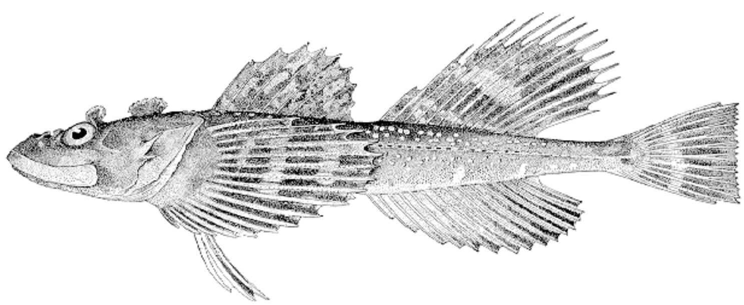
COSEWIC
Assessment and Update Status Report

on the

Fourhorn Sculpin
Myoxocephalus quadricornis

Freshwater form

in Canada



DATA DEFICIENT
2003

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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COSEWIC
Assessment Summary

Assessment Summary – November 2003

Common name
Fourhorn sculpin (Freshwater form)

Scientific name
Myoxocephalus quadricornis

Status
Data Deficient

Reason for designation
There is a lack of necessary data to evaluate the status of this species, combined with uncertainty regarding taxonomic status.

Occurrence
Newfoundland-Labrador, Northwest Territories, Nunavut

Status history
Designated Special Concern in April 1989. Status re-examined in November 2003 and designated Data Deficient. Last assessment based on an update status report.

COSEWIC
Executive Summary

Fourhorn Sculpin
Myoxocephalus quadricornis
(Freshwater form)

Species information

First described by Linnaeus in 1758, the fourhorn sculpin, *Myoxocephalus quadricornis*, has been subjected to various changes in nomenclature. It has been referred to as *Cottus*, *Oncocottus*, *Myoxocephalus*, and *Triglopsis* based on morphological characters. *Myoxocephalus* appears to be the accepted genus in North America whereas European authors prefer *Triglopsis*. A member of the family Cottidae, the fourhorn is commonly called *chaboisseau à quatre cornes* in French and *kanayok* in Inuktitut.

Distribution

The fourhorn sculpin occurs as a landlocked relict in cold, deep freshwater lakes of northern North America and northern Europe, particularly in Canada, Finland, Norway, Sweden, and Russia. In Canada, museum records indicate that the sculpin inhabits lakes in the Northwest and Nunavut Territories. The only province where it has been collected is Newfoundland and Labrador.

Habitat

Little has been reported concerning the habitat requirements of the freshwater form. Individuals from Garrow Lake, Little Cornwallis Island, NU, occur in a depth range of 3.8-15.0 m and a salinity range of approximately 3-35 ppt. Adults are benthic and require a soft substrate to spawn.

Biology

Little is known concerning the reproduction and growth of the freshwater form. Garrow Lake specimens have a slower growth rate than marine forms from the Beaufort Sea and Strathcona Sound. The maximum age, the age at first maturity, and the time required for three generations are unknown. Predators of fourhorn sculpins are piscivorous fishes and birds. They do not appear to be a heavily parasitized species in either freshwater or seawater. Fourhorn sculpins feed mainly on benthic invertebrates, small fishes, and fish eggs.

Population sizes and trends

Little is known about the population sizes and trends of the freshwater form. Distributional data is largely confined to presence-absence records. Some authors feel the Garrow Lake population has been adversely affected by pollution from a nearby, recently decommissioned lead-zinc mine and may become extirpated in the next 20 years. Anecdotal information indicates the population to be healthy at present, but comparisons with historic levels are not possible. The lack of information may be attributed to the fourhorn sculpin not being a species of commercial, recreational, or subsistence interest, in addition to the isolation of the high Arctic lakes it inhabits.

Limiting factors and threats

The fourhorn sculpin is of little direct commercial or sport fishing interest, but it may be caught accidentally by recreational fishers. The marine form is used occasionally as food by natives, but it is unknown if the freshwater form is utilized in this manner. The fourhorn sculpin is of special interest to the scientific community concerned with Canadian post-glacial dispersion and zoogeography. The species may be of value as an indicator of environmental quality and could be a key species to monitor in areas of development in the Arctic.

Existing protection or other status

General protection is provided in Canadian waters under the *Fisheries Act*. There is no listing for this species in CITES, IUCN, or US Fish and Wildlife Service. It is considered ‘Endangered’ in many freshwater lakes in Sweden. The fourhorn sculpin is listed as protected fauna in the summary report of the Convention on the Conservation of European Wildlife and Natural Habitats.

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. 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 and include 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 organizations (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership, chaired by the Canadian Museum of Nature), three nonjurisdictional 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
(After May 2003)

Species	Any indigenous species, subspecies, variety, or geographically or genetically distinct 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.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

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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Freshwater form

in Canada

2003

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SPECIES INFORMATION

Name and classification

The fourhorn sculpin*, Myoxocephalus quadricornis* (Linnaeus 1758), is mainly a marine sculpin with a circumpolar distribution (McAllister 1980). The species is closely related to the lake-dwelling deepwater sculpin, *M. thompsoni* (Girard 1852), and was originally described from the Baltic Sea. The taxonomy has been the subject of several taxonomic and zoogeographic studies, particularly with regards to the marine fourhorn sculpin and the freshwater deepwater sculpin (Berg 1949; Walters 1955; McAllister 1961; Johnson 1964; McAllister and Aniskowicz 1976). Girard (1852) described the deepwater sculpin from Lake Ontario as *Triglopsis thompsoni,* and when McAllister (1961) reviewed the earlier history of the problem he considered the fourhorn sculpin to be a separate species and the ancestral form.

Despite the findings of McAllister (1961), other authors felt that the fourhorn and deepwater sculpins were subspecifically related based on the discovery of distinct populations in three lakes on Victoria Island, NU, that possess some intermediate morphological characteristics (Johnson 1964; McPhail and Lindsey 1970). For this reason, McPhail and Lindsey (1970) followed Nikolsky (1961) and Hubbs and Lagler (1964) in considering that the deepwater sculpin was only subspecifically different from the marine fourhorn sculpin. Based on this relation, they recognized the marine form as *M. quadricornis quadricornis* (Linnaeus) and the freshwater form as *M. quadricornis thompsoni* (Girard).

