

EUROPEAN PLAICE – ICELAND, BOTTOM LONGLINE CAUGHT

Pleuronectes platessa

Sometimes known as Plaice

SUMMARY

European Plaice is a species of flatfish found throughout the coastal waters of Europe and is widely distributed in Icelandic waters. European Plaice grow at moderate rates and can live for over 20 years. The overall abundance of European Plaice in Iceland is at moderate levels, but populations have been declining over the last century and are likely overfished. While the majority of European Plaice in Iceland are captured using Danish seines and bottom trawls, a small percentage of fish are taken in the bottom longline fishery. This fishery results in relatively little damage to the seafloor and some bycatch of juvenile fishes.

Criterion	Points	Final Score	Color
Life History	1.50	2.40 - 4.00	
Abundance	2.25	1.60 - 2.39	
Habitat Quality and Fishing Gear Impacts	3.00	0.00 - 1.59	
Management	2.75		
Bycatch	2.75		
Final Score	2.45		
Color			

LIFE HISTORY

Core Points (only one selection allowed)

If a value for intrinsic rate of increase ('r') is known, assign the score below based on this value. If no r-value is available, assign the score below for the correct age at 50% maturity for females if specified, or for the correct value of growth rate ('k'). If no estimates of r, age at 50% maturity, or k are available, assign the score below based on maximum age.

1.00 Intrinsic rate of increase <0.05 ; OR age at 50% maturity >10 years; OR growth rate <0.15 ; OR maximum age >30 years.

2.00 Intrinsic rate of increase = 0.05-0.15; OR age at 50% maturity = 5-10 years; OR a growth rate = 0.16–0.30; OR maximum age = 11-30 years.

European Plaice is a medium sized flatfish that typically ranges from 30 to 50 cm in Iceland. The maximum-recorded size from Icelandic waters was 85 cm (IIMFA 2010) and European Plaice in Iceland appear to grow larger than in most other European waters (Sæmundsson 1926; Jónsson 1992). European Plaice grow at moderate rates with growth rates (k) ≥ 0.1 (Fishbase 2011), and can reach a larger size than most other flatfish species in Icelandic waters, with the exception of Atlantic and Greenland Halibut. Like most flatfishes, females grow larger than males. Growth of European Plaice varies depending on temperature, food availability, and population size (Rijnsdorp 1994). European Plaice reaches 50% maturity at around the age of 5, with maximum age being more than 20 years (IIMFA 2010). Size at maturity for European Plaice varies slightly between regions in Icelandic waters (Tåning 1929; Einarsson 1956). Solmundsson et al. (2005) reported that 98% of males > 34 cm ($n = 135$) and 97% of females > 39 cm ($n = 36$) captured off Icelandic spawning grounds were mature, while 93% of males > 36 cm ($n = 44$) and 94% of females > 41 cm ($n = 49$) taken from Icelandic feeding areas were mature. We awarded a score of 2 here because European Plaice grow at moderate rates, reach an age at 50% maturity around 5 years, and may live over 20 years.

3.00 Intrinsic rate of increase >0.16 ; OR age at 50% maturity = 1-5 years; OR growth rate >0.30 ; OR maximum age <11 years.

Points of Adjustment (multiple selections allowed)

-0.25 Species has special behaviors that make it especially vulnerable to fishing pressure (e.g., spawning aggregations; site fidelity; segregation by sex; migratory bottlenecks; unusual attraction to gear; etc.).

In Iceland, European Plaice spawn on several distinct spawning grounds off the southwest and west coasts. Spawning begins in late February, peaks in March and April, and is almost finished by mid May (Saemundsson 1926; Sigurdsson 1989; Hjorleifsson and Palsson 2001; Solmundsson et al. 2003). European Plaice also spawn off the north

and east coasts of Iceland approximately one to two months later than in the southwest (Solmundsson et al. 2005).

