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1 Executive summary

During the 2006 meeting the WGMME reviewed any new information on population sizes, bycatches and mitigation measures for fisheries that have a significant impact on small cetaceans and other marine mammals. Additionally, so far as it was possible, the working group summarized the planned observations to meet requirements of EU Regulation 812/2004 by ICES area member state for 2006. The working group also reviewed the information on the diets of marine mammals in the ICES area and provided an overview of the difficulties and methods in studying diet. For each of the WGRED regions, an estimation was made of the 4-6 most important species in terms of biomass and the available information on diet was summarized. Furthermore, the plans to conduct a workshop on environmental quality and marine mammal health were continued and a planning group was proposed. The workshop should address the biological effects at the level of the individual, explore the subsequent impacts at the population and community levels, and finally elaborate on the relevance for integrated chemical-biological assessment of ecosystem health and implications for management The WGMME discussed the possibilities of using the web to exchange information within the working group, within ICES and, assuming some kind of review process is used, with the public. The working group recommended that such a web based report structure and review progress should be developed in the future. Finally, the working group reviewed the results of the North Sea ecosystem assessment undertaken by REGNS. Where appropriate recommendations for further or modified analysis were made.

2 Opening of the meeting

The Working Group on Marine Mammal Ecology (WGMME) met at ICES headquarters in Copenhagen, Denmark from 30 January - 2 February 2006. The list of participants and contact details are given in Annex 1.

The Working Group members were welcomed by Bodil Chemnitz from ICES. The Terms of Reference for the WGMME meeting were discussed on the first morning and a work schedule was adopted for the meeting.

Terms of Reference for the meeting were:

a) in relation to fisheries that have a significant impact on small cetaceans and other marine mammals, review and report on any new information on population sizes, bycatches or mitigation measures;

b) for each of the WGRED regions, review and report on the usefulness of available prey data to quantify marine mammal-prey interactions for multispecies modeling purposes, and provide recommendations for future sampling schemes for quantification of marine mammal-prey interactions;

c) finalize preparations for a Workshop in 2007 (to be held back-to-back with WGMME meeting) on health and immune status, disease agents and links to environment quality;

d) complete work on a Cooperative Research Report on threats to marine mammal populations based on a compilation of prior reports of this and former marine mammal working/study groups.

e) Review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the overview assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant.

The WGMME will report by 2 March 2006 for the attention of ACE.

Justification of Terms of Reference

a) This addresses Goal 1 of the ICES Strategic Plan.

b) Marine mammals are top predators and may consume significant portions of stocks of fish and therefore this information is needed for multi-species modeling.

c) Marine mammals are upper trophic level predators that accumulate high levels of pollutants. This work is needed to develop workshop terms of reference and identify participants. This addresses Goal 2 in the ICES Strategic Plan.

e) this is in response to a request from REGNS.

2.1 Acknowledgements

The Working Group thanks the ICES for providing the location for the meeting. The Working Group gratefully acknowledges the support given to us by Maria Begoña Santos and Graham Pierce, who kindly provided information and/or reports for use by WGMME. We also thank Gordon Waring, Iwona Kuklik and Krzysztof Skora who all contributed support and text by email. The Working Group would also like to thank Marianne Neldeberg for assistance in supporting our computing and system networking and Bodil Chemnitz for general logistical support.

The Chair also acknowledges the diligence and commitment of all the participants, which ensured that the Terms of Reference for this meeting were addressed.

3 TOR A) Population sizes, bycatches and mitigation measures of marine mammals

The term of reference states: in relation to fisheries that have a significant impact on small cetaceans and other marine mammals, review and report on any new information on population sizes, bycatches or mitigation measures

3.1 New information on population sizes.

A comprehensive assessment of cetacean abundance in European Atlantic shelf waters south of 62°N was conducted during the summer of 2005. The SCANS-II survey was a follow up to the 1994 SCANS survey, but the more recent assessment covered not only the waters of the Kattegat, Skagerrak, North Sea but also the European Atlantic shelf. Seven boats and three aircraft were used and over 200 hours of aerial survey effort were flown, and more than 20,000 km of shipboard tracklines were covered, resulting in sightings of 13 species. These data are currently being worked up in order to produce abundance estimates. Preliminary results in the form of maps of sightings by species are available on the SCANS website at: http://biology.st-andrews.ac.uk/scans2

An important preliminary finding was a relatively high encounter rate with harbour porpoises in the southern North Sea, an area that was almost devoid of any cetacean sightings in the first SCANS survey of 1994. The apparent recovery of porpoises in this region is in agreement with observations made in relation to strandings and sightings in Dutch, Belgian and Northern French and south-eastern UK waters in recent years.

Camphuysen (2004) reported an increase in sightings rates of porpoises of over 40% per year between 1990 and 2004 in waters adjacent to the Netherlands. Camphuysen (personal communication) also reports that strandings of porpoises along Dutch coasts have increased at a similar rate in recent years (see Figure 2.1).

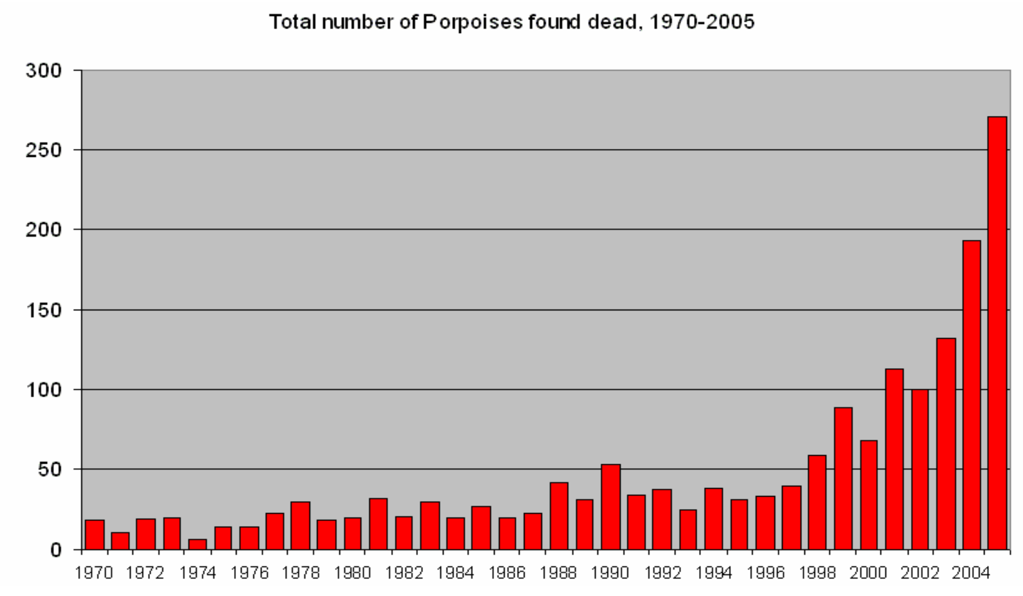

Figure 2.1: Dutch strandings records for harbour porpoises: Camphuysen pers comm.

The number of porpoises stranding on the Belgian coast has also increased over the past ten or more years, as have reported sightings in Belgian waters, while strandings of porpoises on French coasts have shown a systematic increase by as much as an order or magnitude since the early to mid 1990s in the Channel, notably around the straits of Dover (Haelters, *et al.* 2004; Kiszka *et al.*, 2004, Haelters, 2005, van Canneyt, *et al.* 2005). Recorded strandings of harbour porpoises on the south-eastern shores of the UK have also doubled between the early 1990s and the period 2000-2004 (Jepson (ed), 2005). Taken with the increase in sightings rates reported in Dutch waters, these strandings records suggest a similar pattern of increasing local abundance, rather than an increase in local mortality rate.

It is unlikely that this increase in local abundance could be due to an increase in a local population, as the rate of increase, in the Dutch case at least, is biologically infeasible. It is more likely that the increased local abundance of porpoises in this region is the result of redistribution from other areas.

Aerial surveys of French continental shelf waters by CRMM in the Bay of Biscay in 2001-2003 have led to seasonal estimates of dolphins of all species in this region of 23,530 individuals (95% CI: 12,910 – 40,060) for the month of February and 41,080 (95% CI: 16,010 – 89,360) for the month of August. CRMM also conducted ship surveys (PELGAS) during 2003-2005, in which they found that 59% of identified dolphins were common dolphins (*Delphinus delphis*), suggesting abundance estimates for this species of around 14,000 individuals in winter and 24,000 in the summer. These aerial survey results are higher than, but not inconsistent with, the results of the 2002 Atlancet ship survey (see ICES 2005). These surveys did not cover the deep-water areas of the Bay of Biscay, where common dolphins are also known to be present in substantial numbers in summer at least. The surveys do confirm, however, large scale seasonal changes in common dolphin density, which will need to be considered in any assessment of population size versus bycatch, as most abundance surveys are conducted in summer, while the heaviest bycatches appear to be in winter.

In relation to common dolphin abundance estimates and population structure, the WGMME considered a paper submitted by Wang *et al.* (2005) and other material. Recalling the 2005 ICES Advisory Report in which an estimate of approximately 380,000 common dolphins was put forward for the various areas that have been surveyed, the WGMME did not consider that it would be useful to reconsider the abundance estimates at this stage, especially as results from SCANS II are expected in the next few months. The WG noted plans to conduct an abundance surveys for Common Dolphins in waters west of the SCANS II survey area (CODA) in 2007. The WG welcomed this plan and noted that the results from this survey would help ICES considerably in providing advice. Regarding the issue of stock structure, WGMME again considered available information and decided there were no new issues to address.

3.2 New Information on Bycatches

3.2.1 Harbour porpoises in the North Sea

Haelters (2005) reported a relatively high bycatch rate of harbour porpoises in the recreational beach gillnet fisheries in Belgium, as well as some bycatch in the small (three boat) commercial gillnet fishery. Interviews with two of the professional fishermen (capable of setting up to 7.5km of gill nets each) revealed that one had taken approximately six porpoises in 2004, the other fisherman reported having caught none. The third vessel, capable of setting up to 23 kms of gill nets, has not reported whether bycatches occurred or not. A minimum count was reported of 10-18 porpoises and one minke whale all of which were known to have been bycaught.

3.2.2 Common dolphins in pelagic trawl fisheries:

Bycatches of common dolphins in the UK bass pair trawl fishery have been monitored by the SMRU for several years. The most recent estimate is for the winter of 2004-5, where an estimated 139 common dolphins were taken (95% CI 90-207) (Northridge *et al.*, 2005).

Bycatch rates and total bycatch were both substantially lower than in the 2003/4, and are more consistent with 2002/3 and preceding seasons.

PETRACET is a European project dealing with the assessment of impact of pelagic trawling on cetaceans. The European Commission call for tender identified the fisheries to be observed for a one-year observation period with a defined sampling strategy; the UK bass pair trawl fishery was excluded because of the existing high level of observer coverage under a domestic UK programme. The observations took place during 2004 and 2005 and preliminary results suggest that valid observations were made on a total of 952 tows: 371 were directed on anchovy, 295 on seabass, 44 on scad, 92 on mackerel and 150 on tuna. Of these, a total of 21 tows were reported to have some accidental catch, with a total observed bycatch of 93 dolphins, mainly (96 %) common dolphins. The greater part of the bycatch was concentrated in two or three hotspots in the bass and tuna fisheries. Extrapolation from the observed hauls to an estimated total European annual fishing effort in ICES Sub-Areas VII and VIII resulted in a preliminary estimate of an annual bycatch of less than 1000 common dolphins, including the estimate for the UK bass pair trawl fleet. This result confirms the ICES advice of 2005 that the bycatch of common dolphins in pelagic trawl fisheries in ICES Sub-Areas VII and VIII is unlikely to exceed 1.7% of the best estimate of population size.

This estimate relates only to pelagic trawling, and it is known that common dolphins are also caught in a variety of other fisheries in this area. It is also an estimate based on 12 months of sampling, and does not therefore reflect any inter-annual changes in bycatch rates, which may be substantial (a ten fold difference in bycatch rates between seasons in the UK bass fishery has been noted over five observed seasons).

3.2.3 Common dolphins in VHVO bottom pair trawlers

AZTI (Fisheries and Food Technological Institute) operates several observer schemes on commercial fishing vessels based in the Basque Country (Spain) with the objective of studying various technical aspects of the commercial fisheries. Information on cetacean by-catches is also collected. It is worth noting that in all of these observations of fishing operations, the fishermen were not aware that bycatch information was also being collected, and so they were unlikely to have tried to avoid high bycatch areas or fishing methods.

Among those fleets studied, cetacean bycatch was only observed in the bottom pair trawl operations using VHVO trawls and targeting hake in ICES Subarea VII and Divisions VIII a,b,d. During the period 2003-2005 a total of 289 such hauls were observed, among which 12 had some cetacean bycatch. The bycatch comprised 19 common dolphins, 1 striped dolphin and 1 unidentified dolphin. The most frequent number of animals by-caught per haul was 1 (8 hauls), while two animals were by-caught in 2 hauls and groups of 3 and of 6 animals were taken in one haul each.

