Stock Annex: Basking shark (*Cetorhinus maximus*) in Subareas 1–10, 12 and 14 (the Northeast Atlantic and adjacent waters)

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Basking shark

Working Group: Working Group on Elasmobranch Fishes (WGEF)

Created:

Authors:

Last updated:

Last updated by:

General

Stock distribution

In the eastern Atlantic, *Cetorhinus maximus* is present from Iceland, Norway and as far north as the Russian White Sea (southern Barents Sea) extending south to the Mediterranean (Compagno, 1984; Konstantinov and Nizovtsev, 1980). WGEF considers that basking shark in the ICES area exist as a single management unit. However, the WGEF is aware of recent tagging studies demonstrating both transatlantic and transequatorial migrations, as well as migrations into tropical areas and mesopelagic depths (Gore *et al*., 2008; Skomal *et al*., 2009). A genetic study by Hoelzel *et al*. (2006) indicates panmixia; whereas Noble *et al*. (2006) suggested little gene flow between populations in the northern and southern hemispheres. A rough estimates the population size was given by Hoelzel *et al*. (2006). Migration and mixing levels have yet to be fully determined.

Fishery

History of the fishery

Norwegian fishers have always been the major catchers of basking sharks in the Northeast Atlantic. The fishery started off Namdalen and Hitra in 1760 (Moltu, 1932) and spread south to Møre and Romsdal. Strøm, 1762 also describes this fishery and claims it started before 1750 in northern Norway and spread southerly to Møre (western Norway). The fishery started close to shore but after a while the landings decreased and the fishery moved further from shore. According to Moltu, 1932 the fishery peaked in 1808 and the best fishing areas were between Romsdal and Storegga. After some years the fishery ceased, and in 1860 it ended. The fishery generally started around April and May, occasionally as early as March, peaking in June and finished by August or, less commonly, September (Myklevoll, 1968). Basking sharks were caught using hand-held harpoons from open boats. The fleet was composed of small wooden vessels 15–25 feet in length, which were sometimes used for hunting small whales as well as basking sharks (Kunzlik, 1988).

In 1920 the fishery resumed and the fishery employed more modern fishing gear and

vessels. Basking sharks were harpooned by cannons mounted on steam vessels or smacks (Rabben, 1982–1983). This technology was developed for whaling and remained in use for basking sharks until the fishery was closed in 2006.

The Norwegian fleet conducted local fisheries from the Barents Sea to the Kattegat, as well as more distant fisheries ranging across the North Sea and south and west of Ireland, Iceland and Faroes. Norwegian fishers were fishing for porbeagle off the Scottish coast as early as 1934, and they started fishing for basking sharks in the immediate post-war years following the establishment of several native Scottish fisheries. Similarly, Norwegian vessels took basking sharks in Irish waters after the Second World War. The landings increased during the 1930s as the fishery gradually expanded to offshore waters. The main reason was that new markets were developed and thereby the demand for basking shark oil increased. During 1959–1980, catches ranged between 1266 and 4266 sharks per year, but subsequently declined (Kunzlik, 1988). The geographical and temporal distribution of the Norwegian domestic basking shark fishery changed markedly from year to year, possibly as a consequence of the unpredictable nature of the shark's inshore migration (Stott, 1982).

McNally, 1976 and Parker and Stott, 1965 described two basking shark fisheries off the Irish west coast. Large numbers of basking sharks were taken by small boats on the 'Sunfish Bank' for several decades between 1770 and 1830. The season only lasted for a few weeks in April and May, but at least 1000 individuals may have been taken each year at the height of the fishery. In the early 1830s, sharks became very scarce. Despite continued high prices for 'sunfish' (basking shark) oil, the fishery collapsed in the second half of the 19th century. Basking sharks were next recorded in abundance around Achill Island in 1941 and a new fishery started in 1947. Between 1000 and 1800 sharks were taken each year from 1951 to 1955 (an average of 1475/year), but there was a decline in catch records from 1956, the last year in which shark catchers were employed. From 1957 onwards, continued declining sightings and catches made the fishery less profitable for the free-lance fishers who took over from them. Average annual catches were 489 individuals from 1956–1960, 107 individuals from 1961–1965, then about 50–60 individuals per annum for the remaining years of the fishery.

Fairfax, 1998 summarized the limited information available on the earlier 18th and 19th century fisheries in Scotland. These appear, like the Irish fishery, to have ceased by the mid-1830s with large numbers of sharks not being reported again until the 1930s. Fairfax, 1998 and Kunzlik, 1988 describe the 20th century Scottish basking shark fisheries, which concentrated on the Firth of Clyde and West coast. Several small fisheries started up in the 1940s, some targeted basking shark full-time during summer, and others were more opportunistic. These took in all ~970 sharks between 1946 and 1953 (during a period when Norwegian vessels were also catching basking sharks in these waters).

Oil prices rose again in the mid-1970s. About 500 sharks were taken off eastern Ireland in 1974–1975, Norwegian catchers took several hundred sharks in 1975, some Clyde basking shark bycatch was processed in the late 1970s, and a small target harpoon fishery started again in the Clyde in 1982. Initial yields from the latter were good, but these were extremely short-lived and the fishery ceased at the end of 1994 after several years of poor catches and taking in all 333 sharks (Fairfax, 1998).

From 1977–2007, an estimated total of 12 347 basking sharks were caught by Norway and Scotland, and of these Norway landed 12 014 individuals with an annual maximum of 1748 individuals landed in 1979 (Figure 7.1).

More recent data on the price changes for basking shark fins are from the Norwegian

Directorate of Fisheries, and cover the period from 1979 to 2008. This reveals that the nominal value of fins increased dramatically from 12 NOK per kg in 1979 to 165 NOK per kg in 1992, varied between 108 NOK and 203 NOK per kg during 1993–2005, and has decreased after 2005 (Figure 7.2). The inflation adjusted value of fins varied from 18 NOK per kg to 253 NOK per kg during 1990–2007, but has decreased considerably after 2005.

Data

Catch data

Landings

Landings data within ICES Areas 1-14 from 1977–2009 are presented in Table 7.1, and Figure 7.3. The Table and Figure include landings data from UK (Gue.) (1984 and 2009), Portugal (1991–2009), France (1990–2009) and Norway (1977–2009). Most catches are from Subareas 1, 2 and 4 and are taken by Norway. For Portugal and France the reported landings were between 0.3 and 2 t.

Table 7.2 demonstrates the Norwegian landings of liver and fins, official landings in live weight, revised landings in live weight (ICES WGEF 2008), and estimated numbers of landed individuals based on landings of liver and fins using an average weight per individual of 648.5 kg for liver and 71.5 kg for fins of basking shark from 1977–2007.

Table 7.3 demonstrates the proportions (%) of basking sharks caught by various gears as reported to the Directorate of Fisheries in Norway from 1990–2008. Harpoon was the major gear during most of the 1990s, but remained at a relatively low level from 2000, except for 2005 which was the last year with directed fishery. After the ban of directed fishery was introduced in 2006, bycatch has been taken in gillnets only.

Discards

Limited quantitative information exists on basking shark discarding in non-directed fisheries. However, anecdotal information is available indicating that this species is caught in gillnet and trawl fisheries in most parts of the ICES area. Most of this bycatch takes place in summer as the species moves inshore. The total extent of these catches is unknown.

