**Advisory Committee on Ecosystem** **ICES CM 2001/ACE:01**

**REPORT OF THE**

# Working Group on Marine Mammal Population Dynamics and Habitats

**ICES Headquarters**
**23–27 April 2001**



International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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# 1 INTRODUCTION AND MEETING ARRANGEMENTS

The meeting was held from 23–27 April 2001 at ICES Headquarters in Copenhagen, Denmark, with Arne Bjørge (Norway) as Chair. The Chair welcomed the participants to the first meeting of the Working Group on Marine Mammal Population Dynamics and Habitats (WGMMPH) and summarised the meeting schedule. The ICES Environment Adviser, Janet Pawlak, welcomed the Working Group to ICES and the practical arrangements and facilities available at the ICES Secretariat were presented.

The Chair of the Advisory Committee on Ecosystems, Hein Rune Skjoldal, participated in the discussions on Ecological Quality Objectives. Jake Rice, Bob Mohn, and Niels Daan from the Working Group on Ecosystem Effects of Fishing Activities (WGECO) attended the first session of that discussion. The list of WGMMPH participants is attached as Annex 1.

The WGMMPH acknowledges Dr Ailsa Hall and Callan Duck, Sea Mammal Research Unit, University of St. Andrews, for providing UK seal data, and Dr Daniel Pike, Scientific Secretary to the North Atlantic Marine Mammal Commission, for providing information on the northeast Atlantic harvest of marine mammals. Their contributions were essential for developing this report during the Working Group meeting.

# 2 APPOINTMENT OF RAPPORTEURS

Peter Corkeron, Mike Hammill, Tero Härkönen, Simon Northridge, Peter Reijnders, and Mark Tasker assisted the Chair as rapporteurs.

# 3 TERMS OF REFERENCE AND ADOPTION OF THE AGENDA

## 3.1 Terms of Reference

Terms of reference (ToRs) for the meeting, as given in ICES C. Res. 2000/2ACE02 were to:

a) conduct, in response to a request from OSPAR [2001/2.2], the following:
   - i provide a synthesis of the North Sea populations of marine mammals, including consideration of species that have declined or are threatened from human activities;
   - ii provide a synthesis of the health status of marine mammals in the North Sea in relation to the quality of their habitat;
   - iii in liaison with WGECO and SGEAM, provide recommendations for appropriate Ecological Quality Objective (EcoQO) indices for marine mammals based on i) and ii), and develop a proposal for appropriate EcoQOs for North Sea marine mammal populations;
   - iv prepare provisional estimates for the current levels, reference levels, and target levels for the EcoQO indices identified in iii);

b) update a 1998 review of the impact of fisheries on small cetaceans;

c) review progress in studies of marine mammal habitat requirements, particularly in relation to exposure to contaminants;

d) explore possibilities for furthering the research programme on cause-effect relationships between contaminants and population-level effects in seals;

e) adopt a population simulation model framework whereby the population-level effects of environmental impacts may be assessed;

f) continue the work to develop a comprehensive database on North Atlantic marine mammal diet composition that can be used by the ICES community to evaluate two-way trophic interactions between marine mammals and fisheries;

g) evaluate current information on techniques and methodology to estimate seal abundance, particularly grey seals and harbour seals, including stock structure, census (methodologies, techniques, and biases), population growth rates and trends, ageing techniques, mortality, consumption models, and habitat requirements.

WGMMPH will report by 18 May 2001 for the attention of ACE, who will parent the Group, and the Marine Habitat and Living Resources Committees.

In addition to the ToR, a late request was supplied to the group. The European Commission requests ICES to increase its efforts to provide information and advice on other fish stocks and other marine organisms than those targeted by commercial fisheries. This is an area in which the European Commission would encourage ICES to take greater initiative as well as proposing research to support the ongoing efforts to integrate environmental concern into the Common Fisheries Policy.

The EC would in particular be interested to receive information and advice as soon as possible during 2001 on the following:

- Overview of fisheries that have a significant impact on small cetaceans;
- Overview of other sources of mortality of small cetaceans;
- Assess the risks created by fisheries on identified populations;
- Advice on possible remedial actions to reduce the impact by fishing, *inter alia*, technical measures such as changes in gear design, fishing practice, spatial or temporal closures.

### 3.2 Adoption of Agenda

The Agenda was discussed in light of the Terms of Reference and the additional request from the European Commission. The WG agreed to address EC's questions under Agenda Item 8. The Chair announced his intention of raising the question about future Chair of the WGMMPH and the functioning of the group at future meetings (cf. Agenda Item 12, and Section 12 of this report). The agenda was adopted as amended and is attached as Annex 2.

## 4 SYNTHESIS OF THE NORTH SEA POPULATIONS OF MARINE MAMMALS

Four marine mammal species have resident populations in the North Sea, using the North Sea habitat for breeding and feeding: the harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*), the harbour porpoise (*Phocoena phocoena*) and the bottlenose dolphin (*Tursiops truncatus*). The whitebeaked dolphin (*Langenorhynchus albirostris*) and Atlantic whitesided dolphin (*Langenorhynchus acutus*) and the minke whale (*Balaenoptera acutorostrata*) occur regularly over large parts of the North Sea in large numbers mainly to feed. Data are available on these species to be informative regarding their North Sea abundance.

Several marine mammals occur in the North Sea on an occasional or temporary basis. Hooded seals (*Cystophora cristata*), killer whales (*Orcinus orca*), long-finned pilot whales (*Globicephala melas*), Sowerby's beaked whales (*Mesoplodon bidens*), northern bottlenose whales (*Hyperoodon ampullatus*), and Risso's dolphins (*Grampus griseus*) regularly enter the northwest entrances to the North Sea. More occasionally, the larger whales including the sperm whale (*Physeter macrocephalus*), sei whale (*Balaneoptera borealis*), fin whale (*Balaneoptera physalus*), and blue whale (*Balaneoptera musculus*) also approach the borders of the North Sea. The common dolphin (*Delphinus delphis*) and striped dolphin (*Stenella coeruleoalba*) frequently enter both the northwest North Sea entrances and the southern English Channel waters.

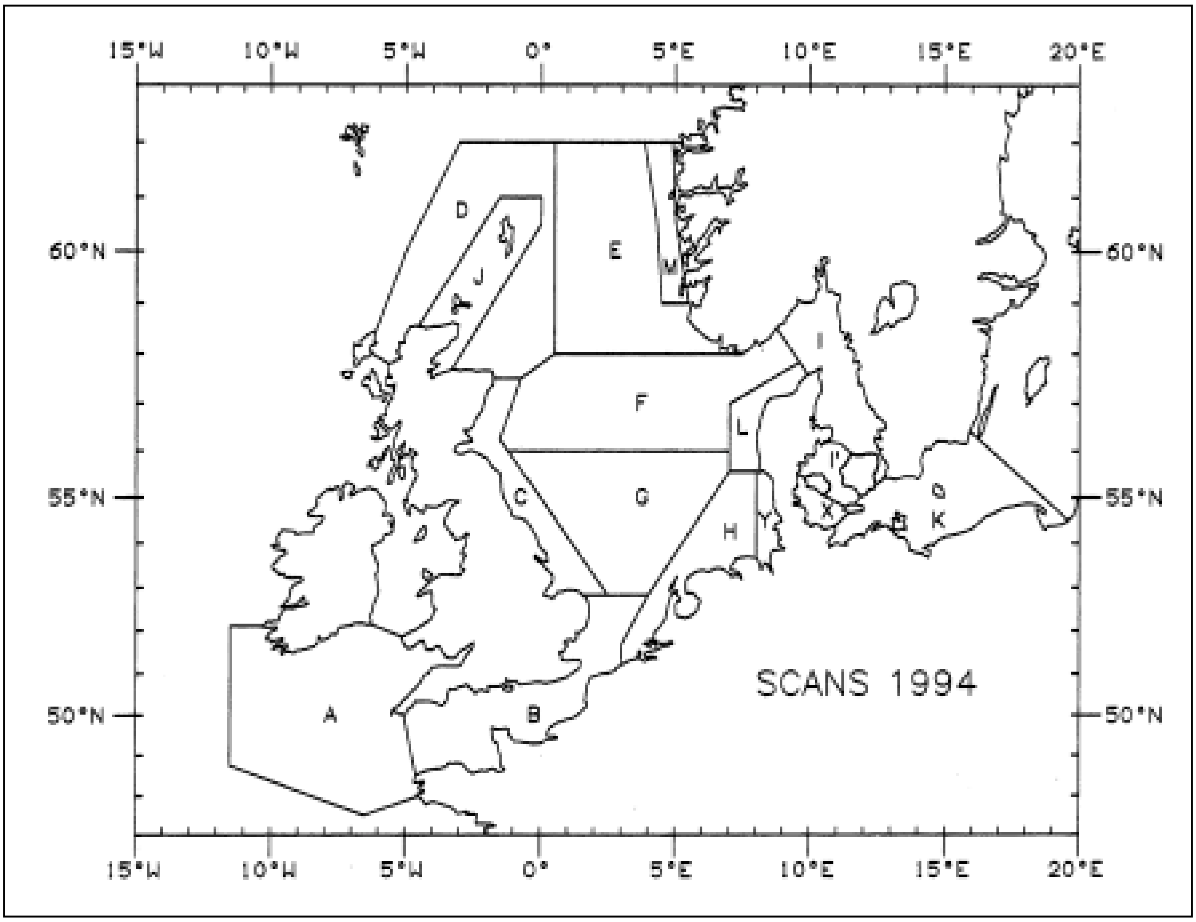
WGMMPH decided to include the four species with resident populations in the North Sea and the three species regularly utilising large parts of the North Sea, in its synthesis of North Sea marine mammal populations.

For its synthesis of seal populations, WGMMPH identified the North Sea area defined as OSPAR Area II (OSPAR, 1995). For the synthesis of cetacean populations, the SCANS blocks B-J, L and Y were chosen because the best available abundance and distribution data for cetaceans were given for these blocks, and abundance estimates for the chosen species were combined accordingly from data given in Hammond *et al.* (1995). This area is similar to OSPAR Area II, except for the waters around the Orkney and Shetland Islands (Figure 4.1).

### 4.1 Current Population Sizes and Trends

Current population size, recent trends and retrospective population simulations may be relevant under this topic. Harbour and grey seal surveys in the Wadden Sea, the Kattegat-Skagerrak, UK North Sea coast (including the Orkneys and Shetland), and the Norwegian North Sea coast are relevant. Further, the large international survey to estimate small cetacean abundance in the North Sea (SCANS) in 1994, and any national surveys for small cetaceans in the North Sea region are relevant.

**Figure 4.1.** The North Sea with the relevant SCANS 1994 survey blocks for estimating abundance of small cetaceans (from Hammond *et al.*, 1995).




### 4.1.1 Harbour porpoise

Harbour porpoises were surveyed by a large international sighting survey (SCANS) in 1994 (Hammond *et al.*, 1995) deploying ten vessels and two aircraft. The shipboard survey was conducted by two independent observer platforms (a primary platform and a tracking platform) on each vessel, and duplicate sighting data from the independent platforms were used to calculate a correction factor for animals missed on the transect line (g(0) correction), and for any movement of animals in response to the survey vessels. The aerial survey was also conducted with two independent platforms (two aircraft flying in "tandem"). The abundance was estimated by a "Modified Logistic Regression" (MLR) method, which built upon the Buckland and Turnock (1992) method, but also included explanatory variables other than perpendicular distance (Hammond *et al.*, 1995). Excluding the Celtic Shelf (Block A), Inner Danish waters (Block I') and the Baltic (Blocks X and K), the total abundance of harbour porpoises in the relevant North Sea area calculated from SCANS data was 309,000 (CV: 0.12, C.I: 237,000–381,000). No information is available for assessing any trend in abundance.

There is no direct take of porpoises in the North Sea. However, three porpoises were taken in 1996 in the Faroe Islands. The fishery by-catch of porpoises in the North Sea is significant (cf. Table 6.1).

### 4.1.2 Bottlenose dolphins

The only population of bottlenose dolphins that has been well studied in the North Sea is that found in waters off the Moray Firth, Scotland. A study based on photo-identification provides an estimate of 129 individual animals (95 % CI = 110–174 animals) in this population (Wilson *et al.*, 1999). Numbers of dolphins show seasonal variation, with peaks in spring and summer (Wilson *et al.*, 1997), suggesting that some animals' ranges include areas outside the Moray Firth. Recent work at the Universities of Aberdeen and St. Andrews indicates a possible decline in abundance of these dolphins (P. Thompson, pers. comm.).

A small group of five individuals that occurs off Dorset has been photographed extensively, and its seasonal pattern of occurrence is well known (M. Tasker, pers. comm.).

Elsewhere, populations are less well known and no other population of comparable size to that in the Moray Firth appears to exist in inshore waters of the North Sea. Insufficient sightings of bottlenose dolphins were made during the SCANS survey to attempt population estimates. By-catches appear uncommon in the North Sea, and the only known direct take in adjacent waters was 21 animals taken in the Faroe Islands drive fishery in 1996 (data made available from the NAMMCO database).

### 4.1.3 Whitebeaked dolphins and Atlantic whitesided dolphins

An estimate based on SCANS sightings for whitebeaked dolphins was 7,900 (CV = 0.30; 95 % CI = 4,000–13,300) for the North Sea (Hammond *et al.*, 1995). The abundance of *Lagenorhynchus* dolphins (unspecified whitesided and whitebeaked) was estimated at 11,000 (CV = 0.25; 95 % CI = 5,500–16,300) for the same area. Norwegian sighting surveys have demonstrated a continuous wider distribution of whitebeaked and Atlantic whitesided dolphins to the north of the North Sea. The abundance of *Langenorhynchus* dolphins is estimated at 133,000 animals in the areas covered by the Norwegian sighting surveys (i.e., the summer distribution of the northeast Atlantic stock of minke whales) (Øien, 1996).

