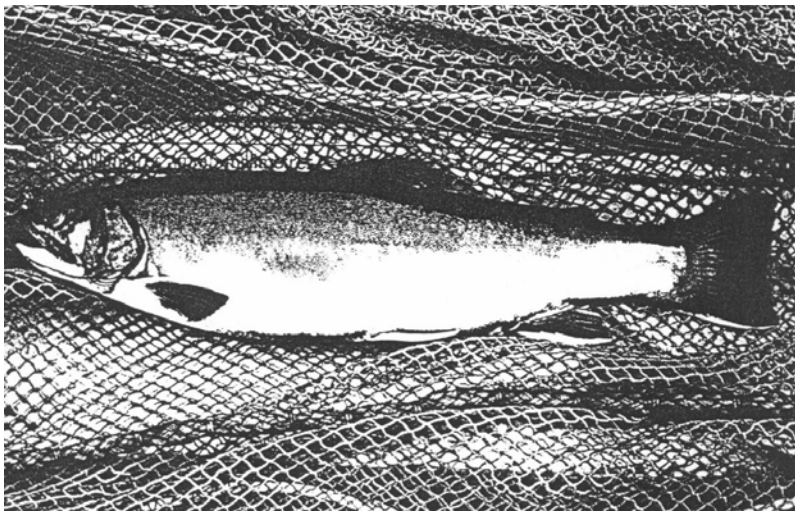
COSEWIC
Assessment and Update Status Report

on the

Aurora Trout
Salvelinus fontinalis timagamiensis

in Canada



ENDANGERED
2000

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION DES
ESPÈCES EN PÉRIL
AU CANADA

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COSEWIC 2000. COSEWIC assessment and update status report on the aurora trout *Salvelinus fontinalis timagamiensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 13 pp. (www.sararegistry.gc.ca/status/status_e.cfm)

Snucins, E., and J. Gunn. 2000. Update COSEWIC status report on the aurora trout *Salvelinus fontinalis timagamiensis* in Canada, *in* COSEWIC assessment and update status report on the aurora trout *Salvelinus fontinalis timagamiensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-13 pp.

Previous report:

Parker, B., and C. Brousseau. 1987. COSEWIC status report on the aurora trout *Salvelinus fontinalis timagamiensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. 16 pp.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur la situation de l'omble Aurora (*Salvelinus fontinalis timagamiensis*) au Canada – Mise à jour.

Cover illustration:
Aurora Trout — photograph of female aurora trout courtesy Ed Snucins.

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COSEWIC
Assessment Summary

Assessment Summary – May 2000

Common name
Aurora trout

Scientific name
Salvelinus fontinalis timagamiensis

Status
Endangered

Reason for designation
Formerly extirpated in the wild, reintroduced populations of this species are dependent on continuing intervention such as the liming of lakes to buffer acidity.

Occurrence
Ontario

Status history
Designated Endangered in April 1987. Status re-examined and confirmed Endangered in May 2000. Last assessment based on an update status report.

COSEWIC
Executive Summary

Aurora Trout
Salvelinus fontinalis timagamiensis

Description

The Aurora Trout is a subspecies of the Brook Trout (*Salvelinus fontinalis* Mitchill 1815) that is endemic to two small lakes (Whitepine and Whirligig) located about 110 km north of Sudbury, Ontario. Aurora Trout are distinguished from other Brook Trout mainly in terms of skin colouration: (1) adult Aurora Trout lack the yellow spots and vermiculations that typically occur on the dorsal surface of other Brook Trout; and (2) the numerous red spots surrounded by blue halos characteristically found on the sides of Brook Trout are greatly reduced in number or are absent on Aurora Trout.

Distribution

The native range of the Aurora Trout consists of two small waterbodies, Whirligig Lake and Whitepine Lake, located 110 km north of Sudbury, Ontario. Reproducing populations that were established during the 1990's in Southeast Campcot Lake and Northeast Campcot near Terrace Bay, Ontario are now extirpated. Currently, 10 other lakes in Northern Ontario contain introduced Aurora Trout populations that are maintained by stocking of hatchery-reared juvenile fish. A captive brood stock is maintained in one provincial fish culture facility near Kirkland Lake, Ontario.

