Rehabilitation of brook trout populations is multi-faceted (e.g. education and outreach, management of fish populations and habitat, enforcement, etc.). Partnerships may be important to effectively accomplish all of these items. Such groups may include anglers, First Nations, municipalities, federal agencies (e.g. Department of Fisheries and Oceans, Lake Superior National Marine Conservation Area) and local MNR offices.

- Goals should be established for rehabilitation. Goals for brook trout rehabilitation in Lake Superior and Lake Nipigon have been established (See Table 1). Similar goals and objectives may be important for the restoration of brook trout populations and fisheries on the Nipigon River. Goals should be revisited regularly to monitor progress towards rehabilitation.

Acknowledgements

We are grateful for the significant contributions to this report from P. Addison, S. Chong , S. Greenwood, Dr. R. Mackereth, G. Madison, Dr. R. McLaughlin, Dr. S. Moore, J. Mucha, , H. Quinlan, D. Schriener, and the numerous co-operative anglers.

References

Addison, P., and C.C. Wilson. 2011. Genetics of Nipigon and Superior Brook Trout. Presentation. Lake Nipigon, Lake Superior, and the Nipigon River Brook Trout Workshop. Thunder Bay, ON, March 11 -12, 2011.

Alexander, K.B. 1911. The log of the North Shore Club: Paddle and portage on the hundred trout rivers of Lake Superior. New York: G.P. Putnam's Sons. 228 pp.

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press.

Coppaway, C.W. 2011. Dynamics of residency for brook charr (*Salvelinus fontanilis)* in Lake Superior tributaries. Master's thesis. University of Guelph. Guelph, ON.

D'Amelio, S. 2002. Conservation genetics and metapopulation structure of brook trout (*Salvelinus fontinalis*) in Nipigon Bay (Lake Superior, Ontario). Master's thesis. Trent University, Peterborough, ON.

D' Amelio, S. and C. Wilson. 2008. Genetic population structure among source populations for coaster brook trout in Nipigon Bay, Lake Superior. Transactions of the American Fisheries Society. 137:1213-228.

D'Amelio, S., J. Mucha, R. Mackereth, and C. Wilson. 2008 Tracking coaster brook trout to their sources: combining telemetry and genetic profiles to determine source populations. North American Journal of Fisheries Management. 28:1343-1349.

Hoenig, J. M., M. J. Morgan, and C. A. Brown. 1995. Analysing differences between two age determination methods by tests of symmetry. Canadian Journal of Fisheries and Aquatic Sciences. 52:364–368.

Fallbaum, G. 1994. Aquatic Resources and Inventory of Pukaskwa National Park. 1992 – 1994 Stream Survey Results. Environment Canada.

Kelso, J.R.M., and J.W. Demers. 1993. Our living heritage: the glory of the Nipigon. Lehto Printers, Thunder Bay, Ontario.

Kelso, J.R.M., and K.I. Cullis. 1996. The linkage among ecosystem perturbations, remediation, and the success of the Nipigon Bay fishery. Canadian Journal of Fisheries and Aquatic Sciences. 53:67-78.

Kusnierz, P.C., Stimmell, S.P., and J.B.K. Leonard. 2009. Movement and growth indicators in resident and adfluvial coaster brook trout (*Salvelinus fontinalis*) in the Hurricane River, Lake Superior, Michigan, USA. Journal of Great Lakes Research. 35:385-391.

Newman, L.E., R.B. DuBois, and T.N. Halpern [editors]. 2003. A brook trout rehabilitation plan for Lake Superior. Great Lakes Fishery Commission Miscellaneous Publication 2003-03. Ann Arbor (MI).

Newman, L.E., and R.B. DuBois. 1997. Status of brook trout in Lake Superior. Great Lakes Fishery Commission, Ann Arbor (MI).

McCrimmon, H.R., and J.S. Campbell. 1969. World distribution of brook trout, *Salvelinus fontinalis.* Journal of the Fisheries Research Board of Canada 26:1699–1725.

Minnesota Department of Natural Resources. 2007. Fisheries Management Plan for the Minnesota Waters of Lake Superior. Minnesota Department of Natural Resources, Section of Fisheries Management, St. Paul (MN).

Moore, S., B. Whiting, and L. Newman. 2006. A Coaster Brook Trout Rehabilitation Plan for the Grand Portage Reservation. Grand Portage Band of Chippawas, Natural Resource Management. Grand Portage (MN).

Mucha, J.M. 2004. Habitat use, movement patterns, and home ranges of coaster brook trout in Nipigon Bay, Lake Superior. Master's Thesis. Lakehead University. Thunder Bay, ON.

Mucha, J.M. and R.W. Mackereth. 2008. Habitat use and movement patterns of brook trout in Nipigon Bay, Lake Superior. Transactions of the American Fisheries Society. 137:1203-1212.

Ontario Department of Game and Fisheries. 1926. Synopsis of Game Laws, 1926. Pamphlet.

Ontario Game and Fish Commission. 1892. Commissioners' Report. Toronto: Warwick & Sons. 483 pp.

Ontario Ministry of Natural Resources (OMNR). 2004. Lake Nipigon Basin Signature Site: Ecological land use and resource management strategy. Nipigon District Office. Nipigon, ON.

Robillard, M.M., J.M. Casselman, R.L. McLaughlin, and R. Mackereth. *In press*. Alternative life histories in populations of Lake Superior brook trout: critical support for partial migration. Biological Conservation.

Robillard, M.M., R.L. McLaughlin, and R. Mackereth. *In press*. Diversity in habitat use and trophic ecology of brook trout in Lake Superior and tributary streams revealed through stable isotopes. Transactions of the American Fisheries Society.

Roland, W. Algoma West: Its mines, scenery and industrial resources. Toronto: Warwick & Sons. 217 pp.

Roosevelt, R. B. 1865. Superior fishing - The striped bass, trout, and black bass of the northern states. Originally published by G.W. Carleton. Minnesota Historical Society Press, St. Paul (MN). 1985.

Ritchie, B.J. and J. Black. 1988. Status of the Lake Nipigon brook trout fishery and assessment of stresses, 1923-1987. Lake Nipigon Fisheries Assessment Unit Report. Ontario Ministry of Natural Resources, Nipigon (ON).

Schreiner, D.R., K.I. Cullis, M.C. Donofrio, G.J. Fischer, L. Hewitt, K.G. Mumford, D.M. Pratt, H. Quinlan, and S.J. Scott. 2008. Management perspectives on coaster brook trout rehabilitation in the Lake Superior basin. North American Journal of Fisheries Management. 28:1350-1364.

Stott, W. Quinlan, H.R., Gorman, O.T., and T.L. King. 2010. Genetic structure and diversity among brook trout from Isle Royale, Lake Nipigon, and three Minnesota tributaries of Lake Superior. North American Journal of Fisheries Management 30:400-411

Thunder Bay Historical Society. 1923. The steamer "Rescue", a pioneer in Great Lakes shipping. [Reprint of an anonymous letter to the Toronto Globe, 1858]. Annual Report of the Thunder Bay Historical Society. 14:11-14.

Wiland L., Moore S., Hewitt L. 2006. The coaster challenge: restoring a native brook trout fishery to Lake Superior. Trout Unlimited, Arlington (VA).

Wilson, C.C., W. Stott, L. Miller, S. D'Amelio, M.J. Jennings, and A.M Cooper. 2008. Conservation genetics of Lake Superior brook trout. North American Journal of Fisheries Management. 28:1307-1320.

Wilson. C.C., P. Addison, S. Chong, and S. D'Amelio. 2010. Regional metapopualtion structure of brook trout in northern Lake Superior. Poster presented at the Canadian Conference for Freshwater Fish Research. Winnipeg, MB, January 7-9 2010.

Wisconsin Department of Natural Resources, and United States Fish and Wildlife Service. 2005. Wisconsin Lake Superior Basin Brook Trout Plan. United States Fish and Wildlife Service, Ashland Fish and Wildlife Conservation Office, Ashland (WI).

Wright, R. 1892. Preliminary report on the fish and fisheries of Ontario. *In* Ontario Game and Fish Commission. 1892. Commissioners' Report. Toronto: Warwick & Sons. 483 pp.

Appendix 1

Table A1-1: Summary of sport fishing regulations for brook trout prior to 2005 in the Ontario waters of Lake Nipigon, the Nipigon River, and Lake Superior including tributary streams. Note: prior to the year 1993 conservation licenses were not available.

Area	Effective years	Season	Catch and Possession Limit (S=Sport License, C-Conservation License)	Size restriction
Lake Superior	1995-2004	Jan. 1 – Labour Day	S: three (3) per day C: two (2) per day	None
Nipigon Bay of Lake Superior –**/ that portion north of line drawn northeast from Magnet Point on Black Bay Peninsula to west shore of Pic River	2000-2004	Last Sat. in April – Labour Day	S: one (1) per day	Minimum size of 51 cm (20 in)
Nipigon River	2000-2004	Last Sat. in April – Labour Day	S: one (1) per day	Minimum size of 51 cm (20 in)
Tributary streams to Lake Superior in Thunder Bay District	1995-2004	Last Sat. in April – Labour Day	S: five (5) per day C: two (2) per day	Only one fish greater than 30 cm (11.8 in)
Tributary streams to Lake Superior in Nipigon/Terrace Bay District	1995-2004	Jan. 1 – Labour Day	S: five (5) per day C: two (2) per day	Only one fish greater than 30 cm (11.8 in)
Tributary streams to Lake Superior in Wawa District	1990-2004	Jan. 1 – Sept. 15	S: five (5) per day C: two (2) per day	None
Tributary streams to Lake Superior in Sault Ste. Marie District	1990-2004	Jan. 1 – Sept. 30	S: five (5) per day C: two (2) per day	None
Lake Nipigon	1999-2004	Apr 24 – Sept 15	S: two (2) per day C: one (1) per day	Minimum length of 46 cm (18.1'')

Appendix 2: Lake Superior, Lake Nipigon, and Nipigon River Brook Trout Workshop – Participant List

First Name	Last Name	Affiliation
Peter	Addison	OMNR, Northwest Science and Information
Randy	Beamish	Angler
Eric	Berglund	OMNR, Upper Great Lakes Management Unit, Thunder Bay
Steve	Bobrowicz	OMNR, Upper Great Lakes Management Unit, Thunder Bay
Russell	Bobrowski	OMNR, Upper Great Lakes Management Unit, Thunder Bay
Tom	Borg	Red Rock Indian Band
Marilee	Chase	OMNR, Upper Great Lakes Management Unit, Thunder Bay
Peter	Colby	Retired, OMNR
Ken	Cullis	OMNR, Upper Great Lakes Management Unit, Thunder Bay
Ray	Dupuis	Angler
Bob	Elliott	OMNR, Wawa District & Ontario Parks
Gord	Ellis	Angler
Erich	Eppert	Sault Fly Fishers
John	Furtado	Lake Nipigon Watershed Advisory Council
Sue	Greenwood	OMNR, Upper Great Lakes Management Unit, Thunder Bay
Bart	Hardy	Biinjitiwaabik Zaaging Anishinaabek First Nation
John	Hay	Northern Ontario Sportsmen Alliance
Peter	Jollymore	Northern Ontario Sportsman Alliance
Nick	Kaplanis	Black Bay Fish & Game Club
Terry	Koslowski	North Shore Steelhead Association
Jacques	Landry	OMNR, Sault Ste Marie
Gary	Lange	Outfitter
Rob	Mackereth	OMNR Center for Northern Forest Ecosystem Research
George	Madison	Michigan Department of Natural Resources
Terry	Marshall	Retired, OMNR
Rob	McLaughlin	University of Guelph
Walter	Momot	Lakehead University
Seth	Moore	Grand Portage Band of Lake Superior Chippewa
Jamie	Mucha	OMNR, Thunder Bay District
Tom	Mulvihill	Red Rock Fish and Game Club

Dave	Nuttall	OMNR Fisheries Management Zone 9 Advisory Council
Terry	Olson	Ducks Unlimited
Paul	Peterson	Thunder Bay Fly Fishing Club
Henry	Quinlan	United States Fish and Wildlife Service
Debbie	Rivard	Ontario Federation of Anglers and Hunters, Zone B
Melissa	Robillard	University of Guelph
Carl	Ronquist	Commercial Fisherman
Don	Schreiner	Minnesota Department of Natural Resources
Mark	Sobchuk	OMNR, Fisheries Section
Greg	Stroud	Lake Superior National Marine Conservation Area
Rob	Swainson	OMNR, Nipigon District
Barry	Tabor	Thunder Bay Salmon Association
Rick	Tomiak	Ontario Federation of Anglers and Hunters, Zone B
Ray	Tyhuis	OMNR, Nipigon District
Albertine	van Ogtrop	OMNR, Lake Nipigon Fisheries Assessment Unit
Neville	Ward	Department of Fisheries and Oceans
Neil	Weins	Ontario Federation of Anglers and Hunters
Tom	Whalley	North Shore Steelhead Association

Appendix 3: Lake Superior, Lake Nipigon, and Nipigon River Brook Trout Workshop Agenda

Presentations will be 20 minutes in length followed by a 5 minute question period. Discussion periods are scheduled Friday evening and Saturday afternoon. Forms will also be available for participants to provide comment.