McAllister and co-workers (McAllister 1961; McAllister and Aniskowicz 1976; McAllister *et al*. 1978) examined specimens of both forms and the recently discovered postglacial Arctic freshwater relicts that have been described (McAllister 1961; Hubbs and Lagler 1964; Johnson 1964; McPhail and Lindsey 1970; Dadswell 1972). They considered the two as distinct species based on morphological characteristics, distribution, and ecology. The postglacial Arctic relicts, the focus of this report, fall within the definitions of *M. quadricornis* and should be commonly referred to as fourhorn sculpin. Nelson (pers. comm., 2002) stated that the marine and freshwater forms of *M. quadricornis* will be listed as specifically distinct from *M. thompsoni* in the new edition of “Common and scientific names of fishes of the United States, Canada, and Mexico” scheduled to be published later this year.

Since being originally described by Linnaeus in 1758, the fourhorn sculpin has been subjected to various changes in nomenclature and classification. It has been included in *Cottus, Oncocottus, Myoxocephalus*, and *Triglopsis* based on morphological characters (McPhail and Lindsey 1970; Scott and Scott 1988; Muus *et al.* 1999; Kallner and Bernander 2001). *M. quadricornis* appears to be the most widely used name by researchers, but *Triglopsis* has been used in Europe after the cottid was affiliated with that genus by Fedorov (1986). Some scientists recognize the fourhorn sculpin as *T. polaris* (Khlebovich 1997). Despite the debate over generic affiliation, the higher classification has remained virtually unchanged: Family Cottidae, Suborder Cottoidei, Order Scorpaeniformes, Superorder Actinopterygii, Infraclass Teleostei, Subclass Neopterygii, Superclass Osteichthyes, Subphylum Vertebrata, Phylum Chordata, and Kingdom Animalia.

Due to its circumpolar distribution, the fourhorn sculpin is resident to a number of North American and European countries. The common names utilized in these countries appear in Table 1. The French commonly refer to the fourhorn sculpin as *chaboisseau à quatre cornes*.

In Inuktitut, the degree of specificity or precision in the correspondence of common names with their taxonomic level, such as species or family, varies according to the subject's food or other interest. For example, chars are regularly used as food and the Inuit accord them not only individual names for each species, but also, in the case of Arctic char, separate names for the marine form (*iqalukpik*), the small land-locked form (*nutilliq*), and the bright red spawning phase (*ivitaaruq*). This does not seem to apply in the case of sculpins. Several species of the family, to which the Inuit resorted for food in times of famine, are in most localities lumped together under only one name – *kanayok* (McAllister *et al*. 1987).

Table 1. The common names, with countries of origin, for *Myoxocephalus quadricornis* (Linnaeus, 1758).

Common Name	Country
Fourhorn sculpin	Canada, USA
Four-horned sculpin	Estonia, Russian Federation
Four-horned bullhead	Europe
Four-horned sea sculpin	Canada, Europe
Härkäsimppu	Finland
Hornsimpa	Sweden
Hornulk	Denmark
Hornulke	Norway
Kur rogacz	Poland
Rogatka	Former USSR
Vierhörniger Seeskorpion	Germany
Alyaskinskaya rogatka	Russia

Description

The freshwater fourhorn sculpin is a relatively small, benthic cottid, rarely reaching a length greater than 100 mm (Bengtsson and Bengtsson 1983; Muus and Dahlstrøm 1999). See Figure 1. Garrow Lake individuals tend to grow larger with upper lengths of 170-194 mm and a recorded range of 20-194 mm (BC Research 1978; Fallis *et al.* 1987). Fallis *et al.* (1987) reported a mean of 155 mm total length (TL) and 26.6 g (10-45 g) from 51 individuals collected. The marine form of the species can be easily distinguished from other cottids by the presence of four long, club-like protuberances (frontal and parietal spines) on the head (Scott and Scott 1988; Coad *et al.* 1995), giving rise to its name. However, these are typically reduced or absent in the freshwater form. Leger (pers. comm., 2003), in describing the Garrow Lake fourhorn sculpin, commented that the horns were soft and very delicate compared to the large, sturdy horns of the marine form. The fourhorn sculpin has four well-developed preopercular spines as well as nasal and cleithral spines. The upper preopercular spine, a simple straight point, is distinctive (Coad et al. 1995).

The body is elongate with a slender caudal peduncle. The head is flattened and wide with close-set eyes on the top of the head. The mouth is terminal with the lower jaw projecting slightly. The vomer in the roof of the mouth bears teeth, but palatine teeth are distinctly absent. Unlike its close relatives there are no folds on the lower flanks. There are two dorsal fins, the first being smaller and spiny; the caudal fin is square or truncate; the anal is soft-rayed and has a long base; the pelvics are small, located well forward beneath the pectorals and have one spine and 3 to 4 soft rays; the soft-rayed pectorals are large and fanlike (see McAllister 1961; Scott and Scott 1988; Coad *et al*. 1995).

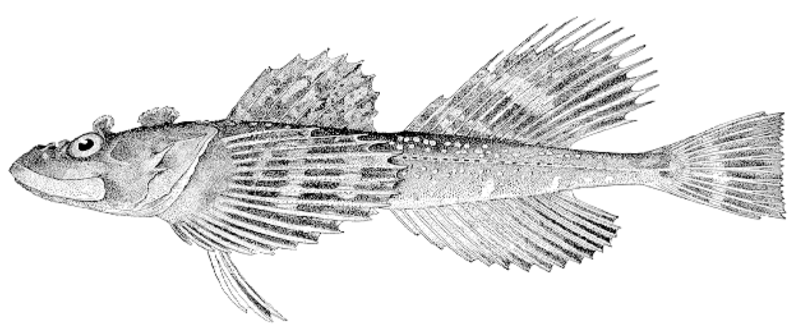

Figure 1. Drawing of the fourhorn sculpin, *Myoxocephalus quadricornis* (Drawing courtesy of Donald McPhail, University of British Columbia).

These fish lack true scales and may have tubercles (sometimes described as large disklike scales), which can be reduced to prickles, above and below the distinct chainlike lateral line that seldom extends posteriorly past the insertion of the second dorsal fin (McAllister 1961). The second dorsal fin is usually larger in mature males than in the female and the pelvics are notably larger. There may be tubercles on the second dorsal and pectoral fins of males that are not found on females (McAllister 1961; McPhail and Lindsey 1970).

The overall colouration is dark grey to brown, the back being darker, becoming lighter along the sides and light ventrally. The back and sides may be speckled or mottled and there are usually four to seven diffuse, saddle-like bands along the back and sides. The pectoral fins may have up to three diffuse darker bands, the pelvics may be spotted, and the dorsal and anal fins blotched. The caudal fin usually shows dark brown mottling. Males develop a rosy colouration under the head, on the lower pectoral fin, and on the anal and pelvic fins (McAllister 1961; Scott and Scott 1988).

