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**REPORT OF THE
STUDY GROUP ON SEALS AND SMALL CETACEANS
IN EUROPEAN SEAS**

Cambridge, England
4-6 December 1995

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TABLE OF CONTENTS

| | | |
|-------|--|-----|
| 1 | INTRODUCTION | 1 |
| 2 | TERMS OF REFERENCE..... | 1 |
| 3 | ASSESSMENT OF THE IMPACT OF FISHERIES ON MARINE MAMMALS..... | 1 |
| 3.1 | General Approach..... | 1 |
| 3.2 | Data Requirements..... | 2 |
| 3.3 | Estimating the Impact of Fisheries and Incorporating the Effects of Population Structure | 3 |
| 3.4 | Evaluating the Effects of Management Actions | 4 |
| 4 | IMPACT OF FISHERIES ON CETACEANS IN THE NORTH SEA | 4 |
| 4.1 | Results from SCANS..... | 4 |
| 4.2 | Available Information on By-catches | 4 |
| 4.3 | Preliminary Evaluation of the Effects of By-catches | 4 |
| 5 | IMPACT OF FISHERIES ON MARINE MAMMALS IN THE BALTIC SEA | 5 |
| 5.1 | Status of Marine Mammal Populations in the Baltic..... | 5 |
| 5.1.1 | Harbour porpoise <i>Phocoena phocoena</i> | 5 |
| 5.1.2 | Grey seal <i>Halichoerus grypus</i> | 5 |
| 5.1.3 | Ringed seal <i>Phoca hispida</i> | 5 |
| 5.1.4 | Harbour (common) seal <i>Phoca vitulina</i> | 5 |
| 5.2 | Available Information on By-catches | 7 |
| 5.3 | Preliminary Evaluation of Effect of By-catches..... | 7 |
| 6 | EFFECTS OF ACOUSTIC DISTURBANCE ON MARINE MAMMALS..... | 7 |
| 7 | EFFECTS OF CONTAMINANTS ON MARINE MAMMALS..... | 8 |
| 7.1 | Review of Contaminant Levels and Effects | 8 |
| 7.2 | Applicability of Biological Effects Techniques | 8 |
| 8 | FUTURE ACTIVITIES | 9 |
| 9 | ANY OTHER BUSINESS | 10 |
| 10 | REFERENCES..... | 10 |
| | Annex 1: Agenda | 11 |
| | Annex 2: List of Participants..... | 12 |
| | Annex 3: List of Working Papers | 15 |
| | Annex 4: Baltic Seals Drowned in Fishing Gear..... | 16 |
| | Annex 5: Action List and Recommendations | 20 |
| | Appendix Tables | A1 |
| | Appendix Table 1: Harbour Seal | A2 |
| | Appendix Figure 1.1..... | A19 |
| | Appendix Figure 1.2..... | A20 |
| | Appendix Table 2: Ringed Seals..... | A21 |
| | Appendix Figure 2 | A22 |
| | Appendix Table 3: Grey Seals | A23 |
| | Appendix Figure 3.1..... | A33 |
| | Appendix Figure 3.2..... | A34 |
| | Appendix Table 4: Harbour Porpoises..... | A35 |
| | Appendix Table 5: Other Small Cetaceans..... | A38 |
| | Appendix Figure 5 | A40 |
| | Appendix References | A41 |

1 INTRODUCTION

The Study Group on Seals and Small Cetaceans in European Seas (SGSEAL) met at the British Antarctic Survey headquarters in Cambridge, England from 4-6 December 1995 under the chairmanship of Dr J. Harwood. The agreed agenda for the meeting is attached as Annex 1. Annex 2 contains a list of meeting participants. Working Papers (WPs) for the meeting are listed in Annex 3.

2 TERMS OF REFERENCE

The terms of reference (C.Res. 1994/2:57) for the 1995 meeting of SGSEAL were to:

- a) assess the status of small cetacean populations in the North Sea in the light of the recent Small Cetacean Abundance Survey in the North Sea and the available information on by-catches;
- b) assess the status of the three seal populations in the Baltic Sea in the light of modelling studies of population dynamics conducted by the Study Group, and available information on by-catches;
- c) review available information and planned research on the potential effects of acoustic disturbance on marine mammal populations;
- d) advise (with the Working Group on the Biological Effects of Contaminants) on the use of biological effects techniques for identifying the extent to which PCBs in marine mammals generate effects at the species and/or population level;
- e) develop plans for a review of contaminant levels in marine mammal populations and the possible effects of these compounds, and identify data sets on contaminants in marine mammals that are suitable for inclusion in the Environmental Data Bank;
- f) identify and review the data that will be required to evaluate the impact of different fisheries in the Baltic Sea on marine mammal populations;
- g) report the findings to the Marine Mammals Committee, ACFM, and ACME.

3 ASSESSMENT OF THE IMPACT OF FISHERIES ON MARINE MAMMALS

3.1 General Approach

SGSEAL considered a draft review of marine mammal by-catch observer schemes with recommendations for best practice (WP2), which had been prepared for the

Advisory Committee of the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). The paper reviews different methods that are used to determine by-catch, including: opportunistic and systematic port interviews and surveys; market monitoring; recovering by-catches from fishermen; logbook schemes; and independent observer schemes. The author concludes that, although port surveys can help to identify fisheries where significant by-catches might occur, only data collected by trained observers can provide reliable estimates of the size of by-catches. SGSEAL agreed with this conclusion. The paper notes that an estimate of cetacean population size is required if the effects of by-catches are to be assessed.

Observer schemes designed to record marine mammal by-catches have problems similar to schemes intended to document levels of discarding. These include:

- i) the need to obtain full cooperation from the fishing industry (this may be a greater problem for schemes aimed at marine mammal by-catch due to public emotion associated with these animals);
- ii) sampling difficulties in widely dispersed and heterogeneous fisheries;
- iii) safety and insurance for observers;
- iv) the need to make an agreement with skippers on the expenses involved in carrying observers;
- v) the need to ensure confidentiality of data.

The number of trips which can be monitored in any scheme will be determined by the expenses agreed with skippers, the salaries of qualified observers, travel and insurance costs, and the costs of data entry, data handling and analysis. WP2 notes that better quality data are more likely to be obtained from schemes employing paid observers than those relying on volunteers. Once the cost of each trip has been determined, coverage of the fishery should be designed to obtain as accurate and precise an estimate of total by-catch as possible. An optimal design requires prior knowledge about variability in by-catch rates which will probably not be available. In most cases the proportion of the marine mammal population removed by fisheries within the area covered by SGSEAL is likely to be small and the variance of the estimated population size is likely to be large (see Section 4, below). As a result, the variance of the ratio will be insensitive to the variance in the estimate of total by-catch. WP2 suggests that it may be appropriate to concentrate on obtaining an unbiased estimate of by-catch rather than a very precise one. This will necessitate representative sampling of all components of the target fisheries. The paper recommends that, at least initially, sampling should be widespread throughout the seasonal and geographical distribution of the relevant fisheries.

Some fisheries are carried out from vessels which cannot accommodate observers. In these cases observers may be able to operate from a specially-chartered accompanying vessel or from a vantage point on shore.

Although WP2 is an initial draft, SGSEAL felt that it provides good advice for the development of new observer schemes.

3.2 Data Requirements

SGSEAL agreed on a standard set of information for all independent observer schemes, and specific information which is required for particular fisheries. This basic information is:

- Date and port of departure
- Date and port of landing
- Gear type(s)
- Declared catch, by species and weight
- Declared effort
- Value of catch (based on official port prices)
- Number and species of marine mammal caught

If a socioeconomic analysis is to be carried out, the following information is desirable:

- Vessel size
- Vessel age
- Fuel consumption (if available)
- Number and age of crew
- Amount of gear lost

For gillnet fisheries SGSEAL recommends that the following information be collected for each string of nets set:

- Location (preferably latitude and longitude)
- Water depth
- Net material (filament type, diameter, colour)
- Mesh size(s)
- Flotation devices
- Headline length
- Net height (in meshes)
- Hanging ratio
- Length of individual nets (in metres and knots)
- Number of nets in string
- Footrope type
- Depth at which net fished
- Time and date at which setting started
- Time and date at which setting ended
- Time and date at which hauling started
- Time and date at which hauling ended
- Location of observer relative to net at hauling*

- Number and species of marine mammals brought on board
- Number and species of marine mammals seen to drop out of string
- Number and species of marine mammals seen to be shaken out of string
- Number and species of marine mammals seen floating in the vicinity of string
- Number and species of fish caught
- Number and species of other by-catches (seabirds, turtles)

* this may affect the ability of the observer to detect drop-outs.

For each marine mammal brought on board, the following should be recorded:

- Species
- Photograph
- Live or dead (live animals should be released immediately after a photograph has been taken)
- Length
- Sex
- Skin sample (for DNA analysis)
- Tooth (for age determination)

If possible, information on reproductive condition, nutritional condition, and stomach contents should be collected. These recommendations are largely based on data requirements identified by the Small Cetacean Subcommittee of the International Whaling Commission (IWC) and cited in WP1.

For towed net fisheries the following information should be collected for each tow:

- Gear type (this should include as much of the following as possible: gape, circumference, length, wingspread, head line height, mesh size)
- Location, time, and date of start of tow
- Location, time, and date of end of tow
- Water depth
- Towing speed
- Depth at which net was fished (for pelagic trawls)
- Number and species of marine mammals brought on board

SGSEAL was less certain about additional data needed for trap net fisheries. However, it was felt that the following should be included:

- Location, time, and date when trap was set
- Time and date when trap was raised or inspected
- Depth of water
- Size of opening

- Length of leader
- Presence/absence of marine mammal excluder
- Presence/absence of marine mammal escape/breathing mechanism
- Number and species of fish in net (including damaged fish)
- Number and species of marine mammals caught
- Number and species of other by-catches

In general, it will not be possible to place observers on every trip undertaken by a fishery; therefore, some kind of sampling scheme must be devised. Results can then be extrapolated to cover the entire fishery and, indeed, to cover the entire range of the cetacean populations which are affected. Thus, it is essential that some of the measures of fishing effort recorded by observers are identical to those which are included in the official fisheries statistics for the national fleet.

SGSEAL noted that the statistics on marine mammal by-catch (species, number, area, type of fishing gear, raw data or extrapolated) which ICES urges its Member Countries to report (C.Res. 1994/4:8) are not sufficient to allow total by-catch to be estimated and are, subsequently, of limited value for ecological assessment. In contrast, the requested resolution for data on the location of by-catches is overly precise. SGSEAL recommends that, in future, Member Countries be requested to provide estimates of by-catch per unit of effort in individual fisheries for each ICES Area with a complete description of how the estimate was arrived at. In general, this will restrict the requirement to data from independent observer schemes. Effort data for each fishery by ICES Area should also be provided, if countries do not already report this information.

Certain cetacean populations are frequently subjected to by-catch by fleets from different nations. Agreed international standards to describe effort in gillnet and trawl fisheries could be included in the forthcoming revision of the European Commission's logbook recording scheme. In the absence of standardization, national fisheries will have to be examined on an individual basis.

3.3 Estimating the Impact of Fisheries and Incorporating the Effects of Population Structure

There has been considerable debate in the scientific community about how to assess the impact of by-catches on marine mammal populations. At its 1995 meeting, the Scientific Committee of the IWC had considered what levels of by-catch can be sustained for particular cetacean populations (WP1). It concluded that by-catches exceeding half of the estimated maximum growth rate for the population might not be sustainable. This approach was applied to harbour porpoise populations in the North Atlantic, where the Committee

concluded that if recorded by-catch exceeded 1% (1/4 of the estimated maximum rate of increase), then this should trigger urgent research. Such research would involve an attempt to determine the actual impact of by-catches on the population (and the overall status of the population—including the effects of factors such as pollution—see Section 7) and assess what management actions could be taken to reduce by-catch. SGSEAL noted that the estimate of maximum rate of increase for harbour porpoises was based on very little data, and that the "half of maximum growth rate" rule was only appropriate for populations believed to be stable or increasing. If a population is decreasing (not necessarily because of the effects of by-catch) but by-catch remains constant, then by-catch mortality will increase with time. However, this might not be recognized until after the next population survey, which could be a decade after the initial survey. By this time the population could have declined substantially. This concern emphasises the need for cost-effective methods for the monitoring of marine mammal populations which SGSEAL recommended at its last meeting ("The Study Group recommended more research on low cost methods for monitoring the abundance and population characteristics of marine mammals".) SGSEAL also noted that the Small Cetacean Sub-committee of the IWC would be considering "criteria for assessing the status of harbour porpoise populations" as a priority item at its 1996 meeting.

The most recent meeting of the Advisory Committee of ASCOBANS (WP10) had requested the opinion of SGSEAL on an appropriate definition of what constitutes an "unacceptable take" of small cetaceans. The discussion planned for the IWC Scientific Committee meeting in 1996 will address this question. The meeting will be attended by members of SGSEAL as well as many other international experts. SGSEAL will await the outcome of that meeting before drafting a statement of its own.

Defining the biological population affected by by-catches is a fundamental problem. For small cetaceans, which are highly mobile and which do not breed in colonies, there may be no clear geographical boundaries for the distribution of a population. At certain times of the year, different biological populations may mix on the same fishing grounds. This is an issue which the IWC's Scientific Committee addressed during the development of its *Revised Management Procedure*. The Committee's basic approach has been to test the robustness of management practices to violations of the underlying assumptions about population structure. SGSEAL recommends that this approach also be adopted for evaluating the impact of by-catches on marine mammals. A preliminary analysis using this approach on the harbour porpoise population in the North Sea is described in Section 4.3.