No cetacean bycatch has been observed in any other cruises with AZTI observers for the other two trawl metiers present in the Basque fishing fleet: 428 hauls have been observed for “Baka” bottom trawl operating in Sub-areas VI and VII and Div. VIII a,b,d, in 2003 and 2004. For bottom pair trawls operating with VHVO nets in VIIIc and targeting blue whiting, 44 hauls were observed in the period 2003-2005. In the same way, previous observations made for the other fishing gear types (fixed gears and purse seines) made in vessels based in the Basque Country harbours and already reported to WGMME in 2003 did not show any cetacean bycatch.

The effort of the VHVO pair bottom trawlers for hake operating in ICES Subarea VII and Divisions VIIIa,b,d has been decreasing overall, and the reduction has been highest in Subarea VII with no effort at all in 2005. This decline is mainly due to a reduction in the fleet size: 9 pairs were operating in 2002 and 7 pairs in 2005. The proportion of the total fishing effort observed for this fleet is low, ranging from 1.35% in 2003 to 2.08% in 2004, though there are observations throughout all the months of the period 2003-2005.

3.2.4 Other marine mammal bycatch observations- Spanish vessels

During 2005 the Spanish Institute of Oceanography placed observers on board vessels operating in several different fisheries in the North Atlantic.

The corresponding number of fishing operations and incidental catches observed are as follows:

Longline fishery for swordfish: 93 sets were observed. An incidental catch of 1 spotted dolphin *Stenella frontalis* was reported.

Trawl fishery in Hatton Bank: 388 hauls were monitored. One incidental catch of a long finned pilot whale *Globicephala melaena* was recorded.

Trawl fishery in Svalbard:128 hauls were monitored and one incidental catch of a harp seal *Pagophilus groenlandicus* was reported.

Trawl fishery in Reikjanes Ridge: 68 hauls observed. No incidental catches were reported.

Pair trawling in ICES areas VII, VIII and IX: 969 hauls were observed. Incidental catches of two bottlenose *Tursiops truncatus* and three common dolphins *Delphinus delphis* were reported.

3.2.5 Baltic seals:

An alternative to observer programs or direct interviews with fishermen is a detailed logbook system. In 1997 such a system was launched by the Swedish Fisheries Board, whereby fishermen were contracted to keep a detailed daily log of fish catches, seal disturbance (damage to gear and to fish and catch losses) and, from 2001, bycaught seals. In total, nearly 38,000 fishing records have been collected to date from a participating group of over 100 fishermen. The fishermen are compensated for their trouble with a small payment. To ensure that the information is properly recorded, all fishermen are contacted personally on a regular basis, and their entries are checked during site visits and by statistical means. Catches of grey seal per unit fishing effort (CPUE) with fixed gear after salmon, for which there is a time series of four years, hovered around 0.003 seals/(day and gear) between 2001 and 2004. The skewed distribution, with many fishermen who caught no seals, while a few caught several, means that the confidence interval is large. The initial sampling scheme was limited in geographical extent, but since 2004 a stratified sampling scheme has been implemented along the entire Swedish coast.

During this year 22 grey seals, 4 ringed seals and 15 harbour seals, but no harbour porpoises, were reported bycaught. The fishing effort represented by the participants in the logbook scheme is approximately 5 % of the total fishing effort in the Swedish coastal fisheries and indicates a total by catch of less then 400 grey seals, 50 ringed seal and 400 harbour seals (Lunneryd *et al*., 2005) which is in accordance with earlier surveys (Lunneryd *et al*., 2004).

3.2.6 Baltic Harbour Porpoises:

In a telephone interview of a random sample of 17 % of all commercial fishermen in Sweden in 2001 no reports were received from the Baltic and none of those asked had caught a porpoise in the Baltic during the last ten years (Lunneryd *et al*., 2004).

Voluntary monitoring of bycatches in the Polish fleet during 2005 resulted in just one record of a harbour porpoise bycatch; the effect of the EU decision to ban driftnets in the Baltic was thought to have affected enthusiasm for voluntary reporting (Kuklik, pers comm.).

3.2.7 Russian Data on Barents Sea Seals:

Zabavnikov reported that harp seals are taken as bycatch in Russian commercial trawl fishing operations in the Barents Sea, with a general annual bycatch estimate of around 150 seals.

3.2.8 Bycatch Monitoring Schemes in Norway

In 2005 the Directorate of Fisheries in Norway instructed independent on-board observers to report on marine mammal bycatches. The observed fishing effort was mainly in the Barents Sea. In addition 20, offshore fishing vessels were contracted by the Institute of Marine Research in 2005 to provide detailed statistics of fishing effort, catch composition (sex and length distribution of target species), and bycatch. The contracted fishing vessels were operating mainly in the North Sea. Preliminary results from these programmes will be submitted to a meeting of the NAMMCO Working Group on Marine Mammal Bycatch, 13th March 2006. Completion of estimates of bycatches in observed fisheries with considerations of observer coverage, are scheduled for December 2006. These programmes are continuing.

A programme to monitor bycatches of marine mammals in small vessels fishing in coastal and inshore waters was initiated in October 2005, following a pilot study in 2004. This programme is covering small vessels where space and other practicalities make independent on-board observers difficult. Therefore, a sub-set of vessels is contracted to provide detailed information on effort, catch and bycatch. The number of small commercial fishing vessels in Norway is declining, but is still about 5 thousand (Figure 2.2). A large part of this fleet operates gill-nets and is supposed to have high bycatch of marine mammals (e.g. Bjørge and Øien, 1995; Bjørge *et al.* 2002).

This programme for small coastal and inshore vessels is focused on gill-netters and tailored to provide information on marine mammal bycatch suitable for extrapolation to entire fisheries. A description of the programme and preliminary data on catch and bycatch will be submitted to the forthcoming meeting of the NAMMCO Working Group on Marine Mammal Bycatch, 13th March 2006.

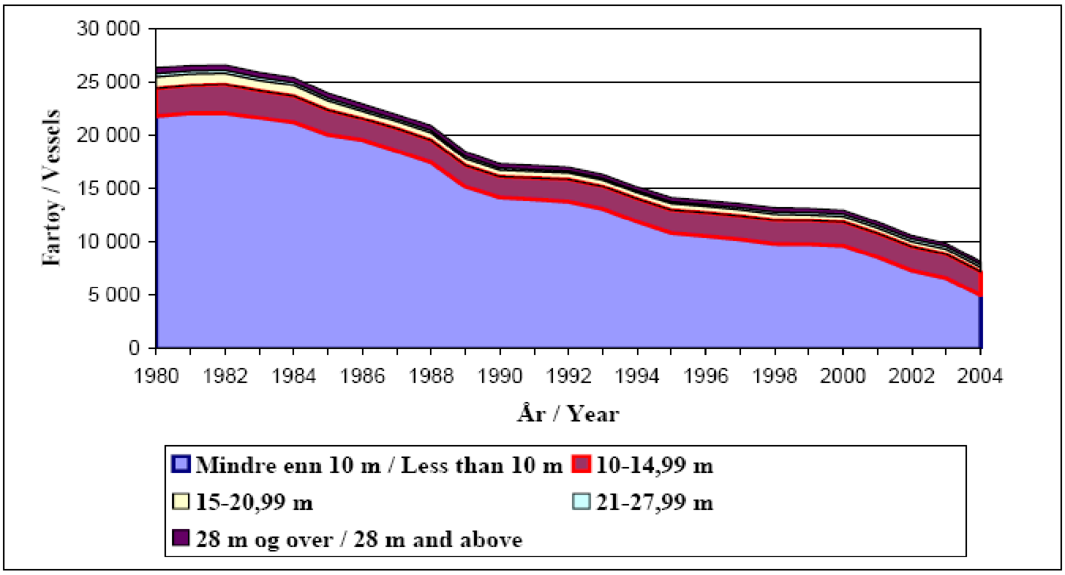

Fig. 2.2. The number of commercial fishing vessels in Norwegian fisheries, 1980-2004. The decline is caused by a reduction of vessels less than 10 m total length operating in coastal waters.

3.2.9 Bycatch Observation schemes under EU Reg 812/2004:

Member states of the EU are obliged under Council regulation 812/2004 to implement on-board monitoring schemes involving independent observers to monitor the scale of bycatch and produce estimates of total cetacean bycatch in an extensive list of prescribed fisheries. The introduction of monitoring schemes is phased according to the type of fishery and the area concerned, in a scheme that is largely described in an Annex to the Regulation. The levels of monitoring are also specified for vessels over 15m, whereas for vessels under 15m (using the same gears in the same areas) pilot projects and scientific studies are required, without any prescribed system of monitoring.

Monitoring was due to begin in January 2005 for pelagic trawl fisheries of all member states operating in Divisions VI, VII and VIII (as well as the Mediterranean) and bottom set gillnets in Sub-Divisions VIa, VIIab, VIIIabc and IXa. Monitoring was due to begin in January 2006 for driftnets in Division IV, VIa, and most of Division VII, for pelagic trawls in IIIabcd, IV and IX, for high opening trawls in VI, VII, VIII and IX and for bottom set nets in IIIbcd. Relevant member states are due to report the initial results of these observations to the Commission by June 2006.

The working group noted that member states are also required to monitor incidental capture and killing of animal species listed in Annex IV of the EU Habitats Directive. This means that fishing activities also need to be monitored more generally to identify incidental bycatch of cetacean species that may have a significant negative impact on the species concerned.

So far as it was possible, the working group reviewed the status of ongoing sampling in each of the relevant member states.

Finland, Estonia, Latvia, Lithuania and Poland are all required to monitor pelagic trawls and bottom set gillnets in the Baltic from January 2006. As far as the working group was aware, no observer programme has yet been implemented in Poland, nor has any monitoring programme for under 15m boats been worked out at present (Kuklik, pers. comm.).

In Sweden an observer scheme is currently being prepared and funding has been made available for the first two years. No sampling has been undertaken yet, but the sampling plan for the coming year is detailed in Table 1. A pilot study for smaller gill net vessels (<15 M) is under preparation.

There was no other information available for the other Baltic States.

In Denmark monitoring requirements include observations of pelagic trawlers in Division VII (starting in 2005), and the monitoring of pelagic trawlers in the North Sea, and set nets in IIIbcd (starting in 2006). Other than some limited monitoring under the EC funded PETRACET project, no monitoring has been undertaken yet, but plans are being made to establish an observer scheme (see table 1), and funding has been made available for 2006.

In the UK an observer scheme was implemented in 2005, though it was not fully underway until March of 2005. During 2005 430 days at sea were monitored in various fisheries, including a limited amount of sampling in several fisheries that are not explicitly mentioned in Council Regulation 812/2004, but which are being monitored in partial fulfilment of obligations to monitor cetacean bycatch in fisheries under the Habitats Directive. A sampling plan has been drawn up for 2006, and this is described in Table 2.1. The UK has established a dedicated cetacean bycatch monitoring scheme, but this is also linked to and integrated with ongoing discard sampling schemes in such a way as to optimise sampling requirements under Council Regulation 812/2004 and the Data Collection Regulation[1]. There is an additional programme of research directed at the UK's bass pair trawl fleet, where a very high level of observer coverage is maintained to monitor cetacean bycatch.

In Germany, dedicated observer programs or pilot studies have not been set up yet, but the regular sampling scheme through the current DCR[1] ensures that all major German fisheries are covered. Fishery observers have been instructed to record any cetacean bycatch. The planned observer days in the various fisheries in 2006 are given in Table 2.1.

In the Netherlands bycatch observations have been ongoing in the Dutch fleet operating off West Africa for some years (see Zeeberg *et al*, in press). Marine mammal bycatches have been monitored for many years in the Dutch pelagic fleet operating in European waters through a fish discard sampling programme. Sampling levels in this programme are currently targeted at around 8% of fishing effort, with ten trips (probably over 200 days at sea) planned for 2006, though specific allocation to fishing areas is difficult as the fleet is highly mobile (Couperus, pers. comm.; see also Table 2.1 below).

In Belgium fisheries are mainly limited to bottom trawling (especially beam trawling) with only three boats using set nets in Belgian waters. There are no monitoring requirements under council regulation 812, and no dedicated observer scheme is being planned. However, stranded animals are routinely examined for evidence of bycatch, and it appears that between 25% and 50% of such animals are the victims of fishery bycatch, but the source is unknown.

