# Seafood Watch
Seafood Report

MONTEREY BAY AQUARIUM®

# Masago
Capelin Roe
***Mallotus villosus***

(Image © Lori Alden)

Final Report
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## About Seafood Watch® and the Seafood Reports

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid". The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

**Disclaimer**

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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# I. Executive Summary

Concentrated primarily in the northern Atlantic Ocean, the capelin (*Mallotus villosus*) fishery is one of the largest fisheries in the world. Norway, Russia, Canada, and Iceland have historically targeted large amounts of capelin; however, the fishery in the Barents Sea, supporting Norway's and Russia's efforts, has recently been closed. Iceland is now the largest producer of capelin in the world. It is exceedingly rare to find capelin meat available in sushi bars; however, capelin roe, or "masago", is a popular item at sushi restaurants. Most major capelin fisheries provide product to the *masago* market.

Capelin is inherently resilient to fishing pressure due to its rapid growth rate, early age at maturity, and high fecundity. It lives no longer than five or six years and its near-circumpolar habitat comprises a vast expanse of ocean. It has been theorized that capelin stocks, once overfished, may have a difficult time rebuilding, even without fishing pressure, due to predation by other species.

The stock status of the major capelin populations in the northern Atlantic is not well understood. Biological reference points, such as $B_{MSY}$ and $F_{MSY}$, are not known; however, acoustic surveys are conducted to project mature stock biomass and set total allowable catch (TAC). Currently, Icelandic capelin populations are at low abundance, but this number may simply reflect a natural cycle. Canadian capelin landings (and possibly populations) have been on the rise for the past few years since historically low landings in 2001. The Barents Sea stock has fully collapsed and has been closed since 2004. As such, the Barents Sea fishery is not evaluated in this report.

Bycatch is a low conservation concern within the Icelandic capelin fishery. Iceland and Norway both follow a no-discard policy which keeps bycatch below 2%. No recent quantitative bycatch data are available for the Canadian purse seine and trap net capelin fisheries. The most recent data are from 1994, and the fishery has substantially improved their management since then, prohibiting discards of male and juvenile capelin. Therefore, the unknown quantity of bycatch in the Canadian fisheries is a moderate concern.

Most major fleets target capelin with purse seines and mid-water pelagic trawls. These are fairly benign gear types from the perspective of potential habitat disruption, as they have no contact with the benthos. There is a growing segment of the Canadian fishery which is relying on trap nets to catch capelin. This gear is generally known to have moderate impacts on habitat.

Capelin is known to be an extremely important forage fish and is indispensable to the food web. It is a major prey item for cod (*Gadus morhua*), saithe (*Pollachius virens*), Atlantic herring (*Clupea harengus*), and other stocks of commercial value in the North Atlantic. It also helps to sustain seabirds, seals, and other animals. Recent crashes in capelin populations have sent tremors throughout much of the fishing industry in the North Atlantic; fishermen who target cod and other predatory fish seem to be particularly concerned about the dwindling capelin populations. The collapse of the Barents Sea fishery coupled with recent scientific research corroborating the importance of capelin in the North Atlantic food web has prompted a shift towards multi-species integrated fishery management, but the extent and effectiveness of this movement remains to be seen.

Iceland follows progressive management techniques which are aimed at protecting the current stock. Canadian management is less progressive but still sets and enforces seemingly precautionary catch limits. Iceland and Canada both have effective systems in place for catch monitoring and policy enforcement, and their respective fishery management bodies are known to follow scientific advice and respond quickly to potential problems.

Due to low inherent vulnerability, negligible amounts of bycatch, and strong management effectiveness in the Icelandic fishery, Seafood Watch® ranks Icelandic capelin as a "Best Choice". Given the moderate status of stocks, bycatch concerns, habitat and ecosystem effects and management effectiveness, Canadian capelin receives a recommendation of "Good Alternative".

## Table of Sustainability Ranks

| | Conservation Concern | | | |
|---|---|---|---|---|
| **Sustainability Criteria** | **Low** | **Moderate** | **High** | **Critical** |
| Inherent Vulnerability | √ | | | |
| Status of Stocks | | √ (Canada, Iceland) | | |
| Nature of Bycatch | √ (Iceland: Purse Seine) | √ (Canada: Purse seine and trap net) | | |
| Habitat & Ecosystem Effects | | √ | | |
| Management Effectiveness | √ (Iceland) | √ (Canada) | | |

**About the Overall Seafood Recommendation:**

- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.

## Overall Seafood Recommendation:

**Iceland:**

**Best Choice** Good Alternative Avoid

**Canada:**

Best Choice **Good Alternative** Avoid

# II. Introduction

**Basic Biology**

Capelin *(Mallotus villosus)* is a small boreoarctic pelagic schooling fish with a slender, elongated body and a pointed snout. It ranges in color from a transparent olive to bottle green along the back while the belly and fins remain silvery or silvery-white. It has very small cycloid scales; males develop a midlateral ridge of elongated scales along their flanks during spawning seasons (FAO 2001).

*M. villosus* occurs in great numbers throughout much of the northern Pacific and Atlantic Oceans (Figures 1, 2) (Hart 1973; Doyle et al. 2002; Sigurjónsson and Vilhjálmsson 2003; FAO 2004a; Hjermann et al. 2004). It is known to spawn throughout its entire range (Hart 1973). Most major capelin fisheries are concentrated in the northern Atlantic Ocean from the coast of Newfoundland to the waters off of Svalbard. The world's largest known capelin population has historically dwelt in the Barents Sea, off of the northern coast of mainland Norway (Hjermann et al. 2004). The exact extent of the habitat of *M. villosus* is unknown, but populations seem to be effectively circumpolar (FAO 2001; SR-mjöl HF 2006).

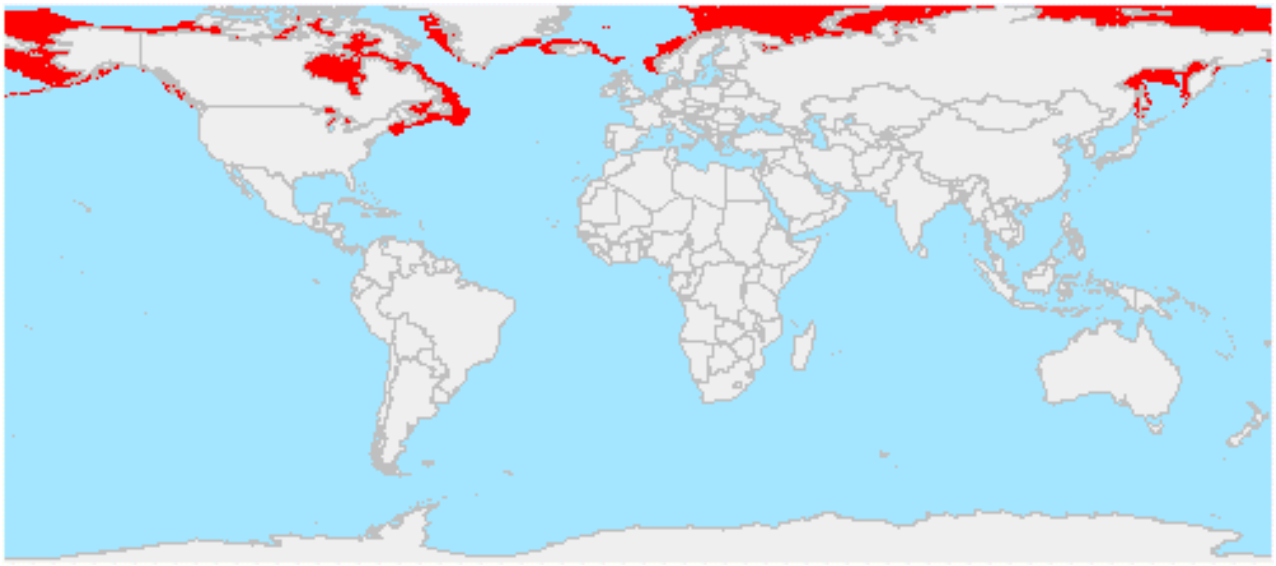

**Figure 1.** Worldwide range of *Mallotus villosus* (FAO 2001).

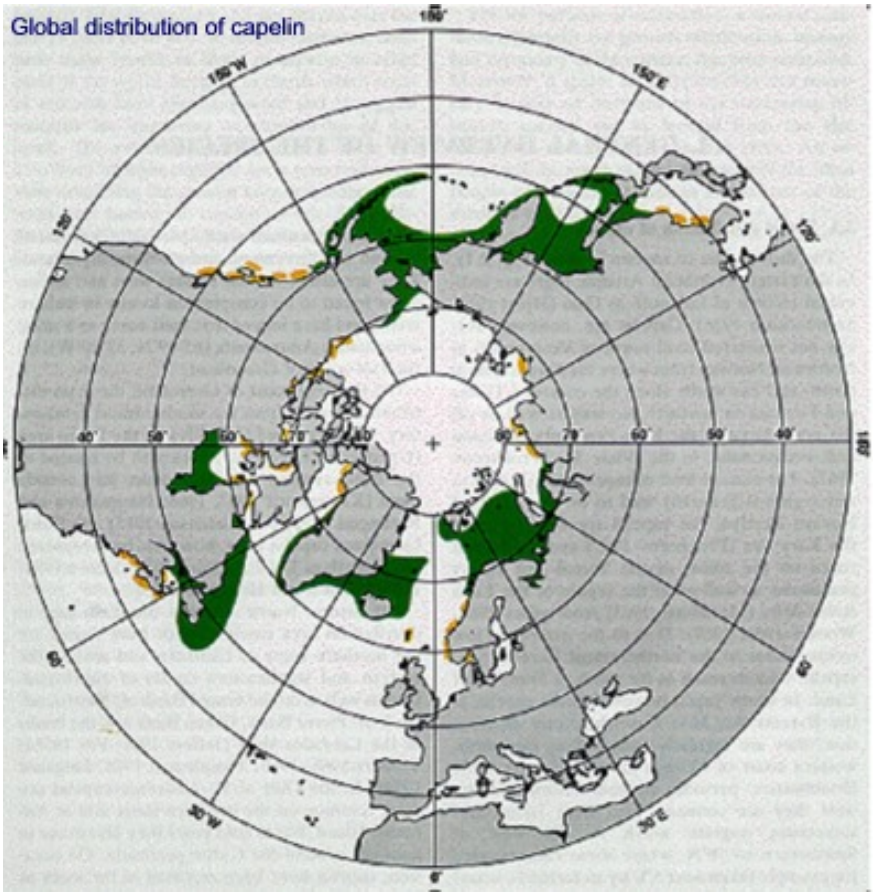


**Figure 2.** Worldwide range of *Mallotus villosus* (SR-mjöl HF 2006).

*M. villosus* is a highly migratory species, with juveniles and adults often participating in distinct migration patterns that do not necessarily overlap. Carscadden et al. (1997) concluded that capelin spawning patterns are linked to water temperature. Though this research was conducted in the seas off of Newfoundland, this characteristic is typical of capelin stocks and can be observed elsewhere (Doyle et al. 2002). In Icelandic and Norwegian waters, there are distinct spawning and feeding migrations (Figure 3).

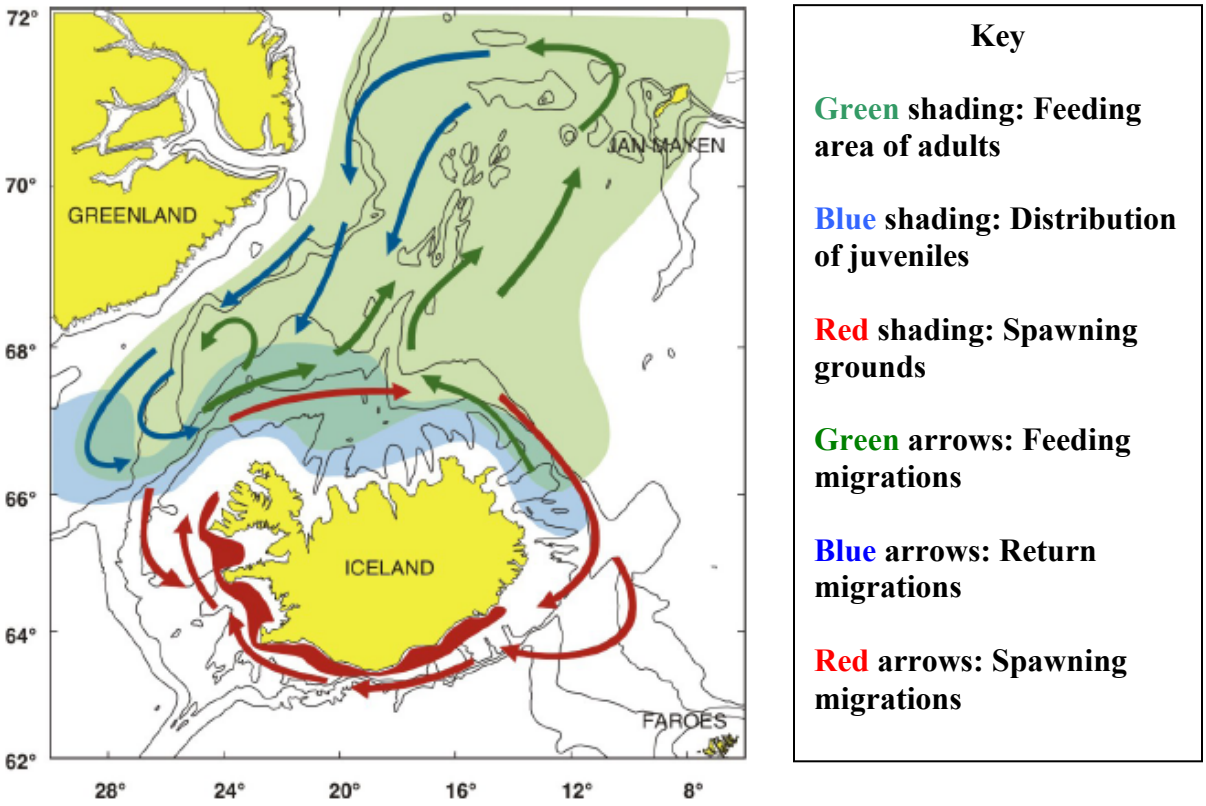


**Figure 3.** Migration behavior among Icelandic capelin stocks (Sigurjónsson and Vilhjálmsson 2003).

Adult capelin are found in colder waters in the summer, following the plankton blooms in order to feed. They return to spawn in warmer, shallower zones. Juveniles travel in separate schools from adults and do not range as far during their foraging (Carscadden et al. 1997; Sigurjónsson and Vilhjálmsson 2003).

