

ARCTIC COD

TAXONOMY

Scientific name: *Boreogadus saida* (Lepechin 1774)

Common name: Arctic cod

Family: Gadidae

Taxonomic comments:

Frequently called Polar cod, which is confusing when not used with scientific name. The American Fisheries Society (AFS) uses polar cod for *Arctogadus glacialis*, which is in the same family. Conversely, the name Arctic cod is often used in European literature for *Gadus morhua*, the Atlantic cod (Mecklenburg et al. 2002).



DESCRIPTION

Basic description: A small marine fish.

General description:

Brownish dorsally with fine black dots and violet or yellowish sheen; silvery white ventrally; caudal and three dorsal fins with white margins, two anal fins with black margins. Body is slender and tapered markedly toward tail, lower jaw slightly protruding or jaws are equal, caudal fin is deeply emarginate. Palatine teeth absent. Scales are non-overlapping, circular and embedded; skin has the texture of coarse sandpaper (Mecklenburg et al. 2002). Length to 40 cm, normally less than 25 cm (Cohen et al. 1990).

Length (cm): 40

Reproduction:

Age at sexual maturity about 2-3 years for males and 3 years for females in the Beaufort Sea and most other parts of its range (Craig et al. 1982); 4-5 years for both sexes in the White Sea (Cohen et al. 1990). Usually spawns no more than once in a lifetime, commonly under sea ice, between November and February (Craig et al. 1982) but may extend to mid-July in the northeastern Chukchi Sea (Wyllie-Echeverria et al. 1997). Eggs produced are the largest and fewest (average of 11,900 per female) of all species in the cod family (ADFG 1986, Cohen et al. 1990). Eggs are fertilized externally and dispersed in the water column. Incubation lasts 45-90 days, and varies with water temperature (Sameoto 1984).

Ecology:

A keystone species in arctic ecosystems; a major trophic link between primary producers/zooplankters and upper trophic levels (Craig et al. 1982.). Human use includes harvest for fishmeal and a source of oil (Cohen et al. 1990). Associated with floating sea ice, under which it may spawn, forage, and seek protection in cracks; antifreeze glycoproteins synthesized in its liver aid survival in water below the equilibrium freezing point of body fluids (Gillispie 1997).

Migration:

Observed in dense schools in open water in late summer and early winter prior to spawning. Migrates to nearshore waters in late summer as water salinity increases, and remains under nearshore ice in winter to spawn before moving offshore in spring (Craig 1984). Have been observed descending to greater depths and colder water when surface temperatures in the Barents Sea increased to 10° C in late summer/early fall (Hognestad 1968, Ponomarenko 1968). Arctic cod from the northern Bering and southern Chukchi seas observed moving north with the receding ice edge (Lowry and Frost 1981).

Food:

Young-of-year (YOY) consume phytoplankton and very small or early stages of zooplankton; adults prey on pelagic zooplankton, substrate and ice-associated crustaceans, and occasionally young fish (ADFG 1986). Zooplankton taken primarily include copepods (*Calanus* spp.), amphipods (*Themisto* spp.), and mysids (Fechhelm et al. 1984; Hop et al. 1997). Often found near ice edges and boundaries between warm and cold water bodies where phytoplankton and zooplankton concentrate. May exhibit two behavior strategies: schooling or individual foraging (Hop et al. 1997).

Phenology:

Spawns between November and February under sea ice (Craig et al. 1982), but spawning may extend to mid-July in some areas (Wyllie-Echeverria et al. 1997). Annual schooling and migrations occur in fall/early winter to nearshore waters; in spring to offshore waters.

Habitat:

Inhabits a wide variety of marine habitats. Prefers cold temperatures (-1.8-10° C) but tolerates variable water temperatures and high or variable salinities (< 14 psu) and turbidities (Craig et al. 1982, ADFG 1986, Cannon et al. 1991). Most commonly found at water's surface, close to shore among ice floes, but may also occur offshore at depths greater than 900m. Associated with the undersurface and cracks in sea ice, but also found near the ocean bottom and throughout the water column in open water (ADFG 1986).

STATUS

Global rank: GNR

Global rank reasons:

Global rank reasons currently unavailable.

State rank: S4S5 (2004-07-15)

State rank reasons:

Based on scant information, species appears relatively secure. However, due to importance as keystone species in arctic food webs it is of particular conservation concern. Widely abundant, population trends variable. Along Beaufort Sea coast, near shore distribution in close proximity to oil exploration, vulnerable to oil spills and contamination. May be particularly sensitive to effects of climate change which could alter sea ice distribution and water temperature.

DISTRIBUTION AND ABUNDANCE

Range:

Global range:

Circumpolar distribution. In Arctic Ocean to the White Sea, Iceland, and southern Greenland, in the western Atlantic into the Miramichi River, New Brunswick, and in the Chukchi, Beaufort, and Bering Sea to Cape Olyutorski, the Pribilof Islands, and Bristol Bay (Allen and Smith 1988). Observed farther north than any other fish species (Dept. of Fisheries and Oceans Canada 2004).

State range:

Present in the Bering, Chukchi and Beaufort Seas. In the Bering Sea, rare in south and central parts but present generally north of 62° N from Bristol Bay northwards, and more commonly found offshore than in nearshore waters (Bradstreet et al. 1986). Present throughout the Chukchi Sea (Wyllie-Echeverria et al. 1997). In the Beaufort Sea, well documented in and near Prudhoe Bay and Simpson Lagoon.