Population Size and Trends

The two native populations were extirpated by lake acidification during the 1960's. Since then the stock has been maintained by artificial breeding that began in 1958 from a founding population of 6-9 individuals. The captive brood stock currently numbers 500-1000 fish. During the 1990's self-sustaining populations were reestablished in the two native lakes following water quality improvements. The biomass of Aurora Trout in Whirligig Lake quickly increased after stocking to levels comparable to that of Brook Trout populations in unacidified lakes and growth rates of the fish are similar to pre-acidification. Natural reproduction occurred in two non-native lakes (Southeast Campcot Lake, Northeast Campcot Lake) during the 1990's, but those populations are now extirpated. There is no evidence of successful reproduction in Alexander Lake, the egg source for hatchery brood stock, or in any of the 9 lakes that are used for the limited recreational fishery.

Biology

It appears that the thermal requirements of Aurora Trout are similar to other Brook Trout. Brook Trout generally inhabit water temperatures below 20^{o}C and when temperatures rise above that they seek cooler water by shifting their depth distribution or by inhabiting groundwater springs. At spawning time Aurora Trout, like other Brook Trout inhabiting lakes on the Canadian Shield, will seek areas of groundwater upwelling on which to build redds. A pH of at least 5.0 is required for successful reproduction and maintenance of self-sustaining populations.

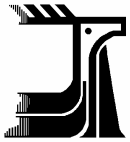
Limiting Factors

The native lakes are located within the zone affected by acid deposition from Sudbury metal smelters. Extirpation of the Aurora Trout during the 1960's coincided with acidification of the lakes to about pH 5.0, the threshold for Brook Trout survival. Although water quality improvements have occurred in the two native lakes since 1989 as a result of whole-lake liming and reductions in atmospheric pollution levels, the lakes are poorly buffered and they remain threatened by acidification. The main source of acid is atmospheric deposition of pollutants, but historically deposited sulphur may also be stored in adjacent wetlands and could contribute to reacidification following drought years when oxidized sulphur is released into the lake.

The spawning sites that have been identified to date are all on groundwater springs. We speculate that the failure of stocked Aurora Trout to reproduce in most non-native lakes is due to the lack of suitable groundwater sites for spawning in the new lakes. The use of groundwater springs for both spawning and as thermal refugia leaves Aurora Trout vulnerable to land use practices (eg. logging) and climatic changes that can affect the quantity and quality of groundwater discharge to lakes.

Special Significance

The Aurora Trout is a unique subspecies of the Brook Trout that is native to only two lakes in the entire world. Valued for its beauty and rarity, it was the only fish stock of hundreds that were extirpated by acidification in Ontario that is now preserved through a captive breeding program.



COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.
** Formerly described as “Not In Any Category”, or “No Designation Required.”
*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
COSEWIC Status Report

on the

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Salvelinus fontinalis timagamiensis

in Canada

Ed Snucins
John Gunn

2000

TABLE OF CONTENTS

List of figures

List of tables

The Aurora Trout is a subspecies of the Brook Trout (*Salvelinus fontinalis* Mitchill 1815) that is endemic to two small lakes (Whitepine and Whirligig) located about 110 km north of Sudbury, Ontario. This form likely evolved from Brook Trout that were isolated after the continental glaciers receded from that area about 10,000 years ago. The Aurora Trout was originally described as a distinct species (=*Salvelinus timagamiensis*) (Henn and Rickenbach 1925), but Martin (1939) considered it a subspecies of the Brook Trout and Vladykov (1954) referred to it as a Brook Trout colour variant. Subsequently, arguments were made for subspecies designation (*Salvelinus fontinalis timagamiensis*) based upon studies that included the original populations in Whitepine and Whirligig Lakes (Sale 1967; Qadri 1968; Behnke 1980). The significant differences that were identified between Aurora Trout and other Brook Trout included: (1) colouration; (2) skeletal structure (eg. numbers of trunk vertebrae, single neural spines, epineurals, strongly bifid ribs); and (3) spawning behaviour, as implied by reproductive isolation with little apparent hybridization between the sympatric populations of Aurora Trout and normal type Brook Trout in Whitepine Lake. In lakes other than Whitepine Lake Aurora Trout do hybridize with other Brook Trout (Sale 1967). The recent genetic analyses done on hatchery-reared Aurora Trout (McGlade 1981; Grewe *et al*. 1990) have not supported subspecies designation, but the significance of the results is uncertain because the extant gene pool originated from a small number of founders and thus may have less variation than the original populations. Allozyme data indicate that the Aurora Trout is the most genetically uniform of the 99 Brook Trout stocks in Ontario that have been evaluated (P. Ihssen, pers. comm., Ontario Ministry of Natural Resources, Box 7000, 3rd Floor N, 300 Water St., Peterborough, Ontario K9N 8M5). The low genetic diversity may be natural and reflect narrow adaptation to the home environment by the original wild stock, or, alternatively it may have arisen more recently when captive breeding began from a small founding population. We think the case for subspecies status made by Sale (1967) and Qadri (1968) and supported by Behnke (1980) has merit, in particular because Aurora Trout were observed in Whitepine Lake between the 1920's and 1950's to exist as a distinct form living sympatrically with normal type Brook Trout.