There are no deliberate takes of whitebeaked or Atlantic whitesided dolphins in the North Sea, but in the adjacent waters of the Faroe Islands, dolphins are targeted in a drive fishery. In the period 1995–1999, a total of 1,097 Atlantic whitesided dolphins was taken. Annual catches varied from 0 to 438 (data made available from the NAMMCO database). By-catches occur in the North Sea but the level is unknown and anticipated to be low.

### 4.1.4 Minke whales

The abundance of minke whales in the North Sea was estimated at 7,300 (CV = 0.21; 95 % CI = 4,200–10,300) based on the SCANS survey (Hammond *et al.*, 1995). The North Sea minke whales are part of the northeast Atlantic stock (IWC definition), which is estimated at 112,000 whales (CV = 0.10; 95 % CI = 88,000–135,000) (Schweder *et al.*, 1997).

Minke whales are taken by the Norwegian small-type whaling. The takes in the North Sea area were 139, 122 and 88 animals in 1998–2000 (cf. Table 6.3). This harvest is regulated by quotas set by Norway, and quotas are generated by the catch limit algorithm developed by the IWC Scientific Committee for use in the IWC Revised Management Procedure. No other direct take is known from the northeast Atlantic stock. Anecdotal information indicates that entanglements of minke whales in fishing gear do occur in the North Sea, but these events are regarded as rare.

### 4.1.5 Harbour seals

The harbour seal forms resident populations along the coastlines of the North Sea. Methods for estimating population sizes differ to some extent among areas, but have in most cases been based on aerial surveys, where major haul-out sites have been photographed during the peak moulting season in August. In some areas (the Kattegat-Skagerrak and the Limfjord) three or more replicate flights were conducted, while in other areas (the Wadden Sea, UK and the Norwegian west coast) one or two annual flights have been carried out. The counts represent hauled-out numbers of seals, and several studies have shown that mean counted numbers amount to about 56–70 % of the total population during the moulting season. However, there might be regional differences in the haul-out tendency, which is why this correction factor cannot be applied to all areas indiscriminately. An overview of populations is shown in Appendix Table 1.

Also the data analyses differ among areas. In the Wadden Sea, the relative abundance estimates are based on the maximum counted numbers, whereas presented counts in the Kattegat-Skagerrak are trimmed mean values (i.e., based on the two highest annual counts).

In the Kattegat including the Danish Straits, the numbers of counted harbour seals amounted to 5,814 in the year 2000, which corresponds to a total population of 10,400 animals. The rate of increase since 1988 has been 9.4 % per year, but a slower annual increase of 5.2 % was observed in recent years (1996–2000). There is no official direct take of seals, and numbers of by-caught animals are unknown but probably less than 100 (T. Härkönen, pers. comm.).

In the Skagerrak, the mean numbers of hauled-out animals amounted to 3,658 in the year 2000. With a correction factor of 0.56, the total population is estimated at 6,500 seals (T. Härkönen, pers. comm.). The rate of increase since 1988 has been 14.2 % per year, which is above the theoretically maximum rate of increase in a population with a stable age structure. A population analysis showed that this high rate of increase could be explained by the perturbed age structure after the 1988 seal epizootic (T. Härkönen, pers. comm.). There is no officially accepted direct take in this area, and numbers of by-caught animals are unknown.

In the Oslofjord, Norway, the mean hauled-out number was 280 animals in the year 2000 (T. Härkönen, pers. comm.). This population was significantly set back by the 1988 Phocine Distemper Virus (PDV) epizootic (Markussen, 1992). Between 1988 and 1998, an annual increase of about 12 % is suggested, however, the early data in the time series are fragmentary (Bjørge and Øien, 1999).

Along the Norwegian west coast south of 62 °N, single annual surveys carried out in 1996–1998 showed 1,203 counted seals (Bjørge and Øien, 1999). No monitoring of harbour seals has been conducted since the IMR stopped its monitoring programme in 1998, and no trend analysis has been conducted. A total of 630 harbour seals was tagged along the Norwegian coast, and 39 tags (6.2 %) were recovered from seals by-caught in fishing gear (Bjørge and Øien, 1999). The effect of the introduction of hunting in 1998 on harbour seal numbers is unclear, as no survey has been conducted since 1998. A survey is due by 2003 (P. Corkeron, pers. comm.). The direct takes by hunters in this area were 48 harbour seals in 1999 and 121 in 2000 (P. Corkeron, pers. comm.). It is allowed to kill seals at salmon farms, standing fishing gear and in salmon rivers, but any seals killed under this allowance are not included in these figures.

In Scotland including Shetland and the Orkneys, the mean annual rate of increase in hauled-out harbour seals was 2.9 % for the period 1988–1999. However, regional differences are found. A negative trend is suggested for the Orkneys, while positive trends are suggested for most other regions (Thompson *et al.*, 2001; C. Duck and S. Northridge, pers. comm.).

In the Wash and the English east coast, a trend analysis of annual surveys since 1989 gives an annual rate of increase at 5.9 %, where 2,300 seals were counted in 1999 (C. Duck and S. Northridge, pers. comm.). The total number counted for the English east coast was 3,658 (S. Northridge, pers. comm.). A by-catch proportion of 0.4 % was recorded from 1,064 harbour seals tagged in the Wash (Hall *et al.*, Working Paper 1).

In the entire Wadden Sea, the maximum total number of seals counted amounted to 17,000 in the year 2000. The rate of increase since 1989 was 13 % per year, but the observed growth rate for the last two years was 6 %. Also within the Wadden Sea, regional differences appeared. An annual rate of increase in the Netherlands was 17 %, whereas lower values were observed in other areas. For the Delta area an annual rate of increase at 21 % is shown and numbers amounted to 97 harbour seals in the year 2000. This high rate of increase in the latter two areas can only be explained by immigration from adjacent areas (P. Reijnders, pers. comm.).

In the Limfjord, Denmark, the number of harbour seals increased exponentially after the PDV epizootic in 1988, and close to 1,000 seals were counted in 1998. Land-based surveys supported a further increase until August 1999. However, a dramatic drop in numbers occurred up to the year 2000, when only 495 seals were counted in the area (J. Teilmann, pers. comm.).

### 4.1.6 Grey seals

In the North Sea area, abundance estimates of grey seals are mainly based on counts of pups at the main breeding grounds. The models used for estimates of total population sizes are not published, which precludes an evaluation of population estimates and trajectories. An overview of populations is shown in Appendix Table 2.

In the Kattegat and the Skagerrak, only some 300 years ago grey seals were the most common species of seals, but intensive hunting extirpated the species during the 1930s. This formerly abundant group of seals gave birth to their pups in late December and early January, which was suggested to be an indication of a distinct population in the area. Ever since the 1930s, numbers of grey seals counted in the area have remained below 40 animals. Documented breeding attempts have failed and only single dead pups have been observed in the area. Most of these dead pups have been found in March, which suggests that the breeding attempts were made by females originating from the Baltic population (T. Härkönen, pers. comm.).

Along the Norwegian west coast up to 62 °N, tagging of 21 pups in 1999 was the first firm evidence of grey seal breeding in the Norwegian North Sea area. Since 1998 there has been a direct take and licenses for 400 grey seals were issued for this part of the coast. This quota exceeds the population size normally associated with an annual production of 21 pups. The actual take was reportedly 9 in 1999 and 70 in 2000 (P. Corkeron, pers. comm.). The available information on by-catches is limited, but north in areas of 62 °N, 5.7 % of grey seal tags were recovered from seals by-caught in fishing gear (Bjørge and Øien, 1999).

The Orkneys, Isle of May, Farne Island and Donna Nook in the UK hold some of the largest estimated grey seal populations in the North Sea area. The sum of estimated population sizes in UK waters amounted to 61,500 animals in 1999, which shows that more than 95 % of the North Sea population of grey seals occurs in UK waters. Compared with pup counts in 1998, declining numbers were observed in all major areas except for Donna Nook, where an increase was noted. Nevertheless, increasing total population sizes are projected up to the year 2004 (C. Duck and S. Northridge, pers. comm.). No information was available on the model used. By-catches estimated from tag returns were 1.8 % for the Farne Islands and Isle of May (6,880 tagged), 1.3 % at Orkney (3,276 tagged), and 2.5 % at Shetland (407 tagged) (Hall *et al.,* Working Paper 1).

In the Wadden Sea, grey seals have been very scarce in recent times, however, successful breeding in the area was observed in the 1980s at Terschelling. Here the numbers of pups born have increased from 2 in 1985 to more than 100 in the years 1999–2000. Total numbers of older animals counted amounted to 550 in 1999 and 380 in 2000 (P. Reijnders, pers. comm.).

### 4.2 Consideration of Species that have Declined or are Threatened from Human Activities

Historically, all populations of marine mammals in the North Sea area have been exploited by man, and most seal populations have declined as a result of direct takes such as subsistence hunting, culling, and by-catches. Further, circumstantial evidence indicates that seal stocks in the Wadden Sea and the Kattegat-Skagerrak have been affected by environmental pollution, leading to reproductive disorders (Reijnders, 1986) and other pathological changes (Mortensen *et al.*, 1992).

Numbers of harbour seals in the Kattegat and Skagerrak increased until 1905, when hunting became intensive as a consequence of the introduction of bounties. Back calculations based on hunting statistics show that the total original harbour seal population must have amounted to about 17,000 animals (Heide-Jørgensen and Härkönen, 1988). The population was reduced to about 2,500 animals in the 1930s, and remained at this level until 1967, when hunting was banned in Swedish waters. Increasing numbers were first noted after hunting was prohibited also in Denmark in 1977. From 1978 to 1987 the population increased exponentially at 12 % per year and reached about 9,000 animals just before the seal epizootic in 1988. The total epizootic mortality was 56 % (T. Härkönen, pers. comm.). Jaws and skulls from seals collected during the epizootic event were analysed, and it was shown that the prevalence of bone lesions had increased compared with samples taken during the first half of the 20$^{th}$ century. Also a new type of pathological change, exostosis of the alveolar bone, was described in the 1988 material, and linked to hormonal imbalance (Mortensen *et al.*, 1992).

A model based on hunting statistics and other forms of direct takes in the Wadden Sea showed that the size of the harbour seal population could have been about 40,000 animals in the beginning of the 20$^{th}$ century. Intensive hunting reduced numbers to some thousands of animals during the 1960s, after which the population started to recover slowly only after hunting was banned in the area. Also in the Wadden Sea, circumstantial evidence indicates that population development was severely affected by pollution.

On the Norwegian coast south of 62 $^{o}$N, Øynes (1966) reported a population of less than 890 harbour seals in the early 1960s. He stated that harbour seals had been severely depleted due to hunting, and were likely to soon be extirpated from parts of southern Norway. Following legal protection in 1973, numbers of harbour seals most likely increased until 1998 (Bjørge and Øien, 1999). Hunting of harbour and grey seals in Norwegian North Sea waters has resumed since 1998. For grey seals, the current quota exceeds the documented population size at the Norwegian North Sea coast. There is no evidence for effects of pollutants in Norwegian seal populations.

The SCANS survey did not record harbour porpoises in the very southern North Sea and the Channel waters, despite the fact that these waters used to support porpoises including calves (Hammond *et al.*, 1995; IJsselling and Scheygrond, 1943; Verwey, 1975). This reduction in porpoise distribution may be associated with heavy human-generated disturbance including pollution in these waters.

Thus historical data indicate that marine mammals in the North Sea are very vulnerable to direct take combined with incidental catches, but that chemical pollution might be a severe threat in some areas. The total number of seals in the North Sea is presently increasing, indicating a current population level below carrying capacity.

## 4.3 Status of Health in Relation to Habitat Quality

The health of free-ranging marine mammals may be discussed at two levels, at the level of the population and at the level of the individual. At both levels, the health status is a very complex concept and requires further specifications and definitions. The concept of habitat quality is also very complex and includes a very wide range of factors that may impact the health of marine mammal individuals or populations. The links between habitat quality and marine mammal health are not well described, and WGMMPH felt unable to provide a synthesis of the status of North Sea marine mammals in relation to the quality of their habitat unless the concepts of “health status” and “habitat quality” are further specified in the request. Two aspects frequently associated with habitat quality are chemical pollution and noise. WGMMPH therefore referred to a review of the effects of chemical contaminants and acoustic disturbance on marine mammals made by the Working Group on Marine Mammal Habitats (WGMMHA) in 1998 (ICES, 1998, 1999).

In its 1998 review of acoustic disturbance, WGMMHA concluded that tolerance to acoustic disturbance may be high in some marine mammals, but anthropogenic noise in the oceans represents an increasing problem. In general, the response thresholds are often low for variable and increasing sounds, intermediate for steady sounds, and high for pulsed sounds. However, WGMMPH notes that recent information indicates that anthropogenic noise may result in behavioural changes that are more significant than recognised previously (e.g., Schick and Urban, 2000; Miller *et al.*, 2000), and perhaps in some instances may contribute to fatalities (e.g., Frantzis, 1998). This topic should be revisited in future by the WGMMPH.

A very large number of elements and chemical compounds may have an effect on marine mammals, and new compounds are added to this list at increasing speed. WGMMHA restricted its 1998 review to the contaminants that were most likely to cause effects. WGMMHA found it likely that in particular the non-*ortho* and mono-*ortho* chlorobiphenyls could cause effects detectable at the level of the population in some contaminated areas. However, WGMMHA concluded that the extent of these effects is unclear, despite some experiments linking contaminants to sub-cellular, cellular or systemic level effects (e.g., Bergman and Olsson 1985; De Guise *et al.*, 1995a, 1995b; De Swart *et al.*, 1994, 1996; Ross *et al.*, 1996). Although suppression of population growth and fecundity rates have been reported for marine mammal populations resident in contaminated areas (e.g., grey and ringed seals in the Baltic Sea, harbour seals in the Wadden Sea), there is no well-defined cause-effect relationship linking specific contaminants to population-level effects.

WGMMPH reiterated the need for further research on cause-effect relationships linking contaminants to effects in marine mammals (cf. Section 8 of this report), and discussed a possible concept for assessing the health status of marine mammals in relation to habitat quality. This is based on a discussion of a working paper presented by P. Reijnders (Working Paper 2).

