COSEWIC
Assessment and Update Status Report

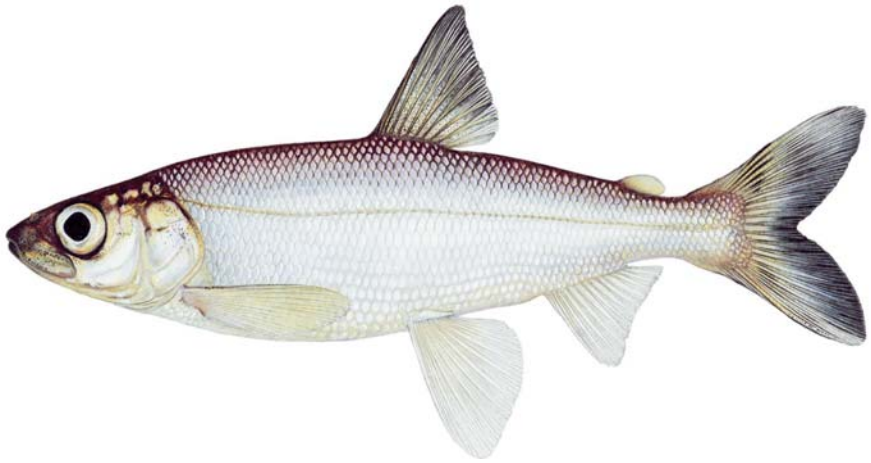
on the

Lake Ontario Kiyi
Coregonus kiyi orientalis

and

Upper Great Lakes Kiyi
Coregonus kiyi kiyi

in Canada



LAKE ONTARIO KIYI - EXTINCT
UPPER GREAT LAKES KIYI - SPECIAL CONCERN
2005

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous report:

Parker, B. 1988. COSEWIC status report on the kiyi *Coregonus kiyi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-18 pp.

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Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur le kiyi du lac Ontario (*Coregonus kiyi orientalis*) et le kiyi du secteur supérieur des Grands Lacs (*Coregonus kiyi kiyi*) au Canada – Mise à jour.

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Kiyi — Illustration by Joe Tomelleri. Reproduced with permission of Fisheries and Oceans Canada.

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COSEWIC
Assessment Summary

Assessment Summary – May 2005

Common name
Lake Ontario kiyi

Scientific name
Coregonus kiyi orientalis

Status
Extinct

Reason for designation
Last recorded from Lake Ontario in 1964, the subspecies was driven to extinction by commercial exploitation, and predation/competition by introduced species.

Occurrence
Formerly Ontario

Status history
Designated Special Concern in April 1988. Split into two subspecies (Upper Great Lakes kiyi and Lake Ontario kiyi) in May 2005. The Lake Ontario kiyi was designated Extinct in May 2005. Last assessment based on an update status report.

Assessment Summary – May 2005

Common name
Upper Great Lakes kiyi

Scientific name
Coregonus kiyi kiyi

Status
Special Concern

Reason for designation
Currently found only in Lake Superior, the subspecies has been extirpated from lakes Huron and Michigan, as the result of a complex of factors, which included exploitation and introduced exotic species. The extirpation in lakes Huron and Michigan occurred more than three generations in the past. The remaining population in Lake Superior appears to be stable, and supports a small, regulated fishery. Other threats, such as the introduction of exotic species, which impacted populations in the lower lakes do not appear to be important in Lake Superior.

Occurrence
Ontario

Status history
Designated Special Concern in April 1988. Split into two subspecies (Upper Great Lakes kiyi and Lake Ontario kiyi) in May 2005. The Upper Great Lakes kiyi was designated Special Concern in May 2005. Last assessment based on an update status report.

COSEWIC
Executive Summary

Lake Ontario Kiyi
Coregonus kiyi
and
Upper Great Lakes Kiyi
Coregonus kiyi kiyi

Species Information

The kiyi is one of 10 cisco species found in Canada, one of seven cisco species found in the Great Lakes, and one of six cisco species identified as endemic to the Great Lakes. The kiyi can be distinguished from the other cisco species found in the Great Lakes by its unique combination of large eye and long paired fins. Two designatable units (*C. kiyi orientalis* occurring only in Lake Ontario, and *C. kiyi kiyi* of the upper Great Lakes) are recognized.

Distribution

The kiyi was endemic to all of the Laurentian Great Lakes of North America except Lake Erie. It is believed to be currently extant only in Lake Superior.

Habitat

The kiyi prefers the deepest parts of lakes in which it is found. It is rarely collected in waters less than 108m deep, and has been reported at depths ranging from 35m to 200m.

Biology

Maximum known age is 10+ years for females and 7+ years for males, and maximum known length is 250 mm Total Length (tip of snout to tip of tail fin).. Spawning occurred from September to January at depths of 106-165m. Age at maturity was reported as 2+ to 3+ years in Lake Michigan and minimum size at maturity was reported as 132mm SL in Lake Superior. Prey items in lakes Huron and Ontario were predominantly small freshwater shrimps. The kiyi (itself) is a prey item for burbot (*Lota lota*) and deep water forms of lake trout (*Salvelinus namaycush*).

