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REPORT OF THE

WORKING GROUP ON MARINE MAMMAL POPULATION DYNAMICS AND TROPHIC INTERACTIONS

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1 INTRODUCTION

The Working Group on Marine Mammal Population Dynamics and Trophic Interactions (WGMMPD) met from 16–18 March 1998, including a joint session on 18 March with the Working Group on Marine Mammals Habitats (WGMMHA), at ICES Headquarters. Dr G.T. Waring chaired the meeting. The Working Group and its terms of reference were established by Council Resolution at the 1997 ICES Annual Science Conference (see Annex 1). A list of meeting participants is given in Annex 2 and the agreed agenda is presented in Annex 3. The list of Working Papers and documents is given in Annex 4.

[*Note: The Working Group's membership was not established until February 1998 which left insufficient time for members to prepare Working Papers for the meeting. Furthermore, due to several factors beyond its control, the WGMMPD did not have sufficient time or resources to address item (d) in the terms of reference.*]

2 MARINE MAMMAL BY-CATCH IN OSPAR REGIONS

2.1 Introduction

The only direct way to obtain reliable quantitative estimates of total marine mammal by-catch in a fishery is via an independent observer scheme covering a representative sample of the fishery (Northridge, 1996; IWC, 1996). Other studies (such as voluntary reporting schemes, examination of stranded animals for net-marks, etc.) can indicate areas where there may be significant by-catch, and where closer monitoring may be needed, but do not provide trustworthy numerical estimates. Small-boat fisheries, where it is difficult or impossible to find space on board for an observer, pose a particular problem for by-catch monitoring (this issue is further considered in Section 4 of this report). In fisheries where no direct observer scheme is feasible, indirect estimates based on by-catch rates for similar gears may provide a useful starting point for estimates. Although observer schemes give the best available estimates, it should be noted that there is always some negative bias associated with the estimates, because of unobserved by-catch (e.g., animals that sink without being seen); while there is a general expectation that such bias should be small, there are no quantitative estimates of its magnitude.

There have been few published studies of marine mammal by-catch in the regions of the OSPAR maritime area (see Figure 1). These are summarised below along with an assessment of which additional fisheries are likely to (based on information from elsewhere) also have a marine mammal by-catch. The summaries are organised by OSPAR region (Figure 1) and by gear-type. Gear-types often correspond to species caught; certain species tend to get caught in certain gear types. It is important to note that lack of a by-catch estimate for a fishery does not necessarily imply that by-catch is negligible. The absolute numbers of animals in a by-catch may not be a good guide to its importance. Thus, there may only be in the order of 10 000 white-beaked dolphins (*Lagenorhynchus albirostris*) in the North Sea (Hammond *et al.*, 1995); a by-catch of 100 animals would have a greater population effect than a by-catch of the same number of harbour porpoises (*Phocoena phocoena*), where there is likely to be in excess of 250 000 in the North Sea.

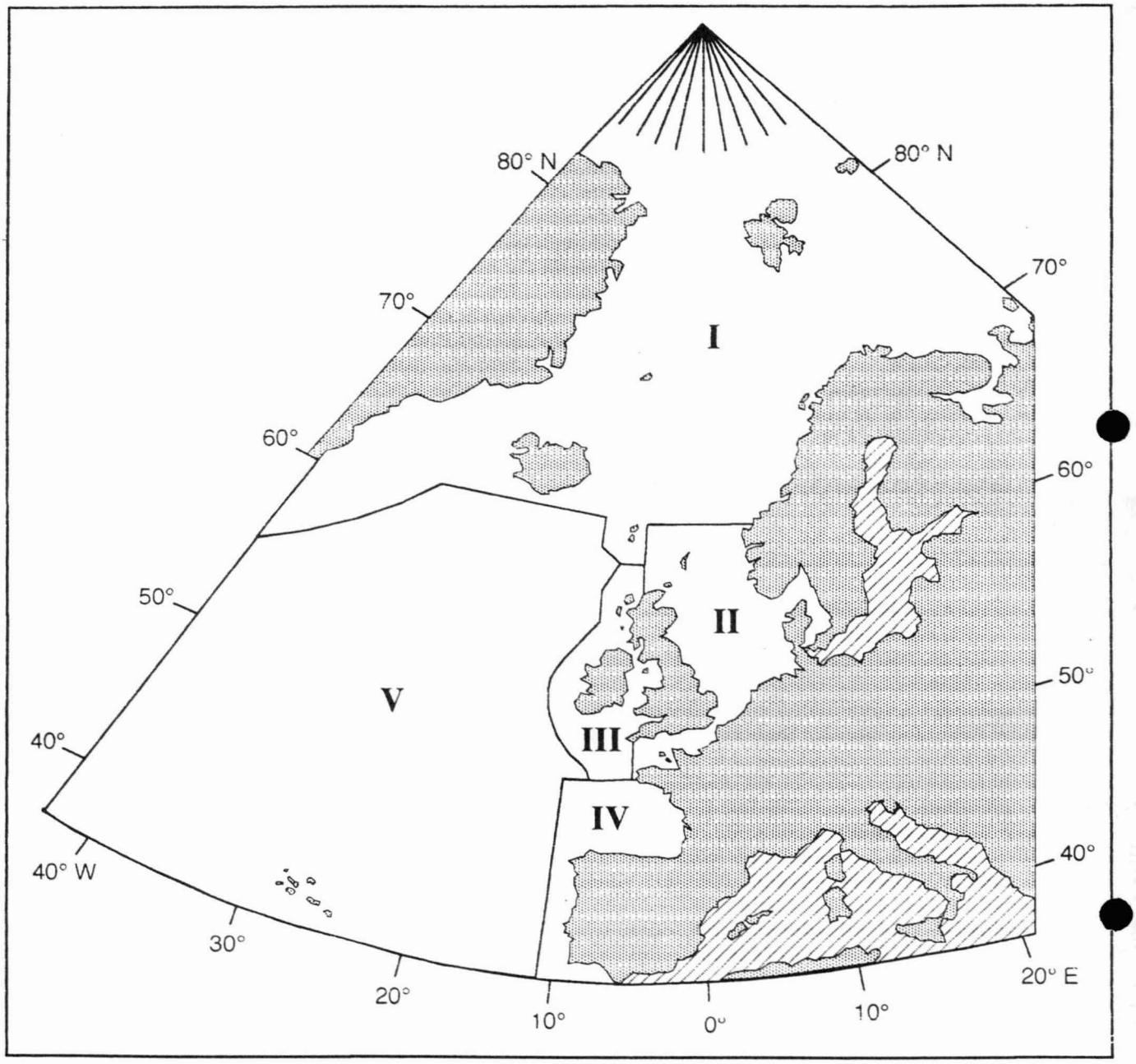
WGMMPD reviewed and evaluated available information for each OSPAR region. This evaluation indicates which known by-catch rates in each region are believed to be non-sustainable and which fisheries merit further immediate study. In some cases, some of these studies have started, but have yet to report. The issue of by-catch in the North and Baltic Seas has been the subject of study by parties to the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS). A report was written for and accepted at the 1997 Meeting of Parties to this Agreement (ASCOBANS, 1997). This report took as an interim rule (which may be tightened in future in the light of further studies) that any by-catch rate above 2 % of the estimated abundance of the population is likely to lead to a population size below about half of its potential, and carries a significant risk of not being sustainable at all and of driving the population towards extinction. It should be noted that this is very much a minimum standard, and a precautionary approach to uncertainty would give a lower threshold. See ASCOBANS (1997) for a full discussion of this issue.