Icelandic European Plaice undertake annual migrations between their spawning and feeding grounds, visiting the feeding areas in early summer to late autumn in the south, west, and northwest waters of the country (Saemundsson 1926; Sigurdsson 1989). Solmundsson et al. (2005) found that from a total of 183 European Plaice tagged on their spawning ground and recaptured in successive spawning seasons, 91% of males and 88% of females were recaptured within 30 km of where they were originally tagged. The researchers also found that from 55 European Plaice tagged on their feeding area and recaptured in subsequent feeding seasons, all males (100%) and almost all females (91%) were recaptured within 30 km of where they were originally tagged. From this data a minimum level of fidelity to the spawning ground was estimated at 94% for the spawning season one year after tagging and at 72% for the second and third spawning seasons, whereas fidelity to the feeding area was estimated at 90% after one year and at 100% after two and three years from tagging (Solmundsson et al. 2005).

- 0.25 **Species has a strategy for sexual development that makes it especially vulnerable to fishing pressure (e.g., age at 50% maturity >20 years; sequential hermaphrodites; extremely low fecundity).**

European Plaice exhibit moderate to high fecundity and usually produce 20,000 to 600,000 eggs per female (Rijnsdorp 1991). However, predation of eggs (Rijnsdorp & Jaworski 1990) and juveniles (Van der Veer et al. 1990) may be high and offset their moderate to high fecundity.

In addition, males have been known to gather in large aggregations on the spawning grounds and are visited by gravid females (Rijnsdorp 1989). These sex-specific behaviors may explain the greater ease of catching males during the spawning season (Solmundsson et al. 2003). Together, these life history characteristics produce a skewed sex ratio towards females (Rijnsdorp 1994). Further, researchers have suggested (e.g. Arnold & Metcalfe 1995; Hoarau et al. 2005) that immature European Plaice probably accompany mature individuals to the spawning ground in order to learn the location of these critical migration routes and habitats, leading to an extended family structure. This type of learning behavior is considered to occur in herring (reviewed in Corten 2002), a species that shares similar life history characteristics with European Plaice. Thus, the effects of increased fishing on European Plaice could not only reduce the size of the spawning aggregations, but could affect the population indirectly by disrupting courtship behaviors that are necessary for successful mating (Hoarau et al. 2005). Because of these contrasting results, no points were subtracted.

- 0.25 Species has a small or restricted range (e.g., endemism; numerous evolutionarily significant units; restricted to one coastline; e.g., American lobster; striped bass; endemic reef fishes).**

European Plaice can be found in the northeast Atlantic from Greenland to Norway and as far south as Morocco as well as the White Sea and the Barents Sea in north Europe and down to the western part of the Mediterranean Sea in the south Europe (IIMFA 2010). In Iceland, European Plaice can be found all around the coastal waters of the country, and especially the warmer south and west waters (Solmundsson et al. 2005). European Plaice in Icelandic waters can be found along sandy or muddy bottoms in depths ranging from 1 to 200 m depth.

Although European Plaice are found throughout Iceland, they appear to be patchily distributed throughout the country. Researchers have suggested that some straying of adult European Plaice between several segregated spawning grounds may indicate the possibility of extinction and re-colonization events (Solmundsson et al. 2005), especially because the Icelandic population occurs at the northern edge of the species' range (Wimpenny 1953) and at the boundaries of cold and warm-water masses (Valdimarsson and Malmberg 1999; Smedbol et al. 2002). This is particularly discouraging because repeated extinctions followed by re-colonization events by a few individuals could lead to a decreased genetic variability (Smedbol et al. 2002), which is consistent with the relatively low genetic diversity (e.g. Hoarau et al. 2004) previously reported for Icelandic Plaice (Solmundsson et al. 2005). These data suggest that European Plaice exhibit a relatively low genetic diversity with a geographic distribution at the edge of their range (Hoarau et al. 2004; Solmundsson et al. 2005).