### 4.3.1 Concepts for evaluating animal health status in marine mammals

Assessment of the health status of marine mammals in relation to the quality of their habitat can basically be approached in two ways. One method would be to determine habitat requirements of marine mammals in “low disturbed” or pristine areas and test to what extent the requirements are fulfilled or a diversion from a required state occurs. The other method is to characterise the condition of populations in demographic and physiological terms. Through measuring variables indicative for both sets of parameters leading to an index for population condition, the state of health or condition of the population in question can be assessed and monitored. The first approach requires assessment of the critical habitat in low- or undisturbed ecosystems. It will be difficult to find any of those systems and to describe a so-called $t_0$ situation may be too complex. Therefore, the second approach was chosen for further elaboration.

#### 4.3.1.1 Population condition

An index for the condition of a population should include a measure of the recuperative power of the population in question. For example, a population may exhibit a “normal” growth rate after a catastrophe, however, if the immune system of the individuals is significantly challenged by, e.g., contaminants, it is evident that additional stress from, e.g., disturbance will be less likely to be absorbed without effect. A specific example is the crash of a reindeer population (Klein, 1968). This population showed a rapid increase and would have been rated high in terms of population condition, but proved to be unable to recover from a crash after environmental perturbation. The inclusion of a measure of recuperative power, or resilience, should apply to both the demographic and the physiological condition. For clarity, resilience could be defined as the power of the individual or a population to recover from environmental disturbance, and will indicate the ability to absorb perturbations.

#### 4.3.1.2 Demographic condition

Caughley (1977) suggested expressing demographic condition by a single statistic that combines the vigour of each age and sex class in the population. He proposed the use of the survival-fecundity rate of increase, called $r_s$. This $r_s$ is calculated from age-specific survival and fecundity schedules under conditions a population experiences at a given point in time. This is an attractive concept because it describes the average reaction of members in a population to the integrated action of all environmental variables. Measurement of $r_s$ is difficult and therefore r (*average r*) is introduced, which is the observed rate of increase. The drawback is that this gives a vigour averaged over a period of time instead of a momentary state.

As explained earlier, a single figure for demographic vigour can be misleading and therefore the use of a combination of demographic parameters has been suggested as being more useful in assessing demographic vigour (Eberhardt, 1977; Hanks, 1981). The events, often observed in a sequence, in a mammalian population with a changing demographic vigour, have been used as indices. Such a sequence of events when vigour declines would be in the order: increase in juvenile mortality > increase in age at first reproduction > decline in fecundity > increase in adult mortality. In other words, if a change in juvenile mortality occurs, this would be the proximate expression of a changing trend in the rate of increase. Besides the importance of monitoring juvenile mortality as a sensitive index for demographic vigour, it can also be concluded that the last parameter that a population "should give away" is an increase in adult mortality.

#### 4.3.1.3 Physiological condition

Commonly used indices of physiological condition in mammalian species are: deposited fat reserves, adrenocortical hypertrophy, physical and chemical blood parameters, urinary excretion of hydroxyproline, and body growth.

##### 4.3.1.3.1 Deposited fat reserves

Deposited fat reserves as a percentage of carcass weight provide a measure of physiological condition. In large mammals this is often substituted by the kidney fat index (KFI). This index is obtained by expressing the perinephric fat weight as a percentage of the kidney weight. The use of the KFI is based on the assumption that the kidney weight is a constant function of body size. This is demonstrated in many ungulate species (e.g., Smith, 1970) but may not hold for species where seasonal fluctuations in kidney weight occur (Hanks *et al*., 1976). The applicability of this measure has therefore to be checked for marine mammals.

Bone marrow fat content (BMF), expressed as a fat percentage of the marrow, is an additional alternative to deposited fat reserves. The apparent relation between KFI and BMF offers a useful field guide to decide for either of the two analyses (Brooks *et al*., 1977). The sequence of fat metabolisation provides another opportunity to assess physiological condition. It has been found in ungulates that rump fat disappears first, followed by subcutaneous fat, visceral fat and finally marrow fat.

Several studies on marine mammals have indicated the potential for using body mass as an indicator of health/condition. This holds for harbour, grey, southern elephant, and Antarctic fur seals.

Further studies on lipokinetics in marine mammals are required to assess the value of using the above-mentioned indices in measuring marine mammal health.

##### 4.3.1.3.2 Adrenocortical hypertrophy

Adrenal hypertrophy and hyperplasia are responses of the body to stress, and increased adrenocortical tissue has a direct relation to adrenal weight. A clear example of this in marine mammals is the adrenocortical hyperplasia found in Baltic seals, reflecting a disease syndrome caused by chemical pollution (Bergman and Olsson, 1985).

It is known that a variety of factors can influence adrenal weight, including low temperature, sexual activity, photoperiod, diet, and population density. Therefore, further studies are needed to establish the relation between adrenal weight and physiological condition.

#### 4.3.1.3.3 Blood chemistry – haematology and clinical chemistry

A number of studies have been carried out on physical and chemical blood parameters in large mammals. Many of these provided baseline values for a number of parameters, and for marine mammals increasing data sets are becoming available (Engelhardt, 1979; Bossart and Dierauf, 1990; Roletto, 1993). It is beyond the context of this summary to describe and assess the potential of the many available parameters as indices for physiological condition. Suffice to say that no single parameter should be used in isolation. Equally, no single value should be used because most values are subject to multi-factorial influences, and only the evaluation of a full set of routine diagnostic parameters may enable to control for that.

For pragmatic reasons, WGMMPH concentrated in the first instance on three categories of health/condition characteristics: reproduction and early development, function of the immune system, and diseases. This choice was based on ongoing developments in responses of marine mammals to toxic compounds. In the ecotoxicological field, that includes studies on marine mammals, progress has been made to identify response variables and endpoints to be used in assessing reproductive, immune system and other disorders (Reijnders *et al*., 1999; Bjørge *et al*., 1999). It is emphasised that the significance of identifying a set of measures to assess endocrine, immune and other health disorders goes beyond merely assessing effects of environmental pollution. Whatever environmental factor is studied, it is equally important to try to distinguish between effects caused by that specific factor and by other stresses.

WGMMPH used the set of parameters listed in Reijnders *et al.* (1999) and evaluated whether these are satisfactory for the purpose of assessing health status.

#### 4.3.1.3.4 Urinary excretion of hydroxyproline

Hydroxyproline is an amino acid and its secretion is related to the rate of collagen metabolism. Low excretion is associated with malnutrition. Based on this concept, the hydroxyproline-creatinine index (HCI) was developed. The HCI index is the amount of hydroxyproline related to the concentration of creatinine in a sample of urine. Basically a high HCI can be equated with good condition as manifested by the rate of growth (Malpas, 1977). However, this concept was criticised and further studies are required to assess its true value and applicability in marine mammal studies.

#### 4.3.1.4 Body growth

A measure of an animal's growth in weight, length, height and girth can provide criteria for assessing physiological condition. This is based on the concept that reduced weight at age or reduced growth rates are linked with poor condition. The value of using body weight as a criterion for growth rate and nutritive status has been clearly demonstrated for ungulates (Klein, 1970). The use of the von Bertalanffy growth equation to measure growth has been suggested, however, its biological significance has been questioned (Hanks, 1972).

Attempts to relate weight, length and girth in deer and other ungulates resulted in the formula: $W = a + LG^2$ (W is total body weight (kg), L is total length (cm), and G is girth (cm)). This relationship was highly significant (Riney, 1960). However, in studies on impalas Hanks *et al.* (1976) demonstrated that changes in fat reserves can occur without expressing themselves in the external appearance of animals. He found that, although the equation mentioned showed a highly significant relationship, the relationship between the same linear measurements and the kidney fat index (KFI) gave a much lower correlation. This implies that animals with identical weight and girth measurements can still differ substantially in deposited fat reserves. This renders the use of body growth as an index for physiological condition, questionable.

In summary, population condition may be best described in terms of demographic condition (vigour) and physiological condition. It is evident that confounding factors such as the influence of sex, age, and seasonality has to be taken into account when values for these indices are established.

Of the several indices discussed for demographic vigour, it is concluded that the rate of increase and juvenile mortality would be practical and sensitive indicators for changes in demographic vigour. Physiological condition may be best described in terms of deposited fat reserves expressed in fat content of body mass preferably, and a set of haematology and clinical chemistry blood parameters.

Data on KFI and BMF can only be obtained through studies on dead marine mammals of which the collection of a sufficient number of adequate samples may be complicated or hardly possible. It is therefore suggested to concentrate on developing the use of fat % of body mass, and clinical chemistry and haematology blood parameters.

WGMMPH emphasises that the assessment of population condition or health should be done through integration of an assessment of demographic vigour with an assessment of physiological condition. Only a matrix of indices derived from both assessment procedures will enable a comprehensive diagnosis, which a single statistic will never achieve.

#### 4.3.1.5 Habitat quality and marine mammal health

In the foregoing sections, WGMMPH elaborated the indices that may be the most powerful. In order to relate health to habitat quality, an assessment of either the way that changes in habitat quality affect "normal" health parameters, or an assessment of the prevailing parameters and actual habitat characteristics in populations with different status, has to be made. WGMMPH suggested the latter, based on preference to investigate environmental factors that could affect population health, rather than predict the consequences of effects.

The approach suggested is basically to take account of the health parameters of marine mammals which have been exposed and the environmental variables (habitat characteristics) which are associated with exposure. By choosing populations of one species exhibiting different status (gradients of condition), it will be possible to investigate the impact of differences in habitat quality on health parameters. Populations in "good condition" could serve as model populations to determine the quality of the habitat characteristics, the sum of environmental attributes.

The complicating factor is the decision on which environmental attributes are relevant in this respect. It is reasonable therefore to depart from classifying factors that are known as threats to marine mammal populations. As elaborated in Reijnders *et al.* (1993), they can be conveniently grouped in terms of their immediacy of their effect into:

- *Immediate threats*
  - results of harvesting or incidental mortality in fisheries;
- *Intermediate threats*
  - results of habitat degradation (environmental contaminants), effects of commercial fisheries on food availability, effects of natural changes in food availability and food quality, disturbance (human presence and noise), changes in the physical environment;
- *Longer-term threats*
  - climate change (affecting distribution and abundance, increased incidence of epizootics);
  - genetic diversity (loss of genetic variability leading to lower ability to respond to environmental change).

Each of these threats has to be evaluated for a specific population in a given area, and rated according to the estimated environmental stress. The added sum of those stresses will give an index of the quality of the habitat in question. This will be a complicated task but already a qualitative rating will be useful to start to build such a framework. Furthermore, the rating might be facilitated by analysing simple mathematical models of the processes involved when a known threat exerts a known effect.

In many cases, changes in environmental factors and responses by populations cannot be measured directly because of a long latency period between a change in the factor and the response. It is therefore suggested to assess the influence of habitat quality on health parameters by using the concept of a dose-response curve, where an index of population condition is expressed against an index of habitat quality.

Again here, a model such as that developed by Anderson and May (1978) could be used to take account of the effects of a combination of stresses and their additive, multiplicative, and interactive effects as elaborated for effects of combinations of contaminants (Harwood *et al.*, 1999).

WGMMPH realises that the implementation of the conceptual framework suggested is a laborious and complicated task. However, WGMMPH believes that the only way to make progress in relating marine mammal health to habitat quality is to try to express marine mammal health in terms of physiological response parameters, reflecting the influence of habitat quality. Starting with populations in areas where good population data as well as habitat characteristics are available should show the potential of this concept. If successful, this system ultimately will provide us with a powerful monitoring instrument that, through its "early warning" characteristics, enables management decisions to be made at the appropriate time.

The question was raised if there has been any effort to analyse existing data with multifactoral analyses to show which environmental parameters could be correlated to various health aspects of marine mammal populations. It was argued that simple and general models should be used to test assumptions or hypotheses. Then a Bayesian approach can be applied to test for best fit of the different models or correlations. It was suggested that with sufficient preparatory work in advance, the complex question of animal health relative to habitat quality could be addressed based on current data, and the WGMMPH ***recommends*** this as a subject for a future special WGMMPH workshop. However, the Working Group underlined the need for describing the mechanisms whereby specific contaminants impact the marine mammals on a sub-cellular, cellular, and systemic level. A description of these mechanisms is required to understand the causes and dynamics of the effects of contaminants at the levels of both the individual and the population (cf. Section 8).