Population Sizes and Trends

Although the deepwater cisco fishery (commonly known as the “chub fishery”) was very important in the Great Lakes, the catches were rarely identified to species. Too few collections of kiyi (recorded to species) have been documented over time in a standardized manner to evaluate population sizes and trends. It is estimated that there were between 22 tonnes and 330 tonnes of kiyi in the deepest parts of Lake Superior in 2000-01.

Limiting Factors and Threats

The decline of kiyi in lakes Huron, Michigan and Ontario was likely the result of commercial overfishing. It has been suggested that remnant kiyi populations in these lakes may have competed with, or have been predated by, introduced fish species. These threats are likely currently unimportant in Lake Superior.

Special Significance of the Species

Of the six cisco species (bloater, blackfin cisco, deepwater cisco, kiyi, shortjaw cisco, shortnose cisco) identified as indigenous to the Great Lakes, the kiyi is one of only three species (bloater, kiyi, shortjaw) known to be extant. The kiyi exhibits unique adaptations to its deepwater habitat including enlarged eyes and pectoral fins.

Existing Protection or Other Status Designations

The kiyi and its habitat are protected by the federal Fisheries Act. It was assessed previously as Special Concern by COSEWIC in 1988. It is listed S3? (Rare to Uncommon?) in Ontario by the Natural Heritage Information Centre. In the United States, it is assigned a conservation status by 5 states.

COSEWIC HISTORY

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. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members 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 Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government members and the co-chairs of the species specialist and the Aboriginal Traditional Knowledge subcommittees. The Committee meets to consider status reports on candidate species.

DEFINITIONS (NOVEMBER 2004)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A wildlife species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction.

* 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.

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

Update
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Upper Great Lakes Kiyi
Coregonus kiyi kiyi

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2005

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SPECIES INFORMATION

Name and classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Actinopterygii
Order:	Salmoniformes
Family:	Salmonidae
Subfamily:	Coregoninae
Genus and Species:	*Coregonus kiyi* (Koelz, 1921)
Common English name:	kiyi (Nelson *et al*. 2004)
Common French name:	kiyi
Subspecies:	*Coregonus kiyi kiyi* Koeltz, 1929
Common English name:	upper Great Lakes kiyi (Nelson *et al*. 2004)
Common French name:	kiyi du secteur supérieur des Grands Lacs
Subspecies:	*Coregonus kiyi orientalis* (Koeltz, 1929)
Common English name:	Lake Ontario kiyi (NatureServe 2005)
Common French name:	kiyi du lac Ontario

The kiyi is one of 10 cisco species found in Canada (Scott and Crossman 1998), one of seven cisco species found in the Great Lakes (Cudmore-Vokey and Crossman 2000), and one of six cisco species identified as an incipient species flock endemic to the Great Lakes by Koelz (1929). These counts exclude the longjaw cisco (*C. alpenae*), described by Koelz (1929) and included in Scott and Crossman (1998) as it is considered a synonym of shortjaw cisco (*C. zenithicus*) by Todd *et al*. (1981). Two (blackfin cisco, *C. nigripinnis*, and shortjaw cisco, *C. zenithicus*) of the six valid species, originally identified as 'endemic' to the Great Lakes by Koelz (1929), may occur outside of the Great Lakes basin (Lee *et al*. 1980, Mandrak and Crossman 1992). The remaining three are the bloater (*C. hoyi*), the deepwater cisco (*C. johannae*) and shortnose cisco (*C. reighardi*). The seventh cisco found in the Great Lakes, but with a wider Canadian distribution, is the cisco, or lake herring (*C. artedii*).

Research on the shortjaw cisco (*C. zenithicus*) revealed that Great Lakes and inland populations of this species were genetically indistinguishable from the cisco (*C. artedi*); however, the shortjaw cisco is still considered to be a valid species (Todd *et al*. 1981, Turgeon *et al*. 1999, Turgeon and Bernatchez 2003). This may be an indication that some, or all, of the endemic cisco species may actually be ecomorphotypes of the cisco (*C. artedi*), rather than valid species. If, in future, this were shown to be true for the kiyi, the kiyi would still be considered an evolutionarily significant unit (ESU) or, at the very least, a unique morphotype. To date, a taxonomic revision of the 'endemic' ciscoes has not been undertaken; therefore, the endemic species should be considered valid.

Description

The kiyi (*Coregonus kiyi*) is a member of the subfamily Coregoninae of the family Salmonidae (Robins *et al*. 1991) (Figure 1). It is characterized by a large eye (22.2-26.4% of head length), terminal mouth with lower jaw usually extending beyond upper jaw, lower jaw with distinct symphyseal knob or projection, pigmented maxillary, 34-47 gill rakers, and long paired fins (Scott and Crossman 1998, Todd, no date). The kiyi can be distinguished from the other cisco species found in the Great Lakes by its unique combination of large eye and long paired fins (Todd, no date).