3.4 Evaluating the Effects of Management Actions

SGSEAL recommends that any evaluation of the impact of by-catches on marine mammal populations and of the effects of management action aimed at reducing such catches should also take into account the effect of such actions on the fishery. The most appropriate way to do this is to develop a framework which allows a risk analysis of the trade-offs between the effect of management (including no action) on the future size of the marine mammal population and on the economics of the fishery. Such a framework should also take into account the uncertainties involved at each stage of the analysis.

4 IMPACT OF FISHERIES ON CETACEANS IN THE NORTH SEA

4.1 Results from SCANS

WP3 is a revision of a paper that was presented at the 1995 Annual Science Conference on the results of a major survey of cetacean abundance in the North Sea and adjacent areas in the summer of 1994. The Small Cetacean Abundance in the North Sea survey (SCANS) was co-funded by the European Commission and a number of national governments. Ships and aircraft were used to survey the area synoptically. Weather conditions were generally good but SGSEAL noted that coverage in the southern and northern parts of block J (the coastal areas of Shetland and northeast Scotland) was poor due to limited visibility. Aerial surveys of the Baltic Sea were not possible in 1994 because of bad weather; however, they were conducted in 1995 (see Section 5.1.1).

SCANS provided data for the following estimates of abundance, with their coefficients of variation (CVs) for small cetaceans in the North Sea (as defined by the 1995 North Sea Conference):

| | |
|------------------------------------|----------------|
| Harbour porpoise | 268,452 (0.13) |
| Minke whale | 7,201 (0.21) |
| Whitebeaked and whitesided dolphin | 10,927 (0.27) |

These estimates, and those derived by SCANS for other areas within the region covered by SGSEAL, are shown in Appendix Tables 4 and 5. The estimate of harbour porpoise numbers on the Celtic Shelf (approximately equivalent to ICES Areas VIIg, j, and h) is 36,280 (0.57).

4.2 Available Information on By-catches

The only new information on by-catches in the North Sea presented at the meeting is found in WP4, which estimates that 20–30 harbour porpoises are caught each year in the German set net fishery. Published information

was also available from a Danish study of by-catches in the bottom set gillnet fisheries for cod and turbot (Vinther, 1995) which operates in ICES Areas IVb and c. The harbour porpoise was the most frequently caught species and it was estimated that 4,449 animals were caught each year in these fisheries. However, it is likely that harbour porpoises were also caught in Danish gillnet fisheries for plaice and hake, and in equivalent English fisheries. SGSEAL noted that independent observer schemes to determine by-catch in these fisheries are now being carried out.

Estimates of by-catch in the English and Irish gillnet fisheries operating on the Celtic Shelf have also been published (Berrow *et al.*, 1994). Again, the harbour porpoise was the most frequently caught species. The by-catch in 1993 was estimated to be 1,937 animals.

4.3 Preliminary Evaluation of the Effects of By-catches

The recorded by-catch of harbour porpoises in the Danish cod and turbot gillnet fishery in the central North Sea is 2.6% (95% confidence limits 1.2–4.0%) of the estimated population size in ICES Areas IVb and c, and 1.7% (95% confidence limits 0.9–2.5%) of the population size in the entire North Sea. These values are substantially higher than the 1% limit adopted by the IWC Scientific Committee as a level which requires urgent investigation, especially since the recorded by-catch is almost certainly an underestimate of the total because it represents catches made by only part of the fishery. SGSEAL therefore recommends that the impact of the by-catch in these, and related, fisheries on harbour porpoises in the North Sea and the effect of management action aimed at reducing by-catch should be investigated as a matter of urgency. SGSEAL was pleased to be informed that the European Commission had agreed to co-fund a major international project (BY-CARE) to carry out these investigations and to study the impact of by-catches in the English and Irish driftnet fishery for albacore tuna. This project is described in WP5. The same study will also investigate by-catches in the Swedish and Danish gillnet fisheries operating in the Kattegat/Skagerrak and Baltic Proper, thus addressing a recommendation made by SGSEAL at its 1994 meeting. Finally, the project will attempt to establish an integrated decision-making framework for assessing the implications of changes in management practice which takes account of the different values of the resources involved.

The recorded by-catch in the English and Irish gillnet fisheries in ICES Areas VIIg and j is 5.3% (95% confidence limits 1.5–9.1%) of the estimated abundance of harbour porpoises in these Areas. SGSEAL recommends that the impact of by-catches of porpoises in the English and Irish gillnet fisheries in ICES Areas VII g and j be investigated as a matter of urgency. SGSEAL also notes, however, that there is

likely to be a substantial reduction in effort in these fisheries from 1995 onwards due to decommissioning in the English fishery and changes in fishing practices in Ireland. In addition, the harbour porpoise population affected by these catches is likely to extend beyond Areas VIIg and j into the Irish Sea and the west coast of Ireland. Thus, the estimated by-catch of these fisheries as a percentage of population size is probably an overestimate.

5 IMPACT OF FISHERIES ON MARINE MAMMALS IN THE BALTIC SEA

Locations mentioned in Section 5 are shown in Figure 1.

5.1 Status of Marine Mammal Populations in the Baltic

5.1.1 Harbour porpoise *Phocoena phocoena*

As noted above, the SCANS survey of small cetaceans in the Baltic was carried out in 1995. Information on the results of this survey was not submitted to SGSEAL, but a preliminary estimate of 1,200 animals in ICES Area IIIId was provided to the ASCOBANS Advisory Committee. Permission to survey Polish and Russian territorial waters in the southern Baltic Sea was not obtained, therefore figures for these areas are not available. The harbour porpoise is apparently much less abundant in the Baltic Sea than it was earlier this century, but it is impossible to estimate the extent of depletion.

5.1.2 Grey seal *Halichoerus grypus*

WP6 is a review of recent estimates of grey seal numbers. Grey seals in the Baltic normally breed on ice and the location of breeding varies unpredictably from year to year. It has therefore not been possible to use conventional survey techniques to monitor the number of pups born each year. However, as a result of a series of mild winters, a large proportion of the grey seal pups born along the Estonian coast over the last five years have been produced on land. In 1992, 876 pups were counted in Estonia and total pup production was estimated to be 1,000.

Annual counts of grey seals hauled out during the moult have been made in Sweden and Finland for more than a decade. Counts at Swedish sites north of 59°N have increased by 12% annually since 1982. Similar counts in Finland have increased by 14% per annum since 1985. However, counts of the approximately 200 individuals at Swedish sites south of 58°N have only increased by about 3% during this period. The species is still absent from most of its former range in the southern Baltic (along the German, Polish, and Russian coasts). Based on counts made during the moult at approximately the same time throughout the Baltic, the minimum size of

the grey seal population in the Baltic is estimated to be 5,300 individuals. This figure is not inconsistent with the estimated pup production from Estonian counts.

In the past, the grey seal population has been affected by a high frequency of uterine occlusions which rendered adult females sterile. Data from animals found dead or caught in fishing gear suggests that these occlusions are now mostly confined to animals older than 30 years.

5.1.3 Ringed seal *Phoca hispida*

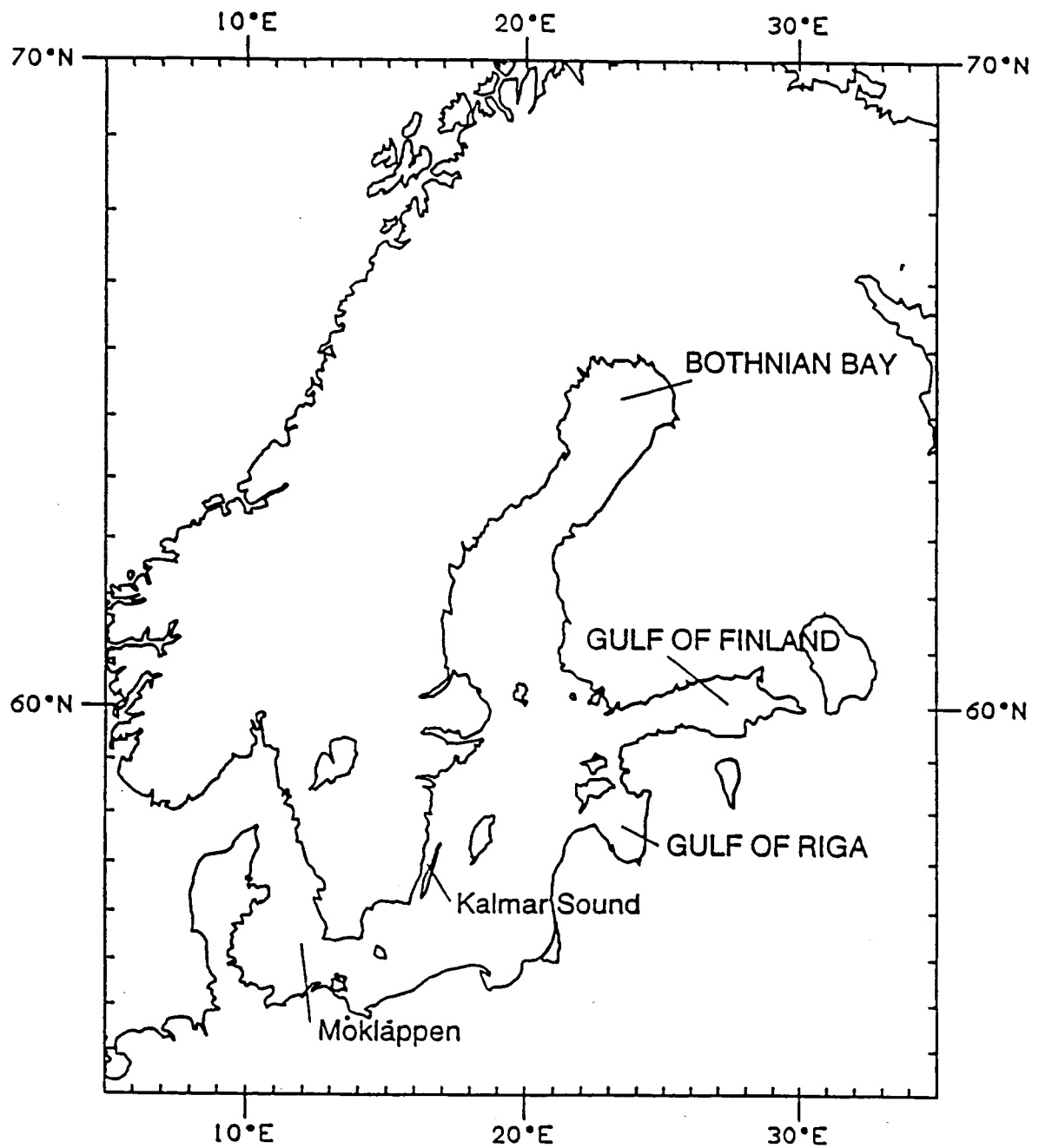
Aerial surveys of ringed seals hauled out on ice in the Bothnian Bay were carried out in 1988, 1989, 1990, 1991, 1993, and 1995. They show an increase of around 5% per year with a current count of around 3,000 animals (Härkönen and Lunneryd, 1992; WP6). Surveys in the Gulf of Finland in 1995 revealed only 162 animals, much less than the number previously reported for this area. These numbers give cause for concern because 100–150 ringed seals were found dead in the winter of 1991/1992. The mean estimate of abundance from three surveys made in the Gulf of Riga in 1994 was 780. Taken together these figures suggest that there are at least 4,000 ringed seals in the Baltic Sea. Range studies of five animals fitted with satellite transmitters suggest that they do not move far and the tagged individuals spent about 70% of their time on the ice during the aerial surveys. If these results are representative of the entire population, the total size of the Baltic population is 5,600 (4,000/0.7).

Like the grey seal, ringed seals in the Baltic have suffered from heavy exploitation in the past and from a high frequency of uterine occlusions in recent years. The prevalence of these occlusions has declined from higher levels recorded in the 1970s. However, unlike the grey seal, occlusions continue to be detected even in the youngest age classes. Data from the Finnish seal hunt and recent scientific sampling indicate that approximately 30% of the mature female population is affected by uterine occlusions.

5.1.4 Harbour (common) seal *Phoca vitulina*

At its last meeting SGSEAL expressed concern about the status of both the populations of harbour seals in the Baltic, in one case because of the effects of the 1988 phocine distemper epidemic and in the other because it is a small population which appears to be genetically distinct. However, data presented in WP6 indicates that both populations are increasing. In the case of the "east Baltic" population in Kalmar Sound, the annual rate of increase has been 11% since 1989, although the maximum count is still only 209 animals. The rate of increase of the "west Baltic" population centred around Moksälppen has been slower, probably due to high and variable pup mortality caused by foxes and grey seals. The maximum count in Swedish and Danish waters has

Figure 1. Location of areas in the Baltic Sea mentioned in the text.



been 170 animals, giving a minimum population estimate for the whole Baltic in 1994 of 379.

5.2 Available Information on By-catches

SGSEAL noted that although the guidelines for estimating by-catches of marine mammals contained in Section 3 were primarily designed for the by-catch of cetaceans, they are also appropriate for determining by-catch of seals. The important features of such schemes are the use of independent observers, the recording of an appropriate measure of fishing effort, representative sampling of the fishery, and the recording of information on the species, age, and sex of by-caught animals.

There are few published data of any kind on by-catches of marine mammals in the Baltic. However, studies of harbour porpoise by-catches in the Swedish gillnet fishery using independent observers began in 1994. These will continue as part of the BY-CARE project and will be extended to Danish vessels operating in the same area. A review of reports of seal by-catches in 1989, 1990, and 1991 provided to HELCOM had been prepared by E. Helle for the 1994 SGSEAL meeting. This review is reproduced in Annex 4. In addition, a study of the by-catch of seals in the Estonian trap net fishery (largely for pike-perch in summer and for herring and whitefish in autumn) had estimated that at least 280 seals were drowned in this fishery in 1994 (WP6). No information on the species of seal which were by-caught has been published, but it is believed that more than 80% were grey seals and that the rest were ringed seals (M. Jüssi, pers. comm. to Härkönen). Using these figures and the average by-catches reported in Annex 4, SGSEAL calculated that a minimum of 300 grey seals, 80 ringed seals, and 7-8 harbour seals are by-caught in the Baltic each year.

