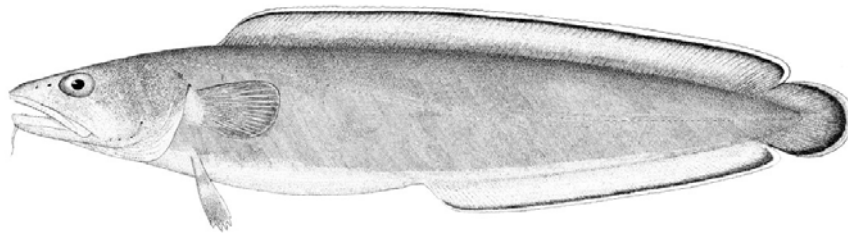


**COSEWIC**  
**Assessment and Status Report**

on the

**Cusk**  
*Brosme Brosme*

in Canada



**THREATENED**  
**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:

COSEWIC 2003. COSEWIC assessment and status report on the cusk *Brosme Brosme* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 30 pp.

Production note: COSEWIC would like to acknowledge David A. Methven for writing the status report on the cusk *Brosme Brosme*, prepared under contract with Environment Canada.

For additional copies contact:

COSEWIC Secretariat  
c/o Canadian Wildlife Service  
Environment Canada  
Ottawa, ON  
K1A 0H3

Tel.: (819) 997-4991 / (819) 953-3215

Fax: (819) 994-3684

E-mail: COSEWIC/COSEPAC@ec.gc.ca

<http://www.cosewic.gc.ca>

Également disponible en français sous le titre Évaluation et Rapport du COSEPAC sur la situation *Brosme (Brosme Brosme)* au Canada

Cover illustration:

Cusk — From an original by H.L. Todd. It was provided by Lisa Palmer, the Smithsonian Institution, NMNH, Division of Fishes.

©Her Majesty the Queen in Right of Canada 2003  
Catalogue CW69-14/832-2003E-PDF  
ISBN 0-662-35352-8  
HTML: CW69-14/332-2003E-HTML  
0-662-35353-6



Recycled paper



## COSEWIC Assessment Summary

### Assessment Summary – May 2003

**Common name**

Cusk

**Scientific name**

*Brosme Brosme*

**Status**

Threatened

**Reason for designation**

The main population of this large, slow-growing, solitary bottom-living fish resides in the Gulf of Maine/Southeastern Scotian Shelf and has been in decline since 1970. Over three generations, the decline rate is over 90%, and the fish occurs in fewer and fewer survey trawls over time. Fishing, unrestricted until 1999, is now capped but remains a source of mortality. This species is in a monotypic North Atlantic genus.

**Occurrence**

Atlantic Ocean

**Status history**

Designated Threatened in May 2003. Assessment based on a new status report.



## COSEWIC Executive Summary

### Cusk *Brosme Brosme*

#### Species information

*Brosme Brosme* (Ascanius 1772) is the only member of its genus and is one of about 20 species of cod-like fishes (Gadidae) listed for the east coast of Canada. It is commonly referred to as cusk. The combination of a single barbel and a single dorsal fin is diagnostic and identifies this member of the Gadidae to species. *Brosme* is treated as a single evolutionarily significant unit (ESU) in this report. No studies have been done on meristic, morphometric and genetic variation on *Brosme* from the western Atlantic.

#### Distribution

*Brosme* is a northern species inhabiting subarctic and boreal shelf waters of the north Atlantic. Its centre of abundance in the western Atlantic is between 41-44°N latitude (Gulf of Maine and southern Scotian Shelf). It also occurs in the deep waters along the edge of the continental shelf off Newfoundland and Labrador where it is rare. Only three fish have been taken from the Gulf of St. Lawrence. Its distribution overlaps the international border of Canada and the United States in the Gulf of Maine.

#### Habitat

Common on hard, rough, and rocky substrates it is seldom taken on bottoms of smooth clean sand. *Brosme* prefers relatively warm water of intermediate depths on the Scotian Shelf and Gulf of Maine. It is found at temperatures from 2-12°C on the Scotian Shelf but 6-10°C is the preferred range. *Brosme* is seldom found near the shore or at depths less than 20-30 m. It mostly occurs between 150-450 m depth throughout its range. The depth range reported by Scott (1982) for *Brosme* off eastern Canada is 73-363 m although it can be found in deeper water along the edge of the continental shelf off Nova Scotia.

#### Biology

Adults reach a maximum length of greater than 100 cm Total Length (TL). Spawning takes place from April to July with peak spawning in late June on the Scotian Shelf. Eggs are buoyant and hatch larvae measuring 4 mm. Larvae remain in the upper water column and settle to the bottom at ca. 50-60 mm. Demersal juveniles and adults

are slow-moving, sedentary and solitary and do not form large aggregations. The largest single catches in over 30 years of bottom trawling on the Scotian Shelf and Gulf of Maine are 35 individuals per tow by the Department of Fisheries and Oceans (DFO) and 12 by the National Marine Fisheries Service (NMFS). Fifty percent of adults mature at ca. 50 cm (5-6 years) although this varies among locations. In this report generation time is estimated as 9 years (c. 60 cm). Maximum age reported is 20 years.

### **Population sizes and trends**

Data used in this report to document numerical decline in Canada come from the Department of Fisheries and Oceans. More than 10,000 stations have been sampled in the Scotia-Fundy region from 1970-2001. In the Newfoundland region >15,000 stations were sampled from 1978-2001.

Survey data from the Scotia-Fundy region show a decline in catch per unit effort (CPUE) beginning in about late 1970 to the early 1980s. Over the full period, 1970-2001, 32 years or 3.5 cusk generations, CPUE declined by 93.4%. Population estimates for fish greater than 50 cm (size of 50% maturity) closely follow declines in CPUE. A decline of 95.5% from 1970-2001 was observed. This is a one order of magnitude decline in population size. Research vessel survey data combined from all sources (Gulf of Maine, Scotia-Fundy and Newfoundland) for all *Brosme* from the northwest Atlantic show CPUE was ca. 0.21 individuals per tow in the early 1970s and declined steadily throughout the period reaching 0.02 in 1994. Over the whole range and full period 1970-1994, 25 years or about 3 generations, the number per tow declined by 90.4%.

### **Limiting factors and threats**

Fishing is an important source of mortality. Other than humans, cod, halibut and hooded seals seem to be the only recorded predators of *Brosme*. Fishing has resulted in average catches of 3469 tons annually. Approximately 80% of landings come from NAFO fishing area 4X (Bay of Fundy, southwest Nova Scotia, Browns Bank). There is apparently some directed fishing on *Brosme*. The DFO Stock Status Report A3-35 in 2000 and in 1998 state elimination of the directed fishery on *Brosme* is necessary for stocks to rebuild. Despite a directed fishery it should be noted that most *Brosme* are taken as bycatch on long lines that target Atlantic halibut, cod, haddock and pollock. The stock was fully assessed in 1998 by the Department of Fisheries and Oceans. The 1998 stock status report and the updates in 2000 and 2001 indicate landings have remained below the long-term average since 1993. In the United States “the ratio of commercial landings to the autumn research vessel survey index has been increasing since 1986, implying increased exploitation. The stock appears to be overexploited and is at a low biomass level.”

### **Special significance of *Brosme***

*Brosme* is a monotypic genus with a very restricted spatial distribution (core distribution is 41-44°N) in the western Atlantic.



## COSEWIC MANDATE

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

## COSEWIC MEMBERSHIP

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

## DEFINITIONS

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

\* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

\*\* Formerly described as "Not In Any Category", or "No Designation Required."

\*\*\* Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994.

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



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.

# **COSEWIC Status Report**

on the

**Cusk**

*Brosme Brosme*

**in Canada**

2003

## TABLE OF CONTENTS

SPECIES INFORMATION.....	4
Name and classification.....	4
Description.....	4
Nationally significant population.....	4
DISTRIBUTION.....	6
Global.....	6
Canadian distribution.....	6
HABITAT.....	7
BIOLOGY.....	8
General.....	8
Spawning.....	10
POPULATION SIZES AND TRENDS.....	10
Population trends.....	11
Spatial distribution.....	16
Proportion of positive stations.....	19
Number of mature fish.....	20
Commercial fishery data.....	20
LIMITING FACTORS AND THREATS.....	23
SPECIAL SIGNIFICANCE OF THE SPECIES.....	24
EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS.....	24
SUMMARY OF STATUS REPORT.....	24
TECHNICAL SUMMARY.....	26
ACKNOWLEDGEMENTS.....	28
LITERATURE CITED.....	28
BIOGRAPHICAL SUMMARY OF CONTRACTOR.....	30
AUTHORITIES CONSULTED.....	30

### List of Figures

Figure 1.	Distribution of <i>Brosme Brosme</i> in the western north Atlantic.....	5
Figure 2.	Distribution of fishing stations by depth and temperature in five-year bins from 1970-2001 that collected <i>Brosme</i> and that did not collect <i>Brosme</i> in the Scotia-Fundy region. ....	9
Figure 3.	Catch per unit effort of <i>Brosme</i> from standardized research vessel surveys in the Scotia-Fundy region (1970-2001). ....	12
Figure 4.	Population estimates (1970-2001) provided by STRAP analyses of Scotia-Fundy July research vessel trawl data for <i>Brosme</i> >50 cm. ....	13
Figure 5.	Catch per unit effort of <i>Brosme</i> from standardized research vessel surveys in the gulf of Maine region (1970-1994) based on ECNASAP survey data.....	14
Figure 6.	Commercial landings and stratified mean catch per tow of cusk from autumn research vessel surveys by the National Marine Fisheries Service...	15
Figure 6.1.	Stratified mean number per tow of <i>Brosme</i> from the Gulf of Maine and Georges Bank region.....	15



Figure 6.2.	Mean weight of <i>Brosme</i> per tow from the Gulf of Maine and Georges Bank region .....	16
Figure 7.	Catch per unit effort of <i>Brosme</i> from all regions of the northwest Atlantic where <i>Brosme</i> are located (1970-1994) based on ECNASP survey data ..	17
Figure 8.	Spatial distribution of <i>Brosme</i> from the Scotia-Fundy region (1971-2000).....	18
Figure 9.	Proportion of catches with <i>Brosme</i> from all research vessel surveys in the Scotia-Fundy region. ....	19
Figure 10.	Cusk catch rate and landings for groundfish longliners in 4X(mnopqr).....	21

**List of tables**

Table 1.	Upper columns show the number of fishing stations by depth and temperature sampled on the Scotian Shelf 1970-2001. Lower columns show the number of stations that caught <i>Brosme</i> for each depth and temperature category. ....	22
----------	--	----

## SPECIES INFORMATION

### Name and classification

*Brosme Brosme* (Ascanius 1772) is a Gadiform species within Gadidae. It is one of about 20 species of cod-like fishes listed for the east coast of Canada. *Brosme* is a monotypic genus. Common names include cusk, tusk, torsk (No), menek (Ru) and *Brosme* (Fr) (Scott and Scott 1988).

