PROPOSED

***Species at Risk Act***
Recovery Strategy Series

# Recovery Strategy for the Aurora Trout (*Salvelinus fontinalis timagamiensis*) in Canada

## Aurora Trout

May 2006

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

## About the Species at Risk Act Recovery Strategy Series

**What is the *Species at Risk Act* (SARA)?**

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

**What is recovery?**

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

**What is a recovery strategy?**

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

**What's next?**

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

**The series**

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

**To learn more**

To learn more about the Species at Risk Act and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

# Recovery Strategy for the aurora trout (*Salvelinus fontinalis timagamiensis*) in Canada

# [Proposed]

**May 2006**

**Recommended citation:**

Aurora Trout Recovery Team. 2005. Recovery Strategy for the Aurora Trout (*Salvelinus fontinalis timagamiensis*) in Canada [Proposed]. *In* Species at Risk Act Recovery Strategy Series. Ottawa: Fisheries and Oceans Canada. 53 pp.

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**Cover illustration:** Aurora trout by Cory Trepanier

**Également disponible en français sous le titre :** «Ébauche stratégie nationale de rétablissement de l'omble de fontaine aurora (*Salvelinus fontinalis timagamiensis)*»


ISBN To come
Cat. no. To come



## DECLARATION

This proposed recovery strategy for the aurora trout has been prepared in cooperation with the jurisdictions described in the Preface. Fisheries and Oceans Canada has reviewed and accepts this document as its recovery strategy for the aurora trout as required by the *Species at Risk Act*.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries and Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries and Oceans invites all Canadians to join Fisheries and Oceans Canada in supporting and implementing this strategy for the benefit of the aurora trout and Canadian society as a whole. Fisheries and Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. The Minister will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of the species. The Minister will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

# RESPONSIBLE JURISDICTIONS

The responsible jurisdiction for the aurora trout is Fisheries and Oceans Canada. Aurora Trout occurs in Ontario, and their respective governments also cooperated in the production of this recovery strategy:

# AUTHORS

This document was prepared by aurora trout Recovery Team.

Members of the Recovery Team:
The members of the existing aurora trout Management Committee have prepared this Recovery Strategy.  Hereafter, for the purposes of this document, the Management Committee will be referred to as the aurora trout Recovery Team (ATRT).  The Recovery Team currently consists of the following members:

- Kevin Pinkerton (Committee Chair); Manager, Hills Lake Fish Culture Station (HLFCS), (OMNR);
- Jeff Brinsmead (Principle Author), Northeast Region, (OMNR)
- Alan Dextrase, Species at Risk Section, (OMNR)
- Thom Heiman, (DFO)
- John Gunn, Cooperative Freshwater Ecology Unit, Laurentian University
- Chris Wilson, Research Scientist, OMNR/Trent University
- Ron Ward, (HLFCS), (OMNR)
- Larry Ferguson, Kirkland Lake District, (OMNR)
- Chuck McCrudden, North Bay District, (OMNR)
- Karen Stokes, Timmins District, (OMNR)
- Raymond Tyhuis, Nipigon District, (OMNR)

Past Recovery Team members involved in the preparation of the Recovery Strategy include: Greg Deyne, Rodger Leith (Principle Author), Mike Mazzetti, Linda Melnyk-Ferguson, Bill McCord and Ed Snucins.

# ACKNOWLEDGMENTS

The Recovery Team would like to thank all Ontario Ministry of Natural Resources (OMNR), Fisheries and Oceans Canada (DFO) and Environment Canada (EC) personnel who provided comments on an earlier draft of the strategy.  OMNR (Fish and Wildlife Branch and the Ontario Parks Species at Risk Program) and the Endangered Species Recovery Fund (co-sponsored by World Wildlife Fund Canada and the Canadian Wildlife Service of Environment Canada) are to be commended for their long-standing and continued financial commitment to the recovery of aurora trout. A debt of gratitude is extended to all those involved in previous and current recovery efforts, especially the staff of the Cooperative Freshwater Ecology Unit, a partnership of OMNR, EC, and Laurentian University, who have conducted field studies in the native lakes for more than 20 years. Lastly, the aurora trout Recovery Team would like to acknowledge the foresight of Paul Graf, former manager at Hills Lake Fish Culture Station, who recognized the plight of this species during the 1950s and took steps to establish a captive breeding program, thereby ensuring a unique component of Canada's rich aquatic biodiversity was not lost forever.

## PREFACE

The aurora trout is a freshwater fish and is under the jurisdiction of the federal government. The *Species at Risk Act* (SARA, Section 37) requires the competent minister to prepare recovery strategies for listed extirpated, endangered or threatened species. The aurora trout was listed as endangered under SARA in May 2000. Fisheries and Oceans Canada – Central and Arctic, led the development of this recovery strategy. The proposed strategy meets SARA requirements in terms of content and process (Sections 39-41). It was developed in cooperation or consultation with:

- Jurisdictions – Ontario
- Aboriginal groups – Abitibi – Wahgoshig, Timiskaming, Matachewan, Mattagami, Wahnapitae, Temagami. Ginoogaming, Long Lake, and Pic River.

## STRATEGIC ENVIRONMENTAL ASSESSMENT

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally-sound decision making.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The recovery planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly in the strategy itself, but are also summarized below.

This recovery strategy will clearly benefit the environment by promoting the recovery of the aurora trout. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not entail any significant adverse effects. Refer to the following sections of the document in particular: Description of the species' needs – biological needs, ecological role and limiting factors; Effects on other species; and Recommended approach for recovery, as applicable.

# EXECUTIVE SUMMARY

First discovered in 1923 by an angling party, aurora trout (*Salvelinus fontinalis timagamiensis*) were initially described in the literature as a new species (*Salvelinus timagamiensis*). Today aurora trout are generally believed to be a form of brook trout (*Salvelinus fontinalis*) that are endemic to only two lakes – Whirligig Lake and Whitepine Lake. Both lakes are located within the same watershed within Lady Evelyn Smoothwater Provincial Park, about 110 kilometers north of Sudbury, Ontario. While many similarities to brook trout have been noted, significant differences have been reported for aurora trout with respect to colouration, skeletal features, and possibly spawning behaviour. These differences have been, and continue to be, used to support arguments for aurora trout to receive a subspecies designation. While genetic evaluation has not supported a subspecies designation to date, recent advancements in genetic assessment may assist in determining their taxonomic status.

Although there remains an element of uncertainty as to whether aurora trout are distinct sub-specifically from brook trout, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated aurora trout as an endangered species in 1987. In reconfirming this designation in 2000, COSEWIC referred to aurora trout as *Salvelinus fontinalis timagamiensis*, a subspecies of brook trout. However, COSEWIC did note concern about their ability to list it as a designatable unit in light of its uncertain taxonomic status.

Aurora trout populations were noted to be declining as early as the 1940s and were extirpated from the wild by 1967 due to lake acidification. A captive breeding program, established by the Ontario Department of Lands and Forests in the late-1950s, prevented the aurora trout from going extinct. Reductions in atmospheric pollutants, in concert with whole lake liming, enabled the re-establishment of self-sustaining populations of aurora trout in both native lakes by the mid-1990s.

While short-term recovery efforts have been extremely successful in terms of re-establishing self-sustaining aurora trout populations into both native lakes, the success of long-term recovery efforts are unknown. Past human intervention (whole lake liming treatments) has been relied upon to maintain adequate lake pH. Although no further intervention has been necessary in over a decade, the principle threats to the long-term success of aurora trout recovery continue to be acidification as well as the potential for inbreeding depression.

The primary long-term goal of this recovery strategy is: *To maintain secure self-sustaining aurora trout populations in both native lakes (Whirligig Lake and Whitepine Lake) at a minimum biomass target of 13 kg/ha for Whirligig Lake and 12 kg/ha for Whitepine Lake; a density of adult fish of 29 fish/ha for Whirligig Lake and 20 fish/ha for Whitepine Lake; and an age class structure that demonstrates no missing year classes. These targets must be achieved in the absence of any further human intervention (e.g. liming).*

In addition to the primary goal, three secondary recovery goals have been identified: *(1) To establish a secure, self-sustaining aurora trout population in one or two non-native, well-buffered lakes to act as a wild brood stock refuge for the native populations in Whitepine Lake and Whirligig Lake; (2) to clarify the taxonomic status of the aurora trout, that is to determine if aurora trout are distinguishable from brook trout at the molecular genetic level; and (3) to maintain the captive breeding program.*

To achieve these goals, a suite of short-term recovery objectives for the period 2005 – 2010 have been developed. To facilitate the delivery of these recovery objectives, specific approaches and strategies were produced and are organized into four broad recovery categories – Legislation and Policy, Research, Habitat Management and Population Management. Implementation will be delivered via a subsequent Recovery Action Plan (RAP) by the ATRT, other government and non-government agencies, experts and stakeholders. A series of specific steps and anticipated effects has been prepared to guide recovery efforts. The evaluation of the success of this strategy will employ a series of biological and social criteria.

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# INTRODUCTION

Aurora trout were initially believed to be a distinct species when first described by Henn and Rickenbach (1925). Since then, others have classified it as a sub-species of brook trout (*Salvelinus fontinalis*) (Martin 1939; Sale 1967; Qadri 1968 and Behnke 1980), while Vladykov (1954) thought it was more a colour variant of brook trout. Aurora trout are currently considered a race of brook trout (Snucins and Gunn 2000); however, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has retained the sub-species designation. Aurora trout are known to have existed with sympatric populations of brook trout in their native lakes with little genetic mixing. This supports the recognition of aurora trout as a distinct evolutionary unit.

Sale (1967) described the colouration of aurora trout comparable to that of brook trout, with the dorsal surface being an olive green to dark brown that fades to an iridescent bluish-silver along the sides, ending in a white underbelly that is often coloured with shades of pink. The dorsal and caudal fins possess a black leading edge, while the remaining fins have a leading white edge followed by a band of black pigmentation with the rear portion sporting a red or orange colouration. All colours intensify during the fall spawning season. Similar to the female brook trout, female aurora trout only show slight heightening of colouration, while both brook trout and aurora trout males develop a more pronounced hook to the jaw and a slight hump to the back. The sides and upper ventral areas in male aurora trout become a brilliant red frequently edged by a black stripe. In their respective descriptions of the aurora trout, Sale (1967) and Henn and Rickenbach (1925) noted two distinct visual differences from that of brook trout: (i) adult aurora trout lack the yellow spots and vermiculations observed on the dorsal surface of brook trout; and (ii) the numerous red spots encompassed by blue halos on the sides of brook trout were significantly reduced in number, or in most cases, were completely absent on aurora trout. Sale (1964) observed a tendency for the yellow markings to be present in young aurora trout, however these markings were absent in adult aurora trout. Quadri (1968) noted that vermiculations were visible on an adult aurora trout preserved in formalin. Pale vermiculations were apparent on some of the aurora trout captured during 2003 in the native lakes (E. Snucins, pers. comm.).