Friday, March 11th

6:30 - 6:55 Opening remarks – Management perspectives on brook trout rehabilitation
Speaker*:* Ken Cullis (OMNR – Upper Great Lakes Management Unit – Lake Superior)

6:55 – 7:20 The status of brook trout populations in South Bay and West Bay of Lake Nipigon
Speaker*:* Rob Swainson (OMNR – Nipigon District)

7:20 – 7:45 Angler surveys on the Nipigon River and South Bay, Lake Nipigon
Speaker: Albertine Van Ogtrop (OMNR – Lake Nipigon Fisheries Unit) & Rob Swainson

7:45–8:10 Co-operative brook trout angler program: Lake Superior, Lake Nipigon and the Nipigon River
Speaker: Rob Swainson

8:10 – 8:20 Break

8:20 – 8: 45 Angler observations:
Speakers: Dave Nuttall – Lake Superior Angler
Gary Lange – Lake Superior Outfitter
Randy Beamish – Nipigon River Angler
Gord Ellis – Lake Nipigon, Nipigon River, and Lake Superior Angler

8:45 – 9:15 Facilitated discussion:
Speaker: Moderator (Steve Bobrowicz – OMNR Lake Superior Management Unit)

Saturday, March 12th

8:30 – 8:40 Welcome
Speaker: Moderator (S. Bobrowicz)

8:40 - 9:05 Biological understanding of coaster brook trout in Ontario and Implications for management

Speaker*:* Dr. Rob Mackereth (OMNR - Centre for Northern Forest Ecosystem Research) & Dr. Rob McLaughlin (University of Guelph)

9:05 – 9:30 Movement and habitat use of brook trout in the Nipigon Bay area of Lake Superior
Speaker: Jamie Mucha (OMNR – Thunder Bay District)

9:30 – 9:55 Movement of brook trout between Lake Superior and tributary streams.
Speaker: Marilee Chase (OMNR – Lake Superior Management Unit)

9:55- 10:05 Break

10:05 – 10:30 Stream temperature and brook trout habitat in the Nipigon Forest
Speaker: Rob Mackereth

10:30– 10:55 Genetic analyses of Lake Superior brook trout populations in Ontario
Speaker: Peter Addison (OMNR - Northwest Science)

10:55 – 11:20 Coaster brook trout research in Western Lake Superior
Speaker: Melissa Robillard (PhD Candidate – University of Guelph)

11:20 – 11:45 Restoring coaster populations in the United States: Minnesota
Speaker: Don Schreiner (Biologist - Minnesota Department of Natural Resources)

11:45 –12:10 Restoring coaster brook trout populations in the United States: Isle Royale, Michigan
Speaker: Henry Quinlan (United States Fish and Wildlife Service)

12:10 – 12:50 Lunch

12:50 – 1:15 Restoring coaster brook trout populations in the United States: Wisconsin
Speaker: H. Quinlan

1:15 –1:40 Restoring coaster brook trout populations in the United States: Michigan
Speaker: George Madison (Biologist - Michigan Department of Natural Resources)

1:40 – 2:05 Restoring coaster brook trout populations in the United States: Grand Portage Minnesota
Speaker: Seth Moore (Biologist – Grand Portage Band of Lake Superior Chippewa)

2:05 –3:30 Facilitated Discussion
Speaker: Moderator (Mark Sobchuk – OMNR Northwest Region) & Ken Cullis

Appendix 4: Lake Nipigon Spawning Shoal Surveys

Tagging studies and spawn collection programs have provided information on the number and size of brook trout using spawning shoals in South Bay and West Bay of Lake Nipigon since the 1920's.

The historical number of brook trout which spawn on shoals in West Bay and South Bay was estimated using records of spawn collection. Methods used to estimated population size are described by Ritchie and Black (1988), and summarized below. Technicians lived in buildings near spawning sites and it is thought that spawn was collected from most brook trout spawning in these areas. Personal diaries of hatchery managers and technicians describe the volume of eggs collected each year. The number of eggs collected each year was estimated by multiplying the typical number of eggs per litre by the annual volume of eggs collected. The number of females was estimated by dividing the number of collected eggs by the fecundity of Lake Nipigon brook trout, which range from 300 to 2,800 eggs per female. To estimate the total number of brook trout used for spawn collection the number of males was assumed to be equal to the number of females.

Tagging studies conducted by the Lake Nipigon Fisheries Assessment Unit (LNFAU) provide more recent information on the size and number of brook trout spawning on shoals in West Bay and South Bay of Lake Nipigon.

Tagging studies from 1969 to 1987 are described by OMNR (1969), Borecky and Coveyduck (1982), Riordan (1985 and1986), Coveyduck and Borecky (1984), Borecky and Riordan (1984), and Ritchie and Black (1988). Fish were captured using gillnets set for a short duration and/or trapnets. Nets were set on or near spawning shoals. Captured brook trout were inspected for previous marks or tags, measured for length and weight, and live released. Pectoral fin rays were collected for ageing. Unmarked brook trout were marked with plastic disk tags attached anterior to the dorsal fin using monofilament.

Tagging studies from 1997 to 2009 followed a more stringent methodology. Throughout the duration of the survey one heavy weight trap net (Sterling 1999) was set overnight on the spawning shoal and three to six 38 mm monofilament gillnets (Hicks 1999) were set during daylight for 20 to 40 minutes. Captured brook trout were inspected for previous marks or tags, measured for length and weight, and live released. Unmarked brook trout were marked using an external floy tag. Ventral fin rays were collected for aging.

All tagging studies used the Schumacher-Eschmeyer method (Ricker 1975) to estimate population size.

Results:

Spawn was collected from Lake Nipigon brook trout intermittently from 1924 to 1984 (Table A4-1). Considerable effort was given to spawn collection. Spawn collection took place for approximately one month during most years, even while the number of eggs collected was relatively low. Estimates of population size illustrate a drastic decline in both South Bay and West Bay. Maximum estimates of population size occurred in 1931 in both West Bay (1,378 to 12,867 brook trout) and South Bay (468 to 4,360 brook trout). In South Bay, lowest estimates occurred in 1946 (62 to 573 brook trout), and in West Bay, lowest estimates occurred in 1984 (52 to 484 brook trout). Estimated population size in West Bay was lower in 1975 and 1976, however these records were disregarded because only nine days were spent collecting spawn in 1976, and the number of days spent netting was unknown in 1975.

Table A4-1: Estimated number of eggs collected during brook trout spawn collection programs from 1924 to 1984 in South Bay and West Bay of Lake Nipigon and resultant estimates of population size. Population sizes are presented as minimum and maximum estimates. Modified from Ritchie and Black (1985).

Year	Dates	West Bay		South Bay	
		Eggs collected	Population size	Eggs collected	Population size
1924	Oct. 3 – Nov. 13	546,000	390-3,640	-	-
1929	Sept. 30 – Nov. 12	834,000	596-5,560	282,000	202-1,880
1930	Oct. 3- Nov. 10	894,000	638-5,960	322,000	230-2,147
1931	Sept. 27 – Nov. 13	1,930,000	1,378-12,867	654,000	468-4,360
1933	Sept. 21 – Nov. 17	1,668,000	1,192-11,120	525,000	376-3,500
1938	N.A.	250,000	178-1,667	-	-
1946	Sept. 27 – Nov 11	-	-	86,000	62-573
1948	Oct. 12 – Nov. 16	297,500	212-1,984	-	-
1953	Oct. 21 – Dec. 7	110,000	78-734	-	-
1954	Oct. 26 – Nov. 9	150,000	108-1,000	-	-
1975	N.A.	54,000	38-360	-	-
1976	Oct. 14 – Oct. 25	41,500	30-277	-	-
1977	Oct. 16 – Nov. 3	91,000	66-607	-	-
1978	Oct. 8 – Nov. 8	92,000	66-613	-	-
1984	Oct. 16 – Nov. 2	72,500	52-484	-	-

Tagging studies were conducted intermittently from 1969 to 2009 (Table A4-2). Fewer days were spent during tagging studies from 1969 to 1987 compared to efforts from 1997 to 2009. This is likely because few fish were encountered during early studies. Tagging studies from 1997 to 2009 lasted nearly the entire month of October. Estimates of population size were lowest in both locations during the late 1980's and highest during most recent surveys.

Table A4-2: Survey dates and estimated number of brook trout from tagging studies in South Bay and West Bay of Lake Nipigon.

Year	Dates	West Bay			South Bay		
		Estimate	Minimum	Maximum	Estimate	Minimum	Maximum
1969	5 days in October and November	65					
1981	Sept. 22 - Oct. 27				73	57	100
1982	Oct. 12 - 28	92	63	166			
1983	Oct. 10 - Nov. 7	52	42	70			
1984	Oct. 16 - Nov. 2	86	72	105			
1985	Oct. 16 - 18				50	29	167
1986	Oct. 19 - 29	13	10	17			
1987	Oct. 13 - 22 (South Bay), Oct 19-21 (West Bay)	18	15	22	69	58	84
1997	Oct. 6 -31				203	180	234
1998	Oct. 6 - 30				334	267	446
2001	Oct. 12 – Nov 7	300	273	334			
2002	Oct. 18 – Nov. 7 (South Bay), West Bay?	246	194	337	213	175	272
2003	Oct. 4 – Nov. 3				269	226	332
2006	Oct. 14 - Nov. 19				353	312	407
2007	Oct. 1 – Nov. 2				605	489	793
2008	Oct. 4 – Nov. 3	424	326	605			
2009	Oct 2 - 31	320	260	417			

The size structure of spawning brook trout populations from 1997 to 2009 are provided in Figure A4-1 for South Bay and Figure A4-2 for West Bay. Information regarding the size of brook trout captured during 1969 to 1987 is provided in Ritchie and Black (1988). Although statistics are not available for these early studies, only one brook trout with a fork length greater than 60cm (23.6 in) was captured. However many brook trout captured from 1997 to 2009 were longer than 60 cm (fork length).