In Ireland no explicit funding is available to implement the requirements of EU Reg 812, but there are ongoing discard monitoring schemes in both gillnet and pelagic trawl fisheries. In 2005 50 gillnet operations were monitored in VIIj and VIIg (not required under Reg 812) in which two porpoise and one common seal mortalities were recorded. A further 12 gillnet operations were observed in VIIb with no observed bycatch. A total of 30 hauls were observed in the albacore trawl fishery in VIIj and 8 hauls in the blue whiting fishery in VIa. No mammal bycatches were observed

1 EU Council Regulation 1543/2000 gives a framework for the collection of data in support of the European Common Fisheries Policy. The detailed rules for the application of this Council regulation are laid down in Commission Regulation 1639/2001, as amended by Commission Regulation 1581/2004. The three regulations together are called the Data Collection Regulation or DCR.

In France sampling during 2005 has been undertaken through the EU funded PETRACET project, and also through a separate project (ProCet) funded by National and regional Authorities. A new monitoring scheme has obtained funding for 2006 and a schedule for sampling has been worked out (see Table 2.1). This programme will begin in spring 2006.

As far as the working group is aware there are no specific plans in Spain for an observer programme to address EU Reg 812/2004, though there are already ongoing observer programmes with several objectives that also record cetacean bycatches – notably in the Basque fleets and in the high-opening trawl fleet from other parts of Spain.

No observer scheme has yet been started in Portugal under Council Regultion 812, but monitoring is planned to start by March 2006. This monitoring will cover only boats larger than 15m operating gillnets . A total of 51 such boats will be sampled over 100 days at sea (Sequeira, personal communication).

TABLE 2.1: Planned Observations to meet requirements of EU Regulation 812/2004 by ICES area member state for 2006 (”–” : No national fishing effort to observe)

AREA	GEAR	START DATE in regulation	FLEET SEG-MENT	OBS. COVE-RAGE	DK (obs. days)	FR (obs. days)	UK (obs. days)	DE (obs. days)	NL (obs. days)	BE (obs. days)	PT (obs. days)	SW (obs. days)	ES (obs. days)	IR (obs. days)
A1. ICES sub areas VI, VII & VIII	Pelagic trawls (single & pair),1 Dec. to 31 March	1 January 2005	≥ 15m	10%	20	480	~200	70	~200*	-	-	-	-	26
			< 15m		-	*20*	*10*	*0*	-	-	-	-	-	-
A2. ICES sub areas VI, VII & VIII	Pelagic trawls (single & pair), 1 April to 30 Nov.	1 January 2005	≥ 15m	5%	20	570	20	30	+	-	-	-	-	60
			< 15m		-	*60*	*10*	*0*	-	-	-	-	-	-
B. Mediterranean Sea (east of the line 5º36’W)	Pelagic trawls (single & pair)	1 January 2005	≥ 15m	5%	-	213	-	-	-	-	-	-	-	-
			< 15m		-	-	-	-	-	-	-	-	-	-
C. ICES div. VIa, VIIa,b, VIIIa, b, c, IXa	Bottom-set gillnet or entangling nets using mesh sizes ≥ 80 mm	1 January 2005	≥ 15m	5%	-	810	46	-	-	-	100	-	70	<40
			< 15m		-	*447*	*18*	-	-	-	*0*	-	*504*	+
D. ICES IV, div. VIa & subarea VII (excl.VIIc) & VIIk	Driftnets	1 January 2006	≥ 15m	5%	-	-	-	-	-	-		-	-	
			< 15m		-	-	*60*	-	-	-	*0*	-	-	
E. ICES sub areas IIIa, b, c, IIId south of 59°N, IIId north of 59°N (1 June-30 Sept.), IV & IX	Pelagic trawls (single and pair)	1 January 2006	≥ 15m	5%	795	-	100	10	+	-	-	162	-	
			< 15m	*5%*	*58*	-	*10*	-	-	-	-	-	-	
F. ICES sub areas VI, VII, VIII & IX	High-opening trawls	1 January 2006	≥ 15m	5%	-	-	-	-	-	-	-	-	205	
			< 15m		-	-	-	-	-	-	-	-	-	
G. ICES sub areas IIIb, c, d	Bottom-set gillnet or entangling nets using mesh sizes ≥ 80 mm	1 January 2006	≥ 15m	5%	21	-	-	-	-	-	-	17	-	
			< 15m	*5%*	*50*	-	-	-	-	-	-	-	-	
					964	*2600*	*474*	*110*	*~200*	*0*	*100*	*179*	*779*	*126*

*The scheduled 200 days is the total for the Dutch pelagic trawl fleet and will be apportioned among temporal and spatial strata at a later date.

3.3 New Information on mitigation measures:

Mitigation measures are here taken to include measures adopted to limit fisheries that have a significant or important level of cetacean bycatch, as well as more technical measures designed to modify fishing gear or animal behaviour in such a way as to reduce bycatch rates. It should be noted again that restrictions on fishing effort – for example a ban on fishing for cod, can have additional but not necessarily intended effects in terms of a reduction in marine mammal bycatch. Similarly decommissioning vessels in fleets that have a significant bycatch problem will also lead to reductions in bycatch.

3.3.1 Fishery Restrictions:

In many fisheries in the central and northern Baltic there are ongoing studies and efforts to replace net fisheries that target whitefish, pike-perch and herring and that are damaged by seals, with static gears that are more easy to protect from seal attacks. Such measures will also lead to a decreased risk of bycatch of marine mammals (Westerberg *et al*., in press). Studies have also been done with fish-cages and smaller fyke nets in the cod gillnet fishery in the central and southern Baltic but with very low success so far.

Driftnets are scheduled to be phased out in the Baltic over the next two years with a complete cessation by January 1st 2008.

In January 2005 the UK introduced domestic legislation to prohibit pelagic pair trawling for bass within 12 miles of the south coast of England (VIIe), with the aim of limiting cetacean bycatch. This legislation does not affect French vessels fishing in the same area that have historic rights to fish for bass inside UK territorial waters. The effects of the ban are hard to determine. Bycatch rates in 2005 were lower than in the 2004 but were similar to some previously sampled years (2001-2003) so the effect of the ban on bycatch cannot be determined. Fewer UK boats participated in this fishery in 2005 than in 2004, which will have limited the overall bycatch of dolphins, and the prohibition may have influenced this level of participation (Northridge *et al.*, 2005).

3.3.2 Technical measures

3.3.2.1 Exclusion devices for pelagic trawls

In the UK trials have been ongoing for four seasons to develop an escape systems for dolphins that are caught in pelagic pair trawls targeting bass. The current work is being carried out largely under the NECESSITY project. The project has shown that dolphins are capable of escaping through hatches, but the presence of barriers in the rear section of the net also alters their normal behaviour, prompting them to try to break through the net much further forward. In the 2004-5 season a minimum of about a quarter of animals inside the net escaped using the escape hatch provided. Further improvements to the system are planned (Northridge *et al.*, 2005). Similar trials are being undertaken in France also under the NECESSITY project and the national project ProCet2.

3.3.2.2 Acoustic measures in relation to pelagic trawls

Studies on the relative efficiency of different acoustic signals to deter dolphins have been conducted in the Mediterranean with bow riding animals. Data are in the process of being analysed by Danish scientists under the NECESSITY project.

Two additional systems have been tested in France, and these have demonstrated a deterrent effect on wild common dolphin groups. One of these, a commercially available pinger, is omni-directional and could therefore induce too large an exclusion area around the gear. Another system which has been proven efficient in deterring wild common dolphins and which has the advantage of being directional is under development to be used inside trawls to deter dolphins from entering trawls. An interactive pinger being developed in Ireland and the UK is also under test on trawls, this device being activated when dolphin echolocation clicks are heard. All of these developments are being conducted under the EU NECESSITY project, which is due to report in May 2007.

Within the framework of the EU funded project Necessity, AZTI has tested several designs of excluder devices for dolphins at model scale in two visits to the Ifremer's flume tank in Lorient. In those trials the most suitable design to exclude dolphins has been decided and is currently in full-scale construction for sea tests with Basque VHVO bottom trawl fishing fleet.

Some work has also been carried out to try to identify the under-water noise pattern of the Basque VHVO net with the aim of providing baseline information for the adjustment of a future interactive pinger device in order to avoid any masking of the signal by trawl- generated noise. In addition, T-POD equipment (automated click detector) has also been tested at sea to detect the presence of cetaceans during fishing operations.

3.3.2.3 Mitigation measures in set net fisheries

The EC Regulation n° 812/2004 imposes measures to limit cetacean bycatch in set net fisheries. Acoustic deterrents are required on nets deployed by netters greater than 12 meters in length in the areas defined in Annex 1 of the regulation. The group was only aware of a very few vessels throughout the EU that had obtained pingers in order to meet this regulatory requirement. There appears to be considerable reluctance on the part of the industry to adopt this measure, mainly due to concerns about the operational characteristics of the devices currently available on the market.

Operational trials of pingers on set nets have been completed recently in the United Kingdom, in Ireland, in France and in Denmark (Caslake, 2005; Caslake and Lart, 2005; Cosgrove *et al.*, 2005, Le Berre, 2005; Larsen, pers. comm.). Three of these studies indicated that:

Pingers may present an increased risk of injury to crew members. Pingers may become entangled in tangle or trammel nets. Pingers have a relatively high rate of mechanical or electrical malfunction.

Larsen reported that only the last of these problems applied to the Danish study.

It is clear that further design improvements to the pinger models that are currently on the market would be useful in order to address these problems. It should be noted that although Regulation 812 requires Member States to monitor and assess the effects of pinger use over time in the fisheries and areas concerned, there are no additional requirements to assess bycatch levels in these fisheries and areas.

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4 TOR B) The prey of marine mammals in each WGRED region

The term of reference states: for each WGRED regions, review and report on the usefulness of available prey data to quantify marine mammal-prey interactions for multispecies modelling purposes, and provide recommendations for future sampling schemes for quantification of marine mammal-prey interactions

4.1 Summary

This section reviews the information on the diets of marine mammals in the ICES area. A review of the difficulties of studying diet and the inherent biases in the various methods used is provided. There are many sources of variability in diet also, ranging from geographic location, season to age and gender of the mammal.

For each of the WGRED regions, an estimation was made of the 4-6 most important species in terms of biomass and a literature review of known diet was undertaken and the diet summarised. Table 3.1 collates these summaries and indicates the approximate quality of the information available. If there had been a reasonably comprehensive study of diet of another less-important (in the terms of this review) species this is also noted in the text. Given the limited resources available it is very likely that important dietary reviews and studies have been overlooked.

Table 3.1 Summary of diet and quality of dietary information of the most important (highest biomass) marine mammal species in regions of the northeast Atlantic and the Baltic. Prey types: Fish, Ceph(alopod), Crus(tacea), Omni(vore). Quality of information: 3 = high quality, good sample size, 2 = medium possibly unrepresentative, sample size, but indicative of diet; 1 = some information from region, often old.

	Species	Predominant prey category	Quality of information
A. Iceland – Greenland	Fin whale *Balaenoptera physalus*	Crus	1
	Minke whale *Balaenoptera acutorostrata*	Fish	3
	Sperm whale *Physeter macrocephalus*	Ceph	1
	Humpback whale *Megaptera novaeangliae*	Fish	1
	Long-finned pilot whale *Globicephala melas*	Ceph	1
	Northern bottlenose whale *Hyperoodon ampullatus*	Ceph	1
B. Barents Sea	Minke whale *Balaenoptera acutorostrata*	Fish	3
	Fin whale *Balaenoptera physalus*	Crus	1
	Harp seal *Pagophilus groenlandicus*	Crus	3
	Humpback whale *Megaptera novaeangliae*	Fish	1
	White-beaked dolphin *Lagenorhynchus albirostris*	Fish	1
C. Faroe Plateau	Long-finned pilot whale *Globicephala melas*	Ceph	3
	Fin whale *Balaenoptera physalus*	Crus	1
	Sperm whale *Physeter macrocephalus*	Ceph	1
	Minke whale *Balaenoptera acutorostrata*	Fish	1
	Sei whale *Balaenoptera borealis*	Crus	1
D. Norwegian Sea	Fin whale *Balaenoptera physalus*	Crus	1
	Minke whale *Balaenoptera acutorostrata*	Fish	3
	Humpback whale *Megaptera novaeangliae*	Fish	1
	Sperm whale *Physeter macrocephalus*	Ceph	1
	Blue whale *Balaenoptera musculus*	Crus	1
	Hooded seal *Cystophora cristata*	Omni	1
E. Celtic Seas	Minke whale *Balaenoptera acutorostrata*	Fish	1
	Short-beaked common dolphin *Delphinus delphis*	Fish/Ceph	2
	Fin whale *Balaenoptera physalus*	Crus	1
	Grey seal *Halichoerus grypus*	Fish	3
	Harbour porpoise *Phocoena phocoena*	Fish	2
F. North Sea	Minke whale *Balaenoptera acutorostrata*	Fish	2
	Harbour porpoise *Phocoena phocoena*	Fish	3
	Grey seal *Halichoerus grypus*	Fish	3
	Harbour seal *Phoca vitulina*	Fish	3
	White-beaked dolphin *Lagenorhynchus albirostris*	Fish	1
G. Bay of Biscay and Iberian Seas	Fin whale *Balaenoptera physalus*	Crus	1
	Long-finned pilot whale *Globicephala melas*	Ceph	1
	Sperm whale *Physeter macrocephalus*	Ceph	1
	Minke whale *Balaenoptera acutorostrata*	Fish	1
	Short-beaked common dolphin *Delphinus delphis*	Fish/Ceph	3
Baltic Sea	Grey seal *Halichoerus grypus*	Fish	3
	Ringed seal *Phoca hispida*	Fish	2
	Harbour seal *Phoca vitulina*	Fish	1
	Ladoga ringed seal *Phoca hispida ladogensis*	Fish	1
	Saimaa seal *Phoca hispida saimenensis*	Fish	2
	Harbour porpoise *Phocoena phocoena*	Fish	1

4.2 Introduction

4.2.1 Interpretation of the Terms of Reference

The term of reference does not call for a comprehensive review of the diet of all marine mammals in each of the WGRED regions. This review focuses on those taxa that comprise the greater proportion of the marine mammal biomass in each WGRED region. Multispecies models require a quantification of consumption, so that data are required not only on the species composition of diet, but also on quantities of each species that may be consumed. It is also useful to know the spatial and temporal patterns of this consumption. In theory this could be derived from knowing the proportion of overall diet comprised by each prey species, then using this in a model that derives the energetic requirement of each marine mammal species.