- 0.25 Species exhibits high natural population variability driven by broad-scale environmental change (e.g. El Nino; decadal oscillations).**

Growth rates of European Plaice have been found to depend on environmental variables such as temperature and food availability (Rijnsdorp 1994). However, it is unclear if or to what extent broad-scale environmental changes influence European Plaice around Iceland, so no points were removed.

- +0.25 Species does not have special behaviors that increase ease or population consequences of capture OR has special behaviors that make it less vulnerable to fishing pressure (e.g., species is widely dispersed during spawning).**
- +0.25 Species has a strategy for sexual development that makes it especially resilient to fishing pressure (e.g., age at 50% maturity <1 year; extremely high fecundity).**
- +0.25 Species is distributed over a very wide range (e.g., throughout an entire hemisphere or ocean basin; e.g., swordfish; tuna; Patagonian toothfish).**

+0.25 Species does not exhibit high natural population variability driven by broad-scale environmental change (e.g., El Nino; decadal oscillations).

1.50 Points for Life History

ABUNDANCE

Core Points (only one selection allowed)

Compared to natural or un-fished level, the species population is:

1.00 Low: Abundance or biomass is <75% of BMSY or similar proxy (e.g., spawning potential ratio).

2.00 Medium: Abundance or biomass is 75-125% of BMSY or similar proxy; OR population is approaching or recovering from an overfished condition; OR adequate information on abundance or biomass is not available.

Due to its abundance and shallow water distribution, European Plaice have sustained high catches in Icelandic waters since the development of trawlers. In Iceland, catches of European Plaice have historically been similar to or higher than all other flatfish species combined. The majority of catches were initially by British trawlers, but Iceland has been exclusively catching European Plaices for the last few decades. Since the start of the 20th century, catches in Iceland have ranged from 5,000 to 10,000 tons per year. Danish seine nets comprise most of the current catches, but bottom trawls also take a considerable share of fish (IIMFA 2010).

British trawlers were the first to catch European Plaice in substantial numbers in Iceland (Thor 1992), but the quantities of these catches did not become available until 1906. It is assumed that catches were high because, at the time, there was already a sign that the population was being overexploited as the catches, catch per unit effort (CPUE), and the proportion of large individuals in catches were declining precipitously (Tåning 1929). European Plaice continued to decline until 1915 when the fishery stopped due to W.W.I. Not surprisingly, populations appeared to recover during the war, with sustained catches of around 6,000 tons/year, mainly by British boats, until their fishery stopped again in 1939 due to W.W.II (Valtysson 1998; IIMFA 2010).

During W.W.II Icelandic catches of European Plaice increased to around 3,000 to 4,000 tons/year because of the new markets in the British Islands. When British trawlers came back after the war and were able to satisfy the British markets, Icelandic catches again declined to very low levels. Although the CPUE of British boats increased after the war,

the new boats they were using were more powerful and technologically better than their predecessors, which could partly explain the increasing CPUE. However, the CPUE then declined rapidly until 1954, when it increased again to levels similar to just after the war. The CPUE then slowly declined until foreign boats were eventually expelled from Iceland. Catches subsequently declined and were relatively low during the 1970s, but increased again primarily due to an increased number of boats using Danish seines (Valtysson 1998). In 1998, population size of European Plaice from trawl surveys indicated an almost continuous decline since the first survey in 1985 (Valtysson 1998).

The total recommended annual catch of Icelandic European Plaice further declined from 10,000 tons in 1992 -1997 to 4,000 tons in 2000 - 2004 due to reduced population size (Solmundsson et al. 2005). In 2009, 6,300 tons were landed, which represented a decrease of 400 tons from 2008. Recently, catch per unit effort and survey indices of Icelandic European Plaice have increased somewhat and recruitment measurements from the groundfish survey also suggest some improvement in the past few years. Nevertheless, the Marine Research Institute has recommended that the catch does not exceed 6,500 tons in the quota year 2010/2011 and has also recommended that regulations regarding area closures on spawning grounds remain in effect (IIMFA 2010).