2.2 OSPAR Region I: Arctic

2.2.1 Fixed bottom-set nets

Material collected during dietary studies in Icelandic coastal waters over five years in the early 1990s indicated that a minimum of two hundred harbour porpoises were by-caught per year in nearshore bottom-set gill net fisheries, mostly between March and May. This timing coincides with the capelin spawning migration in these waters (Víkingsson and Sigurjónsson, 1996). This fishery also catches small numbers of white-beaked dolphins.

Figure 1. Regions of the OSPAR maritime area (OSPAR, 1995).



Norway has conducted marking programmes with conventional external tags on ice-breeding and coastal seals to study migration, ageing methods and abundance. Recoveries from these tagged seals have also been made from fishing gear associated with coastal shelf bottom fisheries using bottom gillnets and fyke nets. These include grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) along the Norwegian coastline and harp seals (*Phoca groenlandica*) along the Norwegian coast and the Icelandic coasts. The vast majority of these catches are taken within OSPAR Region I, while a few are taken in Region II. The recapture information indicates that by-catches occur but not their size (although 4.6 % of all tagged animals were recovered from gillnets, Henriksen *et al.*, 1996) or whether this constitutes a problem. Most of the recaptures in fishing gear are of young seals during their first year of life.

In addition, there were some very exceptional seal invasions on the Norwegian coast during the years 1986–1988. These were mostly harp seals thought to originate from the White Sea/Barents Sea population. The number of by-caught animals peaked in 1987 at 56 000 animals. A further invasion occurred in winter 1994/1995 when about 10 600 harp seals were by-caught in bottom-set cod nets (Nilssen *et al.*, 1996).

Hooded seals (*Cystophora cristata*) breed on the ice to the east of Greenland and off Newfoundland. Both populations range widely to feed in deep-water areas of Region I; however no by-catches of this species in deep water have been recorded.

Hauksson and Bogason (1995a, 1995b, 1995c, 1995d, 1995e) reported seal by-catch in the Icelandic set net fishery. Most of the by-catch was in northern Icelandic waters and was caused by lumpsucker gillnets. By-catch species included harp, ringed (*Phoca hispida*), bearded (*Erignathus barbatus*) and hooded seals.

A large number of vessels participate in the Norwegian fisheries, most of which are small vessels that operate in coastal waters. In 1996, a total of 5 561 vessels used gillnets. Of these, 1 381 operated in 1997 in waters south of 62°N (mostly in OSPAR Region II), while the remainder were in OSPAR Region I (in literature of Norwegian Directorate of Fisheries). In 1989 and 1990, bottom-set gillnet fisheries were surveyed using similar methods to those used to survey drift nets (see below), and significantly lower catch rates and actual catch figures were recorded (Bjørge *et al.*, 1991).

Larsen (1995) reported, on the basis of interviews with fishermen, that there were only a few by-catches of harbour porpoise in the offshore (beyond 30 NM from the coast) net fishery for cod.

2.2.2 Drift nets

In 1988, the drift net fishery for salmon in Norwegian waters was surveyed for cetacean by-catches. During a six-week period, incidental catches of 96 porpoises were revealed. The catch rate in this fishery was relatively high and averaged 0.8 porpoises per 1 000 net km hours. After the 1988 salmon fishing season, all use of large-mesh drift nets was prohibited in Norwegian waters due to the inability of this fishery to discriminate between salmon from different populations.

2.2.3 Longlines

Larsen (1995) reported that harbour porpoises were very occasionally taken on longlines off the Faroe Islands.

2.2.4 Evaluation

WGMMPD noted that, with the exception of recording of the seal by-catch off Norway, there have been no direct assessments of by-catches of marine mammals in this region during the 1990s. On the basis of information available to the group, bottom-set fixed nets appear to offer the greatest potential for by-catch in this region. The fisheries off Iceland, and by small vessels off Norway, would deserve further investigation. No information was available on by-catch in pelagic trawl or deep-water trawl fisheries in the region; these types of fisheries are known to catch marine mammals elsewhere (Donoghue, 1997; Lens, 1997; Pemberton *et al.*, 1994).

2.3 OSPAR Region II: Greater North Sea

Much of this section is based on a report compiled for the second Meeting of Parties to the ASCOBANS Agreement (ASCOBANS, 1997). The contribution of persons who helped write that report who are not members of WGMMPD is gratefully acknowledged.

2.3.1 Fixed bottom-set nets

This covers a variety of gears: trammel nets, tangle nets, and gillnets set at different heights and with different mesh sizes. Evidence from the North Sea and elsewhere indicates that any nets standing off the seabed are liable to catch harbour porpoise (if present in the area), regardless of net type or attachment methods (Frady *et al.*, 1994). However, some types of bottom-setting seem to cause higher by-catch rates than others in the same area.

An observer scheme monitored Swedish cod gillnetters in the marine part of a single ICES statistical rectangle covering about 1500 km^2 lying off Gothenburg, Sweden, in 1995 and 1996 (Carlström and Berggren, 1996). By-catch rates were very similar in the two years, at around 32 porpoises per 10 000 net km hrs, giving an annual by-catch estimate of 53 porpoises in this single rectangle for 1995. Further observations in the cod and pollock fishery in the Swedish Skagerrak occurred from March 1996 to February 1997 (Carlström and Berggren, 1996). By-catch rates were 40 porpoises per 10 000 net km hrs in spring, 39 in autumn, and 0 in winter. This produced an annual estimated by-catch in this fishery of 113 porpoises. However, several Swedish and Danish set-net fisheries operate in this area targeting cod, plaice, spiny dogfish, and lumpsucker, so there is the potential for high total by-catch. A Danish discard-recording project is now active in this area.

About 1,381 small vessels operated with gillnets in the Norwegian fisheries in 1997 in waters south of 62°N, mostly in OSPAR Region II (in literature of Norwegian Directorate of Fisheries). When last monitored in 1989 and 1990, this fishery had a significantly lower catch rate than the now-ceased salmon drift net fishery.

A number of UK gillnetters operate around and between Orkney and Shetland. Porpoises are numerous in the northern North Sea and in neighbouring waters, and there appears to be considerable gillnet effort in this region, so there is the potential for substantial by-catch.

The Danish bottom-set gillnet fleet is presently the largest in the European Community (Lowry and Teilmann, 1994), and the fisheries for cod/sole/turbot in the eastern central North Sea were studied in 1992–1994 (Vinther, 1994, 1995a, 1995b). Extensive observer coverage revealed an estimated annual porpoise by-catch of 4 450 (95 % confidence interval: 2 580 to 6 320) in the cod and turbot fisheries. This was based on an observed by-catch of 161 harbour porpoises in 2 106 km of net on 61 trips. One *Lagenorhynchus* dolphin was also by-caught. Almost all of the by-catch was between 55°30'N and 57°30'N, and no by-catch was seen in the sole fishery, which sets mostly closer to shore. The study and the by-catch estimate excluded smaller Danish boats (ca. 20 % of landings), and the fisheries for plaice, lumpsucker, and hake (the latter associated elsewhere with a high porpoise by-catch rate (Tregenza *et al.*, 1997)). The total Danish by-catch is therefore likely to be substantially higher. Further studies off Denmark are re-examining these fisheries as well as those directed at other species. There is also a recreational inshore gillnet (not all bottom-set) fishery off Denmark which has not been investigated.