There are a variety of ways of studying the diet of marine mammals. Each of these has their advantages and disadvantages.

4.2.2 Review of methods used in marine mammal diet studies

Techniques to study the diet of marine mammals can include investigations of: stomach and intestinal contents; scats; fatty acid composition of blubber; movements and diving behaviour; isotopes of carbon and nitrogen; and genetic analyses of gut remains. Direct observations of feeding behaviour, with or without telemetry have also been used. The following sections review some of the more commonly used techniques. In all cases there are problems relating to scaling and sampling; the results of any dietary study need to be examined carefully to determine if they are suitable for answering the spatial and temporal questions that any modelling study may be attempting to address.

4.2.2.1 Analyses of scats, intestinal and stomach contents

Studies of marine mammal diets have traditionally been based on analyses of either stomach and intestinal contents or scat (faeces). These may come from live animals (faeces), which may in turn facilitate repeat sampling from the same individual. Alternatively, the digestive tract of dead animals might be examined – these may come from opportunistic samples (culled, bycaught or stranded specimens) or from lethal sampling. All of these sources have associated sampling advantages and disadvantages. Faeces collected ashore (seals) may not be representative of food obtained on distant feeding grounds; obtaining faeces at sea can be difficult (whales) or practically impossible (offshore dolphins) (see Pierce and Boyle, 1991). It can be difficult to tell where stranded animals have come from, and they may have been feeding in atypical habitats immediately prior to death, while bycaught animals may have stomach contents that includes the target fish of the fishery taken close to or in the fishing gear. Lethal scientific sampling of marine mammals is controversial globally and is either illegal or would not be permitted in many countries.

Undigested specimens along with hard remains such as fish otoliths and cephalopod beaks recovered from stomach and intestinal contents or scat have been widely used to quantify diets of both seals and whales (e.g. Martin and Clarke, 1986; Pierce and Boyle, 1991, Nilssen *et al.*, 1995a,b; Haug *et al.*, 1996; 2002; Lawson and Stenson, 1997; Lindstrøm *et al.*, 1998; Pauly *et al.*, 1998). The method is based on the assumption that relative frequencies of undigested specimens, otoliths, beaks, exoskeletons and other hard parts in stomachs, intestines or faeces reflect those of fish, cephalopods, crustaceans and other invertebrates in the diet in some known manner. Otoliths and cephalopod beaks are common diagnostic structures in the identification of prey because their size and shape are species specific. The otolith size correlates well with the size of the corresponding animal (see Clarke, 1986; Härkönen, 1986). Exoskeletons can be used both to identify and estimate the contribution of the crustaceans in the diets (e.g. Enckell, 1980). These data allow reconstruction of the original meal by weight (or numbers). The relationship between otolith and fish size may vary from area to area, which must be taken into account during the reconstructions. The relative importance of the different prey items can be calculated by using various feeding indices such as prevalence and reconstructed numbers and biomass (e.g., Hyslop, 1980; Pierce and Boyle, 1991; Lindstrøm *et al.*, 1997).

One major limitation with analyses of scat and contents from stomachs and intestines in seal studies is that otoliths erode during the passage through the gastrointestinal tract. Otoliths from various fish species erode at different rates, and some may be completely digested (da Silva and Neilson, 1985; Prime and Hammond, 1987; Harvey, 1989). Thus, the number and size of fish otoliths are likely to be underestimated (Jobling and Breiby, 1986; Jobling, 1987; Christiansen *et al.*, 2005). This problem is particularly conspicuous when the reconstruction of diets are based on scats, and numerous studies of seals have attempted to quantify the reduction in both number and size of otoliths and beaks recovered from faeces (e.g., da Silva and Neilson, 1985; Murie and Lavigne, 1986; Prime and Hammond, 1987; Harvey and Antonelis, 1994; Tollit *et al.*, 1997b; Berg *et al.*, 2002).

Certainly, differential passage and degradation rates of different fish and cephalopod types, and also possible accumulation of some hard remains, represent methodological problems (e.g. Pierce and Boyle, 1991) and uncertainty has to be accounted for in the diet analyses.

4.2.2.2 Presenting information on diet

There are a variety of ways of presenting information on diet. These include total number of individual dietary remains, proportions of this total, total mass of dietary remains, proportions of this total, diet “reassembled” from remains, both in terms of number and mass. Mass can be expressed as wet or dry. Each of these presentation styles has its advantages and disadvantages and some studies are not explicit in stating in detail which is being used or the assumptions underlying the results stated. This variety of results can also lead to modelling difficulties as it may not be possible to compare results or to determine how similar the results of dietary studies actually are.

4.2.2.3 Fatty acids

The fatty acid composition of a prey is species specific and as these compounds are assimilated through the diet and accumulated in fatty tissues of predators (e.g. in blubber), they can be used as tracers of diet (Iverson *et al.*, 1997). In order to assess the diet of the predator, fatty acid signatures from its blubber should be compared with fatty acid signatures from a variety of potential prey species using classification and regression tree analysis. The use of this method has been primarily qualitative, and has not produced information about the relative composition of individual diets. However, given that marine mammals deposit blubber as energy reserves, this method may be particularly helpful in providing broad scale information on what is eaten over a larger time span. Work published over the past 3 years has given quantitative information on a larger scale (see Bradshaw *et al.*, 2003). Good examples also exist where groups of marine mammals, feeding in different areas, have been classified according to their fatty acid signatures (Smith *et al.*, 1996; Walton *et al.*, 2000; Møller *et al.*, 2002). It has been suggested that the method may provide clues not only to changes in foraging patterns, but also to differences in local prey availability, predominant size classes, and species abundance (Iverson *et al.*, 1997). However, the reliability and usefulness of the fatty acid method in addressing questions relating to such fine scale diet studies has been questioned, and what is the most appropriate statistical test – principal components or classification trees has been heavily disputed (e.g. Grahl-Nielsen, 1999; Smith *et al.*, 1999).

Fatty acid analysis of diet requires a reference database for the fatty acid signature of the various prey species – in principle from all potential prey species in an area unless some baseline data (e.g. from analyses of stomach and intestinal contents or scats) exists which may reduce the number of prey candidates. In addition, there is stratification of fat in the outer and inner blubber layer of marine mammals (e.g. Lockyer *et al.*, 1984; Koopman, 1998) and incomplete sampling (e.g., when biopsy darts are used) of the blubber layer may yield misleading results of dietary information. Additional variability may be associated with the part of the body from which the sample is taken, making inter-study comparison difficult. It may also be difficult to determine whether the fatty acids originate from the prey consumed by the marine mammal or from secondary prey (Falk-Petersen *et al.*, 2004).

4.2.2.4 Stable isotopes

The principle of this method is that ratios of heavier vs lighter isotopes of particular elements (carbon, nitrogen, oxygen sulphur) in tissues of predators can be traced to those of their prey as they are assimilated in the diet. A library of stable isotopes in potential prey species from the actual area is needed. Assuming that foodweb isotopic signatures are reflected in the tissues of organisms and that such signatures can vary spatially based on a variety of biogeochemical processes, the stable isotope method has been widely used to trace nutritional origin and migration in animals (see Hobson, 1999). The method can not be used to identify the importance of individual prey species in predator diets, but has proved useful to indicate trophic level of feeding or the relative importance of different food webs or sources of nutrients to the diet (Hobson *et al.*, 1996; 1997). Although unable to provide quantitative information about the relative diet composition, Hobson *et al.* (1997) emphasize the utility of the stable isotope approach to augment conventional dietary analyses (identification of remains from stomach contents or faeces) of marine mammals. The method has also been applied to assess seasonal variations in feeding intensity (see Schell *et al.*, 1989). The use of several tissue types (e.g., muscle and liver) may increase the power of the stable isotope approach in food web investigations (Hobson *et al*., 1996).

4.2.2.5 Genetic analyses

Genetic analyses of remains from scats or contents in the gastrointestinal tract may be used to identify prey species consumed. Originally the method was applied in combination with more traditional scat analyses, primarily to identify the individual predator or species for individual scats, assuming that epithelial cells from the colon wall, sloughed off and deposited in scats, are a reliable source of DNA to determine species of origin (e.g. Reed *et al*., 1997; Farrell *et al.,* 2000). Provided that a reference database for the genetic signature of actual prey species is available, the method can certainly also be used for qualitative identification of which prey species are present in gastrointestinal contents or in scats (Barros and Clarke, 2002). Recent experiments with whales have demonstrated that it is possible to identify prey species using DNA that survives the predators digestive system (Gales and Jarman, 2002). The technique allows the identification of soft-bodied organisms that would otherwise be overlooked in morphological analyses of intestinal contents and in faeces if they are not fully digested. The method is primarily qualitative and give no information on prey size, and can probably not be used to identify the relative importance of individual prey species in predator diets.

4.2.2.6 Remote monitoring and other techniques

Remote monitoring of seals, using either radio or satellite-linked time-depth recorders and research vessel/aerial visual surveys have been used to indicate potential prey or feeding areas. The approach is based on comparing data on temporal and spatial distribution of the predator, including the dive depths, with related data for potential prey species, in order to identify overlap that may indicate the likely prey species of the predator (e.g., Folkow and Blix, 1995;

1999). Certainly, this approach would depend heavily on the spatial and temporal resolution and quality of resource data, which in most cases are limited and usually linked to the distribution and abundance commercial fish species (Anon., 2001). Some potential marine mammal prey species may even be without commercial interest such that no results from fishery resource assessments are available. Data on distribution in space and time of predators is of course both useful and necessary when their ecological roles are to be assessed, but for co-occurrence of predators and prey in time and space to be indicative of predation, confirmatory observations by other means are always required (Anon., 2001). However, such studies have been carried out in a large programme run by French and Australian scientists looking at foraging ecology of fur seals on one of the French sub-Antarctic islands. This study combined scat sampling, satellite tag and time-depth recorder data, biological oceanographic data collected from ships, and satellite remote sensing of physical oceanography to tie together resource and seal behavioural data (Bonadonna *et al.*, 2001; Guinet *et al.*, 2001; Lea *et al.*, 2002a,b).

Another method based on remote monitoring is using a video or digital camera that is attached and recovered from the actual predator (see Barros and Clarke, 2002). The logistics required are demanding and expensive, and the method is probably not equally applicable to all species (Anon., 2001). The method, so far not widely used, documents feeding behaviour of the predator, and also prey behaviour during detection and capture. It is not likely to yield information about relative diet composition. Both satellite tags and the use of cameras are relatively expensive and in addition the methods require catching live seals which is limited by the number of seals available. How representative the data from such studies are should therefore be considered when results are used to evaluate seal diet and prey consumption. However, this is true for all studies, regardless of what techniques are used. It is important not to infer beyond the limits of the data. What is important is the question being asked by the study, and how that question is of relevance to marine mammal foraging ecology and marine ecosystem processes.

Direct observation, either with or without new technology, can also be an important way to obtain foraging data. Killer whales feeding on herring have been studied using sonar (Similä, 1997) and underwater video (Dominici *et al.*, 2000). Hoelzel *et al.* (1989) showed that minke whales off western Canada have individual prey preferences by visual studies.

4.2.3 Dietary variability and change

It is common for large scale dietary studies of marine mammals (and other "opportunistic" predators) to find a high variability in diet. Diet for the same taxa can vary greatly both spatially and temporally (including daily, seasonally and annually). It is reasonable to assume that some of the variability in diet is driven by fluctuations in prey – for instance in prey density, abundance or availability. There is a considerable literature on the theoretical aspects of these relationships (e.g. Holling, 1959; Charnov, 1976; Pyke *et al.*, 1977; Yodzis, 1998; Turchin, 2003). The wide range of possible foods for many marine animals means that interpreting differences and apparent changes in diet is often difficult and in any case large samples collected over wide spatial scales and over numbers of years are needed to understand predator-prey relationships.