# 5 ECOLOGICAL QUALITY OBJECTIVES FOR MARINE MAMMALS IN THE NORTH SEA

## 5.1 Introduction

The concept of ecological quality objectives (EcoQOs) has been discussed in a number of documents and at a number of recent meetings (Anon., 1999a; Lanters *et al*., 1999; Kabuta and Enserinck, 2000; ICES, 2001a, 2001b). Several key features of an EcoQO may be derived from these discussions. These may be summarised as follows:

EcoQOs

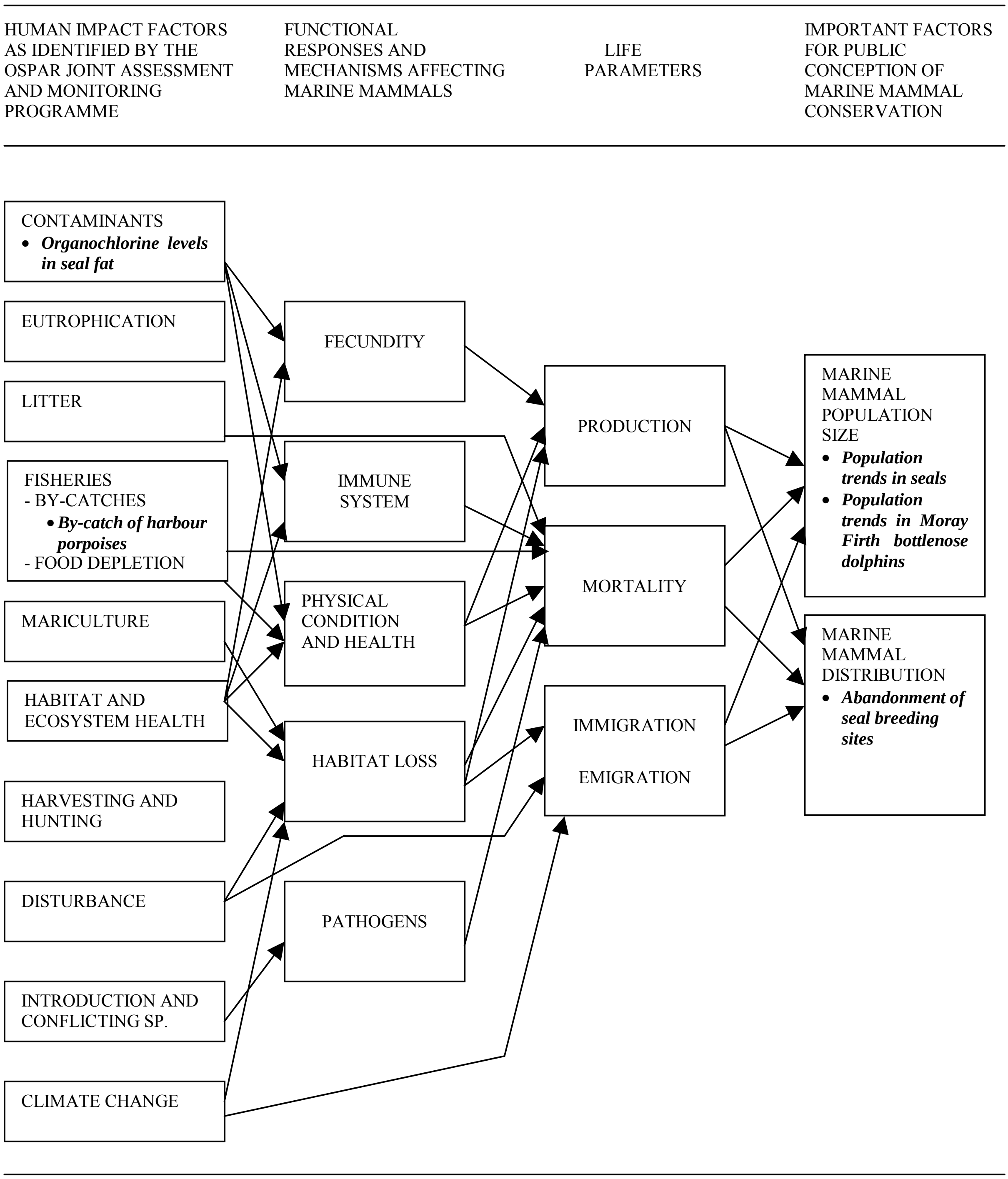
- should improve or maintain ecological quality;
- should be sensitive to a manageable human activity;
- should have a relatively tight linkage in time to that activity;
- should be relatively easily and accurately measured;
- should have a high response to the signal from human activity compared with the variation induced by other factors and a low level of false positive or missed signals;
- should be measurable in a reasonably large proportion of the area to which the EcoQO is to apply;
- should preferably have been measured over a number of years to provide a baseline of information and allow a realistic setting of objectives;
- may relate only to the species/species group/community for which the objective is being set;
- may relate to a wider environmental condition.

In discussing the above, WGMMPH agreed largely with the approach of the Working Group on Seabird Ecology (WGSE) (ICES, 2001b). There were two main directions from which EcoQOs might be derived. One direction would be to examine each marine mammal species or group of species in turn to see if a relatively easily measured metric relating to that species might be usable as an indicator of ecological condition. The other direction was to examine broad categories of ecological effects of human activities in the North Sea and discuss whether marine mammals could provide a suitable EcoQO as an indicator of that effect. WGSE followed the second of these approaches. The WGMMPH, however, felt that this approach did not relate closely enough to the main features that most people would relate to marine mammals: that of population size and distribution.

## 5.2 Discussion of Appropriate Ecological Quality Objectives for Marine Mammals

It was noted that while population size, distribution, and the life factors were usually quantifiable, and have been subject to surveillance and monitoring, these factors are not directly susceptible to management (except by direct human-induced mortality). Human activities are, however, manageable. The difficulty with the setting of EcoQOs is in demonstrating a link between the management of human activity and its eventual effect on marine mammal population size. In the case of effects causing direct mortality (e.g., by-catch), linkage is relatively easy to demonstrate, but in order to calculate total mortality, information is needed on all other sources of mortality.

**Figure 5.2.1.** Population size and distribution are regarded as the most important subjects for management and conservation of marine mammals and their habitat in the North Sea, and the subjects of general public concern. A schematic overview shows how human impact factors (as listed by OSPAR) may be linked to marine mammal population size and distribution through functional responses and life parameters. The overview is not exhaustive. Proposed EcoQOs are shown in bold italics.




WGMMPH discussed both EcoQO reference levels and EcoQO target levels. It was noted that, in contrast to traditional ICES terminology, the OSPAR of definition of EcoQO reference levels refers to a state with minimal impacts of human activity. WGMMPH agreed that it could be very difficult or impossible to determine reference levels for pristine conditions, except for a few human-induced effects (e.g., pollutants not occurring in nature), but was much more difficult in relation to a biological resource (such as a stock of fish). Such biological resources will be affected not only by a directed activity (e.g., removal), but also to an unknown extent indirectly by links through the food chain.

Population size and distribution were identified as two Ecological Quality variables that could be used to describe the ecological condition for particular species of interest. Changes in distribution would reflect impacts by changes in food resource availability, habitat loss, disturbance, or marine mammal-fishery interactions. Changes in these parameters (abundance and distribution) would indicate that significant ecosystem changes are occurring and that investigation into causes of these changes is required. WGMMPH also identified other variables that could act as general Ecosystem Quality monitors or indices as described by WGSE. Obviously, changes in these indices would reflect back on potential impacts on marine mammals and would limit the field of parameters to be examined for negative impact. EcoQO target levels were generally felt to be likely to lie somewhere between the current EcoQO level, and the EcoQO reference level. In relation to target levels, there are no hard scientific facts or rules – these levels are a matter of societal choice and public acceptability.

WGMMPH also considered the setting of EcoQO limit reference points. These would be analogous to the limit reference points set by ICES in the context of fisheries management: these are points beyond which there is an unacceptable risk of serious or irreversible harm to the resource. Although ICES had not been asked for such EcoQO limit reference points, it was felt that in some circumstances they would be useful. Several areas were identified where humans could have a negative impact on the environment (Figure 5.2.1). From this table it was felt that there was sufficient information on pristine levels and impacts to justify using marine mammals as Ecosystem Quality indicators of contaminants and of by-catch.

## 5.3 Proposal for Ecological Quality Objective Indices for North Sea Marine Mammal Populations with Provisional Estimates for the Current Levels, Reference Levels and Target Levels of these Indices

### 5.3.1 Population size as index of seal community health in the North Sea

#### 5.3.1.1 Background

At present, North Sea seal populations are increasing in size (see Section 4.1, above). For some populations, this increase has persisted for many years, possibly as a consequence of past reductions due to hunting and to an increase in the supply of small fish. In other populations, the increase reflects recovery from widespread mortality during an epizootic in the 1980s. Some of these rates of increase are currently high. It would be reasonable to assume that these rates of increase would slow or even reverse as the carrying capacity of the North Sea was reached. At this point, seal populations would change within the limits set by natural and other factors. Documented changes in seal populations cannot usually be explained in full due to a lack of information on how various natural and human-induced environmental factors affect their main population parameters such as reproduction, recruitment, and survival rates. The magnitude of such changes may, nevertheless, serve as an adequate EcoQO for the intrinsic health of seal populations and their habitat. This is based on the simple assumption that a pronounced negative trend in the population of any seal species could indicate that it is an undesirable effect of human activities. Ideally, and as a precautionary measure, reaching such a threshold should then trigger adequate studies targeted at revealing its underlying causes. If the change proves to be an undesired consequence of human activities, any useful mitigating measure should be identified and implemented. In some cases, monitoring the effect of these measures may benefit from defining additional and more specific EcoQOs for the seal populations and/or environmental factors involved.

Where possible, e.g., grey seal pup counts in the UK and harbour seal pup counts in the Kattegat-Skagerrak could be utilised as EcoQOs for population size. Under current conditions, no change or a continued increase in population size and pup production would be expected, whereas a 10 % decline in population or pup production within a 10-year period or less should result in management considerations.

#### 5.3.1.2 Robustness of proposed EcoQO

On a short-term scale, seal population size may not be the parameter most sensitive to environmental change. Due to the longevity and delayed maturity of seals, several years are usually needed before changes in their reproduction or immature survival rates affect their breeding numbers. Substantial increases in adult mortality would have a more immediate effect. Nevertheless, rates of change in population sizes are reasonably good indicators of important changes in seal populations, where density-dependent effects may easily reduce the usability of other population parameters such as absolute size.

The number of births is a sensitive parameter responding more rapidly than total population size to changes in habitat conditions such as food availability. Pup/adult ratio is probably an indicator that will rapidly pick up impaired production in harbour seal populations where populations are surveyed during breeding and moulting seasons.

#### 5.3.1.3 Provisional estimates for EcoQOs in the North Sea

***EcoQO title: Seal population trends as an index of seal community health in the North Sea***

**EcoQO reference levels:** In the absence of major mortality incidents, declines of greater than 5 % per annum would be unusual in seal populations at or below carrying capacity levels.

**Current levels:** Variable, but most populations are increasing (see Section 4.1).

**Target level:** No decline of ≥ 10 % over < 10 years.

### 5.3.2 Population size as an index of cetacean community health in the North Sea

#### 5.3.2.1 Background

Harbour porpoise is the most abundant small cetacean in the North Sea, and suffers from high levels of by-catch and high body burdens of pollutants, and some indications of a decline in distribution are available. However, no EcoQO relative to harbour porpoise population size was suggested owing to a lack of time series of abundance estimates. In addition, power analysis indicated that only a 50 % decline of the population could be detected at the 5 % level using the CV obtained by the 1994 SCANS survey and with the current survey schedule of every ten years. Such analyses have not been carried out for cetaceans other than harbour porpoises, but WGMMPH felt it unlikely that costly widescale surveys of the less abundant species would yield results that were more sensitive than those of the harbour porpoise. For these reasons, no EcoQO is suggested in relation to the population size of most cetaceans in the North Sea.

An exception to the above is in relation to the bottlenose dolphin population inhabiting the northwestern North Sea centred on the Moray Firth. Monitoring of this isolated sub-population can use photographic techniques, which are substantially less costly than widescale surveys. At present, this population numbers about 130 individuals, and modelling analyses indicate that it is declining (see Section 4.1).

The core of the area occupied by this population is the Inner Moray Firth, which has been proposed by the UK Government as a candidate Special Area of Conservation under the EU Habitats Directive. Management in this core area will therefore be aiming to maintain the bottlenose dolphin at a “favourable conservation status”. Such management may not extend widely outside the core area.

Current work at the Universities of Aberdeen and St. Andrews indicates a possible decline in abundance of these dolphins and Bayesian approaches that will lead to a suitable EcoQO are under development (P. Thompson, pers. comm.).

An EcoQO may be useful in triggering further research or management measures. A provisional EcoQO for such populations ought to be to stabilise or increase population size, preferably to as high a level as possible, at least for a short term. Management action to meet this EcoQO is at present difficult to ascertain as the suite of causes for the decline is largely unknown. A first phase must therefore be to initiate a population-wide monitoring scheme coupled with research on the possible causes of decline.

#### 5.3.2.2 Robustness of proposed EcoQO

The bottlenose dolphin population in Moray Firth is well studied and a proportion of the population has been individually identified (photo identification). The population shows site fidelity and a majority of the animals are found within the Inner Moray Firth. This is possibly the small cetacean population in Europe with the highest potential for detecting effects of humans at the level of the population.

#### 5.3.2.3 Provisional estimates for EcoQOs on cetacean population trends as an index of cetacean community health in the North Sea

***EcoQO title: Bottlenose dolphin population trends in Moray Firth***

WGMMPH points to the potential of the Moray Firth bottlenose dolphins for the development of an EcoQO that relates cetacean population size to anthropogenic effects, and refers to the ongoing work at the Universities of Aberdeen and

St. Andrews. However, at present WGMMPH is not in a position to advise on EcoQO levels regarding Moray Firth bottlenose dolphins.

### 5.3.3 Distribution of marine mammal populations as index of habitat quality

#### 5.3.3.1 Background

If habitat quality deteriorates within a species' geographical range, change or reduction in the species distribution may be observed before any impact may be detected in population size. Within the North Sea, there are indications of the absence of harbour porpoises in areas formerly occupied by the species (e.g., Hammond *et al.*, 1995). However, detection of changes in cetacean distribution may be associated with complex survey methodology and high monitoring costs.

In harbour and grey seals, high fidelity to the natal site is documented, and presence/absence at breeding sites would be particularly useful as an Ecological Quality Objective as there is a long time series of data in many areas throughout the North Sea. A useful metric would be the abandonment of breeding sites by seals. WGMMPH did not have the information available to determine the number of known, regularly occurring, breeding sites of seals in the North Sea, but these figures should be relatively easy to derive from existing national seal monitoring data. At a pristine level, no sites would be abandoned. If any breeding sites were abandoned, then this would require management action to determine the causes and to act.

#### 5.3.3.2 Robustness of proposed EcoQO

The presence/absence of seals at breeding sites is easily detectable with cost-effective survey methods. With the fidelity for natal sites documented in harbour and grey seals, abandoning breeding sites is a strong indicator of habitat degradation (or massive depletion of the population).

#### 5.3.3.3 Provisional estimates for EcoQOs on distribution of marine mammal populations as index of habitat quality in the North Sea

***EcoQO title: Utilisation of seal breeding sites as an index of seal community health in the North Sea***

**Reference levels:** Current level may be used as an interim reference level until information on the historic use of breeding sites is compiled for the North Sea region.