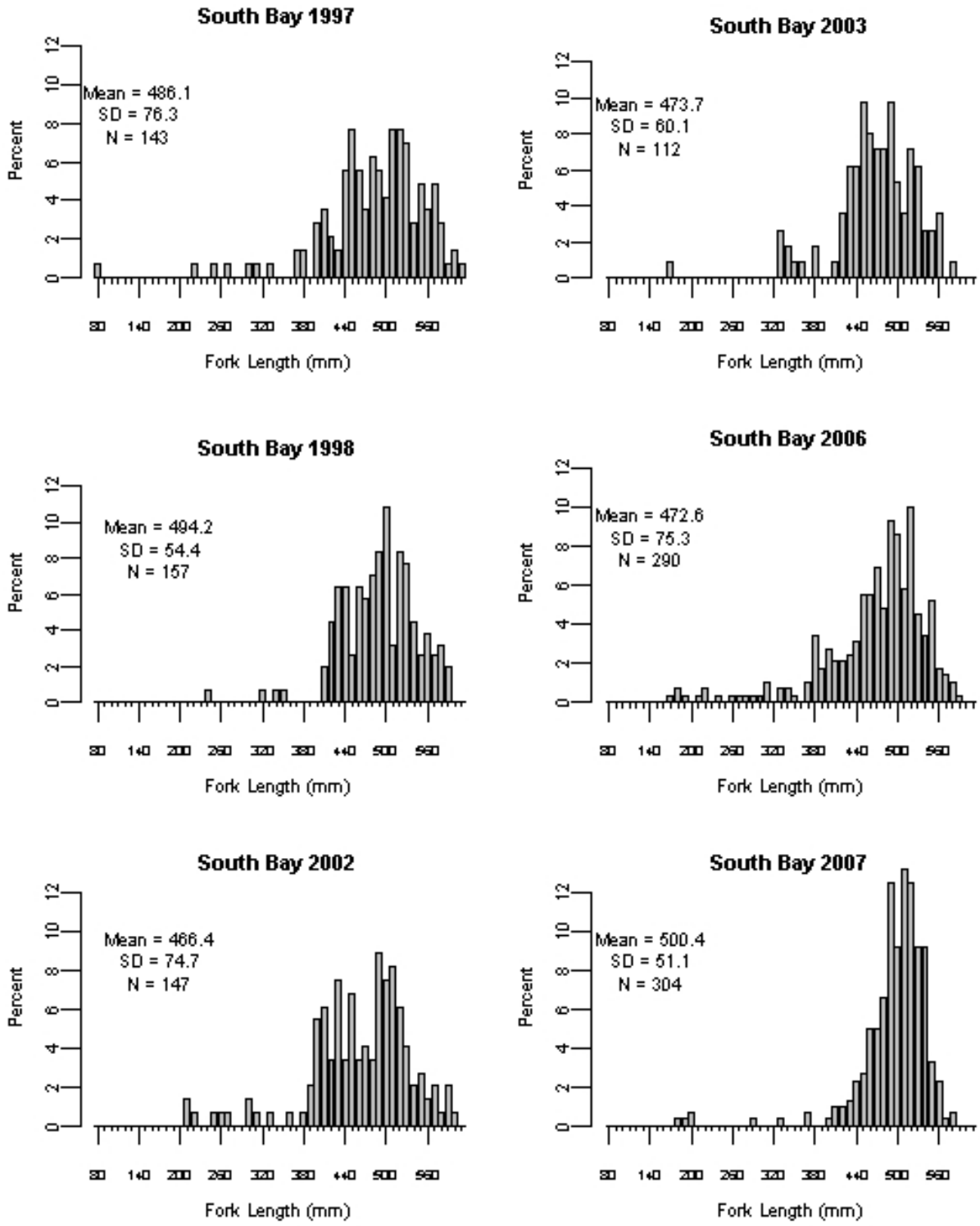


Figure A4-1: Size structure of brook trout captured during spawning shoal surveys on South Bay in 1997, 1998, 2002, 2003, 2006, and 2007.

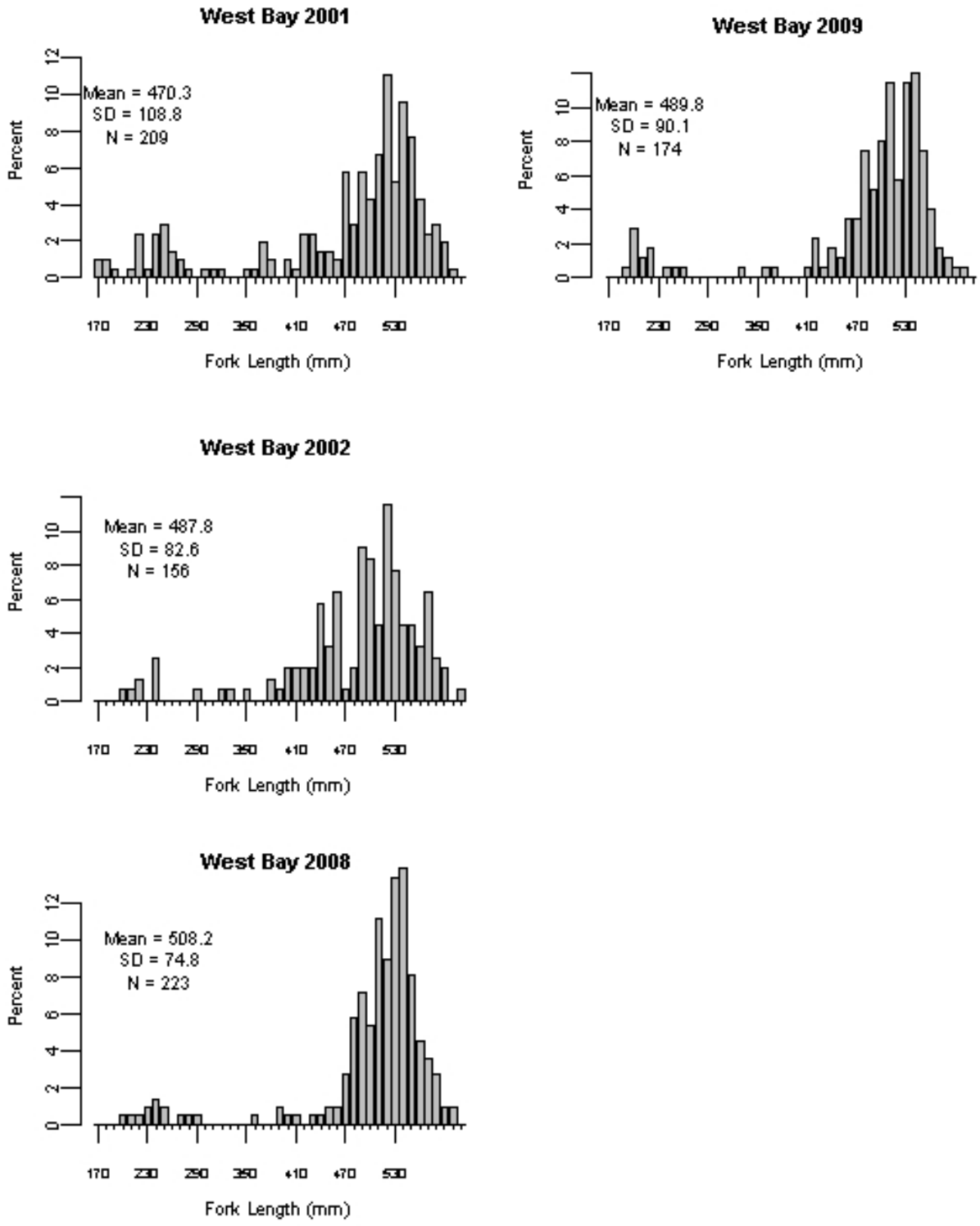


Figure A4-2: Size structure distributions of brook trout captured during spawning shoal surveys on West Bay in 2001, 2002, 2008, and 2009.

References:

Borecky, R. A. and S. G. Coveyduck. 1982. Speckled trout (*Salvelinus fontinalis*) spawning site investigations, South Bay, Lake Nipigon. Lake Nipigon Fisheries Assessment Unit Report. Ontario Ministry of Natural Resources, Nipigon (ON).

Borecky, R.A. and T. Riordan. 1984. Investigation of speckled trout on spawning shoal, West Bay, 1983. Lake Nipigon Fisheries Assessment Unit Report.Report 1984 – 1. Ontario Ministry of Natural Resources, Nipigon (ON).

Coveyduck, S.G. and R.A. Borecky. 1984 Speckled trout spawning site investigation, South Bay, Lake Nipigon, 1983. Lake Nipigon Fisheries Assessment Unit Report.Report 1984 – 1. Ontario Ministry of Natural Resources, Nipigon (ON).

Hicks, F. 1999. Spring Littoral Index Netting – Manual of Instructions. Peterborough: Queen's Printer for Ontario.

Ontario Ministry of Natural Resources, 1969. Annual Report of the Lake Nipigon Fisheries Assessment Unit. Lake Nipigon Fisheries Assessment Unit. Nipigon, Ontario.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191:1-382.

Riordan, T. 1985. Investigations of speckled trout on spawning site, West Bay, 1984. Lake Nipigon Fisheries Assessment Unit Report.Report 1986 – 3. Ontario Ministry of Natural Resources, Nipigon (ON).

Riordan, T. 1986. Investigations of speckled trout spawning, South Bay, 1985. Lake Nipigon Fisheries Assessment Unit Report.Report 1985 – 6. Ontario Ministry of Natural Resources, Nipigon (ON).

Ritchie, B. J., and Black, J. 1988. Status of the Lake Nipigon brook trout fishery and assessment of stresses. Lake Nipigon Fisheries Assessment Unit Report.Report 1988 – 2. Ontario Ministry of Natural Resources, Nipigon (ON).

Sterling, M.R. 1999. Nearshore Community Index Netting – Manual of Instructions. Peterborough: Queen's Printer for Ontario

Appendix 5: Lake Nipigon and Nipigon River Creel Surveys

Background:

The OMNR conducted angler (creel) surveys on the Nipigon River and at the South Bay access point of Lake Nipigon periodically from 1993 to 2010. Angler surveys were used to estimate fishing effort for all species, as well as species-specific estimates of angler effort, catch, and harvest for the entire sampling period.

Methods:

Angler surveys on the Nipigon River used a roving design, while surveys at South Bay used an access point design. Both survey types used a stratified-random approach to select sampling days.

On days selected for sampling the South Bay boat launch was monitored from 13:00 to 21:00. All parties concluding their fishing trip were interviewed at the boat launch to determine fishing times and the number of each species caught, kept, and released. All harvested fish were sampled and in recent years anglers estimated lengths of all released fish.

On each day selected for sampling the Nipigon River was surveyed by boat at three areas: Jessie Lake (from Cameron Falls Dam to Pine Portage Dam), from Alexander Dam to Lake Helen, and from Lake Helen to Lake Superior (See Figure 1). Boats were counted and fishing parties were interviewed. All harvested fish were sampled and anglers estimated lengths for released fish.

Fish harvested from the Nipigon River in 2003 and 2009 were measured for length and scales were collected for age determination. Ageing was conducted by Susan Mann (OMNR, Northwest Science and Information).

Estimates of fishing effort for all species, as well as species-specific estimates of angler effort, catch, and harvest for the entire sampling period were conducted using FISHNET v2.0 (Lester et al. 1989). Angler effort is reported as the length of time one rod was fishing (rod hours). Brook trout effort refers to the percent of the total effort directed at brook trout. Catch and harvest is reported in numbers of fish, and catch rate is reported as the number of brook trout caught per hour of fishing. Statistical error was expressed as the relative standard error (RSE).