McAllister and Aniskowicz (1976) found that fourhorn sculpins from marine, brackish, and freshwater locations had mean vertebral counts of 38-42 with freshwater specimens being smaller and having fewer vertebrae. Fallis *et al*. (1987) reported that the vertebral counts of Garrow Lake individuals ranged from 41-43 with a mean of 42.2.

The fourhorn sculpin appears in the important regional ichthyofaunal compendia of Canadian waters: “Atlantic Fishes of Canada” by Scott and Scott (1988, pp. 504-505); “Encyclopedia of Canadian Fishes” by Coad *et al.* (1995, pp. 295-296); “The Freshwater Fishes of Alaska” by Morrow (1980, pp. 207-209); “Atlas of North American Freshwater Fishes” by Lee *et al.* (1980, pp. 826); and also in “Fishes of the North-eastern Atlantic and the Mediterranean” by Whitehead *et al*. (1986, pp. 1259-1260). The freshwater form described in “Freshwater Fishes of Canada” by Scott and Crossman (1973, pp. 842-847) and “Freshwater Fishes of Northwestern Canada and Alaska” by McPhail and Lindsey (1970, pp. 318-323) is the deepwater sculpin, *M. thompsoni*.

There are approximately 300 species of sculpin, mostly marine but sometimes freshwater, with a few of the marine forms entering rivers and on occasion moving considerable distances upstream. Only three freshwater species, the deepwater sculpin, the slimy sculpin (*Cottus cognatus*), and the spoonhead sculpin (*C. ricei*), overlap the distributional range of the fourhorn sculpin (Lee *et al.,* 1980; Morrow 1980; Page and Burr 1991). The aforementioned distinctive characteristics of the freshwater fourhorn sculpin, as well as its restrictive habitat, should allow it to be relatively easy to identify when captured in high Arctic lakes. However, identification may be difficult when distinguishing between the fourhorn sculpin and the deepwater sculpin as the two species closely resemble one another. The deepwater sculpin, as its name implies, inhabits the bottoms of deep, cold lakes up to a depth of 366 m. This cottid, protected in Canada as a threatened species, differs from the fourhorn sculpin usually in the absence of the four horns on the top of the head, and the absence of tubercles below the lateral line (Morrow 1980; Page and Burr 1991). If head spines are present, they are not club-shaped as in the fourhorn sculpin. A maximum length of 230 mm has been recorded for Lake Ontario individuals; however, these are now extripated. Deepwater sculpins now achieve total lengths of 102 to 127 mm (Delisle and Van Vliet 1968).

DISTRIBUTION

Global range

The freshwater fourhorn sculpin is found as landlocked relicts in deep, cold lakes in North America and Northern Europe, particularly Canada, United States, Sweden, Finland, Norway, and Russia (McAllister 1980; Hammar *et al*. 1996). Delling (1994) reported that the relict fourhorn sculpin inhabited at least 22 lakes in southern and central Sweden. It resides in the lakes of Vättern, Wättern, Fryken, Siljan, Orsasjön, and Mälaren in Sweden and Ladoga and Onega in Russia (Jääskeläinen 1917; Nyman and Westin 1968; Muus *et al.* 1999). Museum records (Canadian Museum of Nature; Appendix I) indicate the presence of individuals in Swan Lake, Baldwin Peninsula, Alaska.

Canadian range

In Canada, the freshwater fourhorn sculpin is resident in the Northwest and Nunavut Territories (Figure 2). The only province where it has been collected is Newfoundland and Labrador, and this consisted of one specimen collected at Lake Sipukat in 1964 by John G. Hunter (Appendix I; identification confirmed 02/28/03).

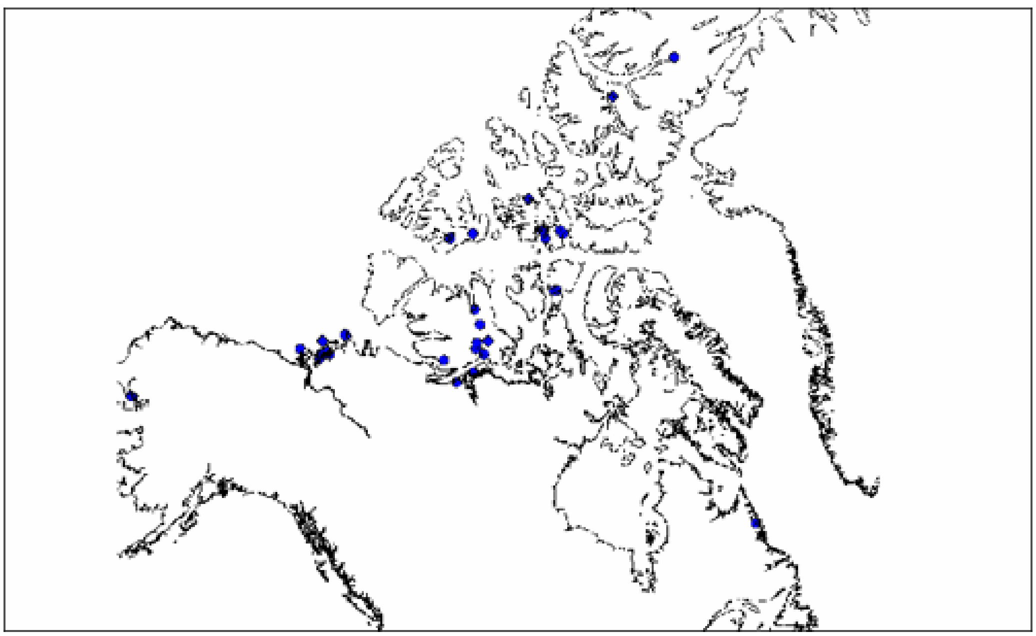

Figure 2. North American distribution of the freshwater fourhorn sculpin, *Myoxocephalus quadricornis*. Map was compiled using museum collection data from the Canadian Museum of Nature (see Appendix I).

Johnson (1964) reported the presence of *M. quadricornis* in three lakes on Victoria Island, NU, while museum records (Appendix I) indicate it is present in the Zeta, Ferguson, Longspur, Washburn, Tassijuak, and Surrey lakes on that island. Ellesmere Island is reported as having fourhorn populations in Lake Tuborg and Romulus Lake. The species has also been collected from lakes on the islands of Cornwallis (Eleanor Lake, Sophia Lake), Little Cornwallis (Garrow Lake), Bathurst, Melville, Somerset (Stanwell-Fletcher Lake), Hepburn (Wentzel Lake), and Campbell (Eskimo Lakes) (Appendix I). Freshwater populations are not limited to island lakes as fourhorn sculpins have been collected from Nauyak Lake on the Kent Peninsula, NU. It has not been reported from lakes in National Parks of the Canadian Arctic (McDonald, pers. comm., 2002).