Berrow, 1994 extrapolated from very limited observer data to suggest that 77–120 sharks may be taken annually in the bottom-set gillnet fishery in the Celtic Sea (south of Ireland), though the reliability of this estimate has been questioned. Berrow and Heardman, 1994 received 28 records from fishers of sharks entangled in fishing gear (mostly surface gillnets) around the Irish coast during 1993, representing nearly 20% of all records of the species that year. At least 22% of basking shark bycatch in fishing nets died.

Bycatch in the Isle of Man herring fishery has amounted to 10–15 sharks annually, and a further bycatch source here is entanglement in pot fishers' ropes, amounting to some 4–5 sharks annually. Fairfax, 1998 reported that basking sharks are sometimes brought up from deep-water trawls near the Scottish coast during winter. Valeiras *et al.*, 2001 reported that of twelve reported basking sharks that were incidentally caught in fixed entanglement nets in Spanish waters between 1988 and 1998, three sharks were sold on at landing markets, three live sharks were released, and three dead sharks were discarded at sea. In contrast to the coastal bycatches, extrapolation of observer data from oceanic gillnet fleets suggests that bycatch in these fisheries is very small; only

about 50 basking sharks were among the several million sharks taken annually offshore in the Pacific Ocean (Bonfil, 1994).

During 2007–2009, five specimens of basking shark were caught and discarded by the Norwegian Coastal Reference Fleet (Vollen, 2010 WD). All specimens were caught in gillnets by vessels <15 m in ICES Subdivision 2. The Norwegian Coastal Reference Fleet is made up by a group of selected vessels that, for economic compensation, provides detailed information on catches and general fishing activity. In 2009, the Reference Fleet included 18 vessels <15 m that covered the Norwegian coast.

Quality of catch data

The official Norwegian conversion factors used to convert from liver weight and fin weight to live fish weight were 10.0 for liver and 100.0 for fins, respectively up to 2007. These conversion factors were too high, and in 2008 the Norwegian conversion factors were revised by the Norwegian Directorate of Fisheries, and they are now 4.64 for liver and 40.0 for fins. Hence, the official Norwegian live weights reported from 1977 to 2007 were overestimated. Landed liver weights constituted the basis for the official catch statistics from 1977 to 1995, and from 1996 landings of fins have constituted the basis for the official catch statistics. A revised Norwegian catch statistics for basking shark is given based on landings of liver from 1977 to 1992 and landings of fins from 1993 to 2008 applying the revised conversion factors 4.64 for liver and 40.0 for fins (Table 7.2) The official Norwegian catch statistics will not be changed between 1977 and 1999, but from 2000–2008 the revised catch figures are applied.

Commercial catch composition

The median weights of liver and fins of 56 probable individual basking sharks caught in Norway during 1992–1997 were 648.5 kg and 71.5 kg, respectively (Figure 7.4). Minimum and maximum weights for liver and fins were 45.0 kg and 974.0 kg and 6.0 kg and 110.0 kg, respectively.

The median estimated live weights of the same individuals were 3009 kg and 2860 kg from liver and fins weights, respectively (Figure 7.5). Minimum and maximum estimated weights were 209 kg and 4519 kg based on liver weights, respectively, and 240 kg and 4400 kg based on fin weights, respectively. This indicates that individuals >2500 kg dominated the catches taken by Norwegian fishers during 1992–1997.

Commercial catch–effort data

There are no effort or cpue data available for the latest years, as there has been no targeted fishery. Hareid (2006 WD) estimated the numbers of Norwegian vessels involved in this fishery and the landings for 13 of the years between 1965 and 1985. These were used to calculate a simple estimate of effort. The largest number of vessels participating in this fishery was 70 vessels in 1978. Based on total landings and number of vessels participating in the fishery an estimate of cpue was generated for the years 1965–1985 (Table 7.4). For this period there was a significant decrease in cpue. This cpue series can be considered an underestimation of the decline in the abundance because the area fished expanded during this period.

Fishery-independent surveys

Several countries, e.g. Norway and Denmark, conduct scientific whale counting surveys. During these surveys observations of basking sharks should also be noted. A number of Norwegian commercial vessels also regularly report observations of whales.

A request for reporting the sightings of basking sharks might yield useful effort-related data.

Life-history information

Most of the information in this Section is summarized from the review on basking shark by Sims *et al*. (2008).

Habitat

In the eastern Atlantic, *C. maximus* is present from Iceland, Norway and as far north as the Russian White Sea (southern Barents Sea) extending south to the Mediterranean (Compagno, 1984; Konstantinov and Nizovtsev, 1980).

Basking sharks have a strong tendency to aggregate in coastal areas of continental shelves dominated by transitional waters between stratified and mixed water columns (Sims *et al*., 2005b). It has been argued that basking shark hibernate during the winter in a non-feeding state (Matthews, 1962; Parker and Boeseman, 1954), but this has been disputed by recent data from studies using satellite tags (Sims *et al*., 2003b; Sims *et al*., 2005b; Skomal *et al*., 2004; Gore *et al*., 2008). All tagged sharks remained on the continental shelf and in shelf-edge habitats during the periods they were tracked, except for one animal crossing the Atlantic to Newfoundland, Canada (Gore *et al*., 2008). There were also indications of seasonal movements, northerly in early summer and southerly in late summer and autumn, in the North Atlantic (Sims *et al*., 2003b; Skomal *et al*., 2004).

In 1993 a sighting scheme was established to determine distribution and abundance of basking shark in Irish coastal areas. The concentrations given by Berrow and Heardman, 1994 are based mainly on sightings made in 1993 correspond to historical accounts from the same area.

Since 2003, the French Association Pour l'Etude et la Conservation des Sélaciens (APECS) has surveyed the migrating basking sharks off the Atlantic coast of France, by recording sightings and using satellite tags.

Doyle *et al*., 2005 presented the results of a public sightings record scheme for basking sharks, primarily in UK waters. The lack of effort information for the great majority of these records limited the application of these data. Other fishery-independent information currently being collected includes the photo-identification of individual sharks and the use of archival tags to track basking shark movements (e.g. Sims *et al*., 2005a; Southall *et al*., 2005).

In a study from 2008, the Irish Basking Shark Study Group tagged two basking sharks with archival satellite tags (Berrow and Johnston, 2010 WD). Both sharks remained on the continental shelf for most of the tagging period. Shark A spent most time in the Irish and Celtic Seas with evidence of a southerly movement in the winter to the west coast of France (Figure 7.6). Movements of Shark B were more constrained, remaining off the southwest coast for the whole period with locations off the shelf edge and in the Porcupine Bight (Figure 7.6) The greatest depths recorded were 144 m and 136 m, respectively, showing that although Shark B was located over deep water off the shelf edge, it was not diving to large depths. The sharks were within 8 m of the surface for 10% and 6% of the time. The study demonstrated that basking sharks were present in Irish waters throughout the winter period and were active and did not hibernate.

Skomal *et al*., (2009) shed further light on apparent winter disappearance of the basking shark. Through satellite archival tags and a novel geolocation technique they showed

that sharks tagged in temperate feeding areas off the coast of southern New England moved to the Bahamas, the Caribbean Sea, and onward to the coast of South America and into the Southern Hemisphere. When in these areas, basking sharks descended to mesopelagic depths (200–1000 m) and in some cases remained there for weeks to months at a time. The authors concluded that basking sharks in the western Atlantic Ocean, which is characterized by dramatic seasonal fluctuations in oceanographic conditions, migrate well beyond their established range into tropical mesopelagic waters. In the eastern Atlantic Ocean, however, only occasional dives to mesopelagic depths have been reported in equivalent tagging studies (Sims *et al*., 2003b). It is hypotesized that, in this area, the relatively stable environmental conditions mediated by the Gulf Stream may limit the extent to which basking sharks need to move during winter months to find sufficient food.