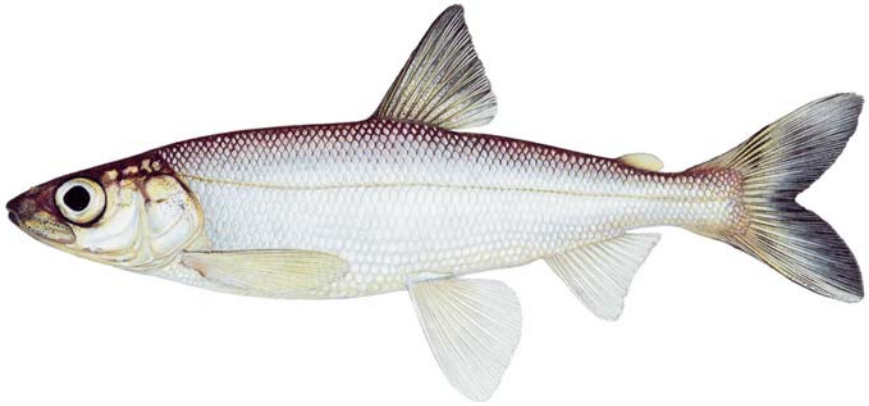

Figure 1. Kiyi, *Coregonus kiyi*. Note that this figure illustrates the less common upper jaw projecting beyond lower jaw, rather than the lower jaw projecting beyond the upper jaw. Illustration by Joe Tomelleri. Reproduced with permission of Fisheries and Oceans Canada.

Designatable units

All Canadian populations are found within the Great Lakes-Western St. Lawrence ecozone of the freshwater ecozone classification adopted by COSEWIC (COSEWIC 2003). Based on morphological data, Koelz (1929) considered the Lake Ontario population to be one subspecies (*C. kiyi orientalis*), and the upper Great Lakes population(s) to consist of a second subspecies (*C. kiyi kiyi*). Thus, two designatable units could be recognized, based on differences of morphology, and the fact that they were never co-occurring in the same Great Lake (NatureServe 2005).

DISTRIBUTION

Global range

The kiyi was endemic to all of the Laurentian Great Lakes of North America except Lake Erie (Koelz 1929, Scott and Crossman 1998) (Figure 2). It is believed to be currently extant only in Lake Superior (Todd 1980). It was last recorded in Lake Ontario in 1964, Lake Huron in 1973, and in Lake Michigan in 1974 (Parker 1989).

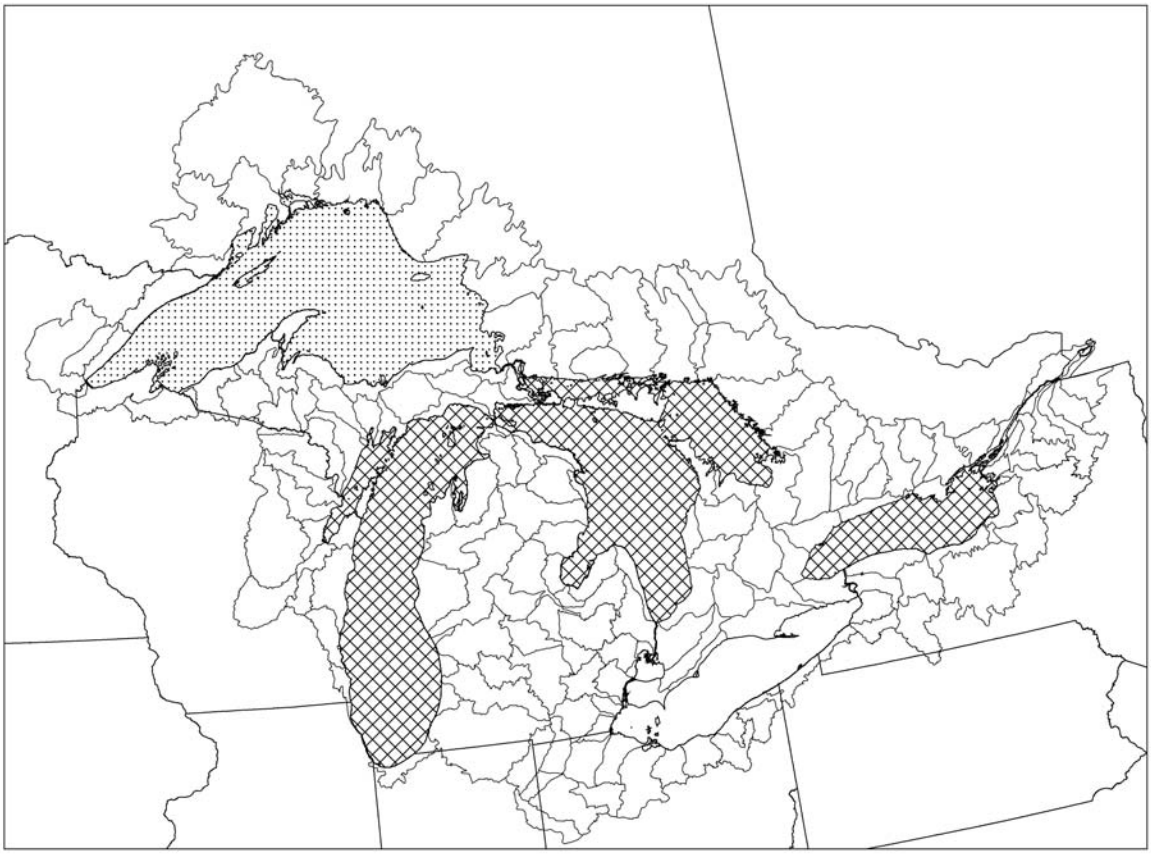

Figure 2. Global distribution of the kiyi, *Coregonus kiyi*. Fine dots represent lake in which it is extant. Cross-hatching represents lakes in which it is extirpated.