HABITAT

Habitat requirements

The relict populations of fourhorn sculpins exist in some freshwater lakes on the islands of the Arctic Archipelago, chiefly on Victoria, Cornwallis, and Ellesmere Islands (Johnson 1964, McAllister and Aniskowicz 1976) and others. Some of these lakes are fresh while others are meromictic with water layers of different salinities. McAllister and Aniskowicz (1976) considered that the fourhorn sculpins were introduced by marine inundation following glaciation and isolated in freshening lakes during subsequent isostatic rebound. Occurrences of the species in these lakes are concurrent with that of a relict isopod, *Mesidosethra entomon glacialis,* which is not found in inland freshwaters on the mainland (McAllister and Aniskowicz 1976).

The suggestion is that these freshwater relict populations arose independently and more recently from the marine fourhorn sculpin than did the deepwater sculpin and should still be referred to as *M. quadricornis*; although morphologically different, the variations are not sufficiently significant to be subspecifically distinct (McAllister and Aniskowicz 1976). Variation in such relict populations would be greater than in the sea because there would be little, if any, gene flow between lake populations and genetic differences would accumulate in lakes but not in the open sea where gene flow would be free. Differences in body lengths and mean meristic values suggest there may be genetic differences. Lake temperatures and salinity in meromictic lakes would fluctuate more [especially during incubation, thereby influencing morphological variability such as number of vertebrae (see McAllister and Aniskowicz 1976)]. It is interesting to note that the relict populations can occur in lakes lacking other freshwater fishes (e.g. Garrow Lake) and sometimes containing the isopod *M. entomon glacialis.*

Little has been reported concerning the habitat restrictions of the freshwater fourhorn sculpin, but the habitat range appears to be narrow. Much of what is known resulted from research conducted in Garrow Lake, NU, on Little Cornwallis Island, approximately 95 km from Resolute (Dickman 1991). Discovered in 1974, this small coastal basin is the northernmost recorded hypersaline meromictic lake (Dickman and Ouellet 1987) with a maximum depth of 47 m (Page *et al.* 1984). Meromictic lakes are normally characterized by their lack of complete vertical mixing, a continuing absence of oxygen in the monimolimnion, and an increase in relative salinity and density with depth below the chemocline (Stewart and Platford 1986). Such conditions prevail in Garrow Lake as it can be divided into four distinct layers: [described by Dickman and Ouellet (1987); summarized by Dickman (1995)]: (1) a 0-5 m deep, oxygen saturated mixolimnion with low salinity (< 1 ppt) attributed to freshwater runoff and ice-melt water; (2) a 5-12 m brackish-water zone with saturated and supersaturated dissolved oxygen and increasing salinity; (3) a 12-20 m deep chemocline with a strong salinity gradient and rapidly decreasing dissolved oxygen; and (4) a 20-47 m anoxic monimolimnion that can be extremely high in salinity (up to 82 ppt, Dickman 1991) and hydrogen sulfide. The majority of Garrow Lake fourhorn sculpin, the only vertebrate in the lake, reside in the brackish-water layer. There is a shallow outflow to the Arctic Ocean (Stewart and Platford 1986) that was dammed by a nearby lead-zinc mining company thereby increasing the lake level by approximately 2.5 m (Donald, pers. comm., 2003).

Garrow Lake fourhorn sculpins have been collected at a depth range of 3.8-15 m (BC Research 1978; Fallis *et al.* 1987; Dickman 1991, 1995) and a salinity range of approximately 3-35 ppt (Dickman 1995). Fourhorn sculpins found in lakes are considered the freshwater form, but some of these forms are capable of inhabiting saline and even hypersaline conditions. The Garrow Lake fourhorn sculpin is restricted to a narrow depth range corresponding to its temperature, oxygen, and dissolved oxygen preference ranges. Below 15 m the temperature rapidly increases reaching 8.9°C at 20 m and the dissolved oxygen rapidly declines to zero at 20 m. The majority of specimens collected by Dickman and colleagues were caught at 7-12 m (Dickman and Ouellet 1987; Dickman 1995). BC Research (1978), using beach seines, gill nets, and SCUBA observations, observed no sculpins below 13 m in Garrow Lake. Fallis *et al.* (1987) reported no fourhorn sculpins captured below 15 m with the majority (92%; n = 51) collected in the depth range 3.8-9.3 m. Divers of Arctic Divers Limited observed fourhorn sculpins in 6-9 m of water with the abundance highest in shallower depths (Gzowski, pers. comm., 2003; Leger, pers. comm., 2003). It is not known whether fourhorn populations inhabiting other Canadian Arctic lakes exhibit similar depth distributions or whether individualistic and/or mass migrations occur. Some populations of the European freshwater fourhorn sculpin have a much deeper depth distribution. Nyman and Westin (1968) collected all specimens in Lakes Vättern and Mälaren at a depth greater than 40 m, whereas in Lakes Orsasjön and Siljan they were found only between 80 and 90 m.

Temperature may also be a factor contributing to the depth distribution of freshwater fourhorn sculpin. Hammar *et al.* (1996) indicated that the Lake Vättern fourhorn sculpin population appeared restricted to depths greater than 40 m in late summer (August-September) to avoid warm water (approximately 8-17°C). The majority of juveniles were collected within or below the thermocline in temperatures below 10°C. The sculpins are usually found on the bottom at a temperature of 5°C or less. Westin (1968) determined the lethal upper temperature of the Baltic fourhorn sculpin to be 14°C; however, the freshwater form may have a higher tolerance for warmer temperatures as Hammar *et al.* (1996) caught one specimen near the surface at 17°C.