There is no clear evidence to indicate differential distribution in the basking shark (Sims *et al*., 2008). Juvenile (2–3 m total length, LT) and putative sub-adult (3–5 m LT) sharks have been frequently observed in the same areas and summer-feeding aggregations as adults (Berrow and Heardman, 1994; Sims *et al*., 1997). Similarly, whether sexual segregation of the population occurs has not been shown unambiguously. Males and females have been observed in the same areas during summer (Matthews and Parker, 1950; Maxwell, 1952; O'Connor, 1953; Sims *et al*., 2000a; Watkins, 1958), although more females than males have been caught in directed fisheries (Kunzlik, 1988) suggesting females may segregate from males, at least when they occur at the surface. Pregnant females are virtually unknown from these same locations so differential habitat utilisation by mature males and females at certain times in the reproductive cycle may well occur.

Importantly in relation to conservation surveys, recent data on vertical movements of basking shark indicate that the probability of sighting them at the surface is dependent on habitat type and prey behaviour and may differ by several orders of magnitude (Sims *et al*., 2005b). The chances of sighting a basking shark in frontal zones are some 60 times higher than in thermally well-stratified areas. These habitat-specific differences in surface occurrence may impact public sightings and research surveys aimed at monitoring numbers in different areas (Sims *et al*., 2008).

Reproduction

The basking shark is thought to be ovoviviparous (Matthews, 1950), and foetuses are suggested to be oophagous (Sims *et al*., 2008). Fertilisation is internal, as in all other sharks. From anatomical examinations of fishery-caught individuals, it is hypothesized that in the northeast Atlantic in U.K. waters, mating occurs during summer months (Matthews, 1950). The gestation period is not known with any certainty, but estimates as high as 3.5 years have been proposed (Parker and Stott, 1965). Only one published record of a pregnant female exists, from the western coast of Norway in August 1936. During towing she gave birth to six pups of 1.5 to 2.0 m, of which one was stillborn. If this number of pups is representative, it has a low fecundity even when compared to other relatively large-bodied ovoviviparous sharks (Compagno, 1984; Sims, 2005a). Little is known about embryo development and parturition (Sims *et al*., 2008).

Growth and maturity

Length-at-maturity for males is thought to be between 5 and 7 m, and 12 and 16 years, whereas females mature at 8.1–9.8 m and possibly 16–20 years (Compagno, 1984). Maximum length is unknown, but thought to be 10–12 m (Sims *et al*., 2008). The growth rate have been estimated to be 0.4 m per year and longevity to be about 40–50 years

(Pauly, 1978; 2002), but new data suggests these estimates should be re-assessed (Sims *et al*., 2003b). Aging using growth rings in vertebrae has proved difficult (Parker and Stott, 1965).

Available, reliable published and unpublished data on lengths and weights of 25 individual basking sharks from the Northeast Atlantic have been compiled, and are demonstrated together with a regression equation in Figure 7.7. E.g. the weight of an individual with a length of 800 cm is estimated at 2583 kg (Blom, 2008 WD).

Food and feeding

The basking shark feeds upon zooplankton prey by swimming with an open mouth so that a passive water flow passes across the gill-raker apparatus, but exactly how the particulate prey is filtered remains unresolved (Sims *et al*., 2008). Prey found in the stomach includes calanoid copepods, fish eggs, cirriped and decapods larvae, as well as Mysid larvae, decapod larvae, chaetognaths, larvaceans, polychaetes, cladocerans, fish larvae and post-larvae, fish eggs, and pelagic shrimp (Matthews and Parker, 1950; Mutoh and Omori, 1978; Sims and Merrett, 1997; Watkins, 1958). Based on filtration rates from the literature, Sims *et al*. (2008) approximated that at 5–7 m long, feeding constantly in food patches, may consume about 30.7 kg zooplankton per day.

Behaviour

Basking sharks observed at the surface in summer feed almost continuously, and frequently occur in large aggregations. In the Western English Channel, groups numbering between three and twelve individuals have been closely tracked (Sims and Quayle, 1998; Sims *et al*., 1997). Aggregations of apparently up to 200–400 individuals have been reported from U.K. regions such as southwest England and northwest Scotland (Doyle *et al*., 2005). Basking sharks are primarily solitary, but their propensity to exhibit prolonged feeding behaviour in specific areas probably results in the formation of feeding aggregations. These have been shown to occur most often near oceanographic or topographic features (Sims and Quayle, 1998). Recent behavioural studies have demonstrated the significant role of fronts as important habitat used for foraging by basking sharks. Basking sharks were thought to be indiscriminate planktivores (Matthews and Parker, 1950), but Sims and Quayle (1998) showed they were selective filter-feeders that chose the richest, most profitable plankton patches. Future surveys for basking shark, where identifying large numbers of individuals becomes important (perhaps using photographic identification; Sims *et al*., 2000b) for estimating population sizes, would benefit from efforts concentrated in front areas (Sims *et al*., 2008). The amount of time individual basking sharks spend on the surface is proportional to the quantity of zooplankton present in surface waters (Sims *et al*., 2003a). Future sightings schemes for basking sharks should therefore take into account zooplankton abundance in specific search areas.

It seems likely that courtship occurs as a consequence of individuals aggregating to forage in rich prey patches whereupon courtship can be initiated. In that way, locating the richest prey patches along fronts may be important for basking sharks to find mates as well as food in the pelagic ecosystem (Sims *et al*., 2008). As courtship-like behaviours occur annually off southwest England, this region may represent an annual breeding area for this protected species, although mating itself probably usually takes place at depth as it has yet to be observed at the surface (Sims *et al*., 2000a).

Exploratory assessment models

No assessments have been undertaken.

Quality of assessments

No assessments have been undertaken.

Reference points

No reference points have been proposed for this stock.

Conservation considerations

The Northeast Atlantic subpopulation of basking shark is listed as "Endangered" in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species. Globally, the species is listed as "Vulnerable".

Basking shark was listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2002. Norway and Iceland have made a reservation on this listing and are therefore treated as 'States not Party to the Convention' with respect to trade in the species. For other States, this listing only affects international trade in basking shark products (including scientific samples). Export, re-export or introduction from the high seas requires a CITES permit from the relevant national authorities. Such a permit can only be granted if the exporting State's Scientific Authority has advised that this export will not be detrimental to the survival of the species (for example, because it comes from a sustainable managed stock), and the Management Authority is satisfied that it was not captured illegally. Imports require that an appropriate export or re-export permit be presented and approved by the importing State's CITES Management Authority. Trade inside the EU is controlled under the provisions of EC Regulations Nos. 338/97 and 1808/2001.

Basking shark was listed in 2005 on Appendices I and II of the Convention on the Conservation of Migratory Species (CMS). CMS Parties should strive toward strictly protecting the endangered species on Appendix I, conserving or restoring their habitat, mitigating obstacles to migration and controlling other factors that might endanger them. The Convention encourages the Range States of Appendix II species (migratory species with an unfavourable conservation status that need or would significantly benefit from international cooperation) to conclude global or regional Agreements for their conservation and management. These Agreements are open to accession by all Range States, not just to the CMS Parties. Some Parties, from the ICES area and elsewhere, intimated that they might take out reservations on this listing, in some cases until they had the necessary legislation in place to implement strict protection measures. Reservations are not yet published.