Hoarau et al. (2005) indicated that the effective population size of Icelandic European Plaice appeared to be very small, with evidence for the emergence of inbreeding between 1950 and 1970, which coincided with large-scale industrial fisheries on the spawning grounds during the 1960s. Given that inbreeding in European Plaice appears to be less than five generations old, inbreeding depression or reduced fitness of inbred individuals may be occurring in the population (Charlesworth & Charlesworth 1987; Hoarau et al. 2005). Additionally, the increase of inbreeding after the 1970s is likely related to the three-fold rise in landings of European Plaice over the last 50 years, especially since fisheries account for 80% of their mortality (Rijnsdorp & Millner 1996). This suggests that, although the potential for inbreeding may be inherent to some degree in the life history of European Plaice, inbreeding is only likely to affect the population under severe exploitation in fisheries (Hoarau et al. 2005). We awarded a score of 2 here because although populations in Icelandic waters have increased slightly over the past few years, overall the population appears to be at moderate levels and is likely well below historical abundance.

3.00 High: Abundance or biomass is >125% of BMSY or similar proxy.

Points of Adjustment (multiple selections allowed)

-0.25 **The population is declining over a generational time scale (as indicated by biomass estimates or standardized CPUE).**

There are indicators based on catch per unit effort (CPUE) that North Sea European Plaice biomass during this century has never even reached half of the biomass during the mid 19th century (Rijnsdorp and Millner 1996; Valtysson 1998). After 1890 European

Plaice biomass declined to levels similar to during the 20th century and this is when British trawlers started fishing for European Plaice in Icelandic waters, but the quantities of catches were not available until 1906. It is assumed that catches were high because by 1915 there was already a sign that the population was being overexploited, with catches, CPUE, and the proportion of large individuals in catches having declined precipitously (Tåning 1929). However, recent data suggest that the population may be increasing slightly. Points will not be subtracted (or added) until further information becomes available.

- 0.25 **Age, size or sex distribution is skewed relative to the natural condition (e.g., truncated size/age structure or anomalous sex distribution).**

In Iceland, fishermen catch a large number of European Plaice directly off feeding areas in summer and autumn (Solmundsson et al. 2005) and these fish are thought to consist of mature individuals from different spawning grounds together with local immature individuals (Sigurdsson 1989; Solmundsson et al. 2005). For example, European Plaice tagged in one feeding area off Iceland dispersed to several southerly spawning grounds off Iceland, while those fish tagged from one spawning area dispersed onto more northerly feeding grounds in summer. This pattern suggests that each feeding ground may contain a mixture of Plaice spawning in different areas, while each spawning ground appears to contain a mixture of plaice using different feeding grounds (Solmundsson et al. 2005).

In addition to this complex age structure at their two most critical habitats, males gather in large aggregations on the spawning grounds and are visited by gravid females (Rijnsdorp 1989). These sex-specific behaviors may make it easier to catch males during the spawning season (Solmundsson et al. 2003), which could potentially result in a skewed sex ratio towards females (Rijnsdorp 1994). However, the implications of a potentially skewed sex ratio are unclear because one male could mate with multiple females (anonymous 2011). No points were subtracted.

- 0.25 **Species is listed as "overfished" OR species is listed as "depleted", "endangered", or "threatened" by recognized national or international bodies.**

Although populations are likely well below historical abundance, European Plaice is currently not listed as overfished in Iceland. Consequently, no points were subtracted.

- 0.25 Current levels of abundance are likely to jeopardize the availability of food for other species or cause substantial change in the structure of the associated food web.
- +0.25 The population is increasing over a generational time scale (as indicated by biomass estimates or standardized CPUE).
- +0.25 Age, size or sex distribution is functionally normal.
- +0.25 Species is close to virgin biomass.