Results & Discussion:

Results from angler surveys on the Nipigon River from 1993 to 2010 are summarized in Table A5-1. Total angler effort directed at all species on the Nipigon River was greatest in 1994 and lowest in 2010. No discernable difference in fishing effort was evident after the sport fishing regulation was modified in 2005. Likewise, brook trout

catch and catch rate was variable amongst years with similar values before and after 2005. The proportion of anglers targeting brook trout was also not substantially different before and after 2005. Brook trout harvest declined dramatically after 2005. The proportion of anglers targeting brook trout declined after 1994, but has recently increased and is approaching pre-1995 values.

Table A5-1: Survey dates and estimated fishery characteristics from angler surveys on the Nipigon River from 1993 - 2010. Relative standard error is included in parentheses.

Year	Survey Dates	Total angler effort (rod*hr)	Brook trout angler effort (% of total effort)	Brook trout catch (No.)	Brook trout harvest (No.)	Brook trout catch rate (No. / Rod hr)
1993	05/18-09/15	17,954 (9)	27	750 (24)	93 (40)	0.12
1994	05/28 - 09/15	24, 826 (9)	44	1215 (22)	265 (22)	0.11
2003	05/16-08/31	12,597 (14)	27	817 (23)	27 (58)	0.2
2009	05/15 - 09/05	23,627 (11)	24	853 (20)	36 (88)	0.13
2010	05/21 - 09/03	12,318 (11)	36	1,007 (170)	4 (100)	0.22

Angler effort directed at brook trout on the Nipigon River is typically highest in the Jessie Lake area, however in 1994 brook trout effort was greatest in the section from Alexander Dam to Lake Helen (Table A5-2). The proportion of Nipigon River anglers which target brook trout has increased in the Jessie Lake area, and was highest in 2010 (83%: Table A4-2)

Table A5-2: Distribution of angler effort directed at brook trout on the Nipigon River. Values are the % of total angler effort directed at brook trout occurring in each area.

Area	1993	1994	2003	2009	2010
Jessie Lake	41	19	55	58	83
Alexander Dam to Lake Helen	39	63	35	33	10
Lake Helen to Lake Superior	20	18	10	9	7

Biological information of harvested fish from /the Nipigon River is summarized in Table A5-3. Length measurements are reported in total length. All sampled brook trout and lake trout were caught in the Jessie Lake area, while all rainbow trout, Chinook salmon, and northern pike were caught downstream of Alexander Dam.

Table A5-3: Summary of length and age information collected from brook trout, lake trout, northern pike, rainbow trout, and Chinook salmon harvested from the Nipigon River. Length measurements are reported in total length

Species	N	Mean length (mm ± SE)	Minimum length (mm)	Maximum Length (mm)	Mean age
Brook trout	13	446 ± 26	279	559	3
Lake trout	32	602 ± 18	457	864	5.4
Rainbow trout	14	541 ±28	450	686	5
Chinook salmon	30	679 ± 12.4	559	864	5.1
Northern pike	2	711 ± 51	660	762	4

Results from angler surveys at the South Bay access point on Lake Nipigon from 1993 to 2009 are summarized in Table A5-4. Angler effort for all species in South Bay peaked in 2003 but declined thereafter, reaching its lowest levels in 2008 and 2009. The percentage of anglers targeting brook trout declined during 2005 and 2006, but has recently increased to pre-2005 levels. Brook trout catch was variable among years with similar values before and after 2005. However, after the regulation was modified angler CUE increased and reached its highest levels in 2006. Beginning in 2005 brook trout harvest declined dramatically.

Table A5-4: Survey dates and estimated fishery characteristics from angler surveys at South Bay, Lake Nipigon from 1993 - 2009. Relative standard error is included in parentheses.

Year	Survey Dates	Total angler effort (rod*hr)	Brook trout angler effort (% of total effort)	Brook trout catch (No.)	Brook trout harvest (No.)	Brook trout catch rate (No. / Rod*hr)
1993	05/15 – 06/30	2497 (13)	29	104(30)	34(36)	0.15
1994	05/15 – 06/30	1959 (17)	40	133(29)	40(37)	0.17
2001	05/15 – 06/30	2220 (9)	48	183(13)	73(12)	0.17
2003	05/15 – 06/30	4399 (10)	51	310(16)	88(15)	0.14
2004	05/15 – 06/30	2364 (10)	70	352(19)	107(21)	0.21
2005	05/15 – 06/30	2153 (15)	39	119(25)	6(26)	0.15
2006	05/15 – 06/30	1812 (17)	51	322(27)	0(0)	0.43
2007	05/15 – 06/30	1866 (9)	73	405(16)	9(23)	0.3
2008	05/15 – 06/30	1628 (10)	64	236(10)	12(22)	0.21
2009	05/15 – 06/30	1753 (10)	70	298(17)	8(47)	0.24

Reference:

Lester, N.P., R.S. Kushneriuk, S. Orsatti, and D.G. Oliver. 1989. FISHNET 2.0 (computer database and software system). Ontario Ministry of Natural Resources. Toronto ON.

Appendix 6: Co-operative Brook Trout Angler Program

The Co-operative Brook Trout Angler Program was established to learn more about brook trout in Lake Superior, Lake Nipigon, and the Nipigon River. A number of experienced anglers were asked to participate in a live-release tagging program and/or log information of their fishing trips using angler diaries. Angler diaries document the location and duration of fishing trips, the species targeted, as well as the size and number of target and non-target species caught.

Anglers participating in the tagging program marked brook trout using t-bar anchor tags. Some anglers also collected a small piece of caudal fin tissue for a DNA sample (See genetics section for results), and scales were collected for ageing. Length, weight, and capture location were also recorded.

Recapture of tagged brook trout allowed calculation of growth, movement, recapture rate, and population size. Only fish recaptured the year following being tagged were used to estimate these parameters. Only tagged brook trout that were recaptured by anglers participating in the program were used in these analyses.

Growth was calculated as the difference in total length between capture and recapture. To evaluate if growth changed as fish became longer, growth rate was calculated for four size categories: less than 355.6 mm (14.0 in), between 355.7 mm (14.0 in) and 457.3 mm (18 in), between 457.4 cm (18.0 in) and 485.0 cm (19.0 in), and greater than 485.1 mm (19.0 in). Size categories were based on the total length of the fish when it was originally tagged.

Movement was calculated as the distance a brook trout traveled between tagging and recapture.

Recapture rate was calculated as the proportion of brook trout tagged in a given year that were later recaptured. This measurement indicates of the proportion of brook trout that are caught by anglers multiple times. This is a minimum estimate as only brook trout captured by co-operative anglers were considered, while many other anglers fish in these areas and catch brook trout.

Chapman's modification of the Peterson method was used to estimate population size and 95% confidence intervals were approximated using a normal distribution (Hayes et al. 2007). The initial year of tagging was used as the capture event and the following year served as the recapture event. Zero tag loss was assumed. This method estimates population size the year the fish was originally tagged. In an effort to reduce the possibility of producing an incorrect estimate, population size was estimated only for years when eight or more tagged fish were recaptured, and when the status of all captured brook trout (e.g. tagged, untagged, recapture) was known.

Information from angler diaries was used to evaluate changes in angler catch rate over time. Catch rate was calculated as the number of brook trout captured by each person for every hour of fishing.

The weight-length relationship of captured brook trout was determined to predict the weight of a brook trout at given length. Regression analysis was used to determine the relationship (Pope and Kruse 2007).

Results / Discussion:

Participation:

Participation has varied since the tagging program began in 1997 (Table A6-1). From 1997 to 2003, four to nine groups of anglers participated in the program and information was collected from two to five regions. From 2004 until present however, only three or four groups of anglers participated in the program and information was collected from two to four regions.

Diaries were provided from three anglers. One angler logged information of fishing trips in Nipigon Bay during 2004, 2008, and 2009. A second angler provided information from Jessie Lake during the period of 2004 to 2010. The third angler provided information from Lake Nipigon from 1987 to 2010.

Table A6-1: Number of groups tagging brook trout in each region from 1997 to 2010. A group refers to an angler participating in the tagging program, as well as other persons they are fishing with (typically 2-3 additional persons per trip). The total number of groups participating each year is included on the right side of the table. NOTE: Many participants tagged fish in multiple regions each year.

Year	*Nipigon Bay*	*Lower Nipigon River*	*Cameron Falls*	*Jessie Lake*	*Lake Nipigon*	Total
1997	4	3	0	0	0	4
1998	4	1	0	4	2	4
1999	5	3	0	2	3	6
2000	6	5	0	2	4	9
2001	5	1	0	0	4	5
2002	2	1	0	0	4	5
2003	4	3	2	3	3	7
2004	1	2	1	1	2	4
2005	2	0	1	1	1	3
2006	1	1	1	1	2	3
2007	1	0	0	2	1	4
2008	1	0	0	2	2	4
2009	1	0	0	2	2	3
2010	1	0	0	2	1	3

Tagging:

From 1997 to 2010 a total of 1,953 brook trout were tagged, and 200 tagged brook trout were recaptured by anglers participating in the tagging program (Table A6-2).

Length frequency distributions and summary statistics of brook trout caught by anglers in each of the five regions are illustrated in Figures A6-2, A6-3, A6-4, A6-5, and A6-6. The years of 2006 to 2008 should be noted. Large numbers of small fish (approximately 30 – 40 cm, 11.8 – 15.7 in) were caught in both Jessie Lake and Lake Superior in 2006. These groups remained present each year as they grew, reaching approximately 56 cm (22 in) in 2009. Few large fish from this size class were present in 2010, however large numbers of small fish were observed again in both regions in 2010.

Table A6-2: Summary of brook trout tagging and recapture information collected by co-operative anglers in regions of Nipigon Bay, Lake Nipigon, and the Nipigon River (Lower Nipigon River, Jessie Lake, and Cameron Falls sections). Recapture rate refers to the proportion of brook trout tagged that year that were later recaptured.

Year	*Nipigon Bay*			*Lower Nipigon River*			*Cameron Falls*			*Jessie Lake*			*Lake Nipigon*		
	Tags Applied	*Tags Recaptured*	*Recapture Rate (%)*	*Tags Applied*	*Tags Recaptured*	*Recapture Rate (%)*	*Tags Applied*	*Tags Recaptured*	*Recapture Rate (%)*	*Tags Applied*	*Tags Recaptured*	*Recapture Rate (%)*	*Tags Applied*	*Tags Recaptured*	*Recapture Rate (%)*
97	116	10	9	29	2	7	0	-	-	0	-	-	0	-	-
98	95	2	2	106	7	7	0	-	-	44	6	14	19	1	5
99	127	4	3	17	0	0	0	-	-	18	2	11	43	3	7
00	97	8	8	23	0	0	0	-	-	22	1	5	48	7	15
01	37	3	8	2	0	0	0	-	-	0	0	0	20	1	5
02	32	1	3	2	0	0	0	-	-	0	0	0	23	0	0
03	64	3	5	19	1	5	21	5	24	68	17	25	13	1	8
04	25	1	4	3	0	0	14	2	14	24	8	33	15	0	0
05	34	6	18	0	0	0	19	0	0	20	2	10	7	0	0
06	34	3	9	1	0	0	2	0	0	59	8	14	33	0	0
07	69	7	10	0	-	-	0	-	-	131	42	32	2	1	50
08	37	1	3	0	-	-	0	-	-	71	20	28	12	0	0
09	38	0	0	0	-	-	0	-	-	52	10	19	5	0	0
10	20	1	5	0	-	-	0	-	-	118	3	3	3	0	0