The basking shark is listed on Annex I, Highly Migratory Species, of the UN Convention on the Law of the Sea (UNCLOS).

The basking shark was listed on the OSPAR (Convention on the protection of the marine environment of the Northeast Atlantic) list of threatened and/or declining species in 2004.

Management considerations

At present there is no directed fishery for this species. The WGEF considers that no directed fishery should be permitted unless a reliable estimate of a sustainable

exploitation rate is available.

The species may be found in all ICES areas, and thus the TAC-area should correspond to the entire ICES area.

Proper quantification of bycatch and discarding both in weight and numbers of this species in the entire ICES area is required.

Where national legislation prohibits landing of bycaught basking sharks, measures should be put in place to ensure that incidental catches are recorded in weight and numbers, and carcasses or biological material made available for research.

References

Anon. 2002. Convention on International Trade in Endangered Species (CITES), 2002. Inclusion of Basking Shark *Cetorhinus maximus* in Appendix II. Proponent: United Kingdom (on behalf of the Member States of the European Community). 12th Meeting of the Conference of Parties Proposal 36.

Berrow, S. D. 1994. Incidental capture of elasmobranchs in the bottom-set gill-net fishery off the south coast of Ireland. Journal of Marine Biological Association UK, 74: 837–847.

Berrow, S. D. and Heardman, C. 1994. The basking shark *Cetorhinus maximus* (Gunnerus) in Irish waters-patterns of distribution and abundance. Proceedings of the Royal Irish Academy, 94B, 2: 101–107.

Berrow, S. D. and Johnston, E. 2010. Basking shark telemetry and tracking in Ireland. .Working Document for the ICES Elasmobranch Working Group (WGEF) 2010.

Blom, G. 2008. Basking shark (*Cetorhinus maximus*). Norwegian conversion factors, regulations and catch statistics (Presentation only). Working Document for the ICES Elasmobranch Working Group (WGEF) 2008.

Bonfil, R. 1994. Overview of world elasmobranch fisheries. FAO Fisheries Technical Paper 341. FAO, Rome.

Compagno, L. J. V. 1984. ''FAO Species Catalogue. IV. Sharks of the World. 1. Hexanchiformes to Laminiformes.'' Food and Agriculture Organisation of the United Nations, Rome.

Doyle, J. I., Solandt, J.-L., Fanshawe, S., Richardson, P. 2005. Marine Conservation Society Basking Shark Report 1987–2004. Marine Conservation Society, Ross on Wye, UK.

Fairfax, D. 1998. The basking shark in Scotland: natural history, fishery and conservation. Tuckwell Press, East Linton, Scotland. 206 pp.

Gore, M., Rowat, D., Hall, J., Gell, F. R., and Ormond, R. F. 2008. Transatlantic migration and deep mid-ocean diving by basking shark. Biol. Lett. 4, 395–398.

Hareide, N.R. 2006. History of Norwegian fishery for basking shark (*Cetorhinus maximus*). Working Document. ICES Working Group on Elasmobranch Fishes. 6 pp.

Hoelzel, A. R., Shivji, M. S., Magnussen, J., and Francis, M. P. 2006. Low worldwide genetic diversity in the basking shark (*Cetorhinus maximus*). Biol. Lett. 2, 639–642.

ICES. 2008. Report of the Working Group Elasmobranch Fishes (WGEF), 3–6 March 2008, Copenhagen, Denmark. ICES CM 2008/ACOM:16. 332 pp.

Konstantinov, K. G., and Nizovtsev, G. P. 1980. The basking shark *Cetorhinus maximus*, in Kandalaksha Bay of the White Sea. J. Ichthyol. 19, 155–156.

Kunzlik, P.A. 1988. The Basking Shark. Scottish Fisheries. Information Pamphlet, No. 14. Department of Agriculture and Fisheries for Scotland. Aberdeen.

Matthews, L. H. 1950. Reproduction in the basking shark *Cetorhinus maximus* (Gunner). Philos. Trans. R. Soc. B 234, 247–316.

Matthews, L. H. 1962. The shark that hibernates. New Sci. 280, 756–759.

Matthews, L. H., and Parker, H. W. 1950. Notes on the anatomy and biology of the basking shark *Cetorhinus maximus* (Gunner). Proc. Zool. Soc. Lond. 120, 535–576.

Maxwell, G. 1952. ''Harpoon at a Venture.'' R. Hart-Davis, London.

McNally, K. 1976. The Sun-Fish Hunt. Blackstaff Press, Belfast.

Moltu, P. 1932. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten aktietrykk.

Mutoh, M., and Omori, M. 1978. Two records of patchy occurrences of the ocean shrimp Sergestes similis (Hansen) off east coast of Honshu, Japan. J. Oceanogr. Soc. Jpn. 34, 36–38.

Myklevoll, S. 1968. Basking shark fishery. Commer. Fish. Rev., 30**:** 59–63.

Noble, L. R., Jones, C. S. Sarginson, J., Metcalfe, J. D., Sims, D. W. and Pawson, M. G. 2006. Conservation Genetics of Basking Sharks. Final Report for Defra Tender CR0288. Report to Wildlife Species Conservation Division, Defra, UK.

O'Connor, P. F. 1953. ''Shark-O!.'' Secker & Warburg, London.

Parker, H. W., and Boeseman, M. 1954. The basking shark (*Cetorhinus maximus*) in winter. Proc. Zool. Soc. Lond. 124, 185–194.

Parker, H. W. and Stott, F. C. 1965. Age, size and vertebral calcification in the basking shark *Cetorhinus maximus* (Gunnerus). Zoologische Mededelingen, 40: 305–319.

Pauly, D. 1978. A critique of some literature data on the growth, reproduction and mortality of the basking shark *Cetorhinus maximus* (Gunnerus). International Council for the Exploration of the Sea Council Meeting 1978/H:17 Pelagic Fish Committee, 10 pp.

Pauly, D. 2002. Growth and mortality of the basking shark *Cetorhinus maximus* and their implications for management of whale sharks Rhincodon typus. In ''Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, 1997'', pp. 199–208. IUCN SSC Shark Specialist Group, Gland, Switzerland and Cambridge, UK.

Rabben, B. 1982–1983. Folk ved havet. Fiskarsoge for Sunnmøre och Romsdal. Sunnmørsposten trykkeri-1982–1983. ISBN 82-990398-03-05.

Sims, D. W. 2005. Differences in habitat selection and reproductive strategies of male and female sharks. In "Sexual Segregation in Vertebrates: Ecology of the Two Sexes" (K. Ruckstuhl and P. Neuhaus, eds), p. 127–147. Cambridge University Press, Cambridge.

Sims, D. W. 2008. Sieving a living. A review of the biology, ecology and conservation staus of the plankton-feeding basking shark *Cetorhinus maximus*. Advances in marine biology 2008: 171-220.

Sims, D. W., Fox, A. M., and Merrett, D. A. 1997. Basking shark occurrence off southwest England in relation to zooplankton abundance. J. Fish Biol. 51, 436–440.

Sims, D. W., and Merrett, D. A. 1997. Determination of zooplankton characteristics in the presence of surface feeding basking sharks *Cetorhinus maximus*. Mar. Ecol. Prog. Ser. 158, 297–302.

Sims, D. W., and Quayle, V. A. 1998. Selective foraging behaviour of basking sharks on zooplankton in a small-scale front. Nature 393, 460–464.