Abundance:

Global abundance:

Unknown, but apparently abundant based on total world catch of 23,709 metric tons in 1984 and 11,713 in 1987 (Cohen et al. 1990). Largest stocks probably occur in the Kara, Barents and White Seas (Ponomarenko 1968). In Alaska, more abundant in northeastern Chukchi and western Beaufort seas than in north Bering and central Beaufort seas (Frost and Lowry 1981).

State abundance:

Localized abundance varies widely and naturally. The most abundant species, by far, in numerous fisheries studies in Arctic waters (Craig et al. 1982, Fruge et al. 1989, Palmer and Dugan 1990). Most abundant in the northeastern Chukchi and western Beaufort seas; least abundant in north Bering and central Beaufort seas (Frost and Lowry 1981). Abundance highly variable between years in Beaufort Sea studies (see State trend comments).

Trends:

Global trend:

Abundance varies widely and naturally. Studies of marine predator diets suggest a potential decline in arctic cod abundance in the Canadian Arctic. Finley et al. (1990) attributed a decline of arctic cod in harp seals' (*Phoca groenlandica*) diets from 1978 to 1979 to a decline in abundance or availability. Arctic cod decreased in murre (*Uria* spp.) diets (frequency of occurrence from 55% to 12%) in coastal Newfoundland between 1984-86 and 1996-98 (Rowe et al. 2000). The frequency of arctic cod delivered to Thick-billed murre (*Uria lomvia*) nestlings in Hudson Bay has declined (43% to 15%) since the 1980's; this decline has been linked to warming waters and a decrease in July ice cover (Gaston et al. 2003). The FAO reports steadily declining world catch numbers from 1984 to 1987, but notes stocks are fished less intensively than in the past (Cohen et al. 1990).

State trend:

High variation in arctic cod abundance often reported in the Beaufort Sea. In the Sagavanirktok Delta, cod abundance varied between 1985 and 1993, but did not increase over time (Griffiths et al. 1998). Between 1977 and 1978, the number of cod collected at Simpson Lagoon, west of Prudhoe

Bay, increased 200-fold (767 vs. 139,790) (Craig et al. 1982). This increase was also observed elsewhere along the Beaufort Sea coast. In the Barter Island region, 200 km east of Prudhoe Bay, significant differences were found in year-to-year abundance of cod between 1988 and 1992 (Underwood et al. 1995). In coastal waters of the Arctic National Wildlife Refuge, catch per unit effort (CPUE) increased from 1988 to 1989, then decreased between 1988/1989 and 1991 (Palmer and Dugan 1990, Underwood et al. 1994).

EXISTING PROTECTION

Global protection:

Unknown.

State protection:

The Alaska Department of Fish and Game has managerial authority over arctic cod extending to three miles offshore. However, because harvest of cod is minimal, no management plan currently exists for this species (ADFG 1986).

CHALLENGES

Global challenges:

This species' preference for cold water and association with sea ice makes it vulnerable to climate change which could result in altering sea ice distribution and water temperatures in Arctic regions. A recent study in Hudson Bay has correlated decreasing July ice cover with a decline in arctic cod abundance (Gaston et al. 2003). Mortality has been associated with strong winds and storms: large numbers of arctic cod have been washed ashore during fall and winter storms in Russia; on the Kara Sea coast heaps of cod from 5 to 10m wide and 3 to 5m high, extending over tens of kilometers have accumulated after storms (Ponomarenko 1968).

State challenges:

Major threats include habitat degradation from coastal development, as well as pollution from offshore oil development, oil spills, and vessel traffic. Arctic cod eggs are buoyant and fish are pelagic, making both vulnerable to toxicants such as hydrocarbons, disinfectants, heavy metals, drilling muds and other chemicals which collect on the surface, in the water column, under ice, and in cracks in sea ice - consolidation areas for both cod and contaminants (Fechhelm et al. 1984, ADFG 1986). This species' preference for cold water and association with sea ice makes it vulnerable to climate change which could result in altering sea ice distribution and water temperatures in Arctic regions.

RESEARCH AND INVENTORY NEEDS

Global research needs:

See State research needs below.

State research needs:

Baseline information on life history and habitat requirements needed. Determine abundance and harvest levels in all parts of the arctic cod's distribution. Identify the effects of

commercial/subsistence fisheries and possible climate change on populations and distribution. Study rates and effects of natural habitat change compared to human-caused habitat change in Arctic oceans.

Global inventory needs:

See State inventory needs below.

State inventory needs:

Baseline information on distribution needed. Monitoring needed to determine annual abundance, inter-annual variability, and population trends. Lack of information on harvest data, and the impacts of harvest on population are unknown; harvest assessment needed.

CONSERVATION AND MANAGEMENT NEEDS

Global conservation and management needs:

See State conservation and management needs below.

State conservation and management needs:

The importance of arctic cod as a primary food source for many marine species make its conservation essential. A regular monitoring program to determine trends in abundance and distribution should be established. Methods for effective pollutant spill cleanup in ice-affected waters should be explored and spill response plans created for areas in arctic cod's range. Bycatch in commercial fisheries should be monitored and regulated.

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