Qadri (1968) observed differences between aurora trout and brook trout in skeletal structure; in particular, the number of trunk vertebrate, the number of ribs with strongly bifid heads, the number of single neural spines and the total number of epineurals. There are also some morphometric differences, including the length of the maxillary.

## SPECIES INFORMATION

**COSEWIC Assessment Summary**

**Common Name:** Aurora Trout
**Scientific Name:** *Salvelinus fontinalis timagamiensis*
**COSEWIC Status:** Endangered
**COSEWIC Reason for designation:** Formerly extirpated in the wild, re-introduced populations of this species are dependant on continuing intervention such as liming of the lakes to buffer acidity
**Canadian Occurrence:** Ontario
**COSEWIC Status History:** Designated Endangered in April 1987. Status re-examined and confirmed in May 2000. Last assessment based on an updated status report

## I. BACKGROUND

**General Biology:**
Based on a 2003 survey, aurora trout in their native waters have a fork length distribution from 90 – 420 mm in Whirligig Lake and 60 – 490 mm in Whitepine Lake. Adults weigh approximately 0.5 – 1.0 kg, although fish approaching 3.5 kg have been angled out of the stocked, non-native, put-grow-and-take waters.

Aurora trout are generalist feeders. Although a large part of their diet is comprised of aquatic insects and zooplankton, they have also been found to consume crustaceans, mollusks, frogs and mice.

Sexual maturity is attained between the ages of 2 – 4 years, and thereafter they are thought to spawn annually. Spawning occurs in October and November and redds are cleared over groundwater upwellings. Courtship and spawning behaviour have not been documented in either of the native lakes; however, it is expected to be similar to the spawning behaviour of brook trout. While cases of hybridization with brook trout have been documented in non-native lakes (Sale 1967), the sympatric populations in Whitepine Lake appeared to coexist with limited interbreeding. This suggests that there may have been either spatial or temporal segregation in the spawning activities of the two species in Whitepine Lake.

Female aurora trout lay approximately 1300 to 1700 eggs. Egg incubation periods documented within the hatchery environment suggest that incubation times are similar to hatchery brook trout (R. Ward, pers. comm.).

Based on field observations and laboratory aging, the maximum known lifespan in the wild is nine years.

**Distribution of the Species:**
Aurora trout are endemic to only two lakes world wide. Both Whirligig Lake (47º 22’ N, 80º 38’ W) and Whitepine Lake (47º 23’ N, 80º 38’ W) are located approximately 110 km north of Sudbury, Ontario within North Bay District (Figure 1). The waterbodies are situated in the hilly Precambrian Shield landscape of Lady Evelyn-Smoothwater Provincial Park in the Montreal River watershed. Other waterbodies have been thought to hold natural aurora trout populations (Henn and Rickenbach 1925, Sale 1967); however no authenticated records of additional native breeding populations have been found (Snucins and Gunn 2000).

Whirligig Lake is 11 ha in size with a maximum depth of 9.1 m, a Secchi depth of 3.3 – 6.2 m and an end of summer thermocline of 3 – 8 m. Whitepine Lake is 77 ha in size with a maximum depth of 21.3 m, a Secchi depth of 3.5 – 6.0 m and an end of summer thermocline of 4 – 9 m.

Both native populations declined in the 1940s and 1950s, and were extirpated from the wild by the late-1960s as a result of acidification. Re-introduction efforts during the early-1990s have re-established self-sustaining, naturally-reproducing populations in both of these waterbodies.

In addition to the successful re-introductions of aurora trout in both native waters, there have been several efforts to establish a self-sustaining population in non-native waters in northeastern Ontario. Previous efforts have included Paddle Lake, Reed Lake and Seahorse Lake (Kirkland Lake District) in the late-1950s and early-1960s, and Strong Lake in the 1980s; Lake # 8 Swartman (Cochrane District) in 1962; Young Lake and Claire Lake (Hearst District) in the mid- to late-1970s; Semple #54 Lake (Timmins District) in the 1990s and Lizard Lake (no date available); however none of these efforts were successful. Stocking no longer occurs in any of these waters. Southeast Campcot Lake (49º 03’ N, 86º 37’ W) and Northeast Campcot Lake (49º 03’ N, 86º 37’ W) near Terrace Bay were stocked in the late-1980s and showed evidence of natural reproduction by the early-1990s, unfortunately both populations appear to have been extirpated by 2001 (Snucins *et al.* 2002). In 2004, aurora trout were again stocked in Southeast Campcot Lake.

At the time of writing, there are non-reproducing aurora trout populations in ten waterbodies in northern Ontario; all of which are maintained through stocking of hatchery-reared fish from a captive breeding program. The lakes are: Liberty Lake (47º 11’ N, 80º 04’ W), Carol Lake (47º 18’ N, 81º 23’ W), Pallet Lake (48º 16’ N, 80º 39’ W), Nayowin Lake (47º 47’ N, 81º 23’ W), Big Club Lake (48º 28’ N, 80º 48’ W), Wynn Lake (48º 16’ N, 79º 53’ W), Borealis Lake (49º 01’ N, 86º 44’ W), Tyrell #21 (47º 37’ N, 80º 57’ W), Timmins #57 (80º 67’ N, 48º 30’ W ) and Alexander Lake (48º 17’ N, 80º 35’ W) (Figure 1).

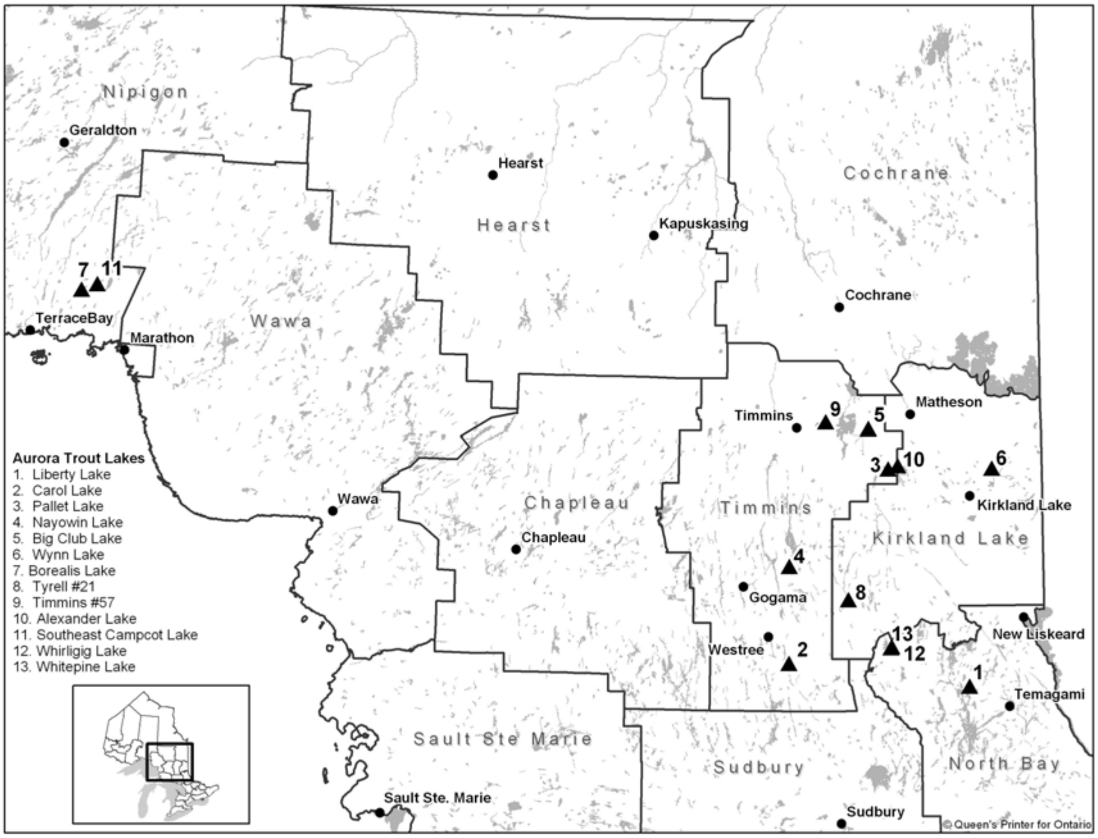


Figure 1 Global distribution of aurora trout (*Salvelinus fontinalis timagamiensis*).

This geographic enhancement of range is the result of (i) the establishment of a 'wild' brood stock lake (Alexander Lake) to facilitate and augment the captive breeding program within the hatchery system; (ii) efforts to establish a self-sustaining aurora trout population in a non-native waterbody with greater natural buffering capacity to act as a refuge in the event of re-extirpation of the native waterbodies or a catastrophic event within the hatchery that may compromise the existing aurora trout stock; and (iii) a two decade old effort to increase public awareness and generate public and stakeholder support for the aurora trout recovery program (and species at risk in general) by establishing a maximum of nine put-grow-and-take lakes.  These lakes provide limited trophy sport fisheries that are tightly regulated and operate on a seasonal, rotational basis (additional details on the rationale for the geographic range enhancement can be found in Section 12 – Activities Permitted by the Recovery Strategy).

**Population Abundance:**
There are no historical population or biomass estimates available for Whirligig and Whitepine lakes.  Data collected during the early to mid-1950s prior to extirpation has been lost, precluding any comparison of the native lake populations between time periods.

The treatment of Whirligig Lake and its headwaters with powdered calcite during October 1989 successfully raised the pH of the lake to 6.5. Following treatment, hatchery-reared aurora trout were stocked in Whirligig Lake in the spring of 1990 and a naturally reproducing self-sustaining population was established (Snucins *et al.* 1995). Whitepine Lake was stocked in 1991 and again in 1994 before a self-sustaining population developed. Since this time, population abundance and biomass have increased in both lakes (Table 1).