There are also individual level differences in diet which may be related, for instance, to age, gender or breeding condition. The scale of these individual differences can be large – adding to sampling difficulties. Determining the diet selection of individual marine mammals is difficult, partly due to the difficulty of recording feeding behaviour and partly due to the difficulty of determining prey availability as experienced by the mammals. For example, large-scale fish stock abundance estimates, based on trawling surveys or analysis of fishery data, may not reliably indicate prey availability as experienced by a given predator.

Furthermore, usually only annual average estimates are available. Despite this, attempts are being made to address these problems through improved sampling at sea.

4.2.4 Data for models

For models to work well, good data are required. In the case of food web models, key data include dietary preferences. In the case of this term of reference, an assessment is being made of the quality of marine mammal dietary information, but it is worth noting that if models are to be run, then other dietary information including preferences may be important.

4.3 Regions

For each of the WGRED regions (Figure 3.3.1), an estimation was made of the 4-6 most important species in terms of biomass and a literature review of known diet was undertaken and the diet summarised. If there had been a reasonably comprehensive study of diet of another less-important (in the terms of this review) species this is also noted in the text. Given the limited resources available it is very likely that important dietary reviews and studies have been overlooked.

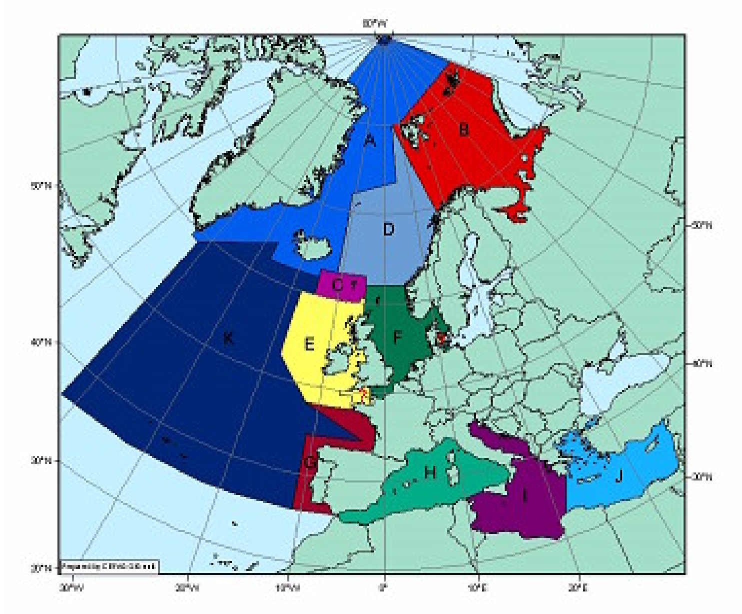

Figure 3.3.1 Map of the Regions used in this term of reference

4.3.1 Region A. Iceland – Greenland

The total prey consumption by cetaceans was estimated by Sigurjonsson and Vikingsson (1997) to be 6.3 million tonnes in Icelandic and adjacent waters, and 8.8 million tonnes in the larger area north of 60°N. Fin and minke whales were estimated to be the largest consumers in the area, followed by long-finned pilot whales and northern bottlenose whales. Crustaceans comprised about 50% of the total consumed biomass, while fish and cephalopods comprised 27% and 22%, respectively.

4.3.1.1 Most important species (highest biomass)

Fin whale *Balaenoptera physalus*

Of 1609 fin whales examined during June-September 1967-89 in Icelandic waters, 96% had krill only in their stomachs, 0.7% capelin, 0.1% sandeel, 0.8% some other fish remains and 2.5% had a mixture of krill and fish remains. Of 159 stomachs sampled during the 1979-89 seasons, 99.4% of the krill was *Meganyctiphanes norvegica* (Sigurjonsson and Vikingsson, 1997).

Minke whale *Balaenoptera acutorostrata*

Around Iceland, analysis of the stomachs of hunted animals showed the diet was overwhelmingly piscivorous, with krill dominating the diet in less than 10% of the stomachs. These data indicate that sandeel is by far the most important prey species for the minke whale around Iceland in the autumn and early summer (NAMMCO 2004). An earlier sample of 58 minke whales that was examined during 1977-90, found that 59% of the prey was fish and 41% krill (Sigurjonsson and Galan, 1991).

Sperm whale *Physeter macrocephalus*

The food composition of sperm whale has been assumed to comprise 76% fish and 24% cephalopods in terms of biomass (Sigurjonsson and Vikingsson, 1997).

Humpback whale *Megaptera novaeangliae*

The food composition of humpback whale has been assumed to comprise 60% fish and 40% crustaceans in terms of biomass (Sigurjonsson and Vikingsson, 1997).

Long-finned pilot whale *Globicephala melas*

The food composition of long-finned pilot whale has been assumed to comprise 20% fish and 80% cephalopods in terms of biomass (Sigurjonsson and Vikingsson, 1997).

Northern bottlenose whale *Hyperoodon ampullatus*

The food composition of northern bottlenose whale has been assumed to comprise 5% fish and 95% cephalopods in terms of biomass (Sigurjonsson and Vikingsson, 1997).

4.3.1.2 Diet studies of other species

Sei whale *Balaenoptera borealis*

Of 247 sei whales caught during 1967-88, 98% had eaten planktonic crustaceans. Two whales had eaten sandeels and one each had eaten capelin and lumpfish (Sigurjonsson and Vikingsson, 1997).

Harp seal *Pagophilusa groenlandicus*

Diet data from harp seals were collected in the Greenland Sea pack ice in the period March-June in 1987, 1990-1992 and 1997, during Soviet/Russian commercial sealing and on Norwegian scientific expeditions. Diet was totally dominated by the pelagic amphipods *Parathemisto* sp. and *Gammarus* sp., but krill and polar cod had also been eaten quite frequently (Potelov *et al.* 2000).

Results from diet studies of harp seals captured in the pack ice belt of the Greenland Sea in summer (July/August) in 2000 and winter (February/March) in 2001 revealed that the diet was comprised of relatively few prey taxa. Pelagic amphipods of the genus *Parathemisto*, the squid *Gonatus fabricii*, the polar cod, the capelin, and sand eels *Ammodytes* spp constituted 63-99% of the observed diet biomass eaten by the harp seals, irrespective of sampling period, but their relative contribution to the diet varied both with species and sampling period/area (NAMMCO 2004).

Hooded seal *Cystophora cristata*

Hooded seal migrational patterns, outside the West Ice breeding and moulting periods, are fairly well known from satellite tagging (Folkow and Blix 1995; 1999; Folkow *et al*. 1996):

these seals appears to be based in ice-covered waters east of Greenland, from where they make long excursions to distant waters, presumably to feed, before returning to the ice again. However, the diet of these animals in the same period remains poorly documented.

Diet data were collected in the Greenland Sea pack ice in the period March-June from hooded seals *Cystophora cristata* in 1992 and 1994, during Soviet/Russian commercial sealing and on Norwegian scientific expeditions. The hooded seals had mainly been feeding on the squid *Gonatus fabricii*, which occurred most frequently in the intestines and also dominated the biomass in the few stomachs with contents. Polar cod also occurred quite frequently in the hooded seal diet, while crustaceans, such as amphipods and krill, occurred only sporadically (Potelov *et al*. 2000).

Diet studies of hooded seals were carried out in the pack ice belt of the Greenland Sea in summer (July/August) in 2000 and winter (February/March) in 2001. *G. fabricii* was the dominant food item in winter 2001, whereas the observed summer 2000 diet mainly comprised a mixture of this squid and polar cod. Also, sand eels contributed importantly to the hooded seal summer 2000 diet, whereas both this prey item and polar cod were almost absent from the winter 2001 samples. In these samples, capelin also contributed substantially (Haug *et al*. 2004).

White-beaked dolphin *Lagenorhynchus albirostris*

Limited examinations of stomach contents from by-caught white-beaked dolphins in Icelandic waters indicated almost total dominance of fish in the diet (Sigurjonsson and Vikingsson, 1997).

Harbour porpoise *Phocoena phocoena*

The food composition of harbour porpoises has been assumed to comprise 95% fish and 5% cephalopods in terms of biomass (Sigurjonsson and Vikingsson, 1997)

4.3.2 Region B. Barents Sea

An overview of the estimates of consumption by predators on the main fish stocks in the Barents Sea is given by Bogstad *et al.* (2000). The main predators are cod *Gadus morhua*, harp seal *Phoca groenlandica* and minke whale *Balaenoptera acutorostrata*. The results indicate that cod is the most important predator, consuming about as much food annually as harp seals and minke whales combined.

4.3.2.1 Most important species (highest biomass)

Minke whale *Balaenoptera acutorostrata*

The minke whale’s diet and consumption of marine resources in the Barents Sea are dynamic and are influenced by variations in the abundance of key prey species such as capelin and immature herring. When capelin is abundant it is a very important minke whale prey item, in particular in Svalbard waters. When the capelin abundance is low, krill becomes more important as minke whale prey. In the southern coastal areas of the Barents Sea, herring and gadoids are important minke whale prey (Haug *et al.* 1996, 2002; Lindstrøm *et al*. 1997, 2002). The total annual food consumption of minke whales in the Barents and Norwegian Seas was estimated to be about 1.8 million tonnes, based on results from diet studies and studies on minke whale energetics carried out during 1992-1997 (Folkow *et al.* 2000).

Fin whale *Balaenoptera physalus*

No known modern dietary studies.

Harp seal *Pagophilus groenlandicus*

With an abundance estimate of 1,829,000 (95% C.I. 1,651,000 – 2,007,000) individuals (ICES 2006) the Barents Sea stock of harp seals is probably one of the most important top predators in this ecosystem. In order to obtain data on their feeding habits stomach contents from harp seals were sampled during the large harp seal invasions to Norwegian coastal waters and in autumn along the drift ice in the northern Barents Sea in 1986-1988 (Haug *et al*., 1991; Lydersen *et al*. 1991; Nilssen *et al*. 1992). More comprehensive feeding studies were continued in the period 1990-1997 to assess the resource use of Barents Sea harp seals throughout the year (Haug and Nilssen 1995; Nilssen 1995; Nilssen *et al*. 1995a,b, 1998a,b, 2000; Lindstrøm *et al*. 1997). Such studies were continued in May-June 2004 (Nilssen and Lindstrøm 2005) and 2005 when the Barents Sea harp seals migrate to northern areas of the Barents Sea, where they feed in open waters and along the drifting pack-ice during summer and autumn.

Seasonal variations in the body condition of harp seals (Nilssen *et al.* 1997, 2000) indicate that summer and autumn are the most intensive feeding periods, and the pelagic amphipod *Parathemisto libellula* appears to be the dominant prey from September until mid-October. During October 1992, when the southward movement of the drift ice forced the seals to move south, a shift in the diet from pelagic crustaceans to fish, mainly capelin *Mallotus villosus* and polar cod *Boreogadus saida*, was observed. In later winter (February) immature herring *Clupea harengus* and polar cod have been found to be important harp seal prey in the southeastern Barents Sea. The energy reserves stored during summer and autumn are maintained until February. During breeding (March) and moult (April-May) the stores of blubber decrease rapidly, indicating restricted food intake at this time. Results from studies of harp seal feeding in Svalbard waters during the period July-August in 1996 and 1997, and in May-June in 2004 showed that krill *Thysanoessa* spp. was the overall dominant prey species (63%) followed by polar cod (16%) and other fish species (10%) in terms of a combined index (frequency occurrence and weight). Resource mapping was performed in two areas simultaneous with the seal sampling, in 1996 and 1997 by using standard acoustic methods. These surveys suggested that krill was the most abundant potential prey in both areas and years; krill constituted 84% and 69% of the total biomass in 1996 (99.7 tonnes/nm^2) and 1997 (21.4 tonnes/nm^2), respectively followed by the pelagic amphipod *Parathemisto libellula* (13 and 18%) and *Gammarus* spp. (2 and 12%).

In the period November-January, knowledge about harp seal feeding habits is very limited (Nilssen *et al.* 2000). However, during the large harp seal winter invasions to the Norwegian coast in 1986-1988, gadoids such as cod *Gadus morhua*, saithe *Pollachius virens* and haddock *Melanogrammus aeglefinus* were important prey (Haug *et al*., 1991; Nilssen *et al*. 1992). In the period between breeding and moult (late March - mid April), harp seals (mainly females) usually migrate from the White Sea to the northeastern parts of the Norwegian coast to feed on spawning capelin (when it is abundant) or gadoids.

The total annual food consumption of the Barents Sea harp seals was estimated to be in the range of 3.3-5 million tonnes, based on results from the studies in 1990-1997, i.e., seasonal changes in diet, distribution and variation in body condition of Barents Sea harp seals (Nilssen *et al.* 2000).