Canadian range

In Canada, the kiyi was known from lakes Huron, Ontario and Superior (Figure 2). It is believed to be currently extant only in Lake Superior (Todd 1980).

A number of Indian Reserves are located along Lake Superior, within the distribution range of the kiyi, but information from First Nations Community members was not available for inclusion in the status report.

HABITAT

Habitat requirements

The kiyi prefers the deepest parts of lakes in which it is found. It is rarely collected in waters less than 108m deep, and has been reported at depths ranging from 35m to

200m (Koelz 1929, Pritchard 1931, Hile and Deason 1947, Dryer 1966, Anderson and Smith 1971, Scott and Crossman 1998). As a result, it lives in a clear, poorly lit, cold water environment year round. Little else is known about its habitat preferences, although Koelz (1929) noted that kiyi were collected over bottoms of clay and mud substrate.

Trends

The preferred deepwater habitat of kiyi has likely changed little over time (Allen *et al.* 1969, Berst and Spangler 1973, Lawrie and Rahrer 1973).

Protection/ownership

The Great Lakes are publicly owned, and all fish habitat within the lakes are protected by the Federal Fisheries Act.

BIOLOGY

General

Maximum known age is 10+ years for females and 7+ years for males (Parker 1989). Maximum known length is 250 mm TL (total length) (Todd 1980, Coker *et al.* 2001).

Reproduction

Spawning occurred from October to November in Lake Huron (Koelz 1929), September to November in Lake Michigan (Hile and Deason 1947), October to January in Lake Ontario (Pritchard 1931), and November to December in Lake Superior (Koelz 1929). Spawning occurred at depths of 106-165m in Lake Michigan (Hile and Deason 1947), and at 128m in Lake Superior (Parker 1989). Age at maturity was reported as 2+ to 3+ years in Lake Michigan (Hile and Deason 1947). Minimum size at maturity was reported as 132mm SL in Lake Superior (Koelz 1929).

Survival

Maximum known age is 10+ years for females and 7+ years for males (Parker 1989). Survival rates unknown.

Physiology

Unknown.

Movements/dispersal

Unknown.

Nutrition and interspecific interactions

Prey items in lakes Huron and Ontario were predominantly the deepwater crustaceans *Mysis relicta* and *Diporeia hoyi* (Koelz 1929, Pritchard 1931). As the result of its preferred deepwater habitat, the kiyi likely has limited interactions with other fish species. It is a prey item for burbot (*Lota lota*) and deep water forms of lake trout (*Salvelinus namaycush*) (Scott and Crossman 1998). Periodic increases in lake trout numbers in the Great Lakes likely increased the predation pressure on the deepwater ciscoes (Christie 1973, Selgeby *et al.* 1994). Petzold (2002) estimated that lake trout may consume up to 1608 tonnes of deepwater ciscoes annually in the eastern basin of Lake Superior. The decline of lake trout in lakes Huron and Ontario may have shifted sea lamprey (*Petromyzon marinus*) predation to deepwater ciscoes and other species (Christie 1973). However, the decline of deepwater ciscoes in Lake Superior pre-dated colonization by the sea lamprey (Lawrie and Rahrer 1973). Smith (1995) noted that the decline in deepwater ciscoes in Lake Ontario coincided with the increasing abundance of alewife (*Alosa pseudoharengus*). He postulated that this may have been the result of competition for plankton, or predation on, larval ciscoes. However, the decline of deepwater ciscoes in Lake Superior pre-dated colonization by the alewife (Lawrie and Rahrer 1973), which have never become abundant in Lake Superior (Selegby *et al*. 1994).

Behaviour/adaptability

Unknown.

POPULATION SIZES AND TRENDS

Although the deepwater cisco fishery (commonly known as the “chub fishery”) was very important in the Great Lakes, the catches were rarely identified to species (Lawrie and Rahrer 1973). Too few collections of kiyi (recorded to species) have been documented over time in a standardized manner to evaluate population sizes and trends.

In Lake Ontario, kiyi made up 52.8% of all ciscoes (n=395) caught in experimental gill nets in 1927 (Pritchard 1931). This number fell to 0.01% (n=899) in 1942 (Stone 1947), and only a single individual (n=15) was captured in 1964, the last year that it was recorded in Lake Ontario (Wells 1969). Subsequent index sampling by OMNR, commercial cisco fishing, and sampling of historic sites in western Lake Ontario in 2002 (N.E. Mandrak, unpubl. data), failed to capture any specimens.

Although there is virtually no historic information on the population size of kiyi (identified to species) for Lake Superior (Lawrie and Rahrer 1973, Selgeby *et al*. 1994),

there are good recent data for Lake Superior (Petzold 2002). Gillnet and trawling surveys of eastern Lake Superior in 2000-01 indicated that kiyi comprised anywhere between 1% and 15% of the chub catch, and there were an estimated 2,211 tonnes (271-4,452 tonnes; 90% CI) of chub in depths greater than 105m, the preferred depths of kiyi. Based on these estimates, there were between 22 and 330 tonnes of kiyi in the deepest parts of the Canadian waters of eastern Lake Superior in 2000-01 (Petzold 2002), which represents approximately 25% of the total Canadian habitat. Based on an average weight of 170 gm (Scott and Crossman 1998) this would equate to approximately 129,412 to 2,000,000 fish in the eastern (Canadian) waters of the lake or an overall range of 500,000 to 8,000,000 fish in the Canadian waters of the lake. Data from 2003 indicated that Kiyi were the second most abundant prey species in Lake Superior and outnumber bloater (*Coregonus hoyi*) in many locations (K. Cullis, pers. comm.).