DESCRIPTION

The basic colouration of Aurora Trout is similar to other Brook Trout (Sale 1967). Dorsal colouration is olive green to dark brown. Along the sides this fades to iridescent steel blue and silver and pales to a white abdomen that is often tinged with pink. Pectoral, pelvic and anal fins have a leading white edge backed by a black bar and orange or red posterior. During spawning season the colour of males intensifies, the sides and upper abdomen taking on a bright red colour, often edged by a band of black along the abdomen (Figure 1). The distinguishing aspects of Aurora Trout colouration (Henn and Rinkenbach 1925; Sale 1967) are: (1) adult Aurora Trout lack the yellow spots and vermiculations that typically occur on the dorsal surface of other Brook Trout; and (2) the numerous red spots surrounded by blue halos characteristically found on the sides of Brook Trout are greatly reduced in number or are absent on Aurora Trout. Sale (1967) further noted that the body colour of Aurora Trout exhibits a strong iridescence not apparent in other Brook Trout.

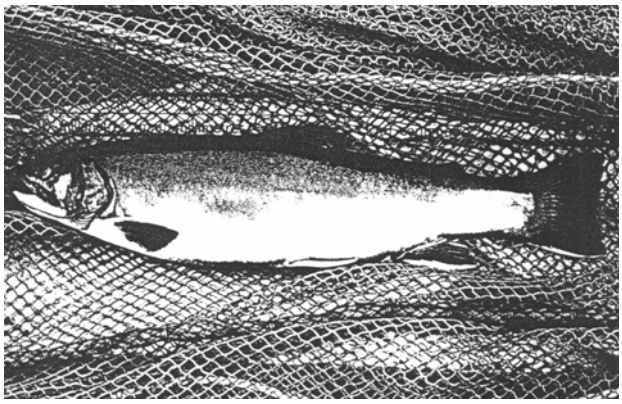

Figure 1. Female Aurora Trout (Photograph by E. Snucins).

Taxonomy

Class:	Osteichthyes
Order:	Salmoniformes
Family:	Salmonidae
Scientific name:	*Salvelinus fontinalis timagamiensis*
Common name:	Aurora Trout, Omble de Fontaine Aurora

DISTRIBUTION

The native range of the Aurora Trout consists of two small waterbodies, Whirligig Lake and Whitepine Lake, located 110 km north of Sudbury, Ontario, in Lady Evelyn Smoothwater Provincial Park. Although Henn and Rinkenbach (1925) listed a number of other waterbodies with possible occurrences, no authenticated records of indigenous breeding populations exist for any other waterbodies including Aurora Lake and Wilderness Lake, both of which were listed as having indigenous populations by Parker and Brousseau (1988). The population in Wilderness Lake reported as native by Sale (1967) was in fact introduced in 1955 when a few adults were transferred across the portage from Whitepine Lake (C. Elsie and D. Butler, personal communication). The infrequent reports of Aurora Trout in Marina Lake likely represent individuals that emigrated downstream from Whitepine Lake, rather than members of a breeding population in Marina Lake (Sale 1964).

During the 1990's self-sustaining Aurora Trout populations were reestablished in both Whirligig Lake and Whitepine Lake following water quality improvements brought about by whole-lake liming of Whirligig Lake. Hatchery-reared fish stocked in Southeast Campcot Lake and Northeast Campcot near Terrace Bay also reproduced successfully, but those populations were subsequently extirpated. Currently, 10 other lakes in Northern Ontario contain introduced Aurora Trout populations that are maintained by stocking of hatchery-reared juvenile fish (Figure 2): Liberty Lake, Carol Lake, Reed Lake, Pallet Lake, Nayowin Lake, Big Club Lake, Semple #54 Lake, Wynn Lake, Borealis Lake, and Alexander Lake.