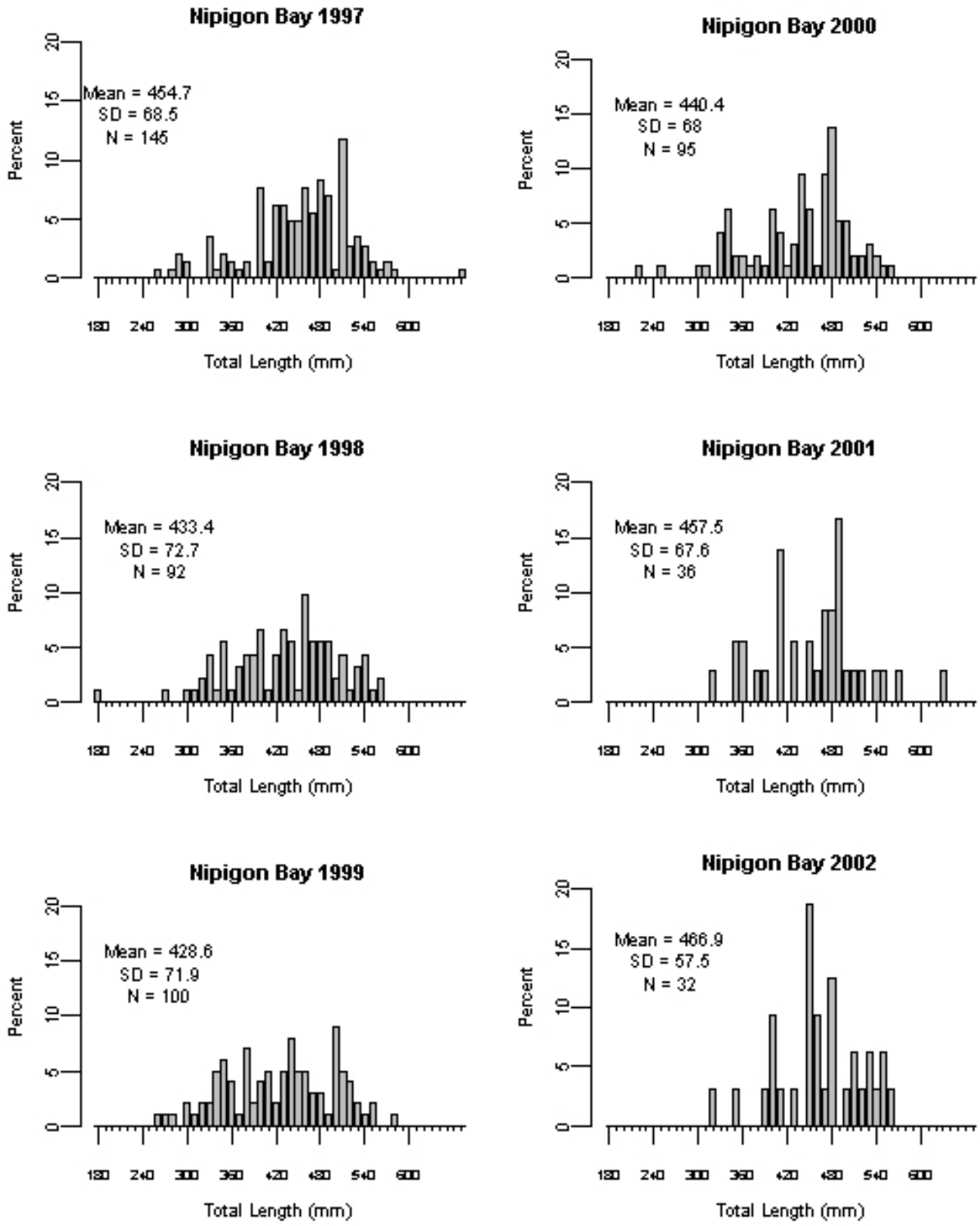


Figure A6-1: Size structure of brook trout caught by anglers in the Nipigon Bay area of Lake Superior from 1997 to 2010.

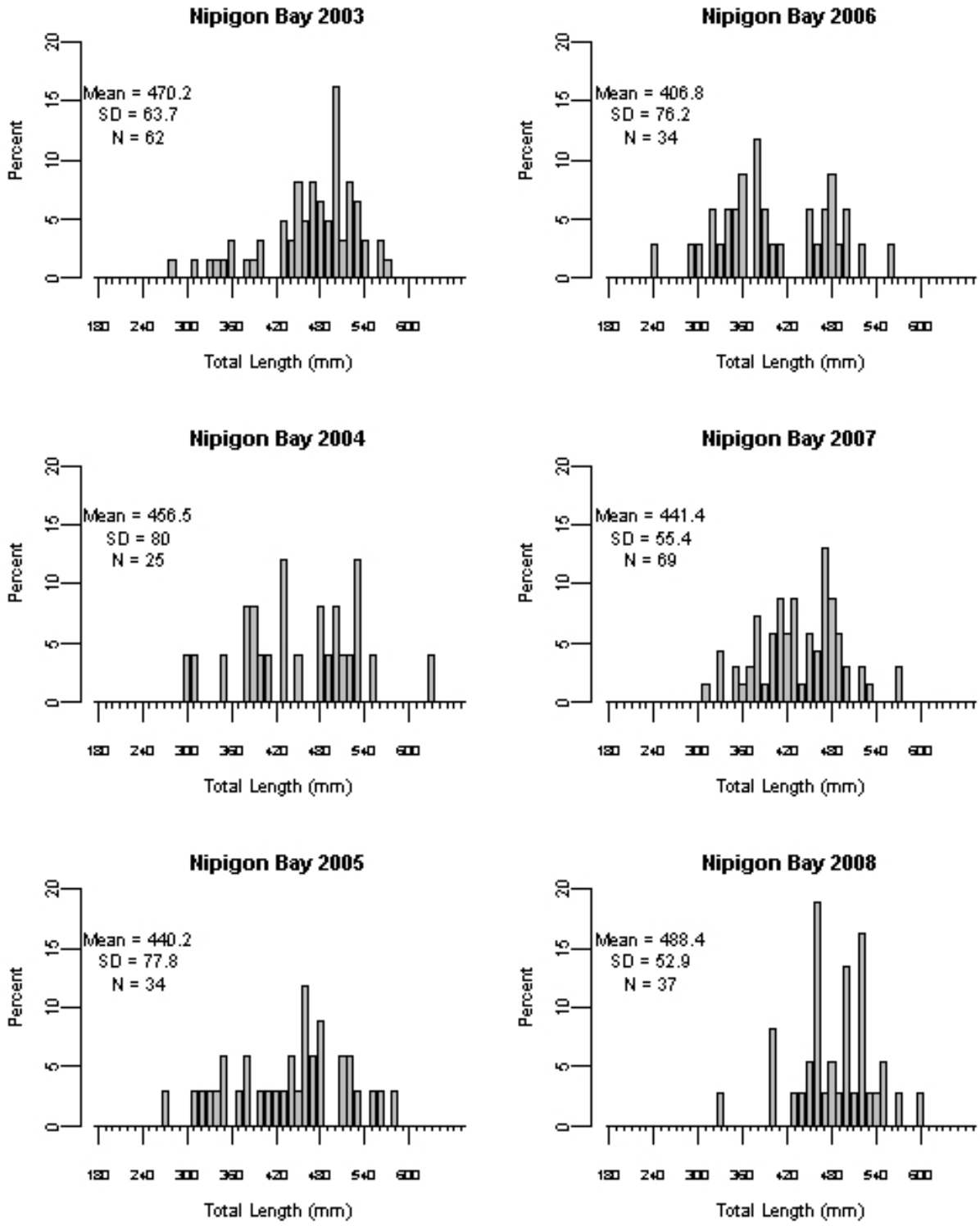
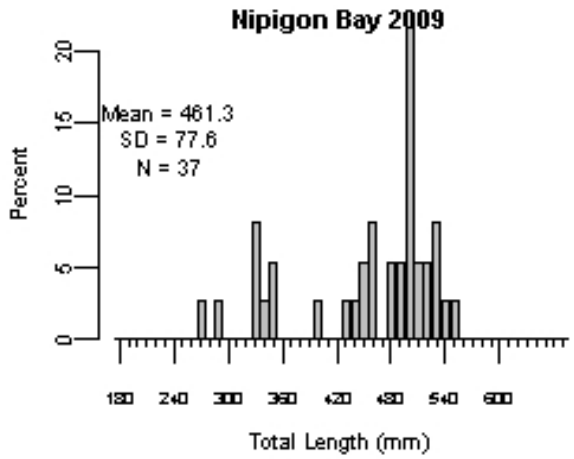


Figure A6-1, continued



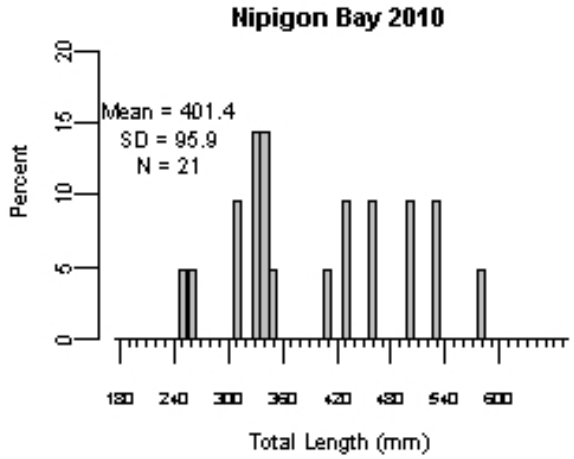


Figure A6-1, continued

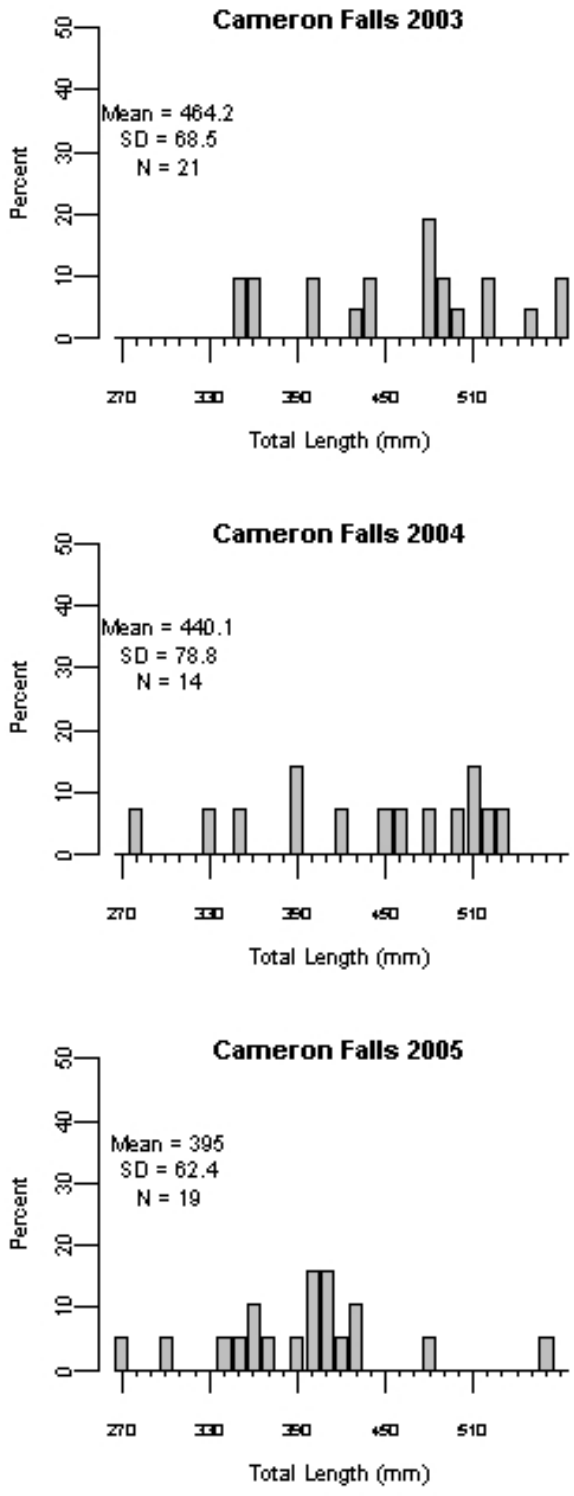


Figure A6-2: Size structure of brook trout caught by anglers in the Cameron Falls area of the Nipigon River from 2003 to 2005. NB: Small sample sizes prevented similar analyses for other years.