No historic data, summarized by cisco species, exist for the Canadian waters of Lake Huron. An examination of 1,943 ciscoes, collected at 46 deepwater locations in Lake Huron in 2002 and 2003, failed to find any kiyi (N.E. Mandrak, unpubl. data).

Although it is possible that populations in lakes Huron and Michigan could be restablished due to a rescue effect from Lake Superior populations, there is no evidence that this has occurred in the 30 years since the kiyi was last recorded in these lakes however, larvae could be flushed through the St. Mary's River.

LIMITING FACTORS AND THREATS

The decline of kiyi in lakes Huron, Michigan and Ontario was likely the result of commercial overfishing (Moffett 1957, Smith 1964, Berst and Spangler 1973, Christie 1973; Miller *et al*. 1989). Commercial fishing of deepwater ciscoes, including kiyi, no longer occurs in the American waters of the Great Lakes, but still takes place in the Canadian waters of lakes Huron and Superior. The chub quota for eastern Lake Superior was 220 tonnes in 2002, below the estimated mean exploitable biomass of 440 tonnes, and well below the 2,211 tonnes estimated to be present in Lake Superior; therefore, overfishing is unlikely to be a major ongoing threat (Petzold 2002). In addition, the kiyi are also known as "black chub" and have lower marketability than other cisco species (Petzold 2002), and the current demand for chubs is low (K. Cullis, OMNR, pers. comm.).

It has been suggested that remnant kiyi populations may have competed with, or have been predated by, introduced fish species. Although, these interactions may have been a factor in the decline of deepwater ciscoes in lakes Huron and Ontario (Berst and Spangler 1973, Christie 1973; Miller *et al*. 1989), they were likely unimportant in Lake Superior, as the deepwater cisco decline pre-dated the colonization of the lake by sea lamprey, alewife and rainbow smelt (*Osmerus mordax*).

SPECIAL SIGNIFICANCE OF THE SPECIES

Of the six cisco species identified as 'endemic' in the Laurentian Great Lakes (bloater, blackfin cisco, deepwater cisco, kiyi, shortjaw cisco, shortnose cisco) by Koelz (1929), the kiyi is one of only three species (other species are *C. hoyi* and *C. zenthicus*) known to be extant. The ciscoes are the most notable of the few species endemic to the relatively young waterbodies of northern North America, and are believed to be one of few examples of the incipient species flock concept in North America (Smith and Todd 1984). As 'endemic' species, these ciscoes represent unique evolutionary and ecological processes. The Laurentian Great Lakes are no more than 18,000 years old (Dyke and Prest 1987); therefore, the 'endemic' ciscoes have likely evolved in the Great Lakes within the last 18,000 years (Smith and Todd 1984). Changes in gill raker morphology (e.g. number, length) over time, have minimized competition between the endemic ciscoes (Smith and Todd 1984). In addition to these unique processes shared by the endemic ciscoes, the kiyi exhibits unique adaptations to its deepwater habitat including enlarged eyes and pectoral fins.

The deepwater ciscoes were once a commercially important species in the Great Lakes and several species, including kiyi, are still harvested in the Canadian waters of Lake Superior. All six have been previously assessed by COSEWIC; the shortnose cisco was originally listed as Threatened in 1987 (re-assessed as Endangered in 2005), as was the shortjaw cisco (re-confimed in 2003); the deepwater (Extinct since 1953, re-confirmed in 2000), and blackfin (Threatened) were listed in 1988. The kiyi was first assessed as Special Concern in 1988, as was the bloater, the only Great Lakes cisco Not at Risk (COSEWIC 2004).

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

The kiyi and its habitat are protected by the federal Fisheries Act. It was previously assessed as Special Concern by COSEWIC in 1988. It is listed as Special Concern by the Ontario Ministry of Natural Resources (OMNR), and as S3(?) in Ontario by the Natural Heritage Information Centre. In the United States, it is listed by 5 states. The Global, National (US and Canada), State and Provincial ranks for kiyi are provided in Table 1. Commercial fishing quotas for all deepwater cisco species combined (including kiyi) in Lake Superior are regulated through the *Ontario Fisheries Regulations* and enforced by OMNR.

Table 1. Global, National, and Subnational (State and Provincial) ranks and status for kiyi (*Coregonus kiyi)*. (NatureServe 2004). G/N/S ranks: 1=critically imperiled; 2=imperiled; 3=vulnerable to extirpation or extinction; X = extinct.

			Subnational	
Global	**US National**	**Canadian National**	**US States**	**Ontario**
G3	N3	Special Concern; N3?	S1 - IN S2S3 - WI S3 - MI, MN SX= NY	S3?; Special Concern

TECHNICAL SUMMARY

***Coregonus kiyi orientalis* (*C. k. orientalis*)**
Lake Ontario Kiyi kiyi du lac Ontario
Range of occurrence in Canada: ON - Lake Ontario.