Sims, D.W., Southall, E.J., Metcalfe, J.D., and Pawson, M.G. 2005a. Basking Shark Population Assessment. Report to Global Wildlife Division, Defra, UK.

Sims, D. W., Southall, E. J., Tarling, G. A., and Metcalfe, J. D. 2005b. Habitat-specific normal and reverse diel vertical migration in the plankton-feeding basking shark. J. Anim. Ecol. 74, 755–761.

Sims, D. W., Southall, E. J., Quayle, V. A., and Fox, A. M. 2000a. Annual social behaviour of basking sharks associated with coastal front areas. Proc. R. Soc. B 267, 1897–1904.

Sims, D. W., Speedie, C. D., and Fox, A. M. 2000b. Movements and growth of a female basking shark re-sighted after a three year period. J. Mar. Biol. Assoc. U.K. 80.

Sims, D. W., Southall, E. J., Merrett, D. A., and Sanders, J. 2003a. Effects of zooplankton density and diel period on the surface-swimming duration of basking sharks. J. Mar. Biol. Assoc. U.K. 83, 643–646.

Sims, D. W., Southall, E. J., Richardson, A. J., Reid, P. C., and Metcalfe, J. D. 2003b. Seasonal movements and behaviour of basking sharks from archival tagging: No evidence of winter hibernation. Mar. Ecol. Prog. Ser. 248, 187–196.

Skomal, G. B., Wood, G., and Caloyianis, N. 2004. Archival tagging of a basking shark, *Cetorhinus maximus*, in the western North Atlantic. J. Mar. Biol. Assoc. U.K. 84, 795–799.

Skomal, G. B., Zeeman, S. I., Chisholm, J. H., Summers, E. L., Walsh, H. J., McMahon, K. W., and Thorrold, S. R. 2009. Transequatorial Migrations by Basking Sharks in the Western Atlantic Ocean, Current Biology 19, 1-4. doi:10.1016/j.cub.2009.04.019.

Southall, E. J., Sims, D. W., Metcalfe, J. D., Doyle, J. I., Fanshawe, S., Lacey, C., Shrimpton, J., Solandt, J-L. and Speedie, C. D. 2005. Spatial distribution patterns of basking sharks on the European shelf: preliminary comparison of satellite-tag geolocation, survey and public sightings data. Journal of the Marine Biological Association of the UK. 85: 1083–1088.

Stott, F. C. 1982. A note on catches of basking sharks, *Cetorhinus maximus* (Gunnerus), off Norway and their relation to possible migration paths. Journal of Fish Biology, 21(2): 227–230.

Strøm, H. 1762. Beskrivelse av fogderiet Søndmør. Del 1. Sorøe 1762.

Vollen, T. 2010. The Norwegian Reference Fleet: Catch and discard of elasmobranchs. Working Document for the ICES Elasmobranch Working Group (WGEF) 2010.

Valeiras J, Lopez, A and Garcia, M. 2001. Geographical, seasonal occurrence and incidental fishing capture of the basking shark *Cetorhinus maximus* (*Chondrichthyes*: *Cetorhinidae*). Journal of the Marine Biological Association, 80: 3712/1–3.

Watkins, A. (1958). ''The Sea my Hunting Ground.'' William Heinemann, London.

Table 7.1. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas 1–14 from 1977–2008.

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1 & 2	3680	3349	5120	3642	1772	1970	967	873	1465	1144	164
3 & 4							734	1188			
5.											
5.b		14		83	28						
6											
7		278	139			186	60	1			
8			7								
9											
10											
12											
14											
TOTAL	3680	3641	5266	3725	1800	2156	1761	2062	1465	1144	164
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1 & 2	96	593	781	533	1613	1374	920	604	792	425	55
3 & 4	10		116	220	84		157	23		43	
5.a											
5.b											
6											
7											
8			1	0	0	0	0	1	0	2	1
9									1	1	
10											
12											
14											
TOTAL	106	593	897	753	1697	1374	1077	628	793	471	56
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1 & 2	31	117	80	54	128	72	87	6	26	4	0
3 & 4					0						
5.a											
5.b											
6											
7							1	0	0	+	+
8	1	1	0	0	0	0	0	0	0	+	
9					1	+	2	0	0		
10			1								
12											
14											
TOTAL	32	118	81	54	129	72	90	6	26	5	+

Table 7.2. Norwegian landings of liver (kg) and fins (kg) of basking shark (*Cetorhinus maximus*) during 1977–2007, estimated landings in live weight (conversion factors of 4.64 for liver and 40.0 for fins), estimated numbers of landed individuals (from landings of both liver and fins using an average weight per individual of 648.5 kg for liver and 71.5 kg for fins), ICES and Norwegian official landings (conversion factors of 10.0 for liver (1977–1995), 100.0 fins (1996–1999), 100.0 for fins (ICES 2000–2008), and 40.0 for fins (Norway 2000–2008)), and landings recommended used by ICES WGEF 2008. In 1995 and 1997, landings of whole individuals measuring 3760 kg (1 individual) and 7132 kg (2 individuals), respectively, were reported. These weights are included in the official and revised landings and in the estimation of landed numbers. (Source: Blom, 2008 WD).

Year	Liver (kg)	Fins (kg)	catch from liver (tonnes)	catch from fins (tonnes)	Landed numbers (livers – fins)	ices official landings (tonnes)	norway official landings (tonnes)	Recommended by ICES WGEF 2008
1977	793 153	0	3680.2	0.0	1223	7931.5	7931.5	3680.2
1978	784 687	0	3640.9	0.0	1210	7846.9	7846.9	3640.9
1979	1 133 477	95 070	5259.3	3802.8	1748–1330	11 334.8	11 334.8	5259.3
1980	802 756	60 851	3724.8	2434.0	1238–851	8027.6	8027.6	3724.8
1981	387 997	27 191	1800.3	1087.6	598–380	3880.0	3880.0	1800.3
1982	464 606	31 987	2155.8	1279.5	716–447	4646.1	4646.1	2155.8
1983	379 428	24 847	1760.5	993.5	585–348	3794.3	3794.3	1760.5
1984	444 171	23 505	2061.0	940.2	685–329	4441.7	4441.7	2061.0
1985	315 629	16 699	1464.5	668.0	487–234	3156.3	3156.3	1464.5
1986	246 474	12 138	1143.6	485.5	380–170	2464.7	2464.7	1143.6
1987	35 244	3148	163.5	125.9	54–44	352.4	352.4	163.5
1988	22 761	1927	105.6	77.1	35–27	227.6	227.6	105.6
1989	127 775	10 367	592.9	414.7	197–145	1277.8	1277.8	592.9
1990	193 179	18 110	896.4	724.4	298–253	1931.8	1931.8	896.4
1991	162 323	18 337	753.2	733.5	250–256	1623.2	1623.2	753.2
1992	365 761	37 145	1697.1	1485.8	564–520	3657.6	3657.6	1697.1
1993	291 042	34 360	1350.4	1374.4	449–481	2910.4	2910.4	1374.4
1994	176 220	26 922	817.7	1076.9	272–377	1762.2	1762.2	1076.9
1995	10 450	15 571	52.2	626.6	17–219	108.3	108.3	626.6
1996	41 283	19 789	191.6	791.6	64–277	1978.9	1978.9	791.6
1997	57 184	11 520	272.5	467.9	90–163	1159.1	1159.1	467.9
1998	3	1366	0.0	54.6	19	136.6	136.6	54.6
1999	20	770	0.1	30.8	11	77.0	77.0	30.8
2000	51	2926	0.2	117.0	41	292.6	117.0	117.0
2001	0	1997.5	0.0	79.9	28	199.7	79.9	79.9
2002	0	1351.5	0.0	54.1	19	135.2	54.1	54.1
2003	0	3191.5	0.0	127.7	45	319.2	127.7	127.7
2004	0	1808.3	0.0	72.3	25	180.8	72.3	72.3
2005	0	2180.5	0.0	87.2	30	218.1	87.2	87.2
2006	0	160	0.0	6.4	2	16.0	6.4	6.4
2007	0	653	0.0	26.1	9	65.3	26.1	26.1
2008	0	98	0.0	3.9	1	9.8	3.9	3.9

Table 7.3. Basking sharks in the Northeast Atlantic. Proportions (%) of basking sharks caught in different gears as reported to the Norwegian Directorate of Fisheries from 1990–2009.