**Table 1. Population and biomass estimates for the native aurora trout lakes (Whirligig Lake and Whitepine Lake). Estimates are for fish >280 mm fork length in Whirligig Lake and >320 mm fork length in Whitepine Lake (except where indicated otherwise). The figures in brackets represent 95% confidence intervals.**

| Year | Lake | | | | | |
|---|---|---|---|---|---|---|
| | Whirligig | | | Whitepine | | |
| | Population (N) | Density (adults/ha) | Biomass (kg/ha) | Population (N) | Density (adult/ha) | Biomass (kg/ha) |
| 1990 | 950[1] | | | | | |
| 1991 | 285[1] | | | 247[1] | | |
| 1993 | 456[2] (337 – 639) | 41 (31 – 58) | 15.8 (11.2 – 23.1) | Not assessed | | Not assessed |
| 1994 | | | | 500[1] | | |
| 2003 | 418 (316 – 566) | 38 (29 – 51) | 17 (12.8 – 23) | 2086 (1565 – 2845) | 27 (20 – 37) | 15.7 (11.8 – 21.4) |

[1] These values represent stocked hatchery-reared adults and juveniles of various ages.
[2] The 1993 survey recorded fish >200 mm fork length

In addition to the two re-introduced native lake populations, as of fall 2003 a captive brood stock population of 2466 adult and sub-adult fish and 13,734 fall fingerlings were present at Hills Lake Fish Culture Station (R. Ward, pers. comm.). Population estimates have not been conducted in Alexander Lake or in any of the put-grow-and-take lakes. The stocking rates received by the angling waters are generally quite small and depend upon the number of lakes involved in any given year. As an example, 38,800 fry (3 lakes), 6,000 fall fingerlings (2 lakes) and 619 adults (2 lakes) were stocked in 2001. 830 fry and 475 adults (1 lake each) were stocked in 2002, and 46,500 fry were stocked into 4 lakes in 2003.

## Biologically Limiting Factors:

### (i) Water Quality:

Aurora trout, similar to brook trout, require a pH of at least 5.0 for successful reproduction and maintenance of self-sustaining populations (Beggs and Gunn 1986). Acidification from atmospheric pollutants in the form of acid rain, and possibly from historically deposited sulphur stored in adjacent wetlands, is believed to have been the proximate factor responsible for the extirpation of the wild aurora trout populations. This continues to be the critical limiting factor to the success of the long-term recovery of aurora trout (Snucins and Gunn 2000). The original extirpation of the native populations coincided with native lake pH levels declining to 5.0 and lower (Keller 1978). Recovery initiatives to date have been successful because of water quality improvements resulting from reduced acid deposition and whole lake liming. For the continued success of aurora trout, the pH of the lake water must be maintained at or above 5.0.

Dissolved oxygen concentrations in the lakes are relatively stable at 4 – 5 mg/L. Sulphate concentrations have declined in the lakes. For example, in Whirligig Lake sulphate levels declined from 9.0 mg/L in 1987 to 6.5 mg/L in 2003. This is in response to emission controls at the Sudbury smelters and at other more distant sources. Alkalinity values for both native lakes are low, and thus the natural buffering capacity of the lakes is considered limited.

**(ii) Spawning Habitat:**
Groundwater upwellings appear to be a key physical feature for successful reproduction and the survival of fry to maturity. Ideal spawning habitat has groundwater upwelling areas with a good flow of well-oxygenated water. Both the groundwater and ambient lake water must have a pH greater than 5.0. In Whirligig Lake, the only one of the two native lakes to have spawning sites documented, all spawning occurs within the lake environment on groundwater seepages in shallow water (4 m or less) over sand, gravel and rock substrate. The location of spawning sites in Whitepine Lake is generally known, but has not been formally documented or characterized. Snucins and Gunn (2000) speculated that the inability of the introduced aurora trout populations in the non-native lakes to establish self-sustaining populations was due to the lack of suitable spawning sites with groundwater discharge.

**Description of the Habitat Requirements of the Species:**
Aurora trout display water quality and thermal requirements similar to brook trout. In general, a good brook trout lake is a good aurora trout lake. Aurora trout prefer cool well-oxygenated lake environments where water temperatures are generally below 20°C and dissolved oxygen levels are approximately 5 – 6 mg/L or above. During the summer months aurora trout seek cooler temperatures as the surface waters warm and a thermocline appears. Aurora trout will congregate at or below the thermocline or utilize cooler localized water temperatures created by groundwater seeps. As previously mentioned, a pH of 5.0 or greater is necessary for successful reproduction. Spawning habitat requirements are outlined in the previous section.

## 1. Threats

**Acidification:**
Acidification from atmospheric pollutants in the form of acid rain is believed to have been the proximate factor responsible for the extirpation of the wild aurora trout populations and continues to be the primary biological threat to the re-introduced populations (Snucins and Gunn 2000). Aurora trout, like brook trout, require a pH of at least 5.0 for successful reproduction and the maintenance of self-sustaining populations (Beggs and Gunn 1986). Extirpation of the native populations occurred at about the time lake pH levels reached approximately 5.0 (Keller 1978). pH levels in Whirligig and

Whitepine lakes remained incompatible with the survival of aurora trout from the late-1960s through to the late-1980s. Studies done in the native lakes during the 1980's showed that the groundwater sites typically used for spawning had suitable water quality for survival of the embryonic stages, but that the ambient lake water was limiting survival after emergence from the substrate (Snucins *et al.* 1988).

Whole lake liming raised pH levels to about 6.5 in Whirligig Lake and natural recovery improved the water quality in Whitepine Lake (Snucins and Gunn 2000). Aurora trout brood stock was re-introduced in Whirligig Lake (1990) and Whitepine Lake (1991 and 1994) and self-sustaining populations have resulted. While pH has shown indications of decline throughout the late-1990s and early-2000s, a field assessment in 2003 demonstrated that pH remained greater than 5.1 in both lakes. A trend analysis revealed that sulphate concentrations have declined over time. It is hoped the concentrations may now be low enough that further declines in pH will not occur and that current conditions will be maintained or improved (E. Snucins, pers. comm.). The current pH of Whirligig Lake is about 5.1 – 5.3 and is similar to the background pH of 5.3 estimated from diatom remains in sediment cores (Dixit *et al.* 1996). The current pH of Whitepine Lake is 5.1, which is still below the estimated background level of 5.4 – 5.7.

**Loss of Adaptive Fitness Due to Inbreeding Depression:**
All descendents of today's aurora trout can be traced back to a single egg collection event in 1958 that involved only 3 females and 6 males (assuming all males contributed genetic material to the breeding). The low founding numbers, 40 years of captive breeding history and supplemental stocking back into the lakes that were the source of breeding individuals has led to speculation that the potential for inbreeding depression exists. The consequence would be a reduction in reproductive fitness (i.e. loss of adaptive ability to respond to ecological stresses) compared to of the original population.

While it is possible that the original population may have had a naturally low genetic diversity, which would be a reflection of their adaptation to a narrow environment, the occurrence of inbreeding appears to be supported by genetic and circumstantial hatchery evidence. Previous allozyme monitoring of the hatchery population has shown that the aurora trout strain is the most genetically uniform of the 99 brook trout stocks examined in Ontario (only minor variation in two genetic loci observed). Mitochondrial DNA analysis identified that aurora trout carried only one genome type, the locally common brook trout haplotype.

Further evidence indicative of inbreeding depression comes from direct observations within the captive breeding program and from the brood stock in Alexander Lake. Low survivorship of early life stages in the hatchery environment has been observed (R. Ward and C. Wilson, pers. comm.). There is a lack of reproduction in Alexander Lake despite high stocking numbers and good survival to adulthood (C. Wilson, pers. comm.) and there is a highly skewed sex ratio of mature adults in Alexander Lake (R. Ward, pers. comm.) Although, it should be noted that the lack of reproduction within

Alexander Lake and the nine put-grow-and-take lakes may be more a result of a lack of suitable spawning habitat (Snucins and Gunn 2000) than to inbreeding depression.

As well, analyses of aurora trout within a controlled hatchery environment have shown survivorship of aurora trout to be far less than that of Nipigon strain brook trout or experimental crosses between brook trout and aurora trout. It is suspected that this may be due in part to a weakened immune response capability which leads to greater susceptibility to stress and disease. In a follow-up experiment pure strain aurora trout were treated with an anti-fungal agent and survivorship increased dramatically (C. Wilson, pers. comm.). While further studies need to be conducted to clarify the threat to long-term survival, preliminary observations of low genetic diversity and low reproductive fitness indicate inbreeding depression.

**Climate Change:**
Although no documentation exists specific to aurora trout lakes, global climate change may be a concern. In other areas of the province, warmer water associated with climate change is having a negative impact on fish populations, including observations of brook trout mortality as far north as the Sutton River, one of the larger river systems of the Hudson Bay Lowlands (E. Snucins, pers. comm.). In addition, climate change could cause a re-acidification of the native lakes. It is not known if a significant amount of sulphur is stored in the watershed of the aurora trout lakes. If a significant amount does exist, then a period of prolonged drought could create conditions that may cause a re-acidification event.

**Others:**
With the two native lakes occurring within a protected landscape, Lady Evelyn-Smoothwater Provincial Park, the following issues may not apply specifically to the re-established native populations. However, these issues should be considered for Alexander Lake, any future non-native lake being considered for the establishment of a self-sustaining population, and for all nine put-grow-and-take angling lakes.

**Land Use Practices:**
Based upon current knowledge, aurora trout are limited to lake environments and require certain habitat parameters, the most important of these being a suitable pH and thermal regime at sites used for spawning. Habitat suitability is susceptible to land use activities which may directly or indirectly impair functionality. Most notably, anthropogenic activities such as resource extraction (e.g. forestry practices, mining, etc.) or road building, have the potential to disrupt the quality and quantity of groundwater which enters the lake, thus impairing the groundwater discharge that provides essential thermal and spawning habitat.