Extent and Area information	
• *extent of occurrence (EO)(km²)* Measured as combined total areas of the lake.	19,477 km^2
• *specify trend*	Decline
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)* Measured as combined areas of depths >100m	8,553 km^2
• *specify trend*	Decline
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations* (Occupy 1 large lake, but population structure is unknown)	0
• *specify trend in # locations*	Not Applicable
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	Not Applicable
• *habitat trend*	Stable?
Population information	
• *generation time (average age of parents in the population*	5 years?
• *number of mature individuals (capable of reproduction) in the Canadian*	0
• *total population trend*	Decline
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater*	0% over last 15 years, last found in 1964
• *are there extreme fluctuations in number of mature individuals (> 1 order of magnitude)?*	No
• *is the total population severely fragmented*	No
• *list each population and the number of mature individuals in each*	0
• *specify trend in number of populations (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats	
- commercial overexploitation, introduced species.	
Rescue Effect (immigration from an outside source)	None?
• *does subspecies exist elsewhere (in Canada or outside)?*	No
• *status of the outside population(s)?*	Not Applicable
• *is immigration known or possible?*	No
• *would immigrants be adapted to survive here?*	Yes
• *is there sufficient habitat for immigrants here?*	Yes
Quantitative Analysis:	Data not available

Existing Status - *C. kiyi orientalis*

Nature Conservancy Ranks (NatureServe 2005)
Global – **G3TX**
National
US – NX
Canada NNR
Regional
X in all states

Wild Species 2000 (Canadian Endangered Species Council 2001)
Canada – NR
Ontario – NR

COSEWIC - Extinct (May 2005)

Status and Reasons for Designation

Status: Extinct	**Alpha-numeric Code**: Not Applicable
Reasons for Designation: Last recorded from Lake Ontario in 1964, the subspecies was driven to extinction by commercial exploitation, and predation/competition by introduced species.	
Applicability of Criteria **Criterion A** (Declining Total Population): Not applicable - The subspecies has not been seen in Lake Ontario since 1964. **Criterion B** (Small Distribution, and Decline or Fluctuation): Not applicable - The subspecies has not been seen in Lake Ontario since 1964. **Criterion C** (Small Total Population Size and Decline): Not applicable - The subspecies has not been seen in Lake Ontario since 1964. **Criterion D** (Very Small Population or Restricted Distribution): Not Applicable - The subspecies has not been seen in Lake Ontario since 1964. **Criterion E** (Quantitative Analysis): Data are not available.	

TECHNICAL SUMMARY

***Coregonus kiyi kiyi* (*C. k. kiyi*)**
Upper Great Lakes Kiyi kiyi du secteur supérieur des Grands Lacs
Range of occurrence in Canada: ON - Lakes Superior.and Huron (and Michigan), extirpated in lakes Huron (and Michigan)

Extent and Area information	
• *extent of occurrence (EO)(km²)* Measured as combined total areas of lakes Huron, Ontario and Superior.	Huron 59,596 Superior 82,414 Total 142,010
• *specify trend (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in EO (> 1 order of magnitude)?*	No
• *area of occupancy (AO) (km²)* Measured as combined areas of depths >100m for lakes Huron and Superior.	Huron 10,013 Superior 57,742 Total 67,755
• *specify trend (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in AO (> 1 order magnitude)?*	No
• *number of extant locations*	1
• *specify trend in # locations (decline, stable, increasing, unknown)*	Decline
• *are there extreme fluctuations in # locations (>1 order of magnitude)?*	No
• *habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat*	Stable?
Population information	
• *generation time (average age of parents in the population) (indicate years, months, days, etc.)*	5 years?
• *number of mature individuals (capable of reproduction) in the Canadian population* See population sizes and trends	Superior: 129,412 to ~2,000,000 based on average weight of 170g, and 22-330t
• *total population trend* • Probably extirpated in lake Michigan as well	Superior – stable Huron – decline, probably extirpated
• *if decline, % decline over the last/next 10 years or 3 generations, whichever is greater* The decline was probably rapid as it was in Lake Ontario where *C. k. orientalis* virtually disappeared from the lake within 15 years (1927-1942). The situation in Lake Michigan was also probably similar.	Huron – 0% over last 15 years, last found in 1973
• *are there extreme fluctuations in number of mature individuals (>1 order of magnitude)?*	No
• *is the total population severely fragmented (most individuals found within small and relatively isolated (geographically or otherwise) populations between which there is little exchange, i.e., ≤1 successful migrant / year)?*	Both lakes: Yes Superior only: No
• *list each population and the number of mature individuals in each*	Superior: 129,412 to ~2,000,000 based on average weight of 170g, and 22-330t Huron: 0 (Michigan 0)
• *specify trend in number of populations*	Superior: stable Huron (Michigan): decline

• *are there extreme fluctuations in number of populations (>1 order of magnitude)?*	No
Threats	
- commercial overexploitation, introduced species?	
Rescue Effect (immigration from an outside source) * Unless one considers American waters of the same lake as a source, but population structure in the lake is unkown.	Superior – Nil* Huron: Low
• *does species exist elsewhere (in Canada or outside)?*	American waters of Superior
• *status of the outside population(s)?*	S2S3 (WI), S3 (MN), S3 (MI)
• *is immigration known or possible?*	Yes?
• *would immigrants be adapted to survive here?*	Yes?
• *is there sufficient habitat for immigrants here?*	Yes?
Quantitative Analysis	Data not available

Existing Status - *C. kiyi kiyi*

Nature Conservancy Ranks (NatureServe 2005)

Global – G3
National
US – N3
Canada N3?
Regional
US - IN – S1, MI – S3, MN – S3, NY – SX, WI – S2S3
Canada - ON – S3.