Figure 2. Location of lakes with Aurora Trout. Closed square indicates the two native lakes with self-sustaining populations. Closed triangle indicates the two non-native lakes with reproducing populations that have been extirpated. Open circles indicate the 10 non-native lakes with populations maintained by stocking of hatchery-reared fish.

PROTECTION

Since 1983 the Aurora Trout Management Committee, composed of OMNR biologists, technicians and hatchery staff, has overseen the management of Aurora Trout. The current management objectives are: (1) to maintain the Aurora Trout gene pool and restore self-sustaining populations to their native habitat; and (2) to introduce Aurora Trout into a limited number of non-native lakes to maintain a brood stock, establish one reproducing satellite population and provide limited angling opportunities. In 1987 the Aurora Trout was assigned an "endangered" designation by COSEWIC. The Conservation Data Centre rating is G5T, ON-S1 and Ontario recognizes the form as endangered, but it is not regulated under the Endangered Species Act.

All lakes that supported reproducing Aurora Trout populations during the 1990's are designated as fish sanctuaries. Angling is not permitted at any time on those four lakes, nor on Alexander Lake which is used as a source of eggs for the hatchery brood stock. Limited angling is allowed in the 9 other non-native lakes containing stocked hatchery-reared fish. Those lakes are opened to angling once every 3 years from August 1 to October 15. The catch and possession limits are one Aurora Trout per licenced angler or zero for anglers with a conservation licence. To prevent the accidental introduction of other species, the use of live baitfish is prohibited in these angling lakes.

The habitat of the Aurora Trout is not protected by any specific legislation. However, the watersheds of the two native lakes are protected from industrial acitivities (eg. logging, mining) by virtue of their location in a wilderness park. General protection for all populations is provided by the federal Fisheries Act.

POPULATION SIZE AND TRENDS

Recent paleolimnological evidence suggests that the native lakes began to acidify as early as the 1940's (Dixit *et al*. 1996). In 1951 the Ontario government began to monitor the native Aurora Trout populations and by the late 1950's the populations had noticeably declined. By 1967 the Aurora Trout had disappeared from its native range. The other fish species in the native lakes were also extirpated.

Since 1958 the Aurora Trout has been maintained artificially in OMNR fish culture facilities. The lineage of all Aurora Trout in existence today can be traced back to a 1958 spawn collection. That year 3644 eggs were collected from one Whitepine Lake female and two Whirligig Lake females (Patrick and Graf 1961). The eggs from each female were mixed with the sperm from two males. Thus, the founding population size was nine individuals (3 females, 6 males) and may have been as few as six if all males did not contribute to fertilization. Currently in any one year 500-1000 fish are kept as brood stock in the Hill's Lake Fish Culture Station. The brood stock is maintained by biannual egg collections in Alexander Lake (25,000-40,000 eggs/year). The total number of eggs collected per year by the captive breeding program, including those from Alexander Lake, is 50,000-150,000.

Successful reproduction has occurred annually in Whirligig Lake since it was restocked with hatchery-reared Aurora Trout in 1990 and in Whitepine Lake since 1994 following stocking that was done in 1991 and 1994. The biomass of Aurora Trout in Whirligig Lake quickly increased after stocking to levels comparable to that of Brook Trout populations in unacidified lakes and growth rates of the fish are similar to pre-acidification (Snucins *et al*. 1995) (Table 1). Natural reproduction was also documented in Southeast Campcot Lake in 1991 and in Northeast Campcot Lake in 1994. The abundance of those populations appeared to decline during the late 1990's and by 2001 they were extirpated. There is no evidence of successful reproduction in Alexander Lake, the egg source for hatchery brood stock, or in any of the 9 lakes that are used for the limited recreational fishery.

Table 1. Estimated number (N) and biomass (B) of stocked and natural aurora trout in Whirligig Lake. Numbers in parentheses are lower and upper 95% confidence intervals.