Capelin reach sexual maturity after 2-5 years of growth, with the majority doing so at 3-4 years of age (Sigurjónsson and Vilhjálmsson 2003). They spawn either in shallow waters offshore or directly on the shore itself, in a process known as "rolling" (DFO 2005). The Pacific and Northwest Atlantic stocks differ from the Icelandic and Barents Sea capelin in spawning behavior; the former populations have a strong predilection towards rolling, while the latter spawn at depth unless forced to beach areas by circumstance (Jóhannsdóttir and Vilhjálmsson 1999).

Spawning generally occurs when water temperatures reach 6˚ - 10˚C. Eggs are typically about 1 mm in diameter and their incubation period is known to vary with temperature; it typically lasts about 15 days in 10˚C water (DFO 2005). Upon hatching, capelin larvae quickly join the plankton cloud.

The larval growth rate of capelin is thought to vary considerably, with estimations of 0.11, 0.2 – 0.35, 0.15-0.25, and 0.28-0.25 mm per day recorded for samples in Alaska, the Gulf of St. Lawrence, Icelandic waters, and Newfoundland waters, respectively (Jacquaz et al. 1977; Doyle et al. 2002). Notochord flexion begins at 8.5 mm SL (standard length) in capelin larvae and is

complete by 25.5 mm SL. At this point, the animal begins the *postflexion* stage of development (Figure 4) (Doyle et al. 2002). This involves the ossification of the vertebrae and fins. Postflexion is generally complete by the time the fish reaches 60 mm SL, at which point it has taken on the general morphology of an adult and commenced its transition into the *juvenile* stage (Doyle et al. 2002).

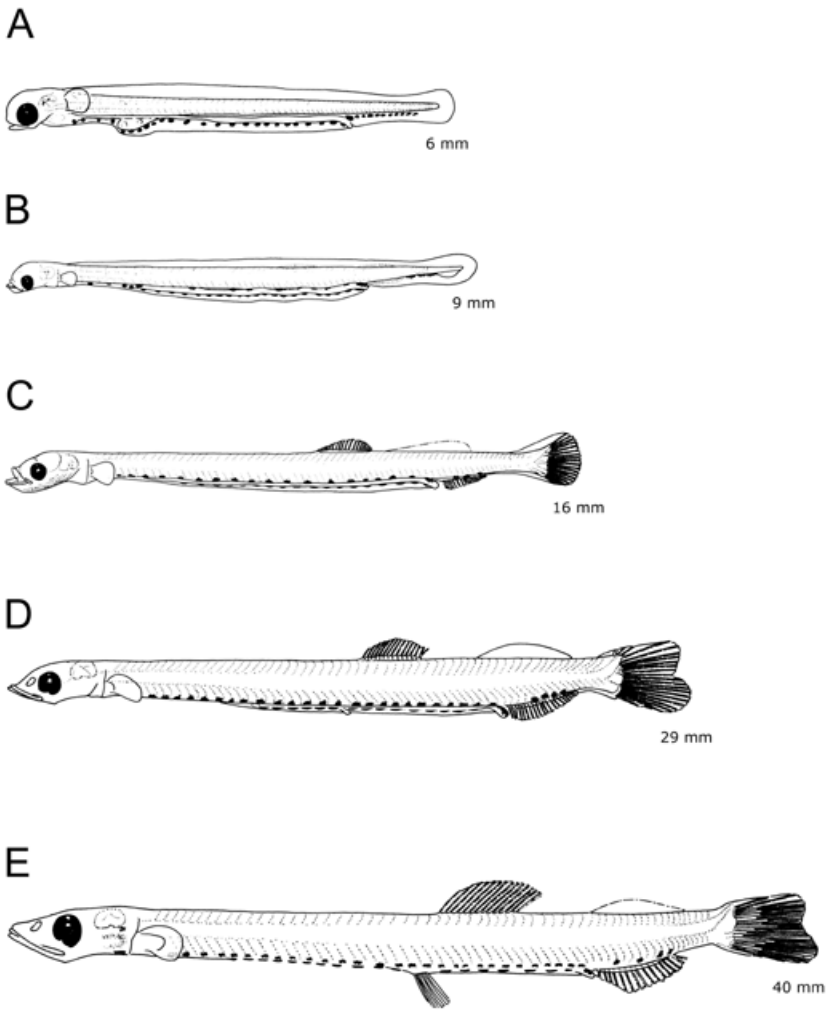


**Figure 4.** Capelin larval and postflexion development patterns (AFSC 2005).

Capelin are considered true juveniles upon reaching 75.0 to 80.0 mm SL. At this point, the cranium is ossified, as are the bones supporting the fins; lateral line scales begin to form, palantine teeth appear, and the skin of the animal takes on the characteristic silver sheen of an adult capelin (Doyle et al. 2002). Growth is rapid during the first two years and then decelerates. Adult males are generally longer than females, but only rarely exceed 210 mm in length (DFO 2005).

Some capelin achieve sexual maturity as early as the age of 2, but it may take as long as 5 years (DFO 2005; Jóhannsdóttir and Vilhjálmsson 1999). At this point they will join a spawning migration and, in the case of males, generally die during or just after the process, with a post-spawning mortality rate approaching 100%.

Unlike males, female capelin are known to be iteroparous, that is, capable of spawning more than once. Although many females die in the spawning process, others survive to spawn again (Flynn et al. 2001; Doyle et al. 2002; DFO 2005). The percentage of surviving females varies widely from 10% to 90% of the spawning female population (Flynn et al. 2001).

**Scope of the analysis and the ensuing recommendation:**
This report concentrates on the capelin fisheries that contribute to the American sushi industry. Due to the high price offered by the Japanese and Taiwanese capelin roe preparation industries, which are the largest sources of the *masago* (processed capelin roe) used in American sushi bars, most major capelin fisheries have adapted to provide product to these markets. The Canadian, Faeroese, Icelandic, and Norwegian capelin fisheries have historically provided the vast majority of the raw roe which is processed into *masago* for the American market. This report offers sustainability recommendations only on the Canadian and Icelandic capelin fisheries. The Barents Sea fishery has been closed since 2004, and the Faeroese fishery does not seem to be currently operating at any major scale. Faeroese ships do target capelin, and landed 32,100 mt of capelin in 2001 – but the vast majority of these landings are taken in Icelandic waters as part of a fishery exchange agreement with Iceland and other North Atlantic states (EU 2004; FAO 2005a). No recommendation is made on Faeroese capelin per se, but it can be assumed that the Faeroese are landing capelin from the same stock and under the same management aegis (ICES, the International Council for the Exploration of the Sea) as Iceland. A similar situation applies to the Norwegian capelin fleet, which now takes a portion of the Icelandic capelin stock in lieu of targeting the Barents Sea capelin population. As such, the recommendation made in this report on Icelandic capelin can be assumed to apply to Faeroese and Norwegian-caught capelin as well.

## Availability of Science

Due in large part to the strong scientific foundation of fishery management practices in the Nordic countries (specifically Iceland and Norway), there is a great deal of information about *M. villosus* and the global *M. villosus* fishery.

Much of the biological data used in the report were taken from researchers such as Carscadden, Doyle, Jóhannsdóttir, and Vilhjálmsson, all experts in capelin life history. Bycatch data were sourced primarily from FAO archives and the Canadian Department of Fisheries and Oceans (DFO). Information on the management regime was obtained from the records and publications of the International Council for the Exploration of the Sea (ICES), the Icelandic Marine Research Institute (MRI), the Norwegian Institute of Marine Research (IMR), DFO, and independent researchers such as Sigurjónsson and Vilhjálmsson. Stock status and landings information were made available by the aforementioned Icelandic, Norwegian, and Canadian oversight agencies, industry figures such as SR-mjöl HF, FAO data, and independent research.

## Market Availability

**Common and market names:**
Capelin is a member of the smelt family *Osmeridae* and is often sold as "smelt" in fish markets. It is known as "sparling" in England. Capelin roe is sold as *masago* in sushi restaurants. It may also be labeled "smelt roe," which is an accurate, if not precise, description of the product.

**Seasonal availability:**
*Masago* is available year-round.

**Product forms:**
It is exceedingly rare to find capelin meat available in sushi bars. Capelin roe, however, is a staple item and is used in many different sushi recipes and creations. This roe is known as *masago* and is generally orange-red in color.

Male and juvenile capelin, as well as eviscerated females less their roe, are often rendered into fish oil and fishmeal (ICES 2006; SR-Mjöl HF 2006).

**Import and export sources and statistics:**
Aside from sturgeon roe, which is classified as caviar and categorized separately, all roe import data are grouped together under the catch-all heading of "roe" within the import/export database of the National Marine Fisheries Service (NMFS). As such, it is impossible to discern how much of the imported roe arriving in the United States is *masago*. It seems likely that most *masago* entering the US is either imported directly from Canada or is purchased as a processed re-export from Japan, Taiwan, and possibly South Korea (NMFS 2006b). It is difficult to prove this assertion, but the vast majority of the sushi restaurants and retail stores interviewed during the research of this report claimed to sell *masago* imported from one of these countries. The origin of the re-exported roe may be Iceland or Canada. Historically, the origin was likely to be Norway or Russia, although this would no longer be the case due to the closure of the Barents Sea capelin fishery in 2004 (Hjermann et al. 2004; MRI 2006; NMFS 2006b).

Due to the difficulty of identifying the original source of re-exported capelin roe and in differentiating *masago* from other types of roe within the NMFS database, little precise information on the US *masago* import regime is available.

The United States has no major domestic capelin fishery. It has historically obtained the vast majority of its imported frozen capelin (not roe) from Canada, buying in figures that outstrip purchases from the next largest exporter (generally Iceland) by orders of magnitude (Figures 5, 6). Whether or not these figures include frozen capelin roe is unknown, but it seems unlikely given the low values (DFO 2006a).