Other
IUCN - VU
AFS – T

Wild Species 2000 (Canadian Endangered Species Council 2001)
Canada – 1
Ontario – 1

COSEWIC
Special Concern (May 2005)

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric Code**: Not Applicable

Reasons for Designation:

Currently found only in Lake Superior, the subspecies has been extirpated from lakes Huron and Michigan, as the result of a complex of factors, which included exploitation and introduced exotic species. The extirpation in lake Huron's and Michigan occurred more than three generations in the past. The remaining population in Lake Superior appears to be stable, and supports a small, regulated fishery. Other threats, such as the introduction of exotic species, which impacted populations in the lower lakes do not appear to be important in Lake Superior.

Applicability of Criteria

Criterion A (Declining Total Population): Not applicable - The subspecies has been extirpated from over 50% of its former extent of occurrence in Canada (as well as from Lake Michigan, the last recorded occurrences in lakes Huron, and Michigan were in 1973 and 1974 respectively). However, the decline in area of occupancy and extent of occurrence did not occur within the last 3 generations or 10 years. The subspecies persists in Lake Superior; however, trends are not known. Overfishing, and competition with exotic species, which are thought to have caused the demise of the subspecies in lakes Huron and Michigan, are unlikely to have as marked an impact in Lake Superior. However, one must keep in mind the rapid declines in the other lakes, which occurred over a short period of time (~ 15 years in Lake Ontario) and that this subspecies could precipitously decline to extinction (as have others of the Great Lakes ciscos) based on unknown concerns.

Criterion B (Small Distribution, and Decline or Fluctuation): Not applicable - The present extent of occurrence (82,000 km^2) and area of occupancy (58,000 km^2) are well above the threshold for Endangered or Threatened (B1 or B2). There is no evidence to suggest that the subspecies is severely fragmented, and the number of locations within Lake Superior is unknown, but certainly greater than the minimal threshold of 10 for Threatened. Similarly, there are no data to indicate extreme fluctuations or continuing decline in number or extent and quality of habitat.

Criterion C (Small Total Population Size and Decline): Not Applicable - Estimates from eastern Lake Superior in 2000-2001 indicate between 22 and 330 tonnes of the species in the deepest parts of Canadian waters. At an average size of 0.17kg (Scott and Crossman 1998) this equates to 130,000 to 2,000,000 individuals, which exceeds the threshold of 10,000 individuals (which is meaningless for such a species at any rate). However, this is based on an average size and provides no information about what proportion comprise mature individuals, but it would be considerably less. Data are simply not available to provide any information on population trends in Lake Superior despite the fact that recent levels of harvest are about 10% of the estimated biomass.

Criterion D (Very Small Population or Restricted Distribution): Not Applicable - The subspecies exceeds the threshold values of 1000 mature individuals, 20 km^2 for area of occupancy, and 5 sites or locations.

Criterion E (Quantitative Analysis): Data are not available.

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Authorities contacted

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LITERATURE CITED

Allen, H.F., J.F. Reinwand, R.E. Ogawa, J.K. Hiltunen and L. Wells (Editors). 1969. Limnological survey of Lake Ontario, 1964. Great Lakes Fishery Commission Technical Report 14.

Anderson, E.D. and L.L. Smith. 1971. Factors affecting abundance of Lake Herring (*Coregonus artedii* Lesueur) in western Lake Superior. Transactions of the American Fisheries Society 100: 691-707.

Berst, A.H. and G.R. Spangler. 1973. Lake Huron: the ecology of the fish community and man's effects on it. Great Lakes Fishery Commission Technical Report 21. 41 pp.

Canadian Endangered Species Council. 2001. The general status of species in Canada. Ottawa: Minister of Public Works and Government Services.

Christie, W.J. 1973. A review of the changes in the fish species composition in Lake Ontario. Great Lakes Fishery Commission Technical Report 23. 65 pp.

Coker, G.A., C.B. Lane, and C.K. Minns. 2001. Morphological and ecological characteristics of Canadian freshwater fishes. Canadian Manuscript Report of Fisheries and Aquatic Science 2554. 86 pp.

COSEWIC. 2003. Operations and procedures manual, November 2003 update. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 44 pp. + appendices.

COSEWIC. 2004. Canadian species at risk, November 2004. Committee on the Status of Endangered Wildlife in Canada (COSEWIC), CWS, Ottawa. 58 pp.

Cudmore-Vokey, B. and E.J. Crossman. 2000. Checklists of the fish fauna of the Laurentian Great Lakes and their connecting channels. Canadian Manuscript Report of Fisheries and Aquatic Science 2550. 39 pp.