Humpback whale *Megaptera novaeangliae*

No known modern dietary studies.

White-beaked dolphin *Lagenorhynchus albirostris*

No known modern dietary studies.

4.3.3 Region C. Faroe Plateau

4.3.3.1 Most important species (highest biomass)

Long-finned pilot whale *Globicephala melas*

Studies from the stomach contents of hunted whales indicate that the two squid taxa *Gonatus* spp. and *Todarodes sagittatus* are very important in the diet, but fish such as greater argentine *Argentina silus*, blue whiting *Micromisistius poutassou*, Greenland halibut *Reinhardtius hippoglossoides* and pandalid shrimp are also consumed (Desportes and Mouritsen, 1993).

Fin whale *Balaenoptera physalus*

No known modern dietary studies.

Sperm whale *Physeter macrocephalus*

No known modern dietary studies.

Minke whale *Balaenoptera acutorostrata*

No known modern dietary studies.

Sei whale *Balaenoptera borealis*

No known modern dietary studies.

4.3.3.2 Diet studies of other species

Grey seal *Halichoerus grypus*

Diet composition from stomach contents obtained from animals taken for scientific purposes in summer 1993-1995 (Mikkelsen *et al*. 2002) showed that gadoids, sandeels *Ammodytes* sp. and catfish *Anarhichas lupus* dominated the seal diet. Some regional variations were found, with gadoids and sandeels most important in the Svínoy area, catfish and gadoids were most important in the Sandoy area, and sandeels and gadoids were most important in the Northwest area. Grey seals of different ages were found to have somewhat different feeding habits. Juveniles fed most frequently on sandeels, pre-adults fed on sandeels and saithe *Pollachius virens* and adults fed on cod *Gadus morhua* and catfish. Adults also fed on larger prey than the younger seals. The grey seals in Faroese waters were only observed to feed on fish, generally smaller than 30 cm in length, but the size range differed among prey species .

4.3.4 Region D. Norwegian Sea

4.3.4.1 Most important species (highest biomass)

Fin whale *Balaenoptera physalus*

No known modern dietary studies.

Minke whale *Balaenoptera acutorostrata*

Adult herring and gadoids are important minke whale prey (Haug *et al.* 1996, 2002).

Humpback whale *Megaptera novaeangliae*

No known modern dietary studies.

Sperm whale *Physeter macrocephalus*

No known modern dietary studies.

Blue whale *Balaenoptera musculus*

No known modern dietary studies.

Hooded seal *Cystophora cristata*

No known modern dietary studies.

4.3.4.2 Diet studies of other species

Grey seal *Halichoerus grypus*

The feeding habits of grey seals in selected areas along the Norwegian coast were investigated based on stomach and intestinal contents and scat samples collected between spring 1999 and winter 2004 by Touminen *et al*. (2006). The diet analysis was conducted with respect to individual variation. The main areas of interest were in Nordland and Finnmark counties, in northern Norway. Grey seals in Norway feed on a wide variety of mostly benthic fish, and on average the most important prey were gadoids such as cod *Gadus morhua*, saithe *Pollachius virens* and haddock *Melanogrammus aeglefinus* and wolffish *Anarchichus* spp. in terms of relative numerical contribution. No seasonal or inter-annual patterns were detected in the different sampling areas, and there was no regional variation between Nordland and Finnmark. There was not very much more pelagic feeding observed in Nordland, even though herring *Clupea harengus* should be highly available as prey for grey seals in this region particularly during autumn and winter. The gadoids eaten by the grey seals were mainly between 10 cm and 20 cm (range 1.4-53.5 cm), while wolffish mainly ranged between 30 cm and 60 cm (range 6.9-62.7 cm) (Touminen *et al*. 2006).

Harbour seal *Phoca vitulina*

Diet studies of harbour seals based on stomach contents and scats were conducted during 1990-1995 in Nordland county in northern Norway. The most important prey species in terms of biomass was saithe, but herring, cod, sandeel *Ammodytes sp.* and various flatfishes were also observed in the diet. Little variation occurred in the diet composition throughout the year, probably due to a large and stable abundance of saithe in the sampling area (Berg *et al*. 2002). Other studies during the early 1980s and 1995-1997 in mid and southern parts of Norway showed that harbour seals consumed a wide range of species depending on area and season and sometimes variations between years. Norway pout *Trisopterus esmarkii*, herring and saithe were the most important species, but many other fishes (mainly gadoids) occurred in the diet. Herring and saithe seemed to be dominant prey when the species were abundant (Olsen and Bjørge 1995; Bjørge *et al*. 2002).

4.3.5 Region E. Celtic Seas

4.3.5.1 Most important species (highest biomass)

Minke whale *Balaenoptera acutorostrata*

Some information available from stomachs of stranded animals (Pierce *et al*., 2004)

Short-beaked common dolphin *Delphinus delphis*

Stomach contents of 132 stranded and bycaught common dolphins from the UK have been analysed by several workers (Pascoe, 1986; Kuiken *et al*., 1994; Natural History Museum, 1995; Gosselin, 2001). The main species consumed are horse mackerel and sardines, followed by mackerel, but the total number of species consumed is quite wide, including several fish species that are usually demersal, suggesting that feeding in UK waters (samples mainly from the Western Channel) may occur throughout the water column and not just in the upper layers of the water column as is sometimes assumed.

Further offshore, Brophy *et al.* (2005) and Berrow and Rogan (1995) have reported on the stomach contents of common dolphins taken in the Irish tuna driftnet fishery in Subarea VIIa. The main stomach contents were squids and mesopelagic fish. Hassani *et al*. (1997) assessed stomach contents of 42 common dolphins from the French tuna driftnet fishery and found a mixture of crustaceans, cephalopods and fish in over 80% of these, with squid dominating the diet.

Fin whale *Balaenoptera physalus*

No known modern dietary studies.

Grey seal *Halichoerus grypus*

In 1985 a total of 511 faecal samples of grey seals from the Inner and Outer Hebrides were analysed. Approximately 40% of the diet was dominated by gadid species (mostly ling, cod and whiting). The main flatfish in the diet were plaice and megrim in the Outer Hebrides, and witch in the Minch/Inner Hebrides. Additionally sandeel and pelagic schooling fish were part of the diet. The dominant species in the diet varied by area and season (Hammond *et al*. 1994b).

Further analyses of seal diet from more recent samples are presently being conducted by UK's Sea Mammal Research Unit and will be supplied to ICES later in 2006.

Harbour porpoise *Phocoena phocoena*

Stomach contents of 60 animals that were stranded or bycaught between 1995 and 2003 in English and Welsh waters were dominated in weight by whiting, with smaller but regular amounts of gobies and poor cod. (IoZ and SMRU unpublished data).

4.3.5.2 Diet studies of other species

Harbour seal *Phoca vitulina*

In northeast Ireland, Wilson *et al*. (2002) found a shift in diet from predominantly flatfish to gadoids (whiting, haddock, pollock and saithe) over a 5-year period, thought to be associated with declines in particular fish stocks. In the Inner Hebrides, Pierce and Santos (2003) observed gadoids (particularly whiting) along with scad, herring and cephalopods in the diet, with distinct temporal and spatial variation in diet.

White-beaked dolphin *Lagenorhynchus albirostris*

Some information available from stomachs of stranded animals (Canning *et al.*, 2005)

4.3.6 Region F. North Sea

4.3.6.1 Most important species (highest biomass)

Minke whale *Balaenoptera acutorostrata*

A comparative study (with relatively small sample sizes) of minke whale diet in the Norwegian and North Seas demonstrated a single species diet in the Norwegian Sea based on herring and a multi-species diet in the North Sea where sandeel was the dominant species (Holst and Olsen, 2001; Pierce et al. 2004).

Harbour porpoise *Phocoena phocoena*

Several studies of the stomach contents of harbour porpoises in the North Sea have been conducted over the past 30 years. Diet is mainly composed of small shoaling fish from both demersal and pelagic habitats with many prey items probably taken on, or very close to, the sea bed. Even though a wide range of species has been recorded in the diet, porpoises in any one area tend to feed primarily on two to four main species (Santos and Pierce, 2003). Rae (1965, 1973) found a mixture of clupeids (herring and sprats) and gadoids (mainly whiting, but also including cod and Norway pout), with smaller quantities of other species including crustaceans, sandeels, mackerel, hake, saithe and flatfish. Martin (1995) examined 100 porpoise stomachs which contained prey material from stranded and bycaught all around the UK between 1989 and 1994. The main prey species recorded were small gadoids (whiting, Norway pout, poor cod, haddock, pollack and bib), followed by sandeels, gobies, herring, sprats and mackerel.

A further 48 animals stranded and bycaught between 1997 and 2003 in the English North Sea have been examined by the SMRU (SMRU/IOZ unpublished data). Whiting dominated the stomach contents, with herring and sandeels being the next most important prey species by weight.

Whiting *Merlangius merlangus* and sandeels *Ammodytidae* are most common in Scottish waters (results from 188 non-empty stomachs recovered from stranded and bycaught animals from 1993 to 2003; Santos *et al*., 2004a); cod *Gadus morhua*, viviparous blenny *Zoarces viviparous* and whiting in Danish waters (results from 58 non-empty stomachs recovered from stranded and bycaught animals from 1985 to 1992; Santos *et al*. 2005); and whiting in Dutch waters (results from 90 non-empty stomachs recovered from stranded and bycaught animals from 1986 to 2003; 2004a; Santos *et al.*, 2005a). The authors found evidence of geographic, seasonal, interannual, ontogenetic and gender differences in prey types or prey sizes.

Grey seal *Halichoerus grypus*

There have been extensive studies in most major haul out areas showing considerable variation in diet. Diet varies with season and location. Prey species include sandeels (up to 50% of diet), as well as gadoids (e.g. saithe, cod) and flatfish; salmonids, cephalopod and crustacean invertebrates are occasionally consumed (Prime and Hammond, 1988; Prime and Hammond, 1990; Thompson *et al*., 1991; Hammond *et al*., 1994a; Hall and Walton, 1999). Further analyses of seal diet are presently being conducted by UK's Sea Mammal Research Unit and will be supplied to ICES later in 2006.

Harbour seal *Phoca vitulina*

Diet varies seasonally and from region to region. In the Moray Firth, Tollit and Thompson (1996) found the key prey to be sandeels, lesser octopus, whiting, flounder, and cod whilst Pierce *et al*. (1991) and Tollit *et al*. (1997) observed seasonal and annual variation in the diet depending on prey availability. In Shetland, Brown and Pierce (1998) found that gadoids (particularly whiting and saithe) accounted for an estimated 53.4% of the annual diet by weight, sandeels 28.5% and pelagic fishes 13.8%. There were also strong seasonal patterns, with sandeels being important in spring and early summer, and gadoids in winter. Pelagic species (mainly herring, garfish and mackerel) were important in late summer and autumn. In The Wash, diet was dominated by whiting, sole, dragonet and gobies, with a strong seasonality apparent (Hall *et al*. 1998). In the Norwegian Skagerrak, Norway pout, saithe and herring are the dominant prey species, but inter-annual variation was observed (Olsen and Bjørge 1995).

White-beaked dolphin *Lagenorhynchus albirostris*

Small numbers of stomach samples from stranded animals available (Canning *et al.*, 2005).

4.3.7 Region G. Bay of Biscay and Iberian Seas

4.3.7.1 Most important species (highest biomass)

Fin whale *Balaenoptera physalus*

No known modern dietary studies.

Long-finned pilot whale *Globicephala melas*

Small numbers of stomach samples from stranded animals available.

Sperm whale *Physeter macrocephalus*

Small numbers of stomach samples from stranded animals available.

Minke whale *Balaenoptera acutorostrata*

No known modern dietary studies.

Short-beaked common dolphin *Delphinus delphis*

Diet described in Galician waters from 414 non-empty stomachs of stranded and by-caught dolphins from the period 1992-2003 (Santos *et al.*, 2004b). They feed mainly on (small) blue whiting *Micromesistius poutassou*, sardine *Sardina pilchardus* and scad *Trachurus* sp., and (in the first quarter of the year) sand smelt *Atherina* sp. There is interannual and seasonal variation in the diet, as well as differences between the diets of male/female and juvenile, sub-adult and adult dolphins together with the influence of cause of death on stomach contents. Other studies on common dolphin diet in the Northeast Atlantic have also shown dolphins preying in a wide variety of fish and cephalopod, although generally no more than 3 or 4 species made up most of the diet in Portugal (Silva, 1999); in France (Collet, 1981; Desportes, 1985).

In a study of the stomach contents of 71 dolphins, Meynier *et al*. (in prep.) found anchovies *Engraulis encrasicolus*, gobids, sardine *Sardina pilchardus* and Sepiolidae formed the bulk of nearly all diet. The mix of these species varied by age, gender and season.