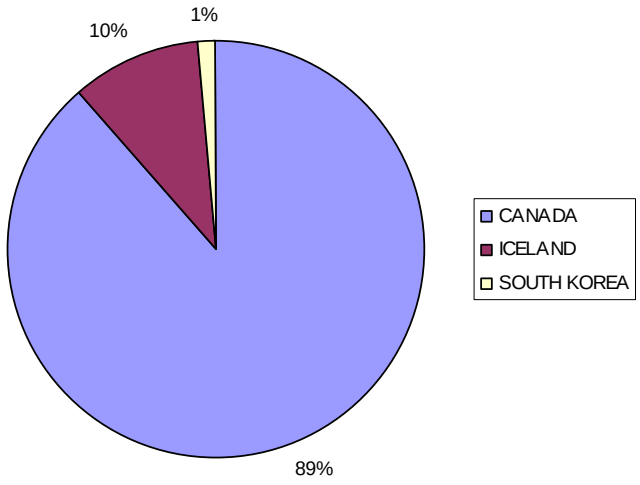


**Figure 5.** Sources of capelin (which may or may not include capelin roe) sold in the US in 2007 (NMFS 2008a).

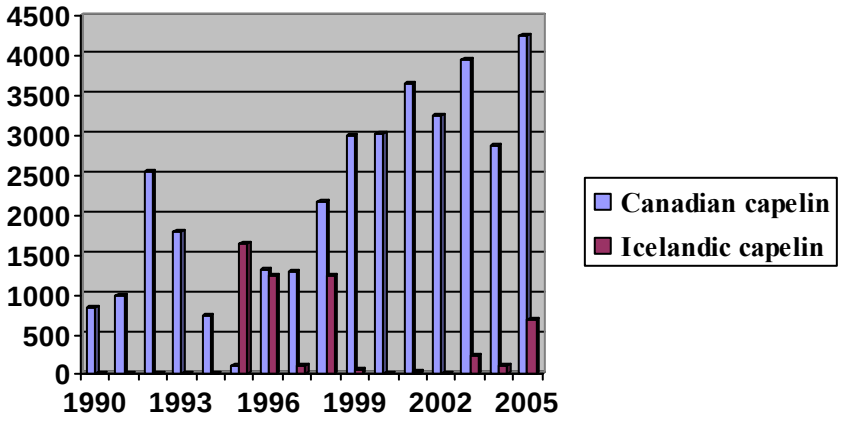


**Figure 6.** US imports of frozen capelin (metric tons) (NMFS 2006b).

# III. Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

## Criterion 1: Inherent Vulnerability to Fishing Pressure

Capelin is a small pelagic fish, only very rarely exceeding 20 cm in length (Jóhannsdóttir and Vilhjálmsson 1999; DFO 2004). Capelin have a short life span, rarely exceeding 5 years (Jóhannsdóttir and Vilhjálmsson 1999). They spawn relatively quickly, usually between the ages of 3 and 4, and generally die soon after spawning (Jóhannsdóttir and Vilhjálmsson 1999). Iterative spawning is known to occur but only among females (Winters 1974; Shacknell et al. 1994; Flynn et al. 2001).

The fecundity of female capelin is related to the length of the fish, which in turn is a function of age (Jóhannsdóttir and Vilhjálmsson 1999). Research conducted on Icelandic capelin stocks have shown higher fecundity levels in longer, larger fish (Figure 7).

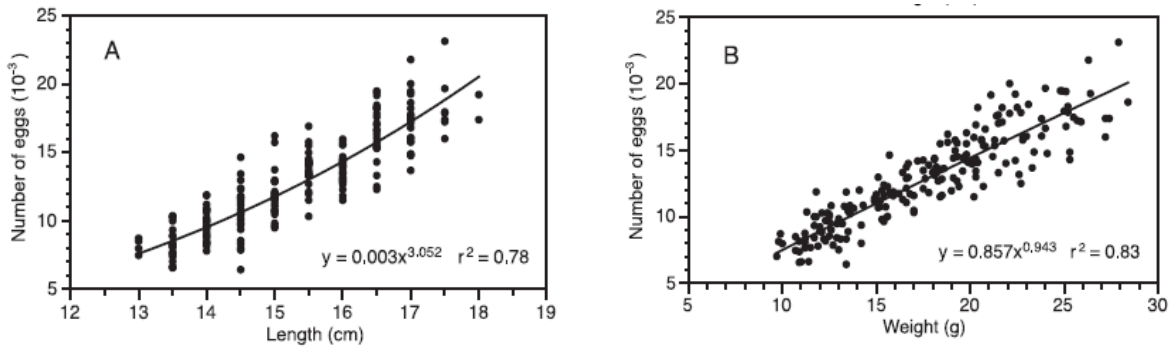


**Figure 7.** Relationships of length (A) and weight (B) to fecundity in Icelandic capelin stocks (Jóhannsdóttir and Vilhjálmsson 1999).

Fecundity studies have also been carried out among Newfoundland stocks, Sakhalin stocks, and others. While the exact relationships vary, a general positive trend is shared by all sampled populations (Figure 8).

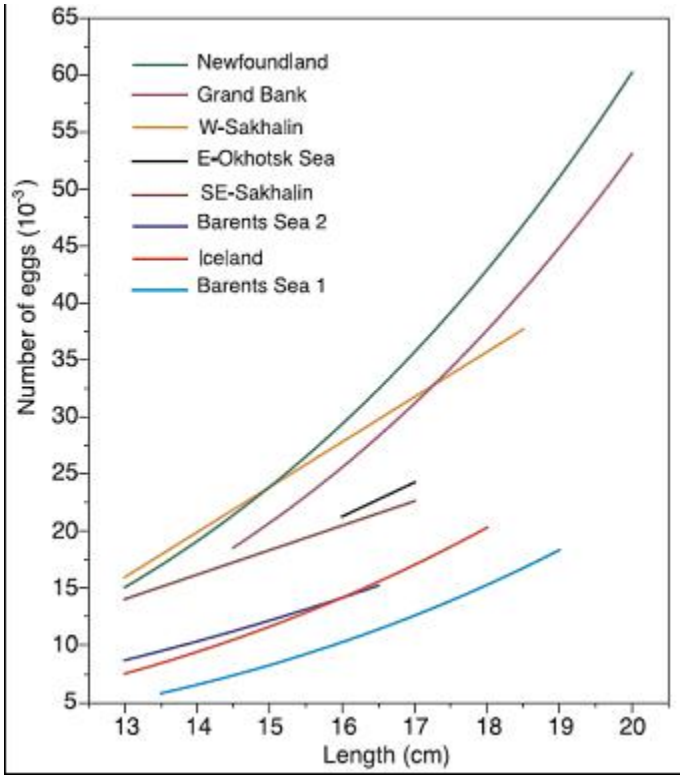


**Figure 8.** Comparative chart of length-fecundity relationships among various capelin populations (Jóhannsdóttir and Vilhjálmsson 1999).

As discussed in the "Basic Biology" section of this report, capelin exist in numerous ocean basins, achieving a nearly circumpolar range between populations in the Barents Sea, the Gulf of Alaska, the Icelandic shelf, and the Grand Banks (Hart 1973; Jacquaz et. al. 1977; Jóhannsdóttir and Vilhjálmsson 1999; Doyle et al. 2002). While there are certain behavioral and physiological discrepancies between individual populations, capelin are largely uniform in terms of life history.

Capelin likely have a high intrinsic rate of increase, although an exact figure is unknown. This fact and the capelin's high von Bertalanffy growth coefficient (k =0.5) are both indicative of the species' rapid growth rate (Fishbase 2006).

**Table 1**. Life history characteristics of *M. villosus.*

| Intrinsic Rate of Increase (r) | Age at Maturity | Growth Rate | Max Age | Max Size | Fecundity | Species Range | Special Behaviors | Sources |
|---|---|---|---|---|---|---|---|---|
| Unk. | 2-5 years | Varies | 5-6 years | 23 cm | High | Almost circumpolar in northern Atlantic and northern Pacific | Numerous migrations for feeding and spawning, but these do not increase vulnerability | Hart 1973; Jóhannsdóttir and Vilhjálmsson 1999; FAO 2001; Doyle et al. 2002; Fishbase 2006 |

**Synthesis**
The rapid growth rate, high fecundity, and early age at maturity of capelin help to protect stocks from fishing pressure. Additionally, its vast range and short lifespan contribute to the resilience of the population.

**Inherent Vulnerability Rank:**

**Resilient** Moderately Vulnerable Highly Vulnerable

## Criterion 2: Status of Wild Stocks

The international capelin fishery is one of the largest fisheries in the world. In the late 1970s, world landings peaked at over 4 million metric tons (mt) before beginning to decline. In 2002, combined international efforts landed 2 million mt of capelin – a number surpassed only by landings of anchoveta, Alaskan pollock and skipjack tuna, each of which exceeded the 2 million mt mark (FAO 2004b). Landings decreased to a total of 784,000 mt in 2004 (MRI 2006). The vast majority of these landings are made in the Northeast Atlantic, where the FAO believes capelin stocks in general to be fully exploited (FAO 2004b).

Unlike most fisheries managed by NOAA Fisheries, the capelin fisheries are not managed using the traditional reference points $B_{MSY}$ and $F_{MSY}$. Due to their high spawning mortality and highly variable year class size, stock abundance can drastically change from year to year. As such, $B_{MSY}$ would be a highly variable and unreliable measure of stock status. Catch per unit effort (CPUE) is also not a suitable measure of stock status. Capelin's schooling nature makes them easily targeted during their fishable phase of life, resulting in high catches. Instead of $B_{MSY}$, $F_{MSY}$ and CPUE, the capelin fisheries use hydro-acoustic surveys (with pelagic trawling for identification) to project mature stock biomass. The surveys measure the abundance of juveniles, and mortality estimates are used to predict the size of the maturing population. The results of the surveys are used to determine catch limits within each jurisdiction. Canada uses single, annual surveys to assess their capelin stock, while the Iceland-East Greenland-Jan Mayen area and Newfoundland use results from several surveys combined to give a total estimate of stock size (Gjøsaeter et al. 2002; Vilhjálmsson and Carscadden 2002).

***Canada***

Canadian capelin is spread across several fishing regions, each delineated alphanumerically by the North Atlantic Fishery Organization (NAFO) (Figure 9).

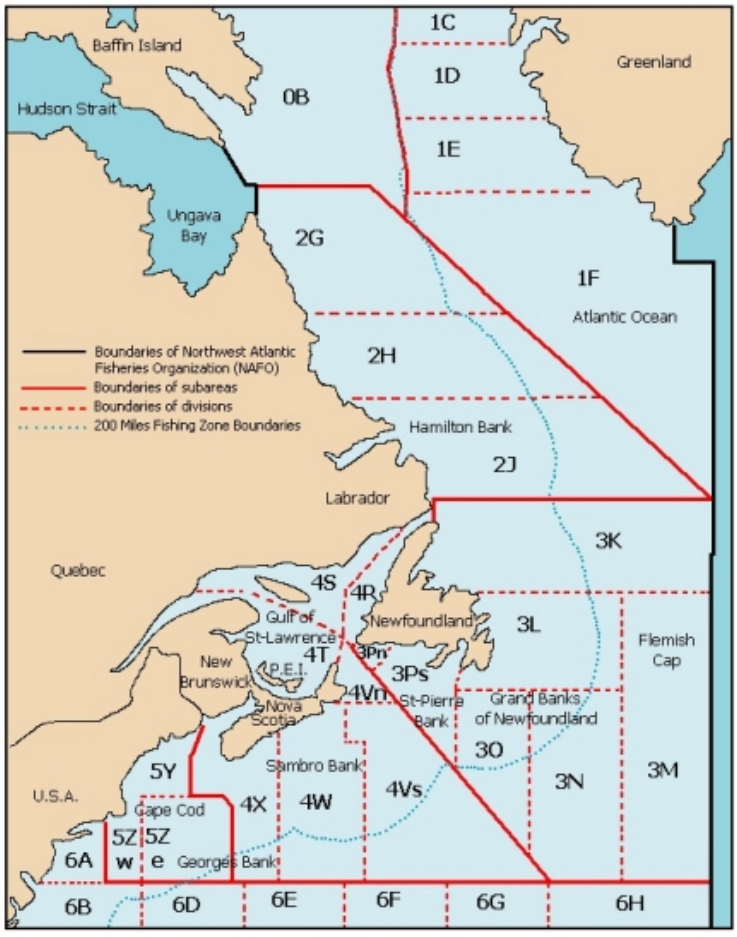


**Figure 9.** Map of Northwest Atlantic Fisheries Organization (NAFO) regions (DFO 2001).

The main fisheries for capelin have historically been concentrated in NAFO divisions 3KL, the waters off the east coast of Newfoundland; divisions 3NO, a vast area of ocean southeast of Newfoundland; and divisions 4RST, which comprise the waters enclosed within the Estuary and Gulf of St. Lawrence (DFO 2006a; Golovanov and Gorchinsky 2006; NAFO 2006b.) The fisheries in 3KL and 3NO are split between NAFO (international) and Canadian (domestic) management due to the boundary between Canadian and international waters, while the fishery in divisions 4RST is managed entirely under Canadian auspices. Total capelin landings for 2004 and 2005 were 33,394 mt and 33,721 mt respectively, with the majority coming from divisions 3KL (DFO 2005).

The capelin fisheries in NAFO Divisions 2J3KL are on mature capelin only. The TACs are set at 10% of the projected mature stock biomass based on the annual acoustic surveys and estimated survival rates (Gjøsaeter et al. 2002). The fishery operating in NAFO Divisions 3KL averaged between 12,000 and 30,000 landed mt per year between 1996 and 1999 (NAFO 2006c). An acoustic survey in NAFO divisions 3KL was last conducted in 2000, and claimed that, due to a number of uncertainties (including some characteristics intrinsic to local capelin populations dynamics and behavior), a stock assessment was not possible (DFO 2000b). However, the claim has been made that fishing pressure has been minimal and there is no evidence of overexploitation on those stocks (Cascardden et al. 2001; Gjøsaeter et al. 2002). This theory may be accurate, but if capelin populations in Canada are similar to those in the Barents Sea, a combination of fishing pressure and other influences (e.g., predation) may be a catalyst for population decline (Hjermann 2004).