Year	Stocked		Natural	
	N	B (kg/ha)	N	B (kg/ha)
1990	209(151-301)	6.7(4.8-9,6)	0	0
1991	307(173-463)	17.2(9.7-26.0)	0	0
1993	156(108-236)	11.3(7.8-17.1)	300(229-403)	4.5(3.4-6.0)

HABITAT

The two native Aurora Trout lakes are part of a chain of lakes situated on a ridge in Lady Evelyn Smoothwater Provincial Park. They are some of the highest elevation lakes in Ontario. Whirligig Lake (11 ha surface area; maximum depth 9.1 m; Secchi depth 3.3-6.2 m in 1999; 435 m elevation) flows into Whitepine Lake (77 ha surface area; maximum depth 21.3 m; Secchi depth 3.5-6.0 m in 1999; 430 m elevation). The surrounding terrain is hilly and rough, topography typical of the Precambrian Shield. The lakes are 10 km from the nearest road and accessible only by canoe and trail or by aircraft. Their watersheds have low acid-neutralizing capacities and are vulnerable to acidification.

The native lakes are located within the zone affected by acid deposition from Sudbury metal smelters (Neary *et al*. 1990). Extirpation of the Aurora Trout during the 1960's coincided with acidification of the lakes to about pH 5.0 (Keller 1978), the threshold for Brook Trout survival (Beggs and Gunn 1986). By 1976 the pH of Whitepine Lake was 4.7. During the 1980's water quality remained unsuitable for Aurora Trout survival in their native lakes (Snucins *et al*. 1988). Following liming in 1989 the pH of Whirligig Lake increased from 4.8 to about 6.5. The pH has subsequently declined and additional limings were necessary in 1993 and 1995 to increase the pH. However, between 1997 and 1999 the pH remained relatively steady at 5.3-5.6. This is close to the natural pH of the lake, as estimated by paleolimnological analysis of sediment cores (Dixit *et al*. 1996), and is suitable for Aurora Trout reproduction. Whitepine Lake also exhibited some water quality improvement. It's pH increased from 4.9 in the late 1980's to 5.2 by 1993 and 5.3-5.4 by 1999. The pre-industrial pH of Whitepine Lake was 5.4-5.7 (Dixit *et al*. 1996). The improvement may be due to input of limed water from Whirligig Lake or atmospheric pollution reductions or both.

The other two lakes that had reproducing populations during the 1990's, Southeast Campcot Lake (35.6 ha, 43 m maximum depth, 6.8 m Secchi depth) and Northeast Campcot Lake (20.8 ha, 28 m maximum depth, 8.3 m Secchi depth), are located in well-buffered watersheds and are not threatened by acidification.

Spawning by Aurora Trout in Whirligig Lake occurs on groundwater seepages over sand, gravel and rock substrate in water 1.2-4.1 m deep at distances of 2-45 m from shore. The spawning sites in the other lakes have not yet been identified.

GENERAL BIOLOGY

Reproductive Capability

Aurora Trout spawn in late October and early November when lake water temperatures are below 8^{o}C. Sexual maturity is reached at age 2^{+} to 4^{+} years. The maximum known lifespan is 9 years. Spawning is thought to occur annually after sexual maturity is reached. The number of eggs produced by mature female Brook Trout is dependent on size. Ripe females in the native lakes ranged in size from 335 mm to 458 mm fork length. Brook Trout of that size typically produce 1000 (325 mm fork length) to 3000 (470 mm fork length) eggs (Vladykov 1956).

Species Movement

It appears that the thermal requirements of Aurora Trout are similar to other Brook Trout (eg. Sale 1962). Brook Trout generally inhabit water temperatures below 20^{o}C and when temperatures rise above that they seek cooler water by shifting their depth distribution or by inhabiting groundwater springs (Scott and Crossman 1973; Power 1980). At spawning time Aurora Trout will seek areas of groundwater upwelling on which to excavate redds.

Behaviour/Adaptability

A pH of at least 5.0 is required for successful reproduction and maintenance of self-sustaining populations (Beggs and Gunn 1986). Aurora Trout stocked into Whirligig Lake during the late 1980's when it was still quite acidic (pH 4.8) survived in small numbers, but they were physiologically stressed, could not reproduce and had shortened lifespans.

The spawning sites that have been identified to date are all on groundwater springs which is typical of Brook Trout on the Canadian Shield (Noakes and Curry 1995). We speculate that the failure of stocked Aurora Trout to reproduce in most non-native lakes is due to the unavailability of suitable groundwater sites for spawning in those lakes.