Year	Area 2.a							Area 4.a		Total
	Harpoon	Gillnets	Driftnets*	Undefined nets	Bottom trawl	Danish seine	Hooks and line	Harpoon	Gillnets	%
1990	84,0	0,0	3,1	0,0	0,0	0,0	0,0	12,9	0,0	100
1991	69,7	0,0	1,0	0,0	0,0	0,0	0,0	29,3	0,0	100
1992	83,1	0,0	6,0	0,0	5,6	0,0	0,4	4,9	0,0	100
1993	99,1	0,8	0,0	0,0	0,1	0,0	0,0	0,0	0,0	100
1994	85,4	0,0	0,0	0,0	0,0	0,0	0,0	14,6	0,0	100
1995	89,8	6,5	0,0	0,0	0,0	0,0	0,0	0,0	3,7	100
1996	89,1	10,3	0,0	0,2	0,0	0,4	0,1	0,0	0,0	100
1997	66,7	23,7	0,0	0,0	0,0	0,0	0,5	9,1	0,0	100
1998	67,2	28,5	0,0	0,0	0,0	0,0	4,4	0,0	0,0	100
1999	9,1	81,8	0,0	7,8	1,3	0,0	0,0	0,0	0,0	100
2000	33,4	58,7	0,0	0,0	7,8	0,0	0,0	0,0	0,0	100
2001	0,0	96,0	0,0	0,0	4,0	0,0	0,0	0,0	0,0	100
2002	16,3	78,5	0,0	0,0	5,2	0,0	0,0	0,0	0,0	100
2003	3,4	89,7	0,0	0,0	7,2	0,0	0,0	0,0	0,0	100
2004	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100
2005	54,1	44,5	0,0	0,5	1,4	0,0	0,0	0,0	0,0	100
2006	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100
2007	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100
2008	0,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	100
2009**	-	-	-	-	-	-	-	-	-	-

*** These driftnets for salmon were banned after 1992.**

**** No catch in 2009**

Table 7.4. Basking sharks in the Northeast Atlantic. Norwegian landings of liver (t), number of vessels participating in the fishery and estimate of cpue. (Source: Hareide, 2006 WD).

Year	Tonnes liver	Number of vessels	cpue
1965	652	31	210
1966	911	30	304
1967	2090	53	394
1968	1580	70	226
1970	1887	57	331
1976	751	26	289
1977	793	32	248
1979	1133	30	378
1981	388	28	139
1982	465	25	186
1983	379	24	158
1984	444	26	171
1985	315	23	137

Figure 7.1. Basking sharks in the Northeast Atlantic. Numbers of basking sharks caught by Norway and Scotland from 1977–2007 in ICES Areas 1–14 from 1977–2009.

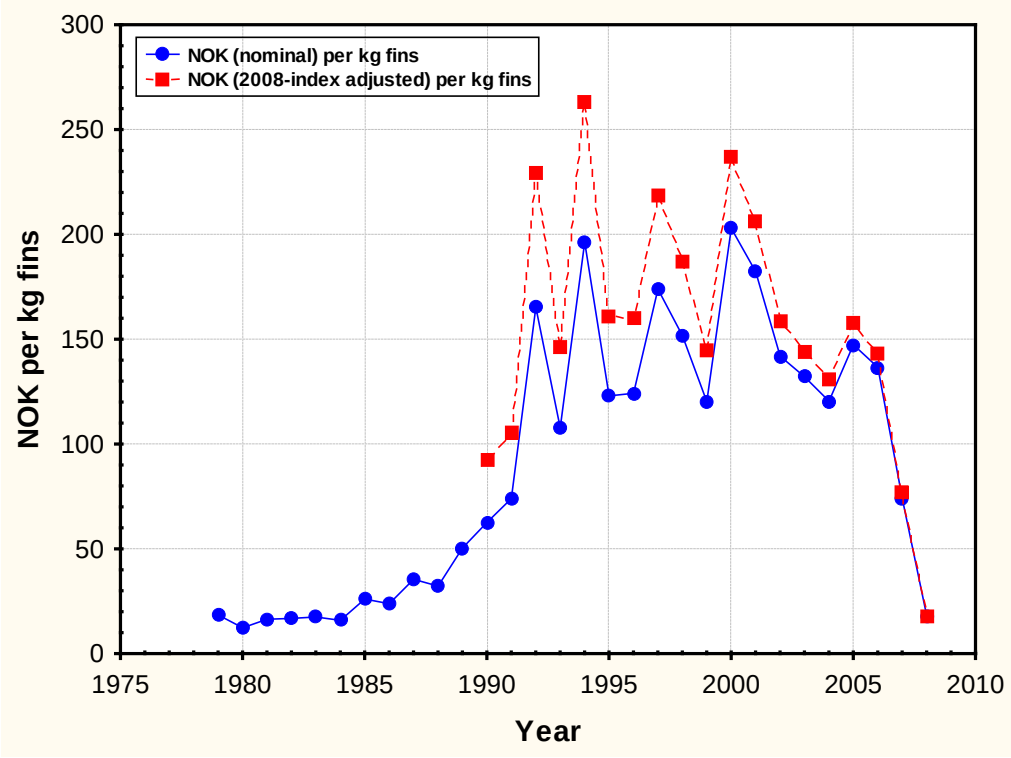


Figure 7.2. Development in nominal and inflation adjusted prices (NOK per kg) paid to fishermen for fins of basking shark during 1979–2008. The data were provided by the Norwegian Directorate of Fisheries. (Source: Blom, 2008 WD).

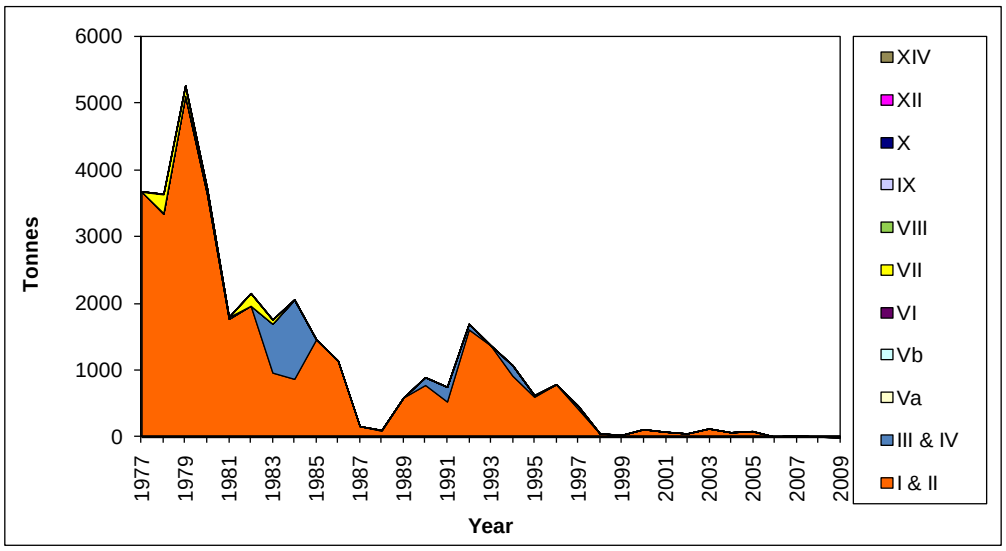


Figure 7.3. Basking sharks in the Northeast Atlantic. Total landings (t) of basking sharks in ICES Areas I-XIV from 1977–2009.