The fishery in divisions 3NO was closed indefinitely in 1992 due to an abrupt decline in stock size. An earlier closure had been implemented during the years 1979-1986 due to dwindling stock size; the causes for this decline are still under debate. There were heavy landings in the years prior to 1979, especially by Soviet ships, with total catches reaching over 130,000 mt (NAFO 2006c). These landings never exceeded the TAC set by NAFO, however, and NAFO publications continue to claim that overfishing could not have been the cause of the dramatic decline in Grand Bank capelin populations (NAFO 2006c). The fishery was re-opened in 1987 and continued until 1992; these years saw landings not exceeding 25,000 mt (NAFO 2006c). It was closed indefinitely in 1993. In 2005, estimates of divisions 3NO capelin stocks place them at their lowest recorded level to date with a sampling catch of 0.06 thousand tons of capelin per square kilometer (Golovanov and Gorchinsky 2006).

An acoustic survey for NAFO divisions 4RST was last conducted in 2005. As in divisions 3KL, general conclusions were that the stock status is difficult to estimate but that anthropogenic effects on the capelin from fishing pressure are likely of minimal impact (DFO 2006a). The TAC is largely preventative in nature as figures for abundance trends, fishing mortality, and biomass limits are unknown.

In divisions 4RST, Canadian capelin landings have increased from <1,000 mt prior to 1976 to approximately 10,000 mt in 1978, 1979, 1989, 1992, 1998, and 2005 (DFO 2006a). This increase is due entirely to the emergence of the Japanese roe market, which has become the driving force behind the Canadian capelin fishery (DFO 2006a).

Landings in NAFO divisions 4RST have hovered between 5,000 and 10,000 landed mt per year since the late 1980s (Figure 10) (DFO 2006a). Following the establishment of a feasible TAC in the early 1980s, landings have generally fallen short of quota aside from 3,500 mt of excess catch in 1992 (DFO 2006a). Within this area, capelin landings tend to be concentrated within division 4R (the west coast of Newfoundland) as opposed to 4S and 4T; division 4R boasted 96% of the region's capelin landings in 2005 (DFO 2006a).

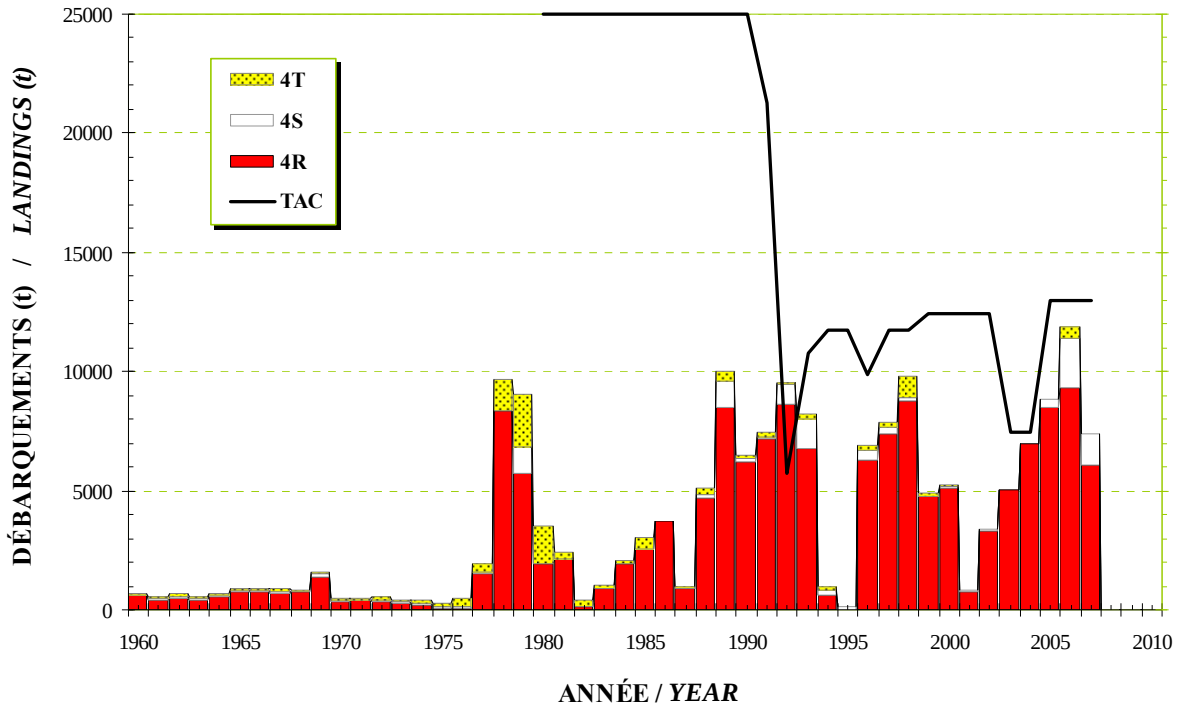


**Figure 10.** Capelin landings and TAC for NAFO divisions 4RST (Estuary and Gulf of St. Lawrence) between 1960 and 2007 (F. Grégoire, DFO, pers. comm.).

In general, the Canadian capelin fishery is operating with limited information. $B_{MSY}$ and fishing mortality figures are unknown, as are long-term abundance trends; however, hydro-acoustic surveys and mortality estimates, which seem to be more suitable to assessing capelin stocks, are used to establish catch limits. Overfishing is not believed to be occurring, but there is a lack of data which prevents a deeper understanding of the current situation, including any definitive knowledge of stock status. Short-term abundance seems to be increasing but this may simply be part of a natural population cycle. Sex and age distribution seem to be functionally normal (DFO 2000a; DFO 2000b; Carscadden et al. 2001; Gjøsaeter et al. 2002; Vilhjálmsson and Carscadden 2002; NAFO 2006c). **Overall, the status of capelin stocks in Canada is considered "moderate" according to Seafood Watch® criteria.**

***Iceland***

Capelin is one of Iceland's most important fisheries. Capelin has been one of the top two species caught in Iceland, providing approximately 20-40% of the country's total landings (Statistics Iceland 2008). Since the closure of the Barents Sea capelin fishery in 2004, the majority of all

international capelin landings have been taken by the Icelandic fleet. In the 2004/2005 season, Iceland landed 640,000 mt of capelin; the global total was 784,000 mt (MRI 2006).

Capelin in the Iceland-Greenland-Jan Mayen area is managed jointly by Iceland, Norway and Greenland. Management has set a target spawning stock of 400,000 mt to leave a sufficient amount of spawners to maintain the stock and to provide adequate prey for predators. Catch limits are predicted from estimates of juvenile abundance obtained during autumn stock assessment surveys (Gudmondsdottir and Vilhjálmsson 2002; Vilhjálmsson and Carscadden 2002).

When acoustic surveys in late 2004 failed to locate the immature capelin in the Denmark Strait, the Icelanders were forced into operating under a great deal of uncertainty. As such, the Marine Research Institute of Iceland (MRI) advised that the fishery remain closed until further data were obtained from subsequent acoustic surveys (MRI 2006).

At present, the Icelandic stocks may be undergoing a major decline. The 2006 winter capelin catch was the poorest on record. The 2005/2006 quota was set at 194,000 mt, a 76% decrease from the 2004/2005 quota of 803,000 mt (SR-Mjöl HF 2006). Icelandic capelin quotas and landings have continued to decrease since 2000 (Figure 11).

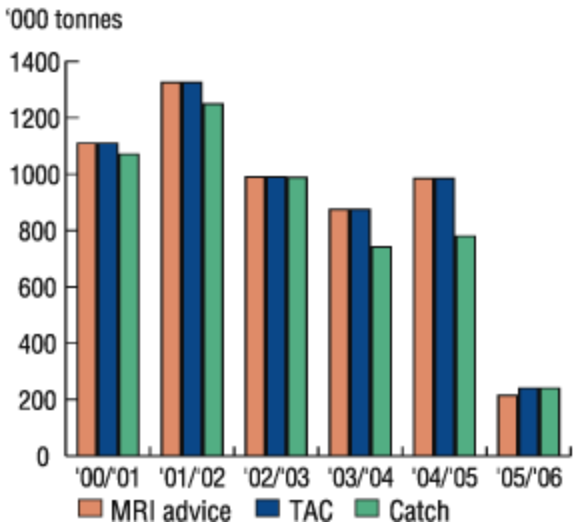


**Figure 11.** Recent Marine Research Institute of Iceland (MRI) suggested quotas, official government quotas, and landings for Icelandic capelin (Figure from ICIMF 2006).

It should be noted that the Icelandic capelin population tends to substantially decline approximately every ten years (Sigurjónsson and Vilhjálmsson 2003; FAO 2004a). The reasons for these declines are still under debate, but it is likely that they are induced by a combination of natural and anthropogenic influences, similar to what occurs among Canadian and Barents Sea capelin stocks [q.v.] (Hjermann et al. 2004).

The Icelandic fishery is currently operating under the advice of the Marine Research Institute of Iceland, which has demonstrated a level of concern about capelin stocks. The local capelin

population has decreased substantially and there are no tangible figures representing stock biomass levels or mortality. It is hypothesized that recent downward trends in abundance are simply part of the natural population dynamic of the capelin stock, but this is uncertain. Long-term abundance trends seem stable if the theory of a cyclical population is accurate. Sex and age distribution, which also indicate the status and health of a stock, seem to be functionally normal. (Sigurjónsson and Vilhjálmsson 2003; FAO 2004a; MRI 2006). **At present, Seafood Watch® ranks Icelandic capelin stocks as a moderate concern.**

**Table 2**. Stock status of capelin.

| Fishery | Classification Status | $B/B_{MSY}$ | Occurrence of Overfishing | $F/F_{MSY}$ | Abundance Trends /CPUE | Age/Size/Sex Distribution | Degree of Uncertainty in Stock Status | Sources | SFW Rank |
|---|---|---|---|---|---|---|---|---|---|
| Canada | Not overfished | Unknown (Unk.) | Unk. | Unk. | Long-term: Unk. Short-term: Upward | Normal | High | DFO 2000a; DFO 2000b; Carscadden et. al 2001; Gjøsaeter et al. 2002; Vilhjálmsson and Carscadden 2002; DFO 2006[a] | Moderate |
| Iceland | Fully exploited | 400,000 mt of remaining spawning stock as a precautionary measure | Unk. | Unk. | Long-term: Flat Short-term: Downward | Normal | Moderate | Gjøsaeter et al. 2002; Vilhjálmsson and Carscadden 2002; Sigurjónsson and Vilhjálmsson 2003; FAO 2004a; MRI 2006; SR-Mjöl HF 2006 | Moderate |

**Synthesis**

Neither Canadian nor Icelandic stocks are managed with the traditional $B_{MSY}$ and $F_{MSY}$ reference points; as such, population abundance and fishing morality are unknown. Overfishing is not believed to be occurring, but in the absence of fishing mortality data, this is not certain. Canadian stocks show a short-term increase but an unknown long-term trend; Icelandic stocks display a short-term decrease but long-term stability. Age, sex, and size distribution seem to follow standard patterns. Given this information, Seafood Watch® ranks both Canadian and Icelandic capelin stocks as moderate.

**Status of Wild Stocks Rank:**

**Canada and Iceland:**

| Healthy | **Moderate/Rebuilding** | Poor | Critical |
|---|---|---|---|

## Criterion 3: Nature and Extent of Bycatch

*Seafood Watch® defines sustainable wild-caught seafood as marine life captured using fishing techniques that successfully minimize the catch of unwanted and/or unmarketable species (i.e., bycatch). Bycatch is defined as species that are caught but subsequently discarded (injured or dead) for any reason. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, accounted for and managed in some way.*

**Canada**

The vast majority of the world's capelin catch is taken by purse seine (Figure 12). It is employed in the Canadian and Icelandic fisheries. Some mid-water pelagic trawl is also intermingled with the purse seine fleets.

**Figure 12.** Fishing for capelin using a purse seine (SR-Mjöl 2006).

Capelin in NAFO divisions 3KL is targeted by purse seines, with a small amount by mid-water pelagic trawl. The capelin fishery in NAFO divisions 4RST has historically been dominated by purse seining, but some beach seines, traps, and weirs have also been used. In recent years, the purse seine has continued to dominate the fishery, accounting for 63% of the local capelin landings (DFO 2006a).

Trap nets are only used in the Canadian capelin fishery (Figure 13) (DFO 2006a). A fish trap net consists of a long lead net that guides fish into a V-shaped enclosure (heart) and through a tunnel into a box-shaped pot (Sea Grant 2008).