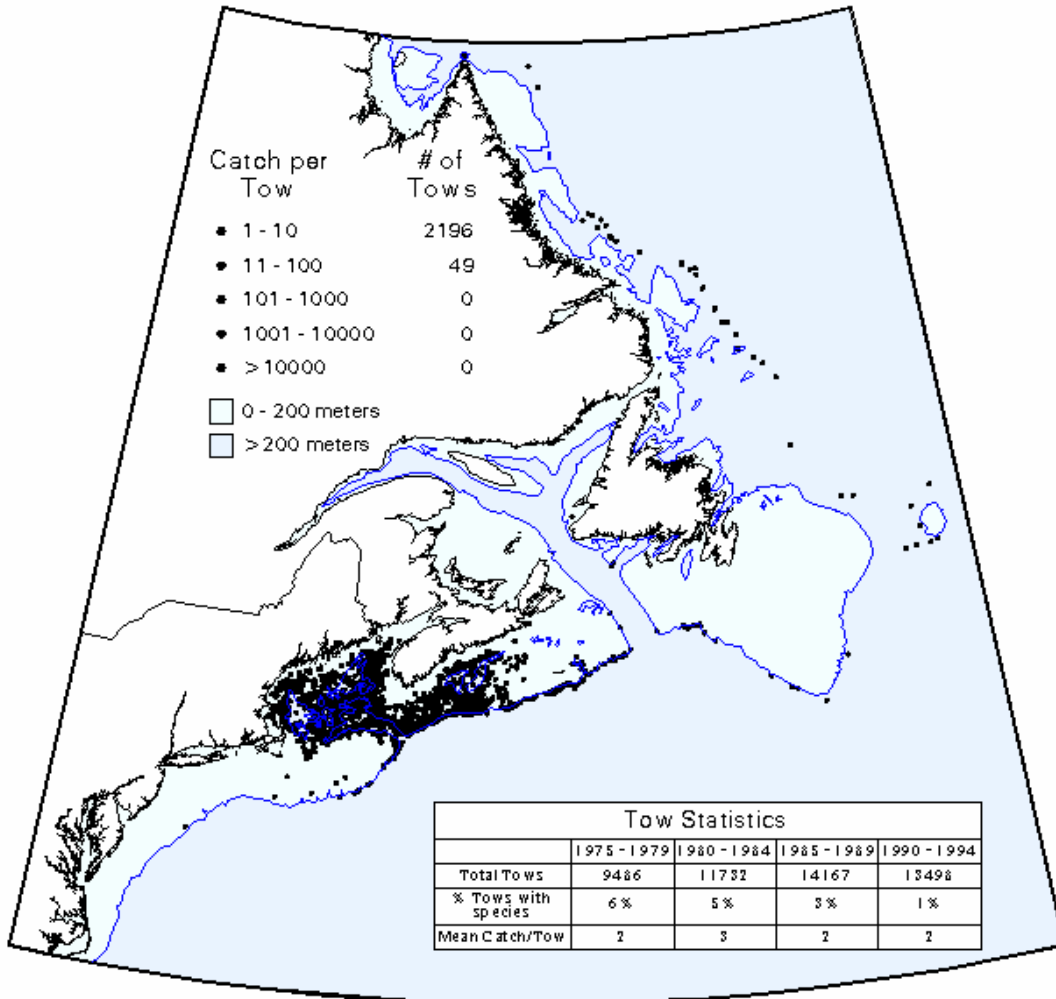
### Description

*Brosme* is a slow swimming, relatively robust demersal species with a heavy head and elongate body reaching a maximum length of greater than 100 cm TL (Cohen et al. 1990). There is one dorsal and one anal fin, both are elongate and extend posteriorly to a rounded caudal fin (Scott and Scott 1988, Collette and Klien-MacPhee 2002). *Brosme* can be distinguished from all western Atlantic Gadidae in possessing a single dorsal fin. The combination of a single barbel on the underside of the chin in addition to the single dorsal fin is diagnostic and identifies this member of the Gadidae as *Brosme Brosme*. The relationship of the anal and dorsal fins with the caudal fin is also distinctive. The dorsal and the anal fins are continuous with the caudal fin at the base but are separated from it by distinct notches (Svetovidov 1948, Scott and Scott 1988, Pethon 1989, Collette and Klien-MacPhee 2002). The small pelvic fins have 4-5 rays and are located below the rounded and brush-like pectoral fins. All fins are thick and fleshy at the base (Collette and Klien-MacPhee 2002). Individual rays are only evident at the margins. The body contains minute, deeply embedded scales (Wheeler 1969). Colour is variously described, being light grey with a brownish tint, paler on the sides, changing to greyish-white on the belly in the north east Atlantic to dark reddish or greenish brown, sometimes lighter brown, shading to cream or white on the belly in the west Atlantic (Bigelow and Schroeder 1953, Scott and Scott 1988, Collette and Klien-MacPhee 2002).

### Nationally significant population

*Brosme* is treated as a single evolutionarily significant unit (ESU) in this report. The surprisingly restricted spatial distribution, with the bulk of the population being located between 41° to 44°N latitude in the Gulf of Maine and southern Scotian Shelf (Fig. 1) is unusual for continental shelf Gadidae. This and the lack of studies on meristic, morphometric and genetic variation for western Atlantic *Brosme* lead to treating the species as a single population (ESU) in the northwest Atlantic. The only genetic study on *Brosme* has focused on specimens from Greenland and further east. Heterogeneity tests showed *Brosme* from the east and west (Greenland) Atlantic probably represent different gene pools. (Johansen and Nævdal 1995).

East Coast of North America Strategic Assessment Project  
 Distribution of Cusk (*Brosme brosme*)



Projection: Lambert Conformal Conic



Science Sector,  
 Department of Fisheries and Oceans (Canada)  
 Office of Ocean Resources Conservation and Assessment,  
 National Oceanic and Atmospheric Administration (USA)



Figure 1. Distribution of *Brosme Brosme* in the western north Atlantic. Distribution chart is from the East Coast of North America Strategic Assessment Project (ECNASAP) and is available at <http://www.orca.nos.noaa.gov/projects/ecnasap/ecnasap.html>

## DISTRIBUTION

### Global

*Brosme* appears in the important regional ichthyofaunal compendia of the North Atlantic. These accounts include identification keys, illustrations, distributional charts and information on biology and relation to man as well as references (Hildebrand and Schroeder 1928, Svetovidov 1948, Bigelow and Schroeder 1953, Wheeler 1969, Scott and Scott 1988, Pethon 1989, Cohen 1990, Collette and Klein-MacPhee 2002).

*Brosme* is a northern species inhabiting subarctic and boreal waters of the north Atlantic on both coasts. In the east it is reported from the northern regions of the North Sea, coasts of Ireland and Scotland, south (where it is rare in the Skagerrak and Kattegat) and west coasts of Norway extending northwards to the Barents Sea and Bear Island (Svetovidov 1948, Bigelow and Schroeder 1953, Wheeler 1969, Pethon 1989). *Brosme* occurs off the Faeroe Islands, Iceland and is reported on the east and west coasts of Greenland where it is rare, although recent information from Henry Lear (DFO-Ottawa) indicates that it may have been more common off west Greenland than previously believed. Lear (personal communication) reports cusk taken in 11 long line sets (450 hooks/set) between Lille Hellefiske Bank and Cape Desolation. Highest catches occurred at 460-485 m.

On the Atlantic west coast *Brosme* occurs in the deep waters along the edge of the continental shelf off Newfoundland and Labrador where it is rare. It is also rare in the Gulf of St. Lawrence where it has only been reported from the west coast of Cape Breton Island off Cheticamp. The centre of abundance in the western Atlantic is the Gulf of Maine, southern Scotian Shelf and entrance of the Bay of Fundy (Scott and Scott 1988, Collette and Klein-MacPhee 2002, Harris et al. 2002). The southern limit appears to occur in the waters between New Jersey and Rhode Island - Cape Cod. It is not reported in Hildebrand and Schroeder's Fishes of Chesapeake Bay (1928) nor is it listed among fishes trawled from the middle Atlantic Bight (Cape Hatteras to Cape Cod) (Colvocoresses and Musick 1984).

### Canadian distribution

The centre of distribution for *Brosme* in the northwest Atlantic is the relatively deep waters of the Gulf of Maine and east and northward of there where Bigelow and Schroeder (1953) report "considerable quantities are caught all along the Nova Scotia Banks, from Browns to Banquereau and to the Canso Ground off Cape Breton Island." *Brosme* is most common on the southwestern Scotian Shelf and slope as well as in the Fundian Channel. It is more common there than elsewhere in the Canadian region (Fig. 1). *Brosme* have been caught at the entrance of the Bay of Fundy, especially near Brier Island on the Nova Scotian side and about Grand Manan on the New Brunswick side but is absent from the innermost reaches of the Bay (Bigelow and Schroeder 1953, Scott and Scott 1988, Collette and Klein-MacPhee 2002). *Brosme* is not listed in bottom trawl records from Passamaquoddy Bay (Tyler 1971, Macdonald et al. 1984). *Brosme* is

also virtually absent from the Gulf of St. Lawrence and is rare north of the Laurentian Channel in the Newfoundland and Grand Bank region. *Brosme* belongs to the south-temperate bank/slope assemblage of fishes with ranges typically extending from the mid-Atlantic Bight to the Grand Banks of Newfoundland (Mahon et al. 1998).

The east coast distribution and species range of *Brosme* is illustrated by the East Coast of North America Strategic Assessment Project (ECNASAP) in Figure 1 of this report. This project summarizes >20 years of distributional data from scientific research surveys from eastern Canada and the northeast United States. The ECNASAP chart for *Brosme* shows it to be concentrated in the Gulf of Maine, entrance of the Bay of Fundy and on the Scotian Shelf off southwest Nova Scotia extending from the Fundian Channel and Browns Bank to Emerald, Western and Sable Island Banks (Fig. 1). This is a region encompassing about three degrees of latitude extending from approximately 41° to 44° N. Occurrence of *Brosme* to the north and south of its core distribution is largely confined to the edge and slope of the continental shelf as shown in Figure 1 and by Harris et al. (2002) in relatively deep water. *Brosme* maintains a very restricted core distribution relative to other members of the Gadidae (cods, hakes, pollock) in the western Atlantic.

## HABITAT

*Brosme* are commonly taken on hard, rough, and rocky substrates and are described by Bigelow and Schroeder (1953) and Collette and Klein-MacPhee (2002) as being “decidedly fastidious in their choice of bottoms, being found chiefly on hard ground, especially where the sea floor is rough with rocks or boulders; on gravely or pebbly grounds, occasionally on mud with hake (*Urophycis*) but seldom on smooth clean sand”. Fishing grounds such as German Bank and Lurcher Shoal on the Scotian Shelf with extensive patches of gravel, pebbles and small stones alternating with sand and clay are less productive fishing areas (Bigelow and Schroeder 1953, Collette and Klein-MacPhee 2002). *Brosme* have been taken with long lines and gillnets off southwestern Norway at depths of 150 to 300 m in coral (*Lophelia pertusa*) habitats (Husebø et al. 2002). Fish in coral habitats (Svedevikov 1948) tended to be larger in size than those in non-coral habitats. *Brosme* were also observed associated with carbonate-cemented slabs, sometimes hiding beneath them in seabed pockmarks and seepages in the central North Sea (Hovland and Judd 1988).

It is noteworthy that *Brosme* prefer relatively warm intermediate depths in the western Atlantic. *Brosme* are found at temperatures from 2-12°C on the Scotian Shelf and ca. 1-10°C in the Gulf of Maine (Scott 1982, Scott and Scott 1988). The preferred temperature range is ca. 6-10°C on the Scotian Shelf (Scott 1982, Scott and Scott 1988). The principal fishing areas are reported to coincide with regions having a minimum bottom temperature of about 4°C (Oldham 1972, Scott 1982, Scott and Scott 1988).

*Brosme* is never found near the shore or at depths less than 20-30 m (Svedevikov 1948). The overall depth range is between 20 to 1100 m (Cohen 1990, Hareide and

Garnes 2001) but it is rarely found deeper than 400m (Andriyashev 1954). In the Canadian Atlantic it is reported to occur between 150-450 m throughout its range. The depth range based on long term (30+ y) bottom trawling by DFO research vessels on the Scotian Shelf is 73-363 m (Scott 1982, Scott and Scott 1988) although *Brosme* is known to occur at deeper depths along the edge of the continental shelf off Nova Scotia. Temperature and depth of *Brosme* from the Scotian Shelf are summarized in Table 1 and Figure 2 for the period 1970 to 2001. These data are provided by the Department of Fisheries and Oceans, St. Andrews New Brunswick and are based on standardized bottom trawl surveys. Table 1 shows 94% of *Brosme* taken in the Scotia-Fundy region occurred at 6.0 to 12.9°C. Ninety-four percent were also taken at depths less than 399m. Only three *Brosme* were taken at depths between 400-699 m. Figure 2 illustrates that the thermal and depth distribution has not changed during 32 years of sampling in the Scotia-Fundy region. It is likely that *Brosme* can occur in deeper water given its presence along the edge of the continental shelf and slope in the Canadian Atlantic as shown in the distributional charts of Harris et al. (2002).

## BIOLOGY

### General

There remain many gaps in our basic knowledge on the biology of *Brosme* despite there being some directed fishing for this species in the western Atlantic. Adults spawn from April to July in the Gulf of Maine (Bigelow and Schroeder 1953, Collette and Klein-MacPhee 2002). Peak spawning occurs in late June in the LaHave Bank region of the Scotian Shelf (Oldham 1972).