**Current levels:** Known, but not compiled at present. Can be compiled rapidly should this be required.

**Target level:** No abandonment of North Sea harbour and grey seal breeding sites.

### 5.3.4 Contaminant levels in marine mammals as index of marine mammal health and index of North Sea habitat quality

#### 5.3.4.1 Background

Marine pollution with environmental chemicals is a worldwide problem, endangering marine organisms and ecosystem health. Persistent toxic substances, such as some groups of organochlorines (OCs), are of special concern. These substances may affect several ecosystem levels and are addressed by this EcoQO. OCs are generally lipophilic and biomagnify in food webs. Marine mammal lipids (e.g., sub-cutanous blubber) contain elevated concentrations of OCs, and these levels may serve as indices of marine mammal health, and indices of the health condition of a wider ecosystem. Monitoring of lipophilic pollutants in mammals is a cost-effective and informative procedure indicating change in marine contamination.

During the 1970s, high PCB concentrations and high DDT levels were correlated with reproductive failures among Baltic seals, particularly ringed seals (*Phoca hispida*) (Helle *et al.,* 1976). Reijnders (1986) also found reproductive failure in captive harbour seals fed fish containing high levels of PCBs, while reproductive failures have been linked with high OC levels among grey seals from the Baltic Sea (Blomkvist *et al.,* 1992). Some OCs are man-made and pristine levels for these OCs would be zero. Other OCs (e.g., some dioxins) are also naturally occurring and pristine levels are difficult to ascertain.

#### 5.3.4.2 Robustness of proposed EcoQO

The elevated levels of OCs in marine mammal lipids relative to concentrations found in other species groups, water, and sediments make mammals suitable candidates for monitoring changes in OC burdens in the North Sea ecosystem. Although the response time to changes in contaminant loads in the marine environment may be several years, OC burden in marine mammals may indicate changing levels and reflect changes in anthropogenic discharges and emissions of OCs.

#### 5.3.4.3 Provisional estimates of contaminant levels in marine mammals as index of marine mammal health and index of North Sea ecosystem health

**EcoQO title: Levels of organochlorines in the fat of seals as an index of seal health and organochlorine pollution in the North Sea**

The dynamics of current OC levels in marine mammals are not well described, and the biological effect mechanisms of OCs, and the complex synergistic effects of the suite of compounds constituting the body burden in marine mammals, are not well understood. Although OCs in seal fat is a potential EcoQO, which may address important aspects of marine mammal and ecosystem health in the North Sea, the WGMMPH is therefore not in a position prepared to advise on EcoQO levels. However, WGMMPH refers to the current research effort by the IWC Scientific Committee on cause-effect relationships of contaminants in cetaceans (IWC, 1999) and the plans for research to address the cause-effect relationships of contaminants in pinnipeds developed by WGMMHA (Bjørge *et al.*, 1999; cf. Section 8 of this report).

### 5.3.5 Marine mammal by-catch as index for marine mammal population status and sustainable fisheries

#### 5.3.5.1 Background

Incidental catches associated with fisheries can have a negative impact on marine mammal populations. Harbour porpoise by-catch has been identified as an important source of mortality, and would indicate that significant by-catches could exist for other species as well. Maximum rates of increase of odontocete populations are not known. In the absence of such information, maximum rates of increase of 4 % have been adopted (Wade, 1998) and may be considered as very conservative for some species (Reilly and Barlow, 1986; Caswell *et al.,* 1998). As an interim measure, the Scientific Committee of the IWC advised that by-catch levels of harbour porpoises should not exceed half the maximum rate of increase (IWC, 1996), and the Committee adopted a figure of 1 % of estimated abundance as a reasonable and precautionary level beyond which to be concerned about the sustainability of anthropogenic removals (IWC, 1996). A joint IWC-ASCOBANS Working Group modelled the maximum by-catch levels of harbour porpoises required for meeting the ASCOBANS management objective (i.e., restoring populations to, or maintain them at, 80 % of the carrying capacity), and found that the maximum annual by-catch must be less than 1.7 % to ensure a high probability of meeting this objective. The IWC-ASCOBANS Working Group therefore advised that the ASCOBANS interim objective is not likely to be met by reducing annual by-catch to 2 % of the lower estimate of abundance and that, to meet the objective, by-catch must be reduced further (IWC, 2000). In 2000, the ASCOBANS Third Meeting of Parties decided that 1.7 % of estimated abundance is the limit of unacceptable incidental takes of all small cetaceans species in the North and Baltic Seas (ASCOBANS, 2000).

The WGMMPH noted that the IWC-ASCOBANS Working Group applied a maximum rate of increase of 4 % in the simulation model, and recognised the considerable debate regarding the adequacy of this figure for harbour porpoise and other small cetaceans (Barlow and Boveng, 1991; Caswell *et al*., 1998; IWC, 1996, 1997; Woodley and Read, 1991). The maximum rates of increase in seals are thought to be substantially higher, and the dynamics of seal populations are much different than those of cetaceans. Levels for unacceptable anthropogenic removals need to be developed, and a scientific approach to achieve this is to apply the best available demographic data and population monitoring time series for simulations on a species-by-species (or population-by-population) basis.

By-catch levels within the North Sea are best documented for harbour porpoises. These are variable by population, but it appears that the highest by-catch level is that of harbour porpoises within the central and southern North Sea. In the combined Danish fisheries alone, the extrapolated by-catch was about 3,000 individuals in 2000. In the recent past, this figure has been as high as 8,000 per year. In addition to this, UK fisheries in the same area took in the order of 800 individuals in 1995, and 440 individuals in 1999. Total by-catch levels most likely exceed the sustainable levels for harbour porpoises in this area of the North Sea. The full impact of these by-catches cannot be evaluated because other fisheries (in particular Norwegian fisheries) operating in the same harbour porpoise abundance area are not yet monitored for by-catches. The recent decline in by-catch levels of Danish and UK fisheries is a result of reduced fishing efforts (cf. Section 6 of this report).

#### 5.3.5.2 Robustness of proposed EcoQO

Obtaining by-catch statistics for porpoises is costly and involves onboard observers. However, statistics from independent observer schemes are regarded as reliable and, when all fisheries in an area are adequately monitored, by-catch levels are good indices for anthropogenic mortality and population status. By-catches are direct effects of human activity and immediate responses in by-catch levels may be expected from management actions targeted at fishing operations.

#### 5.3.5.3 Provisional estimates for EcoQOs on marine mammal by-catch as index for marine mammal population status and habitat quality in the North Sea

***EcoQO title: Harbour porpoise by-catch as an indicator of harbour porpoise population status and of sustainable fisheries in the North Sea***

**Reference levels:** Pre-fishery by-catch levels were zero.

**Current levels:** This cannot be calculated until all relevant fisheries operating in the North Sea are adequately monitored.

**Target level:** By-catches should be reduced to sustainable levels. Presently there is no scientific agreement on the level of sustainable removals for harbour porpoises, and this should be revisited with urgency.

### 5.4 Recommendations

The WGMMPH ***recommends*** that:

- the most common OCs (inter alia, PCBs and DDTs) be converted into Toxic Equivalent Units prior to the next WGMMPH meeting;
- target levels for OCs in marine mammal tissue should be revisited;
- simulations of maximum rate of increase and limits for unacceptable anthropogenic removals of harbour porpoises and other small cetaceans should be revisited with urgency;
- a thorough risk analysis incorporating life history parameters is required to develop the maximum rate of increase and limits for unacceptable anthropogenic removal of seals.

## 6 IMPACTS OF FISHERIES ON MARINE MAMMALS IN EUROPEAN WATERS

### 6.1 Review of Fisheries Impacting Marine Mammals in European Waters

Fisheries may affect marine mammals in two major ways. The mortality of marine mammals as incidental capture in fishing operations is the most obvious, but fisheries may also affect marine mammals by depleting or changing their food supply. In the Barents Sea the marine mammals constitute a significant proportion of consumers on higher trophic levels, and a very few fish species play a major role as prey to piscivorous marine mammals and seabirds (Sakshaug *et al*., 1994). These fish species may act as food-web bottlenecks for the energy flux to higher trophic levels. The capelin (*Mallotus villosus),* which is important in the Barents Sea pelagic ecosystem, has demonstrated very rapid stock collapses and subsequent periods of rapid recovery. These rapid changes in capelin abundance are ecologically driven, but fisheries may enhance the decline of capelin biomass during naturally triggered stock collapses. Nilssen *et al.* (1998) discussed migration, mass mortality, and demographic implications of Barents Sea harp seals (*Phoca groenlandica*) subsequent to collapses of the capelin stock. However, the pelagic ecosystem of the Barents Sea is simple, with few species at each trophic level compared to the North Sea. In general, it remains extremely difficult to demonstrate these kinds of indirect effects from fisheries on marine mammals in more complex ecosystems.

The direct effects of fisheries are easier to address. There have been many studies examining marine mammal by-catch in European fisheries in recent years. Most of these have relied on anecdotal accounts of capture, on returns by fishermen, and on stranded animals that exhibit signs of death in fishing operations. From such studies, it has become clear that certain gear types are more likely to catch marine mammals than others. Monitoring programmes have been established in several such fisheries to provide independent and statistically reliable estimates of rates of marine mammal by-catch. In general, the fisheries that have been targeted for such studies have been gillnet and pelagic trawl fisheries. Information on marine mammal by-catch by fishery type is discussed below.

### 6.1.1 Static gear: gillnets and tangle nets

Gillnet and tangle net fisheries are the fisheries that are most frequently reported to take marine mammals as by-catch. There are thousands of vessels deploying such nets in European waters and numerous metiers – or net characteristics associated with fisheries for specific fish. We consider some of these fisheries below by geographical region.

#### 6.1.1.1 North Sea, Skagerrak and Kattegat

##### 6.1.1.1.1 Set gillnets and tangle nets

Both Denmark and the UK have significant gillnet and tangle net fisheries in the North Sea, and in both countries monitoring programmes have been established to determine levels of by-catch including marine mammals. The Danish monitoring programme was initiated in 1992 and has continued subsequently. The objective was to cover all types of fishery, and although all the major fisheries were covered, in some of the minor fisheries, especially in the Kattegat and Belt Seas, the level of monitoring achieved was insufficient to make estimates of marine mammal by-catch.

Estimates of small cetacean by-catch were made for the Danish cod, hake, sole, plaice, and turbot gillnet and tangle net fisheries (Vinther, 1999). Almost all the marine mammals observed taken were harbour porpoises. There were 325 harbour porpoises recorded, and one *Lagenorhynchus* dolphin. Around 5,000 km of net were monitored between 1992 and 1998 on 152 trips in the North Sea, 78 in the Skagerrak and Kattegat, and 101 in the Baltic. Estimates of porpoise by-catch by fishery are shown in Table 6.1.1.1. These totals exclude several fisheries where there was insufficient monitoring to provide a reliable estimate of cetacean by-catch. There was no mammal by-catch recorded in the sole fishery. The decline in Danish gillnet effort in the North Sea in the most recent years has resulted in a significant decline in porpoise by-catch (ASCOBANS, 2001).

**Table 6.1.1.1.** Estimates of harbour porpoise by-catch in Danish North Sea gillnet fisheries (Vinther, 1999).

| Target species | Mean number by-caught for 1994–1998 | Coefficient of variation |
|---|---|---|
| Hake | 385 | 0.59 |
| Turbot | 1788 | 0.16 |
| Plaice | 1670 | 0.24 |
| Cod | 2942 | 0.20 |
| Sole | 0 | - |
| Total | 6785 | 0.12 |

In the UK a monitoring programme was initiated in 1995, which continues to the present. All gillnet and tangle net fisheries were targeted, and the major fisheries were adequately covered. As with the Danish programme, there was insufficient monitoring to produce estimates of marine mammal by-catch in all minor gillnet fisheries. By October 2000 the programme had monitored 2,300 km of netting in the North Sea on 588 trips (Northridge, pers. comm.). Harbour porpoises were the most frequently recorded species taken, with no records of any other cetaceans, but a number of seals were recorded. The results, when applied to estimates of total fishing effort by each of the major fisheries, suggest that just over 800 porpoises would have been taken in the UK cod, turbot, skate and sole fisheries in 1995, declining with a decline in fishing effort to around 440 in 1999. There was no by-catch recorded in the monkfish fishery. About 84 %–87 % of UK gillnet fishing effort in the North Sea is accounted for by these estimates. Estimates of total seal by-catch have not yet been made from these data. However, by-catches of UK grey seals estimated from the proportion of tag returns were 1.8 % for the Farne Islands and Isle of May (6,880 tagged), 1.3 % at Orkney (3,276 tagged), and 2.5 % at Shetland (407 tagged). A by-catch proportion of 0.4 % is recorded from 1,064 harbour seals tagged in the Wash (Hall *et al.*, Working Paper 1)

In addition to the fisheries described above, there is also a fleet of large (25–40 m) UK-registered freezer netters that operates primarily along the continental slope that has not been monitored and for which no estimates of marine mammal by-catch are available. This fleet fishes in ICES Division IVa around Shetland from time to time.

Swedish gillnet fisheries for cod in a part of the Skagerrak were monitored during 1995/1996. From this study it was estimated that 53 porpoises per year were being taken at that time from a single ICES rectangle (Carlstrom and Berggren, 1996). Swedish gillnet fisheries in the Kattegat and Skagerrak also target flounder, crabs, dogfish, pollack, sole, turbot and herring. Overall catches by set nets have been declining in recent years, but there were no data on fishing effort available to the working group. There is no onboard monitoring of gillnet fisheries apart from the study on cod gillnets in 1995–1996. There are no data on by-catches of seals in the Swedish Kattegat/Skagerrak area, but discussions with fishermen indicate that rather few are taken (S.-G. Lunneryd, pers. comm.).

Norwegian vessels are known to target saithe and possibly other species with gillnets in the northern North Sea (T. Jacobsen, pers. comm.*),* but there are no statistics available to quantify the number of boats involved in these gillnet fisheries or the amount of netting deployed. Nor has there been any monitoring of by-catch in these Norwegian fisheries. A discard survey is currently examining by-catch composition in about five Norwegian vessels, but these include trawlers and purse-seiners.

By-catches in German gillnet fisheries in the North Sea have been described as "negligible" (Kock and Benke, 1995). Moreno (1993) suggested that between 30 and 110 porpoises might be taken per year in German North Sea gillnet fisheries, based on a questionnaire survey of fishermen. Kock and Benke (1995) doubted the validity of this estimate, but reported 23 known by-catches from German waters between 1987 and 1995, mostly from around the Island of Sylt. There do not appear to be any adequate data on German gillnet fishing effort in the North Sea, and no onboard monitoring programme has been established.