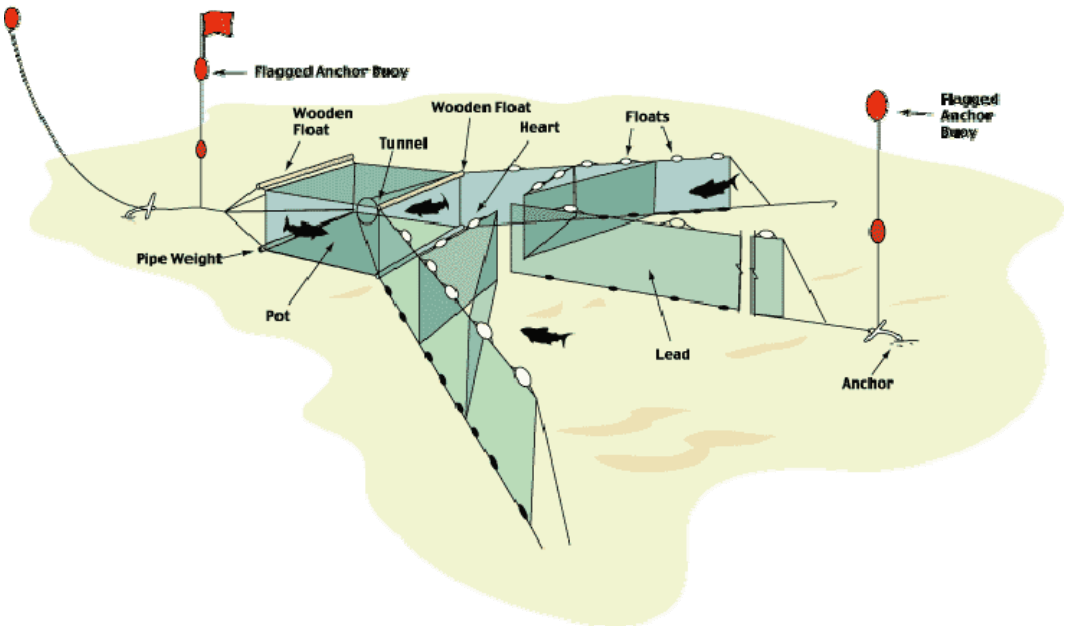


**Figure 13.** Diagram of a trap net (Sea Grant 2008)

They historically have been utilized on a relatively small scale, but have recently shown an increase in popularity, accounting for 33% of 4RST capelin landings in 2005 (DFO 2006a). Of the remainder, the vast majority was taken by purse seine, augmented by a miniscule amount caught by mid-water trawl as bycatch of the shrimp fishery (<3%). The other historical fishing methods include weirs (in the St. Lawrence Estuary) and beach seines, but weirs have not been used on any substantial scale in this fishery since 1998, and beach seines were last utilized in 1995 (DFO 2006a).

In 1994, FAO reported that the discard rate was estimated at 1.33 kg discarded per kg retained in the Canadian capelin purse seine fishery, and 0.8 kg discarded per kg retained in the Canadian capelin trap net fishery (Alverson et al. 1994). There are more recent FAO fishery bycatch documents (Kelleher 2001; Kelleher 2005), but they do not include information on the Canadian capelin fishery. However, the fishery has substantially changed since the early 1990s. The Canadian capelin fishery used to supply the Japanese roe demand. As such, only the adult females were used and the rest of the catch was dumped (CBC 2003). It has been hypothesized that the continual waste of juvenile capelin may adversely affect cod stocks by reducing their food supply (CBC 2003). As a result of this importance of capelin to the marine ecosystem and the desire to maximize benefits for all participants, wastage that occurred in the past is no longer allowed. Beginning in 2006, the Provincial Department of Fisheries and Aquaculture requires local processors to fully utilize all capelin landed in Newfoundland and Labrador (DFO 2006b).

Bycatch of salmon and cod in the capelin trap nets is a concern; however, quantitative data are not available. Effective at the beginning of the 2007 fishing season, the Provincial Department of Fisheries and Aquaculture prohibited the use of trap net leaders with mesh less than 7 inches and required that all license holders release incidental catch immediately in a manner that will cause the least amount of harm to the species. If bycatch of cod reaches high levels, the trap net fishery will be closed in the areas where the high bycatch is occurring (DFO 2006b).

The 2006-2008 Capelin Integrated Fishery Management Plan (IFMP) requires at-sea patrols to monitor bycatch, closed areas/times, catch requirements, dumping at sea, and gear restrictions. In addition, dockside observers are required in an effort to ensure the accuracy of landings. Discarding and wastage of capelin can result in closures or a reduction in the available quota based on the amount wasted (DFO 2006b).

**Iceland**

Capelin in Iceland is caught using purse seines. Icelandic fisheries follow a no-discard policy akin to those in effect in Norway and the Faeroe Islands. Each quota holder is permitted a certain amount of bycatch, which is partially deducted from the quota. The bycatch allowances are tradable between quota holders. The Icelandic Marine Research Institute has a commendable understanding of the population dynamics of the capelin stock in Icelandic waters. Acoustic targeting, juvenile school identification, and migration mapping help to reduce the chance of incidental catch and discard (MRI 2006). FAO data indicate that discard levels in the Icelandic capelin fishery are below 2% of the total catch (Kelleher 2005).

**Table 3.** Bycatch data for the capelin fishery.

| Gear | Fishery | Composition of Bycatch | Population Consequences of Bycatch | Bycatch / Target Species ratio | Trend in Quality & Quantity of Bycatch | Ecosystem Effects | Sources | SFW Rank |
|---|---|---|---|---|---|---|---|---|
| Purse Seine | Canada | Unknown | Unknown | Unknown | Unknown | Unknown | DFO 2006a&b | Moderate |
| Trap Net | Canada | Salmon and cod | Unknown | Unknown | Unknown | Unknown | DFO 2006a&b | Moderate |
| Purse Seine | Iceland | Small pelagics | Negligible | <0.02:1 | N/A because bycatch is low | Negligible | Kelleher 2005; MRI 2006 | Low |

**Synthesis**

No recent quantitative bycatch data are available for the Canadian purse seine and trap net capelin fisheries. The most recent data are from 1994, and the fishery has substantially improved their management since then, prohibiting discards of male and juvenile capelin. This lack of recent bycatch data in the Canadian capelin fisheries is deemed to be a moderate conservation concern. Iceland has no-discard legislation and enforcement ensuring discard rates of <0.02:1. The small amount of bycatch that is taken in the Icelandic fishery is most likely small pelagics and predatory fish intermingling with capelin stocks. Given this information, bycatch in the Icelandic capelin fishery is a low conservation concern.

**Nature of Bycatch Rank:**

**Purse seine – Iceland:**

**Low** Moderate High Critical

**Trap net and purse seine – Canada**

Low **Moderate** High Critical

**Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems**

**Habitat Effects**

The most popular gear type used in capelin fisheries is the purse seine. Some pelagic trawls are used as well, and some trap nets are used in Canada (Sigurjónsson and Vilhjálmsson 2003; DFO 2006a).

Purse seines are a "very low-impact" type of fishing gear as they do not directly impact the seabed or the benthic community. Mid-water pelagic trawls also do not come into contact with the benthic environment and thus have "very low impact" on the seafloor (Chuenpagdee et al. 2003; Morgan and Chuenpagdee 2003) (Figure 14). This lack of contact with the benthos, coupled with modern acoustic location and sounding practices on the part of the capelin fishermen, helps keep habitat effects to a minimum.

Trap nets are a type of fixed gear that consists of a long lead net that guides fish into a V-shaped enclosure (heart) and through a tunnel into a box-shaped pot. Trap nets are supported by flag marker buoys/floats and anchors (Sea Grant 2008). Generally speaking, fixed gears, such as trap nets, have a "medium impact" on habitat; they have fewer habitat impacts than mobile gears, such as trawls (Chuenpagdee et al. 2003). In Canada, capelin trap nets are set in shallow, sandy habitat (Carscadden et al. 2001), and the fishery is conducted on a small spatial scale, causing less of an impact on habitat.

*Figure 5* Experts' Impact Rating, Survey Severity Ranking, and Policy Implications

| GEAR CLASS | HABITAT IMPACTS: Physical | HABITAT IMPACTS: Biological | BYCATCH: Shellfish & crabs | BYCATCH: Finfish | BYCATCH: Sharks | BYCATCH: Marine mammals | BYCATCH: Sea birds & turtles | MANAGEMENT CATEGORY (Policy responses) |
|---|---|---|---|---|---|---|---|---|
| Trawls – bottom | 5 | 5 | 3 | 5 | 2 | 2 | 2 | HIGH IMPACT (Very Stringent) |
| Gillnets – bottom | 3 | 2 | 1 | 4 | 3 | 4 | 3 | |
| Dredges | 5 | 5 | 4 | 2 | 1 | 1 | 1 | |
| Gillnets – midwater | 1 | 1 | 1 | 4 | 4 | 5 | 5 | |
| Pots and traps | 3 | 2 | 4 | 2 | 1 | 3 | 1 | MEDIUM IMPACT (Moderately Stringent) |
| Longlines – pelagic | 1 | 1 | 1 | 3 | 4 | 3 | 5 | |
| Longlines – bottom | 2 | 2 | 1 | 4 | 3 | 1 | 2 | |
| Trawls – midwater | 1 | 1 | 1 | 3 | 2 | 2 | 2 | LOW IMPACT (Least Stringent) |
| Purse seines | 1 | 1 | 1 | 2 | 2 | 3 | 2 | |
| Hook and line | 1 | 1 | 1 | 2 | 3 | 1 | 2 | |

KEY: 5 VERY HIGH IMPACT 4 HIGH IMPACT 3 MEDIUM IMPACT 2 LOW IMPACT 1 VERY LOW IMPACT

**Figure 14.** Experts' Impact Rating, Survey Severity Ranking, and Policy Implications (Morgan and Chuenpagdee 2003).

## Ecosystem Impacts

The ecosystem effects of the capelin fishery are a different matter. However important the capelin fishery may be to the Nordic and Canadian economies, it must be recognized that these fish have as much importance, if not more importance, as prey for 20 fish species including cod (*Gadus morhua*), saithe (*Pollachius virens*), Atlantic herring (*Clupea harengus*), and other predators (Jóhannsdottir and Vilhjálmsson 1999; Dolgov 2002; Hjermann et al. 2004; ICES 2006). Adult capelin is an extremely important source of food for a number of larger fish, many with substantial commercial value. In the Atlantic, capelin is known to be a major prey item for local predators; the Canadian government has recognized that capelin is one of the most, if not the most, important forage species in the Gulf of St. Lawrence marine ecosystem (DFO 2005). Research has shown that the breeding success of some seabirds, such as black-legged kittiwakes, is somewhat dependent on the availability of capelin as prey (Carscadden et al. 2002). Should capelin populations decrease, the health of local cod (*Gadus morhua*), redfish (*Sebastes* spp.), and other predatory stocks may be adversely affected as well (CBC 2003; DFO 2005).

In Canada, there is much discontent among certain biologists and industry members over the capelin industry. Some researchers have suggested that the large catches and high level of dumping may threaten the already depleted cod stocks by decreasing the amount of available prey (CBC 2003). In parallel, Icelandic fisheries scientists have surmised that the current downward trend in the abundance and weight of cod and groundfish off the Icelandic shelf can be attributed to diminished numbers of capelin in the area. In fact, cod stomach sampling has revealed a decreasing proportion of capelin compared to previous years (MRI 2006).

Investigations into population crashes among Barents Sea capelin has led researchers to the conclusion that capelin is an extremely important fish in the marine food web – so much so that recommendations have been made to manage capelin stocks in conjunction with cod and herring in a multispecies/community level management plan (Ushakov and Prozorkevich 2002; Hjermann et al. 2004).

**Table 4.** Habitat and ecosystem effects of the capelin fishery.

| Gear Type | Effect of Fishing Gear on Habitats | Habitat Resilience to Disturbance | Spatial Scale of Impact | Evidence of Food Web Disruption | Evidence of Ecosystem Changes | Sources | SFW Rank |
|---|---|---|---|---|---|---|---|
| Purse Seine / Pelagic trawl | Low | Not applicable because gear damage is minimal | Not applicable because gear damage is minimal | Cod, herring, and other fish feed on capelin | Possible impacts on stock strength of cod, herring, and other fish | Jóhanssdottir and Vilhjálmsson 1999; Hjermann et al. 2004; DFO 2005; ICES 2006; MRI 2006 | Moderate |
| Trap net | Moderate | High | Small scale | Cod, herring, and other fish feed on capelin | Possible impacts on stock strength of cod, herring, and other fish | Jóhanssdottir and Vilhjálmsson 1999; Hjermann et al. 2004; DFO 2005; ICES 2006; MRI 2006 | Moderate |

**Synthesis**

The worldwide capelin fishery generally relies on fishing methods with benign habitat impacts, most commonly purse seines. There is little to no habitat disruption and minimal interaction with the benthos when this gear is used. There is a growing segment of the Canadian fishery which is relying on trap nets to catch capelin. Traps are generally known to have moderate impacts on habitat; the trap nets are set in shallow sandy habitat and are conducted on a relatively small spatial scale. Ecosystem effects are more ominous, as various researchers, scientists, and industry figures from Canada to the Barents Sea have concluded that the link between capelin as a forage fish and predatory populations is too important to ignore. If the fishery does not account for the reliance of cod, herring, and other stocks on capelin, these dependant populations may be impacted by the capelin fishery.