Eggs are buoyant and can be broadly dispersed by ocean currents. Larvae hatch at 4 mm and yolk reserves are absorbed at ca. 5 mm. Larvae remain in the upper water column as pelagic juveniles and are settled to the bottom at ca. 50-60 mm (Schmidt 1905, Fahay 1983, Collette and Klein-MacPhee 2002). Duration in the pelagic environment is not reported but likely depends on water temperature and is presumably comparable to other Gadids, ca. 1-4 months. Demersal juveniles and adults remain strongly associated with the substratum and do not swim up into the water column (Bigelow and Schroeder 1953, Collette and Klein-MacPhee 2002). As adults, *Brosme* are described as a slow-moving, sedentary and solitary, and do not form large aggregations or schools (Svetevidov 1948 Wheeler 1969, Cohen 1990).

Catches of *Brosme* from 32 years of bottom trawling in the Scotia-Fundy, Gulf of Maine and Bay of Fundy regions — where *Brosme* is at the centre of its distribution — are seldom impressive. The maximum catch by the Department of Fisheries and Oceans in a single 30-minute bottom trawl tow is 35 individuals, and is 12 by the National Marine Fisheries Service in the United States. Most of the non-zero catches are limited to <4 individuals per tow. Fish (71.5%) and crustaceans (20.4%) are the dominant prey of *Brosme* from the Gulf of Maine and southern Scotian Shelf (Harris et al. 2002, Langton et al. 1980).

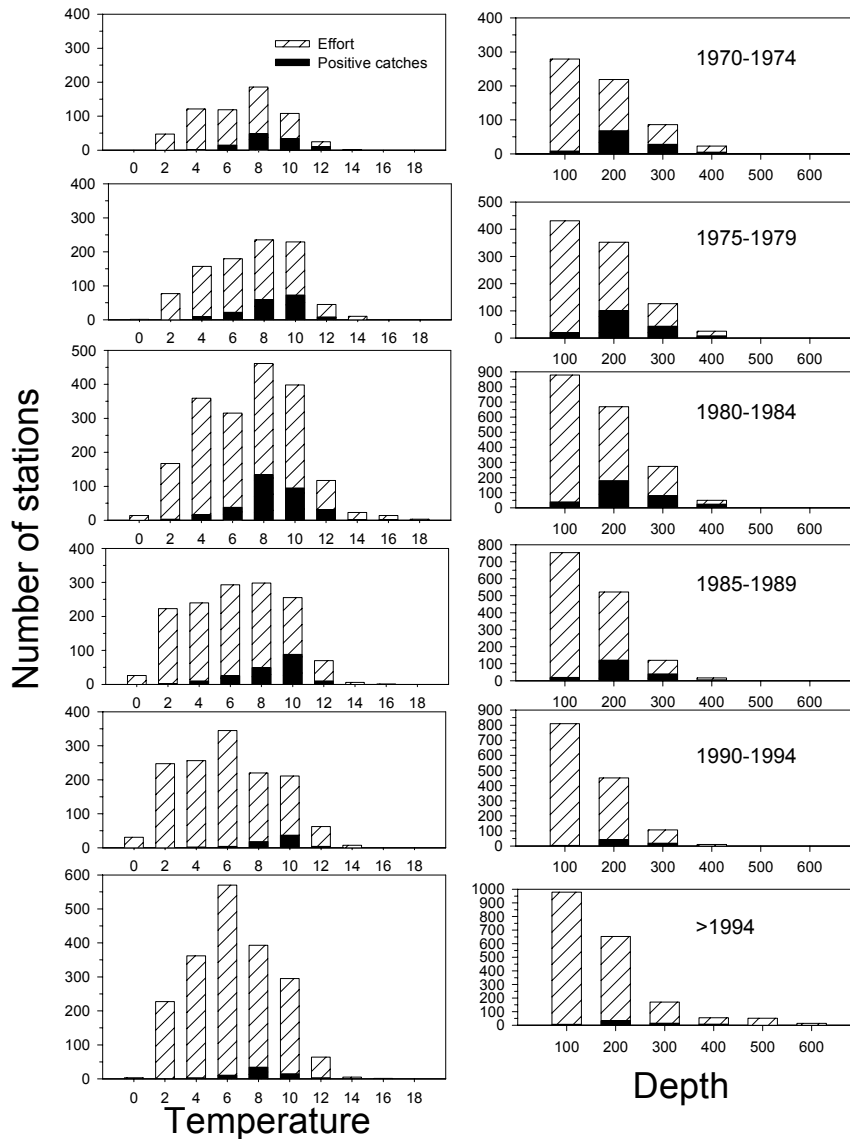


Figure 2. Distribution of fishing stations by depth and temperature in five-year bins from 1970-2001 that collected *Brosme* (black) and that did not collect *Brosme* (grey) in the Scotia-Fundy region.

In the eastern Atlantic *Brosme* are apparently generalists, with fish, crustaceans, and polychaetes being the dominant prey (Andriyashev 1954, Davis 1990, Bergstad 1991). Longline hooks from the commercial fishery were observed in many of the stomachs from the eastern Atlantic Lukmanov et al. (1985). Examination of stomachs of commercially caught *Brosme* is usually unsuccessful because stomachs evert during capture and contents are lost (Scott and Scott 1988). Cusk, being slow and often sedentary, are preyed upon by a variety of fishes including spiny dogfish, winter skate, Atlantic cod, white hake, goosefish, fawn cusk-eel, sea raven, summer flounder and windowpane flounder with dogfish being the most frequent predator (Rountree 1999). Seals are also known predators and include hooded (Jensen 1948) and gray (Bowen et al. 1993) seals.

## Spawning

Cusk are among the most fecund of fishes, there being >1 million eggs in mature fish >60 cm on the Scotian Shelf (Wenner 1983, Oldham 1972). Cusk spawn in spring-summer although spawning time depends on location (Bigelow and Schroeder 1953, Fahay 1983, Cohen 1990, Scott and Scott 1988, Collette and Klein-MacPhee 2002). Spawning occurs from May to August, peaking in late June on the Scotian Shelf (Oldham 1972, DFO Stock Status Report A3-35 2000). The location of 'spawning grounds' if indeed precise spawning sites exist, are not known. Spawning is reported to occur throughout NAFO Div. 4X. There are also no reported spawning migrations. *Brosme* moves little and undertakes only local migrations from greater to lesser depths while remaining in the same general region (Svedevicov 1948, Oldham 1972). Spawning occurs at 5-9°C, with 7°C being the average.

Both Beacham (1982) and Oldham (1972) provide information necessary to estimate generation time. In this report generation time is taken as the age when the majority (95%) of *Brosme* reach maturity. Beacham (1982) indicates *Brosme* are fifty percent mature at 48-56 cm for males and females on the Scotian Shelf. Oldham (1972) reports 50% of males mature at 43.5 cm (age 5) and that 50% maturity for females occurs at 50.7 cm (age 7), for the Scotian Shelf. Consequently, the average age of maturity on the Scotian Shelf is ca. 6 years. Beacham (1982) reports all *Brosme* greater than 70 cm on the Scotian Shelf are mature. Seventy centimetres corresponds to an age of almost 11 years (age length key in Oldham based on data from the early 1970s). Oldham (1972) indicates greater than 95% of all *Brosme* are mature by 60 cm. Sixty centimetres corresponds to an age of 9 and is the estimate of generation time used in this report. Svetovidov (1948) reports sexual maturity is reached at 50 cm (age 8-10 years) in the eastern Atlantic.

## POPULATION SIZES AND TRENDS

For evaluation by COSEWIC, the most important data for marine fishes are those that document numerical decline. Annual scientific research surveys by government agencies are specifically designed to monitor annual change in abundance of demersal fishes. The same data can also provide useful information on change in mean size and whether species range has contracted or shifted.

Scientific research data from random-stratified trawl surveys from the Scotia-Fundy, Newfoundland and northern Gulf of St. Lawrence regions were provided by Fisheries and Oceans Canada. The number of individual tows in any one year varies depending on region but is in the hundreds for the Scotian Shelf and greater than one thousand for the Newfoundland region. Both positive (where *Brosme* were caught) and negative data were provided. Typically, one standardized 30-minute tow is done at each randomly selected sampling site (fishing station). Data from Mont-Joli for the northern Gulf of St. Lawrence confirms reports that *Brosme* is indeed rare in the Gulf. Just 2 fish were collected and these come from the Port aux Basques area of Newfoundland, just inside the Gulf. *Brosme*



have not been caught in research vessel surveys in the southern Gulf of St. Lawrence since 1970 (D. Swain, Department of Fisheries and Oceans, Moncton personal communication). *Brosme* from the northern and southern Gulf of St. Lawrence are therefore not included in this status report given their rare status there.

Data provided for the Newfoundland region also confirm observations of Bigelow and Schroeder that *Brosme* are rare north of the Laurentian Channel. Only 39 specimens were caught at the >15,000 stations sampled from 1978-2001. Data provided by the Department of Fisheries and Oceans in St. Andrews, New Brunswick show the core distribution of *Brosme* is located in the Gulf of Maine and southern Scotian Shelf, between latitudes 41-44°N where greater than 2700 *Brosme* were caught in the more than 10,000 stations sampled from 1970-2001 in 78 research cruises (Fig. 1).

The mean number of *Brosme* per tow or catch per unit effort (CPUE) from research vessel surveys is used as an index of population size. There has been one consistent survey done each year in July in the Scotia - Fundy region where most *Brosme* in Canadian Atlantic are found. Some changes have been made to the survey over the years. These include changes to fishing vessels and sampling gear (e.g., 1983). The survey covers most of the Scotian Shelf, the eastern Gulf of Maine and upper slope but does not cover shallow inshore areas and the deep water between German and Browns Banks. Four additional bottom trawl surveys (spring, autumn, cod, Georges Bank) have also been done on the Scotian Shelf, though for much shorter periods of time (several years). *Brosme* have been caught in these surveys and they have been included in some of the analyses that follow.

Two surveys are done each year in the Newfoundland region. The spring survey in March to June samples the Grand Bank, south coast of Newfoundland and the upper slope of the continental shelf. A second survey samples off Labrador and northeast Newfoundland in August to November. Scotia-Fundy and Newfoundland indices of abundance have been calculated separately. Each index is calculated as the total number of *Brosme* caught in a given year divided by the total number of stations sampled in that year.

Percent decline is calculated as  $1 - e^{(b \cdot t)}$  throughout this report.  $t$  refers to time in years and  $b$  is the slope of the regression of the natural log ( $\ln$ ) of survey CPUE plotted against year.

## Population trends

Survey data from the Scotia-Fundy region indicate a decline in CPUE beginning in about the late 1970s - early 1980s (Fig. 3). CPUE initially averaged 0.6 *Brosme* per tow in the early to mid-1970s and declined to 0.08 during the period 1995 to 2001. Over the full period, 1970 to 2001, 32 years or about 3.5 *Brosme* generations, CPUE declined by 93.4%. The decline is 90.0% for three generations (27 years) of *Brosme*. Percent declines calculated for the Scotia-Fundy region are based on the July research vessel survey data only.

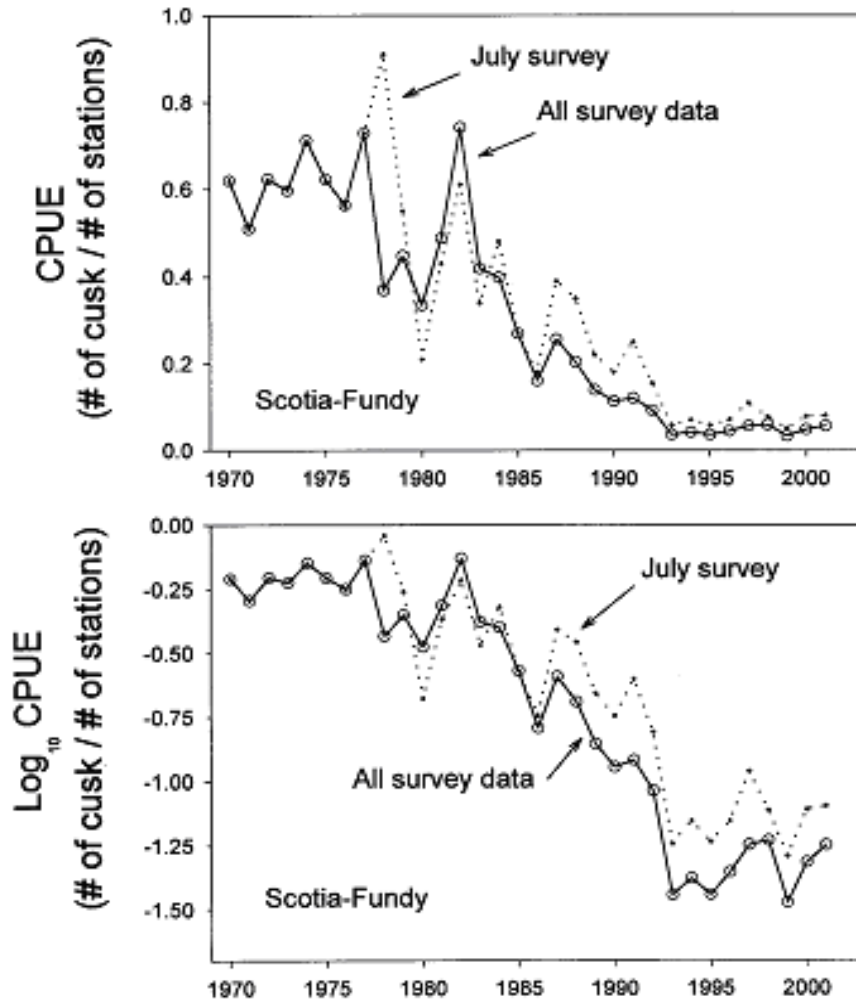


Figure 3. Catch per unit effort of *Brosme* from standardized research vessel surveys in the Scotia-Fundy region (1970-2001). All survey data — includes the July survey as well as four additional shorter time series (spring, autumn, George Bank, 4vw cod).

