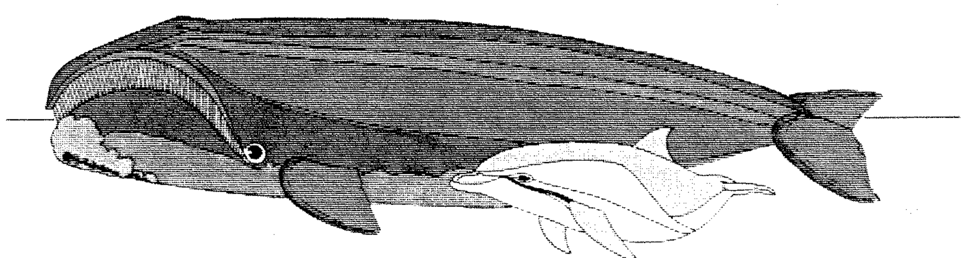
EUROPEAN RESEARCH ON CETACEANS - 3

PROCEEDINGS OF THE THIRD ANNUAL CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY, LA ROCHELLE, FRANCE, 24-26 FEBRUARY 1989



EDITORS: P.G.H. EVANS & C. SMEENK

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Proceedings of the Third Annual Conference
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CONTENTS

Introduction 6

Osborn, D. Pollution and disease pressures on marine vertebrates 8

Reijnders, P.J.H. Pollution impact studies in marine mammals: options of required research 9

Aguilar, A. Organochlorine pollutants and cetaceans: a perspective 10

Ekker, M., Jenssen, B.M. and Espelien, I.S. Environmental pollutants and chromosomal aberrations in minke whales *Balaenoptera acutorostrata* 12

André, J.M., Ribeyre, F., Amiard, J.C., Boudou, A., Amiard-Trequet, C. and Michel, P. Ecotoxicological study of the contamination of *Stenella attenuata* by heavy metals (Hg, Cd, Cr, Cu, Mn, Ni, Se, Zn) and organochlorine compounds (sDDT, PCB) 16

Capelli, R., De Pellegrini, R., Minganti, V. and Poggi, R. Preliminary results on the presence of inorganic, organic mercury and selenium in striped dolphins *Stenella coeruleoalba* from the Ligurian Sea 19

Carlini, R. and Fabbri, F. Mercury, methylmercury and selenium in Italian stranded odontocetes 25

Sanpera, C. and Llorens, M. Mercury in fin whales *Balaenoptera physalus* from the waters of the North Atlantic 29

Aguilar, A. and Borrell, A. Dynamics of DDT and PCB in eastern North Atlantic fin whales *Balaenoptera physalus* 32

Borrell, A. Variation in organochlorine pollution (DDT and PCB) levels in a non-preserved stranded dolphin 34

González, M. The weight of internal organs in the fin whale *Balaenoptera physalus* and its relationship to body size, sex and reproductive status 36

Kröger, R.H.H. and Kirschfeld, K. Visual accommodation in cetaceans 38

Van Pijlen, I.A. The behavioural audiogram of the bottle-nosed dolphin *Tursiops truncatus* - a survey of methods and problems 41

Klinowska, M. Further evidence for the cetacean magnetic travel strategy 44

Hammond, P.S. Estimating cetacean population parameters from individual recognition data 48

Evans, P.G.H. and Scanlan, G. Historical status changes of cetaceans in British and Irish waters 51

Bisther, A., Vongraven, D., Berggren, P. and Johnsson, B. Research on orcas *Orcinus orca* off the mid-Norwegian coast 58

Pourreau, J. and Marin, J. Distribution of bottle-nosed dolphins *Tursiops truncatus* in Normandy (1979-1988) 60

Gannier, A. and O. Some sightings of cetaceans in the western Mediterranean Sea 62

Cagnolaro, L., Magnaghi, L., Podestà, M. and Jann, B. False killer whale *Pseudorca crassidens* - a rare stranding for the Italian coast 65

Podestà, M. and Magnaghi, L. Unusual number of cetacean bycatches in the Ligurian Sea 67

Hervé-Gruyer, Ch. Sightings and behaviour of cetaceans off the Canary Islands 71

Vonk, R. and Martin Martel, V. Goose-beaked whales *Ziphius cavirostris* mass strandings in the Canary Islands 73

Hayes, J., Revault, P. and Tiedje, F. Spring breachings observed in *Stenella coeruleoalba* in the Mediterranean Sea 78

Klinowska, M. Assessing the conservation status and needs of cetaceans 80

Kremer, H. Age determination and growth of the harbour porpoise *Phocoena phocoena* in German waters 86