**Effect of Fishing Practices Rank:**

Benign | **Moderate** | Severe | Critical

## Criterion 5: Effectiveness of the Management Regime

***Canada***

Prior to the 1950s, the Canadian fishery only caught approximately 20,000-25,000 tons of capelin per year, primarily for bait, fertilizer, and food for sled dog teams. During the 1970s, the interest in capelin as a commercial species increased (Carscadden 1983). The fishery expanded quickly and soon reached its historical maximum catch, landing 132,000 mt in 1975 (Golovanov and Gorchinsky 2006). However, the vast majority of these landings were taken by Russian (former Soviet) and Norwegian ships operating in international waters (NAFO 2006a). In later years, due to changes in international law, catches in this area have become almost entirely Canadian (NAFO 2006a).

The emergence of the Japanese roe market in the late 1970s served to increase demand for capelin, but a closure was instituted in divisions 3NO in 1979 in response to ever-increasing TACs coupled with diminishing landings (Golovanov and Gorchinsky 2006). With the establishment of the 3NO closure, the Canadian fleet shifted its attention to stocks in divisions 3KL and 4RST. Capelin roe has proven to be a more highly valued product than capelin itself, and the Canadian fishery moved away from its historical ties to fishmeal and fish oil production in favor of roe harvesting.

Capelin stocks in the Northwest Atlantic have historically been jointly managed by NAFO and the Canadian Department of Fisheries and Oceans (DFO). While NAFO is charged with overseeing catches in international waters, Canadian authorities retain jurisdiction over fisheries falling within the 200-mile Canadian exclusive economic zone. This latter delineation encompasses a large portion of divisions 3KLNO; it also includes all of the inshore capelin fishery of the Estuary and Gulf of St. Lawrence (divisions 4RST) which boasted 8,585 mt of landed capelin in 2005 (DFO 2006a). Although capelin stocks falling under direct NAFO jurisdiction are not technically within Canadian waters, they are exploited almost exclusively by the Canadian fishing fleet and thus are included in the "Canadian" management section of this report. Moreover, divisions 3NO are currently closed to capelin catch; the Canadian fleet catches the majority of its capelin in divisions 3KL and 4RST (DFO 2005; DFO 2006a).

Due to the biology and nature of capelin, the capelin fisheries are not managed using $B_{MSY}$ and $F_{MSY}$ reference points. Instead, DFO projects mature stock biomass based on acoustic surveys and estimated survival rates. They set precautionary TACs at 10% of the projected mature stock biomass (Vilhjálmsson and Carscadden 2002, Gjøsaeter et al. 2002). DFO last conducted an acoustic survey of the capelin fishery in divisions 3KL in 2000 and in divisions 4RST in 2005 (DFO 2005).

DFO has recently began requiring at-sea patrols to monitor bycatch, closed areas/times, catch requirements, dumping at sea, and gear restrictions. In addition, dockside observers are required in an effort to ensure the accuracy of landings. Discarding and wastage of capelin can result in closures or a reduction in the available quota based on the amount wasted (DFO 2006b). This program began in 2007; therefore, its effectiveness has yet to be determined.

In 1990, DFO implemented a 50,000 pound trip limit in the purse seine fishery in 2J3KL and 3Ps. In 2005, the trip limit in the purse seine fishery was discontinued and replaced with a daily limit of 100,000 pounds, which was then reduced to 75,000 pounds in 2006. Daily limits of 70,000 pounds were introduced in the trap net fishery in 2006. The goal of these limits is to slow down the fishing rate and improve quota monitoring (DFO 2006b).

The purse seine fishery operates with a fixed opening date. The fixed gear fleets establish opening dates based on the results of the Industry Monitoring Committee sampling or the purse seine fishery's landings. The season remains open as long as there is quota remaining. Closures are based on reported landings and projected catch. The fishery may also be closed if there is evidence of dumping or wastage at sea, as catches are adjusted upwards to reflect the estimated amount of discards (DFO 2006b).

The traditional biological reference points ($B_{MSY}$ and $F_{MSY}$) are not known in the Canadian capelin fishery. DFO uses acoustic surveys to project mature stock biomass and to set TACs; however, the surveys have not been conducted in a few years and may be out of date. The TACs are set at a precautionary level of 10% of mature stock biomass. In 2007, DFO implemented a bycatch plan but its effectiveness has not yet been determined. The Canadian capelin TAC and landings have varied over time, and there is limited information on stock abundance. As such, it is unclear if management has effectively maintained the stock over time. Given this information, Seafood Watch® considers the Canadian management regime to be moderately effective.

***Iceland***

Although Iceland has landed capelin in large quantities since the 1950s, the targeted Icelandic capelin fishery began as a coastal winter fishery in 1964 (Figure 15) (Sigurjónsson and Vilhjálmsson 2003; FAO 2004a). Gradual expansion led to the exploitation of capelin stocks in eastern Icelandic waters by 1972, and a summer fishery began in the north of Iceland in 1976 (Sigurjónsson and Vilhjálmsson 2003). The modern fishery operates well offshore in the summer and autumn; winter fishing is limited to the shallow coastal waters (Sigurjónsson and Vilhjálmsson 2003). Stocks are targeted by fleets from Iceland, the Faeroe Islands, mainland Denmark, Greenland, and Norway.

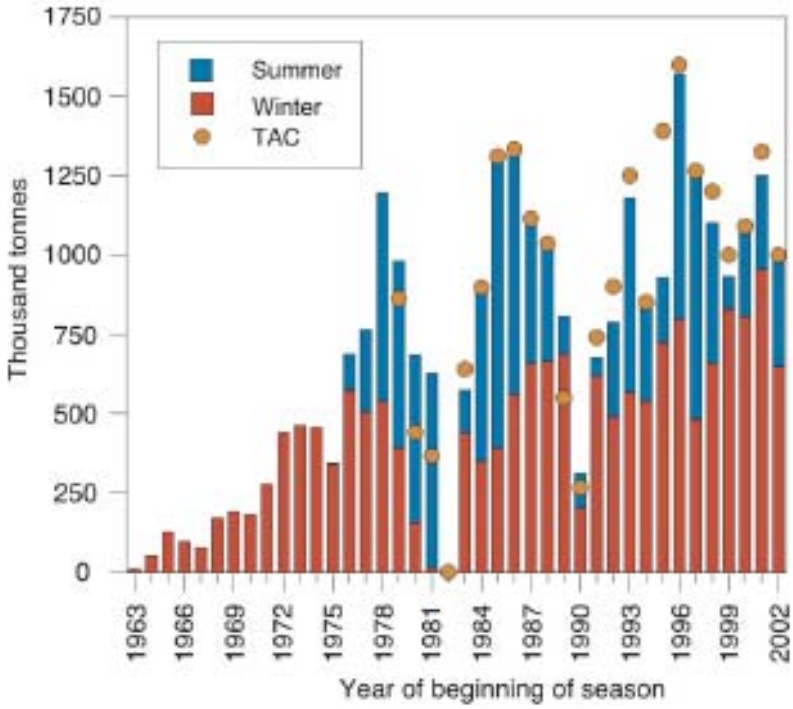


**Figure 15.** Total seasonal TACs and international catches of Icelandic capelin from 1963-64 to 2002-03 (Sigurjónsson and Vilhjálmsson 2003).

Beginning in 1980, Icelandic capelin stocks have been managed under an individual quota system (FIFVO 2006). At first the quotas were attached to particular vessels, but as of 1986, a tradability clause was introduced that transformed the management regime into an individual tradable quota (ITQ) system (FIFVO 2006).

The Icelandic capelin fishery management goal is to preserve a level of spawning stock that will protect the fishery by ensuring propagation to sustainable catch levels under normal environmental conditions. The TAC hinges on population and abundance estimates that are based primarily on acoustic surveys as well as historical relationships between stock size, natural mortality, and growth conditions. Since the 1979/1980 season, the target remaining spawning stock biomass (SSB) has been 400,000 mt (Figure 16) (Sigurjónsson and Vilhjálmsson 2003; MRI 2006). This estimate is a safeguard mechanism to be used in lieu of an actual biomass reference point to protect spawning stock from excessive fishing pressure (MRI 2006).

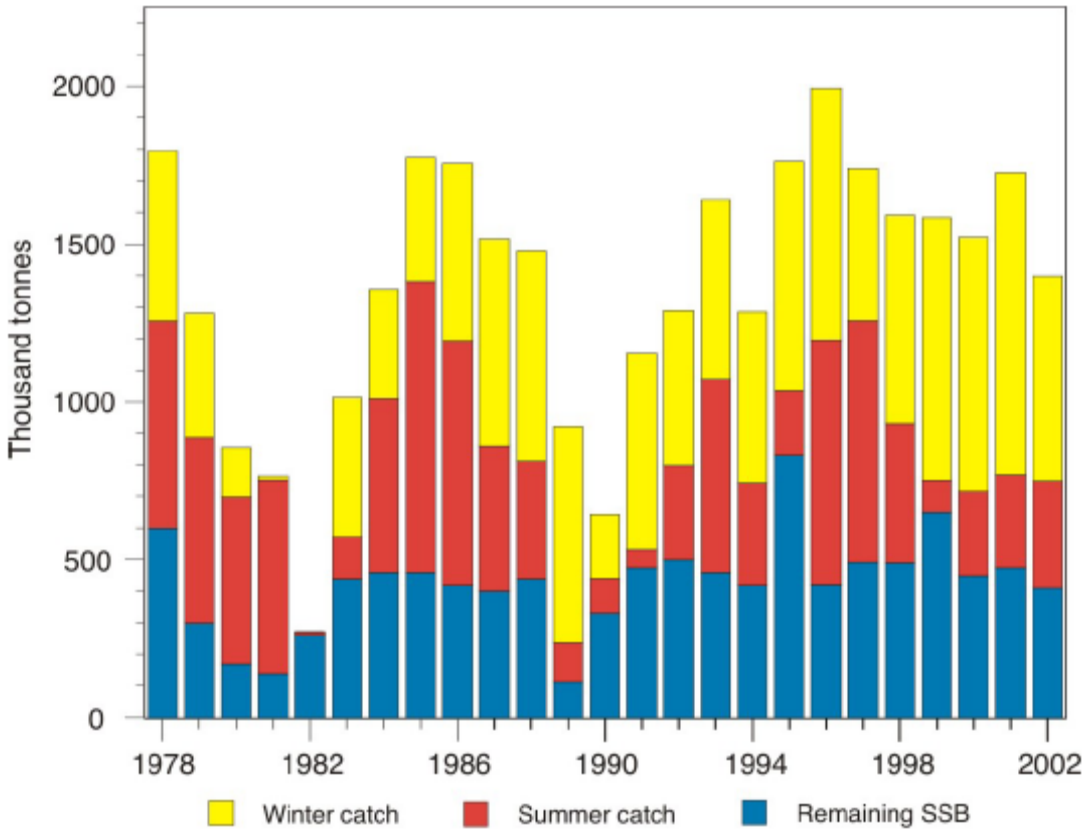


**Figure 16.** International fishery for Icelandic capelin and SSB remaining at the end of the season (Sigurjónsson and Vilhjálmsson 2003).

The Icelandic management authorities have a strong knowledge of the movements and migrations of their local capelin stocks. Generally, the stocks are measured by acoustic trawl survey twice per year, once in late autumn and once in mid-winter. The fishery targets the adult stock; areas with high concentrations of juveniles are closed to the fishery (Gudmundsdottir and Vilhjálmsson 2002; Sigurjónsson and Vilhjálmsson 2003).

In summary, Iceland has a strong management program that conducts regular, independent monitoring and research on the health and behavior of local capelin stocks. The government and fishing industry has a history of judiciously following the advice given by the Marine Research Institute, and declines in population are quickly and sometimes severely addressed in the establishment of quotas designed to protect a set spawning stock (Sigurjónsson and Vilhjálmsson 2003; FIFVO 2006; MRI 2006). Seafood Watch® ranks Icelandic management as highly effective.

**Table 5.** Management measures for the commercial capelin fishery.

| Fishery | Management Jurisdictions & Agencies | Total Allowable Landings | Size Limit | Gear Restrictions | Trip Limit | Closures | Sources |
|---|---|---|---|---|---|---|---|
| Canada | DFO, NAFO | Varies by quota, region, and year; 10% of projected mature stock biomass | None | Fixed gear: max. of 2 traps and 1 bar seine per fishing enterprise; Traps: any mesh less than 7 inches is prohibited | Purse seine: daily limit of 75,000 pounds Fixed gear: daily limit NTE 70,000 pounds | Seasonal | DFO 2005; DFO 2006a&b; Golovanov and Gorchinsky 2006; NAFO 2006a |
| Iceland | ICES, MRI | All capelin above safeguard stock of 400,000 mt | Adult capelin only | 21 mm minimum mesh size purse seine | Varies | Seasonal | Sigurjónsson and Vilhjálmsson 2003; FIFVO 2006; ICES 2006; MRI 2006 |

**Synthesis**

The traditional biological reference points are not known in the Canadian capelin fishery. DFO uses acoustic surveys to set TACs, but these surveys have not been conducted in a few years. In 2007, DFO implemented a bycatch plan but its effectiveness has not yet been determined. The Canadian capelin TAC and landings have varied over time, and there is limited information on stock abundance. As such, it is unclear if management has effectively maintained the stock over time. Given this information, Seafood Watch® considers the Canadian management regime to be moderately effective.