LIMITING FACTORS

The two native lakes are still threatened by acidification. The main source of acid is atmospheric deposition of pollutants, but historically deposited sulphur may also be stored in adjacent wetlands and could contribute to reacidification following drought years (Schindler 1998). The use of groundwater springs for spawning and thermal refugia also leave Aurora Trout vulnerable to land use practices (eg. logging) and climatic changes that affect the quantity and quality of groundwater seepage. In addition, Brook Trout are vulnerable to competition from other species such as yellow perch (Fraser 1978) which can be introduced from fishermen's bait buckets. Fortunately, angling is prohibited in the lakes with reproducing populations and there is a ban on use of live baitfish in all other lakes with Aurora Trout. Despite this illegal harvesting occurred during the 1990’s on Southeast Campcot Lake and Northeast Campcot Lake.

SPECIAL SIGNIFICANCE OF THE SPECIES

The Aurora Trout is a unique subspecies of the Brook Trout that is native to only two lakes in the entire world. Valued for its beauty and rarity, it was the only fish stock out of hundreds that were extirpated by acidification in Ontario that has been preserved through captive breeding.

EVALUATION

The Aurora Trout is a unique subspecies of Brook Trout endemic to two lakes in northeastern Ontario. By 1967 it had been extirpated from both lakes as a result of anthropogenic acidification. It was preserved through captive breeding done by the Ontario Ministry of Natural Resources using brood stock maintained in one sanctuary lake and at a provincial fish culture facility. Reproducing populations were re-established during the 1990's in both native lakes following restoration of water quality by whole-lake liming, but it is not yet certain that pollution levels are low enough to protect the lakes from reacidification. Naturally reproducing populations that were established in two well-buffered non-native lakes were extirpated. Illegal harvesting was documented on those lakes. If Aurora Trout are reintroduced there, consideration should be given to increased protection from illegal harvesting and to protecting the watersheds from potentially harmful industrial activities (eg. mining, logging). The continued survival of wild self-sustaining aurora trout populations depends on protecting their lakes and watersheds from harmful anthropogenic alterations.

Over the past decade great progress has been made in restoring the Aurora Trout to its native habitat, but continued survival of the aurora trout requires a strong commitment to human intervention. It is not yet certain that the water quality in the native lakes will remain suitable for Aurora Trout without additional whole-lake liming. The reproducing populations established in two non-native lakes have recently been extirpated. Given the limited distribution and the current uncertainties regarding continued maintenance of habitat quality, the Aurora Trout should still be considered an endangered species

TECHNICAL SUMMARY

Aurora Trout, L'omble de Fontaine Aurora, *Salvelinus fontinalis timagamiensis*

DISTRIBUTION

Extent of occurrence: <500 km^2

Area of occupancy: <100 km^2

POPULATION INFORMATION

Total number of individuals in Canadian population: Unknown

Number of mature individuals in the Canadian population: 500-1000

Generation time: 3+yr

Population trend: Rapid decline and extinction from 2 original sites, reintroduced fish dependent on intervention for survival

Rate of population decline: Precipitous following acidification (acid rain)

Number of sub-populations: Originally 2, now 13, but natural reproduction occurs at only 2 sites

Is the population fragmented: Yes

Number of individuals in each sub-population: Unknown

Number of extant locations: 2

Number of historic sites from which species has been extirpated: 4

Does the species undergo fluctuations: No

THREATS

Lake acidification by atmospheric deposition of pollutants, competition from introduced species such as yellow perch, and loss and degradation of spawning habitat.

RESCUE POTENTIAL

Does species exist outside Canada No

Is immigration known or possible No

ACKNOWLEDGMENTS

The Aurora Trout restoration program is financed and conducted by the Ontario Ministry of Natural Resources. Support for the water quality monitoring program has been maintained by the Ontario Ministry of the Environment with additional support in recent years from Al Dextrase through the Ontario Ministry of Natural Resources. Additional financial support during the period 1992-1994 was provided by the Endangered Species Recovery fund, cosponsored by World Wildlife Fund, Canada, and the Canadian Wildlife Service of Environment Canada. We thank Al Dextrase and the Aurora Trout management committee, in particular Craig Jessop, Ron Ward, Chuck McCrudden, Linda Melnyk-Ferguson, and Peter Davis for helpful comments on an earlier draft of this report.

LITERATURE CITED

Beggs, G.L., and J.M. Gunn. 1986. Response of Lake Trout *(Salvelinus namaycush*) and Brook Trout (*S. fontinalis*) to surface water acidification in Ontario. Water, Air, and Soil Pollution 30: 711-718.

