24 Greenland shark *Somniosus microcephalus* in the Northeast Atlantic

24.1 Stock distribution

The known North Atlantic distribution of Greenland shark *Somniosus microcephalus*, which has been defined primarily by observations of specimens caught in cold-water commercial fisheries, extends from temperate waters to the Arctic Ocean (MacNeil *et al.*, 2012). It ranges from Georgia (USA) to Greenland, Iceland, Spitzbergen and the Arctic coasts of Russia and Norway to the North Sea and Ireland, with only very occasional individuals recorded further south (Ebert & Stehmann, 2013). Due to their known tolerance for extreme cold water and their ability to inhabit abyssal depths, Greenland shark may be more widespread. The known distribution is also compromised by taxonomic problems in this genus (MacNeil *et al.*, 2012). The stock unit(s) are unknown.

24.2 The fishery

24.2.1 History of the fishery

Fishing for Greenland shark has been a part of the Scandinavian, Icelandic and Inuit cultures for centuries, extending back to the 13th and 14th century in Norway and Iceland, respectively. Although the meat of Greenland shark may be toxic when fresh (e.g. Anthoni *et al.*, 1991; McAllister, 1968), it is eaten in some countries after curing.

In the early to mid-20th century, Greenland sharks were caught in large quantities as a source for liver oil. At that time, peak annual catches e.g. in Norway are thought to have been in the region of 58,000 individuals (Ebert & Stehmann, 2013; MacNeil *et al.*, 2012). After the invention of synthetic oil in the late 1940s, demand for shark oil diminished, and no intensive fisheries for Greenland sharks have been reported since (Nielsen *et al.*, 2014).

Greenland shark is still targeted in small-scale artisanal fisheries in Iceland and Greenland. Artisanal fisheries target Greenland shark with hook and line, longline or gaffs, but it is also taken in seal nets and cod traps (Ebert & Stehmann, 2013). It is also an occasional bycatch in longline, trawl and gillnet fisheries in the cooler waters of the North Atlantic.

24.2.2 The fishery in 2015

No specific changes in the fishery were apparent in 2015. National landings data are available from Iceland, where 18 t were landed in 2015. No other countries reported data.

24.2.3 ICES Advice applicable

ICES has not been asked to provide advice on Greenland shark.

24.2.4 Management applicable

Greenland shark is included in the list of deep-sea sharks on EC quota regulations for deep-sea fishes. There is a zero TAC for deep-sea sharks in EU vessels fishing in Union and international waters of ICES Subareas 5–10 (CEC, 2015).

24.3 Catch data

24.3.1 Landings

Limited landings data are available. More comprehensive landings data are available from Iceland (www.hagstofa.is and Marine Research Institute databases). Reported annual landings by Iceland (Table 24.1) from ICES Division 5.a and Subarea 14 have varied from about 2 t (2007) to 87 t (1998). Monthly Icelandic landings of Greenland shark (2005–2015) indicate a peak during the summer (Fig. 24.1).

24.3.2 Discards

Limited data are available. Greenland shark is a bycatch in trawl fisheries for Greenland halibut *Reinhardtius hippoglossus* and northern shrimp *Pandalus borealis*, as well as in gillnet and longline fisheries (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014).

In the Barents Sea, bycatch of Greenland shark in bottom trawls were related to sea temperature, with more bycatch at lower water temperatures (Rusyaev & Orlov, 2013). Despite limited data on Greenland shark bycatch in the commercial trawl fishery, Rusyaev & Orlov (2013) estimated an annual catch of 140–150 t in the Barents Sea.

In local fishing communities in Greenland, Greenland shark accounts for 50% of the total waste produced by the fishing industry. Estimated annual amounts of waste products of Greenland shark from fishing and hunting in specific counties may be *ca.* 1000 t (Gunnarsdóttir & Jørgensen, 2008).

24.3.3 Quality of catch data

As observers are not mandatory in the fisheries that may possibly have a bycatch of Greenland shark, bycatch levels are uncertain. In some areas there may be confusion with other members of the genus or even basking shark (MacNeil *et al.*, 2012).

24.3.4 Discard survival

No estimates on discard survival available. According to on-board observers, some Greenland sharks caught in offshore trawl and longline fisheries are released alive (MacNeil *et al.*, 2012).

24.4 Commercial catch composition

No information available.

24.5 Commercial catch and effort data

No information available.

24.5.1 Recreational cpue data

There are recreational catch and release fisheries for Greenland sharks in Norway (year-round) and Greenland (in March) (MacNeil *et al.*, 2012), but cpue data are not available.

24.6 Fishery-independent information

Greenland sharks are caught regularly during gillnet and bottom-trawl surveys around Greenland, such as the Greenland Institute of National Resources Annual bot-

tom trawl survey (Nielsen *et al.*, 2014). Catches are also reported from the annual German Greenland groundfish survey (61 individuals between 1982 and 2015, Fig. 24.2). Trawl surveys conducted in the Barents Sea also encounter Greenland shark. Occasional catches are also reported in various Icelandic surveys, but with a total of just 68 observations over the period 1936–2012.