There is a low level of fishing effort by Dutch and Belgian gillnetters with no records of marine mammal by-catch from these few vessels. About four Dutch vessels are reported to be working gillnets on a regular basis, and a few others on an irregular basis. Effort data are lacking.

#### 6.1.1.1.2 Drift nets

Drift net fisheries are less widespread than bottom-set net fisheries, but are operated by several nations around the North Sea, mainly for salmon, mackerel and herring.

By-catch of harbour porpoises in a Norwegian fishery for salmon was examined in 1988. A financial reward was offered to fishermen to return porpoises to port for *post mortem* examinations. Catch rates were among the highest ever recorded for a marine mammal in a net fishery, at around 0.65–1.47 porpoises/km.hour of fishing effort (Bjørge and Øien, 1995). This fishery was closed after the 1998 fishing season, mainly for reasons of salmon stock conservation.

There is a small-scale drift net fishery for mackerel operating from the Norwegian south coast but no effort data were available (T. Jakobsen, pers. comm.). There are Swedish drift net fisheries in the Kattegat and Skagerrak for mackerel (41 tonnes in 1999) and herring (77 tonnes in 1999) (S.G. Lunneryd, pers. comm.). No monitoring of marine mammal by-catch is currently in place for these Norwegian and Swedish fisheries.

In the UK there are drift net fisheries for salmonids along the English coast and for herring around the Thames estuary, for sprats in East Anglia, and for bass in the southern North Sea. Bottom drift nets are also used for cod and other species to a small extent. These fisheries are included in the ongoing marine mammal observer scheme, and effort statistics are also available. Effort per day at sea is very small and so far no marine mammal by-catch has been recorded in those that have been sampled.

#### 6.1.1.2 Baltic Sea

Danish onboard monitoring includes Danish vessels operating in the Baltic cod, herring, and salmon fisheries, but no by-catches of marine mammals were observed in 99 net hauls (Vinther, 1999).

There are have been several other studies that have reported by-catch of seals and porpoises in Baltic fisheries, but these have relied either on fishermen or other people to report instances, and the reports therefore represent absolute minimum levels only.

Berggren (1994) reported on Swedish by-catches as reported by fishermen and others between 1973 and 1993. Most of the reported by-catches in the Baltic were from salmon drift nets and cod set nets. There are no estimates of Swedish gillnet effort available for the Baltic.

There are no estimates of German gillnet fishing effort in the Baltic, but Kock and Benke (1995) list fisheries for herring, cod, flounder and salmon. A by-catch reporting scheme yielded 110 direct reports of porpoise by-catch from fishermen in nine years, mainly from gillnets in the western Kiel Bight. There were no returns of questionnaires from the German salmon drift net fishery. The WGMMPH is unaware of any independent monitoring of marine mammal by-catch in Germany.

Kuklik and Skora (2000) have collected by-catch records from fishermen and others in Poland since 1990, with 44 porpoise by-catches recorded over a ten-year period, mainly from salmon drift nets in Gdansk Bay.

There are numerous anecdotal accounts of porpoise and seal by-catches, mainly in set nets, from the Baltic, and these have been summarised in the 2000 joint report of the WGMMHA and WGMMPD (ICES, 2000). Aside from porpoises, all three Baltic seal species have also been reported taken in various gillnets.

There are no complete fishery statistics currently available to WGMMPH from the Baltic region that would enable an assessment of the amount of gillnet fishing effort that is deployed in the Baltic Sea annually, but accounts of the fisheries suggest that gillnets are very heavily used throughout the region.

#### 6.1.1.3 Channel, Irish Sea and Celtic Shelf

On the English coast, effort data show that the Channel is the most heavily gillnetted region of the country. No observer programmes have been established here because porpoises and other marine mammals are more or less absent from this region (S. Northridge, pers. comm.). Porpoises were frequently recorded from the coasts of Kent and Sussex as recently as the 1950s (Fraser, 1974).

Tregenza *et al.* (1997) assessed the by-catch of marine mammals by Irish and English gillnet vessels in the Celtic Shelf. The study only covered the hake gillnet fishery and only those vessels over 15 m in length. Annual catches were estimated at that time to be around 2,200 porpoises. The fleet has undergone considerable changes since the mid-1990s and there is no revised estimate of porpoise by-catch for this fishery.

There are no estimates of fishing effort or marine mammal by-catch for the French gillnet fisheries operating in this region. There is no independent monitoring scheme to assess marine mammal by-catch in these French fisheries.

A gillnet fishery for anglerfish has developed in the Celtic Sea in the last decade (ICES, 2001c). There are no details of fishing effort or mammal by-catch available.

There are no data on what other fisheries may operate in this area using gillnets.

#### 6.1.1.4 Bay of Biscay and Iberia

In the Bay of Biscay, there has been a substantial replacement of inshore trawling by gillnet fisheries targeting sole (ICES, 2001c). Indeed, gillnets are widely used throughout this area, but there is little information on levels of fishing effort. There are no reliable estimates of marine mammal by-catch, except in the albacore tuna fishery, though there have been several studies where by-catch has been demonstrated in gillnet fisheries throughout the region on the basis of opportunistically obtained information. No marine mammals were caught in 59 net-hauls observed in the southern Bay of Biscay gillnet fishery in the years 1998–2000 (Gorka Sancho, pers. comm.).

The albacore tuna fishery prosecuted by France, Ireland, and the UK has been the subject of a monitoring programme in each of the three countries. By-catch of marine mammals involved common and striped dolphins, and small numbers of bottlenose dolphins, Risso’s dolphins, and one sperm whale (M. Tasker, pers. comm.). The fishery will close early in 2002.

#### 6.1.1.5 Western Ireland / West of Scotland

In Scotland, an observer programme has monitored vessels fishing primarily for dogfish, skate, and crayfish around the Outer Hebrides. Estimates of total by-catch have declined from 165 to 22 between 1995 and 1999 with a rapid decline in fishing effort due to the collapse of the crayfish stock (Northridge, pers. comm.).

An offshore fishery involving UK-registered freezer trawlers has not yet been monitored. Information on Irish gillnet fisheries in this area is lacking, but there are gillnet fisheries for salmon and dogfish at least.

### 6.1.2 Pelagic trawlers

Couperus (1997) describes the incidental catch of cetaceans in Dutch pelagic trawls as found from an independent observer programme that covered about 5 % of the annual effort of this fishery between 1992–1994. In parallel with this independent observer scheme, a self-reporting scheme was set up that covered the same fishery during the last two years of the study. With the addition of some further records from 1989–1991, a total of 71 by-catch incidents were recorded involving a minimum of 312 individual dolphins. Forty-one of these incidents (172 individuals) occurred in one year (1994). Approximately 90 % of the incidents occurred in the late winter/early spring in the mackerel and horse mackerel fisheries that, at this time of year, both operate southwest of Ireland. Atlantic white-sided dolphins were the main by-caught species (83 % of identified individuals), with long-finned pilot whales, short-beaked common dolphins and bottlenose dolphins being caught in this area. Elsewhere (mostly in the western North Sea and the western English Channel), very few white-sided dolphins were caught and short-beaked common dolphins, long-finned pilot whales, and white-beaked dolphins were present in the by-catch. About 40 % of dolphins were not identified to species level.

Morizur *et al.* (1997) found also that pelagic trawling catches dolphins: 13 common dolphins, 5 white-sided dolphins, and 4 grey seals were observed as by-catch in 1,788 hours of pelagic trawling. These fisheries were targeting tuna, hake, bass, horse mackerel, mackerel, and herring. There are no estimates of total fishing effort in these fisheries so it has not been possible to extrapolate the observed catches to the total fleet, and potentially significant levels of cetacean by-catch remain undetermined despite having estimates of mammal by-catch rates for these fisheries.

A total of 417 hauls of pelagic trawls were observed in the southern Bay of Biscay from 1996–2000. Twenty-four dolphins (unidentified species) were caught during these hauls (Gorka Sancho, pers. comm.). A by-catch of pilot whales in a Danish pelagic pair trawl operating in the Skagerrak in 1998 that involved at least 12 animals in one haul has been reported (Anon., 1999b). An onboard observer study is currently under way on UK pelagic trawlers (S. Northridge, pers. comm.).

### 6.1.3 Bottom trawl fisheries

Fertl and Leatherwood (1997) reviewed some information on the incidental catch of cetaceans in trawls worldwide. Unfortunately they did not distinguish between bottom and pelagic trawls in the part of the ICES area covered by the EU Common Fisheries Policy. There are however numerous other anecdotal accounts of marine mammal by-catch in trawls, many of which are referred to in Appendix Table 3.

### 6.1.4 Other fisheries

There are also records of marine mammal by-catches in several other fisheries in European waters. Fyke nets for eels and salmonids take common seals in the Wadden Sea. During the mid-1980s, the number of seals drowned in fyke nets in a specific area of the Dutch Wadden Sea amounted to 30 % of the total number counted present (P. Reijnders, pers. comm.). Similarly, fyke nets account for mortality of an unknown number of common seals in Denmark and Sweden. Records suggest a minimum of 30 animals per year in Sweden (S.G. Lunneryd, pers. comm.).

There have also been occasional records of cetaceans having been taken accidentally on longlines and also in crustacean pot fisheries. In the latter instance, cetaceans in particular are found to entwine themselves in pot mooring lines and drown (Sequira, 1996; Northridge, 1988).

Pound nets in Denmark are known to take at least 20 porpoises every year, though almost all of these were released alive (J. Teilmann, pers. comm.).

## 6.2 Other Sources of Mortality

In the Faroe Islands there is a drive fishery for small cetaceans. The numbers and species of animals taken are given in Table 6.2.1.

**Table 6.2.1.** Catches of small cetaceans in a drive fishery at the Faroe Islands. Data made available to the WGMMPH from the NAMMCO database.

| Year | Long-finned pilot whale | Northern bottlenose whale | Atlantic white-sided dolphin | Bottlenose dolphin | Harbour porpoise |
|---|---|---|---|---|---|
| **1995** | 228 | 5 | 157 | 0 | 0 |
| **1996** | 1,554 | 0 | 152 | 21 | 3 |
| **1997** | 1,162 | 0 | 350 | 0 | 0 |
| **1998** | 815 | 0 | 438 | 0 | 0 |
| **1999** | 608 | 0 | 0 | 0 | 0 |

In Norway there is a managed whale fishery for minke whales. Catches for minke whales north and south of 62 $^{o}$N are given in Table 6.2.2 for the past three years (N. Øien, pers. comm.). The Working Group was not aware of any other directed hunt for cetaceans in European waters.

**Table 6.2.2.** Catches of minke whales north and south of 62 $^{o}$N.
Areas south of 62 $^{o}$N are within the North Sea.

| Year | South of 62 $^{o}$N | North of 62 $^{o}$N |
|---|---|---|
| 1998 | 139 | 429 |
| 1999 | 122 | 411 |
| 2000 | 83 | 347 |

There is a direct hunt for seals in Norway. Since 1998 hunting for harbour and grey seals has been allowed in the North Sea area (the Norwegian coast south of 62 $^{o}$N). In 2000 there were 121 harbour seals and 70 grey seals taken in southern Norway. In northern Norway there were 238 common seals and 106 grey seals taken north of 62 $^{o}$N (P. Corkeron, pers. comm.). This hunt is controlled by quotas. In Norway it is legal to shoot seals if they are approaching salmon fish farms or standing fishing gear, and when they are entering salmon rivers, but these takes are not included in the figures above.

In the UK seals may be shot legally outside the closed season, but there are no figures available. Inside the closed (breeding) season any killing is supposed to be done with a licence, and there are records of the number of licences issued and the returns (25 common and 30 grey seals were reported shot in 1999) (S. Northridge, pers. comm.).

In Sweden and Denmark seals are protected, but some hunting is proposed in Sweden in the near future. Seals may be shot in all three countries to protect certain fisheries. In Sweden 5 seals were shot in winter 2000 to protect salmon farms. There is also some illegal hunting of seals in the Swedish Baltic.

Information from other countries was not available to the meeting.

### 6.3 Assessment of Risks to Marine Mammals Created by Fisheries

Assessing the risk to populations depends very much on political or management objectives and priorities. This issue has been much discussed in more political forums such as ASCOBANS and the IWC. Two approaches are often cited. The first takes as a "rule of thumb" the IWC Scientific Committee's 1995 (IWC, 1996) interim proposal that human removals that exceed 1 % of a population of small cetaceans should be a cause for concern. Half of the likely maximum net rate of population growth ($R_{max}$) expected in a typical small cetacean population is regarded as the maximum limit of sustainable removals. The actual value of $R_{max}$ is unknown for most cetacean species and 0.04 has been taken as a conservative guess. A more rigorous approach is adopted in the USA under the Marine Mammal Protection Act. Wade (1996) developed a simple algorithm (PBR or potential biological removal) to provide a measure of the number of animals that may safely be removed whilst maximising the probability that the population will be maintained at or above its Optimal Sustainable Yield level. These approaches were reviewed by the joint IWC-ASCOBANS Working Group on Harbour Porpoises in 1999 (IWC, 2000). This working group found that the maximum annual by-catch of porpoises that would achieve the ASCOBANS interim objective of a population at 80 % of carrying capacity, over an infinite time horizon, is 1.7 % of the population size in that year, on the assumption of a maximum growth rate of the population ($R_{max}$) of 4 %. This level was adopted by the ASCOBANS Meeting of Parties in 2000 in relation to all small cetaceans (ASCOBANS, 2000).

Population structure remains unclear for most small cetaceans in European waters. It is clear that in the North Sea, at least, the harbour porpoise population structure is complex, with at least three separate biological populations. This makes it very difficult to evaluate the effect of by-catches on biological populations. In at least two areas, the North Sea and the Celtic Sea, annual removals of harbour porpoises have recently been exceeding levels of unacceptable takes relative to the estimate of animal abundance in the area. In these two areas at least, fisheries may therefore be posing a significant risk to porpoise populations.