There are several UK set gillnet fisheries in this area of the central North Sea, with substantial overall effort. The largest component, the English wreck net fishery (about 12 boats working out of Grimsby), is being studied at present in the BY-CARE project, and results are expected at the end of 1998. Most of the English fishery is for cod. The mode of operation is similar to that in the Danish gillnet fishery and there is partial overlap in the areas fished. There is a variety of inshore gillnet fisheries along the east coast of Britain, with the target species including cod, sole, turbot and salmon, and with most effort off the Yorkshire coast. Some by-catches have previously been reported along most of the coast (Northridge, 1988). A small fishery off the east coast of Scotland, which has been in decline in recent years, was reported to be taking from 1–20 animals per year in the 1960s and 1970s (Rae, 1965, 1973).

Very little set-netting is prosecuted off the Netherlands or Belgium. However, since 1988, at least 24 harbour porpoises have stranded dead in Belgium. The cause of death of at least six animals was most probably by-catch (not all animals undergo necropsy) (Coignoul and Jauniaux, 1995; Van Gompel, 1991, 1996; J. Haelters, pers. comm.).

In recent years, there have been small German set-net fisheries for cod and sole in the North Sea (Kock and Benke, 1996). Of the 565 porpoises found dead on beaches or reported as by-catch, only 23 could with certainty be ascribed to by-catch, with another 38 having skin lesions consistent with by-catch. Most of the by-caught animals were less than 2 years old.

Considerable quantities of gill and trammel nets are deployed off France and England. By-catch has not been studied systematically, but two porpoises were recorded in the 1980s (Martin *et al.*, 1990). This area has very low cetacean densities and inevitably by-catch rates will be low, so that very high percentage coverage would be required to obtain reliable estimates from a conventional observer scheme in this area.

2.3.2 Pelagic trawls

By-catch in the German pelagic trawl fisheries for herring and mackerel in the North Sea was investigated in 1996. Observers were on board during five fishing trips (out of 33). Four pilot whales (*Globicephala* sp.) were caught in August while fishing for mackerel and an additional four were caught in December while fishing for herring (Kock, 1997).

2.3.3 Drift nets

There are few drift net fisheries left in the North Sea and overall cetacean by-catch is therefore probably low compared with other fisheries. Although large mesh nets have been prohibited in Norwegian waters since 1988, small mesh (mesh size 3.5 cm) nets (e.g., for mackerel) may still be used. However, in order to avoid by-catches it is mandatory to submerge these nets at depths of at least 3 m below the surface. In 1996, a total of 149 vessels used nets for mackerel, and 147 operated in the ASCOBANS area. Most of these vessels were small and 125 vessels were under 11 m in length (in literature of Norwegian Directorate of Fisheries). A similar, but smaller (27 vessels in 1997 fishery) operates off Sweden.

A salmon fishery off the northeast coast of England uses relatively short nets with the fisherman always in attendance. By-catch has been reported, but most animals are reputedly released alive. A small (ca. 50 small boats) UK inshore drift net fishery for herring operates off the East Anglia coast as far north as the Wash and there is a commercial herring drift net fishery of around 15 boats in the Blackwater estuary. Porpoises are rare in this area.

2.3.4 Fixed gear apart from set nets

Harbour porpoises are caught in pound nets around Denmark, but many are released alive (Lowry and Teilmann, 1994). A variety of similar gears are used in England and Scotland for catching salmon, and porpoises have been reported caught; however, there is no estimate of numbers. The small scale of the fisheries means that by-catch is likely to be very low compared to that caused by set nets.

2.3.5 Other fishing methods

The other common fishing methods in this OSPAR region are bottom trawling, beam trawling, seining, and longlining. There are records and several anecdotal reports of cetacean by-catch from some of these fisheries (Kock and Benke, 1996; Northridge 1988, 1991; Martin *et al.*, 1990). By-catch rates appear to be very low and at present it seems likely that any by-catch rates from these unrecorded fisheries is small compared to that from set nets and pelagic trawls. However, effort from bottom trawls in particular is very high, so that even a low by-catch rate could potentially cause significant total by-catch.

2.3.6 Evaluation

The harbour porpoise by-catch in the central and southern North Sea by a component of the bottom-set gillnet fishery is estimated at 4 450, which comprises more than 2.6 % of the number of harbour porpoises inhabiting this area. This level of by-catch could very likely lead to a decline in the population size. Estimates are required of the level of by-catch in other similar fisheries in the central and southern North Sea. There are no by-catch estimates available in the northern North Sea, although observer schemes are now running in some fisheries. Understanding of this by-catch and of the harbour porpoise population that is being impacted is required. The by-catch of harbour porpoises in the Swedish Skagerrak is likely to exceed 4 % of the population; this, coupled with evidence of declining numbers of harbour porpoises in the area (Carlström and Berggren, 1996), would indicate that action is now needed to reduce the by-catch. By-catch in the pelagic trawl (other than German) and demersal trawl fisheries in the region have not been systematically monitored.

2.4 OSPAR Region III: Celtic Seas

2.4.1 Fixed bottom-set nets

From August 1992 to March 1994, there was an observer scheme for the English and Irish hake gillnet, tanglenet, and wreck net fisheries in the seas to the west of England and south of Ireland, originally to monitor the by-catch of common dolphins (*Delphinus delphis*) (Tregenza *et al.*, 1997). Observers were present for the hauling of over 2 500 km of net which caught 43 harbour porpoises and four common dolphins. Nearly all of the porpoises caught were in the hake

fisheries, with only one in a tangle net and none in wreck nets. Although common dolphin by-catch was small, harbour porpoise by-catch was estimated to be 2 200 (95 % confidence interval: 900 to 3 500). This figure represents 6.2 % of the estimated number of porpoises in this area and there is a serious cause for concern about the ability of this population to sustain this level of by-catch. The scheme did not cover trammel netters or smaller boats, which may contribute substantially to overall by-catch. In the southern Celtic Shelf, where porpoise densities may be lower, there are large French set net fisheries (Morizur *et al.*, 1992).

During a study of predator damage to net-caught angler fish off the south coast of Ireland, Collins *et al.* (1993) examined four young grey seals which had been by-caught.

A fishery on the shelf edge to the west of Scotland uses bottom-set nets targeting angler fish. There have been no reports of by-catch in this fishery and it also appears to operate to the west of the main part of the range of the harbour porpoise. In recent years, vessels have been licensed to use these nets closer to the coast, within the main part of the harbour porpoise range. An observer scheme for this fishery is presently being implemented.

2.4.2 Pelagic trawls

There is evidence from the Celtic Shelf that pelagic trawling catches substantial numbers of dolphins (Morizur *et al.*, 1997a, 1997b); 13 common dolphins, 5 white-sided dolphins (*Lagenorhynchus acutus*), and 4 grey seals were observed as by-catch in 1 788 hours of pelagic trawling. These fisheries were targeting tuna, hake, sea bass, horse mackerel, Atlantic mackerel and herring. Forty-seven white-sided dolphins were reported as by-catch in Dutch trawl fisheries in 1993 and 1994 off southwest Ireland (Addinck *et al.*, 1996). Kuiken *et al.* (1994) reported a mass stranding of common dolphins in southwest England bearing characteristic markings of by-catch. The high overall effort from pelagic trawls in these waters means that there is the potential for significant by-catch.