+0.25 Current levels of abundance provide adequate food for other predators or are not known to affect the structure of the associated food web.

European Plaice prey on small animals such as polychaetes and mollusks (IIMFA 2010), while also providing food for other fish. Although populations appear to be fairly low from a historical context, current levels of abundance are likely high enough to maintain their relatively small role in the Icelandic marine ecosystem.

2.25 Points for Abundance

HABITAT QUALITY AND FISHING GEAR IMPACTS

Core Points (only one selection allowed)

Select the option that most accurately describes the effect of the fishing method upon the habitat that it affects

1.00 The fishing method causes great damage to physical and biogenic habitats (e.g., cyanide; blasting; bottom trawling; dredging).

2.00 The fishing method does moderate damage to physical and biogenic habitats (e.g., bottom gillnets; traps and pots; bottom longlines).

While the majority of European Plaice are caught using Danish seines and bottom trawls (IIMFA 2010), a small proportion of fish are taken in the Icelandic mixed species bottom longline fishery that primarily targets Cod and Haddock. In Iceland, bottom longlines may be as long as 20 km with up to 16,000 hooks. These hooks are usually left on the bottom for periods of one to four hours (IIMFA 2010). We awarded a score of 2 here because bottom longlines cause low to moderate damage to the living and non-living benthic marine environment.

3.00 The fishing method does little damage to physical or biogenic habitats (e.g., hand picking; hand raking; hook and line; pelagic long lines; mid-water trawl or gillnet; purse seines).

Points of Adjustment (multiple selections allowed)

- 0.25 Habitat for this species is so compromised from non-fishery impacts that the ability of the habitat to support this species is substantially reduced (e.g., dams; pollution; coastal development).
- 0.25 Critical habitat areas (e.g., spawning areas) for this species are not protected by management using time/area closures, marine reserves, etc.
- 0.25 No efforts are being made to minimize damage from existing gear types OR new or modified gear is increasing habitat damage (e.g., fitting trawls with roller rigs or rockhopping gear; more robust gear for deep-sea fisheries).
- 0.25 If gear impacts are substantial, resilience of affected habitats is very slow (e.g., deep water corals; rocky bottoms).

+0.25 Habitat for this species remains robust and viable and is capable of supporting this species.

In Iceland, European Plaice can be found primarily on sandy or muddy bottoms in depths ranging from 1 to 200 m (IIMFA 2010). These benthic habitats are more resilient to bottom damage from fishing gear and likely remain healthy enough to support populations of European Plaice.

+0.25 Critical habitat areas (e.g., spawning areas) for this species are protected by management using time/area closures, marine reserves, etc.

Large areas are often closed for fishing in Iceland, some temporarily and others permanently. The Icelandic Marine Research Institute has recommended that regulations regarding area closures on European Plaice spawning grounds remain in effect (IIMFA 2010).

+0.25 Gear innovations are being implemented over a majority of the fishing area to minimize damage from gear types OR no innovations necessary because gear effects are minimal.

In Iceland, bottom longlines may be as long as 20 km with up to 16,000 hooks. These hooks are usually left on the bottom for periods of one to four hours (IIMFA 2010). Cod, the target species in the mixed bottom longline fishery, typically occur along hard bottoms (NOAA 1999) where longline hooks may be damaging to the seafloor. In Iceland, however, Cod likely exhibit a fairly even distribution over most bottom type (anonymous 2011) and European Plaice are usually taken over soft bottoms that are resilient to longline hooks.

+0.25 If gear impacts are substantial, resilience of affected habitats is fast (e.g., mud or sandy bottoms) OR gear effects are minimal.

Gear impacts from bottom longlines are generally moderate or little. Icelandic European Plaice are typically found along sandy or muddy bottoms (IIMFA 2010), which are resilient to longline hooks.

3.00 Points for Habitat Quality and Fishing Gear Impacts

MANAGEMENT

Core Points (only one selection allowed)

Select the option that most accurately describes the current management of the fisheries of this species.