Population estimates for *Brosme* >50 cm (c. 50% maturity based on 1970s data in Odham and in Beacham) from the Scotian Shelf closely follow declines in survey CPUE. A decline of 95.5% from 1970-2001 (Fig. 4) was observed. The population estimate for the number of mature fish from the Scotia-Fundy region is provided by Harris et al (2002, Fig. 27) and is approximately three million fish in the mid 1970s. This declined throughout the 1980s and reached historic lows in the 1990s. Harris et al. (2002) estimate the current (2001) population size of mature individuals (c. >50 cm) to be 314,520. This is a one order of magnitude decline in number of mature fish since the 1970s. They caution, however, that the 2001 estimate is based on a small sample size. Further caution is warranted given that the catchability of cusk to the research vessel fishing gear although unknown is considered to be low and that some of the cusk habitat is not fully sampled. For example, shallow coastal waters and depths >500-600 m are seldom sampled.

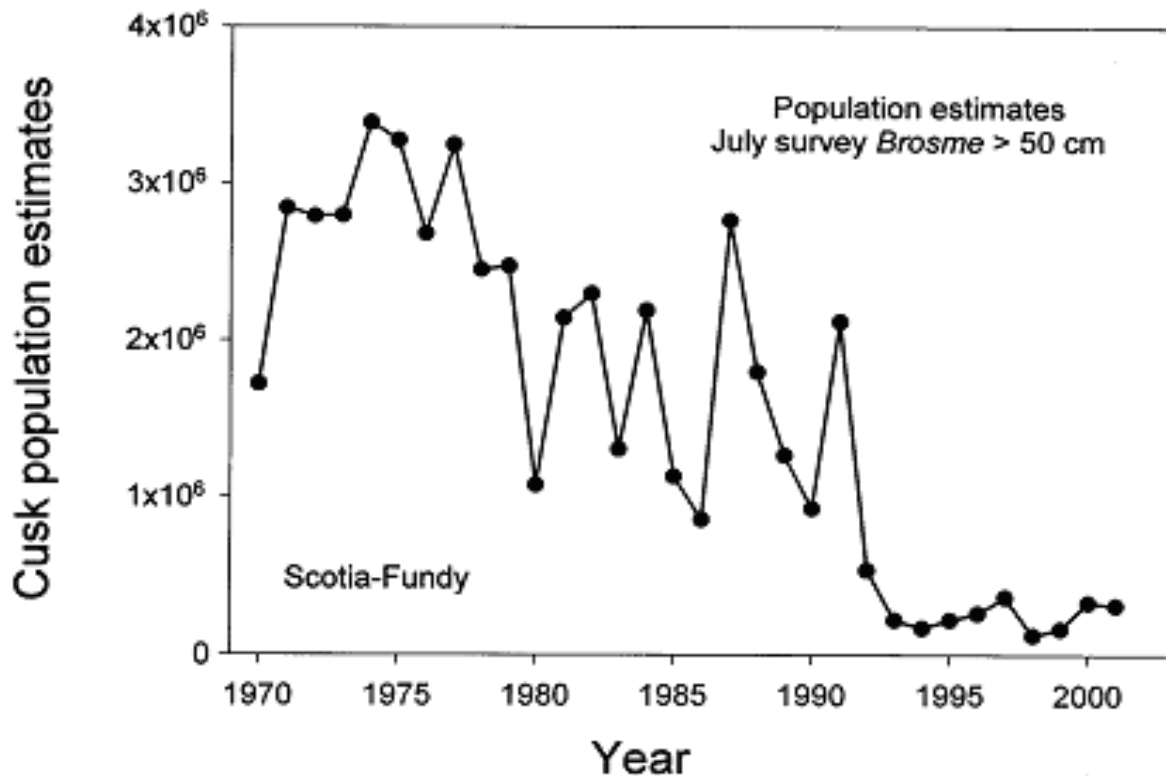


Figure 4. Population estimates (1970-2001) provided by STRAP analyses of Scotia-Fundy July research vessel trawl data for *Brosme* >50 cm.

Survey data for *Brosme* from the Newfoundland region indicate catch per tow was initially very low to begin with, 0.026 in 1978. CPUE declined to 0.001 in 2000. No *Brosme* were caught in the Newfoundland surveys in 1987, 1990-1992, 1998, and 2001. CPUE is low because *Brosme* are close to their northern limit in the Newfoundland region (Scott and Scott 1988, Cohen 1990) and this is reflected in the very few fish caught (n=39) in the entire period from 1978-2001. Over the full period that data are available, 1978-2001, 23 years or 2.5 cusk generations, the number per tow declined by 90.1%. This rate of decline is based on 39 *Brosme* from the Newfoundland region and caution is warranted given the small sample size. The percent decline for the Newfoundland region is calculated despite the low sample size because it mirrors declines from other regions where higher catch rates were observed.

The core of the *Brosme* distribution in the western Atlantic occurs between 41-44°N in the Gulf of Maine, southern Scotian Shelf and entrance of the Bay of Fundy (DFO Stock Status Report A3-35 2000). The core distribution straddles international boundaries in the Gulf of Maine and Georges Bank where *Brosme* are surveyed by both the National Marine Fisheries Service (O'Brien 2000) and the Department of Fisheries and Oceans. CPUE of *Brosme* from research vessel surveys in the Gulf of Maine was ca. 0.25 individuals per tow in the 1970s (Fig. 5). CPUE decline began in the 1980s and continued until 1994, the last year of data for the ECNASAP data set. Over the 25 years

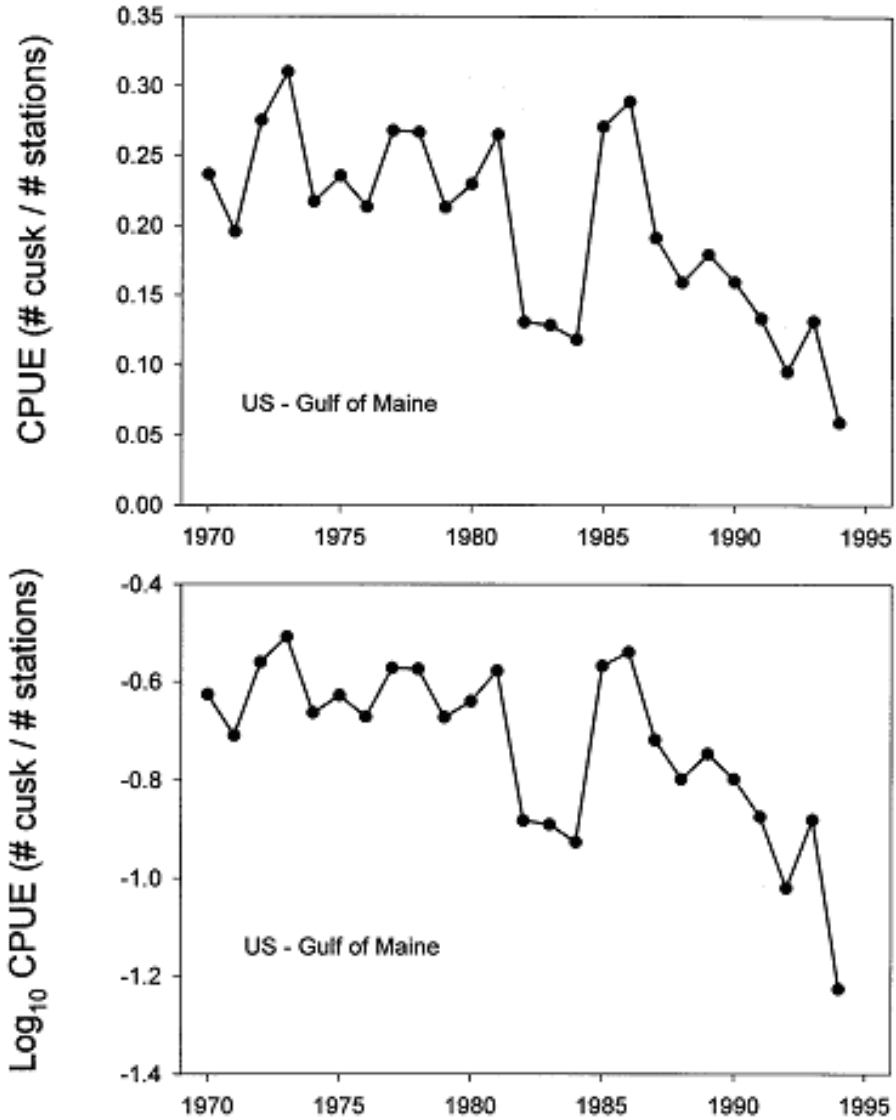


Figure 5. Catch per unit effort of *Brosme* from standardized research vessel surveys in the gulf of Maine region (1970-1994) based on ECNASAP survey data (see text).

(1970-1994) or almost 3 generations, the number of *Brosme* per tow declined by 60.2%. Updated information by O'Brien for the Gulf of Maine (Fig. 6) shows the Gulf of Maine population has remained at low levels with 1998 (the last year in the data series) being the lowest catch recorded. A more recent and more complete analysis of percent decline was calculated with data from the Georges Bank and Gulf of Maine Area for the period 1964 to 2001. These data were provided by L. O'Brien (NMFS-Woods Hole) and are summarized in Figures 6.1 and 6.2. Over the full period that data are available, 1964 to 2001, 38 years or 4.2 cusk generations, the number per tow declined by 76.15%. These data have been included in this report because *Brosme* straddles international boundaries in the Gulf of Maine and Georges Bank region. It suggests that a "rescue effect" for the Scotia-Fundy region is unlikely.

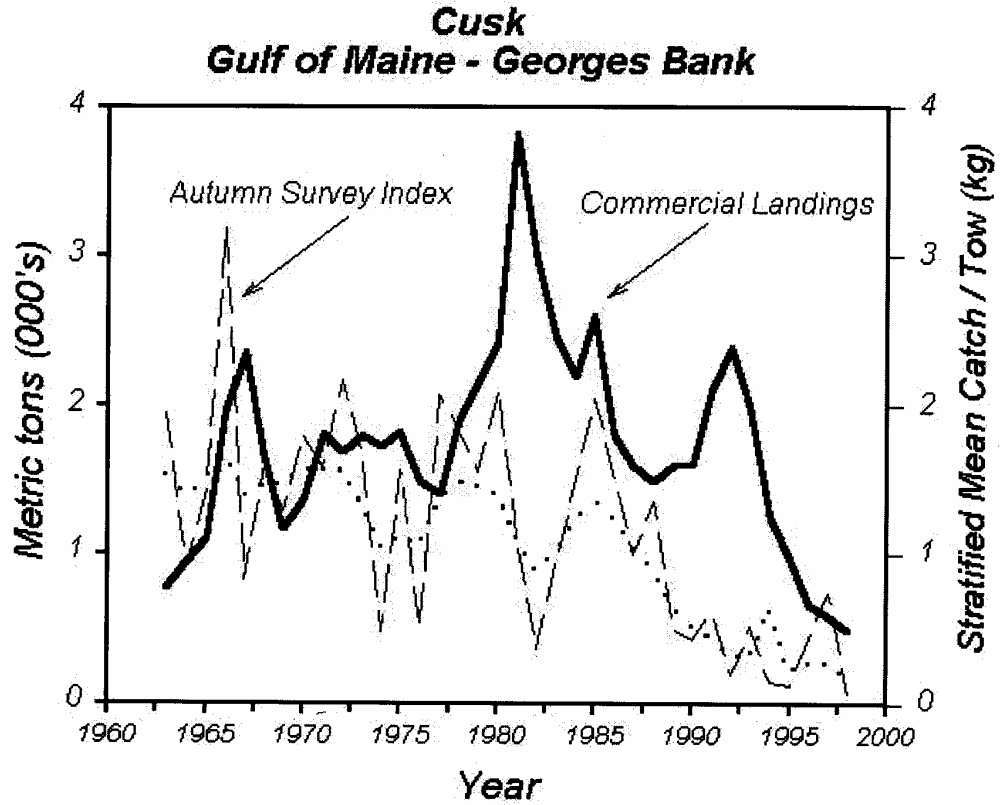


Figure 6. Commercial landings and stratified mean catch per tow of cusk from autumn research vessel surveys by the National Marine Fisheries Service. This figure is from O'Brien (2000; <http://www.nefsc.noaa.gov/sos/spsyn/og/cusk/>).