2.4.3 Drift nets

The albacore drift net fishery to the west of Britain and France and southwest of Ireland has a by-catch of common and striped dolphins (*Stenella coeruleoalba*) (Goujon *et al.*, 1993; Antoine *et al.*, 1997). The fishery straddles the boundaries of OSPAR Regions III, IV, and V. The by-catch of striped dolphins is likely to exceed 2 % of the number of animals in the area.

2.4.4 Evaluation

The by-catch in fixed bottom-set nets in the seas to the south of Ireland is likely to place the population of harbour porpoises in this area at risk. The by-catch in the pelagic trawl fisheries in the same area may be placing populations of other delphinids at risk. There is presently no information available on by-catch in waters to the west and north of Ireland. Monitoring schemes for the fixed bottom-set net fisheries in these areas are needed. The low populations of cetaceans in the Irish Sea would probably mean that any by-catch rate there would be low (no information is available), but equally any by-catch might place any localised population in this area at risk.

2.5 OSPAR Region IV: Bay of Biscay and Iberian Coast

2.5.1 Gillnets

By-catches, principally in gillnets (type unspecified), have been reported for several decades in the Bay of Biscay and in Atlantic waters off the Iberian coast (Reiner, 1980; Pérez *et al.*, 1997; Lens *et al.*, 1995; Garcia-Castrillo *et al.*, 1990 1992, 1993, 1994) based on reports by fishermen and also from the examination of stranded animals.

Pérez *et al.* (1997) reported seven by-catches and twelve strandings of common dolphins with evidence of having been caught in gillnets.

Ten cetacean species (pygmy sperm whale (*Kogia breviceps*), goose-beaked whale (*Ziphius cavirostris*), fin whale (*Balaenoptera physalus*), pilot whale, Risso's dolphin (*Grampus griseus*), common dolphin, bottlenose dolphin (*Tursiops truncatus*), spotted dolphin (*Stenella* sp.), striped dolphin, and harbour porpoise), and two Phocid seal species (grey and common) have been recorded by-caught in fishing gear. Cetacean by-catches are typically higher in waters off the northwest coast of Spain compared with the Bay of Biscay. In all regions, the frequency and scale of strandings (many net-marked animals) coincide with available by-catch data. Numerically, common dolphins are the species most

frequently taken (10–80 animals annually since the early 1980s). Strandings data, however, are likely to be negatively biased, particularly during the early phases (1980s) of monitoring programmes.

Sequeira and Ferriera (1994) considered that there was little reliable data on marine mammal by-catch on the Portuguese coast, but that common dolphin and harbour porpoise dominate in the marine mammal by-catch of gillnets.

2.5.2 Pelagic trawl

Morizur *et al.* (1997a, 1997b) investigated several pelagic trawl fisheries in the Bay of Biscay. Cetaceans were observed as by-catch in the French tuna, hake, and sea bass trawl fisheries. The tuna fishery observed by-catch consists of bottlenose and common dolphins, while the other two fisheries recorded only common dolphins. The amount of observation undertaken was low but catch rates were comparatively high. The authors considered that by-catch was not insignificant and that it required continued monitoring.

A comparatively small (i.e., when compared with gillnets) by-catch of common dolphin in trawls (type unspecified, but likely to be pelagic trawl) in this region was reported by Pérez *et al.* (1997).

2.5.3 Fish traps

Sequeira and Ferriera (1994) noted that minke whales (*Balaenoptera acutorostrata*) occasionally become entangled in fishing trap leader-lines.

2.5.4 Evaluation

By-catch in this region has been briefly assessed for some pelagic trawl fisheries. These assessments indicate that some trawl fisheries are catching delphinids. These fisheries, and others presently not assessed, should receive further investigation. There is some evidence of by-catch in gillnets; these fisheries also could usefully be formally monitored.

2.6 OSPAR Region V: Wider Atlantic

2.6.1 Drift nets

Following two years of experimental fishing, French fishers initiated a summer/autumn albacore tuna drift net fishery in 1997. The fishery primarily occurs between longitude 10°W to 21°W and 51°N to 53°N latitude (Goujon *et al.*, 1993a, 1993b, 1996; Antoine *et al.*, 1997). An observer programme to estimate cetacean by-catch was conducted during the 1992 and 1993 fishing seasons. Fifty-eight and 63 vessels (trips) were covered in 1992 and 1993, respectively. Annually this represented about 25 % of the total number of trips undertaken. Ten cetacean species were by-caught (Table 1). Total incidental mortality of the common dolphin was estimated at 330–400 and that of striped dolphin, 1 135–1 160. These two species accounted for 90 % of the by-catch.

Table 1. Numbers of cetaceans observed as by-catch in the French Atlantic tuna fishery in 1992 and 1993 (Goujon *et al.*, 1996).

Species	1992	1993
Striped dolphin	330	243
Common dolphin	114	90
Long-finned pilot whale	13	16
Bottlenose dolphin	10	8
Sperm whale	1	6
Fin whale	2	0
Minke whale	0	1
Risso's dolphin	1	7
Pygmy sperm whale	0	1
Unidentified cetaceans	4	5

2.6.2 Evaluation

WGMMPD found information on only one fishery in this area. No information concerning fisheries around the Azores was found. No information was available on by-catch in pelagic trawl or deep-water trawl fisheries in the region; these types of fisheries are known to catch delphinids elsewhere.

Overall, WGMMPD is concerned regarding the number of fisheries in the OSPAR regions that do not have adequate by-catch monitoring programmes. Similarly, the lack of information on marine mammal distribution and abundance, particularly in areas with known or suspected high levels of by-catch (based on intermittent observer programmes and/or standing data) make it difficult to evaluate the impact of mortalities on populations. We wish to draw the attention of fisheries managers to those fisheries where marine mammal mortality exceeds levels likely to cause population decline.

3 CETACEAN TROPHIC ECOLOGY

3.1 Identification of Cetacean Prey in the North Atlantic

Data on prey species are provided in Tables 2 and 3; one for baleen whales and the other for odontocetes. The data are derived from various sources. Most information on baleen whales has come from commercial whaling and research whaling operations. Information for sperm whales (*Physeter macrocephalus*) is derived from whaling and also strandings. Information on most smaller cetaceans come from incidental catches and/or strandings. The data cover many years and seasons and there are known wide variations in dietary preference between areas and seasons and from year to year. The tables are not a fully comprehensive compilation of predators and prey items at this stage, and do not include all known prey species for those predators listed. The focus has been on the predators that are most known and important in conservation and management and their main prey. (Note that for killer whales (*Orcinus orca*), in some areas such as the Faroes (Bloch and Lockyer, 1988), large prey such as seabirds, seals, and even other cetaceans form part of the diet. However, this is not recorded in the prey table.)

3.2 Review of Data Types

Potential sources of sampling and data on cetacean diet and contaminants can be obtained from the following sources:

1) commercial takes of cetaceans;
2) research takes of cetaceans;
3) by-catches of cetaceans;
4) strandings of cetaceans;
5) biopsies from live cetaceans;
6) foraging behaviour of free-living cetaceans;
7) captive cetaceans;
8) collection of cetacean faeces.

Stomach and intestinal contents can be used for prey identification. However, these are likely to be most useful from commercial and research takes and by-catches, since stranded animals often have empty stomachs and gut. Blubber and tissue samples can be used for fatty acid profiles for dietary intake and also for contaminant levels. Again, the samples of stranded origin may be less useful because of the poor nutritive condition of the animals and the possible depletion of blubber lipids and consequential effects on lipophilic contaminant levels. Biopsies of blubber from free-living animals should ideally include the full depth of blubber tissue, but this is impracticable for the large whales. Observations of foraging behaviour are useful in some situations for the identification of prey, especially when simultaneous trawl sampling, video photography, and acoustic recordings are taken. Faeces collected from cetaceans defecating near the sea surface may be useful for fatty acid profiles of dietary items.