4.3.7.2 Diet studies of other species

Cuvier's beaked whale *Ziphius cavirostris*

Small numbers of samples from stranded animals are available (Santos *et al*., 2001).

Bottlenose dolphin *Tursiops truncatus*

Diet description based on a sample of 59 non-empty stomachs from stranded animals collected from 1990 to 2002 showed a dominance of blue whiting *Micromesistius poutassou* and hake *Merluccius merluccius* in the diet of bottlenose dolphins from Galicia. A wide variety of other species were also present (including at least 13 species cephalopods) (Santos *et al*., 2005b). Separate analysis of dolphins known to be fishery by-catches suggested that their diet was very similar to that recorded in the overall sample.

Striped dolphin *Stenella coeruleoalba*

Spitz *et al.* (in press) examined the stomach contents of stranded animals on the French Atlantic coast. Fish accounted for 91% of diet by number of items and 61% by mass, with the rest being mostly cephalopods. Ringelstein *et al*. (in press) examined the stomach contents of 60 striped dolphins caught in the summer albacore fishery in the Bay of Biscay and found that cephalopods comprised 56% by mass of the total diet and 40% of the diet if the effects of digestion are allowed for, while fish were 39% by mass of the total diet and 55% of the diet if the effects of digestion are allowed for. Prey composition and size range differed slightly with gender, age and body size.

4.3.8 Baltic

4.3.8.1 Most important species (highest biomass)

Grey seal *Halichoerus grypus*

Analysis of 247 stomach contents of hunted and by-caught grey seals has been undertaken in Swedish waters between 2003 and 2005. The diet in central Baltic calculated from size corrected otoliths was dominated by herring (50 %) followed by sprat (20 %) and cod (8 %) The diet in north Baltic (north of N 60°) was even more dominated of herring (70 %) followed by whitefish *Coregonus laveratus* (10 %) and *Salmo spp*. (5 %) (Lundström *et al*. (in press), Lundström and Hjerne. 2006).

Ringed seal *Phoca hispida*

In a study of ringed seal stomachs the diet was dominated by herring followed by three-spined sticklebacks *Gasterosteus aculeatus* (Stenman and Pöyhönen, 2005).

Harbour seal *Phoca vitulina*

No known modern dietary studies

Harbour porpoise *Phocoena phocoena*

No known modern dietary studies

Saimaa ringed seal *Phoca hispida saimenensis*

Vendace *Coregonus albula* and smelt *Osmerus eperlanus* are the most important prey species for the Saimaa ringed seal. In the years when vendace is scarce, other small fish such as whitefish *Coregonus lavaretus*, perch *Perca fluviatilis* and roach *Rutilus rutilus* are also eaten (e.g. Sipilä and Hyvärinen 1998, Kunnasranta *et al.* 1999).

Ladoga ringed seal *Phoca hispida ladogensis*

In the Sortavala veterinary station autopsies were made on 27 Ladoga ringed seals, which had drowned in fishing gears in the northern part of the lake during period 2000-2003. The most important fish species in the scanty material studied were the smelt *Osmerus eperlanus* and the vendance *Coregonus albula*. In addition, eight other fish species were found in diet, among them ruff *Gymnocephalus cernuus* as the commonest. Typical for the fishes found was their small size. The bigger salmon fish species were seldom represented in the material. Crustaceans, particularly *Gammaracanthus lacustris*, were quite common (Stenman *et al.* 2005).

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5 TOR C) Workshop planning

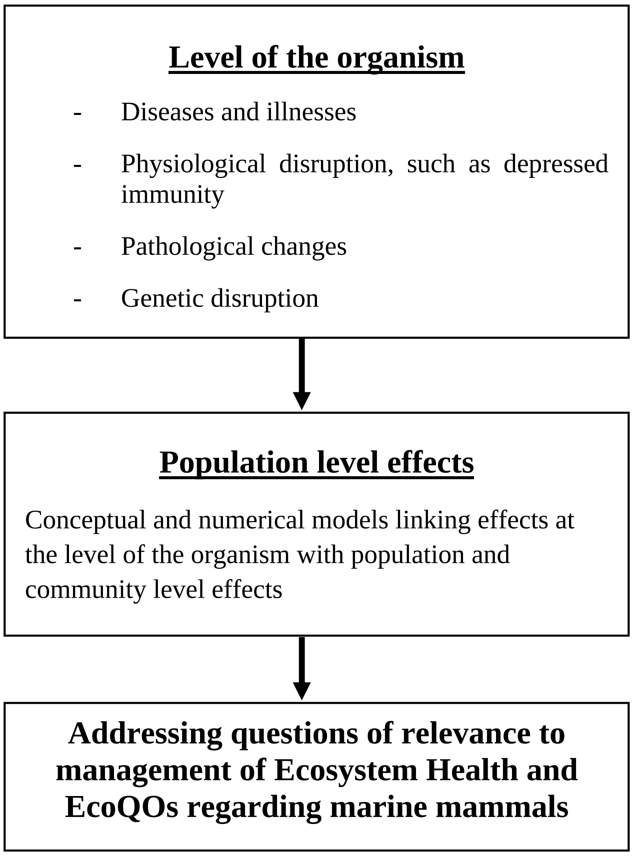
The term of reference states: finalise preparations for a workshop in 2007 (to be held back-to-back with WGMME meeting) on health and immune status, disease agents and links to environmental quality

5.1 WGMME Workshop on Environmental quality and Marine Mammal health

Epizootics are known to have occurred in marine mammal populations in the past. However, these incidents seem to have occurred more frequently in the recent past, e.g. in 1988 and 2002 in Kattegat - North Sea harbour seals. Possible relations between habitat quality, immune depression and epizootics are poorly understood and the involved mechanisms are not well described. Therefore, the relation between habitat quality and marine mammal health remains an intriguing question.

In several large marine ecosystems (LMEs), processes are initiated to establish Ecosystem Management Plans with associated ecological quality objectives (EcoQOs). Attempts are made to select relevant indicators or parameters to monitor and assess the ecosystem health (e.g., Hopkins, 2005; ICES, 2005; von Quillfeldt and Dommasnes, 2006). However, selecting the appropriate monitoring parameters essential for assessing ecosystem health is challenging (see e.g. ICES, 2000).

Marine mammals are generally at high trophic levels exposed to biological effects of biomagnified and accumulated pollutants. Marine mammals are often selected as potential indicators of ecosystem health (e.g. OSPAR’s EcoQOs for the North Sea, HELCOM EcoOs for the Baltic Sea, Norwegian EcoQOs for the Barents Sea). However, for most indicators relating marine mammals to environmental quality, this requires better understanding the involved mechanisms and processes. Therefore, the WGMME will convene a workshop to address the unsolved questions linking ecosystem/environmental health to different harmful effects on the health status of marine mammals, such as physiological disruptions, increased occurrences of diseases, reproductive disorders and other pathological changes. The three-step workshop should address the biological effects at the level of the individual, explore the subsequent impacts at the population and community levels, and finally elaborate on the relevance for integrated chemical-biological assessment of ecosystem health and implications for management as outlined in the figure below.



The workshop is planned for the autumn (October-December) of 2007, and a planning group is suggested for furthering the plans. At this time the group includes Antonio Fernandez, Ailsa Hall, Thierry Jauniaux, Paul Jepson, Madeleine Nyman, Ursula Siebert, Jeff Stott and Peter Reijnders. Thierry Jauniaux has agreed to chair this planning committee.

The workshop will consider some case studies, including seals in the Baltic Sea ecosystem (other suggested case studies include North Sea porpoises (Jepson and Siebert) and Sarasota Bay bottlenose dolphins).

The following drafting group is suggested to prepare the Baltic Sea seals case study: Britt-Marie Bäcklin, Sweden, Arne Bjørge, Norway, Madeleine Nyman, Finland, and Tero Härkönen, Sweden. A Baltic seal expert workshop recommended new management principles for seals in the Baltic linking the management of seals closer to the ecosystem approach to management (ANON. 2005). The Baltic seal case study will explore current knowledge of environmental quality and marine mammal health in relation to the scientific requirements to implement the proposed management principles. Focus will be on the impact of chemical pollution on seals. This includes biomarkers, histopathology and reproductive disorders (more specifically e.g. uterine occlusions, bone lesions, ulcers) at the level of the individual. At the level of the population we will consider fertility rates, survival rates and spatial range. We will discuss the significance for the HELCOM Monitoring and Assessment Strategy and the HELCOM Monitoring Scheme for Ecosystem Assessment.

A proposal for developing a Pollution Index (PI) to be applied in the Baltic Sea is discussed by the WGBEC (2005). The index could consist of 5 elements. Each element is composed of separate indicators (parameters). The elements involved in the proposed PI represent different levels of detection of pollution and its effects in the marine environment potentially affecting population, community and ecosystem levels. The Baltic seal case study will also examine the merits of this approach and the relevance for seals.

The WGMME will review the progress of the planning process at its next meeting and ***recommends*** the following to be included in the ToR of WGMME 2007:

→Review the progress report of the Planning Group for the WGMME Workshop on Environmental quality and Marine Mammal health

5.2 References

Anon. 2005. Outcome of the HELCOM/ICES/EU Seal Expert Workshop, Stockholm, Sweden, 6-8 September 2005.

Hopkins, C.C.E. 2005. The concept of ecosystem health and association with the ecosystem approach to management and other initiatives. Keynote paper for ICES BSRP/HELCOM UNEP Regional Seas Workshop on Baltic Sea Ecosystem Health Indicators, 29 March – 2 April 2005, Sopot, Poland.

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ICES 2000. Report of the Study Group on Ecosysntem Assessment and Monitoring. ICES CM 2000/E:09.

von Quillfeldt, C.H. and Dommasnes, A. (eds). 2006. Proposals for indicators and environmental quality objectives for the Barents Sea. 178pp. http://barentshavet.imr.no/

WGBEC 2005. ICES Working group on biological effects of contaminants. ICES Marine Habitat Committee, ICES CM 2005/E:08

6 TOR D) WGMME cooperative research reports – current status and future format

The term of reference states: complete work on a Cooperative Research Report on threats to marine mammal populations based on a compilation of prior reports of this and former marine mammal working/study groups

6.1 Alternative to cooperative research reports

When addressing this term of reference a general discussion in the WGMME about the main goal of producing Cooperative Research Reports was started. It was agreed that this should be the presentation of an overview of all data collected over the last years. The WG found that compiling such a report based on the previous work of the WG would lead to a number of problems. Such a report would try to compile data that is changing at a fast pace, e.g. bycatch data, and thus such a publication would be outdated by the time it would appear. Some of the specific issues, e.g. pollution, have only been addressed in reports that are several years old and a compilation that included such information would not represent the state of current knowledge.

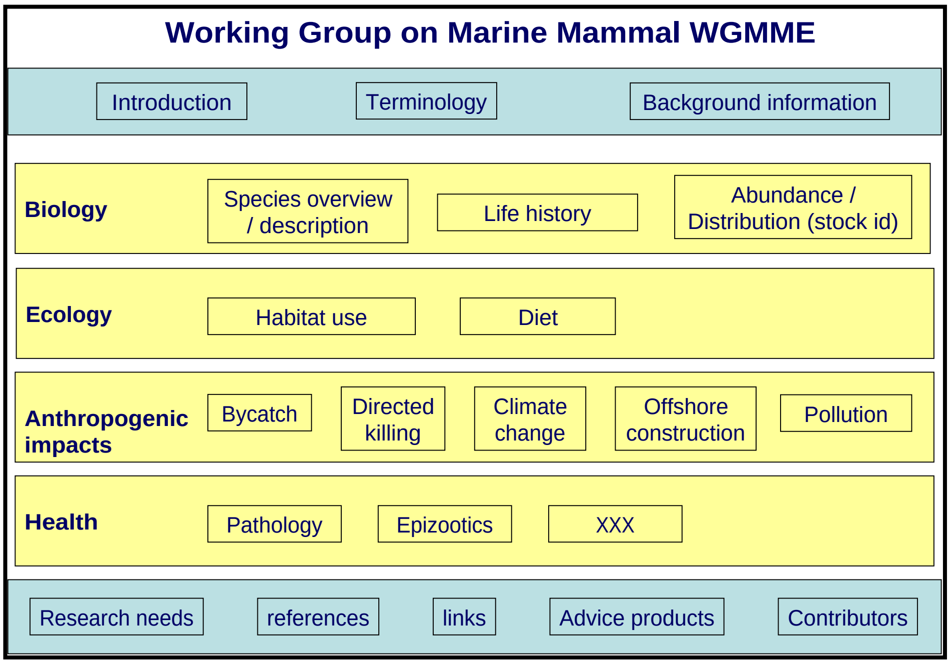
The working group heard that the SGESME is thinking about putting their reports and data out in a new format using the web. The WGMME favoured a similar approach, and recognised that it could potentially be very useful in making the most recent information available in a timely manner. At a basic level this could be a web page which all members of the WG would have access to. Data such as those on abundance estimates or bycatch could be updated regularly. Information would in this way be readily available, easily accessible and hyper-linked in appropriate ways, and this would allow new members to get a good overview and existing members to keep abreast of developments. Although this process will initially represent an increase in the workload of members of the WGMME, it would later greatly facilitate the compilation of annual reports. In the longer term such a web page could be linked to other working groups in ICES. If web-based data could in some way go through a review process within the WGMME or ICES it could also be made available to the public.