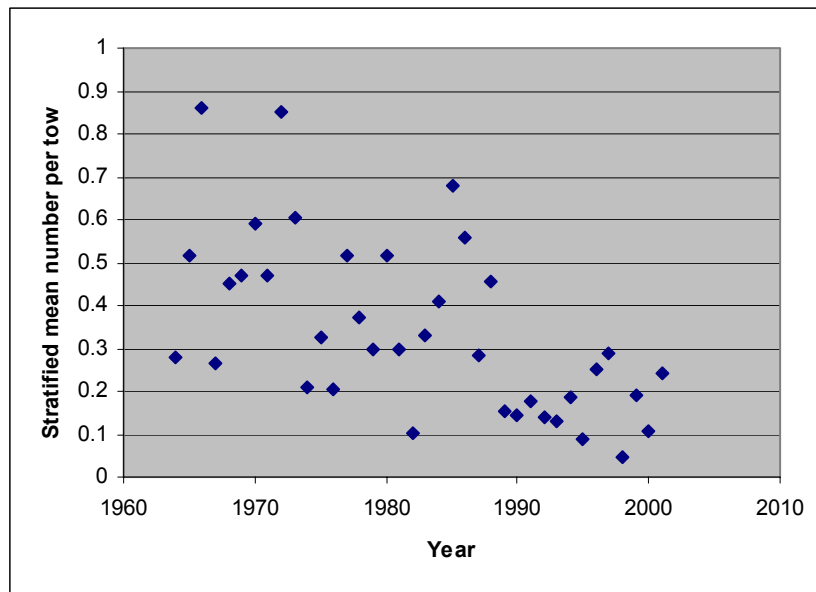


Figure 6.1. Stratified mean number per tow of *Brosme* from the Gulf of Maine and Georges Bank region. Data provided by L. O'Brien, NMFS-Woods Hole.

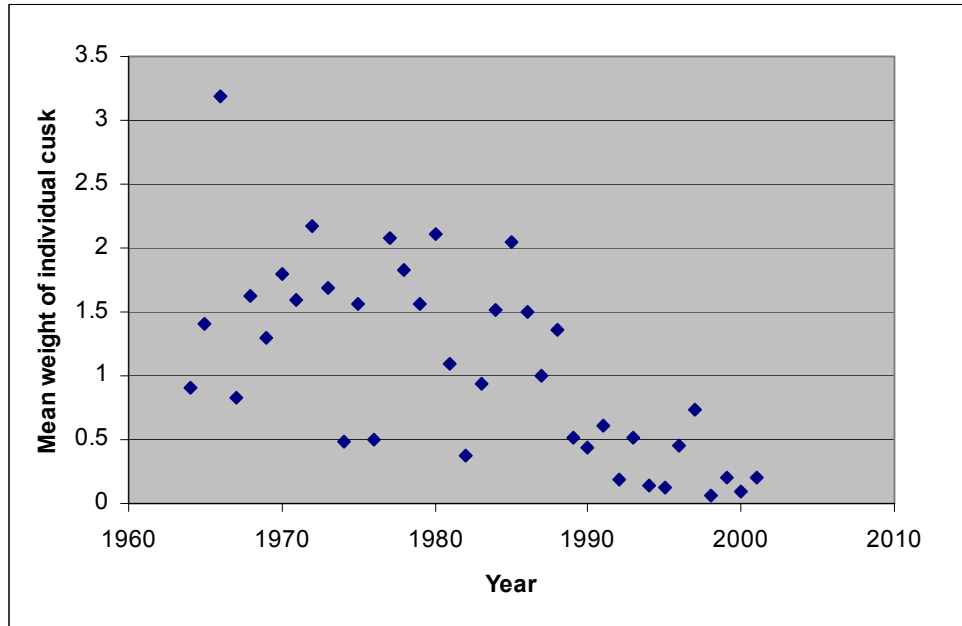


Figure 6.2. Mean weight of *Brosme* per tow from the Gulf of Maine and Georges Bank region. Data provided by L. O'Brien, NMFS-Woods Hole.

Research vessel survey data combined from all sources (Gulf of Maine, Scotia-Fundy and Newfoundland) for all *Brosme* from the northwest Atlantic are summarized in the ECNASAP data in Figure 6. CPUE was ca. 0.21 individuals per tow in the early 1970s and declined steadily throughout the period reaching 0.02 individuals per tow in 1994. Over the full period 1970-1994, 25 years or almost 3 generations, the number per tow declined by 90.4% (Fig. 7).

Other indicators of cusk status are briefly discussed below. These include:

- i. spatial distribution in the Scotia-Fundy region,
- ii. percentage of (positive, non-zero) stations that collected at least one *Brosme*,
- iii. weight and length of individual *Brosme* and proportion of mature fish taken each year
- iv. commercial data.

### Spatial distribution

The spatial distributions of *Brosme* from the Scotia-Fundy and Gulf of Maine regions are shown in Figure 8 for 32 years of research vessel data (1970-2001). This figure is at <http://cephbase.biology.dal.ca/gmbis/aconscripsts/GroundfishSurveyMap.html>. Figure 8 and the DFO Stock Status Report show “few *Brosme* are distributed along the seaward edges of Sable Island and Western, Emerald and Banquereau Banks after 1991.” The

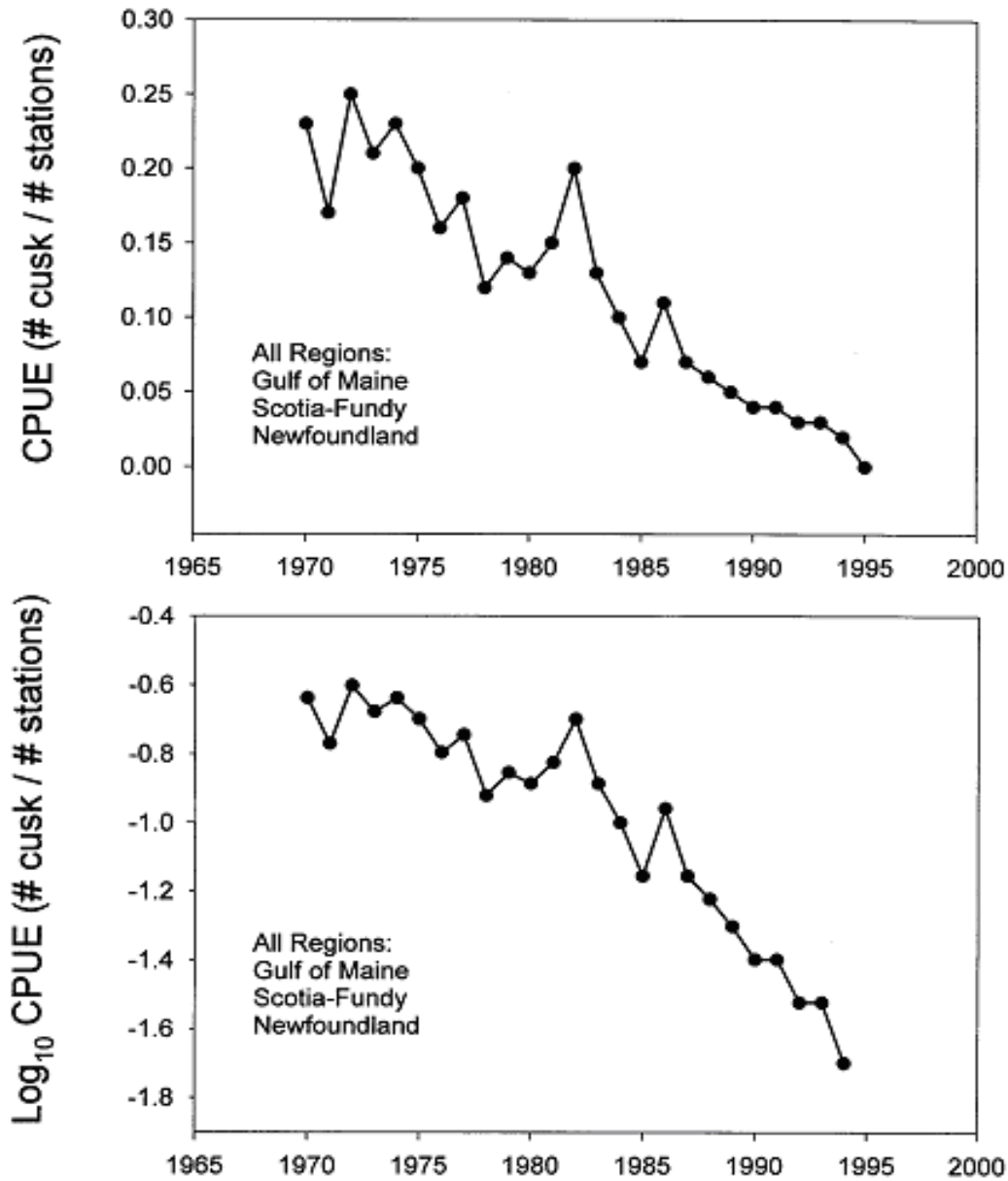


Figure 7. Catch per unit effort of *Brosme* from all regions of the northwest Atlantic where *Brosme* are located (1970-1994) based on ECNASP survey data (see text).

reduction in area occupied by *Brosme* is quantified in Figure 24 of Harris et al. (2002). Their study shows the proportion of the survey area with 75% of the total catch declined steadily from ca. 10% in the early 1970s to ca. 2.0% in 2001. This means *Brosme* are being taken in a smaller area each year on the Scotian Shelf. Ten percent (early 1970s) and two percent (2001) of the Scotia-Fundy management zone (46,890 square nautical miles; Gulf of Maine and Scotian Shelf) is equivalent to 4689 and 937 square nautical miles respectively. This represents an order of magnitude change in the spatial distribution of *Brosme* over a 25-30 year period on the entire Scotian Shelf.



Figure 8 (this study) indicates that the cusk population is contracting towards NAFO region 4X in the southern Scotian Shelf. This suggests that 4X will be among the last regions to show declines in biomass of *Brosme*. This suggestion is confirmed in Figures 25 and 26 of Harris et al. (2002) who report on the range and prevalence of cusk in the longline fishery of 4X from 1991 to 2001. Range is defined by the proportion of 5-minute square units where cusk was reported. Prevalence is defined as the proportion of commercial trips that reported cusk. When both range and prevalence are plotted from 1991 to 2001 they show little change, both plots are relatively flat (Fig. 26 Harris et al. 2002) showing no significant change in the spatial distribution of *Brosme* within NAFO Division 4X, a region generally thought to represent the core or central part of cusk's distribution (DFO Stock Status Report A3-35 2000).