Forestry practices may also have the potential to affect the pH of a lake (Watmough *et al.* 2003). The harvesting of trees removes a major source of base cation deposition to the soil. Initially there may be an increase in base cations available to the soil as logging debris decays, but over the long-term it is expected that base cation deposition rates would decrease. Base cations are transferred from terrestrial ecosystems to adjacent aquatic ecosystems through the leaching of soil minerals in runoff. Reduced concentrations of base cations will reduce the buffering capacity of the lake and increase acid sensitivity.

**Introduction of Invasive Species:**
Brook trout have been demonstrated to be vulnerable to competition from other species, notably yellow perch, *Perca flavescens* (Fraser 1978). Given the strong biological similarities between brook trout and aurora trout, it is anticipated that aurora trout may also be susceptible to competition from spiny-rayed fishes. To prevent the accidental introduction of other competitors, which would likely displace aurora trout, all lakes with natural reproduction (i.e. Whitepine, Whirligig, Northeast Campcot and Southeast Campcot lakes) have been designated as provincial fish sanctuaries. This status prohibits any sport angling, hence minimizing the potential for accidental or intentional introductions. This same sanctuary status has also been granted to Alexander Lake. In the remaining lakes, where limited recreational trophy angling opportunities are permitted, the use of live baitfish is prohibited to reduce the risk of accidental introductions of competitors.

The accidental introduction of other invasive species, such as aquatic plants or invertebrates, could also have an impact on aurora trout. For example, the spiny waterflea (*Bythotrephes sp.*) has invaded lakes across southern Ontario and is now being found in lakes in northern Ontario as well. The invasion of spiny waterfleas generally results in a significant shift in the zooplankton community of a lake, with *Bythotrephes* becoming dominant in the species assemblage. Although the effect of such a shift on the recovery, survival and health of aurora trout is unknown, the types of prey available to the fish would likely change.

The mechanism of invasion for such species is generally on the hulls of boat, the pontoons of aircraft or on other equipment that may be used in multiple lakes without proper washing. It is difficult to address this problem on the angling lakes that are open to the public once every three years. A program to increase angler education regarding invasive species has been initiated in northern Ontario by the OMNR Invasive Species program and the Ontario Federation of Anglers and Hunters (OFAH). Accidental introductions to the native lakes are easier to control as these lakes are remote and difficult for the public to access. The landing of aircrafts in Provincial Parks requires a permit and thus is controlled by Ontario Parks. Ontario Parks has indicated that the Lady Evelyn-Smoothwater Provincial Park Management Plan (currently in preparation) will include a protocol for reducing the risk of invasive species that will apply to researchers and recovery workers accessing lakes in the park (E. Morris, pers. comm.). This protocol should be developed in consultation with researchers that are currently working within the park.

**Illegal Harvesting:**
To date, poaching has not been considered to be a major problem. Only one case of poaching has been well documented. In 1994, a small group of poachers were apprehended and charged on Southeast Campcot Lake. Nipigon District Enforcement

staff have frequently patrolled both Northeast and Southeast Campcot lakes before and after this incident, up until 2001 when it was realized that the introduction had failed. It did not appear that any additional incidents occurred. The reason for the extirpation of the Campcot populations is unknown. There are no documented incidents of poaching on any of the other aurora trout lakes.

**2. Knowledge Gaps:**

The following briefly summarizes key knowledge gaps that should be addressed as information becomes available to assist with recovery efforts. Actions to address these gaps, where feasible, appear in Table 2 (see Section 5 (c)).

(i) Historical population abundance and biomass measures are not available. Efforts to locate historical population data, including contacting the primary individual responsible for the early population assessments have been unsuccessful (E. Snucins, pers. comm). Thus, historical reference points were not available for setting recovery targets. Population assessments were conducted in Whitepine and Whirligig lakes in the fall of 2003 to determine the current population status of aurora trout within their native waters. These results were of assistance to the recovery team in the completion of this strategy.

(ii) The status report for aurora trout is currently in draft form only. The species assessment by COSEWIC and the subsequent development of a recovery strategy have utilized the draft status report. This report needs to be finalized. Although this is not a knowledge gap per se, this is an information gap that needs to be addressed.

(iii) As indicated in Section 2 b) of this document, preliminary evidence suggests inbreeding may be an issue with aurora trout (C. Wilson, pers. comm.). Further examination of this is required. To assist in this, 100 genetic samples were taken from each of the re-established native lake populations in the fall of 2003. The samples were submitted to the OMNR genetics laboratory in Peterborough for analysis to determine if any divergence has occurred among the wild fish, the current hatchery stock and the population in Alexander Lake (E. Snucins, pers. comm.).

(iv) Further genetic assessment is required to establish the true taxonomy of aurora trout. To date, genetic examinations have not provided support for a subspecies designation. As noted previously, the investigation of allozyme data by OMNR staff in the 1990s demonstrated aurora trout had very low levels of genetic variation but no unique alleles when compared against brook trout (C. Wilson, pers. comm.). Grewe *et al.* (1990) and Danzmann (unpubl. data, C. Wilson, pers. comm.) both found that mitochondrial DNA (mtDNA) failed to show fixed diagnostic differences in molecular markers that would suggest genetic separation between aurora trout and brook trout. However, broader mtDNA work by Reed *et al.* (1998) has shown that subspecies and even sister species in Canada generally cannot be discriminated based on mtDNA, and mitochondrial divergence between sister species in deglaciated areas is generally quite low (Bernatchez and Wilson 1998). Thus, genetic evaluations completed to date on aurora trout may not have been able to detect differences.

Advancements in the use of new genetic assessment markers like nuclear ITS (internal transcribed spacer) regions or gene introns may clarify the taxonomy of aurora trout. The outcome of such research would provide key information for a future status assessment by COSEWIC. As well, the information could assist in refining management options, specifically in the areas of experimental crossings, match plantings or gene infusion opportunities that may increase the genetic fitness of aurora trout. If aurora trout are found to be genetically distinct, crossings with brook trout and the infusion of brook trout genes will not be considered as a management option.

(v) A formal captive breeding policy does not exist and is required, especially in light of the aforementioned potential for loss of adaptive reproductive fitness. It has been left up to the knowledge of staff at the Hills Lake Fish Culture Station (HLFCS) (with assistance as needed from other ministry staff) to look after breeding and culture of the aurora trout. Captive breeding has been underway at the HLFCS since 1958. Prior to the early-1980s captive domestic (hatchery raised) aurora trout were spawned by putting eggs from one or two females with the milt of at least two males and the eggs were pooled in order to maximize successful fertilization without regard for family distinction. The resulting progeny were used in efforts to establish a self-sustaining population in a non-native waterbody, in support of the angling lakes and every second year 10,000 fry were placed into Alexander Lake. After this time, following discussions with OMNR’s fish geneticist, a strategy was initiated by hatchery staff to try and increase family lines.

Currently the breeding strategy employs a family approach (one male to one female) from the domestic brood stock with each fish only being bred once. Egg collection targets vary on an annual basis depending upon recovery targets and the number of angling lakes due for stocking. Generally 20 families (ranging from 16 – 25 families) are collected from Alexander Lake bi-annually (this produces approximately 25,000 – 30,000 eggs). The families are incubated separately until the eyed-egg stage. At this time, even numbers are counted from each family to form the new hatchery brood stock with the remainder being returned to Alexander Lake. In addition to the egg collection at Alexander Lake, 100,000 - 150,000 eggs are collected each year from the captive hatchery brood stock population for the stocking of fry into the angling lakes. Presently, fish are stocked back into Alexander Lake every year to maximize the number of year classes (and hopefully the number of family lines) in the brood stock lake.

(vi) Spawning habitat assessments are required. Spawning site locations and general habitat descriptions have been documented for Whirligig Lake, but only general locations are known for Whitepine Lake. It is presumed that all known sites in both lakes are at groundwater upwelling locations, however flow measurements are required for confirmation. Detailed descriptions and mapping of spawning sites are also required for Whitepine Lake. Although it has been speculated that the reason aurora trout in Alexander Lake are not reproducing is because of a lack of suitable spawning habitat, this requires confirmation.

(vii) Great strides in recent emission controls have significantly lowered atmospheric pollutants (especially sulphur) from smelters located in Sudbury and other distant sources. This has assisted in the recovery of the native lakes. It would be useful to determine whether or not current acid deposition levels exceed the critical load for the native aurora trout lakes (to ensure that the pH remains above 5.0).

**3. Recovery Feasibility:**

The recovery of aurora trout is technically and biologically feasible. Self-sustaining populations have been restored in both native waters with successful reproduction occurring in Whirligig Lake since 1990 and in Whitepine Lake since 1994. Both populations are at biomass levels well within the range documented for brook trout in similar low productivity oligotrophic lakes. Of particular importance, a recent evaluation revealed that the aurora trout populations are in good condition with no evidence of missing year classes in either lake. Missing year classes would be considered an early indicator that the populations are under acid stress (E. Snucins, pers. comm.). The biomass and abundance of aurora trout in Whirligig Lake did not change significantly between 1993 and 2003.

Suitable habitat for the recovery of aurora trout is available in both of the native lakes. Water quality monitoring has been undertaken since 1987, and despite the presence of short-term transient pH depressions in 2001 and 2002, water quality remains good with a pH of 5.1 - 5.3 in Whirligig Lake and 5.1 in Whitepine Lake. The natural background pH, as estimated from diatom remains found in sediment cores, is 5.3 for Whirligig Lake and 5.4 – 5.7 for Whitepine Lake (Dixit *et al.* 1996). No further powdered calcite treatments (to increase pH) have been required in either lake since 1995.

Trend analysis of water chemistry data has demonstrated that sulphate concentrations continue to decline and current readings may be low enough that further pH depressions will not occur. The trend of declining sulphate concentrations is consistent with the general patterns observed in other Northeastern Ontario lakes (Keller *et al.* 2001). Recent emission control measures introduced in early 2004 by the Ministry of the Environment (MOE) at Sudbury area smelters, in conjunction with similar emission reduction initiatives undertaken in other jurisdictions, has enhanced the potential for these waterbodies to continue to maintain suitable pH levels for successful self-sustaining populations. There have been a number of other cases where biological recovery has followed water quality recovery, both locally (i.e. within the deposition zone downwind of Sudbury) and in other jurisdictions. While all of this suggests a brighter future for aurora trout, only time and the continuance of a long-term monitoring program will indicate whether recovery efforts to re-establish self-sustaining aurora trout populations within the native waters have succeeded. In the end, the biological recovery is dependent on re-acidification being prevented.