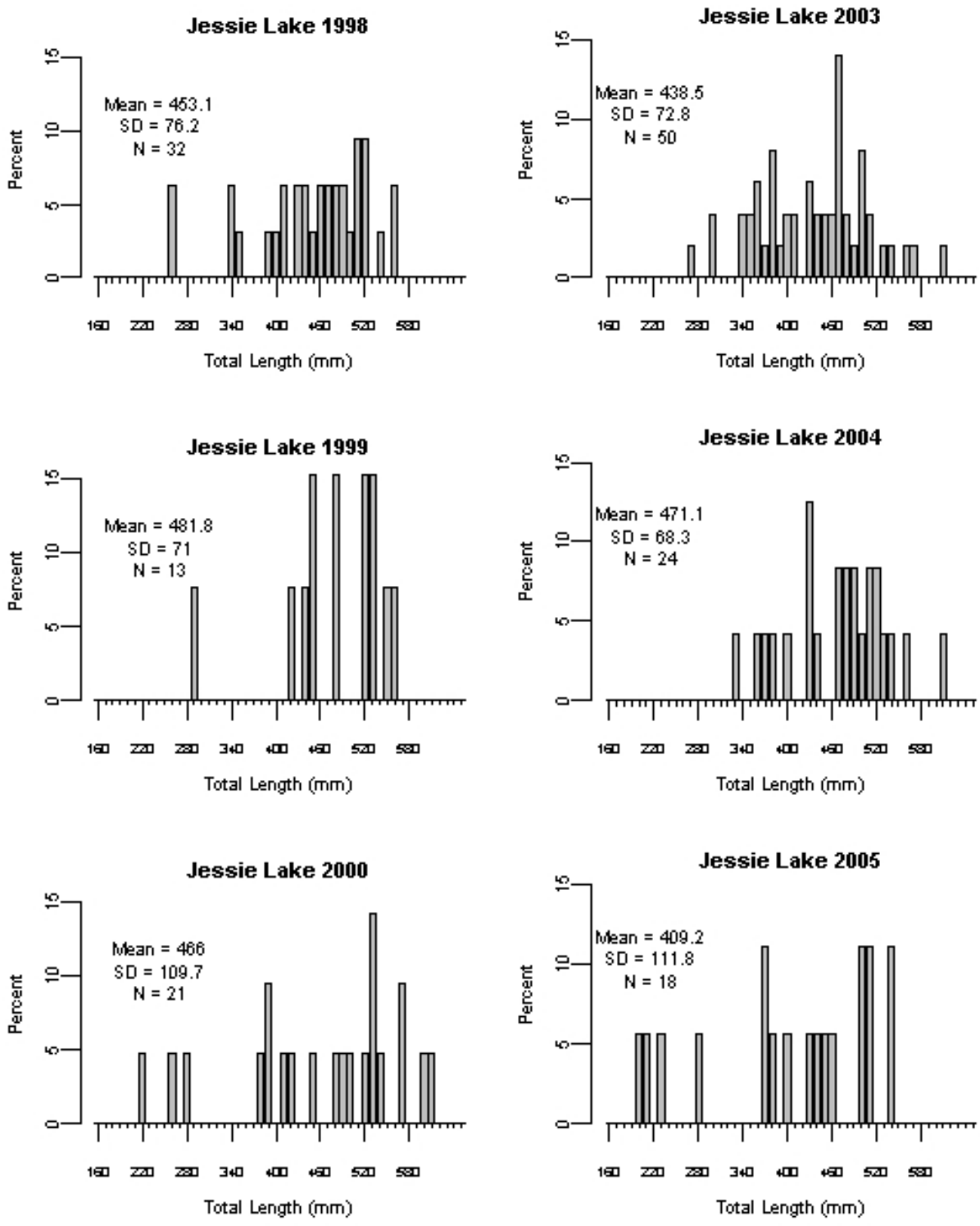


Figure A6-3: Size structure of brook trout caught by anglers in the Jessie Lake area of the Nipigon River from 1997 to 2010.

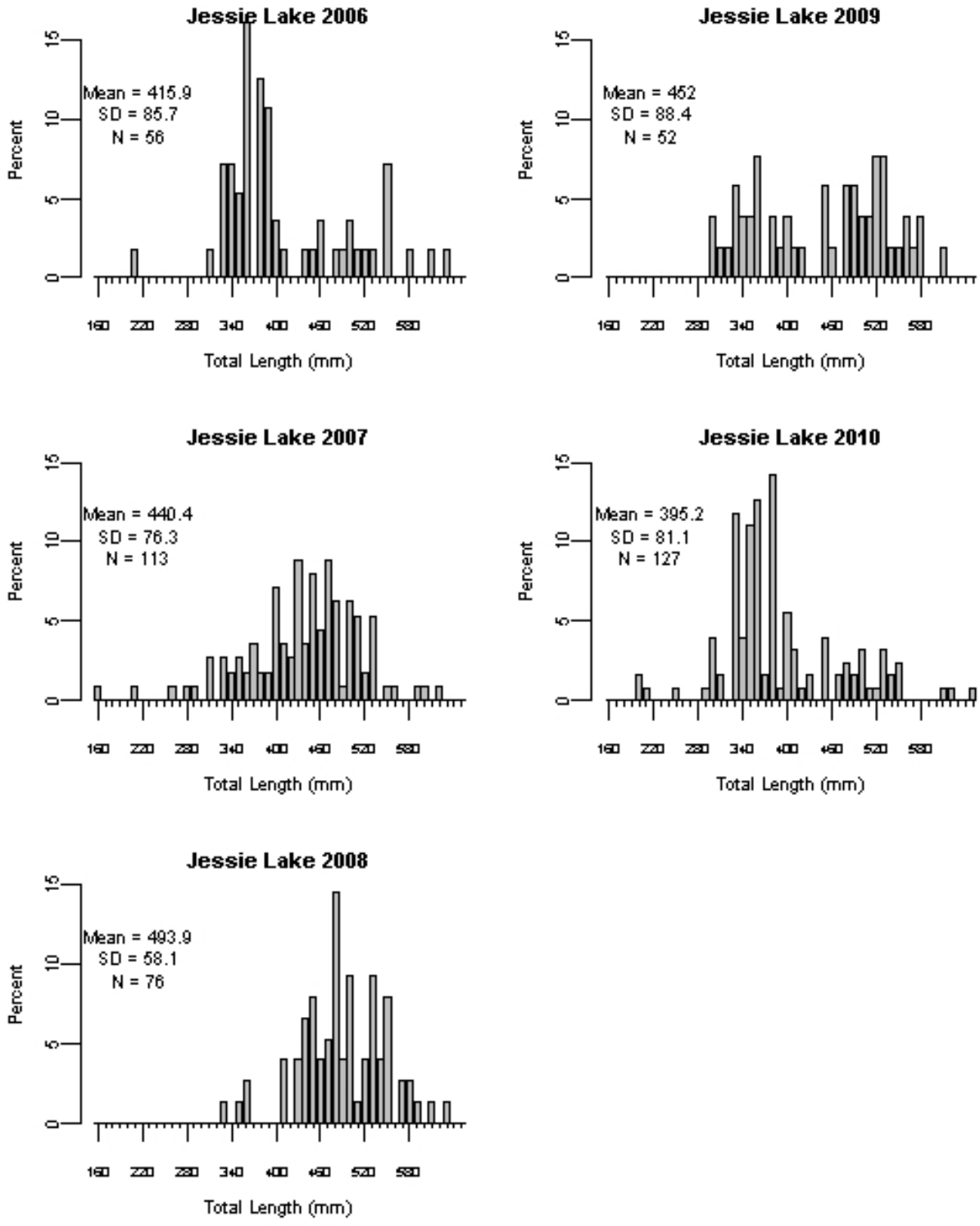


Figure A6-3, continued

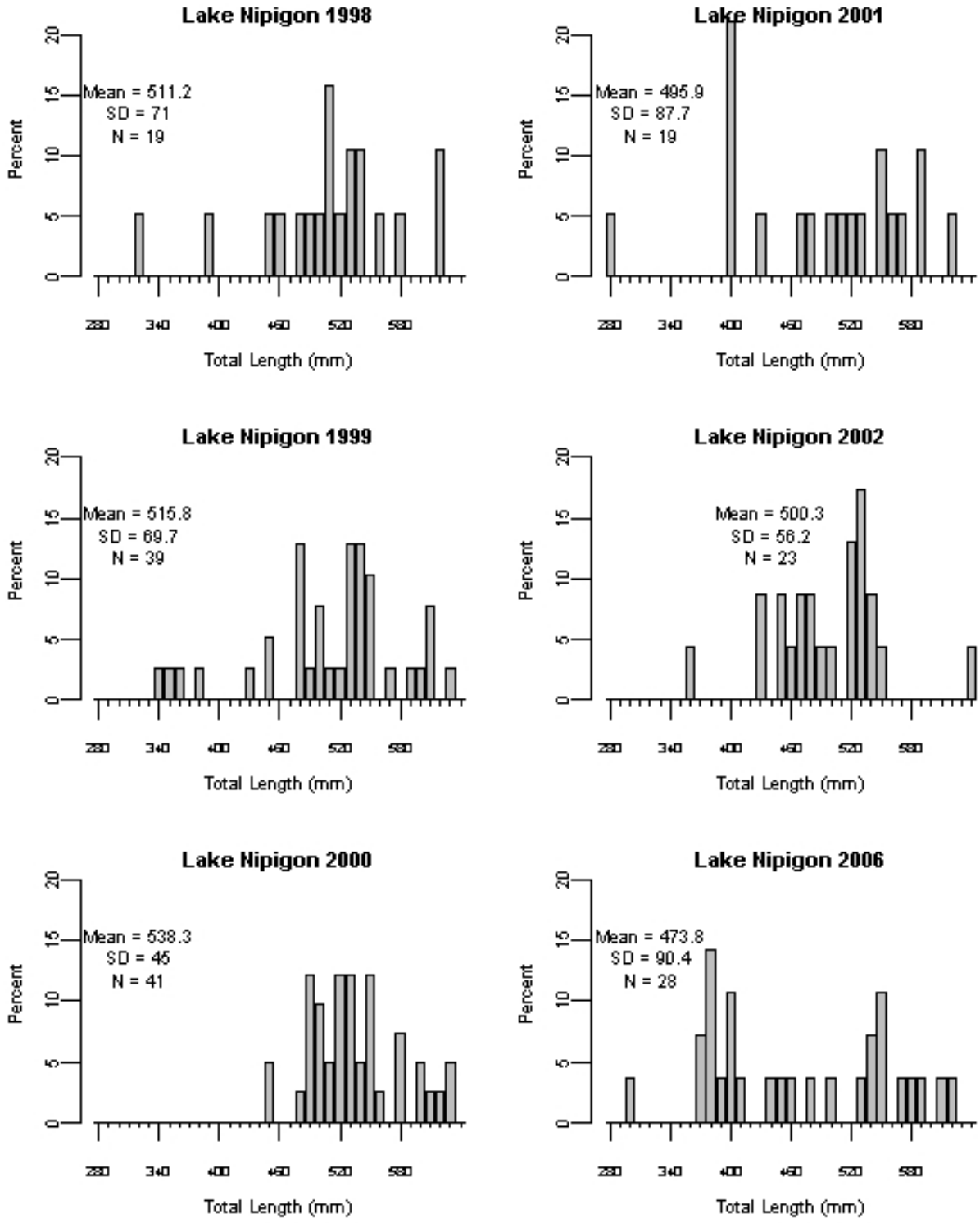


Figure A6-4: Size structure of brook trout caught by anglers in Lake Nipigon during 1998, 1999, 2000, and 2006. NB: Small sample sizes prevented similar analyses in other years.