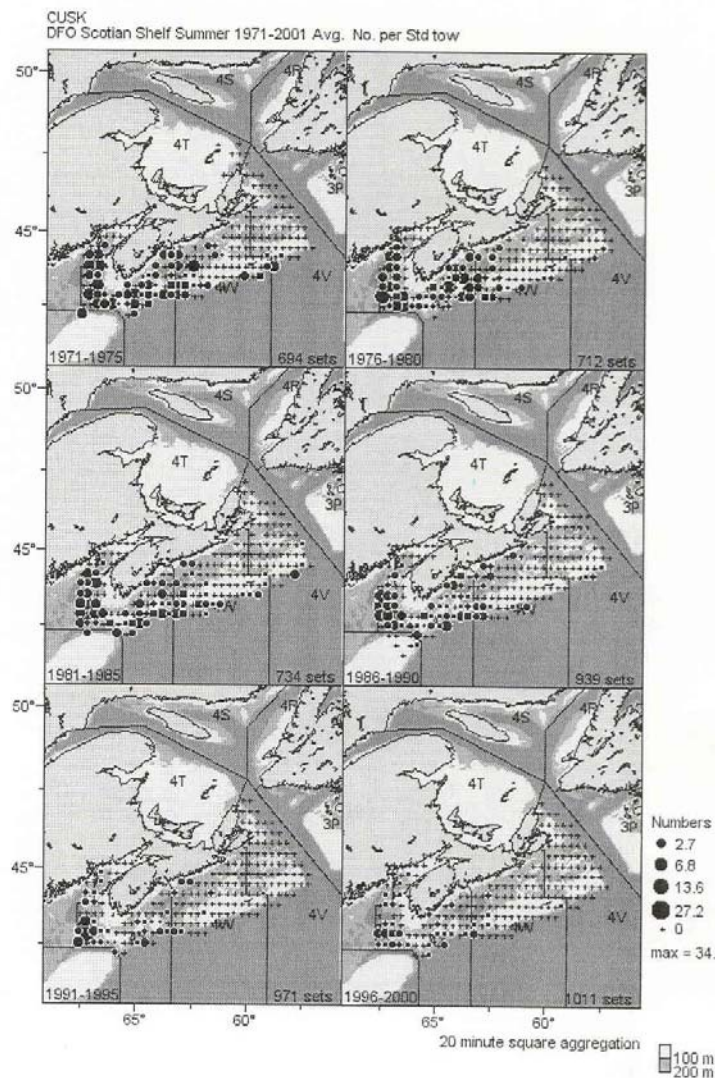


Figure 8. Spatial distribution of *Brosme* from the Scotia-Fundy region (1971-2000). (<http://cephbase.biology.dal.ca/gmbis/aconscripts/GroundfishSurveyMap.html>).



## Proportion of positive stations

The proportion of survey stations that captured at least one *Brosme* is another index of area occupied. This index is highly correlated with cusk abundance. Figure 9 of this report in addition to the DFO Science Stock Status Report for 2000, indicates a steady decline in this index beginning in the late 1980s. Approximately 10-20% of all sampling stations in any given year caught at least one *Brosme* from 1970 to the late 1980s. This index declined from 19% in 1988 to 3% in 2001 for the July Scotian Shelf research vessel survey (Fig. 9). Four other Scotian Shelf surveys (of shorter duration) show findings similar to the July survey (Fig. 9).

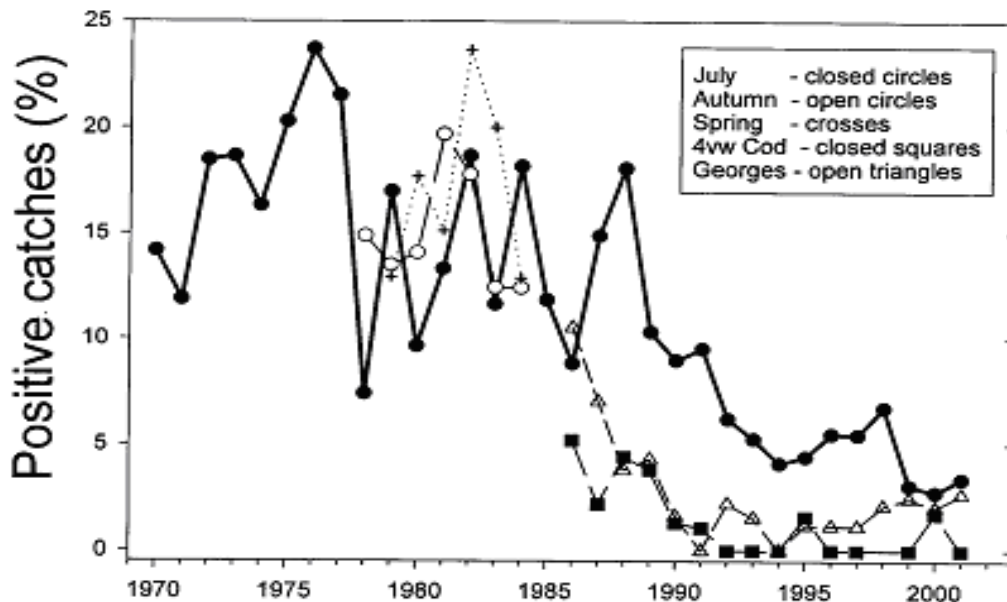


Figure 9. Proportion of catches with *Brosme* from all research vessel surveys in the Scotia-Fundy region (July, spring, autumn, Georges bank and 4vw cod).

The reduction in spatial distribution and decline in proportion of positive stations occurs at approximately the same time (late 1980s) for *Brosme* in the Scotia-Fundy and Gulf of Maine regions. These observations in addition to declines in number taken each year were key information leading to the following statements in the 2000 DFO Science Stock Status Report, "Given the apparent collapse of the *Brosme* population since 1992, immediate and substantial restrictions on *Brosme* landings are required. Elimination of the directed fishery is necessary."

Strong and Hanke (1995) in a separate study of Scotian Shelf fishes (but using much of the same data), also list *Brosme* among those species showing pronounced declines in the proportion of stations. Pronounced declines also occurred in smooth skate (*Raja senta*), thorny skate (*Raja radiata*), monkfish (*Lophius americanus*), haddock (*Melanogrammus aeglefinus*) and wolffish (*Anarhichas lupus*) in addition to cusk (*Brosme Brosme*).

## Number of mature fish

The mean weight of individual *Brosme* (estimated from over 2700 fish caught on the Scotian Shelf RV surveys) has been declining since 1989 (DFO Stock Status Report A3-35 2000, Harris et al. 2002, Fisheries Resource Conservation Council 2002). This observation is consistent with overexploitation in a size selective fishery such as longlines, which target larger fish. Weights of individual fish averaged ca. 3 kg in the early 1970s and ca. 1.5 kg in the late 1990s. This is a 50% reduction in weight over a 25-30 year period. Number of fish >50 cm is also decreasing. Fish greater than 50 cm are mostly spawners. Harris et al. (2002, Fig. 28) show the proportion of spawners has steadily declined on the Scotian Shelf. Greater than 80% of the *Brosme* taken in the 1970s were >50 cm. This has declined to less than 60% in recent years (c. 2000). This decline represents an order of magnitude change in the number of mature fish, from ca. three million in the early 1970s to ca. 314,520 in 2001.

A similar decline in average weight per tow is observed for Gulf of Maine – Georges Bank region cusk (Fig. 6.2). These data (from O'Brien NMFS Woods Hole) show mean weight of individual cusk increased over the period 1964 to about the mid-1970s. From the mid-1970s mean weight of cusk per tow declined from about 1-5 to 2.0 kg to about 0.2-0.4 kg per tow in the late 1990s.

## Commercial fishery data

Emphasis in this report is placed on the longest time series available – that being the DFO research vessel ground fish survey. This is a 30+ year time series and consequently receives the most coverage in this report and by Harris et al. (2002).

Commercial fishery and industry survey information are also available. This information is discussed below because it represents an additional source of information based on long lines, stationary sampling equipment that can be deployed in a variety of habitats including deep water along the edge of the continental shelf and in rocky bottom regions that may not be well sampled by the trawl on DFO research vessels. It is generally acknowledged that *Brosme* are relatively sedentary and 'prefer' hard bottom habitats where the catchability of cusk to bottom trawl gear may be reduced.

Information from the commercial fishery has been summarized in Figures 10-15, 25, and 26 of Harris et al. (2002) and are based primarily on long line catches. Catch data presented in Figures 10 and 11 of Harris et al. (2002) show no obvious trends (consistent with the DFO July research vessel data for the same time period) and encompass time frames that are too short to be useful (1995-2001, 1998-2001 respectively). Figure 14 of Harris et al. (2002), reproduced in this report as Figure 10 appears to show a 50-60% decline rate between the late 1980s and present day. The DFO research vessel data for the same time period (Fig. 3 of this report) indicate roughly a 75% decline. These two decline rates are similar for the time period considered, especially given that commercial CPUE typically under-estimate actual trends in abundance. Harris et al. (2002) imply based upon anecdotal information "that

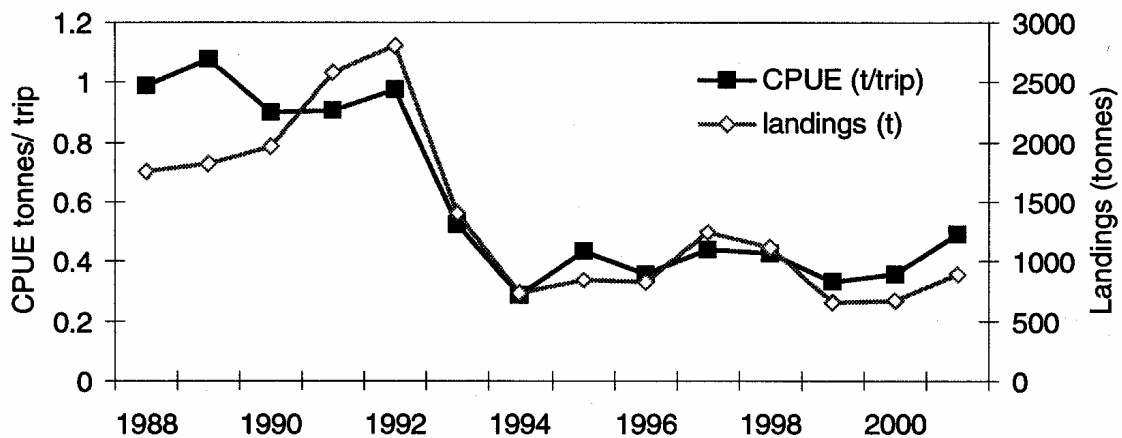


Figure 10. Cusk catch rate and landings for groundfish longliners in 4X(mnopqr). This figure is from Figure 14 of Harris et al. (2002).

there was much misreporting of cusk in the landing data before 1999. Until 1999 cusk catches were unregulated and so other species were landed as cusk when quotas were exceeded.” If true, there should have been a marked change in CPUE between 1998 and 1999 – yet none is evident indicating any misreporting alluded to had no discernable effect on catch rate.

Commercial catch data evident in Figure 14 of Harris et al. (2002) are for the 4X area of the Scotian Shelf – southwest Nova Scotia and the Bay of Fundy. The distribution of cusk caught in this area over a 12 month period from January to December 2001 is shown in detail for NAFO Div. 4X in Figure 25 of Harris et al. (2002). The southwest portion of the Scotian Shelf appears to be the region that cusk is most abundant given the contraction in spatial distribution that is evident in Figure 8 herein.

Figure 15 of Harris et al. (2002) also shows commercial landings of cusk from Canadian waters and all sectors of the fishery declined by about 4/5<sup>ths</sup> from about 5000 tonnes in the early 1970s to about 1000 tons in 2000 (Fig. 15, Harris et al. 2002). The extent to which these commercial data are valid or are not valid cannot be assessed by the author given the misreporting of cusk in the landings data before 1999 (Harris et al. 2002). If these data reflect actual landings of cusk then trends evident in the commercial data are consistent with trends presented in this report and with the DFO Stock Status Report (2000), both of which show substantial declines in abundance of *Brosme* (c. 90%). If commercial landings data are not accurate they should not be considered further.