Although suitable habitat is available in both native lakes and the re-introduced populations have been maintained by natural reproduction for over 10 years, it appears that spawning habitat is very limited or absent in Alexander Lake and the nine angling lakes. For this reason, the ATRT is continuing to investigate the possibility of establishing one or two naturally reproducing, non-native satellite populations. Northeast Campcott and Southeast Campcott Lakes were stocked with aurora trout in the late-1980s, were confirmed to have naturally reproducing populations in the early-1990s, but appear to have been extirpated by 2001. Since the cause of the extirpation remains unknown, it has been decided that Southeast Campcott Lake will be stocked again. The condition of the lake environment and the status of the population will be monitored carefully. The establishment of one other naturally reproducing aurora trout population is still desirable, possibly in a location more proximate to the watershed of the native lakes. Little Whitepine Lake, located just upstream of Whirligig Lake, is a possible candidate. Prior to stocking this lake, such a proposal would require the authorization of the Park Superintendent of Lady Evelyn-Smoothwater Provincial Park, the completion of a Class Environmental Assessment for Provincial Parks and Conservation Reserves and the completion of the risk assessment screening outlined in the National Code on Introductions and Transfer of Aquatic Organisms.

It appears that threats to the survival of the native populations can largely be minimized, mitigated or eliminated. The native lakes appear to be recovering from acidification and aurora trout are successfully reproducing in both lakes. It will be critical to continue monitoring these lakes to ensure that additional intervention (i.e. whole lake liming) is not necessary. Since both lakes are remote and located in a Provincial Park, the risk of accidentally introducing non-native species can be minimized, poaching is unlikely and the effects of anthropogenic land use disturbances are minimal. It is hoped that the issues surrounding the genetic diversity and adaptive fitness of aurora trout can be optimized through the captive breeding program. Depending on the results of the genetic taxonomic assessment, the infusion of brook trout genes to increase diversity may be an option. As for all coldwater fish species, the possible effects of future climate change remain uncertain.

The recovery techniques used to date appear to be highly successful. The techniques (including captive breeding, stocking and whole lake liming) are commonly used recovery techniques. Past industrial emissions reduction programs have been successful in reducing acid deposition in central and northeastern Ontario. The latest initiative undertaken by MOE and several industries in Sudbury will only help the situation.

# II. RECOVERY

## 1. Recovery Goals, Objectives and Approaches:

### a) Recovery Goals:

Although historical data on population and biomass was not available for the native lakes, the recovery team was able to develop recovery goals for aurora trout. These goals are based on a knowledge of brook trout populations in similar oligotrophic waters, the current population and biomass in the native lakes and a realization that re-acidification is the principle threat to the populations.

The primary long-term goal of this recovery strategy is:

*To maintain secure self-sustaining aurora trout populations in both native lakes (Whirligig Lake and Whitepine Lake) at a minimum biomass target of 13 kg/ha for Whirligig Lake and 12 kg/ha for Whitepine Lake; a density of adult fish of 29 fish/ha for Whirligig Lake and 20 fish/ha for Whitepine Lake; and an age class structure that demonstrates no missing year classes. These targets must be achieved in the absence of any further human intervention (e.g. liming).*

The values above represent the lower end of the 95% confidence interval for the biomass and adult population estimates from the 2003 field survey (to recognize statistical uncertainty in the population estimates). This survey was completed more than 10 years after aurora trout were re-introduced to the native lakes and it is assumed that the populations are now stable.

It is the contention of the recovery team that the above identified targets should be achieved without the requirement for further whole lake liming for at least 10 years. If this occurs, aurora trout could potentially be considered for down-listing or de-listing by COSEWIC.

In addition to the primary goal, three further secondary recovery goals have been identified:

i. *To establish a secure self-sustaining aurora trout population in one or two non-native, well-buffered lakes to act as a wild brood stock refuge to the native populations in Whitepine and Whirligig lakes;*
ii. *To clarify the taxonomic status of aurora trout, that is to determine if aurora trout are distinguishable from brook trout at the molecular genetic level*
iii. *To maintain the captive breeding program.*

The recovery team believes it is necessary to establish a viable self-sustaining aurora trout population in a waterbody secure from known threats. The chosen waterbody will act as a wild brood stock refuge in the event of re-extirpation in the native waters or an unforeseen event that may compromise the captive breeding program. If no significant genetic differences are found between aurora trout and brook trout, then aurora trout could be considered for de-listing by COSEWIC or could be listed as a specific race or population rather than as a separate sub-species. Even if no genetic differences are found, aurora trout would still be managed by OMNR as a unique component of Ontario's biodiversity on the basis of their phenotypic differences.

**b) Short-term Recovery Objectives:**

The following short-term recovery objectives provide the focus for recovery initiatives over the next 3 to 5 year period (2005-2010). These objectives will be accomplished by the formation of a number of Recovery Implementation Groups (RIGs). The ATRT will continue to act as an overseer RIG, but will establish a number of task-oriented RIGs to assist in implementing the various aspects of this recovery strategy.

1) The RIGs will ensure continuation of the long-term data collection and monitoring of water quality, trophic level food chains and the status of the re-established aurora trout populations within Whirligig and Whitepine lakes. This protocol is to expand to include data collection and monitoring of any future waters where a self-sustaining, non-native population is established.

2) A Genetics RIG will conduct an examination of molecular genetic data utilizing the most advanced techniques and newest molecular markers (such as nuclear ITS region or gene introns). The purpose of these studies is to determine if aurora trout are genetically distinct from brook trout; to initiate investigations into potential genetic inbreeding depression; and to provide a recommended course of action(s) to reduce impacts if inbreeding is deemed to be a threat.

3) A science-based RIG will:
   i. Ensure that data and analyses for the native lake field assessments are completed and the results are documented in a timely manner to provide guidance for future action planning. Past data and analyses will be synthesized into a report so that the pertinent information is more readily available;
   ii. Complete critical load modeling for sulphate deposition in the native lakes that would maintain a pH above 5.0;
   iii. Conduct detailed spawning habitat assessments in Whitepine Lake. Only general locations are known in Whitepine Lake at the present time. Groundwater flow measurements are also required for Whirligig Lake;
   iv. Develop a suite of criteria based upon the habitat requirements of aurora trout to assist managers in the identification of suitable waters for the establishment of one or two non-native aurora trout populations. If established such populations could act as a wild brood stock refuge to minimize the risk to aurora trout viability in the event of a catastrophic loss within the captive breeding program or the re-extirpation of the native lakes;

v. Assist with the establishment of such a wild brood stock population(s);
vi. Develop a breeding strategy which applies knowledge established from Short-term Objective #2 (above).

4) An approved recovery strategy will allow the continuation of the limited recreational angling opportunities, as well as any lethal sampling that may be required for either scientific or for fish health purposes (for additional details, see Section 12 – Activities Permitted by the Recovery Strategy).

5) A communications based RIG will:
   i. Develop and implement a communications plan to engage the cooperation of potential stakeholder partners including other government agencies, industry, environmental groups and the public;
   ii. Revise, deliver and monitor an educational campaign to measure the success of maintaining the specially regulated recreational angling opportunities for aurora trout. This is a means of increasing public awareness and generating support for species at risk in general;
   iii. Update existing and create new brochures, videos, displays and websites as necessary to facilitate recovery messages;
   iv. Review and update the provincial aurora trout policy and legislation to provide protection to all aurora trout populations and the watersheds they inhabit.

**c) Approaches for Recovery:**
The broad approaches identified for recovery efforts include Legislation and Policy, Research, Habitat Management and Population Management. Proposed actions related to each approach are detailed in Table 2.