5.3 Preliminary Evaluation of Effect of By-catches

The estimated by-catch of grey seals is 5.7% of the minimum population size for the entire Baltic. Given the fact that the population appears to be increasing, this by-catch may be sustainable. However, its impacts will depend on the ages and sex of animals by-caught in the Estonian trap net fishery, since a seal population can sustain a much higher catch of juvenile animals than of adults. SGSEAL therefore recommends further studies of the by-catch in this fishery to determine the age and species of the seals which are caught. Gear modifications to reduce the by-catch should also be investigated.

The by-catch of ringed seals is 2% of the estimated number of seals hauled out on the ice and 1.4% of the estimated total population. Most of this by-catch is probably taken in Estonia, where the local ringed seal population is relatively small (around 1,000 animals). These local catches may not be sustainable if ringed

seals are as sedentary as the satellite transmitter data indicates and if the relatively high frequency of uterine occlusions which are still observed in ringed seals from the Bothnian Bay also occurs in the Gulfs of Riga and Finland.

By-catches of harbour seals are 2.5-3% of the minimum size of the population. Whether or not this by-catch is sustainable will depend on the ages of animals which are caught. However, the regular monitoring of these populations which is currently underway should allow the negative effects of by-catch and other factors to be detected. SGSEAL recommends an analysis of the statistical power of the time series of harbour seal counts in the Baltic to detect change (see Taylor and Gerodette, 1994).

SGSEAL reiterates its 1994 recommendation for further modelling studies of the population dynamics of all three seal species in the Baltic Sea. This should include an investigation of the effect of current reported by-catches on the recovery of the ringed and grey seal populations, and back calculations of population size to the beginning of the century.

SGSEAL is concerned by the recommendation in WP7 that "as one of several steps to reduce the damage caused to the fishing industry grey seals should be culled with a view to studying the effect of limited culls in areas where extensive damage is caused by seals". SGSEAL notes that the Scientific Advisory Committee of the UNEP Marine Mammal Action Plan had drawn up detailed guidelines for the evaluation of proposals to cull marine mammals to benefit fisheries. This will soon be published by UNEP. SGSEAL recommends that this document be considered by the international management group which is planning the limited culls of seals in the Baltic Sea.

6 EFFECTS OF ACOUSTIC DISTURBANCE ON MARINE MAMMALS

A number of studies have indicated that marine mammals respond to acoustic disturbances by changing their surfacing behaviour, vocalizing less frequently or moving out of the area where disturbances occur. Usually these responses are temporary. A number of more detailed studies are now underway in EU waters, and additional studies are being conducted in the USA as part of the Environmental Impact Assessment carried out in conjunction with the Acoustic Thermometry of Ocean Climate experiment. Preliminary results of a number of these studies will be presented at the Biennial Conference of the Society of Marine Mammalogists in Orlando, Florida, in December 1995.

SGSEAL is not aware of any study addressing the population implications of the changes in the behaviour

of marine mammals or of their prey species which have been observed in response to acoustic disturbances. This is a substantial analytical problem which also besets the analysis of data on the effects of pollution. It can probably be addressed through the use of individual-based models of population dynamics (see DeAngelis and Gross, 1992). This approach is discussed in more detail in Section 7.

7 EFFECTS OF CONTAMINANTS ON MARINE MAMMALS

7.1 Review of Contaminant Levels and Effects

SGSEAL noted the report of the 1995 IWC Workshop on Chemical Pollution and Cetaceans (WP8). The Workshop reviewed information on the effects of chemical pollution on cetaceans and considered information from studies of pinnipeds where this was relevant. A Special Issue of the Reports of the International Whaling Commission will include the report of the Workshop and a number of other relevant papers. The Workshop had purposefully not considered the effects of marine debris, sewage, and other non-chemical forms of pollution. Nor did it have the expertise to consider the effects of oil pollution. SGSEAL noted that there is a need for a Workshop to address the oil pollution issue.

Other recently published symposium volumes (e.g., Science of the Total Environment vol. 154 combined issues 2 and 3, Blix *et al.*, 1995) have also included reviews of contaminant levels and their potential effects on marine mammals. In addition, the forthcoming Special Issue of the Reports of the International Whaling Commission on harbour porpoises will include a thorough review of contaminant levels in this species by a member of SGSEAL (A. Aguilar).

The general conclusion of these reviews was that epidemiological studies have shown a link between high levels of heavy metals, organochlorines, and polycyclic aromatic hydrocarbons (PAHs) and reproductive and immune system disfunction as well as pathological abnormalities in marine mammals. However, no direct cause and effect relationship has been demonstrated. Laboratory studies of harbour seals have shown that a diet which is high in organochlorines results in reproductive failure and immunosuppression. Possible population consequences of these observed relationships are discussed below.

Reijnders offered to prepare a review extending the work of the IWC Workshop to cover pinnipeds for the 1996 ICES Annual Science Conference. This review will focus on species in the North Atlantic, although it will take account of data from other areas to place the results from the North Atlantic in a global context. It will also identify potential sources of data for the ICES

Environmental Data Bank, and will take account of the recent ICES/IOC/OSPARCOM Intercomparison Exercises on the Analysis of Chlorobiphenyl Congeners in Marine Media (*ICES Cooperative Research Report* Nos. 183 and 204).

SGSEAL discussed the suitability and availability of data on contaminant levels for inclusion in the ICES Environmental Data Bank. Most members felt that their laboratories would only be willing to provide data which had already been published. WP8 stresses the importance of biological data on animals which have been sampled for interpreting contaminant levels. It suggests that information on age, sex, reproductive state, and nutritional condition should be provided for each animal sampled. The Environmental Data Bank has fields for all these variables, but this information is often not available for older samples. It is also important to ensure that data from different laboratories are compatible, especially if they are to be used to provide summary statistics. The Data Bank also has fields which allow laboratories to indicate their Quality Assurance/Quality Control procedures and which ICES intercalibration exercises they have participated in. SGSEAL recommends that only data which include quality assurance information should be accepted for the Data Bank.

7.2 Applicability of Biological Effects Techniques

Although the terms of reference for SGSEAL relate only to PCBs, it is usually impossible to distinguish the effects of these compounds from other halogenated organic compounds. SGSEAL therefore considered the applicability of biological effects techniques for assessing the effects of a wide range of organic compounds of anthropogenic origin.

The Chairman of SGSEAL had discussed how to coordinate common activities with Dr R Stagg, Chairman of the Working Group on Biological Effects of Contaminants (WGBEC). The next meeting of WGBEC is scheduled for March 1996. Dr Stagg suggested that SGSEAL should consider the biological effects techniques which were reviewed by WGBEC at its 1995 meeting (CM 1995/ENV:3) and identify the techniques that might be appropriate for use on marine mammals. WGBEC would then consider how these techniques might be implemented in a monitoring programme at its March 1996 meeting.

The IWC Workshop (WP8) also reviewed a wide range of biological effects techniques which had either been used on marine mammals or which were being considered for that purpose. Many of these techniques are still at an experimental stage and, therefore, they were not considered by WGBEC. Two main problems in the use of such techniques on marine mammals are that suitable samples are difficult to collect for ethical and practical reasons and there is a lack of experimental and

baseline data (especially from cetaceans) to establish a dose-related response.

The Workshop identified four areas of research which were particularly relevant for the development of biological techniques to be applied to marine mammals:

- i) **Toxicokinetic markers.** In particular, the use of enzyme induction (MFO) such as EROD and 4-OHAA for the methylcholantrene type of PCB, and PROD for the phenobarbital type of PCB; the use of an enzyme-based DNA adduct method such as the luciferase assay for the AH-receptor type of PCB; and chemical specific antibodies as direct measures of contaminant exposure.
- ii) **Reproduction and early development.** Here there is a need for samples from foetal, neonatal and juvenile animals of the same species which suffered different levels of exposure. Protocols for tissue collection and analysis are described in WP8.
- iii) **Immunosuppression.** A number of techniques have been developed and used with harbour seals and bottlenose dolphins (see WP8 for references), but there is a particular need for baseline measurements of immune system performance in animals from uncontaminated environments.
- iv) **Cancer induction and mutagenic effects.** Cancer is seldom documented in marine mammals (except in the case of beluga whales from the St Lawrence estuary, Canada) and is rarely a cause of death. However, carcinogenic and mutagenic effects in beluga whales are usually associated with exposure to PAHs, although their effects can be reinforced by coplanar PCBs.

The majority of the biological effects techniques considered by WGBEC are directed at monitoring in lower trophic levels or early stages of development, and tend not to be contaminant specific. Of the approaches reviewed at the IWC Workshop, only the use of bulk DNA adducts (to measure genotoxic effects), EROD induction, and general measures of immunocompetence were considered by WGBEC.

The IWC Workshop identified a clear need for more fundamental research on the biological response of marine mammals to contaminants, in order to provide techniques which could be used to measure exposure and adverse effects on a large scale. Until such techniques are available and tested it will be difficult to carry work on the impact of pollution on marine mammal populations much further.

However, even when such techniques do become available, they can only be used to determine the response of individual marine mammals. At present no techniques are available which can be used to estimate the effects of PCB exposure on populations or species. Even the experimental immunotoxicological

studies of harbour seals, which had been reasonably successful in demonstrating differences between differentially exposed groups, have not provided data which can be used to estimate population implications of particular contaminant levels either in the environment or in the tissue of marine mammals.

The IWC Workshop recommended that the best approach to the population problem is to carry out intensive studies of a number of populations of three relatively well-studied species (beluga whales, harbour porpoises, and bottlenose dolphins) whose ranges expose them to different environmental levels of contaminants. SGSEAL supports this approach but notes that there are a number of confounding factors which could seriously limit the statistical power of any analysis.

SGSEAL proposes that an alternative approach borrowed from human epidemiology be developed. The aim would be to target groups of individuals within each study population which have a number of characteristics in common and to study their survival and reproduction in relation to contaminant exposure and its related adverse effects. Results from such an epidemiological study could then be incorporated into individual-based population models to investigate the population consequences of different levels of exposure. However, the basic techniques necessary to carry out such studies are still under development.

SGSEAL recommends that the ICES General Secretary approach the IWC regarding a co-sponsored workshop early in 1997 to evaluate and refine the experimental approach outlined above, and to develop protocols appropriate for field studies of marine mammals. The report of this workshop could then be used as a basis for a theme session on the same subject at the 1997 Annual Science Conference.

8 FUTURE ACTIVITIES

SGSEAL has been in existence for much longer than most ICES Study Groups. During this time the group has addressed varied terms of reference. Members of the group see a continuing need for the function provided by SGSEAL. In particular, SGSEAL serves as a mechanism for responding relatively rapidly to requests for advice on marine mammal issues other than those directly related to the management of pilot whales, harp seals, and hooded seals (which are covered by other Working Groups). It was proposed that J. Harwood should remain as the elected chairman of SGSEAL, but that future membership should be determined by the Delegates in consultation with the chairman in response to specific terms of reference.

9 ANY OTHER BUSINESS

SGSEAL updated the Appendix Tables summarizing marine mammal abundance and by-catch published in its 1994 report.

At previous meetings SGSEAL took note of the importance of protected areas for encouraging the recovery of harbour seal populations in Denmark and Sweden and fully supports proposals to HELCOM for the establishment of more protected areas in the Baltic Sea, particularly those which will allow grey and harbour seals to recolonize their former range in Germany, Poland, and Russia.

10 REFERENCES

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ANNEX 1

ICES STUDY GROUP ON SEALS AND SMALL CETACEANS IN EUROPEAN SEAS

Cambridge, England
4-6 December 1995

AGENDA

1. Opening of meeting
2. Assessment of impact of fisheries on marine mammals
 - 2.1 General approach
 - 2.2 Data requirements
 - 2.3 Estimating the impact of fisheries and incorporating the effects of population structure
 - 2.4 Evaluating the effects of management actions
3. The impact of fisheries on cetaceans in the North Sea
 - 3.1 Results from SCANS
 - 3.2 Available information on by-catches
 - 3.3 Preliminary evaluation of effect of by-catches
4. The impact of fisheries on marine mammals in the Baltic Sea
 - 4.1 Status of marine mammal populations in the Baltic
 - 4.2 Available information on by-catches
 - 4.3 Preliminary evaluation of effect of by-catches
5. Effects of acoustic disturbance on marine mammals
 - 5.1 Review of available information
 - 5.2 Review of planned research
6. Effects of contaminants on marine mammals
 - 6.1 Review of contaminant levels and effects
 - 6.2 Applicability of biological effects techniques
7. Future activities
8. Any other business
9. Agreement of final report

ANNEX 2

ICES STUDY GROUP ON SEALS AND SMALL CETACEANS IN EUROPEAN SEAS

Cambridge, England
4-6 December 1995

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ANNEX 3

ICES STUDY GROUP ON SEALS AND SMALL CETACEANS IN EUROPEAN SEAS

Cambridge, England
4-6 December 1995

WORKING PAPERS

- WP1 Report of the Scientific Committee of the International Whaling Commission, Dublin. 1995. Section I: small cetaceans.
- WP2 Northridge, S. A review of marine mammal observer schemes with recommendations for best practice.
- WP3 Hammond, P.S., *et al.* The distribution and abundance of harbour porpoises and other small cetaceans in the North Sea and adjacent waters. ICES CM 1995/N:10 revised.
- WP4 Kock, K.-H. Preliminary investigations on the German set net fishery in the North Sea in 1995.
- WP5 Assessment and reduction of the by-catch of small cetaceans (BY-CARE).
- WP6 Olsson, M. 1995. Baltic seals, a status report.
- WP7 Report from the informal meeting on conflicts between seals and fishing industry in the Baltic Sea.
- WP8 Report of the Workshop on Chemical Pollution and Cetaceans. International Whaling Commission document SC/47/Rep 2.
- WP9 Draft Executive Summary of the Second Meeting of the Advisory Committee on the Agreement for the Conservation of Small Cetaceans of the Baltic and North Seas.
- WP10 Skora, K. Marine mammals in Polish waters.