It should also be pointed out that in both the Baltic Sea and the English Channel populations of porpoises have declined to very low levels for unknown reasons. At present because the populations are very low, any by-catch may hinder population recovery, and by-catches are known in both areas.

### 6.4 Possible Remedial Actions to Reduce the Impact of Fishing

Two European studies have tested acoustic alarms (pingers) on gillnets (Larsen, 1997; and studies at SMRU, S. Northridge, pers. comm.). In both studies pingers were shown to reduce porpoise by-catch in gillnets by more than 90 %. Pingers are now being deployed seasonally in certain Danish fisheries and their deployment in certain UK fisheries is under discussion. In both the North Sea and the Celtic Shelf, area-based restrictions have been considered but rejected due to the widespread nature of porpoise by-catch and the lack of any identifiable focal areas of higher by-catch.

The Scientific Committee of the IWC considered possible means of reducing small cetacean by-catch other than pingers at its June 2000 meeting in Adelaide. No techniques currently available for reducing marine mammal by-catch were identified as alternatives to pingers, but ongoing work in a number of areas was discussed, and further work in such areas was encouraged.

WGMMPH noted that ASCOBANS has recently commissioned and received a report on potential mitigation measures for reducing by-catches of small cetaceans in ASCOBANS waters (Read, 2000). The report draws on experience from by-catch reduction plans in the US, and underlined the need for clear objectives for by-catch reduction plans and pointed to possible conflicts between fishery management and management of marine mammal populations. Further, the report stressed the importance of including all stakeholders, and referred to the experience of practical fishing operations represented by participating fishermen. Finally, the report advised that without unbiased data on the pattern and variation of by-catches from independent observer programmes, it is not possible develop or evaluate by-catch reduction plans, and recommended case-specific approaches for the development of such plans.

### 6.5 Recommendations

WGMMPH had great difficulty in addressing the impacts of fisheries on marine mammals in the absence of input from several member countries. Specifically, no information on by-catch or relevant fisheries was made available to the WGMMPH from Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Poland, Portugal, Russia, or Spain. The WGMMPH ***recommends*** that:

- ICES Member Countries encourage active participation by their scientists in WGMMPH;
- detailed information on pelagic trawl and gillnet fishing effort by vessels be made available from France, Germany, Ireland, Netherlands, Norway, Portugal, Spain, and all the Baltic states to WGMMPH.

WGMMPH noted that information on by-catch levels is missing from several areas, and in some areas documented by-catch levels may exceed unacceptable levels. Accordingly, WGMMPH ***recommends*** that:

- independent monitoring of marine mammal by-catch levels be established in gillnet and pelagic trawl fisheries wherever there are believed to be significant levels of fishing effort, and where no such monitoring has previously been done;
- levels of fishing effort deployed and the frequency of porpoise entanglement be reported with urgency from the Baltic Sea, because the frequency of reports of by-catch, coupled with the apparent rarity of porpoises, suggests an unsustainable situation and demands a rigorous assessment of the various gillnet fisheries;
- by-catch levels in Norwegian gillnet fisheries in the North Sea be monitored with urgency, because the two other major gillnet fishing nations (Denmark and the UK) have revealed significant by-catches of harbour porpoises in their gillnet fisheries, but a full evaluation of the conservation status of harbour porpoises cannot be made until data are available from the third major fishing nation in the area;

- by-catch in gillnet fisheries operated by vessels from all nations operating on the Celtic Shelf should be investigated because by-catch levels of around 6 % of the estimated number of porpoises have been revealed by two of the gillnet fishing nations (UK and Ireland);
- pelagic trawl fisheries be further investigated because some information on by-catch per tow combined with the high overall fish landings particularly in the North Sea shows the need for an investigation to determine whether a conservation problem is likely.

WGMMPH identified several research needs relative to the assessment of by-catch and by-catch mitigation measures, and therefore ***recommends*** research on:

- the population structure, distribution and movements of harbour porpoises, common dolphins and seals as well as information on the population structure of these animals in the by-catch;
- unacceptable removal levels for other small cetaceans and seals;
- marine mammal by-catch mitigation methods, including gear modification, modification of fishing operations and alternative fishing regulations.

## 7 REVIEW OF PROGRESS IN STUDIES OF MARINE MAMMAL HABITAT REQUIREMENTS IN RELATION TO EXPOSURE TO CONTAMINANTS

This agenda item was a Term of Reference inherited from the WGMMHA. This subject was considered to be of general importance for the overall work of the WGMMPH, and the Working Group therefore ***recommends*** "marine mammal habitat requirements" as a candidate for a special session or workshop at a future meeting of the WGMMPH.

## 8 FURTHERING THE RESEARCH PROGRAMME ON CAUSE-EFFECT RELATIONSHIPS BETWEEN CONTAMINANTS AND POPULATION-LEVEL EFFECTS IN SEALS

WGMMHA had developed a proposal for a research programme to study cause-effect relationships between environmental contaminants and population-level effects in pinnipeds. An editorial group was nominated by the WGMMHA to develop applications for funding based on the proposal. An application was submitted to the EU for funding in February 2000, but was not accepted for funding.

WGMMPH felt that this research proposal is of importance also for its work, and ***recommends*** that the nominated editorial committee continue to seek funding for the research. An attempt should be made to include North American participation in the project.

## 9 DEVELOPMENT OF A COMPREHENSIVE DATABASE ON NORTH ATLANTIC MARINE MAMMAL DIET COMPOSITION

This agenda item is inherited from the WGMMPD. It was felt that this item was of less current importance to the WGMMPH, and did not consider it at this meeting. However, WGMMPH welcomed a working paper on the diet of grey seals in northern Norway submitted under this agenda item.

## 10 POPULATION SIMULATION FRAMEWORK WHEREBY THE POPULATION-LEVEL EFFECTS OF ENVIRONMENTAL IMPACTS MAY BE ASSESSED

T. Härkönen presented a population simulation framework for assessing the population-level effects of environmental impacts. Theoretical population models can be difficult to relate back to biological systems. Applying simple models represents reduced versions of complex models, capturing the essence of their dynamics. Härkönen has studied harbour seals in the Kattegat-Skagerrak over several years, and developed a model that can be used to investigate population-level properties.

Survey data on harbour seal abundance over time can allow an exponential function to be calculated to estimate growth rate. This represents a powerful way to estimate growth rate if basic data are good. However, this includes little information about population dynamics, so population growth rate is a robust but relatively uninformative approach.

Using age-structured models (Leslie matrices) increases information. The assumption of stable age structures tends to underlie these models. As the seal epizootic in the late 1980s perturbed the age structure, this affects the behaviour of Leslie matrix modelling. For example, survey results in 1989 overestimated the abundance of seals due to changed age structure, and thus haul-out patterns (mostly because all pups were absent in 1989). By 1990, population estimates underestimated population size; after 1990 the bias in population estimates was reduced and stabilised as the population returned to a stable age structure.

A Leslie matrix was used to project pup production and this was then compared with actual pup production. As there was a good fit of modelled to observed pup production, the Leslie model captured the essence of the dynamics in this population. Using Leslie matrices it is possible to project per capita growth rate. Although the growth rate exceeded 20 % per year for a few years (estimated from aerial survey data), this is due to a non-stable age structure.

Absolute maximum growth rates are ~13 % per year for harbour seals, and 10 % for European grey seals. There are cases of higher increases owing to perturbed age structure, for up to 10 years after; skewed population age structure contributes to higher rates than predicted.

Discussion then moved to the effects of different parameters on population growth rate. Investigations of elasticity of fertility and mortality on growth rate indicate that mortality is far more important than fertility. Generally, it seems impossible to detect population effects from fertility changes, but from Baltic ringed seals in the Bothnian Bay it is possible to use fertility rates to model population changes as there are good data on changes in fertility rates and on population sizes. Before 1960, fertility was approximately 0.8, by 1985, fertility decreased to 0.25. Using hunting statistics, it was possible to estimate the minimum population size required for the hunt (~15,000 animals). Predictions from a simplified Leslie model were that the population declined until around 1996, and then levelled off. The model generated similar patterns regardless of the age structure used. Aerial surveys in the Bothnian Bay in the 1980s showed population trends that fitted the Leslie matrix results quite well.

Independent data are needed to test Leslie matrix models. The Bothnian Bay data are an example of how this can be achieved. WGMMPH ***recommends*** that this framework be applied in different contexts in order to investigate a variety of marine mammal population processes.

Stochastic events are important in driving population structure, particularly influences on pup survivorship. Year cohort strength can be variable, and affects the likelihood of a stable age structure existing. There was discussion regarding the relationship between incorporating independent data with a model or using independent data to test the model, i.e., issues of model over-fitting and the relationship between a better description or a more valid description.

## 11 CURRENT TECHNIQUES AND METHODOLOGY TO ESTIMATE SEAL ABUNDANCE, PARTICULARLY FOR GREY AND HARBOUR SEALS

Working Paper 4 (Corkeron *et al.*, 2001) presented a model for estimating grey seal pup production from one or a few surveys per season. Discussion centred on the reliability of stage duration estimates. Verification of stage durations from study sites in northern Norway was identified as an important step to improve the model as presented. Whether a normal model was an appropriate descriptor for whelping patterns observed was discussed, in particular whether one site demonstrated a bimodal distribution of births. Collecting data from areas with larger pup cohorts was identified as a way of progressing this.

In a wider discussion of methodology to estimate grey and harbour seal abundance, the Working Group addressed the following topics:

- Numbers of surveys carried out each year and precision issues.
- Surveys during whelping or moult? Annual stability in the proportion of the population available is more important than when the maximum proportion of the population is available for sighting.
- Pup counts are important for observing changes in population structure. The third week of August is a good time for harbour seal population counts in the Wadden Sea.
- Guidelines for surveys are important, as it is important to carry out surveys in a similar fashion at least in the same areas.
- Analytical improvements include ways to improve data extracted from aerial surveys, e.g., using information hidden in replicate flights to improve the precision of overall trend analyses.
- Questions were asked regarding how to deal with replicate counts from areas within surveys – should maxima be used – if not, does that provide a falsely reduced trend in abundance?
- Are data collected in slightly different manners comparable? Guidelines on techniques are a good idea – a separate sub-group should hold a meeting to discuss techniques for estimating abundance to arrive at standardised techniques.
- Tidal and diurnal influences need to be considered in survey design.

- Different population sizes lead to different asymptotic proportions of populations counted during multiple surveys. When several surveys cover the same area over one counting season, should we use the mean, trimmed mean, or the median from a specific distribution that the data might represent?
- Also, combining telemetry results with aerial survey data to get separate estimates of the probability of animals being hauled out. This would be valuable for estimating absolute abundance and checking index stability.
- The importance of movements of animals between counts was discussed. Movements are not a serious problem with harbour seals over short time periods.
- Maximum counts should be the least variable, closest to true population size.

Present methods include biases; analyses can be improved and techniques could be standardised across research groups, *inter alia,* researchers involved in aerial surveys to estimate the abundance of European coastal seals, and land-breeding seals in Canada and the USA. WGMMPH therefore ***recommends*** that**:**

- "Monitoring techniques and estimating abundance of land-breeding seals" be the topic of a special Theme Session at an ICES Annual Science Conference. Preferably the session should occur during the 2002 ASC, if this is not possible, then in 2003;
- Tero Härkönen, Sweden, and Mike Hammill, Canada, be nominated as conveners for this Theme Session.

## 12 FUTURE WORK OF THE WGMMPH AND RECOMMENDATIONS

### 12.1 Future Work of the WGMMPH

The Chair invited a discussion of the way the ICES WGMMPH works at present, and he raised the question of the future Chair of the working group. The WGMMPH continues the work of two dissolved ICES marine mammal working groups with more specialised Terms of Reference. The WGMMPH is therefore supposed to cover a very wide field of expertise ranging from population dynamics and ecology to endocrine physiology and biological responses to contaminants. The present Chair feels unable to cover all relevant fields with sufficient detailed knowledge.

The Chair suggested a different approach for chairing the group and a different structure of future meetings. The Chair proposed that Co-Chairs should be elected and share responsibility for planning and convening future meetings. He suggested a group of three conveners (e.g., to cover the fields of ecology, population dynamics, and exposure/biological effects of contaminants). Further, he suggested that working group meetings could be arranged as short business session(s) where the conveners and the core members (or relevant members) meet and develop responses to requests and undertake other administrative tasks of little or limited scientific interest. The rest of the meeting could be devoted to discussions of topics of general interest to a wider scientific audience, or address specialised topics of particular interest to experts. This could be done in the form of workshops or special sessions at the beginning or end of a week of working group meetings. One example of such a workshop was the Workshop on the Distribution and Sources of Pathogens in Marine Mammals arranged in relation to a meeting of the ICES Study Group on Seals and Small Cetaceans in European Seas.

WGMMPH agreed that there is a need to reconsider the way the Working Group functions and **recommends** that Peter Reijnders, the Netherlands, and Tero Härkönen, Sweden, be nominated as Co-Chairs to assist the current Chair with future work related to the WGMMPH. Further, the Working Group felt that a network of contact persons (both with regard to fields of research and geographical areas) should be established to facilitate intersessional work and planning of future meetings.

### 12.2 Recommendation for Future Meeting (cf. Annex 4)

The Working Group on Marine Mammal Population Dynamics and Habitats [WGMMPH] (Co-Chairs: Dr A. Bjørge, Norway, Dr T. Härkönen, Sweden, and Dr P. Reijnders, the Netherlands) will meet 11–15 February 2002 at a venue to be decided to:

a) complete the estimation of current levels, reference levels, and target levels for the EcoQOs recommended for marine mammals in the North Sea:
    i) review simulations of the maximum rate of increase and develop limits for unacceptable anthropogenic removals for harbour porpoises and other small cetaceans;
    ii) estimate maximum rates of increase and develop limits for unacceptable anthropogenic removals of seals based on a thorough risk analysis incorporating life history parameters;
    iii) incorporate Toxic Equivalent Units in the EcoQO for body burden of contaminants in marine mammals;

b) develop further the basis for a response to the European Commission request regarding fisheries that have a significant impact on small cetaceans and other marine mammals:
   i) provide a comprehensive overview of the background information available to set limits for unacceptable anthropogenic removals of marine mammal populations;
   ii) provide a scientific evaluation and critical review of the background information under i);
   iii) simulate the consequences and risks associated with alternative levels of removals;
   iv) further develop the overview of fisheries that have a significant effect on small cetaceans and other marine mammals pending new information being made available to the Working Group;
   v) provide further advice on possible remedial actions to reduce the impact by fishing, pending new information being made available to the Working Group;

c) prepare for a WGMMPH Workshop on Marine Mammal Health in relation to Habitat Quality.