The size of brook trout caught by anglers did not increase in all regions after the sport fishing regulation was changed in 2005, nor did the proportion of brook trout greater than 56 cm (22 in) increase in all regions (Table A6-3). However, the proportion of brook trout greater than 22 inches increased in Nipigon Bay and Jessie Lake, but not at Cameron Falls and Lake Nipigon (Table A6-3). The average size of angled brook trout increased in Lake Nipigon, but not at Cameron Falls, Nipigon Bay, and Jessie Lake (Table A6-4).

Table A6-3: Length statistics for brook trout caught by anglers on Nipigon Bay, Lake Nipigon, and sections of the Nipigon River before and after the sport fishing regulation was modified in 2005. Insufficient data prevented similar analysis for other regions.

Region	Period	Number	Min	Max	Average (± SD)	Statistically different (p value)	% >22"
Nipigon Bay	Pre-2005	587	180	675	447.2mm (±70.1)	NO(P=0.6)	3.0
	Post-2005	232	241	603	443.2mm (±74.2)		3.4
Jessie Lake	Pre-2005	140	229	616	455.6mm (±79.6)	YES (P <0.005)	8.6
	Post-2005	442	165	657	433.6mm (±80.0)		5.2
Cameron Falls	Pre-2005	35	285	571	454.7mm (±72.6)	YES P(<0.01)	5.9
	Post-2005	21	270	560	398.5mm (±64.8)		4.8
Lake Nipigon	Pre-2005	141	305	635	495.8mm (±76.2)	NO (p = 0.2)	18.8
	Post-2005	52	280	647	516.5mm (±65.4)		18.3

Recaptures:

The number and rate of tagged brook trout that were later recaptured varied across years and regions (Table A6-2). In years when data was available, recapture rate was highest in Jessie Lake and Cameron Falls, and varied from 5% to 33% and 14% to 24%, respectively. Higher recapture rates were observed in Lake Nipigon in 2007, however only two brook trout were tagged that year. Recapture rates in Lake Nipigon were generally lower than other regions. Recapture rates in Nipigon Bay ranged from 2 to 18%. Recapture rates observed in this study should be considered a minimum estimate, as numerous anglers not participating in the tagging program catch and recapture brook trout in each of the regions.

The longest time between capture and recapture was 3 years. This brook trout was 51 cm (20.1 in) when tagged in Nipigon Bay, and 54 cm (21.3) when recaptured. Conversely, the shortest time between capture and recaptured was displayed by a brook trout tagged on the Lower Nipigon River that was recaptured later that same day.

The number of brook trout in the Jessie Lake sport fishery was estimated in 2007 using mark-recapture methods. One angler tagged 102 brook trout in 2007. In 2008, the same angler captured 135 brook trout, 16 of which were tagged in 2007. Using this information, an estimated 823 (± 325) brook trout were present in the sport fishery in the Jessie Lake area in 2007. Similar information was not available for other regions and years because the status (i.e tagged, untagged) of all captured brook trout was unknown, or the number of recaptures was less than 8, which would result an estimate with low statistical confidence (Krebs 1999).

Growth:

Information on the growth of brook trout in the Jessie Lake area of the Nipigon River was provided from the recapture of 32 tagged brook trout (Table A6-4). In general, brook trout grew approximately 7.5 cm (3 in) and 450g (1 lb) per year and growth reduced as fish became longer.

Table A6-4: Annual growth of brook trout in the Jessie Lake section of the Nipigon River.

Brook trout size	Growth	
	Length	Weight
Less than 355.6mm (14.0 in)	129 mm (5.1 in)	957g (1.9 lbs)
Between 355.7mm (14.0 in) and 457.2mm (18.0 in)	83mm (3.3 in)	590g (1.3lbs)
Between 457.3mm (18.0 in) and 485.0mm (19.0 in)	54mm (2.1 in)	685g (1.5 lbs)
Longer than 485.1 mm (19.0 in)	21mm (0.8 in)	241g (0.5 lbs)

Information on brook trout growth in the Cameron Falls area of the Nipigon River, Lake Nipigon, and Nipigon Bay is based on the recapture of 5, 8, and 16 brook trout, respectively. The average increase in total length was 43 mm/year (SD=52) in Nipigon Bay, 14 mm/year (SD=0.4) at Cameron Falls, and 42 mm/year (SD= 48) in Lake Nipigon.

Maximum increase in weight was displayed by a brook trout tagged in Jessie Lake in 2004, which grew 115 mm (4.5 in) and 1768g (3.9 lbs) in approximately one year. Maximum increase in length was observed by a brook trout captured in Nipigon Bay which grew 160mm (6.3in) in one year, however weight was not recorded.

Length and weight information was collected from 316 brook trout captured within Cameron Falls, Jessie Lake, and Lake Nipigon ranging in size from 317 g to 4173g (0.1 to 9.1 lbs), and 270 mm to 635 mm (10.6 to 25.0 in) (Figure A4-1). The weight - length relationship can be described by the following equation:

$_{Log}WT=010.82564 +2.950 * {}_{log}TL$

Using this relationship, the weight was predicted for brook trout of various lengths (Table A5-5).

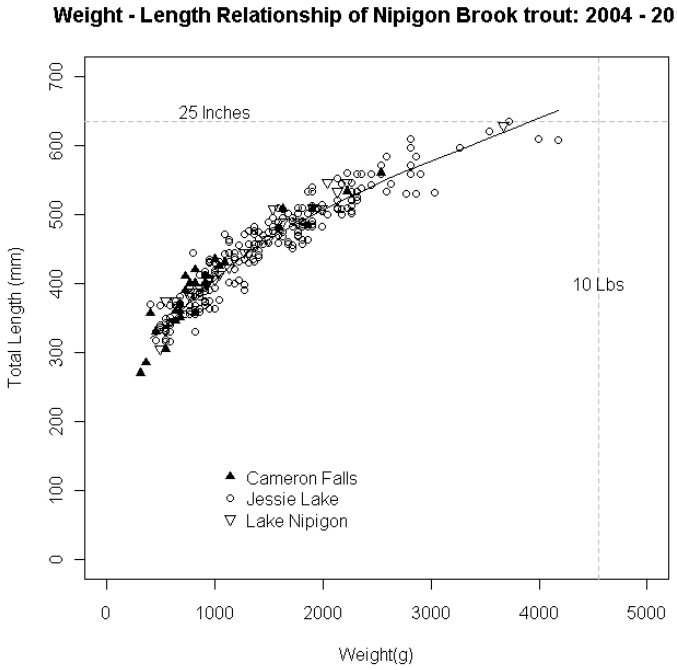


Figure A6-5: Length-weight relationship of brook trout captured within Cameron Falls, Jessie Lake, and Lake Nipigon from Co-operative angler program.

Table A6-5: The predicted weight of Nipigon area brook trout of a given lengths.

Length – mm (Inches)	Predicted Weight - Grams (Lbs)
300 (11.8'')	391 – 428 (0.96 – 0.84 lbs)
350 (13.8'')	626 -665 (1.37 – 1.46 lbs)
400 (15.75'')	937 – 976 (2.06 – 2.15 lbs)
450 (17.7'')	1330 – 1379 (2.93 – 3.03 lbs)
500 (19.7'')	1808 – 1889 (4.0 – 4.16 lbs)
550 (21.7'')	2379 – 2521 (5.24 – 5.55 lbs)
600 (23.6'')	3051 – 3284 (6.71 – 7.23 lbs)

References:

Krebs, C.J. 1999. Ecological Methodology, 2nd Edition. Menlo Park (CA): Addison Wesley Educational Publishers. 620pp

Pope, K. L., and C. G. Kruse. 2007. Condition. Pages 423-471 *in* C. S. Guy and M. L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda (MD).

Appendix 7: Estimating the age of Coaster Brook Trout

Accurately estimating the age of brook trout may be an important tool in efforts to restore brook trout populations in the Lake Superior and Lake Nipigon watersheds. Age estimates can provide information on life span, mortality/survival, and growth.

Brook trout ages are commonly estimated by inspecting scales, fin rays, or otoliths. Otoliths are considered to be a more accurate method for estimating the age of most fish species (DeVries and Frie 1996), however collecting otoliths requires lethal sampling. Scales and fin rays can provide a non-lethal alternative, although estimated age can be inaccurate, particularly for older brook trout (Stolorsky and Hartman 2008; Steele 1986; Dutil and Power 1977). Scales and fin rays may still be a valid method for estimating age for younger fish.

The possibility of using non-lethal methods to accurately estimate the age of brook trout in Lake Superior was investigated using aging structures collected during previous studies. Both scales and ventral fin rays were collected from fifty brook trout captured in the Cypress River in the fall of 2006. Scales and otoliths were collected from 38 brook trout captured in Nipigon Bay tributaries and nine brook trout captured in Nipigon Bay from 2005 to 2007. North Shore Environmental Services (Thunder Bay, ON) provided age estimates for scales and fin rays and Melissa Robillard (University of Guelph) conducted age estimates for otoliths.

Multiple structures collected from each fish provides an opportunity to evaluate the discrepancy in the estimated age between the two methods. The discrepancy in estimates of age of scales versus otoliths, and scales versus fin rays was evaluated using a variation of the age-bias plotting method (Campana et al. 1995). The age of each fish was estimated using both structures. Each fish was assigned to a group based on its age estimated using scales. The average age of all fish in each age group was then determined using the second structure (either otoliths or fin rays). This information is plotted to visualize the relationship between the age estimated using scales compared to fin rays (Figure A7-1), and scales compared to otoliths (Figure A7-2).

Data Interpretation

- Estimates of age using fin rays and scales are similar; however, scales underestimated the age of brook trout relative to fin rays typically by one year beginning at age 4. If estimates are indicative of true age, either method may be useful for management purposes.

- Estimates of age using scales and otoliths are not similar. Scales underestimated the age of brook trout relative to otoliths by 2 to 5 years beginning at age 1.

- Although estimates of age differed among structures, it remains unknown which structure most accurately represents true age. Further work is recommended to understand if age estimates using scales, fin rays, and othliths are indicative of true age.

- Estimates of age are highly variable depending on the structure used, suggesting age estimates and derivative parameters (e.g. mortality) should not be used in efforts to manage brook trout in Lake Superior.