Distributional information on cusk is presented in Figures 12 and 13 of Harris et al. (2002). This information is based on the commercial index and on fixed survey sets of the halibut industry survey over a short time period from 1998-2001. Most fishing effort for halibut in the commercial index portion of the fishery is primarily done at depths <500 m along the slope of the continental shelf off Nova Scotia. This is as deep as the

fishery generally extends and is within the depth range sampled by DFO research vessels during the summer ground fish survey. These distributional plots show *Brosme* can be taken in relatively deep water and that it seems that catch density was less in 2001 than in 1998, especially in the shallower portions of the western Scotian Shelf (62-64° W) (Fig. 12, Harris et al. 2002). The fixed site portion of the halibut industry survey, where fishing effort is more dispersed on the Scotian Shelf and along the edge of the shelf show three important features of cusk distribution that are all evident in Figure 1 and especially Figure 8 of this report: 1. that cusk occur on the southwest portion of the Scotian Shelf, 2. that cusk are virtually non-existent on the eastern Scotian Shelf, and 3. that cusk are present in a narrow strip along the continental slope of the eastern and western Scotian Shelf with minor amounts being taken on the southern slope of Grand Bank. Deep water of the continental slope (>500 m) off Nova Scotia is not regularly sampled by DFO research vessels. It was only from 1995 to about 2000 that 2-4 sites deeper than about 500 m were sampled by DFO each year. *Brosme* were taken at depths >500 m but catches were very low compared to shallower depths sampled by DFO research vessels (Table 1, Figure 2 this report).

**Table 1. Upper columns show the number of fishing stations by depth and temperature sampled on the Scotian Shelf 1970-2001. Lower columns show the number of stations that caught *Brosme* for each depth and temperature category.**

Depth/T°C	0	2	4	6	8	10	12	14	16	18	Sum	%
100	65	705	1016	1124	638	391	144	31	15	2	4131	50.86
200	10	243	404	487	770	733	200	17	1	1	2866	35.28
300	0	40	74	92	297	337	38	4	0	0	882	10.86
400	0	0	1	53	88	35	1	0	0	0	178	2.19
500	0	0	0	52	0	0	0	0	0	0	52	0.64
600	0	0	0	14	0	0	0	0	0	0	14	0.17
Sum	75	988	1495	1822	1793	1496	383	52	16	3	8123	100.00
%	0.92	12.16	18.40	22.43	22.07	18.42	4.72	0.64	0.20	0.04	100	
Depth/T°C	0	2	4	6	8	10	12	14	16	18	Sum	%
100	0	2	24	27	21	17	3	0	2	0	96	10.45
200	0	3	16	68	197	202	56	2	0	0	544	59.19
300	0	0	2	11	94	112	6	0	0	0	225	24.48
400	0	0	0	8	31	11	1	0	0	0	51	5.55
500	0	0	0	1	0	0	0	0	0	0	1	0.11
600	0	0	0	2	0	0	0	0	0	0	2	0.22
Sum	0	5	42	117	343	342	66	2	2	0	919	100.00
%	0.00	0.54	4.57	12.73	37.32	37.21	7.18	0.22	0.22	0.00	100	

## LIMITING FACTORS AND THREATS

Fishing is an important source of mortality for *Brosme* (DFO Stock Status Report 2000, O'Brien 2000, Fisheries Resource Conservation Council 2002). Although there is some directed fishing, *Brosme* is mainly caught as bycatch in cod, haddock, pollock and halibut longline fisheries (Harris et al. 2002). *Brosme* was placed under bycatch limitations for the first time in 1999 (DFO Stock Status Report 2000) on the Scotian Shelf. The Fisheries Resource Conservation Council (2002) states "the current restricted bycatch should be made more restrictive to avoid further deterioration of this stock and to continue to assist in rebuilding efforts." Humans, hooded seals, cod, halibut and several other fish species including dogfish seem to be the only recorded predators of *Brosme* (Jensen 1948, Bowen et al. 1993, Rountree 1999). Larvae have been recorded from the stomachs of *Limanda ferruginea* yellowtail flounder at a single site on Georges Bank (Collie 1987).

Fishing has resulted in an average catch of 3469 tons of *Brosme* annually ranging from a maximum of 5130 tons in 1973 to a low of 90 tons in NAFO Division 4X in 1999 (DFO Stock Status Report 2000). Cusk was placed under bycatch limitations in 1999 with a cap of 1000 tons being placed on the combined landings of all fleets. Approximately 80% of landings come from NAFO fishing area 4X in the vicinity of the Bay of Fundy, southwest Nova Scotia and offshore in the Browns Bank area. The stock was last fully assessed in 1998 (DFO Stock Status Report 2000). The 1998 stock status report and the updates in 2000 and 2001 indicate "landings have remained below the long-term average since 1993. Landings in 2000 were 800 tons and have increased in 2001 to over 1000 tons".

Coincident with reduced landings are declines in both length and weight of *Brosme* taken since the late 1970s (Harris et al. 2002). Recent values of individual weights and numbers of *Brosme* captured are the lowest recorded. The declining landings and the negative indicators outlined above resulted in a quota of 1000 tons being placed on the stock in 1999. "Many of these characters and trends are present in other species although not to the extent seen in *Brosme* since 1992," at which time the Department of Fisheries reported that the stock abruptly collapsed. The Fisheries Resource Conservation Council (2002) notes, "Despite recommendations and restrictions to limit by-catch, indications are *Brosme* landings will easily exceed 1000 tons in the 2001-2002 fishing year".

The core distribution of *Brosme* straddles the Canada-United States border. The trends observed above for Canada are in many respects similar to those observed in the United States (O'Brien 2000). The cusk fishery in the United States is not under management. Bottom trawls have accounted for most of the historical catch (50-87%) but long lines appear to have become increasingly more important. The fishery is largely confined to the Gulf of Maine where relatively stable landings of 1,700 metric tons were experienced in the late 1960s and early 1970s (O'Brien 2000). Commercial landings increased in the late 1970s to mid-1980s before declining rapidly in 1981. O'Brien (2000) states "The ratio of commercial landings to the autumn research vessel survey

index has been increasing since 1986, implying increased exploitation. The stock appears to be overexploited and is at a low biomass level.” US landings in 1998 were ca. 500 metric tons compared to ca. 1,500 for Canada.

### **SPECIAL SIGNIFICANCE OF THE SPECIES**

*Brosme* is a monotypic genus. *Brosme Brosme* is therefore the only animal species that occurs worldwide in the genus.

In the western north Atlantic *Brosme* is found primarily between latitudes 41 to 44°N. This is a very restricted spatial distribution for a continental shelf gadid off the east coast of Canada and the United States. Most have a much broader spatial coverage. *Brosme* is rare to the north of 44°N and to the south of 41°N. Hence, the only concentration in the western Atlantic occurs in the Gulf of Maine and southern Scotian Shelf. There is no information available on the newly settled stages of *Brosme*. This stage is not listed in any studies from inshore or offshore locations.

*Brosme* is not reported to make extensive spawning migrations or to have well defined spawning grounds. Area closures to protect the species during spawning when it is aggregated may therefore be difficult to establish. Nursery habitat (location) information is also lacking. It is not known if juveniles concentrate in specific nursery locations as other gadids do.

### **EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS**

*Brosme* is not listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or by the International Union for the Conservation of Nature (IUCN) and is being reviewed in this status report for the first time. *Brosme* from the Scotia-Fundy region are managed by the Department of Fisheries and Oceans but are not fully assessed each year. The most recent full assessment was done in 1998. Bycatch limitations were established for the first time in 1999 with 1000 tons being placed on the combined landings of all fleets in the Scotia-Fundy region.

### **SUMMARY OF STATUS REPORT**

In this report, *Brosme* are considered to be a single population. In the western Atlantic the center of distribution is between 41° and 44°N (Gulf of Maine, southern Scotian Shelf). This distribution straddles the Canada-United States border. The general biology is poorly known, e.g., nursery areas for juveniles and spawning areas for adults, if they exist, are not known. Adults are demersal, slow-moving, sedentary and solitary, and do not form large aggregations or schools. The maximum length is 100-110 cm.

Eighty percent of commercial fishing landings come from NAFO area 4X (Bay of Fundy, southwest Nova Scotia, Browns Bank). There is some directed fishing but most *Brosme* appear to be taken as bycatch, usually on long line. Landings have remained below the long-term average since 1993 and are at historic lows in recent years. Research vessel surveys in the Scotia-Fundy area also show historically low catch rates from the early 1990s and onwards.

Survey data from the Scotia-Fundy region indicate a decline in CPUE of *Brosme* beginning in about the late 1970s to early 1980s. Over the full period, 1970-2001, 32 years or 3.5 *Brosme* generations, CPUE declined by 93.4%. Population estimates for adults (>50 cm) closely followed declines observed for CPUE. A decline of 95.5% from 1970-2001 (Fig. 4) was observed. The population size of mature fish (>50 cm) was estimated at 314,520 individuals in 2001. This is an order of magnitude decline from estimates of three million in the mid-1970s. In the Newfoundland region, over the full period that data are available, 1978-2001, 23 years or 2.5 generations, the number per tow declined by 90%.

In the Gulf of Maine, from 1970-1994, 25 years or almost 3 generations, the number of *Brosme* per tow declined by 60%. Updated information (1964-2001) shows a percent decline of 75% and indicates the cusk population still remains at low levels with 1998 and 2000 having the lowest catches on record.

Taken collectively, research vessel survey data for all sources (Gulf of Maine, Scotia-Fundy and Newfoundland) show a 90% decline in CPUE from 1970-1994.

Changes in the spatial distribution, in weight and length of individual *Brosme* and in the proportion of mature fish taken each year are also indicators of the status of the *Brosme* population. *Brosme* on the Scotian Shelf are now being taken in a smaller area each year. There is an order of magnitude change in the spatial distribution from 1970-2001. The mean weight of individual fish is also declining on the Scotian Shelf. Weights of individual fish averaged ca. 3 kg in the early 1970s and ca. 1.5 kg in the late 1990s. This is a 50% reduction in a 25-30 year period. Number of mature fish (>50 cm) is also decreasing and shows an order of magnitude change from ca. three million in the early 1970s to 314,520 in 2001.

## TECHNICAL SUMMARY

**[Scientific name] *Brosme Brosme***

[Common name (English)] **cusck**

[Common name (French)] ***Brosme***

[Population name (if applicable)] **southern Scotian Shelf - Gulf of Maine**

[Range of Occurrence in Canada (by province / territory / ocean)] **Atlantic Ocean**

<b>Extent and Area information</b>	
<ul style="list-style-type: none"> <li>• <i>extent of occurrence (EO)(km<sup>2</sup>)</i></li> </ul>	Canadian range is Gulf of Maine to northern Labrador
<ul style="list-style-type: none"> <li>• <i>specify trend (decline, stable, increasing, unknown)</i></li> </ul>	Decline on Scotian Shelf, Gulf of Maine and NF (NF shows decline based on small sample size)
<ul style="list-style-type: none"> <li>• <i>are there extreme fluctuations in EO (&gt; 1 order of magnitude)?</i></li> </ul>	General decline observed on Scotian Shelf (1970-2001) for DFO research vessel data. Decline not observed in 4X, central core of cusk distribution based on analyses of longline fishery data (1991-2001) by Harris et al. (2002).
<ul style="list-style-type: none"> <li>• <i>area of occupancy (AO) (km<sup>2</sup>)</i></li> </ul>	75% of the Scotian Shelf population is estimated to occur within 937 square nautical miles. Estimate based on 30+ years of RV survey data. Decline not observed in 4X (see above and text on page 13)
<ul style="list-style-type: none"> <li>• <i>specify trend (decline, stable, increasing, unknown)</i></li> </ul>	Decline observed for entire population on Scotian Shelf. Stable trend observed for 4X.
<ul style="list-style-type: none"> <li>• <i>are there extreme fluctuations in AO (&gt; 1 order magnitude)?</i></li> </ul>	1 order magnitude decline observed on Scotian Shelf, 1970-2001 based on RV surveys.
<ul style="list-style-type: none"> <li>• <i>number of extant locations</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>specify trend in # locations (decline, stable, increasing, unknown)</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>are there extreme fluctuations in # locations (&gt;1 order of magnitude)?</i></li> </ul>	Unknown
<ul style="list-style-type: none"> <li>• <i>habitat trend: specify declining, stable, increasing or unknown trend in area, extent or quality of habitat</i></li> </ul>	Unknown
<b>Population information</b>	
<ul style="list-style-type: none"> <li>• <i>generation time (average age of parents in the population) (indicate years, months, days, etc.)</i></li> </ul>	Approximately 9 y
<ul style="list-style-type: none"> <li>• <i>number of mature individuals (capable of reproduction) in the Canadian population (or, specify a range of plausible values)</i></li> </ul>	Estimated at 314,520 (2001) based on RV surveys (30+ y). Estimate may be conservative – RV survey samples only part of the distribution (inshore rocky area not sampled, depths > 500-600 m poorly surveyed)
<ul style="list-style-type: none"> <li>• <i>total population trend: specify declining, stable, increasing or unknown trend in number of mature individuals</i></li> </ul>	Total population and number mature declining
<ul style="list-style-type: none"> <li>• <i>if decline, % decline over the last/next 10 years or 3 generations, whichever is greater (or specify if for shorter time period)</i></li> </ul>	93% decline (1970-2001) for Scotia-Fundy region. 32 y is ca. 3.5 generations – based on RV surveys (30+ y)
<ul style="list-style-type: none"> <li>• <i>are there extreme fluctuations in number of mature individuals (&gt; 1 order of magnitude)?</i></li> </ul>	Proportion mature declined from >80% in 1970s (c. 3 million) to <60% in 2001 (c. 314,520). 1 order of magnitude decline.