The WGMMPH will report to the ACE, the Marine Habitat and the Living Resource Committees.

**Justifications:**

Item a) is justified by the OSPAR request for recommendations for appropriate Ecological Quality Objectives for North Sea marine mammals, and the preparation of provisional estimates for the current, reference, and target levels for the proposed EcoQO indices.

Item b) is justified by the European Commission request for an increase in ICES efforts to provide information and advice on fisheries by-catch of other marine organisms than those targeted by commercial fisheries.

Item c) is justified by the need to interpret marine mammal health in relation to marine mammal habitats as identified by the WGMMHA, WGMMPH and the OSPAR request.

### 12.3 Recommendation for an ASC Theme Session (cf. Annex 4)

WGMMPH recognises that present methods to estimate the abundance of land-breeding seals include biases, and that analyses can be improved and techniques standardised across research groups. WGMMPH therefore ***recommends*** that***:***

- "Monitoring techniques and estimating abundance of land-breeding seals" be the topic of a special Theme Session at an ICES Annual Science Conference. Preferably the session should occur during the 2002 ASC; if this is not possible, then at the 2003 ASC;
- T. Härkönen, Sweden, and M. Hammill, Canada, be nominated as conveners for this Theme Session.

## 13 OTHER BUSINESS

There was no other business.

## 14 ADOPTION OF REPORT

The report was adopted and submitted to the ICES Secretariat as amended 15 May 2001.

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# APPENDIX TABLE 1

**Appendix table 1.** Summary of harbour seal populations in the North Sea area shown as counted hauled-out seals and estimates of total populations. na = not available. Documented direct takes and by-catches are given; actual figures are likely to be higher due to illegal hunt and fisheries not monitored for by-catches.

| | | **ESTIMATE** | | | **TREND** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Area** | **Year** | **Hauled out** | **CI** | **Total** | **Years** | **Estimate** | **Method** | **Direct take** | **By-catch** |
| Kattegat | 2000 | 5,814 | 696 | 10,400 | 1988–2000 | +9.4 %* | Air photo, multiple flights | no | unknown |
| Skagerrak | 2000 | 3,658 | 596 | 6,500 | 1988–2000 | +14.2 % | Air photo, multiple flights | no | unknown |
| Oslofiord | 2000 | 280 | 56 | 500 | 1988–2000 | +12 % | Air photo, multiple flights | yes | unknown |
| **Katt-Skag. Total** | **2000** | **9,752** | | **17,414** | **1988–2000** | | Air photo, multiple flights | | |
| **Norwegian west coast** | **1996–1998** | **2,285** | **na** | **na** | | | Air photo, single flights* | yes | ~ 6 % ^ |
| Shetland | 1996–1997 | 5,991 | na | na | 1988–1996 | +4.0 % | Air photo, single flights | 25 tot. UK | |
| Orkney | 1996–1997 | 8,522 | na | na | 1988–1996 | −1.1 % | Air photo, single flights | | |
| Moray Firth | 1999 | 810 | na | 1,350 | 1992–1999 | −3–4 % | Ground | | |
| Scottish east coast | 1996–1997 | 811 | na | na | | | Air photo, single flights | | |
| English east coast | 1994–1999 | 3,568 | | na | 1989–1999 | +5.9 %*** | Air photo, single flights | | ~1.4 %^^ |
| **Tot. UK North Sea** | **1994–1999** | **19,702** | **na** | **na** | | **+2–4** % | Air photo, single flights | | |
| Delta area, Netherlands | 2000 | 97 | | | 1989–2000 | +21 % | Air photo, two flights | | |
| Wadden Sea NL | 2000 | 3,330 | | | 1989–2000 | +18.2 % | Air photo, two flights | | |
| Wadden Sea NS | 2000 | 5,230 | | | 1989–2000 | | Air photo, two flights | | |
| Wadden Sea SH | 2000 | 6,300 | | | 1989–2000 | | Air photo, two flights | | |
| Wadden Sea DK | 2000 | 2,140 | | | 1989–2000 | | Air photo, two flights | | |
| **Wadden Sea tot** | **2000** | **18,000** | **na** | **na** | **1989–1999** | **+13** %**** | Air photo, two flights | | |
| Limfiord East | 2000 | 410 | | 732.1 | 1998–2000 | −46 % | Air photo, multiple flights | | |
| Limfjord west | 2000 | 85 | | 151.8 | 1998–2000 | − 5 % | Air photo, multiple flights | | |
| **Limfiord Total** | **2000** | **495** | | 883.9 | 1998–2000 | −**40** % | Air photo, multiple flights | | |

*For the period 1996–2000 the rate of increase was 5.2%
** every 5th yr
*** for the Wash
****=6 % for 1998–2000
^ Estimated from tag return proportions
^^ Estimated from tag return proportions in the Wash

# APPENDIX TABLE 2

**Appendix table 2.** Summary of grey seal populations in the North Sea area shown as pup counts by year. na = not available; "Air and ground" describes aerial and ground surveys. Documented direct takes and by-catches are given. Actual figures are likely to be higher due to illegal hunt and fisheries not monitored for by-catches.

| | | **ESTIMATE** | | | **TREND** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Area** | **Year** | **Pup count** | **CI** | **Total** | **Years** | **Estimate** | **Method** | **Direct take** | **By-catch** |
| Kattegat | 2000 | 0 | | 30 | 1988–2000 | 0 | Air and ground | no | no |
| Skagerrak | 2000 | 0 | | 5 | 1988–2000 | 0 | Air and ground | no | no |
| **Norwegian west coast** | **2000** | **21** | | na | | + | Air and ground | licences for 400 animals | na |
| Orkney | 1999 | 15,253 | | 50,300 | 1998–1999 | −6 % | Air | | 1.3 %* |
| Isle of May + Fast castle | 1999 | 2,034 | | 6,700 | 1998–1999 | −9 % | Air | | |
| Farne Islands | 1999 | 843 | | 2,800 | 1998–1999 | −35.5 % | Air | | 1.8 %* |
| Donna Nook | 1999 | 503 | | 1,700 | 1998–1999 | +14.5 % | Air | | |
| Southwest England | 1994 | na | | na | | | | | |
| **UK North Sea total** | | **18,633** | | **61,500** | | **+6.5 %*** | | | |
| Wadden Sea NL | 2000 | 43 | | 400 | 1980–2000 | +23–25 % | | | |
| Wadden Sea NS | 2000 | na | | | | | | | |
| Wadden Sea SH | 2000 | na | | | | | | | |
| **Wadden Sea tot** | **2000** | | | | | | | | |

***** Estimated from tag return proportions

**APPENDIX TABLE 3**

Literature with confirmed or anecdotal information on by-catches of small cetaceans. Full bibliographic references are given in the list of references.

| Species | Source |
|---|---|
| Harbour porpoise | Andersen and Clausen, 1983<br>Anon., 1988<br>Anon., 1989<br>Anon., 1990<br>Benke *et al.,* 1991<br>Currey *et al.,* 1990<br>Gaskin, 1984<br>Kinze, 1994<br>Lindstedt and Lindstedt, 1989<br>Mitchell, 1975<br>Moreno, 1993<br>Northridge, 1988<br>Northridge, 1991<br>Reijnders and Lankester, 1990<br>Ropelewski, 1957<br>Sequiera and Ferreira,1994<br>Skora *et al*., 1988 |
| Common dolphin | Duguy, 1977<br>Duguy and Hussenot, 1982<br>Pascoe, 1986<br>Reijnders and Lankester, 1990<br>Sequiera and Ferreira, 1994 |
| Long-finned pilot whale | Duguy, 1977<br>Duguy and Hussenot, 1982<br>Northridge, 1988<br>Reijnders and Lankester, 1990 |
| Risso's dolphin | Northridge, 1984<br>Reijnders and Lankester, 1990 |
| Striped dolphin | Northridge, 1984<br>Duguy, 1977 |
| Bottlenose dolphin | Anon., 1988b<br>Currey *et al*., 1990<br>Duguy, 1977<br>Duguy and Hussenot, 1982<br>Mitchell, 1975 |
| White-beaked dolphin | Couperus, 1994<br>Leatherwood and Reeves, 1983<br>Northridge, 1988<br>van Bree and Nijssen, 1964 |
| Atlantic white-sided dolphin | Couperus, 1994 |

# ANNEX 1: LIST OF PARTICIPANTS

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## ANNNEX 2: AGENDA

Working Group on Marine Mammal Population Dynamics and Habitats,
Copenhagen, 22–27 April 2001

1 Introduction and meeting arrangements

2 Appointment of rapporteurs

3 Terms of reference and adoption of agenda

4 Synthesis of the North Sea populations of marine mammals
  - **4.1** Current population sizes and trends
  - **4.2** Consideration of species that have declined or are threatened from human activities
  - **4.3** Status of health in relation to habitat quality

5 Ecological Quality Objectives for marine mammals in the North Sea
  - **5.1** Provisional estimates for current levels
  - **5.2** Provisional estimates for reference levels
  - **5.3** Provisional estimates for target levels

6 Impacts of fisheries on marine mammals in European waters
  - **6.1** Review of fisheries with by-catch of marine mammals
  - **6.2** Other sources of mortality
  - **6.3** Assessment of risks to marine mammals crated by fisheries
  - **6.4** Possible remedial actions to reduce impact of fishing

7 Review of progress in studies of marine mammal habitat requirements in relation to exposure to contaminants

8 Furthering the research programme on cause-effect relationships between contaminants and population-level effects in seals

9 Development of a comprehensive database on North Atlantic marine mammal diet composition

10 Population simulation framework whereby the population-level effects of environmental impacts may be assessed

11 Current techniques and methodology to estimate seal abundance, particularly for grey and harbour seals

12 Future work of the WGMMPH and recommendations

13 Other business

14 Adoption of report

## ANNEX 3: LIST OF WORKING PAPERS

Working Group on Marine Mammal Population Dynamics and Habitat,
Copenhagen, 22–27 April 2001

Working Paper 1. Hall, A.J., McConnell, B.J., and Breen, C. By-catch of seals in fishing gear – a preliminary analysis of tagging data, 1950–2000.

Working Paper 2. Reijnders, P.J.H. Health status of marine mammals in relation to habitat quality – a conceptual framework.

Working Paper 3. Corkeron, P.J., Haug, T., Haugen, R., and Nilssen, K.T. Modelling the abundance of grey seals, *Halichoerus grypus*, from pup counts.

Working Paper 4. Das. K., and Bouquegneau, J.-M. Trace metals and Marine Mammals in the North Sea: Implication for their health status and Ecological Quality objectives

Working Paper 5. Nilssen, K.T., Haug, T., Corkeron, P., and Lindblom, C. On the diet of grey seals *Halichoerus grypus* in Lofoten and Finnmark, North Norway.

## ANNEX 4: RECOMMENDATION FOR FUTURE MEETING OF THE WGMMPH

The Working Group on Marine Mammal Population Dynamics and Habitats [WGMMPH] (Co-Chairs: Dr A. Bjørge, Norway, Dr T. Härkönen, Sweden, and Dr P. Reijnders, the Netherlands) will meet 11–15 February 2002 at a venue to be decided to:

a) complete the estimation of current levels, reference levels, and target levels for the EcoQOs recommended for marine mammals in the North Sea;
   i) review simulations of the maximum rate of increase and develop limits for unacceptable anthropogenic removals for harbour porpoises and other small cetaceans;
   ii) estimate maximum rates of increase and develop limits for unacceptable anthropogenic removals of seals based on a thorough risk analysis incorporating life history parameters;
   iii) incorporate Toxic Equivalent Units in the EcoQO for body burden of contaminants in marine mammals;

b) develop further the basis for a response to the European Commission request regarding fisheries that have a significant impact on small cetaceans and other marine mammals
   i) provide a comprehensive overview of the background information available to set limits for unacceptable anthropogenic removals of marine mammal populations;
   ii) provide a scientific evaluation and critical review of the background information under i);
   iii) simulate the consequences and risks associated with alternative levels of removals;
   iv) further develop the overview of fisheries that have a significant effect on small cetaceans and other marine mammals, pending new information being made available to the Working Group;
   v) provide further advice on possible remedial actions to reduce the impact by fishing, pending new information being made available to the Working Group.

c) prepare for a WGMMPH workshop on Marine Mammal Health in relation to Habitat Quality.

The WGMMPH will report to the ACE, the Marine Habitat and the Living Resource Committees.

### Justifications

Item a) is justified by the OSPAR request for recommendations for appropriate Ecological Quality Objectives for North Sea marine mammals, and the preparation of provisional estimates for the current, reference, and target levels for the proposed EcoQO indices.

Item b) is justified by the European Commission request for an increase in ICES efforts to provide information and advice on fisheries by-catch of other marine organisms than those targeted by commercial fisheries.

Item c) is justified by the need to interpret marine mammal health in relation to marine mammal habitats as identified by the WGMMHA, WGMMPH and the OSPAR request.

### Recommendation for an ASC Theme Session

WGMMPH recognises that present methods to estimate the abundance of land-breeding seals include biases, and that analyses can be improved and techniques standardised across research groups. WGMMPH therefore ***recommends that:***

- “Monitoring techniques and estimating abundance of land-breeding seals” be the topic of a special Theme Session at an ICES Annual Science Conference. Preferably the session should occur during the 2002 ASC; if this is not possible, then at the 2003 ASC;
- T. Härkönen, Sweden, and M. Hammill, Canada, be nominated as convenors for this Theme Session.