Trends

Little is known about the stability of freshwater habitat for the fourhorn sculpin in North America. However, some research has been conducted concerning the limnology of Garrow Lake, NU (Page *et* al. 1984; Stewart and Platford 1986; Dickman and Ouellet 1987; Fallis *et al.* 1987; Dickman 1991, 1995). Garrow Lake, because of the high sulfide concentration in the hypersaline profundal layer, was determined to be an ideal water body for the disposal of mining waste, consisting primarily of lead and zinc tailings, from the Polaris mine. An environmental assessment stated that lead and zinc mine tailings entering the monimolimnion would come in contact with sufficient concentrations of sulfide to result in the rapid precipitation of metal sulfides into the lake's sediments. This process was essential in keeping the metals out of the surface waters where they pose a threat to the natural biota of both the lake and the sea from which Garrow Lake is separated by a shallow stream (Dickman 1991). From November 1981 to August 2002, roughly 15 million metric tonnes of lead and zinc mine tailings entered Garrow Lake from the mine (Donald, pers. comm., 2003). This pollution severely impacted the sulfide generating bacteria, the lake's major primary producer. Sulfide concentrations in the lake's anaerobic zone declined as lead and zinc concentrations increased in the surface waters (Dickman 1991) though zinc levels remained below the 0.5 mg/L permissible limit (Donald, pers. comm., 2003). The entire food chain has been impacted, and it was a concern of Dickman (1991) that the fourhorn sculpin, which survived the last 3000 years in Garrow Lake, would become extirpated within the next twenty years. However, the Polaris Mine was decommissioned in 2002 and Teck Cominco Limited has initiated plans to return the lake to its once pristine condition. Activities, such as removal of tailings disposal pipes and docking wharves, have been initiated while the dam has been removed so that the lake can resume its normal seasonal discharge cycles. Studies will also be conducted to determine the effects the mine has had on the resident fourhorn sculpin population (Donald, pers. comm., 2003).

BIOLOGY

Reproduction

Very little is known about the reproduction of the freshwater fourhorn sculpin. Fallis *et al*. (1987) determined the sex and maturity of 27 Garrow Lake sculpins collected by gillnets under the ice in May. The sample was predominantly females (22) with 12 having eggs in the early stages of development. The number of eggs per female was not recorded. None of the mature females was in spawning condition though Fallis *et al*. (1987) proposed spawning would occur within a few months. The age at first maturity is unknown. However, Hammar *et al*. (1996), after examination of the otolith, determined sexually mature Lake Vättern fourhorn sculpins, ranging in length from 82 - 110 mmTL, to be possibly between 4+ and 6+ years of age.

The reproductive cycle of the marine form has been well described by Morrow (1980) and some of the general features would apply to the freshwater form. Fertilization is internal. Fourhorn sculpins are territorial nest-builders with only the males defending the eggs until the pelagic larvae hatch. Nyman and Westin (1968) stated the lake populations of fourhorn sculpin in Sweden have been found to differ in roe colour. In Lakes Vättern, Orsasjön, and Siljan, the egg colour is yellow. The sculpin population in Lake Mälaren has a greenish-blue egg colour similar to those found in the

Baltic. In Lake Fryken, fourhorn sculpin with both egg colours have been reported. The two different roe colours led Svärdson (1961) to believe that the populations were distinct subspecies; those with green-to-greenish-blue eggs were *M. quadricornis relictus* whereas those with yellow roe were *M. q. quadricornis*. Nyman and Westin (1968) compared blood proteins of three forms, consisting of the Baltic fourhorn sculpin (*M. quadricornis*), *M. q. quadricornis,* and *M. q. relictus*, and concluded that there was no significant difference amongst the various forms.

Little is known concerning the growth of the freshwater fourhorn sculpin. Fallis *et al.* (1987) reported the Garrow Lake sculpin as having a very slow growth rate compared to marine specimens from the Beaufort Sea and Strathcona Sound areas based on length-weight regressions. According to Bond and Erickson (1989), marine fourhorn sculpin from Phillips Bay, YK, grew slowly to a maximum otolith age of 14 years. Young-of-the-year (YOY) sculpin were 10-14 mmTL in late June and by September total lengths of 15-39 mmTL were observed. Fourhorn sculpins ranging in size from 40-99 mmTL probably represent age groups 1 to 3 (Bond and Erickson 1989). Subsequent growth of the marine form is as follows: age 5+ and 6+ sculpin are 21-24 cm; age 7 and 8 sculpins are 24-27 cm; age 10+ sculpins are, on average, 30-31 cm (Morrow 1980). Garrow Lake fourhorn sculpins are generally smaller and Fallis *et al*. (1987) suggested that the slower growth of the Garrow Lake fourhorn sculpin be attributed to the lack of suitable habitat and available prey items in the lake. The maximum age and time for three generations in the freshwater form are unknown.

Survival

Predation on the freshwater fourhorn sculpin has largely been attributed to piscivorous fishes and birds. Fish species include burbot (*Lota lota*), lake char (*Salvelinus namaycush*), northern pike (*Esox lucius*), and Arctic char (*Salvelinus alpinus*) (Dickman 1995; Hammar *et al*., 1996). Due to its shallow water distribution, the fourhorn sculpin can be significantly predated by avian predators, including gulls, loons, herons, cormorants, grebes, and mergansers. The swimming ability is relatively poor making it susceptible to predation (Bengtsson 1993). However, in the marine environment, the sculpin inhabits very shallow water where its cephalic spines are presumed to disrupt the body outline thereby making it less discernible to avian predation. The freshwater form, having absent or diminished cephalic spines, typically has a deeper depth distribution, usually beyond the depth where effective avian predation occurs (Dickman 1995).

Little is known concerning the parasites of freshwater fourhorn sculpin, but Scott and Scott (1988) stated that the species does not appear to be heavily parasitized in either freshwater or seawater. Hammar *et al.* (1996) observed acanthocephalan parasites in three of 19 fourhorn sculpin collected. The parasitized individuals were small (39-41 mmTL) and had a maximum of one worm/individual.

Physiology

Virtually nothing is known about the physiology of the freshwater fourhorn sculpin.

Movements/dispersal

Little information is available on movements of fourhorn sculpins in Canadian lakes, but seasonal migrations have been demonstrated by the Lake Vättern population that migrates to depths greater than 40 m from August through September to avoid layers affected by summer warming (Hammar *et al*., 1996). Furthermore, 19 small-sized fourhorn sculpins (27-110 mmTL; mean = 53.9 mmTL) were collected by Hammar *et al.* (1996) while conducting nocturnal pelagic midwater trawls for European smelt (*Osmerus eperlanus*) and European cisco (*Coregonus albula*) in Lake Vättern. Hammar *et al.* (1996) suggested that the nocturnal vertical migration of these YOY and small sexually mature individuals into the warmer pelagic layers enabled the fourhorn sculpins to maximize their metabolic rates and growth, as a direct or indirect way of decreasing cannibalism from profundal concentrations of large-sized conspecifics, as well as interspecific predation and competition from Arctic char and burbot.