<ul style="list-style-type: none"> <li>• <i>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., <math>\leq 1</math> successful migrant / year)?</i></li> </ul>	Bulk of population located between 41-44°N latitude, rare to the north and south
<ul style="list-style-type: none"> <li>• <i>list each population and the number of mature individuals in each</i></li> </ul>	Scotia-Fundy, 314,520 mature, estimated in 2001
<ul style="list-style-type: none"> <li>• <i>specify trend in number of populations (decline, stable, increasing, unknown)</i></li> </ul>	Population considered a single ESU
<ul style="list-style-type: none"> <li>• <i>are there extreme fluctuations in number of populations (&gt;1 order of magnitude)?</i></li> </ul>	Unknown
<b>Threats (actual or imminent threats to populations or habitats)</b>	
-directed commercial fishery -bycatch from directed fisheries (mostly cod, pollock, haddock, Atlantic halibut) -habitat destruction	
<b>Rescue Effect (immigration from an outside source)</b>	Low
<ul style="list-style-type: none"> <li>• <i>does species exist elsewhere (in Canada or outside)?</i></li> </ul>	Rare in NF, exists outside Canada in US Gulf of Maine. Stock straddles Can. - U.S. boundary. Exists also in northeastern Atlantic.
<ul style="list-style-type: none"> <li>• <i>status of the outside population(s)?</i></li> </ul>	60% decline in US Gulf of Maine population 1970-1994
<ul style="list-style-type: none"> <li>• <i>is immigration known or possible?</i></li> </ul>	Possible (likely as larvae, juvenile and adult)
<ul style="list-style-type: none"> <li>• <i>would immigrants be adapted to survive here?</i></li> </ul>	Likely
<ul style="list-style-type: none"> <li>• <i>is there sufficient habitat for immigrants here?</i></li> </ul>	Likely
<b>Quantitative Analysis</b>	No

## ACKNOWLEDGEMENTS

We thank David Kulka (St. John's, NF) and Diane Archambault (Mont-Joli, QU) of the Department of Fisheries and Oceans and especially Lei Harris (DFO St. Andrews) for providing research vessel survey data on *Brosme*. Lisa Palmer of the National Museum of Natural History Division of Fishes at the Smithsonian Institution provided the illustration of *Brosme* (No. P02360) by H.L. Todd on the cover. Tarah Cunningham of the Department of Biology at Memorial University provided several of the references. Don Clark, Peter Comeau, Lei Harris, Kent Smedbol, and Rob Stephenson of the Department of Fisheries and Oceans, St. Andrews, in addition to COSEWIC and other DFO personnel who attended the National Science Review Meeting on Species at Risk in Halifax, contributed to the report through numerous discussions on cusk biology and distribution and by commenting on earlier versions of the report. Doug Swain at the Department of Fisheries and Oceans is thanked for discussing calculation of percent decline. Loretta O'Brien (NMFS Woods Hole) kindly provided data on *Brosme* from the Gulf of Maine. We thank Richard Haedrich of COSEWIC, Henry Lear (DFO – Ottawa), David Coffin and W.C. Reardon for providing comments on the status report. Funding for this status report was provided by the Canadian Wildlife Service, Environment Canada.

## LITERATURE CITED

- Andriyashev, A.P. 1954. Fishes of the northern seas of the USSR. Israel Program for Scientific Translation, Jerusalem 1964. 53:146-147.
- Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin 74 of the U.S. Fish and Wildlife Service. Vol. 53, 577 p.
- Beacham, T.D., 1982. Median length at sexual maturity of halibut, cusk, longhorn sculpin, ocean pout, and sea raven in the Maritimes area of the Northwest Atlantic. Canadian Journal of Zoology 60:1326-1330.
- Bergstad, O.A., 1991. Distribution and trophic ecology of some gadoid fish of the Norwegian deep. 1. Accounts of individual species. Sarsia 75:269-313.
- Bowen, W.D., J.W. Lawson and B. Beck. 1993. Seasonal and geographical variation in the species composition and size of prey consumed by gray seals. (*Halichoerus grypus*) on the Scotian Shelf. Canadian Journal of Fish and Aquatic Science. 50:1768-1778.
- Cohen, D.M., T. Inada, T. Iwamoto, and N. Scialabba. 1990. Gadiform fishes of the world. Food and Agriculture Organization of the United Nations Species Catalogue, Vol. 10, Fir/S125, Vol. 10.
- Collette, B. and G. Klein-MacPhee (eds.). 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine. Third Edition. Smithsonian Institution Press, Washington DC. 748 p.
- Collie, J.S. 1987. Food selection by yellowtail flounder (*Limanda ferruginea*) on Georges Bank. Canadian Journal of Fisheries and Aquatic Science 44:357-367.
- Colvocoresses, J.A. and J.A. Musick. 1984. Species associations and community composition of middle Atlantic bight continental shelf demersal fishes. Fishery Bulletin U.S. 82(2):295-313.

- Davis, P.S. 1990. The first occurrence of torsk, *Brosme Brosme* (Ascanius 1772) for the coast of Northumberland, and additional records of the swordfish *Xiphias gladius* Linnaeus 1758. Transactions of the Natural History Society 55. 149 p.
- Department of Fisheries and Oceans Science Stock Status Report A3-35. 2000. Cusk on the Scotian Shelf. [http://www.mar.dfo-mpo.gc.ca/science/rap/internet/A3-35\(2000\)E.pdf](http://www.mar.dfo-mpo.gc.ca/science/rap/internet/A3-35(2000)E.pdf)
- Fahay, M.P. 1983. Guide to the early stages of marine fishes occurring in the western north Atlantic Ocean, Cape Hatteras to the southern Scotian Shelf. Journal of the Northwest Atlantic Fisheries Science Vol. 4, 423 p.
- Fisheries Resource Conservation Council. 2002. R.1. 2002/2003 conservation requirements for groundfish stocks on the Scotian Shelf and in the Bay of Fundy [4VWX], in sub-areas 0, 2 + 3 and redfish stocks. Report to the Minister of Fisheries and Oceans.
- Hareide, N.-R. and G. Garnes. 2001. The distribution and catch rates of deep water fish along the Mid-Atlantic Ridge from 43 to 61°N. Fisheries Research, 51:297-310.
- Harris, L.E., P.A. Comeau and D.S. Clark. 2002. Evaluation of cusk (*Brosme Brosme*) in Canadian waters. Department of Fisheries and Oceans Canadian Science Advisory Secretariat Working Paper 2002/x. 32 p.
- Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Smithsonian Institution Press, Washington D.C. 388 p. Reprinted in 1972 for the Smithsonian Institution by T.F.H. Publications, Inc., Neptune, New Jersey.
- Hovland, M. and A.G. Judd. 1988. Seabed pockmarks and seepages: Impact on geology, biology and the marine environment. Kluwer Academic Publishers Group, Norwell, Massachusetts.
- Husebø, Å., L. Nøttestad, J.H. Fosså, D.M. Furevik and S.B. Jørgensen. 2002. Distributions and abundance of fish in deep-sea coral habitats. Hydrobiologia. Special issue with Proceedings of the First International Symposium on deep-sea corals.
- Jensen, A.S. 1948. Contributions to the ichthyofauna of Greenland. VIII-XXIII. Spolai. Zool. Mus. Haun. 9:1-182.
- Johansen, T. and G. Nævdal. 1995. Genetic analysis of population structure of tusk in the north Atlantic. Journal of Fish Biology 47(Supp. A):226-242.
- Langton, R.W. and R.E. Bowman. 1980. Food of fifteen northwest Atlantic gadiform fishes. National Oceanic and Atmospheric Administration Technical Rep. National Marine Fisheries Service SSRF-740. 23 p.
- Lukmanov, E.G., T.B. Nikiforova and V.P. Ponomarenko. 1985. Distribution of menek, *Brosme Brosme*, in waters of the Norwegian and Barents Sea. Scrip. Technica Inc. 133-139.
- Macdonald, J.S., M.J. Dadswell, R.G. Appy, G.D. Melvin and D.A. Methven. 1984. Fishes, fish assemblages and their seasonal movements in the lower Bay of Fundy and Passamaquoddy Bay, Canada. Fishery Bulletin U.S., 82:121-139.
- Mahon, R., S.K. Brown, K.C.T. Zwanenburg, D.B. Atkinson, K.R. Buja, L. Clafin, G.D. Howell, M.E. Monaco, R.N. O'Boyle and M. Sinclair. Assemblages and biogeography of demersal fishes of the east coast of North America. 1998. Canadian Journal of Fisheries and Aquatic Science 55:1704-1738.
- O'Brien, Loretta. 2000. Status of fisheries resources off northeastern United States – cusk. <http://www.nefsc.noaa.gov/sos/spsyn/og/cusk/>

- Oldham, W.S. 1972. Biology of Scotian Shelf Cusk, *Brosme Brosme*. International Convention for the Northwest Atlantic Fisheries Research Bulletin 9:85-98.
- Pethon, P. 1989. Aschehougs store fiskebok. H. Aschehoug and Company. Stockholm 447 p.
- Rountree, R.A. 1999. November diets of Northwest Atlantic fishes and squid. <http://www.fishecology.org>. Accessed winter 2003.
- Schmidt, J. 1905. On the larval and post-larval stages of the torsk (*Brosmius Brosme* (Ascan)). Meddelelser fra Kommission for Danmarks Fiskeri og Havundersokelser. Serie Fiskeri 1:1-12.
- Scott, J.S. 1982. Depth, temperature and salinity preferences of common fishes on the Scotian Shelf. Journal of Northwest Atlantic Fisheries Science 3:29-39.
- Scott, W.B., and M.G. Scott. 1988. Atlantic Fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Science No. 219. 731 p.
- Strong, M., and A. Hanke. 1995. Diversity of finfish species in the Scotia-Fundy Region. Canadian Technical Report of Fisheries and Aquatic Science No. 2017. 106 p.
- Svetovidov, A.N. 1948. Fauna of the U.S.S.R. Fishes, Gadiformes Vol. IX, No. 4. Zoological Institute of the Academy of the U.S.S.R. New Series No. 34. Translated from Russian and published for the National Science Foundation, Washington, D.C., by the Israel Program for Scientific Translations, Jerusalem 1962. 304 p.
- Tyler, A.V. 1971. Periodic and resident components in communities of Atlantic fishes. Journal of the Fisheries Research Board of Canada 28:935-946.
- Wenner, C.A. 1983. Biology of the longfin hake, *Phycis chesteri*, in the Western North Atlantic. Biological Oceanography 3(1):41-75.
- Wheeler, A. 1969. The Fishes of the British Isles and north-west Europe. Michigan State University Press, East Lansing.

## **BIOGRAPHICAL SUMMARY OF CONTRACTOR**

David Methven is a fish biologist and ecologist. His degrees are from Mount Allison University (B.Sc. 1977) and Memorial University (M.Sc. 1983, Ph.D. 1997) where his dissertation examined variability in density of juvenile cod at multiple spatial and temporal scales during the stock's collapse in the early 1990s. In 2002 he left Memorial University to join the University of New Brunswick in Saint John as an assistant professor in the Department of Biology. He is author of more than 30 publications on biology, ecology and taxonomy of Atlantic fishes and a member of COSEWIC's Marine Fish Species Specialist Subcommittee. Research interests include questions on life history, taxonomy and structure of coastal fish assemblages in addition to conservation of species at risk.

## **AUTHORITIES CONSULTED**

COSEWIC and DFO personnel attending the National Science Review Meeting on Species at Risk in Halifax (March 2002), especially Lei Harris, Kent Smedbol, Don lark, Rob Stephenson and Chris Wood. Lei Harris (DFO - St. Andrews, NB), David Kulka, (DFO - St. John's NF), Doug Swain and Diane Archambault (DFO Mont-Joli, QU).