Existing scientific surveys are not appropriate for monitoring the abundance of Greenland sharks in their distribution area.

24.7 Life-history information

24.7.1 Habitat

Greenland shark show a marked preference for cold water with most observations from waters of -1.8 to 10°C and the majority of records from waters <5°C (Skomal & Benz, 2004; Stokesbury *et al.*, 2005; Fisk *et al.*, 2012; MacNeil *et al.*, 2012). It occurs on continental and insular shelves and upper slopes (Ebert & Stehmann, 2013). Confirmed observations cover a broad depth range from abyssal depths of at least 1,560 m (Fisk *et al.*, 2012) to shallow water (Yano *et al.*, 2007; MacNeil *et al.*, 2012). Though primarily considered a demersal species, it may be caught both at the surface and in the pelagic zone (e.g. Stokesbury *et al.*, 2005; MacNeil *et al.*, 2012). They often associate with fjordal habitats (MacNeil *et al.*, 2012).

24.7.2 Spawning, parturition and nursery grounds

The only captures of Greenland shark with near-term embryos were near fjords in the Faroe Islands. Based on observations on two presumed neonatal specimens captured by mid-water trawl off Jan Mayen Island, Kondyurin & Myagkov (1983) suggested that parturition may occur in the Norwegian Sea in July–August. Specimens of presumed neonatal size have also been reported from Canadian, Norwegian and Greenland fjords (Bjerkan & Koefoed, 1957).

24.7.3 Age and growth

Greenland shark is the second largest shark in the ICES area and the largest fish inhabiting Arctic seas (Ebert & Stehmann, 2013). Bigelow & Schroeder (1948) reported a maximum size of 640 cm L_T and weight of 1023 kg. Females may attain a larger size than males. The growth rate of Greenland shark is unknown, but observations from tagging experiments indicate growth rates of 0.5–1 $cm.y^{-1}$ (Hansen, 1963). Conventional vertebral ageing methods are not applicable for Greenland shark (MacNeil *et al.*, 2012).

24.7.4 Reproductive biology

Greenland shark is an aplacentally viviparous species (Carrier *et al.*, 2004; Ebert & Stehmann, 2013). The exact size at birth as well as the gestation period remain unknown, but size at birth is thought to be *ca.* 40–100 cm L_T (MacNeil *et al.*, 2012). Size-at-maturity is difficult to determine. The onset of maturity in male Greenland shark probably occurs at *ca.* 260 cm L_T but is variable, and males may reach maturity at *ca.* 300 cm L_T (Yano *et al.*, 2007). Females from Icelandic waters mature at 355–480 cm L_T (MacNeil *et al.*, 2012). Based on changes in ovary weight, Yano *et al.* (2007) suggested that females matured at >400 cm L_T. Fecundity is uncertain, but may be ca. ten (Bjerkan & Koefoed, 1957; Ebert & Stehmann, 2013).

24.7.5 Movements and migrations

Studies using conventional and electronic (satellite and acoustic) tags have informed on their movements and migrations. Fisk *et al.* (2012) deployed 20 archival pop-off tags on Greenland sharks off Svalbard, Norway. The sharks displayed a broad vertical distribution (from 6 to more than 1500 m) but no obvious diel movements were noted. Average daily distances travelled also varied and most tags popped off less than 500 km from tagging sites. Two sharks travelled 725 and 980 km, respectively. Previous studies have also examined the behaviour of Greenland shark in the Northwest Atlantic (Skomal & Benz, 2004; Stokesbury *et al.*, 2005). All such studies have found examples of localized movements and site fidelity, as well as some larger scale movements.

24.7.6 Diet and role in ecosystem

Greenland shark feed on a wide variety of invertebrates, fish and marine mammals, indicating they are generalist predators on both benthic and pelagic organisms (MacNeil *et al.*, 2012; Nielsen *et al.*, 2014), and they are important predators in Arctic food webs (Leclerc *et al.*, 2012). They are also important scavengers, including of whales (Leclerc *et al.*, 2011).

24.8 Exploratory assessment models

No exploratory stock assessments have been undertaken.

24.9 Stock assessment

No stock assessment has been undertaken.

24.10 Quality of the assessment

No stock assessment has been undertaken.

24.11 Reference points

No reference points have been proposed for this stock.

24.12 Conservation considerations

On the basis of possible population declines and limiting life-history characteristics, Greenland shark is listed as Near Threatened in the IUCN Red List (Kyne *et al.*, 2006). It is listed vulnerable in the Swedish Red List of endangered species (Svensson *et al.*, 2010).

24.13 Management considerations

Stock status and many other aspects of the biology of Greenland shark are unknown. Given the large body size of this species and perceived low population productivity, further studies to better understand population dynamics and sources of mortality are required.

Ruud (1968) reported a longer-term decline in Greenland shark in the Oslofjord, but it is unclear as to how such local depletions towards the south of the distribution range relate to wider population trends.

24.14 References

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Table 24.1. Greenland shark Somniosus microcephalus in the Northeast Atlantic. Preliminary estimates of landings (t) for the period 1992–2015. Data sources: National Icelandic database (*www.hagstofa.is*;) and Marine Research Institute database. Data for 2005 onwards from landings data provided to the WG, and 2015 data considered provisional. Note: Official Icelandic landings in 2014 (60 t) differ from those reported in the Data Call (26 t).