1.00 Regulations are ineffective (e.g., illegal fishing or overfishing is occurring) OR the fishery is unregulated (i.e., no control rules are in effect).

2.00 Management measures are in place over a major portion over the species' range but implementation has not met conservation goals OR management measures are in place but have not been in place long enough to determine if they are likely to achieve conservation and sustainability goals.

Iceland is generally a model for progressive and sustainable fisheries management, especially since a large portion of the Icelandic economy depends on fishing and the trickle down effects of the country's fisheries. The current fisheries management policy of the Icelandic government advocates ecologically and economically responsible and sustainable management (IIMFA 2010).

Iceland campaigned for three quarters of century to win full jurisdiction over their fishing grounds. The cornerstone of the country's fisheries management system is a catch limitation system established in 1990. The catch limitation system is based on the catch share allocated to individual vessels in which each vessel is allocated a certain share of the total allowable catch (TAC) of the intended species. The TAC is set by the Minister of Fisheries and Agriculture and the decision is based on scientific information (when available) from the Icelandic Marine Research Institute (MRI). The MRI carries out scientific research on the status and productivity of all commercial fish populations, including European Plaice. The MRI also carries out long-term research on the marine environment and ecosystems around Iceland. The results of this research inform sustainable catch levels for the fishery (IIMFA 2010). Day to day administration and

enforcement of the Fisheries Act is regulated by the Directorate of Fisheries. The Icelandic Coast Guard monitors fishing activities in Icelandic waters, including surveillance of areas closed for fishing and inspection of mesh sizes and other gear (IIMFA 2010).

Additional Icelandic fisheries management regulations include fishing gear restrictions, area restrictions, the use of closed areas to conserve important and vulnerable habitats, and temporary closures of fishing areas to protect spawning fish. Discards are prohibited by law, which means that all catches must be landed. This is a very useful way of ensuring that there is adequate monitoring of undersized fish and all bycatch in the fisheries, although it is known from indirect sources that discards still occur in Iceland (anonymous 2011). For example, this might occur when a boat accidentally fishes European Plaice, but has finished its annual quota for the species (anonymous 2011). The Icelandic Ministry of Fisheries also mandates strict requirements for the keeping of logbooks on-board all fishing vessels and that they be made available to fishery inspectors (IIMFA 2010).

In Iceland, fishermen did not catch European Plaice and other flounder species in large numbers during most of the 20th century because they focused on species such as Atlantic Cod that were more easily caught. Large-scale Icelandic fisheries targeting flatfishes, which included European Plaice, began in the early 1980s when the TAC on other species had decreased or were restricted (IIMFA 2010). Although the majority of European Plaice is currently caught with Danish seine and bottom trawls (IIMFA 2010), some are caught in the mixed species longline fishery.

The mixed species longline fishery, which primarily targets Cod, operates throughout the year in Iceland, but fishing is highest in the winter months on the Cod spawning grounds and along the migration routes to the spawning grounds. During other seasons, the majority of catches occur on the Cod feeding grounds northwest and southeast of the country. In Iceland, Cod, and thus European Plaice, is mostly caught at depths of 100 - 250 m and ocean temperatures of 4 - 7 °C (IIMFA 2010).

We awarded a score of 2 here because management measures for European Plaice have not been in place long enough to confidently determine the extent to which they have been successful, current populations are likely overfished and remain well below historical levels, and critical feeding areas that Plaice demonstrate high site fidelity to remain unprotected.

- 3.00 Substantial management measures are in place over a large portion of the species range and have demonstrated success in achieving conservation and sustainability goals.

Points of Adjustment (multiple selections allowed)

- 0.25 There is inadequate scientific monitoring of stock status, catch or fishing effort.