Programmes of dietary and contaminant sampling and analyses would be more informative if designed as collaborative programmes. Individuals sampled from commercial and research takes, by-catches, and strandings can be sampled and documented comprehensively, and should also include the following information to allow a full interpretation of the effects of sex, age, reproductive status, season and year effects, as well as general health.

Table 2. Principal prey for several odontocete whales in the ICES and/or NAFO areas.

Prey species	Sperm whale	Pilot whale	Northern bottlenose whale	Killer whale	Harbour porpoise	White-beaked dolphin	White-sided dolphin	Striped dolphin	Common dolphin	Beluga	Narwhal	Risso's dolphin	Bottlenose dolphin
CEPHALOPODA	Va, IVa, VIIIc			IIa		IVa	IVa	IVa, VIIIc, VIIg	VIIg	1A, B, C–F		IVa, VIIIc	IVa
Todarodes sagittatus		VIIIc, Vb1, Vb2,Va											
Gonatus fabricii	IIa, IIb	Vb1, Vb2	Vb1, Vb2,IVb					VIIg	VIIg				
Brachioteuthis sp.		Vb1, Vb2											
Illex illecebrosus		3p			4X				5z	4S, 4T			
Sepiola atlantica		Vb1, Vb2			Va, VIIg								
Mastigoteuthis sp.	VIIIc												
Teuthowenia megalops	VIIIc												
Loligo forbesi					VIIg				VIIg				
Loligo pealei		6a											
PISCES													
Arctogadus glacialis										1A, B, C–F	1A, B, C		
Boreogadus saida										1A, B, C–F, I	1A, B, C		
Trachurus trachurus					VIIg		VIIg						
Sebastes marinus	IIa, Va				4X						1A, B, C		
Mallotus villosus					I, Va					4S, 4T			
Clupea harengus				IIa, Va	I, IIa, IIb, IVb, IIIan+s, IVa, VIIg, 4x	VIIg							
Argentina silus		Vb1, Vb2											
A. sphyraena							VIIg		VIIg				
Micromesistius poutassou		Vb1, Vb2			IIa, IIb	VIIg						VIIIc	VIIIc
Maurolicus muelleri					IIa, IIb								
Trisopterus minutus					IIa, VIIg		VIIg	VIIg	VIIg				
Merlangius merlangus					IVa, VIIg			VIIg	VIIg				
Gobiidae sp.				IIa	IIIan+s, VIIg			VIIg	VIIIc				
Gadidae sp.				IIa	I, IIa, IIb, IVb, IIIan, Va, IVa, VIIIc	IVa, Va	IVa	IVa, VIIIc	VIIIc				IVa, VIIIc
Gadus morhua	Va				IVb, 4X, VIIg				IVa				
Merlanogrammus aeglefinus					VIIg								
Ammodytes sp.					IIIan+s, IVa, Va				IVa	4S, 4T			
Merluccius merluccius					IVb								VIIIc
Merluccius bilinearis					4X	VIIg							
Sprattus sprattus					IIIan, VIIg			VIIg					
Scomber scombrus					4X		VIIg		VIIg				
Rhinonemus cimbrius					IIIan								
Osmerus mordax					4X					I			
Urophysis sp.					4X								
Cyclopterus lumpus	IIa, IIb, Va												
Salmo salar										I			IVa
Reinhardtius hippoglossoides				Va									
CRUSTACEA								VIIg					

This information should include:

1) position of capture or stranding;
2) time of day of capture/finding AND estimated post-mortem time;
3) sex, length, weight, age (from teeth or ear plugs, depending on type of cetacean);
4) reproductive condition: collection and examination of gonads and foetuses;
5) nutritional condition i.e., girth and blubber depth, blubber lipid content, etc.;
6) pathology: collection of adrenals, tissue samples from organs, etc., for health assessment.

Table 3. Principal prey for several large baleen whales in ICES/NAFO areas.

Prey Species	Minke whale	Fin whale	Humpback whale	Sei whale	Right whale	Blue whale
PISCES						
Mallotus villosus	IIa, IIb, Va, XIVb, 1A-F	I, IIa, Va	IIa, Va	Va		
Clupea harengus	IIa, I, 5Y, 4X	4X, 5Y, 5Z	4X, 5Y, 5Z			
Gadidae sp.	Va					
Gadus morhua	IIa, IIb, I, XIVb, Va					
Melanogrammus aeglefinus	IIa					
Ammodoytes sp.	I, 1A-F, Va	Va, 5Y, 5Z	5Y, 5Z	Va		
Merluccius merluccius						
Scomber scombrus	5Y	5Y, 6A	5Y, Va			
CRUSTACEA						
Thysanoessa inermis	IIa, IIb, Va, XIVb, 1A-F	I, IIa, IIb	IIa	I, IIa	I, IIb	I, IIa
Meganyctiphanes norvegica	Va	I, IIa, Va		Va		
Calanus finmarchicus		I, IIa, IIb		I, IIa	5Y, 5Z	

Information provided in Table 1 of IWC document SC/49/Rep 6 (which is a working document for WGMMPD and WGMMHA) details the different types of tissues required for certain contaminant and physiological measurements together with collection scope and feasibility, and limitations. This table is reproduced below (Table 4).

The authors of this document also selected three focal species for PCB studies: bottlenose dolphin, harbour porpoise, and beluga whale (*Delphinapterus leucas*). All three examples recommended occur within the North Atlantic region. It is clear that a full understanding of contaminant levels in any species and population, depends on life history; especially distribution and migration, feeding areas and prey items. The trophic system is the underlying mechanism for contaminants entering the population, and this is highly dynamic. Therefore, in a comprehensive investigation it is essential to collect information on diet, and contaminant levels in the prey when examining contaminant levels in cetaceans.

Examples of contaminant levels exist for potential prey species of cetaceans in some areas, but matching contaminant levels in specific prey with cetacean predators in the same area is required, and for the same time period. This way, integrated patterns of contamination and models of the dynamics may be developed. One problem is that even in cetacean species known to favour certain prey, seasonal and year-to-year fluctuations can occur, and the intake of contaminants over time can vary so that both short- and long-term effects may be difficult to predict. In populations where there is a steady consumption of highly contaminated prey, long-term effects may be severe, so that monitoring is also important in order to follow changes in general health, fecundity and recovery from any ill effects.

Table 4. Table 1 from Proposal to the IWC on furthering the recommendations of the Pollution Workshop, SC/49/Rep 6.