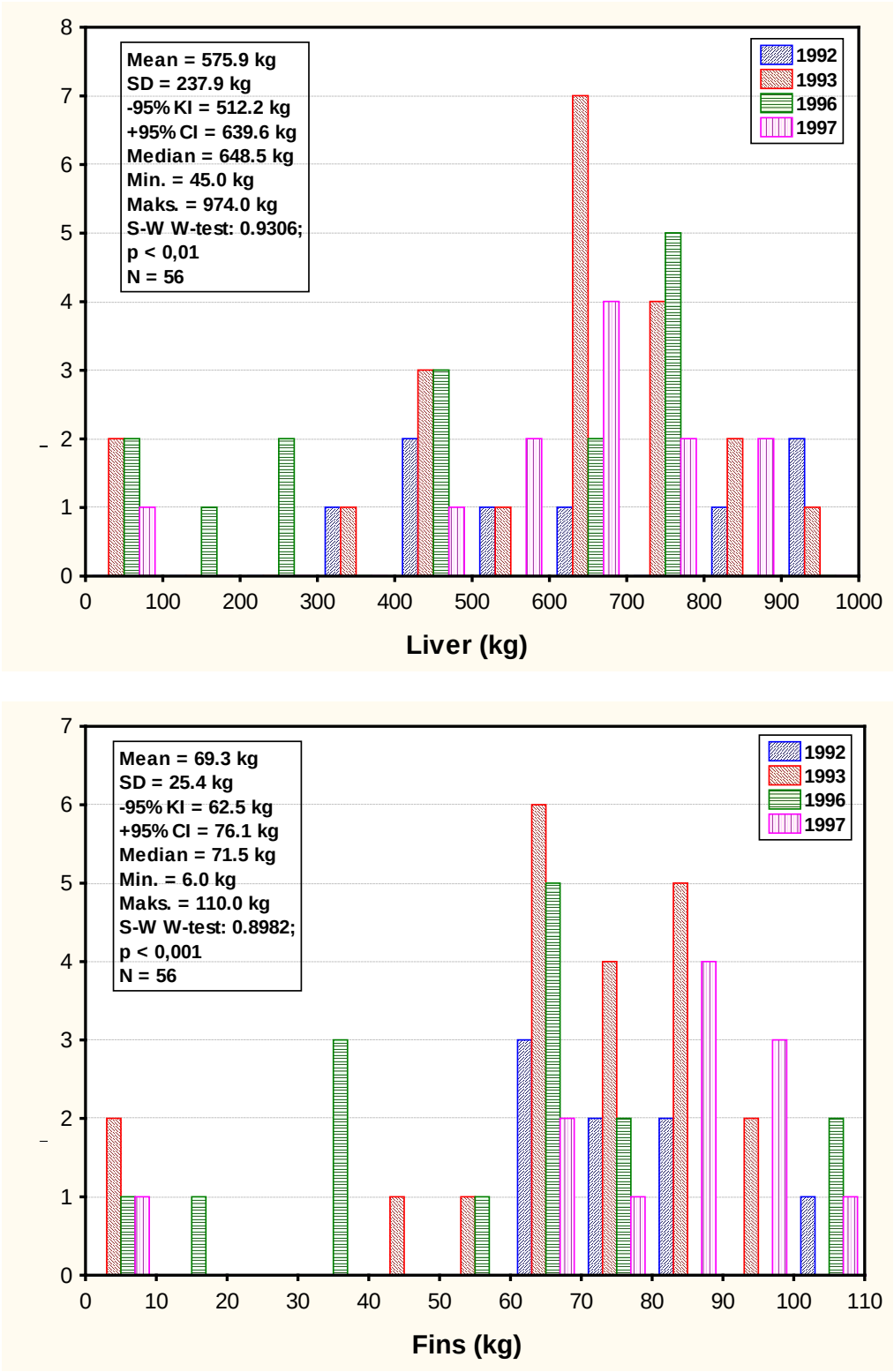
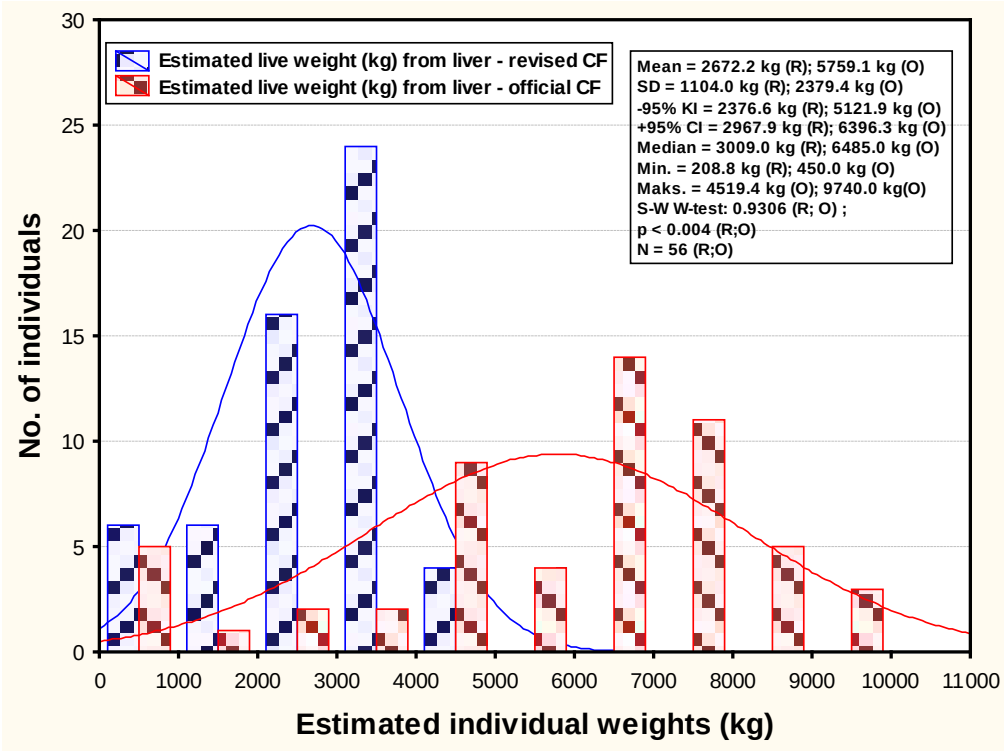


Figure 7.4. Liver (A) and fin weights (B) (kg) of 56 probable individual basking sharks landed in 1992, 1993, 1996 and 1997. The distributions of liver and fin weights were different from a normal distribution (Shapiro-Wilk's W-test; p <0.004). (Source: Blom, 2008 WD).