**Table 2. Strategies and Approaches for Recovery**

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| Low | 5(iv) | Legislation & Policy | All | Review existing relevant policies and legislation to determine current level of protection afforded to aurora trout and recommend appropriate improvements. | Establishes an effective regulatory framework for overall aurora trout conservation. |
| Low | 5(iv) | Legislation & Policy | All | Provide input and advice on revisions to the provincial aurora trout policy. | Updates provincial aurora trout policy that provides strategic direction for the conservation and management of aurora trout and their habitat. |
| Low | 5(iv) | Legislation & Policy | All | Provide input and advice on existing habitat protection guidelines. | Update provincial protection to aurora trout lakes, specifically those lakes containing aurora trout which lie outside of protected areas (i.e. Provincial Parks). |
| | | | | | |
| High | 2 | Research | Inbreeding | Investigate the taxonomy of aurora trout utilizing new genetic procedures and markers. Molecular data from representative samples from wild and hatchery populations are to be collected from both aurora trout and brook trout. Newer molecular markers (Nuclear ITS, gene introns) will be used to determine if clear fixed differences exist between aurora trout and brook trout. | If fixed differences are apparent this would provide COSEWIC with quantitative supporting evidence for maintaining aurora trout on the legal list of Species at Risk. If no fixed differences are found using these new techniques (which is consistent with earlier genetic assessments), then there would not be molecular genetic justification for maintaining aurora trout on the legal list and down-listing or de-listing could be considered (or aurora trout could be maintained as a designated population at risk). Should this research provide evidence for COSEWIC to de-list aurora trout nationally |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| | | | | | as an endangered species, the province of Ontario would continue to manage aurora trout as a unique element of global biodiversity. Secondly, it is necessary to determine the taxonomic status of aurora trout prior to considering potential solutions for the infusion of new genetic material. |
| High | 2 | Research | Inbreeding | Investigate potential inbreeding depression as a result of low founding population size by examining available historical genetic material (e.g. tissue, scales, preserved specimens). | It has been surmised that the low founding size resulted in lower diversity (and thus reduced fitness) in the current population as compared to populations of the 1940s and 1950s. Genetic analysis may determine if historical diversity is adequately represented today. This analysis would also provide information on the current fitness of the stock and may aid in developing potential solutions to address the long-term viability of aurora trout. |
| Medium | 2, 3(vi) | Research | Inbreeding | Continue to assess the extent of potential inbreeding threats through further examination of 2nd generation crosses of aurora trout and Nipigon strain brook trout. These fish are to be bred and maintained in the hatchery only. No proposal to stock these fish into the wild would be considered until the taxonomy of aurora trout is clarified. | 2nd generation experimental crosses would clarify whether inbreeding does exist within the captive bred aurora trout. In addition, the work would give an indication of the MHC (major histocompatibility complex – the functional genes responsible for immune response capabilities) diversity in aurora trout and whether these genes still have the capability to evolve. |
| Medium | 2, 3(vi) | Research | Inbreeding | If aurora trout are genetically distinct from brook trout, inbreeding may still be a threat. | This would make best use of the total available genetic diversity in existence in present day |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| | | | | To maximize available genetic diversity, efforts need to be directed towards locating the most genetically diverse individuals to develop the best combination of crosses. An opportunity exists to enhance reproductive fitness of aurora trout without impacts upon the phenotype. | aurora trout. It is very labor intensive, requires a great deal of time and still may not resolve the threat of inbreeding should it exist. Despite this, it is still the best method of maximizing genetic diversity without compromising the genetic and phenotypic integrity of aurora trout. |
| Medium | 2, 3(vi) | Research | Inbreeding | Should the results of the taxonomic investigation determine that aurora trout are not genetically distinct from brook trout, there exists the opportunity to design an experimental management approach. That is, matched plantings of pure aurora trout vs. aurora trout x brook trout crosses could be bred and followed over two to three generations to compare reproductive fitness. Initially, these fish would only be held in the hatchery for 2-3 generations, but under this scenario, the fish may be stock in non-native lakes and their fitness compared under field conditions. | The two native lakes would not be part of such an experiment and would always remain with pure aurora trout in them. The results of this study would allow researchers to determine which strain is more reproductively fit. As well, it would allow an examination of the benefits and consequences of introducing brook trout genes into aurora trout to enhance the reproductive fitness of aurora trout without compromising the phenotype (i.e. create an aurora trout phenotype that is carrying brook trout genes to increase genetic diversity). Additional discussions of the ATRT will be required prior to the implementation of this approach. |
| Medium | 1, 2 | Research | Inbreeding | Genetic monitoring needs to occur for both juvenile and adult aurora trout in both native lakes. Non-lethal genetic samples are required to track genetic diversity across successive generations. | This will provide evidence of changes in genetic diversity over time should this be occurring. It will provide evidence of whether or not the aurora trout populations are still capable of evolutionary change. This will also allow ties back to individual fish and will allow the |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
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| | | | | | establishment of a pedigree. |
| | | | | | |
| High | 1, 3(iii), 4(iv) | Habitat Management | All | Investigate and describe in detail necessary habitat requirements (e.g. spawning habitat) for aurora trout based upon studies within the two native lakes. | Will provide baseline critical habitat knowledge. This can be used to develop criteria for assessing the potential of non-native lakes for future introductions, thus allowing the establishment of additional secure, self-sustaining populations. |
| High | 1, 3(ii), 3(iv) | Research; Habitat and Population Management | Acidification | Critical load modeling will be completed to determine the reductions in atmospheric pollutants that need to be targeted to prevent re-acidification. Pollutants must be reduced to a level where pH will not be depressed again in the future. This will eliminate the negative impacts of acidification on aurora trout recruitment. | Similar modeling has already been completed for a number of lakes in Killarney Provincial Park. Reductions in air borne emissions responsible for acid rain will contribute to improved water quality. This will provide additional information for the Recovery Team and associated Recovery Implementation Group(s) in determining whether future liming will be necessary. Furthermore, knowing the extent of the required reductions in atmospheric pollutants is necessary background information for MOE in developing operating Certificates of Approval for industry. |
| High | 3(iii), 3(iv) | Research; Habitat & Population Management | Fulfills a Knowledge Gap | Need to define the characteristics of suitable spawning sites. It appears that groundwater upwellings are necessary, although little is known about the required flow rates for successful spawning. | Groundwater requirements for spawning are necessary for the selection of future candidate lakes for introductions. Establishing a non-native, self-sustaining, satellite population(s) is desirable for maintaining the future viability of the species. |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| High | 3(v), 5(iv) | Habitat & Population Management | Acidification | A Class Environmental Assessment (EA) for Provincial Parks and Conservation Reserves is to be completed for Little Whitepine Lake. This step will require approval from the Superintendent of Lady Evelyn-Smoothwater Provincial Park as current Ontario Parks' policy generally prohibits the introduction of species that are not native to the receiving waters. A risk assessment screening as outlined in the National Code on Introductions and Transfers of Aquatic Organisms will also be required. | Completion of the EA allows Little Whitepine Lake to be approved for future stocking. Little Whitepine Lake is an ideal candidate as it is within the original watershed but was never acidified. The water chemistry is acceptable for the purpose of establishing a self-sustaining population; however, issues with spawning habitat need to be assessed. |
| High | 5(iv) | Habitat & Population Management | Acidification | A Class Environmental Assessment for Provincial Parks and Conservation Reserves will be necessary to allow any future whole lake liming treatment of the native lakes should this be necessary. | While recent results suggest whole lake liming is not necessary in the short-term, it would be ideal to complete an EA in advance to ensure no delays are encountered should liming become necessary for the native lakes in the future. The ATRT should determine if an EA can be completed in advance to avoid possible delays. |
| High | 1, 5(i), 5(iii), 5(iv) | Habitat & Population Management | All | The park management plan for Lady Evelyn-Smoothwater Park requires completion. The recovery team suggests this plan not only be completed but needs to incorporate management actions for the recovery and management of the native aurora trout lakes. | Completion of the park plan will allow for the better coordination of recovery and management actions between park managers and the ATRT. |
| High | 1 | Habitat & Population | All | Maintain long-term monitoring programs for water quality and benthic invertebrates within | Provides critical information on the water quality status of the aurora trout lakes. This is |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| | | Management | | Whitepine and Whirligig lakes. This program will be expanded as naturally reproducing non-native lake populations are established. It is necessary to review the data collected to date and re-examine the current sampling frequency. All monitoring activities for the native lakes(this action item and the following two actions) should be completed in collaboration between the ATRT and Ontario Parks. | especially critical for the native lake populations. This information will help determine whether or not additional intervention acts (e.g. re-application of whole lake liming) may be necessary in the short-term to prevent the re-extirpation of aurora trout. It should be noted that all work within a Provincial Park requires approval of the Park Superintendent. |
| High | 1, 3(i) | Population Management | All | Finalize the current draft status report for aurora trout. As well, compile all data and complete reports related to fish population surveys completed in Whitepine and Whirligig lakes. | Completion of these reports will provide resource managers with access to the most relevant up-to-date data on the status of aurora trout. |
| High | 1, 2, 3(i), 3(iv) | Population Management | All | Continue to conduct fish population surveys to establish population estimates, biomass estimates, growth rate, age class structure, sex ratios, acquire genetic material, etc. in Whitepine and Whirligig lakes. Repeat at least once every 5 years with frequency increasing if results suggest the potential for re-extirpation. This survey work will be extended to include any future waters where aurora trout are introduced with the intent of establishing self-sustaining populations. | Provides critical baseline information necessary to assess the success of the re-introductions into the native lakes (and into any non-native lakes). This population information from the native lakes will also provide insight into determining the need for future intervention (e.g. whole lake liming) to prevent re-extirpation of aurora trout. |
| High | 2, | Population | N/A | As set out in subsection 83(4) of the | Continuation of the limited trophy angling |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| | 3(v), 3(vi), 4, 5(ii) | Management | | *Species at Risk Act*, a person can engage in an otherwise prohibited activity if the activity is permitted by a recovery strategy and the person is authorized under an Act of Parliament to engage in that activity. The activities permitted by this recovery strategy under s.83(4) are described under Section 12 – Activities Permitted by the Recovery Strategy. | opportunities will enhance public knowledge and interest in the species and support for recovery efforts. Additional activities such as egg collections from the brood stock lake and non-lethal and lethal sampling are necessary to ensure the long-term sustainability of aurora trout. Continuation of these activities is critical for managers to continue to monitor the success of native lake populations over the long-term, as well as for hatchery personnel who must ensure no disease agents are unknowingly introduced into the hatchery environment. |
| High | 2, 3(v), 3(vi) | Population Management | Maintenance of hatchery brood stock | Continue to maintain aurora trout culture and production facilities at Hills Lake Fish Culture Station and continue to use Alexander Lake as a brood stock lake. | Provides egg collection opportunities from existing managed brood stock for the purpose of ensuring long-term survival of the aurora trout populations. Maintaining Alexander Lake ensures that the entire brood stock would not be lost following a catastrophic event in the hatchery population and vice versa. The brood stock are being used as a comparison to the re-introduced native populations to detect genetic divergence. The brood stock also is used to produce fish for stocking to the put-grow-and-take angling lakes. |
| High | 3(vi) | Population Management | Inbreeding | Develop a breeding strategy based upon outcomes of research into taxonomic assessment and the other genetic studies. | Will provide a method to maximize genetic diversity of aurora trout |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| High | 4, 5(ii) | Population Management | N/A | Maintain a total of nine angling lakes with the surplus fish from the hatchery. | Provides excellent opportunities to promote awareness and provide education regarding the plight of species at risk and in particular that of aurora trout. This does not affect the recovery of the aurora trout because the native lakes (as well as any naturally reproducing non-native lakes and Alexander Lake) are closed to angling at all times. Limiting the number of aurora trout angling lakes to a maximum of nine and minimizing their geographic distribution helps to ensure aurora trout remain a unique element of global biodiversity. Unrestricted expansion of trophy fishing opportunities will only serve to minimize the uniqueness of aurora trout and the conservation value it represents. |
| Medium | 3(iv), 3(v) | Population Management | Acidification. Meets a secondary Recovery Goal | Investigate the potential of other waters to support a self-sustaining aurora trout population. Preference shall be given to lakes within the original watershed. However, in recognition of acidic deposition and water quality issues with the native lakes, it may be necessary to assess waters outside of the original watershed. In this case, preference will generally be given to adjacent watersheds, then across Northeast Region, and then to other watersheds outside of Northeast Region. Any lake selected must | Priority will generally be given to suitable waters closest to the native lakes and with the lowest acidic deposition rates for the establishment of a self-sustaining satellite population. The area of search for suitable waters will start within the original watershed and will expand outward from there. Any water selected for an introduction will require a Class EA and the completion of the risk assessment screening outlined in the National Code for Introductions and Transfers of Aquatic Organisms. |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| | | | | meet selection criteria established by the Recovery Team. Acidic deposition zones will also be considered when evaluating potential new waters. | |
| Low | 4, 5(i), 5(ii) | Population Management | Illegal harvesting | Encourage increased angler compliance through education and enhancing the current level of enforcement monitoring. | Ensure that non-compliance events related to lake closures do not occur to assist with on-going and future recovery efforts. |
| Low | 4, 5(ii), 5(iv) | Population Management | | Establish criteria for selecting new angling lakes if any of the existing lakes become unsuitable for stocking. | Provides direction for selecting potential waterbodies as candidate angling lakes should any of the existing lakes be compromised. |
| Low | 5(i), 5(ii), 5(iii) | Habitat and Population Management | All | Update the existing aurora trout brochure. | Provides clear messaging to the public and others on the current status of aurora trout. This and other communications products should be developed in Co-operation among Ontario Parks and OMNR Fish & Wildlife Branch. |
| Low | 5(i), 5(ii), 5(iii) | Habitat and Population Management | All | Establish a biodiversity display at Lady Evelyn-Smoothwater Provincial Park (or another nearby Ontario Parks office) and possibly at the angling lakes. | Similar to the display developed at Hills Lake Fish Culture facility, this display will be an educational tool for delivering species at risk messaging. |
| Low | 5(i), 5(iii) | Habitat and Population Management | Knowledge Gap | Observe and record on video aurora trout spawning behaviour for use in displays. | Provides excellent video images for media outlets that are always looking for up-to-date information on this flagship species at risk success story. |
| Low | 5(i), 5(ii), 5(iii) | Habitat and Population Management | Introduction of Invasive Species | Educate the anglers on the consequences of using live bait in aurora trout lakes through brochures and signs at the existing aurora trout angling lakes. | Will assist in preventing the introduction of non-native species into the put-grow-and-take aurora trout lakes. This will be coordinated through OMNR's existing Invasive Species program and |