ANNEX 4

ICES STUDY GROUP ON SEALS AND SMALL CETACEANS IN EUROPEAN SEAS

Cambridge, England
4-6 December 1995

**DATA ON NUMBERS OF SEALS REPORTED TO BE DROWNED IN FISHING GEAR
IN THE BALTIC SEA AS REPORTED TO HELCOM**

Summarized by Dr E. Helle

GREY SEAL

| | Baltic Proper | | | Bothnian Bay | | | Gulf Of Finland | | | Gulf Of Riga | | | Total | | |
|-----------|---------------|------|------|--------------|------|------|-----------------|------|------|--------------|------|------|-------|------|------|
| Year | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 |
| Estonia | 12 | 27 | 15 | 0 | 0 | 0 | - | 3 | 2 | - | 5 | 17 | 12 | 34 | 34 |
| Finland | 0 | 0 | 0 | 11 | 17 | 23 | 20 | 5 | 13 | 0 | 0 | 0 | 31 | 32 | 36 |
| Germany | 1 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 1 | - | - |
| Latvia | - | - | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 35 | 3 | 1 | 36 |
| Lithuania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Poland | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | - |
| Russia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sweden | 8 | 6 | 10 | 18 | 6 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 12 | 17 |
| Total | 21 | 34 | 26 | 29 | 23 | 30 | 20 | 8 | 15 | 3 | 6 | 52 | 73 | 70 | 123 |

HARBOUR SEAL

| | Baltic Proper | | | Bothnian Bay | | | Gulf Of Finland | | | Gulf Of Riga | | | Total | | |
|-----------|---------------|------|------|--------------|------|------|-----------------|------|------|--------------|------|------|-------|------|------|
| Year | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | - | 0 | 0 | 0 | 0 | 0 |
| Finland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | 1 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 1 | - | - |
| Latvia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Poland | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Russia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sweden | 7 | 5 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 10 |
| Total | 8 | 5 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 5 | 10 |

RINGED SEAL

| | Baltic Proper | | | Bothnian Bay | | | Gulf Of Finland | | | Gulf Of Riga | | | Total | | |
|-----------|---------------|------|------|--------------|------|------|-----------------|------|------|--------------|------|------|-------|------|------|
| Year | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 | 1989 | 1990 | 1991 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | - | 3 | 2 | - | 0 | 0 | 0 | 3 | 2 |
| Finland | 0 | 0 | 0 | 1 | 3 | 9 | 25 | 4 | 9 | 0 | 0 | 0 | 26 | 7 | 18 |
| Germany | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - |
| Latvia | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 2 | 1 | 0 |
| Lithuania | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Poland | - | 0 | - | - | - | - | - | - | - | - | - | - | - | 0 | - |
| Russia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Sweden | 0 | 0 | 2 | 2 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 5 |
| Total | 2 | | | 3 | 7 | 12 | 25 | 7 | 11 | 2 | 1 | | 32 | 15 | 25 |

ANNEX 5

ICES STUDY GROUP ON SEALS AND SMALL CETACEANS IN EUROPEAN SEAS

Cambridge, England

4-6 December 1995

ACTION LIST AND RECOMMENDATIONS

The response of the Study Group on Seals and Small Cetaceans in European Seas to its terms of reference is summarized below:

- a) *assess the status of small cetacean populations in the North Sea in the light of the recent Small Cetacean Abundance Survey in the North Sea and the available information on by-catches;*

The results from SCANS provided the following estimates of abundance, with their coefficients of variation (CVs) for small cetaceans in the North Sea (as defined by the last North Sea Conference):

| | |
|-------------------------------------|----------------|
| Harbour porpoise | 268,452 (0.13) |
| Minke whale | 7,201 (0.21) |
| Whitebeaked and whitesided dolphins | 10,927 (0.27) |

The recorded by-catch of harbour porpoises in the Danish cod and turbot gillnet fishery in the central North Sea is 2.6% (95% confidence limits 1.2–4.0%) of the estimated population size in ICES Areas IVb and IVc, and 1.7% (95% confidence limits 0.9–2.5%) of the population size in the entire North Sea. These values are substantially higher than the 1% limit adopted by the IWC Scientific Committee as a level which requires urgent investigation, especially since the recorded by-catch is almost certainly an underestimate of the total because it represents catches made by only part of the fishery. The Study Group on Seals and Small Cetaceans in European Seas therefore recommends that the impact of the by-catch in these, and related, fisheries on harbour porpoises in the North Sea, and the effect of management action aimed at reducing by-catch should be investigated as a matter of urgency. The Study Group also recommends that any evaluation of the impact of by-catches on marine mammal populations and of the effects of management action aimed at reducing such catches should take account of the effect of such action on the fishery. The Study Group also recommends that there is an urgent need to investigate the impact of by-catches of porpoises outside the North Sea, in the English and Irish gillnet fisheries in ICES Areas VIIg and VIIj.

- b) *assess the status of the three seal populations in the Baltic Sea in the light of modelling studies of population dynamics conducted by the Study Group, and available information on by-catches;*

Annual counts of grey seals hauled out during the moult have been made in Sweden and Finland for more than a decade. Counts at Swedish sites north of 59°N have increased by 12% annually since 1982. Similar counts in Finland have increased by 14% per annum since 1985. The species is still absent from most of its former range in the southern Baltic (the German, Polish, and Russian coasts). Based on counts made during the moult at approximately the same time throughout the Baltic, the minimum size of the grey seal population in the Baltic is estimated to be 5,300 individuals. The estimated by-catch of grey seals is 5.7% of this minimum population size. Given the fact that the population appears to be increasing, this by-catch may be sustainable. However, its impacts will depend on the ages and sex of animals by-caught in the Estonian trap net fishery, since a seal population can sustain a much higher catch of juvenile animals than of adults. The Study Group on Seals and Small Cetaceans in European Seas therefore recommends further studies of the by-catch in the Estonian trap-net fishery to determine more precisely the age and species of seals caught and the potential for gear modification to reduce the by-catch.

Aerial surveys of ringed seals hauled out on ice in the Bothnian Bay were carried out in 1988, 1989, 1990, 1991, 1993, and 1995. They show an increase of around 5% per year with a current count of around 3,000 animals. Taken together with the results of surveys in the Gulf of Finland and Gulf of Riga, these figures suggest that there are at least 4,000 ringed seals in the Baltic. The total size of the Baltic population may be around 5,600 animals, based on the results of satellite-tagging studies. The by-catch of ringed seals is 2% of the estimated number of seals hauled out on the ice and 1.4% of the estimated total population. Most of this by-catch is probably taken in Estonia, where the local ringed seal population is relatively small (around 1,000 animals).

The "east Baltic" population of harbour seals in Kalmar Sound has increased by 11% annually since 1989. The rate of increase of the "west Baltic" population centred around Mokoläppen has been slower. The minimum size of the harbour seal population in the Baltic in 1994 is estimated to be 379. Recorded by-catches are 2.5–3% of this estimate. The regular monitoring of these populations which is currently underway should allow the negative effects of by-catch and other factors to be detected. However, the Study Group on Seals and Small Cetaceans in European Seas recommends an analysis of the statistical power of the time series of harbour seal counts in the Baltic to detect change.

The Study Group on Seals and Small Cetaceans in European Seas reiterates the recommendation it made at its 1994 meeting that there should be further modelling studies of the population dynamics of all three seal species in the Baltic. This should include an investigation of the effect of current reported by-catches on the recovery of the ringed and grey seal populations, and back calculations of population size at the beginning of the century.

c) review available information and planned research on the potential effects of acoustic disturbance on marine mammal populations;

A number of studies have indicated that marine mammals respond to acoustic disturbance by changing their surfacing behaviour, vocalizing less frequently, or moving out of the area where disturbance occurs. A number of more detailed studies are now underway in EU waters, and additional studies are being conducted in the USA. No study known to the Study Group has addressed the population implications of the changes in the behaviour of marine mammals or of their prey species which have been observed in response to acoustic disturbance.

d) advise (with the Working Group on the Biological Effects of Contaminants) on the use of biological effects techniques for identifying the extent to which PCBs in marine mammals generate effects at the species and/or population level;

A Workshop on Chemical Pollution and Cetaceans convened by the International Whaling Commission (IWC) in 1995 had reviewed a wide range of biological effects techniques which had either been used with marine mammals or which were being considered for this purpose. Many of the techniques were at an experimental stage and had not been considered by the Working Group on the Biological Effects of Contaminants (WGBEC). There are two main problems with using such techniques on marine mammals: suitable samples are difficult to collect for ethical and practical reasons; and there is a lack of experimental and baseline data (especially from cetaceans) to establish a dose-related response. The majority of the biological effects techniques considered by WGBEC are directed at monitoring in lower trophic levels or at early stages of development, and tend not to be contaminant specific. Of the approaches reviewed at the IWC Workshop, only the use of bulk DNA adducts (to measure genotoxic effects), EROD induction, and general measure of immunocompetence were considered by WGBEC.

There is a clear need for more fundamental research on the biological response of marine mammals to contaminants in order to provide techniques which could be used to measure exposure and adverse effects on a large scale. At present there is no technique which can be used to estimate the effects of PCB exposure on populations or species. The Study Group suggested that this problem could be addressed by investigating survival and reproduction rates in relation to contaminant exposure and its related adverse effects in targetted groups of individuals. Results from such a study could then be incorporated into individual-based population models to investigate the population consequences of different levels of exposure. However, the basic techniques necessary to carry out such work are still being developed. The Study Group on Seals and Small Cetaceans in European Seas recommends that the ICES General Secretary approach the IWC about a co-sponsored workshop early in 1997 to evaluate and refine the an experimental approach to the problem of the population consequences of contaminant exposure and to develop protocols appropriate for field studies of marine mammals. The report of this workshop could then be used as a basis for a theme session on the same subject at the 1997 Annual Science Conference.

e) develop plans for a review of contaminant levels in marine mammal populations and the possible effects of these compounds, and identify data sets on contaminants in marine mammals that are suitable for inclusion in the Environmental Data Bank;

The IWC Workshop had reviewed information on the effects of chemical pollution on cetaceans and had considered information from studies of pinnipeds where this was relevant. Reijnders will prepare a review which extends the work of the IWC Workshop to cover pinnipeds for the 1996 ICES Annual Science Conference. This review will focus on species in the North Atlantic, although it will take account of data from other areas to place the results from the North Atlantic in a global context. It will also identify potential sources of data for the ICES Environmental Data Bank, and

will take account of the recent ICES/IOC/OSPARCOM Intercomparison Exercise on the Analysis of Chlorbiphenyl Congeners in Marine Media (*ICES Cooperative Research Report* No. 183 and No. 204).

The Study Group on Seals and Small Cetaceans in European Seas recommends that only results from marine mammals for which there is associated information on analytic procedures, Quality Assurance/Quality Control procedures, and participation in intercalibration exercises should be included in the ICES Environmental Data Bank. In addition, at a minimum, information on age, sex, reproductive state and nutritional condition should be provided for each animal sampled.

f) identify and review the data that will be required to evaluate the impact of different fisheries in the Baltic Sea on marine mammal populations;

Guidelines for estimating by-catches of marine mammals can be found in Section 3 of this report. Although these are primarily designed for determining by-catch of cetaceans, they are also appropriate for determining by-catch of seals. The important features of such schemes are the use of independent observers, the recording of an appropriate measure of fishing effort, representative sampling of the fishery, and the recording of information on the species, age and sex of by-caught animals.

The Study Group on Seals and Small Cetaceans in European Seas recommends that, in future, Member Countries are requested to provide estimates of by-catch per unit of effort in individual fisheries for each ICES Area with an indication of how that estimate was arrived at. Effort data for each fishery by ICES Area should also be provided.

APPENDIX TABLES

THESE APPENDIX TABLES SUMMARIZE ALL DATA ON THE CURRENT AND HISTORICAL SIZE OF SEAL AND SMALL CETACEAN POPULATIONS IN EUROPEAN SEAS WHICH WERE AVAILABLE TO THE STUDY GROUP

THE SOURCE OF DATA IS INDICATED BY A SUPERScript, IF THERE IS NO SUPERScript DATA WERE PROVIDED BY MEMBERS OF THE STUDY GROUP

THE FOLLOWING LETTERS IN THE COLUMNS LABELLED "METHODS" INDICATE WHICH TECHNIQUE WAS USED TO ESTIMATE NUMBERS:

- A. Single count of grey seal pups. These figures are usually multiplied by a correction factor to obtain an estimate of the total number of pups born during the season. The way in which this factor has been obtained is not always clearly specified in published reports, so the figures shown are the actual number of pups counted. Confidence limits for these numbers cannot be calculated.
- B. Estimate of grey seal pup production obtained from a series of counts made during the breeding season. These estimates are inherently more accurate than those obtained using method A. Confidence limits can be calculated.
- C. Counts made from aerial survey of seals hauled out in a particular area during the moult. Harbour seals spend much of their time out of the water during the moult, thus a large proportion (probably around 60%) of the population can be counted in surveys conducted at this time. Confidence limits are available for locations where more than one survey has been made in a year.
- D. Estimates of abundance based on aerial survey of ringed seals hauled out on ice during the moult. Confidence limits can be calculated for these estimates.
- E. Counts of seals hauled out made from boat, land or air at times other than the moult. The total count for a region is often made over a number of years, thus there may have been movement of animals between areas. No confidence limits are available.
- F. Line transect survey of cetacean abundance. Such surveys provide estimates of the density of cetaceans in the area of the survey. These can be adjusted to take account of animals missed on the track line, and are scaled up to provide an estimate of total population size in the area surveyed. Confidence limits can be calculated.
- G. Estimation based on photo-identification.
G1 Number of individuals in the photo-identification catalogue.
G2 Capture-recapture estimate
- H. Back-calculation of population size from catch records.
- I. "Instantaneous" count of all cetaceans visible in a particular area over a short period; for large areas counts are made simultaneously by a number of observers.