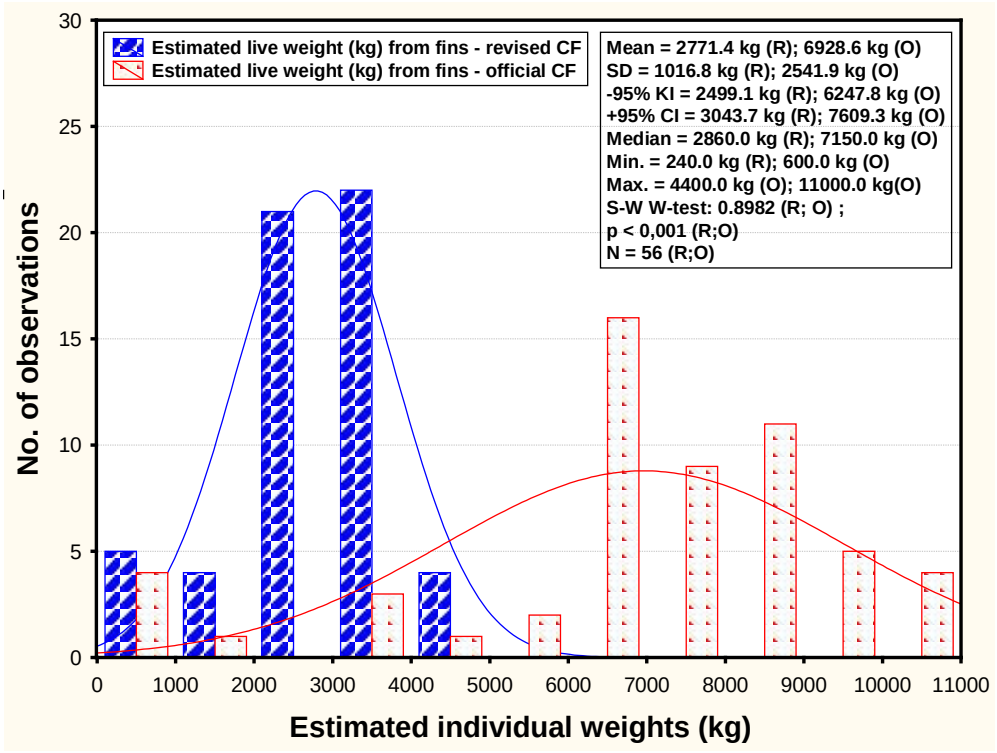


Figure 7.5. Comparison of estimated weight (kg) of 56 probable individual basking sharks landed in Norway in 1992, 1993, 1996 and 1997 applying A. the revised (4.64) and old (10.0) conversion factors for liver, and B. revised (40.0) and old (100.0) conversion factors for fins. The distributions of weights differed from a normal distribution (Shapiro-Wilk's W-test; p <0.004). (Source: Blom, 2008 WD).

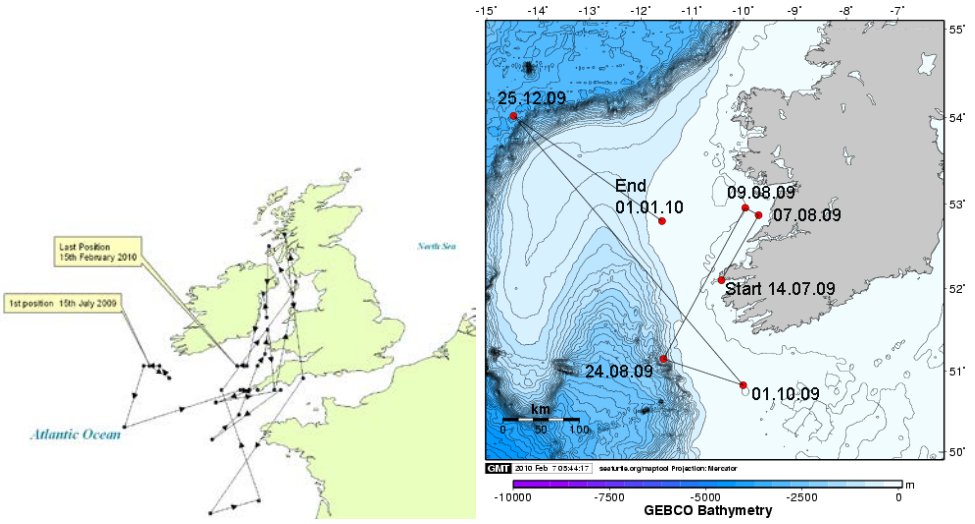


Figure 7.6 Geo-locations from basking shark A (left, sex=male) and B (right, sex=unknown). (Source: Berrotw and Jackson, 2010 WD).

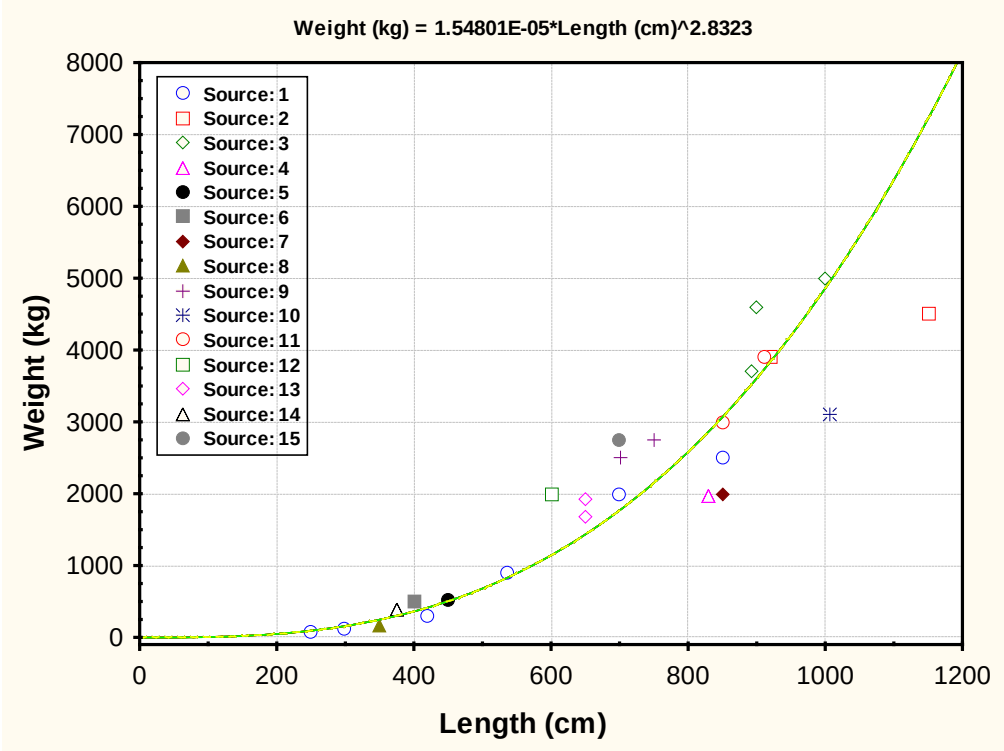


Figure 7.7. Length–weight regression of basking shark based on various published and unpublished (websites on basking shark and information from newspapers) data on measured lengths and weights. The original log length-log weight regression equation was given as: log Weight = - 11.075953 + 2.8323*log Length; R^2 = 0.939; N = 26. (Source: Blom, 2008 WD).