Dryer, W.R. 1966. Bathymetric distribution of fish in the Apostle Islands region, Lake Superior. Transactions of the American Fisheries Society 95: 248-259.

Dyke, A.S. and V.K. Prest. 1987. Paleogeography of northern North America: 18,000-5,000 years ago. Geological Survey of Canada Map 1703A.
Hile, R. and H.J. Deason. 1947. Distribution, abundance, and spawning season and grounds of the kiyi, *Leucichthys kiyi* (Koelz), in Lake Michigan. Transactions of the American Fisheries Society 74:143-165.
Koelz, W. 1921. Description of a new cisco from the Great Lakes. Occasional Papers of the Museum of Zoology, University of Michigan 104. 4 pp.
Koelz, W. 1929. Coregonid fishes of the Great Lakes. United States Bureau of Fisheries Bulletin 43 (Part II): 297-643.
Lawrie, A.H. and J.F. Rahrer. 1973. Lake Superior: a case history of the lake and its fisheries. Great Lakes Fishery Commission Technical Report 19. 69 pp.
Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer Jr. Editors. 1980. Atlas of North American Freshwater Fishes. North Carolina Biological Survey Publication Number 1980-12.
Mandrak, N.E. and E.J. Crossman. 1992. A checklist of Ontario freshwater fishes annotated with distribution maps. Royal Ontario Museum Life Sciences Miscellaneous Publication. 186 pp.
Miller, R.R, J.D. Williams, and J.E. Williams. 1989. Extinctions of North American fishes during the past century. Fisheries 14(6): 22-38.
Moffett, J.W. 1957. Recent changes in the deepwater fish populations of Lake Michigan. Transactions of the American Fisheries Society 86: 393-408.
NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: February 25, 2005).
Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea and J.D. Williams. 2004. A list of scientific and common names of fishes from the United States and Canada. Sixth Edition. American Fisheries Society Special Publication 29.
Parker, B.J. 1989. Status of the kiyi, *Coregonus kiyi*, in Canada. Canadian Field-Naturalist 103: 171-174.
Petzold, M. 2002. Distribution and abundance of chub species (*Coregonus* sp.) in eastern Lake Superior (2000 – 2001). Upper Great Lakes Management Unit, Ontario Ministry of Natural Resources. Technical Report 1-2002.
Pritchard, A.L. 1931. Taxonomic and life history studies of the ciscoes of Lake Ontario. University of Toronto Studies in Biology Series 35. Publication of the Ontario Fisheries Research Laboratory 41. 78 pp.
Scott, W.B., and E.J. Crossman. 1998. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184. 966 pp. + xvii. Reprinted by Galt House Publications, Burlington, ON.
Selgeby, H.H., C.R. Bronte, and J.W. Slade. 1994. Forage species. pp. 53-62 In: Hansen, M.J. (Editor). The state of Lake Superior in 1992. Great Lakes Fishery Commission Special Publication 94-1.
Smith, G.R. and T.N. Todd. 1984. Evolution of species flocks of fishes in north temperate lakes. pp. 45-68 In: Echelle, A.A. and I. Kornfield (Editors). Evolution of fish species flocks. University of Maine at Orono Press, Orono.

Smith, S.H. 1964. Status of the deepwater cisco population of Lake Michigan. Transactions of the American Fisheries Society 93:155-163.
Smith, S.H. 1995. Early changes in the fish community of Lake Ontario. Great Lakes Fishery Commission Technical Report 60. 38 pp.
Stone, U.B. 1947. A study of the deep-water cisco fishery of Lake Ontario with particular reference to the bloater, *Leucichthys hoyi* (Gill). Transactions of the American Fisheries Society 74: 230-249.
Todd, T.N. 1980. *Coregonus kiyi*. p. 83 In: Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer Jr. Editors. 1980. Atlas of North American Freshwater Fishes. North Carolina Biological Survey Publication Number 1980-12.
Todd, T.N. no date. Tom Todd's sure-fire guide to morphological characteristics of ciscoes (*Coregonus* spp.) of the Great Lakes region. United States Geological Survey, Ann Arbor, MI. Unpublished report.
Todd, T.N., G.R. Smith and L.E. Cable. 1981. Environmental and genetic contributions to differentiation in ciscoes (Coregoninae) of the Great Lakes. Canadian Journal of Fisheries and Aquatic Sciences 38: 59-67.
Turgeon, J.A. and L. Bernatchez. 2003. Reticulate evolution and phenotype diversity of North American ciscoes, *Coregonus* ssp. (Teleostei: Salmonidae): implications for the conservation of an evolutionary legacy. Conservation Genetics 4: 67-81.
Turgeon, J., A. Estoup, and L. Bernatchez. 1999. Species flock in the North American Great Lakes: Molecular ecology of Lake Nipigon ciscoes (Teleostei: Coregonidae: Coregonus). Evolution 53(6): 1857-1871.
Wells, L. 1969. Fishery survey of U.S. waters of Lake Ontario, pp. 51-57 In: Allen, H.F., J.F. Reinwand, R.E. Ogawa, J.K. Hiltunen and L. Wells (Editors). Limnological survey of Lake Ontario, 1964. Great Lakes Fishery Commission Technical Report 14.

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COLLECTIONS EXAMINED

None.