Nordic management regimes and protocols are generally strong, progressive, and seemingly effective. Governments are known to follow the advice of the domestic and international scientific bodies that offer quota recommendations on the capelin stocks. The efforts of ICES, MRI, and the Icelandic and Norwegian governments are stymied to some extent by a lack of essential scientific data, but research continues. Until necessary biomass benchmarks and mortality figures are obtained, Iceland uses a precautionary measure to safeguard a remaining stock judged to be sufficient to support the fishery and ecosystem. Given this information, Seafood Watch® ranks the Icelandic management regime as highly effective.

**Effectiveness of Management Rank:**

**Iceland:**

**Highly Effective** Moderately Effective Ineffective Critical

**Canada:**

Highly Effective | **Moderately Effective** | Ineffective | Critical

## IV. Overall Evaluation and Seafood Recommendation

Life history characteristics such as high fecundity and rapid maturation make capelin resilient to fishing pressure. Capelin stocks seem to follow a natural population cycle, although not enough information is available to conduct any definitive analyses of stock status, and the magnitude of the anthropogenic factors involved in this population cycle remain under debate. Bycatch is generally not a concern in the Icelandic fishery, whereas recent bycatch levels in the Canadian capelin fisheries are unknown. As a forage fish, capelin play an integral role in the ecosystem. Overall, the habitat and ecosystem impacts of the capelin fishery are a moderate concern. The management regime in Iceland is making strides towards thoughtful and integrated policies, and is considered highly effective, but it is unknown if Canadian management measures have maintained the productivity of the capelin stock. Management is ranked as moderately effective.

*Masago* from Icelandic capelin is the most sustainable option in the US market due to high inherent resilience to fishing pressure, sound bycatch elimination legislation and protocol, and progressive management techniques. Norwegian and Faeroese vessels fishing Icelandic stocks can be assumed to be operating under similar conditions and thus produce a sustainable product. *Masago* from Iceland is recommended as a "Best Choice." Canadian *masago* receives a recommendation of "Good Alternative" due to an uncertain stock status, moderate bycatch rates and moderately effective management.

## Table of Sustainability Ranks

| | Conservation Concern | | | |
|---|---|---|---|---|
| **Sustainability Criteria** | **Low** | **Moderate** | **High** | **Critical** |
| Inherent Vulnerability | √ | | | |
| Status of Stocks | | √ (Canada, Iceland) | | |
| Nature of Bycatch | √ (Iceland: Purse Seine) | √ (Canada: Purse seine and trap net) | | |
| Habitat & Ecosystem Effects | | √ | | |
| Management Effectiveness | √ (Iceland) | √ (Canada) | | |

## Overall Seafood Recommendation:

**Iceland:**

**Best Choice** Good Alternative Avoid

**Canada:**

Best Choice **Good Alternative** Avoid

## Acknowledgements

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*Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.*

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# VI. Appendix I

## Capture Fisheries Evaluation

| | |
|---|---|
| **Species**: *Capelin* | **Region:** *Sushi* |
| **Analysts**: *Casson Trenor & Stephanie Danner* | **Date:** *August 20, 2008* |

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following **guiding principles** illustrate the qualities that capture fisheries must possess to be considered sustainable by the Seafood Watch program. Species from sustainable capture fisheries:

- have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics;
- have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity;
- are captured using techniques that minimize the catch of unwanted and/or unmarketable species;
- are captured in ways that maintain natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and do not result in irreversible ecosystem state changes; and
- have a management regime that implements and enforces all local, national and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

Seafood Watch has developed a set of five sustainability **criteria**, corresponding to these guiding principles, to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Inherent vulnerability to fishing pressure
2. Status of wild stocks
3. Nature and extent of discarded bycatch
4. Effect of fishing practices on habitats and ecosystems
5. Effectiveness of the management regime

Each criterion includes:

- Primary factors to evaluate and rank
- Secondary factors to evaluate and rank
- Evaluation guidelines[2] to synthesize these factors
- A resulting **rank** for that criterion

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other wild-caught invertebrates.
[2] Evaluation Guidelines throughout this document reflect common combinations of primary and secondary factors that result in a given level of conservation concern. Not all possible combinations are shown – other combinations should be matched as closely as possible to the existing guidelines.

Once a rank has been assigned to each criterion, an **overall seafood recommendation** for the species in question is developed based on additional evaluation guidelines. The ranks for each criterion, and the resulting overall seafood recommendation, are summarized in a table. Criterion ranks and the overall seafood recommendation are color-coded to correspond to the categories of the Seafood Watch pocket guide:

**Best Choices/Green:** Consumers are strongly encouraged to purchase seafood in this category. The wild-caught species is sustainable as defined by Seafood Watch.

**Good Alternatives/Yellow:** Consumers are encouraged to purchase seafood in this category, as they are better choices than seafood in the Avoid category. However there are some concerns with how this species is fished and thus it does not demonstrate all of the qualities of a sustainable fishery as defined by Seafood Watch.

**Avoid/Red:** Consumers are encouraged to avoid seafood in this category, at least for now. Species in this category do not demonstrate enough qualities to be defined as sustainable by Seafood Watch.

## CRITERION 1: INHERENT VULNERABILITY TO FISHING PRESSURE

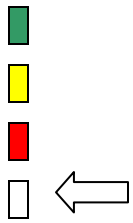
*Guiding Principle:* Sustainable wild-caught species have a low vulnerability to fishing pressure, and hence a low probability of being overfished, because of their inherent life history characteristics.

---

***Primary Factors[3] to evaluate***

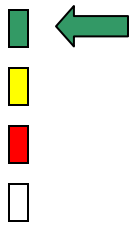
Intrinsic rate of increase ('r')

- High (> 0.16)
- Medium (0.05 - 0.16)
- Low (< 0.05)
- Unavailable/Unknown



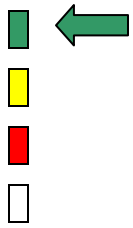
Age at 1st maturity

- Low (< 5 years) **2 – 5 years**
- Medium (5 - 10 years)
- High (> 10 years)
- Unavailable/Unknown



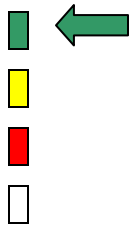
Von Bertalanffy growth coefficient ('k')

- High (> 0.16) **0.5**
- Medium (0.05 - 0.15)
- Low (< 0.05)
- Unavailable/Unknown



Maximum age

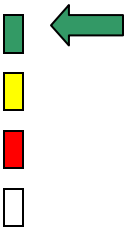
- Low (< 11 years) **5 – 6 years**
- Medium (11 - 30 years)
- High (> 30 years)
- Unavailable/Unknown



[3] These primary factors and evaluation guidelines follow the recommendations of Musick et al. (2000). Marine, estuarine, and diadromous fish stocks at risk of extinction in North America (exclusive of Pacific salmonids). Fisheries 25:6-30.

Reproductive potential (fecundity)

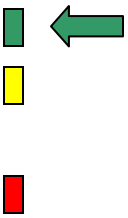
- High (> 100 inds./year)
- Moderate (10 – 100 inds./year)
- Low (< 10 inds./year)
- Unavailable/Unknown



***Secondary Factors to evaluate***

Species range

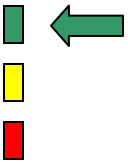
- Broad (e.g. species exists in multiple ocean basins, has multiple intermixing stocks or is highly migratory)
- Limited (e.g. species exists in one ocean basin)
- Narrow (e.g. endemism or numerous evolutionary significant units or restricted to one coastline)



Special Behaviors or Requirements: Existence of special behaviors that increase ease or population consequences of capture (e.g. migratory bottlenecks, spawning aggregations, site fidelity, unusual attraction to gear, sequential hermaphrodites, segregation by sex, etc., OR specific and limited habitat requirements within the species' range).

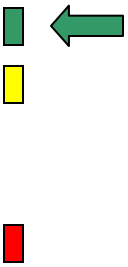
- No known behaviors or requirements OR behaviors that decrease vulnerability (e.g. widely dispersed during spawning)

  Some (i.e. 1 - 2) behaviors or requirements
- Many (i.e. > 2) behaviors or requirements



Quality of Habitat: Degradation from non-fishery impacts

- Habitat is robust
- Habitat has been moderately altered by non-fishery impacts
- Habitat has been substantially compromised from non-fishery impacts and thus has reduced capacity to support this species (e.g. from dams, pollution, or coastal development)



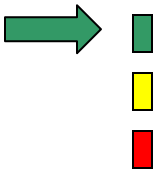
### *Evaluation Guidelines*

1) Primary Factors
   a) If 'r' is known, use it as the basis for the rank of the Primary Factors.
   b) If 'r' is unknown, then the rank from the remaining Primary Factors (in order of importance, as listed) is the basis for the rank.

2) Secondary Factors
   a) If a majority (2 out of 3) of the Secondary Factors rank as Red, reclassify the species into the next lower rank (i.e. Green becomes Yellow, Yellow becomes Red). No other combination of Secondary Factors can modify the rank from the Primary Factors.
   b) No combination of primary and secondary factors can result in a Critical Conservation Concern for this criterion.

**Conservation Concern: Inherent Vulnerability**

- Low (Inherently Resilient)
- Moderate (Inherently Neutral)
- High (Inherently Vulnerable)



## CRITERION 2: STATUS OF WILD STOCKS

*Guiding Principle*: Sustainable wild-caught species have stock structure and abundance sufficient to maintain or enhance long-term fishery productivity.

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### *Primary Factors to evaluate*

Management classification status

- Underutilized OR close to virgin biomass
- **Fully fished (Iceland)** OR recovering from overfished OR **Unknown (Canada)** 
- Recruitment or growth overfished, overexploited, depleted or "threatened"

Current population abundance relative to $B_{MSY}$

- At or above $B_{MSY}$ (> 100%)
- Moderately Below $B_{MSY}$ (50 – 100%) OR **Unknown (Canada, Iceland)** 
- Substantially below $B_{MSY}$ (< 50%)

Occurrence of overfishing (current level of fishing mortality relative to overfishing threshold)

- Overfishing not occurring ($F_{curr}/F_{msy}$ < 1.0)
- Overfishing is likely/probable OR fishing effort is increasing with poor understanding of stock status OR **Unknown (Canada, Iceland)** 
- Overfishing occurring ($F_{curr}/F_{msy}$ > 1.0)
- N/A because the fishery is closed

Overall degree of uncertainty in status of stock

- Low (i.e. current stock assessment and other fishery-independent data are robust OR reliable long-term fishery-dependent data available)
- Medium (i.e. only limited, fishery-dependent data on stock status are available) **(Canada, Iceland)** 
- High (i.e. little or no current fishery-dependent or independent information on stock status OR models/estimates broadly disputed or otherwise out-of-date)

Long-term trend (relative to species' generation time) in population abundance as measured by either fishery-independent (stock assessment) or fishery-dependent (standardized CPUE) measures

- Trend is up
- Trend is flat or variable (among areas, over time or among methods) OR **Unknown** (**Canada, Iceland**)
- Trend is down

Short-term trend in population abundance as measured by either fishery-independent (stock assessment) or fishery-dependent (standardized CPUE) measures

- Trend is up **(Canada)**
- Trend is flat or variable (among areas, over time or among methods) OR Unknown
- Trend is down (**Iceland**)

Current age, size or sex distribution of the stock relative to natural condition

- Distribution(s) is(are) functionally normal (**Canada, Iceland**)
- Distribution(s) unknown
- Distribution(s) is(are) skewed

### *Evaluation Guidelines*

**A "Healthy" Stock:**

**1)** Is underutilized (near virgin biomass)
**2)** Has a biomass at or above BMSY AND overfishing is not occurring AND distribution parameters are functionally normal AND stock uncertainty is not high

**A "Moderate" Stock:**

**1)** Has a biomass at 50-100% of BMSY AND overfishing is not occurring
**2)** Is recovering from overfishing AND short-term trend in abundance is up AND overfishing not occurring AND stock uncertainty is low
**3)** Has an Unknown status because the majority of primary factors are unknown.

**A "Poor" Stock:**

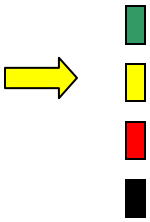
**1)** Is fully fished AND trend in abundance is down AND distribution parameters are skewed
**2)** Is overfished, overexploited or depleted AND trends in abundance and CPUE are up.
**3)** Overfishing is occurring AND stock is not currently overfished.