Raga, J.A., Kinze, C. Chr., Balbuena, J.A., Ortiz, T. and Fernández, M. New data on helminth parasites of the harbour porpoise *Phocoena phocoena* in Danish waters 88

Kinze, C. Chr. On the reproduction, diet and parasitic burden of the harbour porpoise *Phocoena phocoena* in west Greenlandic waters 91

Lindstedt, I. and M. Incidental catch of harbour porpoises *Phocoena phocoena* in Swedish waters in the years 1973-1988 96

Evans, P.G.H. and Lane, M.-R. Field studies of harbour porpoises *Phocoena phocoena* in North Scotland 99

Berggren, P. and Pettersson, F. Preliminary sighting records of harbour porpoises *Phocoena phocoena* in Swedish waters 108

Addink, M. and Smeenk, C. Stranding records of the harbour porpoise *Phocoena phocoena* in the Netherlands: 1970-1987 111

Balbuena, J.A., Raga, J.A., Fernández, M. and Ortiz, T. Ectoparasites and epizoits of the long-finned pilot whale *Globicephala melas* off the Faroe Islands, with special reference to *Isocyamus delphinii* (Amphipoda: Cyamidae) 115

Gannier, O. and A. Names of whales, dolphins and pinnipeds 118

Evans, P.G.H. Sightings working group 122

Second annual report of the European Cetacean Society: 1988 127

Report of the annual general meeting, 25th February 1989, La Rochelle 128

Financial report over 1988 129

European Cetacean Society 130

INTRODUCTION

The third annual conference of the European Cetacean Society was held in La Rochelle, France between 24th and 26th February 1989. Nearly two hundred members from fourteen countries attended the conference and we particularly thank Anne Collet for her sterling efforts in organizing a very enjoyable meeting.

The proceedings that follow are abstracts of the talks and posters offered to the conference. The contributions have been edited only to improve clarity and maintain a uniformity of presentation. No external refereeing has taken place and we hope that much of the material presented here will ultimately be formally published in greater detail in scientific journals. We have tried to arrange the abstracts broadly by subject. A report of the Sightings Working Group arising from the meeting in La Rochelle is included at the end.

Finally we are very grateful to Susanne Levy for typing the proceedings.

Peter G.H. Evans
Chris Smeenk

The organization of the conference has been very much helped by the participation of:

the City of La Rochelle; the Musée Océanographique; the Crédit Mutuel Océan; the Maison de la Culture; the Centre des Congrès; the Société des Transports Collectifs Rochelais; the Syndicat d'Initiative; the Aquarium Coutant; the Musée Maritime; the Muséum d'Histoire Naturelle; Christine Pons; the Bar André; the Tartiérie; the Hôtel Arcade; the Hôtel de la Monnaie and the La Rochelle Youth Hostel.

The European Cetacean Society gratefully acknowledges their contribution, and we would particularly like to thank the following people:

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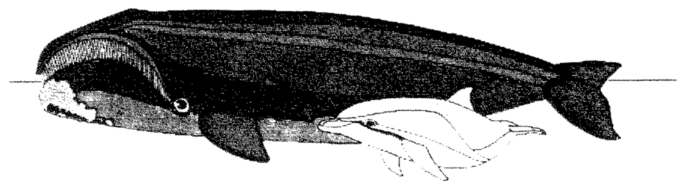
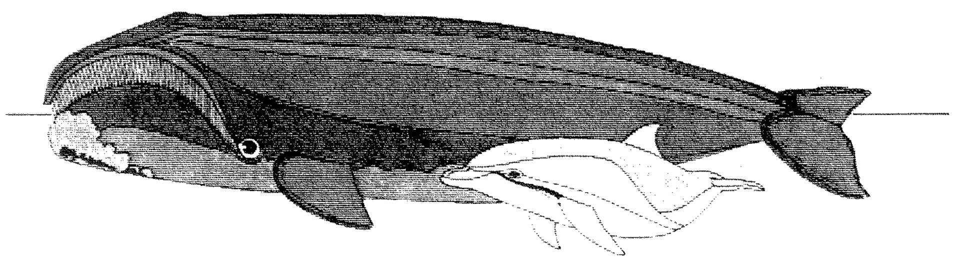
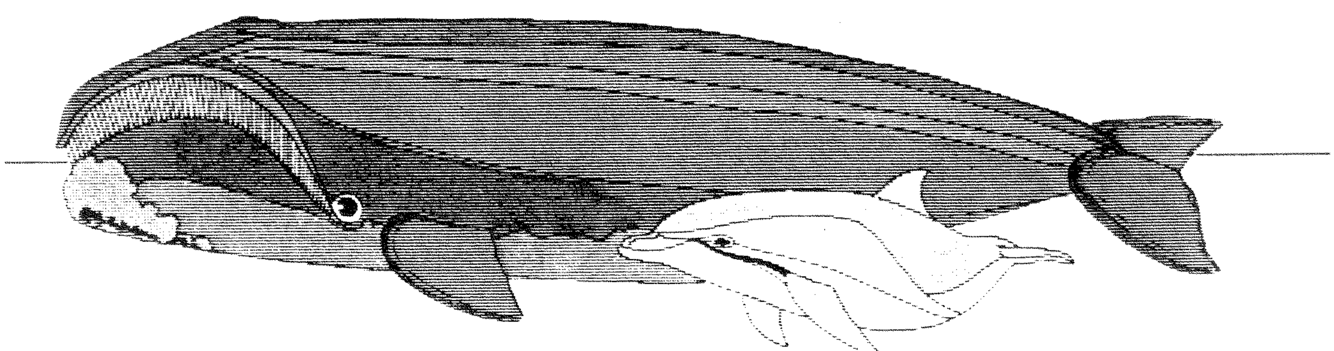
I also wish to thank the ECS board members who have always been present, at least on the phone, to help with so many details which form the organization of such a conference. They are: Alex Aguilar, Geneviève Desportes, Peter Evans, Carl Kinze, Ronald Kröger, Michela Podestà and Chris Smeenk.