| Priority | Obj. No. | Broad Approach | Threat Addressed | Specific Steps | Anticipated Effect |
|---|---|---|---|---|---|
| | | | | | may include partnerships with organizations such as OFAH. |

## 2. Critical Habitat:

### a) Identification of the Species' Critical Habitat:

This recovery strategy identifies both native lakes, Whirligig Lake and Whitepine Lake, as the Critical Habitat for the recovery of aurora trout. A whole lake approach has been taken, rather than a habitat feature-based approach, given that the habitat requirements of the species depend on the lakes being treated as a holistic system. This approach is prudent due to the small size of the native lakes and is reasonable given that they are located in a protected area – Lady Evelyn-Smoothwater Provincial Park (a wilderness class park).

### b) Examples of Activities Likely to Result in Destruction of Critical Habitat:

The two native lakes are located within the boundaries of a wilderness class park so they are protected from land use activities (e.g. resource extraction such as forestry or mining, road building, urban development, etc.) that would otherwise be of concern due to potential negative impacts to critical habitat. They do, however, continue to remain susceptible to acidification due to industrial emissions and this must be monitored closely.

Both lakes are also provided some protection through the application of the *Timber Management Guidelines for the Protection of Fish Habitat*. In addition, the *Federal Fisheries Act* provides general fish habitat protection. All lakes are protected from the harmful alteration, disruption or destruction of fish habitat under this Act.

### c) Schedule of Studies:

In the opinion of the recovery team, sufficient information exists to warrant the proposal of identifying whole waterbodies as critical habitat for the native lakes (Section 6 (a)). However, studies are required to fully document the spawning habitat location(s) in Whitepine Lake and to identify ground water flow rates in both native lakes. Additional consideration related to defining critical habitat for the non-native lakes needs to be given, particularly for lakes that are expected to be maintained through natural reproduction. Monitoring for natural reproduction in any newly introduced lake will be required. If natural reproduction is found in one of the non-native lakes, critical habitat components such as spawning sites could be added as an amendment to this strategy as the location of these sites are identified. If it is determined that the designation of critical habitat is advantageous in the stocked lakes, habitats within these lakes could also be added through an amendment to this strategy.

Alexander Lake and the other lakes that are to be used for the establishment of self-sustaining, non-native populations (e.g. Southeast Campcot Lake and/or Northeast Campcot Lake) will not be identified as critical habitat for the species at this time As additional studies are completed to determine the specific habitat requirements of aurora trout, habitat components in the non-native lakes can be identified as critical habitat through an amendment to this strategy.

## 3. Effects on Other Species:

Prior to extirpation, but during the latter stages of decline, Sale (1964) noted that aurora trout in Whitepine Lake co-existed with brook trout and white sucker (*Catostomus commersoni*) and only with white sucker in Whirligig Lake. No other fish species were apparent. He reported the invertebrate fauna to be typical of lakes in the area with Chironomidae, Trichoptera, Odonata, Notonectidae and Gyrinidae present; however, zooplankton (Copepod and Cladocera) were present in only small numbers and Gammarus were missing. Crayfish (*Orconectes* sp.) were also present.

Presently, the self-sustaining re-introduced aurora trout populations are the only fish species within the two native lakes. Assessments of invertebrate communities were conducted after each liming treatment in Whirligig Lake to determine the impacts of the treatments on the biota. Species richness and abundance increased after each liming treatment, but overall the species composition reflects that of low productivity environments (E. Snucins, pers. comm.). The number of phytoplankton taxa almost doubled by the mid-1990s, while zooplankton species have only slightly increased compared to their pre-liming abundance. Known acid-sensitive species are rare or absent, but acid-tolerant species, especially larger cladocerans, which are preferred prey for planktivorous species like aurora trout, are present in large numbers. Odonata have declined. Ephemeroptera on the other hand have increased due to an increase in the abundance of an existing species (*Leptophlebia* sp.) and the successful colonization of an acid-sensitive species (*Stenacron interpunctatum*) (Carbone *et al.* 1998).

In instances where aurora trout are being considered for introduction into non-native waters it is anticipated there will be some level of impact. It is recommended in each instance that a pre- and post-assessment of the abiotic factors and biotic community be completed in order to determine if any negative impacts resulted and their extent. Prior to any future introduction, a Class EA for Resource Stewardship and Facility Development Projects will have to be completed for any lake situated on Crown Land, or the Class EA for Provincial Parks and Conservation Reserves would have to be completed for any lake within a Provincial Park or Conservation Reserve. As well, the risk assessment screening process outlined in the National Code on Introductions and Transfers of Aquatic Organisms would have to be completed. Class EA's have been completed for all recent introductions of aurora trout. As of the writing of this report, a Class EA and risk assessment screening is currently being completed for one new aurora trout lake (Timmins #57 Lake). No other introductions have occurred since the inception of the National Code in September 2003.

## 4. Recommended Scale for Recovery:

The aurora trout is ideally suited to an individual species recovery planning effort since it has a very restricted native range and occurred naturally within simple fish communities. There is no other 'at risk' or rare species occupying the same lakes or watershed to permit consideration of a multi-species recovery planning process. Since Lady Evelyn-Smoothwater Provincial Park is in the process of developing a management plan there will be opportunities to compliment recovery actions (related to the two native lakes) with park activities and policies.

## 5. Statement of When One or More Action Plans in Relation to the Recovery Strategy Will Be Completed:

An action plan, in the form of the provincial aurora trout Management Plan, has been guiding recovery actions since 1983. This plan, produced by the aurora trout Management Committee, has been revised twice - once in 1993 for the operating period 1994 - 2004, and a second time in 2000 for the period 2000-2010. The current Management Plan is to be reviewed and updated to ensure that it meets the requirements of a Recovery Action Plan under the *Species At Risk Act* within one year of the approval of this Recovery Strategy. The Recovery Action Plan will provide additional details on the recovery tasks to be completed, the sampling and management protocols to be followed and the timing and frequency of the tasks such as monitoring and assessment.

Since the inception of the first aurora trout Management Plan in 1983, the aurora trout Management Committee (referred to as the ATRT in this strategy) has operated similar to an overseer RIG. The current structure and role of the ATRT is expected to continue for decision-making and guiding management actions with respect to recovery initiatives. Given the recovery direction identified within this strategy, it is likely that the ATRT will continue to act as an overseer RIG, but will establish task-oriented RIGs to deal with each of the broader approaches identified in Section 6 (b).

## 6. Evaluation:

Success of this recovery strategy will be evaluated through the establishment of specific lake monitoring programs and through the results of applied research. The evaluation will be carried out by the appropriate RIG, but must achieve the following:

- long-term maintenance of self-sustaining aurora trout populations attaining stated biomass, year class presence, and spawning age density targets in the goal statement;
- no further human intervention required to manipulate water quality within the native lakes. Specifically, intervention in the form of further liming treatments to ensure a pH of at least 5.0 should not be necessary;
- successful establishment of one (or more) self-sustaining, non-native aurora trout populations;
- clarification of the taxonomic status of aurora trout;
- success in achieving further reductions in sulphate and other industrial emissions;
- development of a captive breeding strategy, including potential solutions for reducing the threat of inbreeding depression and maximizing the reproductive fitness potential of aurora trout; and
- reporting on the establishment of new recovery partners and partnerships, general public awareness of aurora trout, number of media contacts, anglers utilizing the limited recreational angling opportunities, etc.

## 7. Activities Permitted by the Recovery Strategy

As set out in subsection 83(4) of the *Species at Risk Act*, a person can engage in an otherwise prohibited activity if the activity is permitted by a recovery strategy and the person is authorized under an Act of Parliament to engage in that activity.

**a) Continuation of Limited Sport Angling Opportunities**

This recovery strategy permits holders of a sports fishing license issued under the regulations of the *Fish and Wildlife Conservation Act* to participate in the trophy sport fisheries for Aurora Trout as per the regulations set out under the *Ontario Fishery Regulations*, *1989* pertaining to the recreational fishery of Aurora Trout.

For a number of years, OMNR has maintained a maximum of nine put-grow-and-take aurora trout lakes to increase public awareness and generate public and stakeholder support for the aurora trout recovery program (and species at risk in general). These lakes provide limited trophy sport fisheries that are tightly regulated and operate on a seasonal, rotational basis. Only a maximum of three lakes may be open in any one year and each may only be open once in every three years for the period August 1$^{st}$ to October 15$^{th}$, with a catch and possession limit of one fish. The permissible exploitation rate for the aurora trout in non-native lakes should not exceed the catch and possession limit of one per day. These lakes are maintained by stocking fry, fingerlings or adults fish (depending upon availability) from Hills Lake Fish Culture Station.