A stock is considered a **Critical Conservation Concern** and the species is ranked "Avoid**"**, regardless of other criteria, if it is:

**1)** Overfished, overexploited or depleted AND trend in abundance is flat or down
**2)** Overfished AND overfishing is occurring
**3)** Listed as a "threatened species" or similar proxy by national or international bodies

**Conservation Concern: Status of Stocks**

- Low (Stock Healthy)
- Moderate (Stock Moderate or Unknown) (**Canada, Iceland**)
- High (Stock Poor)
- Stock Critical



## CRITERION 3: NATURE AND EXTENT OF DISCARDED BYCATCH[4]

*Guiding Principle:* A sustainable wild-caught species is captured using techniques that minimize the catch of unwanted and/or unmarketable species.

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### *Primary Factors to evaluate*

Quantity of bycatch, including any species of "special concern" (i.e. those identified as "endangered", "threatened" or "protected" under state, federal or international law)

- Quantity of bycatch is low (< 10% of targeted landings on a per number basis) AND does not regularly include species of special concern (**Purse seine: Iceland)**

- Quantity of bycatch is moderate (10 – 100% of targeted landings on a per number basis) AND does not regularly include species of special concern OR **Unknown** (**Canada: trap and purse seine**)

- Quantity of bycatch is high (> 100% of targeted landings on a per number basis) OR bycatch regularly includes threatened, endangered or protected species

Population consequences of bycatch

- Low: Evidence indicates quantity of bycatch has little or no impact on population levels (**Iceland**)

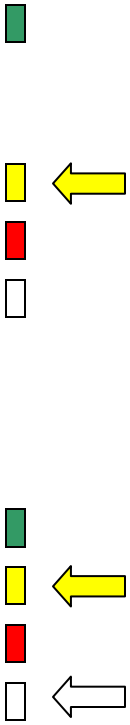
- Moderate: Conflicting evidence of population consequences of bycatch OR **Unknown** (**Canada: trap and purse seine**)

- Severe: Evidence indicates quantity of bycatch is a contributing factor in driving one or more bycatch species toward extinction OR is a contributing factor in limiting the recovery of a species of "special concern"

[4] Bycatch is defined as species that are caught but subsequently discarded because they are of undesirable size, sex or species composition. Unobserved fishing mortality associated with fishing gear (e.g. animals passing through nets, breaking free of hooks or lines, ghost fishing, illegal harvest and under or misreporting) is also considered bycatch. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, is accounted for, and is managed in some way.

Trend in bycatch interaction rates (adjusting for changes in abundance of bycatch species) as a result of management measures (including fishing seasons, protected areas and gear innovations):

- Trend in bycatch interaction rates is down
- Trend in bycatch interaction rates is flat OR **Unknown** (**Canada: trap and purse seine**)
- Trend in bycatch interaction rates is up
- Not applicable because quantity of bycatch is low (**Iceland**)



***Secondary Factor to evaluate***

Evidence that the ecosystem has been or likely will be substantially altered (relative to natural variability) in response to the continued discard of the bycatch species

- Studies show no evidence of ecosystem impacts
- Conflicting evidence of ecosystem impacts OR **Unknown** (**Canada**)
- Studies show evidence of substantial ecosystem impacts
- N/A because bycatch is low (**Iceland)**



***Evaluation Guidelines***

Bycatch is **"Minimal"** if:

1) Quantity of bycatch is <10% of targeted landings AND bycatch has little or no impact on population levels.

Bycatch is **"Moderate"** if:

1) Quantity of bycatch is 10 - 100% of targeted landings
2) Bycatch regularly includes species of "special concern" AND bycatch has little or no impact on the bycatch population levels AND the trend in bycatch interaction rates is not up.

Bycatch is "**Severe**" if:

1) Quantity of bycatch is > 100% of targeted landings
2) Bycatch regularly includes species of "special concern" AND evidence indicates bycatch rate is a contributing factor toward extinction or limiting recovery AND trend in bycatch is down.

Bycatch is considered a **Critical Conservation Concern** and the species is ranked "Avoid", regardless of other criteria, if:

1) Bycatch regularly includes species of special concern AND evidence indicates bycatch rate is a factor contributing to extinction or limiting recovery AND trend in bycatch interaction rates is not down.
2) Quantity of bycatch is high AND studies show evidence of substantial ecosystem impacts.

**Conservation Concern: Nature and Extent of Discarded Bycatch**

- Low (Bycatch Minimal) (**Iceland**) 
- Moderate (Bycatch Moderate) (**Canada: trap and purse seine**) 
- High (Bycatch Severe)
- Bycatch Critical

## CRITERION 4: EFFECT OF FISHING PRACTICES ON HABITATS AND ECOSYSTEMS

*Guiding Principle*: Capture of a sustainable wild-caught species maintains natural functional relationships among species in the ecosystem, conserves the diversity and productivity of the surrounding ecosystem, and does not result in irreversible ecosystem state changes.

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### *Primary Habitat Factors to evaluate*

Known (or inferred from other studies) effect of fishing gear on physical and biogenic habitats

- Minimal damage (i.e. pelagic longline, midwater gillnet, midwater trawl, purse seine, hook and line, or spear/harpoon) (**Purse seine: Canada, Iceland**)
- Moderate damage (i.e. bottom gillnet, bottom longline or some pots/ traps) OR Unknown (**Trap net: Canada)**
- Great damage (i.e. bottom trawl or dredge)

For specific fishery being evaluated, resilience of physical and biogenic habitats to disturbance by fishing method

- High (e.g. shallow water, sandy habitats) (**Trap net: Canada**)
- Moderate (e.g. shallow or deep water mud bottoms, or deep water sandy habitats)
- Low (e.g. shallow or deep water corals, shallow or deep water rocky bottoms)
- Not applicable because gear damage is minimal (**Purse seine: Canada, Iceland**)

If gear impacts are moderate or great, spatial scale of the impact

- Small scale (e.g. small, artisanal fishery or sensitive habitats are strongly protected) (**Trap: Canada**)
- Moderate scale (e.g. modern fishery but of limited geographic scope)
- Large scale (e.g. industrialized fishery over large geographic areas)
- Not applicable because gear damage is minimal (**Purse seine: Canada, Iceland**)

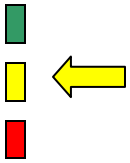
### *Primary Ecosystem Factors to evaluate*

Evidence that the removal of the targeted species or the removal/deployment of baitfish has or will likely substantially disrupt the food web

- The fishery and its ecosystem have been thoroughly studied, and studies show no evidence of substantial ecosystem impacts
- Conflicting evidence of ecosystem impacts OR Unknown
- Ecosystem impacts of targeted species removal demonstrated

Evidence that the fishing method has caused or is likely to cause substantial ecosystem state changes, including alternate stable states

- The fishery and its ecosystem have been thoroughly studied, and studies show no evidence of substantial ecosystem impacts
- Conflicting evidence of ecosystem impacts OR **Unknown**
- Ecosystem impacts from fishing method demonstrated



### *Evaluation Guidelines*

The effect of fishing practices is **"Benign"** if:

1) Damage from gear is minimal AND resilience to disturbance is high AND neither Ecosystem Factor is red.

The effect of fishing practices is "**Moderate**" if:

1) Gear effects are moderate AND resilience to disturbance is moderate or high AND neither Ecosystem Factor is red.
2) Gear results in great damage AND resilience to disturbance is high OR impacts are small scale AND neither Ecosystem Factor is red.
3) Damage from gear is minimal and one Ecosystem factor is red.

The effect of fishing practices **is "Severe"** if:

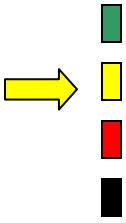
1) Gear results in great damage AND the resilience of physical and biogenic habitats to disturbance is moderate or low.
2) Both Ecosystem Factors are red.

Habitat effects are considered a **Critical Conservation Concern** and a species receives a recommendation of "**Avoid"**, regardless of other criteria if:

- Four or more of the Habitat and Ecosystem factors rank red.

**Conservation Concern: Effect of Fishing Practices on Habitats and Ecosystems**

- Low (Fishing Effects Benign)
- Moderate (Fishing Effects Moderate) (**All**)
- High (Fishing Effects Severe)
- Critical Fishing Effects



## CRITERION 5: EFFECTIVENESS OF THE MANAGEMENT REGIME

*Guiding Principle*: The management regime of a sustainable wild-caught species implements and enforces all local, national and international laws and utilizes a precautionary approach to ensure the long-term productivity of the resource and integrity of the ecosystem.

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### *Primary Factors to evaluate*

Stock Status: Management process utilizes an independent scientific stock assessment that seeks knowledge related to the status of the stock

- Stock assessment complete and robust (**Iceland**)
- Stock assessment is planned or underway but is incomplete OR **stock assessment complete but out-of-date or otherwise uncertain** (**Canada**)
- No stock assessment available now and none is planned in the near future

Scientific Monitoring: Management process involves regular collection and analysis of data with respect to the short and long-term abundance of the stock

- Regular collection and assessment of both fishery-dependent and independent data (**Iceland**)
- Regular collection of fishery-dependent data only **(Canada)**
- No regular collection or analysis of data

Scientific Advice: Management has a well-known track record of consistently setting or exceeding catch quotas beyond those recommended by its scientific advisors and other external scientists:

- No (**Iceland & Canada**)
- Yes
- Not enough information available to evaluate OR not applicable because little or no scientific information is collected

Bycatch: Management implements an effective bycatch reduction plan

- Bycatch plan in place and reaching its conservation goals (deemed effective)
- Bycatch plan in place but effectiveness is not yet demonstrated or is under debate **(Canada)**
- No bycatch plan implemented or bycatch plan implemented but not meeting its conservation goals (deemed ineffective)
- Not applicable because bycatch is "low" (**Iceland**)

Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems

- Mitigative measures in place and deemed effective
- Mitigative measures in place but effectiveness is not yet demonstrated or is under debate
- No mitigative measures in place or measures in place but deemed ineffective
- Not applicable because fishing method is moderate or benign (**All**) 

Enforcement: Management and appropriate government bodies enforce fishery regulations

- Regulations regularly enforced by independent bodies, including logbook reports, observer coverage, dockside monitoring and similar measures (**Iceland**) (**Canada**) 
- Regulations enforced by fishing industry or by voluntary/honor system
- Regulations not regularly and consistently enforced

Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity

- Management has maintained stock productivity over time OR has fully recovered the stock from an overfished condition

  **Stock productivity has varied and management has responded quickly (Iceland)**

  OR stock has not varied but management has not been in place long enough to evaluate its effectiveness OR **Unknown (Canada)** 
- Measures have not maintained stock productivity OR were implemented only after significant declines and stock has not yet fully recovered

### *Evaluation Guidelines*

Management is deemed to be "**Highly Effective**" if the majority of management factors are green AND the remaining factors are not red.

Management is deemed to be "**Moderately Effective**" if:

1) Management factors "average" to yellow
2) Management factors include one or two red factors

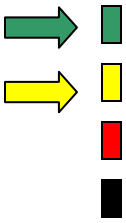
Management is deemed to be "**Ineffective**" if three individual management factors are red, including especially those for Stock Status and Bycatch.

Management is considered a **Critical Conservation Concern** and a species receives a recommendation of "**Avoid"**, regardless of other criteria if:

1) There is no management in place
2) The majority of the management factors rank red.

**Conservation Concern: Effectiveness of Management**

- Low (Management Highly Effective) (**Iceland**)
- Moderate (Management Moderately Effective) (**Canada**)
- High (Management Ineffective)
- Critical (Management Critically Ineffective)



## *Overall Seafood Recommendation*

*Overall Guiding Principle*: Sustainable wild-caught seafood originates from sources that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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## *Evaluation Guidelines*

A species receives a recommendation of "**Best Choice**" if:

1) It has three or more green criteria and the remaining criteria are not red.

A species receives a recommendation of "**Good Alternative**" if:

1) Criteria "average" to yellow
2) There are four green criteria and one red criteria
3) Stock Status and Management criteria are both ranked yellow and remaining criteria are not red.

A species receives a recommendation of "**Avoid**" if:

1) It has a total of two or more red criteria
2) It has one or more Critical Conservation Concerns.

### *Summary of Criteria Ranks*

| | Conservation Concern | | | |
|---|---|---|---|---|
| **Sustainability Criteria** | *Low* | Moderate | **High** | **Critical** |
| Inherent Vulnerability | √ | | | |
| Status of Stocks | | √ (Canada, Iceland) | | |
| Nature of Bycatch | √ (Iceland: Purse Seine) | √ (Canada: Purse seine and trap net) | | |
| Habitat & Ecosystem Effects | | √ | | |
| Management Effectiveness | √ (Iceland) | √ (Canada) | | |

**Overall Seafood Recommendation**

**Best Choice** **(Iceland)**

**Good Alternative** **(Canada)**

**Avoid**