Numbers in the column labelled REPORTED CATCH come from official statistics of the number of animals killed each year for commercial purposes or fisheries protection. For seals, the numbers refer to pups only, unless otherwise indicated. The absence of figures from this column or the one labelled BY-CATCH does not mean that there was no catch, only that no figures are available.

APPENDIX TABLE 1: HARBOUR SEAL

NORWAY - BARENTS SEA COAST

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|---------|------------------|--------|-------------------------|----------------|----------|
| 1964-66 | 180 ¹ | E | Does not include Russia | | |
| 1977-89 | 195 ¹ | E | Does not include Russia | | |

NORWAY - WEST AND NORTH SEA COASTS

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|---------|-------------------|--------|----------|----------------|----------|
| 1964-66 | 3670 ¹ | E | - | | |
| 1977-89 | 3341 ¹ | E | - | | |

NORWAY - OSLOFJORD

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|---------|------------------|--------|----------|----------------|----------|
| 1964-66 | 190 ¹ | E | | | |
| 1977-89 | 93 ¹ | E | | | |

BALTIC

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|--------------------------|----------------|----------|
| 1989 | | | | | 8 |
| 1990 | | | | | 5 |
| 1991 | | | | | 10 |
| 1992 | 367 | E+C | 120 in Denmark | | |
| 1993 | 269 | E+C | Does not include Denmark | | |
| 1994 | 379 | E+C | 209 in Denmark | | 7-8 |

APPENDIX TABLE 1: HARBOUR SEAL

KATTEGAT / SKAGERRAK

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|-------------------|--------|-----------------------|----------------|----------|
| 1979 | 2350 ² | C | | | |
| 1980 | 2825 ² | C | | | |
| 1981 | 3100 ² | C | | | |
| 1983 | 3800 ² | C | | | |
| 1984 | 3975 ² | C | | | |
| 1985 | 5275 ² | C | | | |
| 1986 | 5700 ² | C | | | |
| 1988 | 2901 ³ | C | 2497-3305 | | |
| 1989 | 3146 ³ | C | 2823-3469 | | |
| 1990 | 2820 ³ | C | 2247-3393 | | |
| 1991 | 3897 ³ | C | 3157-4636 | | |
| 1994 | 5184 | C | 4145-6223 | | |

APPENDIX TABLE 1: HARBOUR SEAL

DENMARK - LIMFJORDEN

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|------------------|--------|-----------------------|----------------|----------|
| 1976 | 90 ⁴ | C | | | |
| 1977 | 200 ⁴ | C | | | |
| 1978 | 330 ⁴ | C | | | |
| 1979 | 326 ⁴ | C | | | |
| 1980 | 300 ⁴ | C | | | |
| 1981 | 440 ⁴ | C | | | |
| 1982 | 420 ⁴ | C | | | |
| 1983 | 588 ⁴ | C | | | |
| 1984 | 639 ⁴ | C | | | |
| 1985 | 657 ⁴ | C | | | |
| 1986 | 710 ⁴ | C | | | |
| 1987 | 682 ⁴ | C | | | |
| 1989 | 490 | C | 229-752 | | |
| 1990 | 498 | C | 426-570 | | |
| 1991 | 628 | C | 345-910 | | |
| 1994 | 510 | C | 199-821 | | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - DENMARK | | | | | |
|----------------------|-------------------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1976 | 389 ⁴ | C | | | |
| 1977 | 410 ⁴ | C | | | |
| 1978 | 332 ⁴ | C | | | |
| 1979 | 421 ⁴ | C | | | |
| 1980 | 671 ⁴ | C | | | |
| 1981 | 656 ⁴ | C | | | |
| 1982 | 789 ⁴ | C | | | |
| 1983 | 924 ⁴ | C | | | |
| 1984 | 853 ⁴ | C | | | |
| 1985 | 958 ⁴ | C | | | |
| 1986 | 1261 ⁴ | C | | | |
| 1987 | 1477 ⁴ | C | | | |
| 1988 | - | C | | | |
| 1989 | 868 ⁴ | C | | | |
| 1990 | 1048 | C | | | |
| 1991 | 1097 | C | | | |
| 1992 | 1168 | C | | | |
| 1993 | 1433 | C | | | |
| 1994 | 1507 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - SCHLESWIG-HOLSTEIN | | | | | |
|---------------------------------|----------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1951 | 1200 | C | | 88 | |
| 1952 | 1200 | C | | | |
| 1953 | 1275 | C | | 94 | |
| 1954 | 1350 | C | | 109 | |
| 1955 | 1700 | C | | 172 | |
| 1956 | 1200 | C | | 166 | |
| 1957 | 1650 | C | | 194 | |
| 1958 | 1700 | C | | 254 | |
| 1959 | 1420 | C | | 270 | |
| 1960 | 1410 | C | | 261 | |
| 1961 | 1720 | C | | 272 | |
| 1962 | 1400 | C | | 256 | |
| 1963 | 1210 | C | | 206 | |
| 1964 | 1420 | C | | 276 | |
| 1965 | 1620 | C | | 273 | |
| 1966 | 1660 | C | | 277 | |
| 1967 | 1605 | C | | 226 | |
| 1968 | 1560 | C | | 265 | |
| 1969 | 1710 | C | | 261 | |
| 1970 | 1647 | C | | 230 | |
| 1971 | 1490 | C | | 178 | |
| 1972 | 1500 | C | | 195 | |
| 1973 | 1600 | C | | 93 | |
| 1974 | 1544 | C | | 31 | |
| 1975 | 1749 | C | | 39 | |
| 1976 | 1653 | C | | 36 | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - SCHLESWIG-HOLSTEIN | | | | | |
|---------------------------------|----------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1977 | 1806 | C | | 25 | |
| 1978 | 1795 | C | | 10 | |
| 1979 | 1919 | C | | 12 | |
| 1980 | 2202 | C | | 15 | |
| 1981 | 2200 | C | | 20 | |
| 1982 | 2350 | C | | 35 | |
| 1983 | 2500 | C | | 25 | |
| 1984 | 2700 | C | | 24 | |
| 1985 | 3300 | C | | 11 | |
| 1986 | 3195 | C | | 15 | |
| 1987 | 3793 | C | | 17 | |
| 1988 | 4209 | C | | | |
| 1989 | 1741 | C | | | |
| 1990 | 1974 | C | | | |
| 1991 | 2313 | C | | | |
| 1992 | 2861 | C | | | |
| 1993 | 3285 | C | | | |
| 1994 | 3085 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - NIEDERSACHSEN | | | | | |
|----------------------------|----------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1958/59 | 1827 | ? | | 365 | |
| 1959/60 | 1936 | ? | | 368 | |
| 1960/61 | 2250 | ? | | 482 | |
| 1961/62 | 2165 | ? | | 377 | |
| 1962/63 | 2238 | ? | | 286 | |
| 1963/64 | 1899 | ? | | 282 | |
| 1964/65 | 1695 | ? | | 318 | |
| 1965/66 | 1670 | ? | | 268 | |
| 1966/67 | 1744 | ? | | 245 | |
| 1967/68 | 1665 | ? | | 180 | |
| 1968/69 | 1541 | ? | | 185 | |
| 1969/70 | 1347 | ? | | 142 | |
| 1970/71 | 1299 | ? | | 97 | |
| 1971/72 | 1282 | ? | | 72 | |
| 1972/73 | 1441 | ? | | 47 | |
| 1973/74 | 1276 | ? | | 7 | |
| 1974/75 | 1240 | ? | | 10 | |
| 1975/76 | 1121 | ? | | 7 | |
| 1976/77 | 1163 | ? | | 4 | |
| 1977/78 | 1140 | ? | | 5 | |
| 1978/79 | 1228 | ? | | 11 | |
| 1984 | 1870 | C | | | |
| 1985 | 1929 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - NIEDERSACHSEN | | | | | |
|----------------------------|----------|--------|----------|-------------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1986 | 2032 | C | | | |
| 1987 | 2245 | C | | | |
| 1988 | - | C | | | |
| 1989 | 1400 | C | | | |
| 1990 | 1620 | C | | | |
| 1991 | 1924 | C | | | |
| 1992 | 2255 | C | | | |
| 1993 | 2482 | C | | | |
| 1994 | 3078 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - NETHERLANDS | | | | | |
|--------------------------|----------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1900 | 16 000 | H | | | |
| 1960 | 1250 | E | | | |
| 1961 | 1250 | E | | | |
| 1962 | 1375 | E | | | |
| 1963 | 1500 | E | | | |
| 1964 | 1515 | E | | | |
| 1965 | 1450 | E | | | |
| 1966 | 1245 | E | | | |
| 1967 | 890 | E | | | |
| 1968 | 920 | E | | | |
| 1969 | 975 | E | | | |
| 1970 | 965 | E | | | |
| 1971 | 665 | E | | | |
| 1972 | 650 | C | | | |
| 1973 | 540 | C | | | |
| 1974 | 530 | C | | | |
| 1975 | 520 | C | | | |
| 1976 | 480 | C | | | |
| 1977 | 485 | C | | | |
| 1978 | 505 | C | | | |
| 1979 | 545 | C | | | |
| 1980 | 515 | C | | | |
| 1981 | 585 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

| WADDEN SEA - NETHERLANDS | | | | | |
|--------------------------|----------|--------|----------|-------------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1982 | 654 | C | | | |
| 1983 | 710 | C | | | |
| 1984 | 740 | C | | | |
| 1985 | 775 | C | | | |
| 1986 | 800 | C | | | |
| 1987 | 1055 | C | | | |
| 1988 | 975 | C | | | |
| 1989 | 535 | C | | | |
| 1990 | 560 | C | | | |
| 1991 | 750 | C | | | |
| 1992 | 960 | C | | | |
| 1993 | 1075 | C | | | |
| 1994 | 1230 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

THE NETHERLANDS - DELTA

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|-------------------|----------|
| 1900 | 11500 | H | | | |
| 1953 | 1000 | E | | | |
| 1954 | 900 | E | | | |
| 1955 | 800 | E | | | |
| 1956 | 590 | E | | | |
| 1957 | 560 | E | | | |
| 1958 | 515 | E | | | |
| 1959 | 435 | E | | | |
| 1960 | 350 | E | | | |
| 1961 | 330 | E | | | |
| 1962 | 310 | E | | | |
| 1963 | 325 | E | | | |
| 1964 | 290 | E | | | |
| 1965 | 250 | E | | | |
| 1966 | 180 | E | | | |
| 1967 | 135 | E | | | |
| 1968 | 30 | E | | | |
| 1969 | 10 | E | | | |
| 1970 | 15 | E | | | |
| 1992 | 18 | E | | | |

APPENDIX TABLE 1: HARBOUR SEAL

FRANCE

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| | 30 | E | | | |

ENGLAND - EAST COAST

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1968 | 1468 | C | | | |
| 1969 | 1722 | C | | | |
| 1970 | 1662 | C | | | |
| 1971 | | | | 315 | |
| 1972 | 1632 | C | | 385 | |
| 1973 | | | | 395 | |
| 1974 | | | | 1 | |
| 1975 | | | | 1 | |
| 1976 | | | | | |
| 1977 | | | | | |
| 1978 | 2176 | C | | | |
| 1980 | 2191 | C | | | |
| 1988 | 3026 | C | | | |
| 1989 | 1576 | C | | | |
| 1990 | 1531 | C | | | |
| 1991 | 1551 | C | | | |
| 1992 | 1645 | C | | | |
| 1993 | 1721 | C | | | |
| 1994 | 2309 | C | | | |
| 1995 | 2575 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

SCOTLAND - NORTHEAST COAST

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|------------------|----------------|----------|
| 1971 | | | | 66 | |
| 1972 | | | | 70 | |
| 1973 | | | | 59 | |
| 1974 | | | | 105 | |
| 1975 | | | | 50 | |
| 1976 | | | | 121 | |
| 1977 | | | | 40 | |
| 1978 | | | | | |
| 1979 | | | | | |
| 1980 | | | | 5 | |
| 1981 | | | | 3 | |
| 1988 | 1249 | C | Moray Firth only | 30 | |
| 1989 | 1118 | C | Moray Firth only | | |
| 1990 | 1570 | C | Moray Firth 1103 | | |
| 1991 | 1836 | C | Moray Firth 1166 | 5 | |
| 1992 | 2081 | C | Moray Firth 1308 | 1 | |

APPENDIX TABLE 1: HARBOUR SEAL

SCOTLAND - ORKNEY

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1971 | | | | 12 | |
| 1972 | | | | 116 | |
| 1973 | | | | 198 | |
| 1974 | | | | 198 | |
| 1975 | | | | 86 | |
| 1976 | | | | 96 | |
| 1977 | | | | 17 | |
| 1978 | | | | | |
| 1979 | | | | | |
| 1980 | | | | 28 | |
| 1982 | | | | 2 | |
| 1985 | 6600 | C | | | |
| 1989 | 7100 | C | | | |
| 1993 | 7873 | C | | | |

SCOTLAND - SHEILAND

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1971 | 2500 | E | | | |
| 1978 | 4000 | E | | | |
| 1984 | 4800 | E | | 4 | |
| 1985 | | | | 3 | |
| 1986 | | | | 10 | |
| 1987 | | | | 12 | |
| 1988 | | | | 23 | |
| 1991 | 4797 | C | | | |
| 1993 | 6227 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