Pollutants	Potential tissues	Biopsies	24-3hr pm	<3hr pm	Captive animals	Variables	Laboratories
PCBs	Blubber	1	1	1	1	S,A,N	UB,IBN,MLL,CHL
	Blood	4	3	1	1	S,A,N	UB,IBN
Hg, methyl-Hg	Skin	1	1	1	1	A,S	ICES group, CL,US,CHL
	Liver	4	1	1	4	A,S	ICES group, CL, US
Cadmium	Skin	1	1	1	1	A,S	ICES group, CL,US,CHL
	Kidney	4	1	1	4	A,S	ICES group, CL, US
Indicators							
Enzyme induction	Liver	4	1*	1	4	S,A	LUW, US, WH, GL
	Skin	1*	1*	1*	1*	S,A	LUW, US, WH, GL
Sex hormones	Blood	4	2	1	1	S,A	IBN Hospitals
(Oestradiol, testosterone,	Muscle	3	2	1	2	S,A	YL
progesterone)	Blubber	1*	2*	1*	1*	S,A	?
Vitamin A	Blood	4	1	1	1	?	LUW, UB
	Liver	4	1	1	4	?	LUW, UB
	Skin	1*	1*	1*	1*	?	LUW, UB
Thyroid hormones	Blood	4	4	1	1		LUW
	Liver	4	4	1	4	S,A	LUW
DNA adducts	Skin	1	1	1	1	A	ML, UU
	Liver	4	1	1	4	A	ML, UU
Porphyrins	Liver	4	2	1	4	?	UB, IBN
	Skin	1*	2*	1*	1*	?	UB, IBN
Luciferase	Blubber	1	1	1	1	?	LUW
	Skin	1	1	1	1	?	LUW
	Blood	4	1	1	1	?	LUW
Metallothioneins	Liver	4	?	1	4	A	LUW, WL
Histopathology	Liver	4	2	1	4	A	LUW, WL

1 Feasible
2 Potentially feasible
3 Dubious
4 Infeasible
A Age
S Sex
N Nutritive condition

*Analytical technique under development
CHL = Charleston laboratory
GL = Goksoyr laboratory
ML = Martineau laboratory
UB = University of Barcelona
UU = University of Utrecht
WL = Wagemann laboratory

CL = Caurant laboratory
IBN = Institute for Forestry and Nature Research
MLL = Mount Lake laboratory
US = University of Sienna
WH = Woods Hole
YL = Yoshioka laboratory

3.3 Utility of Compiling a Comprehensive Dataset on North Atlantic Cetacean Prey

WGMMPD indicated that the tables of cetacean prey compiled at this working group session should be regarded as a starting point. The data therein are not comprehensive and, in any case, only provide the main prey species taken in different areas. It is clear that although cetaceans have general food preferences, the actual composition of prey can vary from area to area. Therefore the tables here detail prey type by ICES (Figure 2) and/or NAFO (Figure 3) area. These tables could be developed and updated regularly. One potential use of these types of data would be in developing multispecies models. Additional information to be gained to make the prey information more useful, would be levels of pollutants of different types in prey by ICES/NAFO area. Other information useful for modelling would be data on quantities of food consumed by cetacean species. A useful focus could be these three data types for the three cetacean species identified in IWC/SC/49/Rep 6. This may make initial efforts more productive than a blanket request for information. The ancillary data and information needed to enhance such studies are detailed in Section 3.2, above.

4 REVIEW OF METHODS FOR MONITORING BY-CATCH OF MARINE MAMMALS ON VESSELS TOO SMALL TO CARRY OBSERVERS

In several areas of the North Atlantic, large numbers of small vessels are operating in coastal fisheries. These fleets are operated by full-time, part-time, and an increasing number of spare-time (leisure) fishers. For practical and economic reasons, large-scale observer coverage is not feasible in these fisheries (Berggren, 1994; Northridge, 1996).

In fisheries where it is not possible to provide sufficient observer coverage, marine mammal by-catch may be monitored by automated techniques (Anon., 1998). Video cameras that are automatically switched on when gear is hauled may be used for both quantitative and qualitative monitoring of the by-catch. However, the cost of reviewing the recording may be very large and the method may not be feasible when a large number of vessels is involved. Video cameras are more likely to miss those animals that fall from nets before being hauled aboard.

Simultaneous monitoring of fisheries from independent vessels or from elevated shore-based locations may be possible under circumstances where fishing effort is concentrated over small areas. These types of observer programmes have been used to monitor nearshore small vessel gillnet fisheries off the U.S. Atlantic and Pacific coasts (G. Waring, pers. comm.). However, this approach may not be feasible in most fisheries.

Mandatory reporting of marine mammal by-catches together with catch statistics of target species in the fisherman's log may be used to identify fisheries (area, gear type, effort, and season) where by-catches of marine mammals occur (H. Westerberg, pers. comm.). In fisheries where the by-catch may be significant (by actual number or sustainability), the reported by-catch statistics may be subject to further examination. Detailed studies aimed at estimating correction factors may be conducted by placing observers onboard a sub-sample of the fleet, by interviews of the fishers, contracting fishers to produce detailed information, etc. The reported by-catch statistics may be used to stratify the fishery, which could be used for stratified extrapolation or corrections of the entire fishery.

One further consideration is that any by-catch recorded in a scheme will also need to be extrapolated to total fleet by-catch. In some instances, figures of catch landed may be used, but they may not be available for some (e.g., recreational) small boat fisheries. It is important when designing any scheme to consider how extrapolation should be carried out.

In summary, WGMMPD felt that there is not one method or protocol that can be applied to all small vessel fisheries. For automated techniques, further developments and testing are required. For mandatory reporting and sub-sampling, a feasibility study and a pilot project is recommended. WGMMPD underlined the importance of sound experimental design and precise and detailed description of the methods used in any pilot study.

5 JOINT SESSION OF WGMMPD AND WGMMHA

The Working Group on Marine Mammal Population Dynamics and Trophic Interactions (WGMMPD) and the Working Group on Marine Mammal Habitats (WGMMHA) met jointly on 18 March. The meeting was attended by the ICES Environment Adviser and members of WGMMPD and WGMMHA.

G. Waring, Chairman of WGMMPD, welcomed members of WGMMHA to the joint session. A document for consideration at the joint session was prepared by WGMMHA and presented by A. Bjørge, Chairman of WGMMHA. The discussion at the joint session followed the outline of this document.

5.1 Working Group Participation and Future Co-operation

The problems of obtaining attendance of sufficient and relevant expertise to both working groups were addressed. Chairmen of both groups arrived in Copenhagen without full knowledge of the participation at their respective meetings. This made preparation for the meetings difficult and hindered the possibilities of soliciting working papers from participating experts. The ICES Environment Adviser indicated that these problems are experienced by many new working groups at their first meeting. There is a tendency of delayed nomination and a reluctance by Member Countries to send their scientists to working group meetings due to budgetary constraints.

The possibility of convening the two marine mammal working groups just before or after large marine mammal conferences was considered. This may reduce travel costs for the participants and facilitate participation of scientists not normally attending ICES working groups. Concerns were expressed that the larger conferences may dilute the focus on the tasks of the working groups. No conclusion was drawn on this subject.

Figure 2. ICES Fishing Areas in the Northeast Atlantic.