Year	Iceland (previous estimate)	Iceland	Greenland	Portugal	Sweden	Total
1992		68				68
1993	(43)	41				41
1994	(26)	42				42
1995	(32)	43				43
1996	(32)	61				61
1997	(62)	73				73
1998	(56)	87				87
1999	(52)	51				51
2000	(37)	45				45
2001	(36)	57				57
2002	(47)	56				56
2003	(62)	55				55
2004	(66)	58				58
2005	(54)	50		0.3		51
2006	(29)	28		0.5		28
2007	(2)	2	17	0.7		20
2008	(42)	35		0.6		35
2009	(26)	26			0.4	26
2010	(43)	43				43
2011	(18)	18				18
2012	(19)	19				19
2013	(6)	6				6
2014	(60)	26				26
2015	(18)	17				17

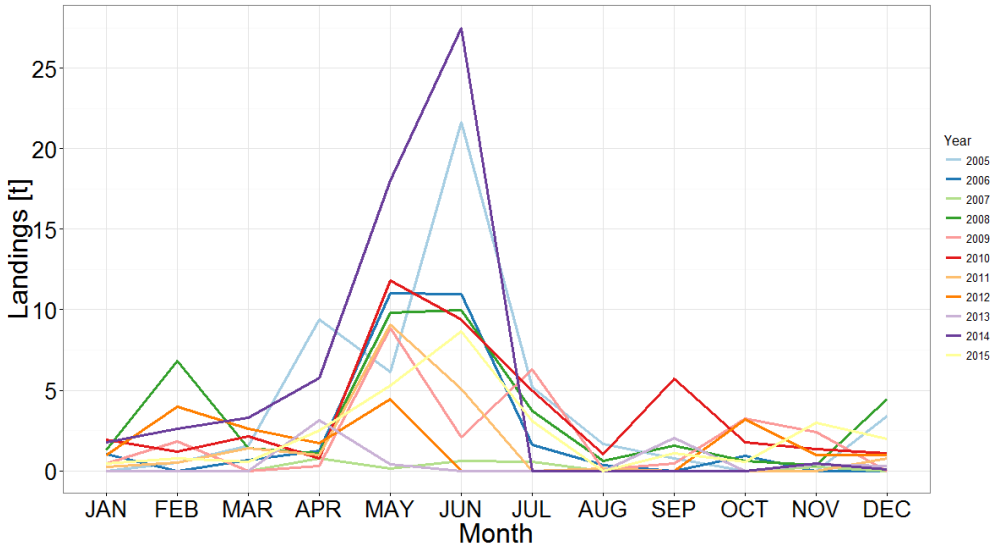

Figure 24.1. Greenland shark (*Somniosus microcephalus*) in the Northeast Atlantic. Monthly Icelandic landings of Greenland shark 2005–2015. Data from www.hagstofa.is

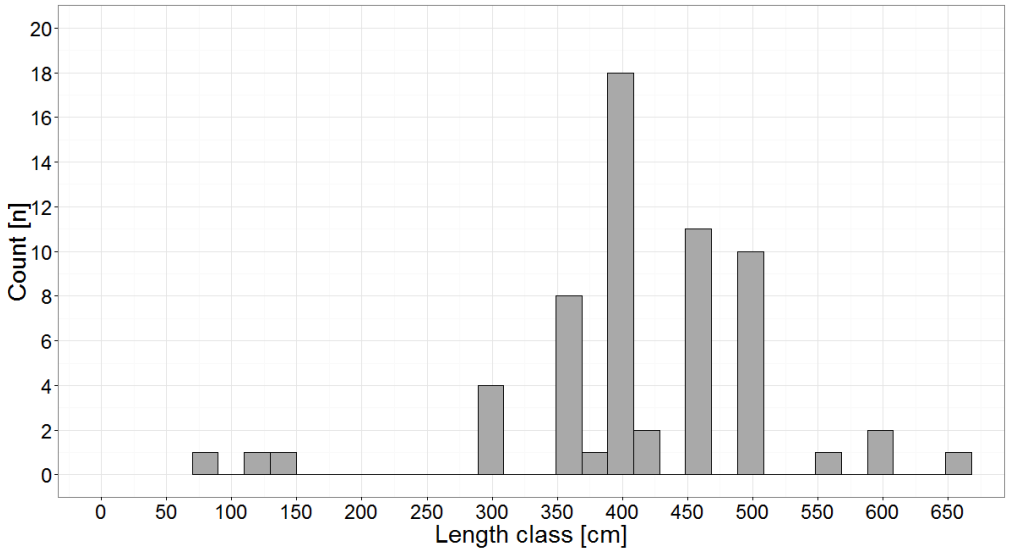

Figure 24.2. Greenland shark (*Somniosus microcephalus*) in the Northeast Atlantic. Length distribution of Greenland shark captured during the annual German Greenland Groundfish Survey (1982–2015; n = 61).