SCOTLAND - WEST COAST

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|-------------------|----------|
| 1971 | | | | 267 | |
| 1972 | | | | 230 | |
| 1973 | | | | 250 | |
| 1974 | | | | 235 | |
| 1975 | | | | 190 | |
| 1976 | | | | 208 | |
| 1977 | | | | 211 | |
| 1978 | | | | 340 | |
| 1979 | | | | 350 | |
| 1980 | 5900 | E | | 350 | |
| 1981 | | | | 350 | |
| 1982 | | | | 3 | |
| 1983 | | | | | |
| 1984 | | | | | |
| 1985 | | | | 1 | |
| 1986 | | | | 22 | |
| 1987 | | | | | |
| 1988 | | | | 44 | |
| 1989 | 8044 | C | | | |

APPENDIX TABLE 1: HARBOUR SEAL

SCOTLAND - OUTER HEBRIDES

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1974 | 1300 | E | | 15 | |
| 1975 | | | | 50 | |
| 1976 | | | | 42 | |
| 1977 | | | | 39 | |
| 1992 | 2278 | C | | | |

NORTHERN IRELAND

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|-----------------------|----------------|----------|
| 1977 | 348 | E | Strangford Lough only | | |
| 1978 | 585 | E | Strangford Lough 332 | | |
| 1988 | 1112 | E | Strangford Lough only | | |
| 1989 | 784 | E | Strangford Lough only | | |
| 1990 | 898 | E | Strangford Lough only | | |
| 1991 | 718 | E | Strangford Lough only | | |
| 1992 | 603 | E | Strangford Lough only | | |

APPENDIX TABLE 1: HARBOUR SEAL

REPUBLIC OF IRELAND

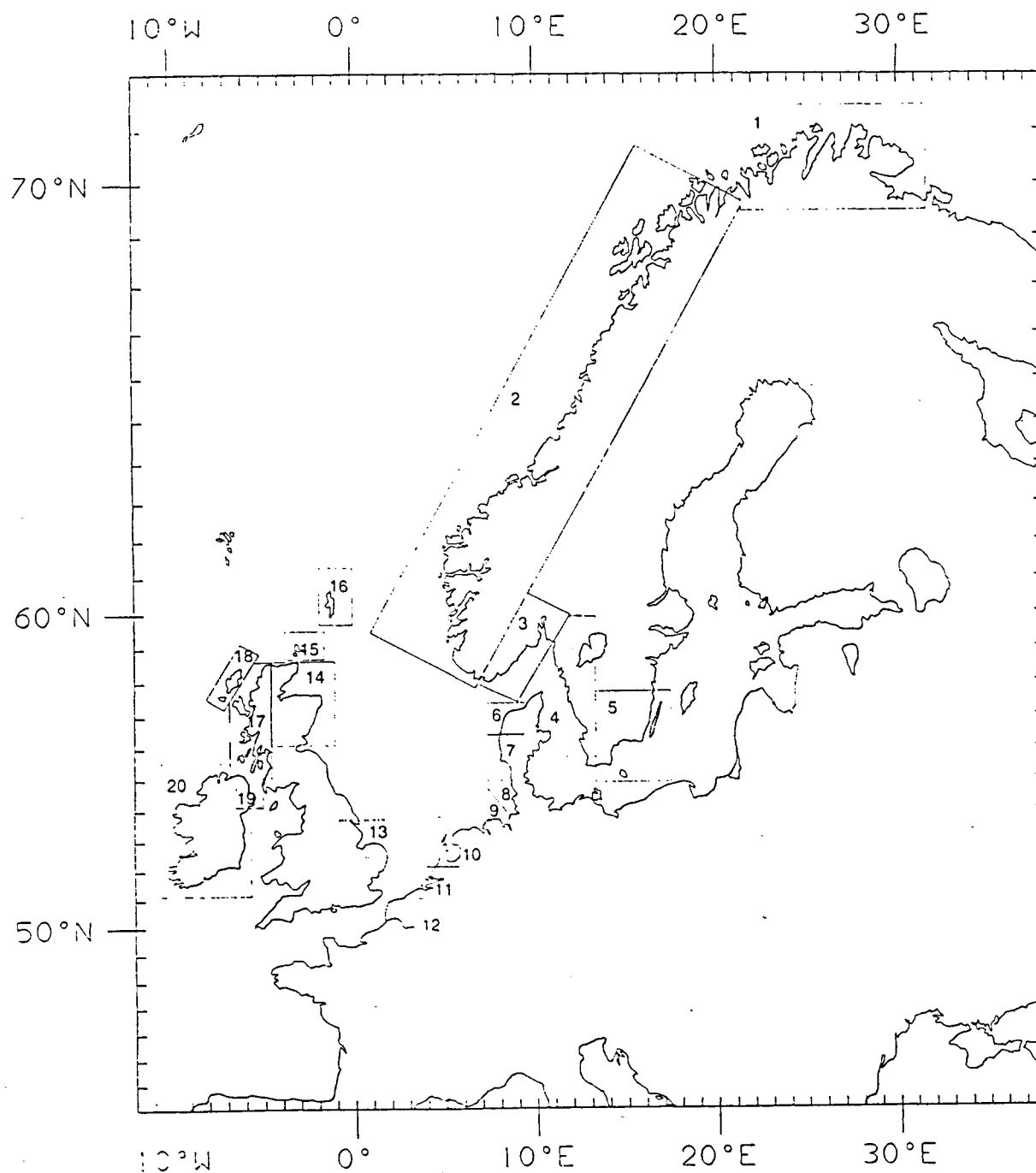
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|-------------------|--------|----------|----------------|----------|
| 1972 | | | | 176 | |
| 1973 | | | | 68 | |
| 1974 | | | | 52 | |
| 1975 | | | | 117 | |
| 1976 | | | | 38 | |
| 1978 | 1248 ^s | E | | | |

APPENDIX FIGURE 1.1

KEY

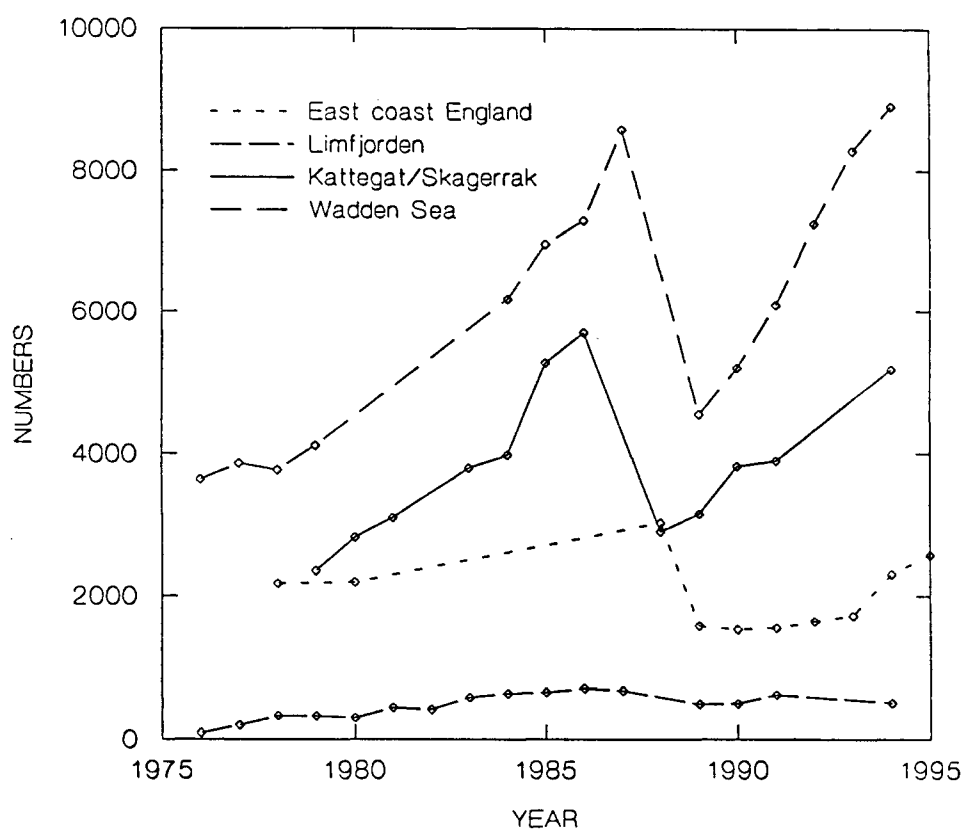
1. Norway - Barents Sea coast
2. Norway - West and North Sea coasts
3. Norway - Oslofjord
4. Kattegat/Skagerrak
5. Baltic
6. Denmark - Limfjorden
7. Wadden Sea - Denmark
8. Wadden Sea - Schleswig-Holstein
9. Wadden Sea - Niedersachsen
10. Wadden Sea - Netherlands
11. Netherlands - Delta
12. France
13. England - East coast
14. Scotland - East coast
15. Scotland - Orkney
16. Scotland - Shetland
17. Scotland - West coast
18. Scotland - Outer Hebrides
19. Northern Ireland
20. Republic of Ireland

APPENDIX FIGURE 1.1
Location of Areas referred to in APPENDIX TABLE 1
 (see p A18 for a key to the areas)



APPENDIX FIGURE 1.2

Trends in the abundance of the major harbour seal populations in Europe over the period 1975-95.



APPENDIX TABLE 2 RINGED SEALS

| BALTIC - BOTHNIAN BAY | | | | | |
|-----------------------|----------------------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1900 | 300 000 ⁶ | H | | | |
| 1975 | 3000 | D | | | |
| 1984 | 2000 | D | | | |
| 1989 | 2500 ⁷ | D | 2075-2925 | | |
| 1991 | 2970 | D | | | 24 |
| 1993 | 3140 | D | | | 24 |
| 1995 | 2800 | D | | | |

| BALTIC - GULF OF FINLAND | | | | | |
|--------------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1994 | 170-200 | D | | | |
| 1995 | 162 | D | | | |

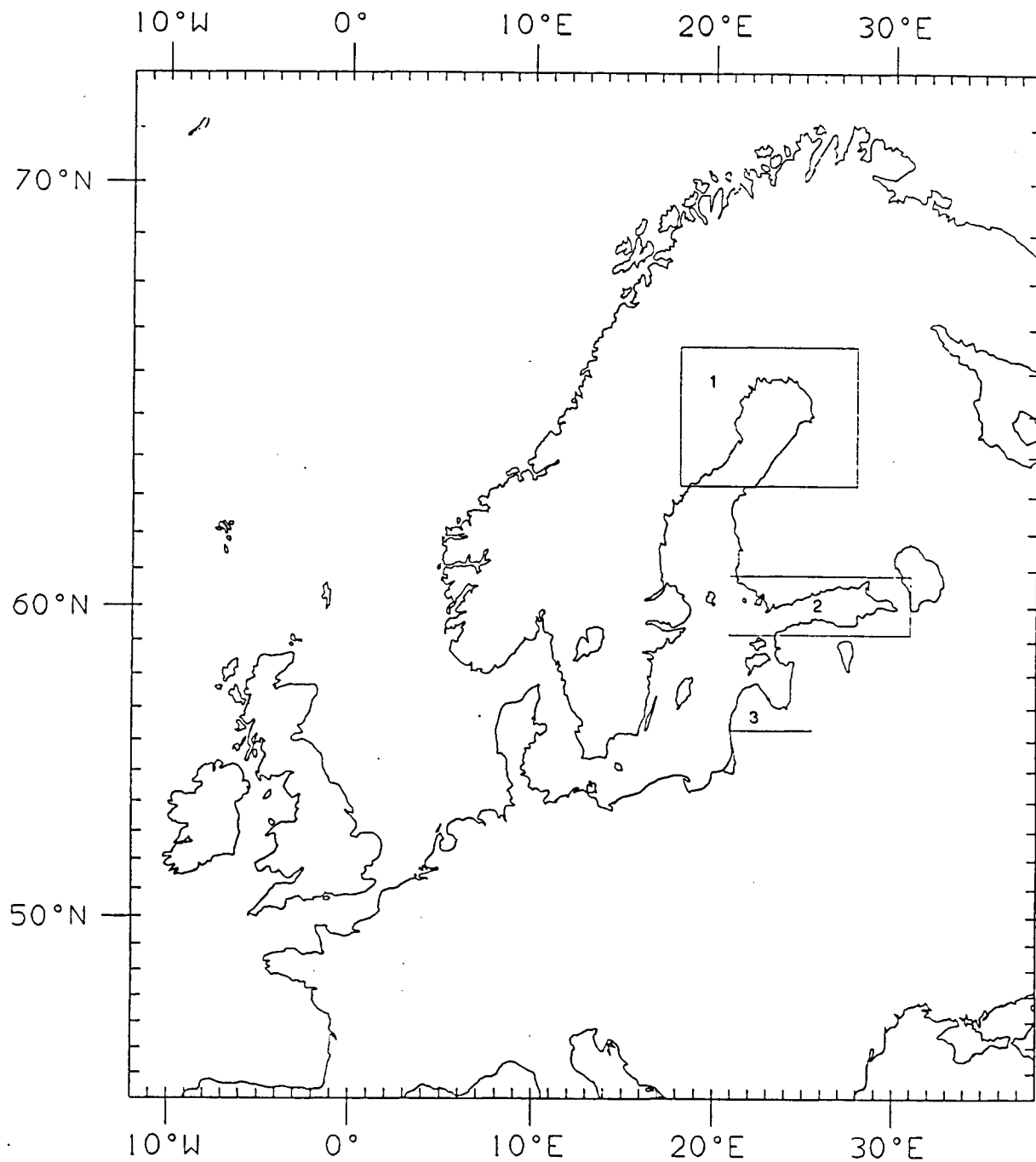
| BALTIC - GULF OF RIGA | | | | | |
|-----------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1994 | 780 | D | | | 56 |

APPENDIX FIGURE 2

Location of Areas referred to in APPENDIX TABLE 2.