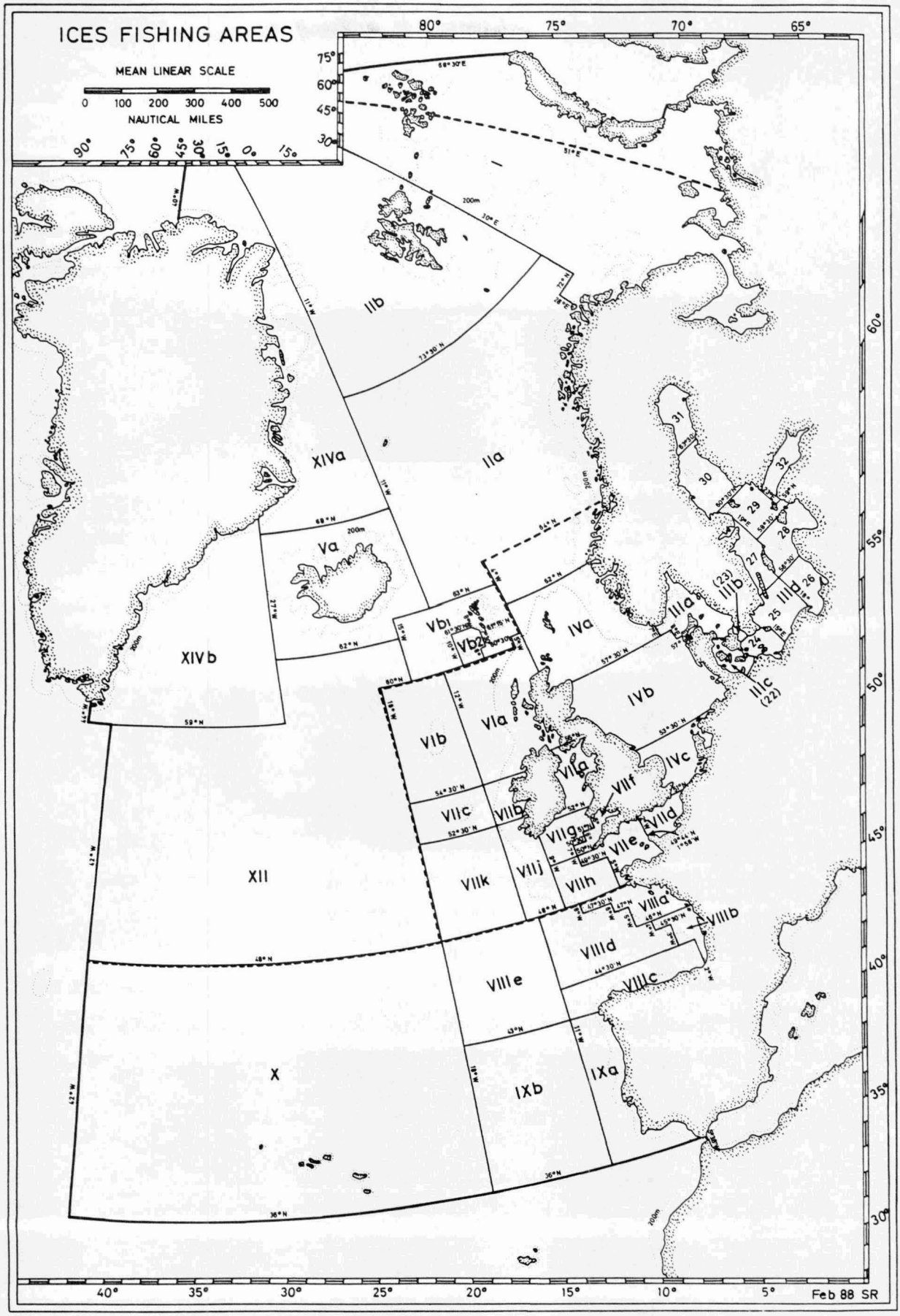
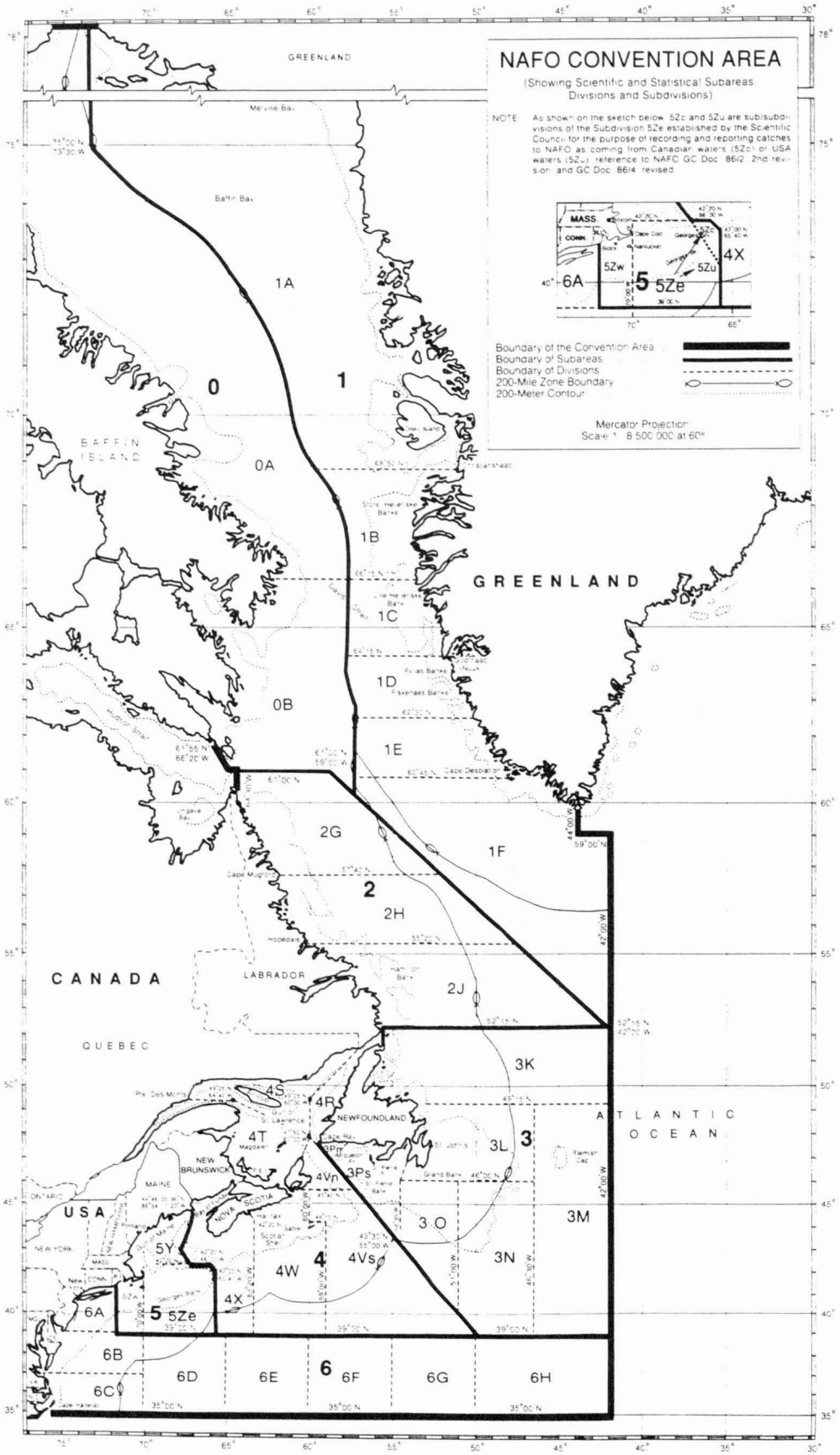


Figure 3. Scientific and statistical Subareas, Divisions and Subdivisions of the NAFO Convention Area (NAFO, 1995).



It was agreed that more emphasis on proactive research and a general focus on methodology in the future activities of the groups may attract relevant experts. It was underlined that proactive research may be required for the ICES Five-Year Science Plan, and as a side effect such focus may be of interest to scientists at universities and independent research institutes.

The possibility of merging the two groups was also discussed. Concerns were expressed that this would bring more focus on reactive work in response to requests for advice and less opportunity for scientific dialogue between more specialised groups. This may further hamper participation at the working group meetings, therefore merging the two groups was not recommended.