Nutrition and interspecific interactions

The fourhorn sculpin is an ambush predator that is capable of crushing large food items before swallowing (Leonardsson *et al*., 1988). Its feeding activities are largely nocturnal, but such activities become diurnal from November to April (Froese and Pauly 2002). The general diet consists of invertebrates, such as priapulids, mysids, isopods, amphipods, copepods, annelids, chironomids, and mollusks, as well as small fishes and fish eggs, particularly that of conspecifics. Invertebrates inhabiting the benthos appear to be the most important prey items and routinely consist of the isopod *Mesidotea entomon*, the amphipod *Pontoporeia affinis*, and the mysid *Mysis relicta*. The stomach contents of the sculpins have also been found to contain insects, plant material, sand, gravel, and unidentified animal material (Morrow 1980; Muus *et al*., 1999).

Fallis *et al*. (1987) examined the stomach contents of 27 Garrow Lake sculpins and found that approximately half (14) were empty. An abundant food item, in terms of presence (30.8%) and biomass (69.1%), was unidentified eggs and these were possibly sculpin eggs because the fourhorn sculpin is the only freshwater fish collected in the lake (BC Research 1978; Fallis *et al*., 1987; Dickman 1995). Some of the stomachs contained plant material (15.4%) and copepods (7.7%), but the biomass was low at 3.3% and 2.2%, respectively (Fallis *et al*. 1987). *Limnocalanus* species, according to BC Research (1978), was the dominant prey item with respect to occurrence. Fallis *et* al. (1987) discovered that some of the fourhorn sculpins, approximately 7.7%, had ingested amphipods, representing a negligible biomass. The majority of stomachs held unidentified materials (53.8%), representing 25.4% of the total biomass.

Svärdson *et al*. (1988) felt the fourhorn sculpin was the most specialized feeder on the relict deepwater crustacean fauna of Lake Vättern with *M. relicta* and *Pallasea* *quadrispinosa* dominating in sculpin smaller than 200 mm, and *Sadurai entomon, P. quadrispinosa,* and *Gammaracanthus lacustris* dominating in sculpin larger than 200 mm. The stomach contents of smaller Lake Vättern fourhorn sculpins (27-45 mmTL) were predominantly large sized cyclopoid copepods and *M. relicta* while slightly larger sculpin (82-110 mmTL) also consumed *P. quadrispinosa, M. affinis,* and *G. lacustris*. *S. entomon*, chironomid larvae and pupae, and ostracods were found in stomachs, but were low in terms of abundance and biomass (Hammar *et al*. 1996).

Behaviour/adaptability

The adaptability of the fourhorn sculpin to natural disturbance is evident in that it is a glacial relict. During the last ice age its distribution is thought to have extended much further south. When the ice retreated, many local populations were left behind in freshwaters since their access to the sea had been cut off. These managed to become adapted to the changed conditions, and so the fourhorn sculpin is found today as a relict in many deep cold freshwater lakes in northern North America and northern Europe (Muus and Dahlstrøm 1999; Muus *et al*. 1999).

POPULATION SIZES AND TRENDS

Information about the size and trends of the freshwater fourhorn sculpin populations is mostly limited to presence-absence records. Most locations have not been sampled extensively or sequentially, therefore making it extremely difficult to estimate the number of individuals and the number of mature individuals in Canada. Even estimating the population size in a particular lake is difficult as abundance-level data is very limited. A couple of reasons are evident for the lack of data concerning this species:

1. The freshwater fourhorn sculpin is not harvested for commercial, recreation, or subsistence use. Though the species is considered edible, there is a small meat yield per fish and much energy and time would be required to separate the meat from the bone (Morrow 1980). This high labour-to-yield ratio makes it unfavourable as either a commercial or subsistence species. Furthermore, its small size (generally < 100 mm) causes it to be undesirable with respect to recreational fishers.

2. Many of the lakes the fourhorn sculpin inhabits are located in the high Arctic and far from centres of population. The isolation and inaccessibility of such water bodies thereby make it difficult to perform extensive and sequential fish population studies. The remoteness also adds cost to such studies in terms of transportation and labour. Furthermore, these lakes are generally ice-covered for most of the year because of the high latitudes in which they occur. This causes the season to be extremely short in which open-water sampling methods can be employed. Sampling through the ice is possible, but can be costly and expensive with respect to the labour and equipment required.

Usually sampling only occurs when an environmental assessment is required for hydrocarbon and raw material exploration and development. Garrow Lake, for example, was only discovered in 1974 and is ice-covered for 11 months of the year. Only a few years after its discovery, the lake was used as a dumping area for waste from a lead-zinc mine to diminish the pollution input to the Arctic Ocean (Dickman and Ouellet 1987).

LIMITING FACTORS AND THREATS

Little is known concerning the limiting factors and threats affecting the freshwater fourhorn sculpin; however, a considerable amount of work has been conducted with the marine form in the brackish Gulf of Bothnia (Bengtsson and Bengtsson 1983; Hansson et al. 1984; Bengtsson *et al*. 1985; Bengtsson 1991,1993). A large proportion of fourhorn sculpins suffer from vertebral and spinal abnormalities due to metal-ore smeltery and pulp mill effluents highly concentrated with heavy metals and chlorinated hydrocarbons. Other abnormalities can include delayed first maturity, deformed gill rakers, blackening of the tail, and impaired hematology and ion balance. This susceptibility to pollution presented the marine fourhorn sculpin as a candidate indicator species for monitoring effects of various types of pollution on natural fish populations in Sweden (Gyllensten and Ryman 1985) and the Arctic (Khlebovich 1997).

Pollution problems are as yet minimal in the Canadian range of the species, but may become more prevalent if and when development, particularly petrochemical exploration and exploitation, intensifies in the Arctic. Moulton and George (2000) described the adverse effects Arctic oil-fields can place on freshwater fish populations. Oil-field activities can alter, delay, or block migrations and can affect the quantity and quality of overwintering habitats. Migration blockage has occurred in scour pools on the downstream side of culverts within the active floodplain of the Sagavanirktok River, Prudhoe Bay, Alaska. Fish moving through the culverts during breakup flows became trapped in pools when water levels dropped. According to Moulton and George (2000), these fish are usually lost to the population because of stress related to high summer temperatures or freezing of the pools during the following winter. Many of the migration and habitat needs of the freshwater fish, and activities that would affect these needs, were recognized early in oil-field development, and facilities in or around the oil-fields were normally designed or modified to avoid or minimize effects to freshwater fish populations. The authors sampled 279 Arctic coastal plain lakes in an oil-field region of Alaska. Seventeen species of freshwater fish were collected with ninespine stickleback (*Pungitius pungitius*), Arctic grayling (*Thymallus arcticus*), least cisco (*Coregonus sardinella),* broad whitefish (*C. nasus*), and round whitefish (*Prosopium cylindraceum*) being dominant with respect to abundance and distribution. Only 11 fourhorn sculpins, representing 3.9% of the total catch, were collected with the majority caught in tapped lakes (i.e. lakes that have an active connection to a river channel during the summer). The authors concluded that oil development posed little risk to freshwater species because (1) freshwater habitat capable of supporting fish year-round was in limited supply in the oil-fields compared to nearby regions and (2) the design and placement of facilities, such as bridges and culverts or water withdrawal facilities, have incorporated features to minimize impacts to the fish populations that are present.