- 0.25 Management does not explicitly address fishery effects on habitat, food webs, and ecosystems.
- 0.25 This species is overfished and no recovery plan or an ineffective recovery plan is in place.
- 0.25 Management has failed to reduce excess capacity in this fishery or implements subsidies that result in excess capacity in this fishery.
- +0.25 There is adequate scientific monitoring, analysis and interpretation of stock status, catch and fishing effort.**

In Iceland, the Marine Research Institute (MRI) carries out scientific research on the status and productivity of all commercial fish populations, including European Plaice. The MRI is responsible for conducting long-term research on the marine environment and the ecosystem around Icelandic waters. The results of the MRI's research help inform sustainable catch levels for the European Plaice fishery. MRI employs about 100 scientists and research assistants and uses two research vessels (IIMFA 2010). The MRI plays a critical role in helping Iceland achieve responsible and sustainable fisheries management, so points were added.

- +0.25 Management explicitly and effectively addresses fishery effects on habitat, food webs, and ecosystems.**

European Plaice feed primarily on benthic invertebrates, and to a lesser extent small fishes such as sandeels (Pálsson 1983). While fisheries management in Iceland addresses the marine ecosystem and impacts to it from fisheries (IIMFA 2010), management measures do not specifically (or at least effectively) address European Plaice fishery effects on habitat, food webs, or ecosystems. Therefore, no points were added (or removed).

- +0.25 This species is overfished and there is a recovery plan (including benchmarks, timetables and methods to evaluate success) in place that is showing signs of success OR recovery plan is not needed.**

The Marine Research Institute has recommended that the catch does not exceed 6,500 tons in the quota year 2010/2011 and has also recommended that regulations regarding area closures on spawning grounds remain in effect (IIMFA 2010). Although populations are likely well below historical abundance, populations in Icelandic waters appear to be increasing slightly over the past few years, suggesting that management measures may be working.

+0.25 Management has taken action to control excess capacity or reduce subsidies that result in excess capacity OR no measures are necessary because fishery is not overcapitalized.

Iceland controls excess capacity through the catch limitation system, which is based on the catch share allocated to individual vessels. In this system, each vessel is allowed a certain share of the total allowable catch of the targeted species. The system is effective because it provides an incentive to minimize overfishing.

2.75 Points for Management

BYCATCH

Core Points (only one selection allowed)

Select the option that most accurately describes the current level of bycatch and the consequences that result from fishing this species. The term, "bycatch" used in this document excludes incidental catch of a species for which an adequate management framework exists. The terms, "endangered, threatened, or protected," used in this document refer to species status that is determined by national legislation such as the U.S. Endangered Species Act, the U.S. Marine Mammal Protection Act (or another nation's equivalent), the IUCN Red List, or a credible scientific body such as the American Fisheries Society.

- 1.00 Bycatch in this fishery is high (>100% of targeted landings), OR regularly includes a "threatened, endangered or protected species."
- 2.00 Bycatch in this fishery is moderate (10-99% of targeted landings) AND does not regularly include "threatened, endangered or protected species" OR level of bycatch is unknown.**

European Plaice are landed in the mixed species bottom longline fishery, where Cod and Haddock are the target species. The Ministry of Fisheries in Iceland mandates strict requirements for the keeping of logbooks on board all fishing vessels and that they are made available for fishery inspectors. The logbooks are also important for scientific assessment purposes (IIMFA 2010). In Iceland, while Cod and Haddock discards are monitored (see Pálsson et al. 2009), the amount of European Plaice discarded in bottom longlines is unknown, although the species is hardy so survival may be high upon being discarded (anonymous 2011). Bycatch of flatfishes in the mixed Cod and Haddock bottom longline fishery is very low, with the exception of Greenland and Atlantic Halibut (anonymous 2011). Overall, we awarded a score of 2 here because bycatch levels in bottom longlines appear to be moderate and some data is unknown.

3.00 Bycatch in this fishery is low (<10% of targeted landings) and does not regularly include "threatened, endangered or protected species."