The angling opportunities are currently regulated under the *Ontario Fishery Regulations*, *1989* (under the federal *Fisheries Act*) and are allowed through a sports fishing license issued under the regulations of the *Fish and Wildlife Conservation Act*. The sport fisheries utilize surplus hatchery fishes not required for the 'wild' brood stock lake or the establishment of self-sustaining, non-native refuge lake (note – the native lakes are supported by natural reproduction and are not presently stocked). The harvest of fish from the angling lakes does not jeopardize the recovery of aurora trout in the wild because the fisheries are based solely on fish raised in the hatchery and there is no natural reproduction in these lakes. The two native aurora trout lakes have been permanently closed to angling under the Ontario Fishery Regulations since 1950.

**b) Field Sampling**

This recovery strategy permits persons authorized under a Licence to Collect Fish for Scientific Purposes issued under the *Ontario Fishery Regulations, 1989*, and OMNR staff undertaking fisheries management initiatives as part of their job to engage in field sampling of Aurora trout for the purposes described below and in accordance with authorized methods.

A sampling program is necessary to monitor the status and health of aurora trout populations found in both the native lakes and the non-native lakes. It is recommended that the native populations be sampled at least once ever five years and more frequently if the populations appear to be threatened by re-acidification or some other stress. Sampling in Whitepine and Whirligig lakes will provide information that is critical to managing and ensuring the viability of these populations. Parameters monitored include: population estimates, biomass estimates, growth rate, age class structure, sex ratios, etc. Field sampling is also used to acquire genetic samples for analysis. In the non-native lakes it may periodically be necessary to complete sampling protocols to ensure that the populations are safe from extirpation or to determine if natural reproduction is occurring. For example, it will be important to closely monitor the introduced population in Southeast Campcott Lake. This population was extirpated once before for unknown reasons. Additional monitoring may allow extirpation to be avoided this time and could assist in explaining the cause of the past extirpation.

Past sampling was completed by OMNR's partners under the authority of a Licence to Collect Fish for Scientific Purposes issued under the *Ontario Fishery Regulations, 1989*. OMNR staff do not require this permit while undertaking fisheries management initiatives as part of their job. Generally, field sampling has used non-lethal methods of capturing fish so that they can be released unharmed. Periodically it may be necessary to use lethal sampling methods (e.g. for fish health and disease testing).

**c) Sampling for Genetic Studies**

This recovery strategy permits persons authorized under a Licence to Collect Fish for Scientific Purposes issued under the *Ontario Fishery Regulations, 1989*, and OMNR staff undertaking fisheries management initiatives as part of their job to engage in sampling for genetic studies of Aurora trout for the purposes described below and in accordance with authorized methods.

As mentioned throughout this strategy, there are several important genetic questions that need to be answered to ensure the successful recovery of aurora trout. First, it is necessary to determine the taxonomic status of aurora trout. The results of these studies are also important for determining what management options are available to maximize the genetic diversity of aurora trout. Analyses are required to determine the most genetically diverse fishes for developing a breeding strategy and to determine if genetic diversity is changing over time in the native and hatchery populations. Generally, genetic samples are taken using non-lethal means under a Licence to Collect Fish for Scientific Purposes issued under the *Ontario Fishery Regulations, 1989*. As mentioned previously, OMNR staff do not require this permit.

If aurora trout are not distinct from brook trout, management options such as backcrosses of aurora trout with brook trout may be considered to increase the diversity of aurora trout. Currently, studies are ongoing to investigate the survival and fitness of backcrosses versus pure strain aurora trout. To date these studies have been maintained entirely within the hatchery environment, although in the future it may be desirable to determine how these strains perform over several generations in a lake environment. Another option would be to infuse brook trout genes into aurora trout to increase diversity. Aurora trout with brook trout genes are to be solely maintained in the hatchery until the taxonomy of aurora trout is clarified. No matter the taxonomic status of aurora trout, backcrosses and/or aurora trout with infused brook trout genes would not be stocked into the native lakes.

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# APPENDIX 1

## RECORD OF COOPERATION AND CONSULTATION

OMNR has led the management and recovery of aurora trout for nearly 50 years. Over this time there have been a number of consultation opportunities where the public, other stakeholders and First Nations have had an opportunity to become involved with the management of aurora trout.

Early consultation initiatives conducted in the mid-1980s through OMNR District Fisheries Management Plans and with provincial interest groups helped to form the basis of the first aurora trout Management Plan in 1983. Consultation and information dissemination on recovery efforts for acid-stressed habitats, including the native aurora trout lakes, was carried out in the mid- to late-1990s as part of a much broader land use planning initiative entitled the Temagami Land Use Plan (OMNR 1996) which was completed by the OMNR North Bay District (Temagami Area). Presentations were made to a number of audiences at the time, including the general public and the Comprehensive Planning Council (which included representatives from provincial, regional and local stakeholder organizations), regarding the ongoing recovery efforts surrounding aurora trout.

Over the past 20 years, when aurora trout have been introduced to new waters, Class Environmental Assessments have been completed. At the time of an introduction, the OMNR district office would also have to close the selected lake to angling, except for the short aurora trout season that would occur once every three years. Through consultation and in receiving public comments there were never any serious concerns expressed about stocking the lakes or closing them to angling. This is likely because all of the aurora trout lakes are small lakes that do not support any other sport fish species.

OMNR staff have presented information about aurora trout at numerous local fish and game club meetings over the years. As well, OMNR district offices have received numerous calls from the public (and from First Nation band members) regarding aurora trout. District staff on the ATRT have characterized these past conversations as almost exclusively positive or neutral in nature. Often people are just asking the district offices for information about aurora trout. The most frequent inquiries are related to the put-grow-and-take lakes. Anglers contact OMNR to ask which lakes are open in any given year and to inquire about season dates.

As well, a brochure on the biology, history and past recovery efforts was prepared in 1995 and was available to the public through various OMNR and Ontario Parks offices. This brochure is now out of date and should be updated (as identified in Table 2) in cooperation between the ATRT and Ontario Parks.

Consultation efforts have continued over the past few years as this Recovery Strategy was developed. In the summer of 2004 the strategy author was interviewed twice by

CBC radio affiliates in Thunder Bay and Sudbury, Ontario. Both interviews were primarily about the ongoing recovery efforts (although the 2004 closure of the angling lakes was briefly discussed) and were positive in nature. Subsequently, affected OMNR district staff contacted their local fish and game clubs to inform them that the aurora trout fishery would be closed while the Recovery Plan was prepared. Although some individuals did react negatively to the closure, many simply wanted to know when the lakes would be open to angling again. As the August 1, 2004 opening date approached, OMNR provided a central news release that was distributed to local media outlets in the vicinity of the lakes that were to be closed and signage was erected at the lakes.

Presentations on aurora trout and the recovery plan have been made to a number of audiences. For example, the management and recovery of aurora trout was presented to the Hills Lake Fish Culture Station Clients' Meeting in April 2005. Similar information was presented to an Ontario Nature meeting in North Bay in June 2005 and aspects of the aurora trout research have been presented to the scientific community in the past. As mentioned above, presentations on the recovery of the native aurora trout lakes were delivered as part of the Temagami Land Use Planning process.

Further public consultation is planned through the federal *Species at Risk Act* Registry posting, as well as the direct solicitation of comments from selected provincial and regional organizations (e.g. OFAH, the Northern Ontario Tourist Outfitters, Ontario Nature, World Wildlife Fund Canada). Once received, these comments will be considered by the Recovery Team and revisions to the Recovery Strategy will be made accordingly. Additional consultation is anticipated through the management planning process for Lady Evelyn Smoothwater Provincial Park which is now underway.

First Nation communities have also been consulted on the ongoing management and recovery of aurora trout. Communities have been invited to consult through the various land use planning exercises in the past (e.g. the Temagami Land Use Plan in the early- to mid-1990s, the various Environmental Assessments that have been completed for the introduction of aurora trout, etc.). Although it is evident that community members are aware of the management and recovery initiatives that have taken place over the years, there has been very little interest shown by the communities regarding involvement in the recovery process. Various OMNR district offices have received questions and comments from individual First Nation community members, but have not received official comments or inquiries from any community as a whole. Generally, the comments and questions received are from individuals that are only looking for information on aurora trout. Again, district staff have characterized the inquiries as being positive or neutral.

The two native aurora trout lakes may be located within a land claim that is currently being negotiated with Temagami First Nation. Negotiations regarding this land claim have been ongoing for some time now. Through discussions to date, no interest has been expressed in the management of aurora trout or related to the two native lakes. Staff have indicated that they do not believe this is particularly surprising given the small size and remote location of the two native lakes. To the best of OMNR's knowledge, aurora trout do not have any special spiritual or sustenance value to First Nation communities.

Additional opportunities for information exchange, comments and consultation will be afforded as the land claim negotiations continue. Based on the current state of the negotiations, it seems unlikely that the native aurora trout lakes will be included in the land claim settlement.

Contacts, via phone, were made with First Nations which were located within a geographic proximity to the aurora trout observed natural habitat and stocked lake areas. These communities included Ginoogaming, Long Lake, Pic River. Abitibi – Wahgoshig, Timiskaming, Matachewan, Mattagami, Wahnapitae, and Temagami. Meetings were held with four of them. The general impression is that there is limited interest in these Aboriginal communities for the species, probably because it is nearly indistinguishable from the local Brook Trout. As well, all First Nation communities and members will have additional opportunities to comment through the *Species At Risk Act* Registry posting and the development of the management plan for Lady Evelyn-Smoothwater Provincial Park.

Overall, the comments received from both the public and First Nations to date can be characterized as being either positive or neutral in tone. Generally the questions received by OMNR are related to when the angling season is open and what lakes will be open for angling. Both the public and First Nations communities seem to agree that the recovery of aurora trout from near extinction is a good news story.

Previous drafts of this Recovery Strategy have been reviewed by DFO, OMNR (including Ontario Parks and the Aquatic Research and Development Section), EC and the RENEW – Secretariat. In addition, the strategy has been reviewed and commented on by an anonymous peer reviewer. Comments from the various agencies and reviewers have been incorporated into this draft of the strategy.