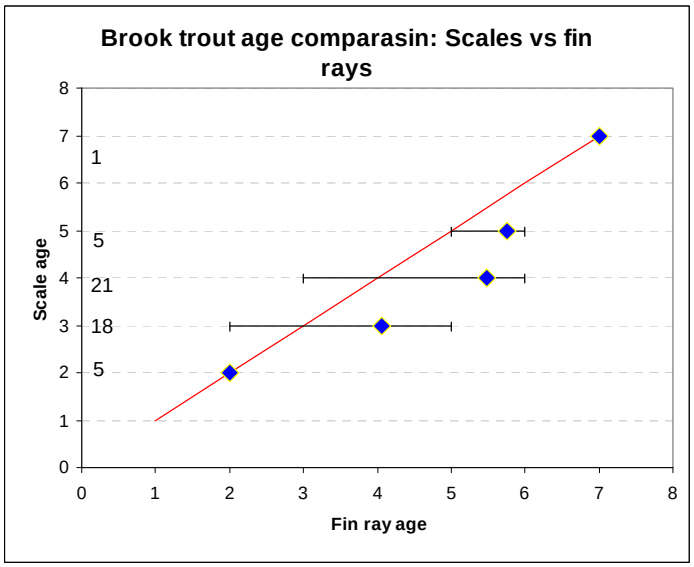


Figure A7-1: Comparison of the estimated ages of fifty Cypress River brook trout using scales and fin rays. The red line represents 1:1 agreement in the estimated age using the two structures. Numbers along the y-axis represent sample sizes. Error bars represent the range of ages estimated using fin rays

- Estimates of age are highly variable depending on the structure used, suggesting age estimates and derivative parameters (e.g. mortality) should not be used in efforts to manage brook trout in Lake Superior.

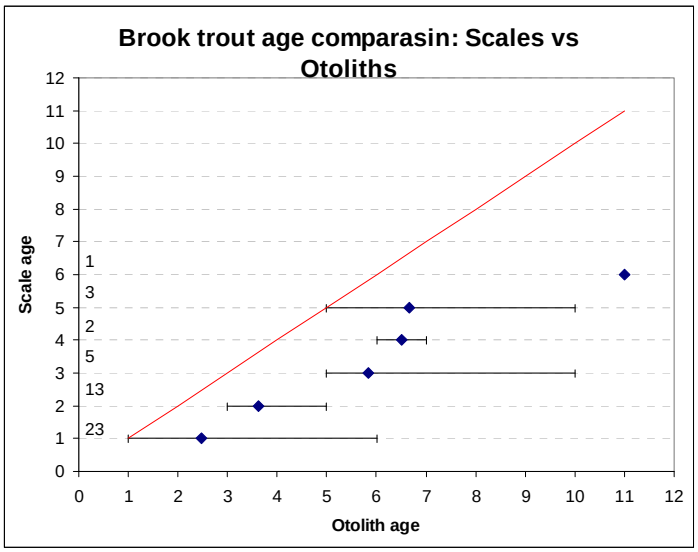


Figure A7-2: Comparison of the estimated ages of 47 brook trout from the Nipigon Bay watershed using scales and otoliths. The red line represents 1:1

Steele (1986) similarly compared age estimates using otoliths, fin rays, and scales from Sutton River (ON) brook trout, with comparable results to the Lake Superior studies. Maximum estimated age using scales was 6, and was 1 to 8 years younger than estimates using othliths.

Ritchie and Black (1988) compared the estimated ages of fin rays and otoliths collected from Lake Nipigon brook trout and found fin rays consistently underestimated the age of otoliths by at least one year, beginning at age 3.

In addition to the age estimates of Lake Superior brook torut presented above, North Shore Environmental Services also conducted age estimates for Ritchie and Black (1988), and Steele (1986).

References:

Campana, S. E., M. C. Ann, and, and J. I. McMillan. 1995. Graphical and statistical methods for determining the consistency of age determinations. Transactions of the American Fisheries Society. 124:131-138.

DeVries, V.R., and R.V. Frie. 1996. Determination of Age and Growth. Pages 209-242 *in* A. H. Whetherley, and H. S. Gill [editors]. The Biology of Fish Growth. New York, Academic Press.

Dutil, J. D., and G. Power. 1977. Validity of reading otoliths compared to reading scales for determination of age of brook trout (*Salvelinus fontinalis*). Naturaliste Canadien. 104:361–367.

Ritchie, B.J. and J. Black. 1988. Status of the Lake Nipigon brook trout fishery and assessment of stresses, 1923-1987. Lake Nipigon Fisheries Assessment Unit Report. Ontario Ministry of Natural Resources, Nipigon (ON).

Steele, P.O. 1986. Life History Strategies of a North Temperate Salmonid, *Salvelinus fontinalis*, in Polar Bear Provincial Park, Ontario. Page 199. Department of Zoology. University of Western Ontario, London, ON.

Stolarski, J.T. and K.J. Hartman. 2008. An evaluation of the precision of fin ray, otolith, and scale age determinations for brook trout. North American Journal of Fisheries Management 28:1790-1795.

Appendix 8: Lake Superior, Lake Nipigon, and Nipigon River Brook Trout Workshop – Minutes of Final Discussion Period

Monitoring and Assessment

Participants expressed concern over limited information available for Lake Superior brook trout. Recommendations were made to collect more information on both brook trout populations (abundance, size, & distribution), and their associated sport fisheries (angler catch & harvest).

The challenging logistics associated with a brook trout creel survey on Lake Superior were discussed. Few anglers are spread across a large area, and many access points are used. The possibility of working with municipalities was suggested. A voluntary creel may be suitable in this case, similar to creel survey used in Algonquin Provincial Park.

The Co-operative Brook Trout Angler Program may provide some of the information needed for Lake Superior. Specifically, measures of relative abundance (catch per unit effort), population structure (size and age), and distribution. Perhaps the number of participating anglers should be expanded and a gradient of anglers from expert to novice should be included to provide a representative sample. Perhaps the FMZ 9 Advisory Council could be expanded to eastern Lake Superior to engage more anglers. OMNR should decide what information is needed from Co-op anglers and communicate annual findings to participants. Concerns were raised over the amount of co-ordination required. Perhaps "new-age media" may be appropriate for co-op angler program (e.g. internet blogs).

Concerns were raised that the Co-op program may not provide sufficient information, and a fishery independent survey was recommended. The methods used in the US (boat electrofishing nearshore habitats) may be appropriate. Inter-jurisdiction partnerships were recommended to continue assessment of populations on a lake-wide scale. Data sharing among agencies may be possible through the Great Lakes Fisheries Commission – Lake Superior Technical Committee. Suggestion that a survey of this type could also provide more information on aging.

Concern was expressed regarding the known distribution of brook trout in Lake Superior and Lake Nipigon. Undocumented streams may support coaster populations. Information collected during 1980's from Pukaskwa National Park should be investigated, and studies are recommended. Fall surveys similar to those conducted by the Minnesota DNR may be appropriate for this type of work. Historical data of coaster presence Lake Superior should be explored.

Recommendation that survey of groundwater upwellings along Lake Superior shoreline should be finalized. This work began in the mid-1990's, but has not been formally reported.

Research

The following research topics were suggested:

Determine if Lake Nipigon brook trout use stream environments. This has been documented in Lake Superior, but not in Lake Nipigon. Perhaps habitat information from Lake Superior tributaries could be used to predict which Lake Nipigon tributaries contain migratory brook trout. Work described by Moore (2008) and D'Amelio (2004) may provide this type of information.

Determine if Lake Superior brook trout spawn on shoals in Ontario. This is currently unknown but occurs in U.S. populations (Isle Royale, Michigan)

Is migratory behaviour of coaster brook trout a genetic trait? Is the large size of brook trout in this region a genetic trait?

A human dimensions study may be necessary to identify the most effective audience and vector for education/outreach to improve rehabilitation efforts. A case study from Fundy National Park in New Brunswick was discussed, and similar academic research was suggested. OMNR research scientists may be able to conduct such a study (Dr.'s Len Hunt and Rob Rempel recommended). It was suggested that restrictive regulations decreased fishing activity for Lake Superior coaster brook trout and a human dimension study may have prevented this.

Still appear to be unanswered questions related to movement of brook trout in Lake Superior. However, monitoring brook trout populations and fisheries is the more pressing information need.

Research projects should be prioritized to address most important information for the rehabilitation of brook trout populations and fisheries.

Additional Management Actions

History has shown low success of stocking. Recommendation that stocking should not occur in Ontario.

Water crossings along Nipigon Bay tributaries may be revisited in the future. OMNR should work with DFO to address coaster brook trout requirements for water crossings.

Objectives for brook trout rehabilitation should be established (qualitative/quantitative values for abundance, size, distribution, age, etc.). Perhaps Lake Superior, Lake Nipigon and Nipigon River should have separate goals. OMNR Fisheries Management Zone Councils could be responsible for establishing goals.

Adaptive management was suggested to implement research. Clearly stated management objectives were suggested which use the most current information. Management goals and progress should be re-evaluated when changes occur and new information is available.

Including more persons and organizations in management was suggested. Partnerships may be important to address management issues.

A public education strategy was suggested to help rehabilitation. Outreach to younger ages may be important. High school education sessions similar to previous efforts by Minnesota SeaGrant may be effective.

References:

Moore, S.A. 2008. Predicting brook trout distribution based on landscapes, habitats, fish communities, and life history traits. Doctoral Dissertation. University of Minnesota.

D'Amelio, S. 2004. Coaster brook trout stream habitat. Trout Unlimited Technical Report # ON – 001.

Appendix 9: Lake Superior, Lake Nipigon, and Nipigon River Brook Trout Workshop – Comments received from the Ontario Federation of Anglers and Hunters, March 15 2011

Thank you for the opportunity to participate in the workshop. A lot of our concerns are reflective of what was discussed and noted at the end of the session, however, I feel that the OFAH Zone B needs to be on record with these concerns as well.

Lake Nipigon and the Nipigon River above Alexander Dam needs to have its own management plan. We can agree that from Alexander Dam down to Lake Superior be included in the existing regulations because Coaster Brook Trout from Lake Superior do use that portion of the river. However, the upper reaches are not available to them due to OPG dams. We feel that the brook trout in the upper reaches of the river and Lake Nipigon are a separate population and therefore, should be managed as such.

In order to properly address the Coaster Brook Trout issue we feel that the east side of Lake Superior FMZ 9 sub-committee needs to be struck. This is a lake wide issue and it is important that stakeholders from around the whole of Lake Superior have input. There are also 3 land- based Fisheries Management Zone (FMZ) Councils (FMZ 6, FMZ 7 and FMZ 10) that are affected by this regulation. These councils should be consulted and their input taken into account.

To date all research has been confined to Nipigon Bay and the tributaries. Although more work is needed in that area, we also feel that there are still areas where research should be further expanded. In the background summary provided to the original Coaster Brook Trout committee under "Thunder Bay District" it states that upwelling areas were identified from Pigeon River to Thunder Cape. Nipigon strain Brook Trout fingerlings were raised by the Thunder Bay Salmon Association and stocked from 1994-1997 over sites that contained suitable habitat. The background summary at that time indicated that large Brook Trout were being caught but no further assessment of the success of the stocking had been conducted. Assessment of the population from Thunder Cape to Pigeon River, as well as, east of Nipigon Bay needs to take place. Any decisions that may come out of this cannot be based solely on the data that has been collected from the Nipigon system.

Research is required to identify spawning areas in Lake Superior used by Coaster Brook Trout to help determine the amount of spawning that occurs in the lake versus in tributary habitats.

A better understanding of what characteristics of tributary streams make them productive (i.e. what triggers the development) in terms of Coaster Brook Trout, and how these critical habitats can be enhanced in other streams. Naturalized species such as Rainbow Trout, Chinook and Coho salmon may utilize the same tributaries for spawning and nursery habitat. The Ministry of Natural Resources (MNR) has indicated that Brook Trout compete for spawning sites, while the juveniles compete for food

and territory. Further research needs to be done to determine what, impacts, if any; this may be having on Brook Trout populations.

Is it realistic to expect numbers of Coaster Brook Trout to return to historic levels with environmental and habitat changes that have occurred during the last century? Goals for rehabilitation need to be reasonable and achievable.