The conclusion that oil-field development does not adversely affect fish populations does not apply to all industrial development. An exception to these conclusions may be Garrow Lake. Teck Cominco Limited, in an attempt to reduce the ecological footprint left by the recently decommissioned Polaris lead-zinc mine, has incorporated the use of divers to remove tailing disposal pipes in the lake as well as nearshore structures, such as docking wharves. A diving company has conducted work for the Polaris mine since its incorporation in 1981 and its divers have recently observed fourhorn sculpins to be of high abundance in relatively shallow water (6-9 m). However, it is difficult to assess how the present abundance compares to historic levels because the divers tended to work in deeper waters, beyond the observed range of the resident sculpin population (Gzowski, pers. comm., 2003). There was never any attempt to estimate the size of the Garrow Lake fourhorn population. When the mine was proposing to use the lake as a tailings facility, there was no significant concern raised about the health of the sculpin population. When Teck Cominco Limited was given approval to use Garrow Lake their licence indicated that the company did not need to protect the sculpins in any way (Donald, pers. comm. 2003). Considering these factors it is surprising that the Garrow Lake fourhorn sculpin appears to be in good health and has not been extirpated.

SPECIAL SIGNIFICANCE OF THE SPECIES

The fourhorn sculpin is of little direct commercial or sportfishing interest, but recreational fishers may inadvertently catch it. For example, Dayman (pers. comm. 2002) accidentally snagged an individual on a hook baited with bacon while ice-fishing on the Husky Lakes, NT. The marine form has been occasionally used as food by native people in the Hudson Bay region (Scott and Scott 1988), but there is little evidence indicating whether the freshwater form has been utilized in this manner.

The fourhorn sculpin is of special interest to the scientific community concerned with Canadian post-glacial dispersion and zoogeography. The species may be of value as an indicator of environmental quality due to morphological changes resulting from sublethal effects of pollutants and could be a key species to monitor in areas of development in the Arctic. Its distribution and evolution in the freshwater and euryhaline lakes of the Arctic Islands is of scientific interest and the populations should be protected in these environments that are particularly sensitive to perturbance, as the fish may be genetically different from marine populations.

EXISTING PROTECTION OR OTHER STATUS

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Houston 1990) has assessed in 1989 the post-glacial Arctic relict freshwater fourhorn sculpin as ‘Special Concern’. This status was based on the narrow distribution, restricted habitat and special habitat requirements of the freshwater fourhorn sculpin, and the presumed overall rareness. General protection is provided in Canadian waters under the Fisheries Act. There is no listing for this species in CITES, IUCN, or US Fish and Wildlife Service. It is considered ‘Endangered’ in many of the freshwater lakes in Sweden (Kullander 1992; Nilsson 1996). The fourhorn is listed in Appendix III as protected fauna in the summary report of the Convention on the Conservation of European Wildlife and Natural Habitats, otherwise known as the Bern Convention, but it is not specified what forms are protected.

SUMMARY OF STATUS REPORT

Very little is known about the population status of the post-glacial freshwater form of the fourhorn sculpin, *Myoxocephalus quadricornis*. The species is restricted to at least 23 lakes in the Canadian Arctic (Appendix I) and the only lake from which some information is known of this species is Garrow Lake. The resident population may be indirectly threatened by pollution from a nearby lead-zinc mine that has virtually eliminated the primary producer population, leading to a breakdown in the food chain. Dickman and co-workers expect this population of sculpins to become extirpated within the next twenty years, but anecdotal evidence indicates the population is abundant. Though little is known about the populations found in other high Arctic lakes, they are probably genetically unique and may be sensitive to natural and anthropogenic disturbance. More detailed information is required on the distribution, abundance, biology and ecology of the freshwater form, which is extremely lacking compared to what is known about the marine form.

TECHNICAL SUMMARY

Myoxocephalus quadricornis
Fourhorn sculpin *chaboisseau à quatre cornes*
High Arctic lakes in Northwest and Nunavut Territories; one lake in Newfoundland and Labrador

Extent and Area Information	
• *Extent of occurrence (EO)(km²)*	High Arctic lakes of northern Canada
• *Specify trend in EO*	Unknown
• *Are there extreme fluctuations in EO?*	Unknown
• *Area of occupancy (AO) (km²)*	Unknown
• *Specify trend in AO*	Unknown
• *Are there extreme fluctuations in AO?*	Unknown
• *Number of known or inferred current locations*	At least 23 lakes
• *Specify trend in #*	Unknown
• *Are there extreme fluctuations in number of locations?*	Unknown
• *Specify trend in area, extent or quality of habitat*	Stable
Population Information	
• *Generation time (average age of parents in the population)*	Unknown, possibly less than 5 years
• *Number of mature individuals*	Unknown
• *Total population trend:*	Unknown
• *% decline over the last/next 10 years or 3 generations.*	Unknown
• *Are there extreme fluctuations in number of mature individuals?*	Unknown
• *Is the total population severely fragmented?*	Unknown
• *Specify trend in number of populations*	Unknown
• *Are there extreme fluctuations in number of populations?*	Unknown
• List populations with number of mature individuals in each:	
Threats (actual or imminent threats to populations or habitats)	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?* USA: occurs in a few lakes; populations appear stable Sweden: rare in some lakes in Sweden (listed EN)	
• *Is immigration known or possible?*	No
• *Would immigrants be adapted to survive in Canada?*	Probably Yes
• *Is there sufficient habitat for immigrants in Canada?*	Probably Yes
• *Is rescue from outside populations likely?*	Probably Yes
Quantitative Analysis	Unknown

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BIOGRAPHICAL SUMMARY OF THE REPORT WRITER

Lee Sheppard convocated from Memorial University of Newfoundland (MUN) in October 2002 with a Bachelor of Science (Honours) focusing in Marine Biology. His Honours dissertation dealt with fish habitat and examined annual variation in eelgrass (*Zostera marina* L.) area and complexity in Newman Sound, Bonavista Bay, NL, over a period of four years (1998-2001). Lee is currently undertaking a Masters of Science with a focus in Marine Ecology at MUN and is involved in studying the population dynamics of the Greenland cod (*Gadus ogac*) within Newman Sound. His non-academic interests include biking, SCUBA diving, and reading Tom Clancy novels.