Behnke, R.J. 1980. A systematic review of the genus *Salvelinus*. Pages 441-479 in E.K. Balon, editor. Charrs: Salmonid fishes of the genus *Salvelinus*. Dr. W. Junk, The Hague, The Netherlands.

Dixit, A.S., S.S. Dixit, and J.P. Smol.1996. Long-term trends in limnological characteristics in the Aurora Trout lakes, Sudbury, Canada. Hydrobiologia 335: 171-181.

Fraser, J.M. 1978. The effect of competition with yellow perch on the survival and growth of planted brook trout, splake and rainbow trout in a small Ontario lake. Transactions of the American Fisheries Society 107: 505-517.

Grewe, P.M., N. Billington, and P.D.N. Hebert. 1990. Phylogenetic relationships among members of Salvelinus inferred from mitrochondrial DNA divergence. Canadian Journal of Fisheries and Aquatic Sciences 47: 984-991.

Henn, A.W., and W.H. Rickenbach. 1925. Description of the Aurora Trout (*Salvelinus timagamiensis*), a new species from Ontario. Annals of the Carnegie Museum 16: 131-141.

Keller, W. 1978. Limnological observations on the Aurora Trout lakes. Technical report. Ontario Ministry of the Environment, Sudbury, Ontario, Canada.

Martin, W. 1939. The arctic char of North America. M.A. thesis. University of Toronto, Toronto, Canada.

McGlade, J.M. 1981. Genotypic and phenotypic variation in the Brook Trout, *Salvelinus fontinalis* (Mitchell) Ph. D. thesis. University of Guelph, Guelph, Canada.

Neary, B.P., P.J. Dillon, J.R. Munro, and B.J. Clark. 1990. The acidification of Ontario lakes: an assessment of their sensitivity and current status with respect to biological damage. Technical report. Ontario Ministry of the Environment, Toronto.

Noakes, D.L.G., and R.A. Curry. 1995. Lessons to be learned from attempts to restore *Salvelinus* species other than *S. namaycush*: a review of reproductive behaviour. Journal of Great Lakes Research 21 (Supplement 1): 54-64.

Parker, B.J., and C. Brousseau. 1988. Status of the Aurora Trout, *Salvelinus fontinalis timagamiensis*, a distinct stock endemic to Canada. Canadian Field-Naturalist 102: 87-91.
Patrick, N.D., and P. Graf. 1961. The effect of temperature on the artificial culture of Aurora Trout. The Canadian Fish Culturist 30: 49-55.
Power, G. 1980. The Brook charr, *Salvelinus fontinalis*. Pages 141-203 in E.K. Balon, editor. Charrs: Salmonid fishes of the genus *Salvelinus*. Dr. W. Junk, The Hague, The Netherlands.
Qadri, S.U. 1968. Morphology and taxonomy of the Aurora char, *Salvelinus fontinalis timagamiensis*. National Museums of Canada Contributions to Zoology 5: 1-18.
Sale, P.F. 1962. A note on the lethal temperature of the aurora trout, *Salvelinus timagamiensis*. Canadian Journal of Zoology 40: 367-369.
Sale, P.F. 1964. Ecology and taxonomy of the Aurora Trout. M.A. thesis. University of Toronto, Toronto, Canada.
Sale, P.F. 1967. A re-examination of the taxonomic position of the Aurora Trout. Canadian Journal of Zoology 45: 215-225.
Schindler, D.W. 1998. A dim future for boreal waters and landscapes. Bioscience 48: 157-164.
Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 1-966.
Snucins, E.J., V.A. Liimatainen, and P.A. Gale. 1988. Effect of acidic lake water on survival of Aurora Trout (*Salvelinus fontinalis*) embryos and alevins. Ontario Fisheries Acidification Report Series no. 88-15. Ontario Ministry of Natural Resources, Toronto.
Snucins, E.J., J.M. Gunn, and W. Keller. 1995. Restoration of the Aurora Trout to its acid-damaged native habitat. Conservation Biology 9: 1307-1311.
Vladykov, V.D. 1954. Taxonomic characters of the eastern North American chars (*Salvelinus* and *Cristivomer*). Journal of the Fisheries Research Board of Canada 11: 904-932.
Vladykov, V.D. 1956. Fecundity of wild speckled Trout (*Salvelinus fontinalis*) in Quebec lakes. Journal of the Fisheries Research Board of Canada 13: 799-841.

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