KEY

1. Bothnian Bay 2. Gulf of Finland 3. Gulf of Riga



APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

RUSSIA - KOLA PENINSULA

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|-------|------------------|--------|----------|----------------|----------|
| 1960s | 200 | A | | | |
| 1986 | 233 ⁸ | A | | | |
| 1987 | 230 ⁸ | A | | | |
| 1990 | 203 ⁸ | A | | | |
| 1991 | 328 ⁸ | A | | | |

NORWAY - FINNMARK

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|-----------------|--------|----------|----------------|----------|
| 1990 | 39 ⁸ | A | | | |

NORWAY - TROMSO

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|-----------------|--------|----------|----------------|----------|
| 1986 | 27 ⁸ | A | | | |
| 1991 | 17 ⁸ | A | | | |

NORWAY - NORDLAND

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|------------------|--------|----------|----------------|----------|
| 1976 | 130 ⁸ | A | | | |
| 1977 | | | | 70 | |
| 1987 | | | | 324 | |
| 1989 | 105 ⁸ | A | | 32 | |
| 1991 | 171 ⁸ | A | | | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

NORWAY - NORD-TRONDELAG

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|-----------------|--------|----------|----------------|----------|
| 1979 | 47 ⁹ | A | | 27 | |

NORWAY - SOR-TRONDELAG

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|------------------|--------|------------|----------------|----------|
| 1974 | 97 ⁹ | A | Froan only | 27 | |
| 1978 | 118 ⁹ | A | Froan only | 310 | |
| 1979 | 228 ⁹ | A | | | |
| 1982 | 114 ⁹ | A | Froan only | | |
| 1983 | 172 ⁹ | A | Froan only | | |
| 1985 | 173 ⁹ | A | Froan only | | |
| 1986 | 167 ⁹ | A | Froan only | | |
| 1987 | 141 ⁹ | A | Froan only | | |

BALTIC

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1989 | | | | | 73 |
| 1990 | | | | | 70 |
| 1991 | | | | | 123 |
| 1992 | 876 | A | | | |
| 1994 | | | | | 300 |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

WADDEN SEA - THE NETHERLANDS

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1985 | 2 | A | | | |
| 1986 | 2 | A | | | |
| 1987 | 5 | A | | | |
| 1988 | 6 | A | | | |
| 1989 | 6 | A | | | |
| 1990 | 6 | A | | | |
| 1991 | 9 | A | | | |
| 1992 | 21 | A | | | |
| 1993 | 25 | A | | | |

WADDEN SEA - SCHLESWIG-HOLSTEIN

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1993 | 7 | A | | | |
| 1991 | 6 | A | | | |
| 1990 | 7 | A | | | |
| 1989 | 3 | A | | | |
| 1988 | 9 | A | | | |

FRANCE

| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|----------|----------------|----------|
| 1993 | 2 | A | | | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

| ENGLAND AND SCOTLAND - NORTHEAST COAST | | | | | |
|--|----------|--------|-----------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1956 | 751 | B | complete counts | | |
| 1957 | 854 | B | | | |
| 1958 | 869 | B | | | |
| 1959 | 898 | B | | | |
| 1960 | 1020 | B | | | |
| 1961 | 1141 | B | | | |
| 1962 | 1118 | B | | | |
| 1963 | 1259 | B | | | |
| 1964 | 1439 | B | | | |
| 1965 | 1404 | B | | | |
| 1966 | 1728 | B | | | |
| 1967 | 1779 | B | | | |
| 1968 | 1800 | B | | | |
| 1969 | 1919 | B | | | |
| 1970 | 1987 | B | | 6 | |
| 1971 | 2041 | B | | 17 | |
| 1972 | 1617 | B | | 1329 | |
| 1973 | 1678 | B | | 20 | |
| 1974 | 1668 | B | | 9 | |
| 1975 | 1617 | B | | 1467 | |
| 1976 | 1426 | B | | 8 | |
| 1977 | 1243 | B | | 343 | |
| 1978 | 1162 | B | | 175 | |
| 1979 | 1620 | B | | 217 | |
| 1980 | 1617 | B | | 93 | |
| 1981 | 1531 | B | | 226 | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

| ENGLAND AND SCOTLAND - NORTHEAST COAST | | | | | |
|--|----------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1982 | 1637 | B | | 190 | |
| 1983 | 1238 | B | | 28 | |
| 1984 | 1325 | B | | 37 | |
| 1985 | 1711 | B | | 37 | |
| 1986 | 1834 | B | | 31 | |
| 1987 | 1867 | B | | 13 | |
| 1988 | 1556 | B | | | |
| 1989 | 1921 | B | | | |
| 1990 | 2341 | B | | 18 | |
| 1991 | 2368 | B | | 13 | |
| 1992 | 2354 | B | | 13 | |
| 1993 | 2724 | B | | | |
| 1994 | 2735 | B | | | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

| SCOTLAND - ORKNEY | | | | | |
|-------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1964 | 2163 | B | | | |
| 1965 | 2266 | B | | | |
| 1966 | 2394 | B | | | |
| 1967 | 2522 | B | | | |
| 1968 | 2722 | B | | | |
| 1969 | 2443 | B | | | |
| 1970 | 2638 | B | | 731 | |
| 1971 | 2914 | B | | 975 | |
| 1972 | | B | | 699 | |
| 1973 | 2704 | B | | 341 | |
| 1974 | 2836 | B | | 975 | |
| 1975 | 2876 | B | | 1050 | |
| 1976 | 3407 | B | | 1020 | |
| 1977 | 3520 | B | | 841 | |
| 1978 | 3947 | B | | 1067 | |
| 1979 | 4135 | B | | 1015 | |
| 1980 | 4616 | B | | 1195 | |
| 1981 | 5146 | B | | 1219 | |
| 1982 | 5344 | B | | 1184 | |
| 1983 | | | | 8 | |
| 1984 | 4741 | B | ± 10% | 2 | |
| 1985 | 5199 | B | ± 10% | 1 | |
| 1986 | 5796 | B | ± 10% | 2 | |
| 1987 | 6340 | B | ± 10% | 21 | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

| SCOTLAND - ORKNEY | | | | | |
|-------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1988 | 5983 | B | ± 10% | | |
| 1989 | 6911 | B | ± 10% | | |
| 1990 | 7037 | B | ± 10% | | |
| 1991 | 8964 | B | ± 10% | | |
| 1992 | 10408 | B | ± 10% | 1 adult | |
| 1993 | 11108 | B | ± 10% | | |
| 1994 | 11864 | B | ± 10% | | |

| SCOTLAND - SHETLAND | | | | | |
|---------------------|----------|--------|----------|----------------|----------|
| YEAR | ESTIMATE | METHOD | COMMENTS | REPORTED CATCH | BY-CATCH |
| 1970 | | | | 60 | |
| 1971 | | | | 39 | |
| 1972 | | | | 30 | |
| 1973 | 578 | A | | 49 | |
| 1974 | | | | 73 | |
| 1975 | | | | 68 | |
| 1976 | | | | 72 | |
| 1977 | 700 | A | | 10 | |
| 1978 | | | | 59 | |
| 1979 | | | | 37 | |
| 1980 | | | | 40 | |
| 1981 | | | | 40 | |
| 1982 | | | | 49 | |
| 1983 | | | | 1 | |
| 1984 | | | | 1 | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

| SCOTLAND - OUTER HEBRIDES | | | | | |
|---------------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1961 | 3142 | B | | | |
| 1966 | 3311 | B | | | |
| 1967 | 3265 | B | | | |
| 1968 | 3421 | B | | | |
| 1970 | 5070 | B | | | |
| 1971 | | B | | 11 | |
| 1972 | 4933 | B | | 7 | |
| 1973 | | B | | 386 | |
| 1974 | 6173 | B | | 868 | |
| 1975 | 6946 | B | | 754 | |
| 1976 | 7147 | B | | 600 | |
| 1977 | - | B | | 718 | |
| 1978 | 6243 | B | | 85 | |
| 1979 | 6670 | B | | 200 | |
| 1980 | 8026 | B | | 7 | |
| 1981 | 8086 | B | | 2 | |
| 1982 | 7763 | B | | | |
| 1983 | | B | | | |
| 1984 | 8000 | B | ±10% | | |
| 1985 | 8571 | B | ±10% | 5 | |
| 1986 | 8861 | B | ±10% | | |
| 1987 | 9235 | B | ±10% | 15 | |
| 1988 | 9259 | B | ±10% | | |
| 1989 | 9901 | B | ±10% | | |
| 1990 | 10642 | B | ±10% | | |
| 1991 | 11300 | B | ±10% | | |
| 1992 | 12496 | B | ±10% | | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

| SCOTLAND - OUTER HEBRIDES | | | | | |
|---------------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1993 | 12715 | B | ±10% | | |
| 1994 | 12926 | B | ±10% | | |

| SCOTLAND - INNER HEBRIDES | | | | | |
|---------------------------|----------|--------|-----------------------|----------------|----------|
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
| 1984 | 1332 | B | ±10% | | |
| 1985 | 1190 | B | ±10% | | |
| 1986 | 1711 | B | ±10% | | |
| 1987 | 1969 | B | ±10% | | |
| 1988 | 1950 | B | ±10% | | |
| 1989 | 1945 | B | ±10% | | |
| 1990 | 2092 | B | ±10% | | |
| 1991 | 2498 | B | ±10% | | |
| 1992 | 2851 | B | ±10% | | |
| 1993 | 2938 | B | ±10% | | |
| 1994 | 2788 | B | ±10% | | |

APPENDIX TABLE 3 GREY SEALS

Note: These are counts or estimates of pup numbers, not total numbers

WALES

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|-----------------------|----------------|----------|
| 1977 | 645 | A | | | |
| 1992 | 1321 | B | | | |
| 1993 | 1377 | B | | | |
| 1994 | 1343 | B | | | |

ENGLAND - SOUTHWEST

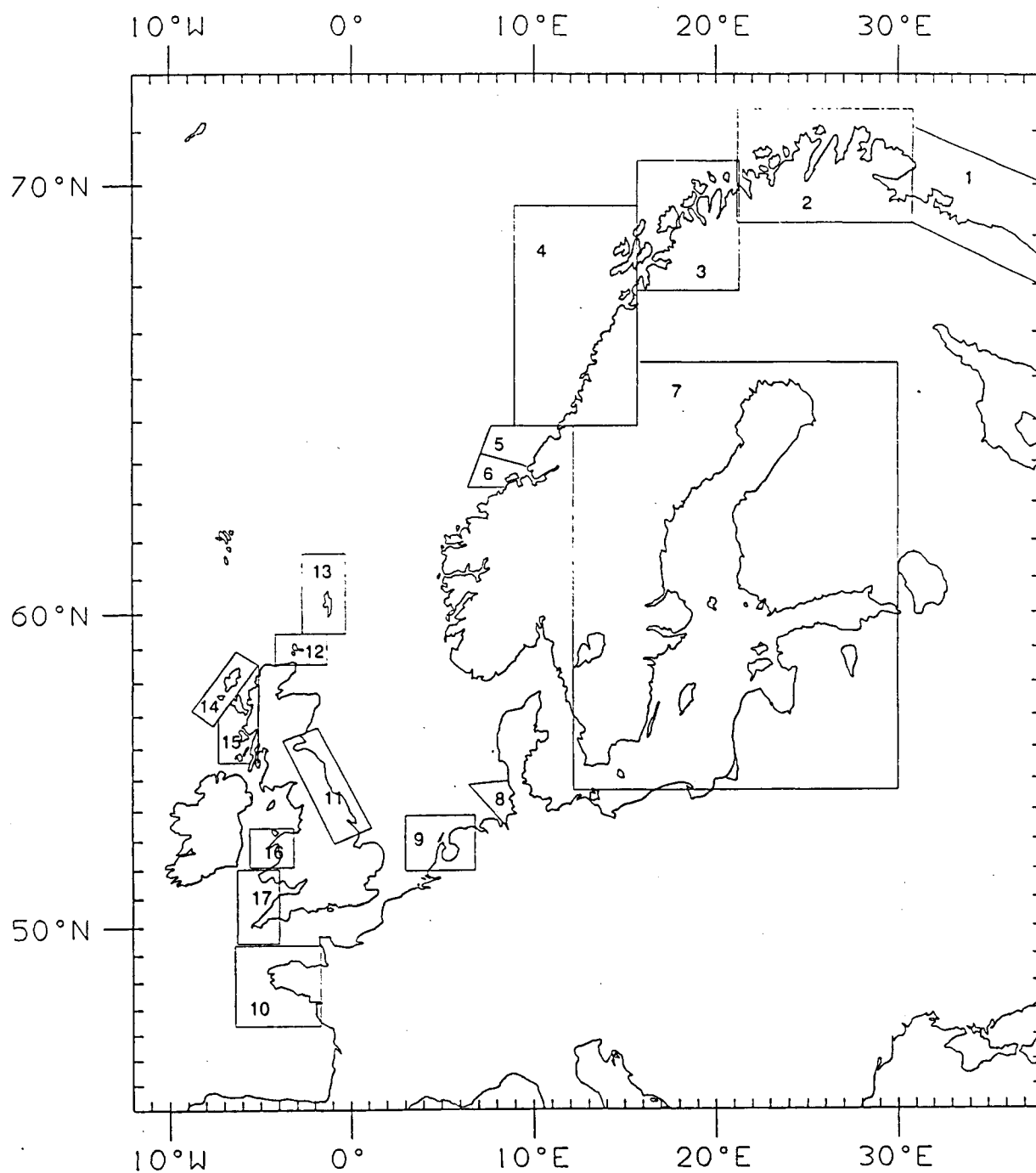
| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------|--------|-----------------------|----------------|----------|
| 1973 | 107 | A | | | |