AUTHORITIES CONSULTED

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COLLECTIONS EXAMINED

The zoological collections of the following museums were examined for records of *Myoxocephalus quadricornis*: Canadian Museum of Nature, Royal Ontario Museum, and The Manitoba Museum. No records of the freshwater fourhorn sculpin were present in the collections of the Royal Ontario Museum or The Manitoba Museum.

Appendix 1. Collection records of glacial relict freshwater fourhorn sculpin, *Myoxocephalus quadricornis,* of the Canadian Museum of Nature to November 2002 (N.A. = North America; CA = Canada; NT = Northwest Territories; NU = Nunavut Territory; NL = Newfoundland and Labrador; AK = Alaska).

Catalog Number	Number of Specimens	Collection Date	Place	Locality
CMNFI 2002-0013.1	1	2002	N.A.: CA: NU	Lake Tuborg, Ellesmere Island
CMNFI 62-0439.1	7	8/11/1962	N.A.: CA: NU	Romulus Lake, Ellesmere Island
CMNFI 62-0487.1	62	8/11/1962	N.A.: CA: NU	Romulus Lake, Ellesmere Island
CMNFI 63-0079.1	1	9/1/1962	N.A.: CA	Washburn Lake, Victoria Island
CMNFI 63-0080.1	15	8/24/1962	N.A.: CA	Ferguson Lake, Victoria Island
CMNFI 65-0365.1	46	9/3/1962	N.A.: CA	Washburn Lake, Victoria Island
CMNFI 72-0338.1	1	7/9/1962	N.A.: CA	Ferguson Lake, Victoria Island
CMNFI 72-0341.1	1	8/31/1962	N.A.: CA	Surrey Lake, Victoria Island
CMNFI 74-0328.1	3	9/3/1974	N.A.: CA: NU	Nauyak Lake, Kent Peninsula
CMNFI 75-1527.1	8	7/29/1974	N.A.: CA: NU	Nauyak Lake, Kent Peninsula
CMNFI 75-1528.1	1	7/31/1974	N.A.: CA: NU	Nauyak Lake, Kent Peninsula
CMNFI 75-1529.1	2	8/22/1974	N.A.: CA: NU	Nauyak Lake, Kent Peninsula
CMNFI 75-1530.1	2	8/27/1974	N.A.: CA: NU	Nauyak Lake, Kent Peninsula
CMNFI 75-1932.1	1	6/23/1975	N.A.: CA	Stanwell/ Fletcher Lake, Somerset Island
CMNFI 75-1933.1	14	6/25/1975	N.A.: CA	Stanwell/ Fletcher Lake, Somerset Island
CMNFI 75-1939.1	5	8/31/1975	N.A.: CA	Sophia Lake, Cornwallis Island
CMNFI 77-1205.1	3	7/23/1971	N.A.: CA: NT	Northern Eskimo Lakes, Campbell Island
CMNFI 77-1206.2	6	7/25/1971	N.A.: CA: NT	Eskimo Lakes, Beaufort Sea
CMNFI 77-1207.3	19	7/26/1971	N.A.: CA: NT	Eskimo Lakes, Campbell Island
CMNFI 77-1251.3	51	9/1/1971	N.A.: CA: NT	"Thumb Lake", Liverpool Bay, Beaufort Sea
CMNFI 77-1294A.1	1	8/29/1962	N.A.: CA: NT	Zeta Lake, Victoria Island
CMNFI 77-1334.1	1	6/21/1962	N.A.: CA	Ferguson Lake, Victoria Island
CMNFI 77-1335.1	1	8/7/1962	N.A.: CA: NU	Eleanor Lake, Cornwallis Island.
CMNFI 77-1470A.1	13	7/23/1961	N.A.: CA: NT	Eskimo Lakes, Thumb Island
CMNFI 77-1471A.2	88	7/31/1961	N.A.: CA: NT	Eskimo Lakes, Thumb Island
CMNFI 77-1664.1	1	8/24/1962	N.A.: CA: NU	Ferguson Lake, Victoria Island
CMNFI 77-1665.1	1	8/23/1962	N.A.: CA: NU	Ferguson Lake, Victoria Island
CMNFI 77-1706.1	2	8/22/1977	N.A.: CA: NU	Garrow Lake, Little Cornwallis I.
CMNFI 77-1711.1	24	1977/08/00	N.A.: CA: NU	Garrow Lake, Little Cornwallis I.
CMNFI 78-0233.1	1	8/5/1976	N.A.: CA: NU	Longspur Lake, Victoria Island
CMNFI 82-0098.1	3	7/20/1981	N.A.: CA: NT	Unnamed Lake, Melville Island
CMNFI 82-0099.2	3	7/21/1981	N.A.: CA: NT	Unnamed Lake, Melville Island
CMNFI 82-0102.1	3	7/30/1981	N.A.: CA: NU	Unnamed Lake, Bathurst Island
CMNFI 82-0196.2	8	8/1/1981	N.A.: CA: NU	Unnamed Lake, Cornwallis Island
CMNFI 82-0197.1	17	8/1/1981	N.A.: CA: NU	Garrow Lake, Little Cornwallis Island
CMNFI 82-0513.1	98	7/25/1977	N.A.: CA: NT	Thumb Lake, Eskimo Lakes
CMNFI 83-0034.1	1	8/4/1971	N.A.: CA: NT	Thumb Lake, Eskimo Lakes

Catalog Number	Number of Specimens	Collection Date	Place	Locality
CMNFI 83-0100.4	1	8/25/1964	N.A.: CA: NL	Lake Sipukat, Okak Bay
CMNFI 83-0108.2	1	8/4/1982	N.A.: CA: NU	Tassijuak Lake, Victoria Island
CMNFI 84-0173.6	3	8/3/1983	N.A.: US: AK	Swan Lake, Baldwin Peninsula
CMNFI 86-0573.1	1	8/16/1967	N.A.: CA: NU	Wentzel Lake, Hepburn Island
CMNFI 90-0120.1	3	8/18/1976	N.A.: CA: NU	Nauyak Lake
CMNFI 90-0123.1	2	8/25/1976	N.A.: CA: NU	Nauyak Lake
CMNFI 90-0130.1	10	9/23/1979	N.A.: CA: NT	Alexie Lake