Points of Adjustment (multiple selections allowed)

- 0.25 Bycatch in this fishery is a contributing factor to the decline of "threatened, endangered, or protected species" and no effective measures are being taken to reduce it.
- 0.25 Bycatch of targeted or non-targeted species (e.g., undersize individuals) in this fishery is high and no measures are being taken to reduce it.
- 0.25 Bycatch of this species (e.g., undersize individuals) in other fisheries is high OR bycatch of this species in other fisheries inhibits its recovery, and no measures are being taken to reduce it.
- 0.25 The continued removal of the bycatch species contributes to its decline.
- +0.25 Measures taken over a major portion of the species range have been shown to reduce bycatch of "threatened, endangered, or protected species" or bycatch rates are no longer deemed to affect the abundance of the "protected" bycatch species OR no measures needed because fishery is highly selective (e.g., harpoon; spear).**

Bottom longlines have been known to incidentally capture numerous marine mammals, seabirds, sea turtles, and sharks (Lewison et al. 2004; Wallace et al. 2010), many of which are endangered and/or protected. Critically endangered Leatherback Sea Turtles can be found in Icelandic waters (IIMFA 2010) and are prone to incidental capture in various longlines fisheries throughout the world (Wallace et al. 2010), but there are no known reports of these turtles being caught as bycatch in Icelandic waters (IIMFA 2010) and they appear to be extremely rare in the coastal waters surrounding the country, at least in the areas with bottom longline fisheries (anonymous 2011). To our knowledge, no endangered or protected species are taken as bycatch in the Icelandic bottom longline fishery.

- +0.25 There is bycatch of targeted (e.g., undersize individuals) or non-targeted species in this fishery and measures (e.g., gear modifications) have been implemented that have been shown to reduce bycatch over a large portion of the species range OR no measures are needed because fishery is highly selective (e.g., harpoon; spear).**

In Iceland, areas are monitored and frequently closed to longline fishing if too many juvenile fish (usually Cod or Haddock) are being landed. Additionally, longlines most likely do not regularly catch juvenile European Plaice because their mouths are too small for the longline hooks that are used in the fishery (anonymous 2011).

Circle hooks have been used to increase post-release survival of large animals that are incidentally captured in longline fisheries (Lewison et al. 2004). In Iceland, there appears

to be small bycatch of some sharks and seals (IIMFA 2010). To our knowledge, these hooks are not being used in bottom longline fisheries, but they may not be necessary since bycatch levels of large animals (e.g. sharks, seabirds, marine mammals, sea turtles) appear to be very low in Icelandic fisheries.

- +0.25 Bycatch of this species in other fisheries is low OR bycatch of this species in other fisheries inhibits its recovery, but effective measures are being taken to reduce it over a large portion of the range.**

It is possible to estimate size-based discards of some species, most notably Cod and Haddock (measured less than 1% in 2009; Pálsson et al. 2009) by comparing length distribution in catches (measured by on-board inspectors that regularly travel between the boats) and length distribution in landings. In Iceland, even though discards are prohibited (IIMFA 2010) it is known from indirect sources that discards do occur and the amount of European Plaice discarded is unknown (anonymous 2011). Due to this uncertainty, no points were added.

- +0.25 The continued removal of the bycatch species in the targeted fishery has had or will likely have little or no impact on populations of the bycatch species OR there are no significant bycatch concerns because the fishery is highly selective (e.g., harpoon; spear).**

In Iceland, all catch is recorded and monitored, regardless of whether or not the catch is bycatch or the target species (IIMFA 2010). To our knowledge, the continued removal of any species taken in the bottom longline fishery will likely have little impact on the population, especially since landings are monitored. Further, the take of large animals (e.g. sharks, seabirds, marine mammals, sea turtles), which are particularly vulnerable to small levels of exploitation (see Lewison et al. 2004; Wallace et al. 2010), appear to be negligible in Iceland.

2.75 Points for Bycatch

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