At the present meeting, WGMMPD had its emphasis primarily on population level aspects, e.g., on cetacean prey and two-way trophic interactions. WGMMHA focused on effects of contaminants and disturbance, where an in-depth understanding of the interaction between environment and mammals at the level of the organism is required. These working group profiles are designed primarily to match the remits of the two new parent committees, the Living Resource Committee and the Marine Habitat Committee, respectively.

There was agreement on the benefits of maintaining two working groups to focus on two different levels (WGMMPD at the level of population, and WGMMHA at the level of the organism). This requires involvement of different expertise, but both levels are necessary for progress in work of ICES on marine mammals as outlined in the Proposal for an ICES Policy on Marine Mammals (ICES, 1994). This may provide opportunity for complementary work on the same topics and an interesting platform for further collaboration and the possibility to develop research of interest to a wider group of marine mammal scientists. It was therefore agreed that the two groups should continue in close co-operation. For the short term, it is advised that the groups be convened at the same time and venue (or let the WGMMHA meet first) with possibilities for joint sessions. This way the two groups could even focus on the same problems, one group from the perspective of the organism and the other group from the population level. Both perspectives may be necessary to answer specific requests but require involvement of different expertise.

5.2 Marine Mammal Aspects of the ICES Five-Year Plan

In addition to providing a scientific basis to answering external requests, the proposed ICES Policy on Marine Mammals (ICES CM 1994/Del:8) requires a thorough approach to bring progress in marine mammal research under the agenda ICES has set for itself (e.g., under the ICES Five-Year Plan).

The joint session proposed that the working groups should focus on the following topics under the ICES Five-Year Plan:

WGMMPD

1) Issues related to the expanding grey seal and harbour seal populations in the North Atlantic.
2) Development of appropriate population models and population concepts in more general terms.

WGMMHA

1) Initiate an ICES research programme for improved methods and precision in estimation of life history parameters.
2) Develop an ICES research programme to establish the cause/effect relationships between contaminants and aspects of pinniped health, and seek collaboration with a parallel effort by the IWC Scientific Committee for studies on cetaceans.

6 RECOMMENDATIONS FOR FUTURE ACTIVITIES

WGMMPD agreed that the best dates for future meetings (3–4 days) would be in mid-January. WGMMPD recommends that a meeting be held at ICES Headquarters in mid-January in 1999 and that a meeting be held in mid-January in one of the Baltic countries in 2000.

WGMMPD recommended that activity for the 1999 meeting focus on cetacean trophic ecology, with emphasis on population dynamics and consumption rates. WGMMPD noted that new prey data are becoming available as a result of marine mammal by-catch monitoring programmes, are presented in Annex 5.

WGMMPD noted that there is some overlap with WGMMHA suggestions for future work (i.e., item (b) herein, and item (a) in the WGMMHA report). Although the perspectives of the two groups are different, they share common goals that require co-operation and joint sessions.

The Chairman of WGMMPD will work closely with the Chairman of WGMMHA to explore possibilities for convening joint meetings at times and venues that facilitate optimal participation of both groups.

WGMMPD will be required to address the triennial HELCOM request, relative to marine mammals in the Baltic Sea in 2000 . As the status of Baltic harbour porpoise, ringed seal, grey seal and harbour seal populations will be reviewed, the group proposed that a review and evaluation of methods used to obtain grey seal and harbour seal abundance estimates also be conducted. This latter topic will require participation by non-WGMMPD scientists from several North Atlantic countries as well as researchers from the Pacific coast of North America. Therefore, in order to adequately address the issue of 'expanding seal populations', it is recommended that this be the focus of the 2001 meeting.

WGMMPD reiterates previous recommendations made by SGSEAL and WGSEAL regarding the need for Member Countries to support/develop/maintain programmes to monitor marine mammal by-catch and to provide estimates of by-catch per unit of effort in individual fisheries for each ICES area, with an indication of how that estimate was arrived at. Fisheries effort data also need to be provided.

7 OTHER BUSINESS

WGMMPD wishes to thank ICES for its use of their fine facilities and staff assistance.

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ANNEX 1

TERMS OF REFERENCE

ICES C.Res.1997/2:59

A **Working Group on Marine Mammal Population Dynamics and Trophic Interactions** [WGMMPD] will be established under the chairmanship of Dr G.T. Waring (USA) and meet at ICES Headquarters from 16–18 March 1998 to:

a) compile and evaluate information on incidental mortality of marine mammals on a species (and gear type) basis for each of the five OSPAR regions [OSPAR 1998/4.2];

b) review methods (e.g., video systems) for monitoring by-catches of marine mammals on vessels too small to carry observers;

c) in association with a request from IWC concerning contaminant uptake via food sources, identify the prey of the cetacean species in the North Atlantic as a first step in determining contaminant uptake;

d) develop proposals for how fishermen and fisheries managers could be incorporated into the process of developing new fisheries and gear types to minimize marine mammal by-catches;

e) consider the future work programme in relation to the remit of the Living Resources Committee, including cooperation with other Working Groups, and, in joint session with the WGMMHA, develop the marine mammal aspects for the ICES Five-Year Plan.

WGMMPD will report to ACFM and ACME before their meetings in May/June 1998 and to the Living Resources and Marine Habitat Committees at the 1998 Annual Science Conference.

ANNEX 2

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ANNEX 3

AGENDA

1 Introduction and opening comments.

2 Marine mammal by-catch for each of the five OSPAR regions.

2.1 Identify fisheries that have been documented to or are likely to (by analogy) have amarine mammal by-catch problem.

3 Cetacean trophic ecology.

3.1 Identification of cetacean prey in the North Atlantic.

3.2 Review of data types (i.e., strandings, by-catch, etc) and potential sampling programs and data bases.

3.3 Utility of compiling a comprehensive data set on North Atlantic cetacean prey.

4 Overview of alternative marine mammal by-catch monitoring methods.

5 Joint meeting with Working Group on Marine Mammal Habitats.

6 Recommendations.

7 Other business.

8 References.

ANNEX 4

LIST OF WORKING PAPERS AND DOCUMENTS

WP1 ASCOBANS. 1997. Cetacean by-catch issues in the ASCOBANS area. Report of the ASCOBANS Advisory Committee Working Group on By-catch to the 2nd meeting of parties to ASCOBANS.

WP2 International Whaling Commission. 1997. Proposal to the IWC on furthering the recommendations of the Pollution Workshop. SC/49/Rep 6. 5 pp.

ANNEX 5

RECOMMENDATIONS

The Working Group on Marine Mammal Population Dynamics and Trophic Interactions (WGMMPD) recommends that it meet for 3–4 days in mid-January 1999 at ICES Headquarters to:

a) completion of Tables 2 and 3 on cetacean prey for ICES/NAFO, which will provide a broad-scale summary of preferred prey;

b) conduct a more thorough review of seasonal/spatial distribution and abundance data for several focal species *(harbor porpoise, bottlenose dolphin, beluga whale (three IWC candidate species, see section 3.2), grey seals and harbour seals)* and their prey (this may require an external contract to get the best results);

c) review data on prey size and compare these to size frequency in commercial catches and/or fisheries survey data;

d) review and evaluate information on potential ecological effects of fishing on marine mammal trophic interactions. The WGMMPD noted that this issue was addressed at the 1992 meeting of SGSEAL (Anon., 1992), but considerable new information on marine mammals has become available as a result of both by-catch monitoring and directed field programmes.