APPENDIX FIGURE 3.1

KEY

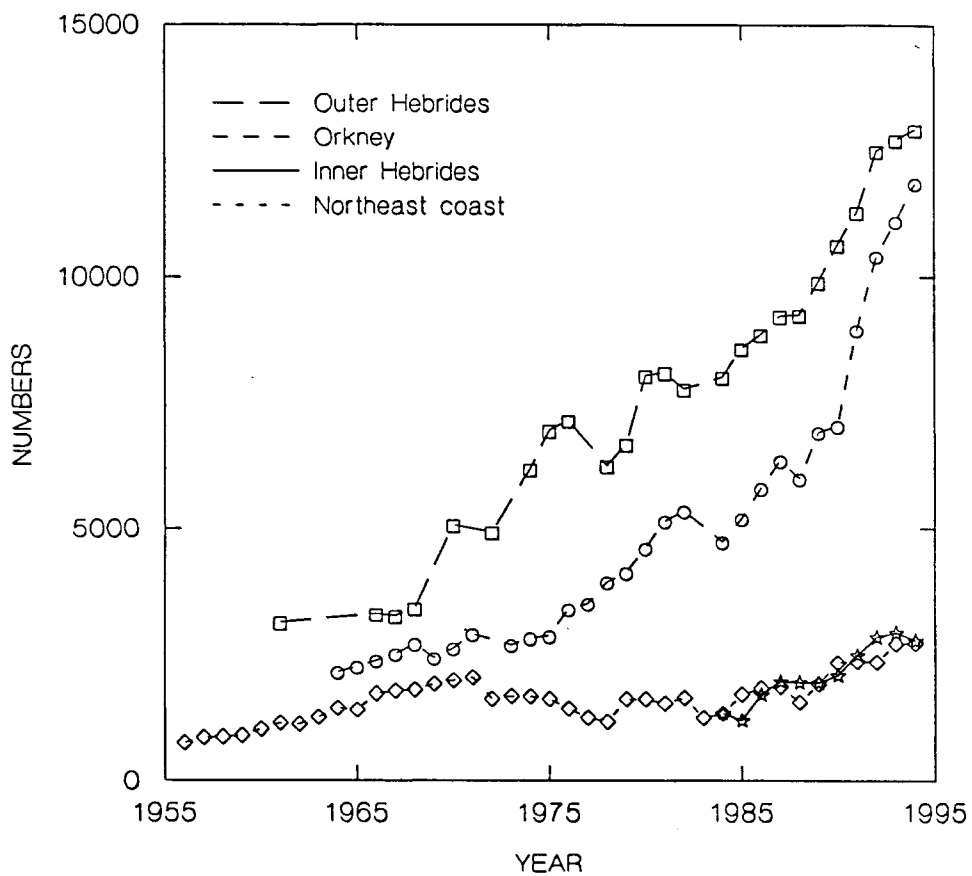
1. Russia - Kola peninsula
2. Norway - Finnmark
3. Norway - Tromsø
4. Norway - Nordland
5. Norway - Nord-Trøndlag
6. Norway - Sør-Trøndlag
7. Baltic
8. Wadden Sea - Schleswig-Holstein
9. Wadden Sea - Netherlands
10. France
11. England & Scotland - northeast coast
12. Scotland - Orkney
13. Scotland - Shetland
14. Scotland - Outer Hebrides
15. Scotland - Inner Hebrides
16. Wales
17. England - southwest

APPENDIX FIGURE 3.1
Location of Areas referred to in APPENDIX TABLE 3
 (see p A32 for a key to the areas)



APPENDIX FIGURE 3.2

Trends in the number of grey seal pups born at the major colonies in England and Scotland over the period 1955-95



APPENDIX TABLE 4 HARBOUR PORPOISES

BALTIC

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|-----------|----------|--------|-----------------------|----------------|----------|
| 1819-1892 | 50 000 | H | | ≈1035 per year | |
| 1916-1919 | | | | ≈ 500 per year | |
| 1941-1944 | | | | ≈ 320 per year | |

ICES AREA IIIa + b

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------------------|--------|-----------------------|----------------|----------|
| 1994 | 36 046 ¹⁰ | F | 20 276 - 64 083 | | |

ICES AREA IIIc

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|---------------------|--------|-----------------------|----------------|----------|
| 1992 | 1 196 ¹¹ | F | | | |
| 1994 | 5 850 ¹⁰ | F | 3 749 - 9 129 | | |

KATTEGAT/SKAGERRAK + DANISH NORTH SEA COAST

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|--------------------------------|----------|--------|-----------------------|----------------|----------|
| 1987 | 7000 | F | 2800 - 11200 | | |
| 1988 (January/ February) | 7600 | F | 3500 - 11700 | | |
| 1988 (April/May) | 12800 | F | 6300 - 25900 | | |

APPENDIX TABLE 4 HARBOUR PORPOISES

GERMAN BIGHT

| YEAR | | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|------------------|----------|--------|-----------------------|----------------|----------|
| 1992 | January/February | 8 800 | F | 5 200 - 15 000 | | |
| | April/May | 17 000 | F | 8 400 - 34 600 | | |

ICES AREAS IIa + IVa

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------------------|--------|-----------------------|----------------|----------|
| 1989 | 82 600 ¹² | F | 42 740 - 121 460 | | |

ICES AREA IVa

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------------------|--------|-----------------------|----------------|----------|
| 1994 | 98 564 ¹⁰ | F | 66 679 - 145 697 | | |

ICES AREA IV b + c

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|---------|-----------------------|--------|-----------------------|----------------|------------------------|
| 1980-81 | | | | | 1000-3000 ^a |
| 1990 | | | | | 750 ^b |
| 1993 | | | | | 7000 ^c |
| 1994 | 169 888 ¹⁰ | F | 124 121 - 232 530 | | |

a based on interviews with Danish fishermen

b based on interviews with Danish fishermen in one harbour

c estimated by-catch in Danish gill net fishery

APPENDIX TABLE 4 HARBOUR PORPOISES

ICES AREA VIIj

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------------------|--------|-----------------------|----------------|----------|
| 1989 | 19 210 ¹³ | F | 6 408 - 32 012 | | |

ICES AREA VIII^f + g + h + j

| YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|------|----------------------|--------|-----------------------|----------------|--------------------|
| 1994 | 36 280 ¹⁰ | F | 12 828 - 102 604 | | 1 937 ^d |

d estimated by-catch in Irish and English gillnet fishery

APPENDIX TABLE 5 - OTHER SMALL CETACEANS

BOTTLENOSE DOLPHIN

| AREA | YEAR | ESTIMATE | METHOD | REPORTED CATCH | BY-CATCH |
|--------------------|---------|-----------------|--------|----------------|----------|
| NORTHEAST SCOTLAND | 1991 | 78-95 | E+G1 | | |
| BRITANY | 1993 | 30 | E+G1 | | |
| MONT ST MICHEL | 1993 | 60 | E | | |
| ARCACHON | 1993 | 6 | G1 | | |
| SADO ESTUARY | | ? | | | |
| CORNWALL | 1991/93 | 15 | E | | |
| DORSET | 1994-95 | 5 ¹⁴ | G1 | | |
| CARDIGAN BAY | 1991 | 14-106 | G1 | | |
| SHANNON ESTUARY | 1995 | 50-60 | I | | |
| GALWAY BAY | | ? | | | |
| CLEW BAY | | ? | | | |
| DINGLE BAY | 1995 | 12 | I | | |

KILLER WHALE

| AREA | YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|--------------------|---------|----------|--------|-----------------------|----------------|----------|
| NORTHERN NORTH SEA | 1989 | 7 029 | F | 3 400 - 14 400 | | |
| NORTH NORWAY | 1991/92 | 475 | G2 | | | |

LAGENORHYNCHUS spp (WHITE-BEAKED AND WHITE-SIDED DOLPHINS)

| ICES AREA | YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|-------------|------|----------------------|--------|-----------------------|----------------|----------|
| IIa + IVa | 1989 | 26 665 ¹⁵ | F | 7 623 - 93 279 | | |
| IIa & IVa | 1990 | 16 781 ¹⁵ | F | 3 955 - 71 206 | | |
| IVa | 1994 | 1 685 ¹⁰ | F | 690 - 4 113 | | |
| IVb | 1994 | 9 242 ¹⁰ | F | 5 344 - 15 981 | | |
| VIIIf+g+h+j | 1994 | 833 ¹⁰ | F | 159 - 4 360 | | |

APPENDIX TABLE 5 - OTHER SMALL CETACEANS

COMMON DOLPHIN

| AREA | YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|--------------------|------|----------------------|--------|-----------------------|----------------|----------|
| NORTHEAST ATLANTIC | 1992 | | | | | 410* |
| | 1993 | 61 888 ¹⁶ | F | | | 419* |
| ICES VIIIf+g+h+j | 1994 | 75 449 ¹⁰ | F | 22 900 - 284 900 | | |

* data from French albacore fishery only

STRIPED DOLPHIN

| AREA | YEAR | ESTIMATE | METHOD | 95% CONFIDENCE LIMITS | REPORTED CATCH | BY-CATCH |
|--------------------|------|----------------------|--------|-----------------------|----------------|----------|
| NORTHEAST ATLANTIC | 1992 | | | | | 1193* |
| | 1993 | 73 843 ¹⁶ | F | | | 1152* |

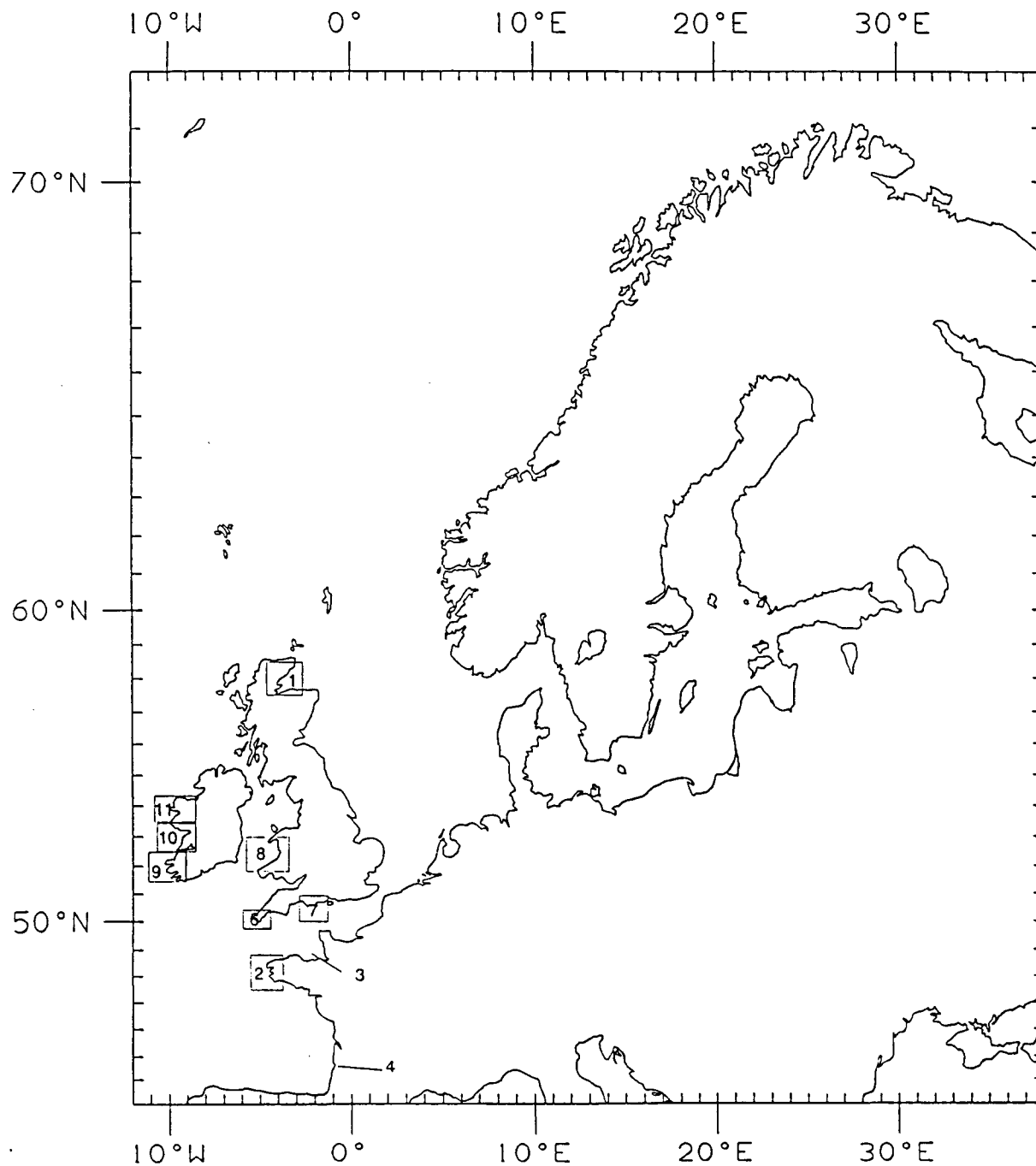
* data from French albacore fishery only

APPENDIX FIGURE 5

Location of Areas referred to in APPENDIX TABLE 5

KEY

- | | | | | | | | |
|----|---------------------|----|----------|-----|----------------|-----|----------|
| 1. | northeast Scotland. | 2. | Brittany | 3. | Mont St Michel | | |
| 4. | Arcachon | 6. | Cornwall | 7. | Dorset | | |
| 8. | Cardigan Bay | 9. | Shannon | 10. | Galway Bay | 11. | Clew Bay |



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