6.2 Concerns

The contents of the webpage will be under the control of WGMME and one of our responsibilities will be to control that the information available on the webpage is factual and good quality is assured.

Any other suggestions from the ICES community on how such a quality control should occur and how comments from other contributors could be incorporated would be greatly appreciated.

6.3 Draft for web page design



7 TOR E) Review REGNS North Sea ecosystem assessment

The term of reference states: review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the "overview" assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant

7.1 Introduction

The REGNS report 2005 ideally requires data that covers the period 1950 to present and at a spatial resolution of ICES statistical square (30 by 30 nautical miles) covering regions IVa, b and c, and regions IIIa (Skaggerak) and VIId (Eastern English Channel). Marine mammal data has not been collected in this way, in part because it is notoriously difficult and expensive to collect. Work has generally been conducted on a more localised basis (e.g. seal counts in breeding colonies) and usually at broader temporal scales, particularly with regard to cetaceans (e.g. the distribution of cetaceans in the North Sea assessed in by SCANS in 1994, which was repeated by SCANS 2 in 2005).

7.2 Parameters

Cetacean sightings. The term 'sightings' suggests that the data may not be effort linked. All data in the Joint Cetacean Database (JCD) is effort linked and contributes to the knowledge of cetacean distribution. This data covers sightings and surveys between 1989 and 1998, and is pooled on a monthly basis over a 10 year period (see Reid *et al.*, 2003 available at www.jncc.gov.uk). Therefore it is suggested that the name should be adjusted to 'cetacean distribution'. The database should be updated with the SCANS 2 data and other data sources when they become available.

Marine mammal bycatch. This is a rapidly evolving field, consequently it will be difficult to keep information up to date in the REGNS assessment. Annual updates on cetacean bycatch for specific gear/areas/fisheries can be found in the ACE and WGMME annual reports (available at www.ices.dk). National programmes to assess the extent of bycatch in the North Sea are currently being undertaken (additional information is provided in TOR a of this document). Bycatch studies have been conducted in areas IVa, IVb, IVc, IIIa, coastal and VIId at variable levels of spatial and temporal resolution. Data are available for 90-00 and 00-10. See the SMRU (www.smru.st-and.ac.uk) and DEFRA (www.defra.gov.uk) web sites for further UK information.

Marine mammals organic contamination. Since the 1980s, a number of studies have examined the contaminant burden of marine mammals in the North Sea. Examples include the levels of organic contaminants in sperm whales in the southern North Sea (Holsbeek *et al.*, 1999), harbour porpoises (*Phocoena phocoena*) throughout the North Sea (Kleivane *et al.*, 1995; van Scheppingen *et al.*, 1996; Boon *et al.*, 2002) and in harbour seals (*Phoca vitulina*) (Boon *et al.*, 2002). However, it should be noted that the majority of these studies are reliant on samples from stranded animals for which a number of issues have been raised. Samples from stranded cetaceans often have a skewed age composition, include an abnormally large number of individuals in poor condition and contain large numbers of diseased animals (Aguilar *et al.*, 2002). Nutritive condition, incidence of disease, preservation state of the tissue, and type of sampling method are all known sources of variation in the level of organic contamination detected (for a review see Aguilar *et al.*, 1999). Consequently, the levels of contaminants recorded from stranded animals is thought unlikely to be representative of that within the wider cetacean community. More recently, studies have undertaken that take some of these issues into account. For example, Jepson *et al.* (1999, 2005) examined the effect of organic contaminants in harbour porpoises comparing animals that died of acute physical trauma with those dying of infectious disease in UK waters.

It should be noted that assessing trends in organic pollution in marine mammals is extremely complex because of age and gender influences on accumulation. For many species, there is a maternal transfer of persistent organic contaminants from mother to offspring during gestation and lactation. For orcas (*Orcinus orca*), contaminant burden increased with age for males, but is greatly reduced in reproductively active females (Ross *et al.*, 2000). In addition, the contaminant load in reproductive female orcas was lower than that of sexually immature individuals in the same age class (Ylitalo *et al.*, 2001). Similar male/female differences have been recorded in Risso's dolphins (*Grampus griseus*) (Kim *et al.*, 1996). Passing of some of the organic pollutant burden onto calves or pups during lactation has been recorded for Atlantic white-sided dolphins (*Lagenorhynchus acutus*) (Tuerk *et al.*, 2005), harbour seals (Neale *et al.*, 2005) and grey seals (Sormo *et al.*, 2003) and the contaminant load of the mother has also been found to affect offspring survival in bottlenose dolphins (*Tursiops truncatus*) (Reddy *et al.*, 2001). In addition, the contaminant burden of northern fur seal (*Callorhinus ursinus*) pups was greater in those pups born to young mothers (presumably primiparous) than those of older (multiparous) mothers (Beckman *et al.*, 1999).

Suggested additional necessary information: Seal abundance

At the 2003 Joint Ministerial meeting of the Helsinki and OSPAR Commissions agreed at ecological quality objective (EcoQO) for seals in the North Sea stating that there should be no decline in population size or pup population of ≥10% over a period of up to 10 years. As such, it is important that seal populations are considered by REGNS.

With respect to the North Sea, grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals are the most abundant. Grey seal abundance estimates are usually calculated from pup counts whilst harbour seal abundance is estimated during the annual molt when the greatest and most consistent numbers of animals are ashore.

Annual seal surveys are undertaken in the UK by the Sea Mammal Research Unit (SMRU) for the Special Committee on Seals (SCOS) and also by the National Trust at a variety of sites within ICES divisions IVa-c. For some areas long term data sets exist, e.g. counts have been made in the Farne Islands annually from 1956 to 2003, the Isle of May in the Forth of Forth between 1979 and 2003 and in Orkney between 1960 and 2003. Annual updates are available on the SCOS website (www.smru.st-and.ac.uk, with a summary table provided for grey seals at http://smub.st-and.ac.uk/CurrentResearch). The seal population in the Wadden Sea (ICES division IVb, covering Denmark, Germany and the Netherlands) has been monitored for some considerable time. Regular annual counts from the entire area are available from 1979 (see http://cwss.www.de/management/SMP/seals.html).

Seal counts were undertaken in Norwegian waters (ICES division IIIa) in 1998/99 and are repeated at regular intervals. These data are available at http://www.imr.no/produkter/publikasjoner/havets_ressurser. Section 2.3 of the document provides an English summary.

Suggested changes to marine mammal extracts from REGNS Annex 3

Data		Cetacean distribution	Seal abundance	Marine mammal bycatch	Marine mammal organic contamination
identifier		Reid *et al.* 2003	Several national sources	Several national sources	Many national sources
priority		2	2	2	2
Spatial resolution		Quarter ICES squares	Breeding sites	By fishery	Site specific
Spatial extent	VIId	X	X	X	X
	coast	X	X	X	X
	IIIa	X	X	X	X
	IVc	X	X	X	X
	IVb	X	X	X	X
	IVa	X	X	X	X
Temporal resolution		Max. monthly	Min. annual or less	Assessment usually annual	Variable
Temporal extent	00-10		X	X	X
	90-00	X	X	X	X
	80-90	X	X		X
	70-80		X		
	60-70		X		
	50-60		X		
Comments				Many different sources	Most studies associated with stranded animals.

7.3 References

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8 Recommendations for future activities

8.1 Recommendation I

We have considered the terms of reference for a meeting in 2007 and included these as ANNEX 3.

→The working group **recommends** that ACE adopts these terms of references for WGMME.

8.2 Recommendation II

Using a web based structure to present the work of the working groups could potentially improve the work process. Information would in this way be readily available, easily accessible and hyper-linked in appropriate ways, and this would allow new members to get a good overview and existing members to keep abreast of developments.

→The working group **recommends** that members begin the development for a web based report structure and review progress at the next meeting. It is also recommended that ICES considers the best format and procedure for the implementation of such a web based representation of the working groups.

8.3 Recommendation III

Trends in the abundance of small cetaceans in European waters are not well known, with there having only been two abundance surveys in some areas, and fewer elsewhere. Abundance surveys are very costly to organise and there is a need to be able to monitor cetacean populations (both for trends in numbers and changes in range). The European SCANS II project is examining options for such monitoring, and it seems likely that piggybacking on existing wide scale surveys of European waters may be a way forward. Cetacean surveys may come in two forms – visual, with the use of one or two observers in a high, forward looking location on the outside of the ship, or acoustic, with the use of a towed hydrophone cable (and associated computer equipment. At present, WGMME is unaware of the likely recommendations from the SCANS II project, but would be willing to help facilitate consideration by WGIBTS.

→WGMME notes that WGIBTS is considering revising protocols for the North Sea IBTS, and therefore **recommends** that it considers the possibilities of adding cetacean surveys to its protocols.

8.4 Future meeting

The membership of the WGMME confirmed their readiness to meet for 4 - 5 days in 2007. The German Federal Agency of Nature Conservation (Bundesamt für Naturschutz) has cordially invited the WGMME to meet on the island of Vilm, Germany. The date of the meeting still needs to be confirmed but the best time for such a meeting is during the last two weeks of March 2007.

Annex 1: List of participants

Working group WGMME 29 January to 3 February 2006

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Annex 2: Agenda

Monday 30 January
09:00 Opening of meeting, adoption of agenda, forming of subgroups
10:45 Coffee break
11:00 Working in sub groups
13:00 Lunch
14:00 Working in sub groups
16:00 Coffee break
16:30 Working in sub groups
~19:00 End of session

Tuesday 31 January
09:00 Plenary,
Presentation of Vladimir Zabavnikov on aerial and shipboard surveys in the Barents Sea
10:45 Coffee break
11:00 Working in sub groups
13:00 Lunch
14:00 Plenary, revision of first drafts
16:00 Coffee break
16:30 Working in sub groups
~19:00 End of session

Wednesday 1 February
09:00 Plenary, revision of first drafts
10:45 Coffee break
11:00 Working in sub groups
13:00 Lunch
14:00 Working in sub groups
16:00 Coffee break
16:30 Plenary, final drafts
~19:00 End of session

Thursday 2 February
09:00 plenary, final drafts
10:45 Coffee break
11:00 plenary, tors 2007, final draft
13:00 Lunch
14:00 Adoption of WGMME 2006 draft report
16:00 END

Annex 3: WGMME terms of reference 2007

The **Working Group on Marine Mammal Ecology** [WGMME] (Chair: M. Scheidat, Germany) will meet on Vilm, Germany March 2007 to:

a) review any new information submitted on the populations of seals and harbour porpoise in the Baltic marine area, including the size and structure of the populations, distribution, migration pattern, reproductive capacity, effects of contaminants on the health status, and additional mortality owing to interactions with commercial fisheries by sub-region (bycatch, intentional killing), review and consider recent research into unaccounted mortality in commercial fisheries;

b) review any new information on population sizes, by catches or mitigation measures and suggest relevant advice in response to the European Commission standing request regarding fisheries that have a significant impact on small cetaceans and other marine mammals.

c) review the outputs of the SCANS II project and report on the usefulness of future work for ICES.

d) Review intersessional work on the development of a web based report structure.

e) review the progress report of the Planning Group for the WGMME Workshop on Environmental Quality and Marine Mammal Health

Supporting Information

PRIORITY:	High.
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	Action Plan No: Term of Reference a) This is a response to a biannual request from HELCOM Term of Reference b) This work is required in relation to MoU between the European Commission and ICES. This also addresses Goal 1 of the ICES Strategic Plan. Term of Reference c) Much of the results from SCANS II will be considered under tor a but some additional aspects will be helpful to the WGMME in interpreting the request for advice from the EU. Term of Reference d) We think this will be in accordance with the goals of the ICES strategic plans. Term of Reference e) Marine mammals are upper trophic level predators that accumulate high levels of pollutants. This addresses Goal 2 in the ICES Strategic Plan.
RESOURCE REQUIREMENTS:	No specific requirements beyond the needs of members to prepare for, and participate in, the meeting
PARTICIPANTS:	The Group is normally attended by some 10–20 members.
SECRETARIAT FACILITIES:	None.
FINANCIAL:	None.
LINKAGES TO ADVISORY COMMITTEES:	The WGMME reports to the ACE (Advisory Committee on Ecosystems).
LINKAGES TO OTHER COMMITTEES OR GROUPS:	Under tor c it is likely we would like to develop a working relationship with WGIBTS.
LINKAGES TO OTHER ORGANIZATIONS:	
SECRETARIAT MARGINAL COST SHARE:	