Finally, I am pleased to thank all the ECS members, notably those 178 who could afford to come to La Rochelle and who made the 3rd annual conference of the European Cetacean Society very successful.

Anne Collet
Organizer, 3rd ECS conference







POLLUTION AND DISEASE PRESSURES ON MARINE VERTEBRATES

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In various parts of the world there is evidence that marine vertebrates have suffered from the effects of either pollution or disease. There are also examples of contamination of marine vertebrates with chemicals or organisms at levels that do not appear to present any real threat to the animals.

As with most other groups of animals, a relatively large amount of attention has been focused on persistent pollutants. These may not be the only chemicals that cause harm. There is always the possibility that a chemical could have an effect on an organism without leaving an identifiable analytical trace. Techniques may be needed to take account of this possibility, including more work on the characteristics of animals that make them either good at accumulating pollutants or sensitive to their effects.

Chemicals and disease organisms could act independently or in conjunction with each other, or in combination with a number of other factors (some of them quite natural such as population density) that may lessen or enhance the adverse influence of either of the two groups of agents that this talk is primarily concerned with. The relative importance of natural factors and those originating from human activity needs to be assessed.

Neither single factor nor multi-factor interactive cause and effect relationships are easy to establish in the wild, and this is made more acute because of the difficulty of extrapolating between the data available from standard toxicity tests and the species of interest in its natural habitat. Even work on the species of interest in captivity may not provide an accurate guide to impacts in the environment because of the additional pressures an animal faces in the wild (for example, it must hunt for food, which is more readily available in captive conditions). However, a number of techniques are becoming available that may make it possible to unravel some of the complexities that are involved in attempting to assess the impact of potentially injurious exogenous agents even in such difficult groups as cetaceans. Some of these techniques may help to reduce the need to kill animals for scientific purposes, although they might necessitate the development of new techniques of capture, sampling, and release not previously contemplated.

For those concerned with cetaceans, there are useful examples to be drawn on from studies conducted on other marine vertebrates, such as fish and seabirds, seals and sealions, and selected examples are given of the work that has been conducted on these other groups. Some theoretical and methodological approaches are outlined that may help to further develop approaches to the study of disease and pollution in cetaceans.

It is suggested that those whose primary scientific interest is disease and those whose primary scientific interest is chemical impacts have much to gain by working more closely together, and of course with those for whom the biology of cetaceans is the main concern. For groups such as cetaceans, international co-operation is of great importance, and a number of possible co-operative efforts could be considered to enhance the exchange and management of information if it were felt that, as happens all too often, research results languish under-used in the professional literature.

POLLUTION IMPACT STUDIES IN MARINE MAMMALS: OPTIONS OF REQUIRED RESEARCH

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In coastal marine mammals especially, high levels of several pollutants have been analysed. Despite their recognized toxic abilities, only in very few case studies, could clear effects of pollutants be established. From those studies it emerged that the key question is to detect the biochemical process(es) that a pollutant induces which then results in a physiological response in the animal. Some prominent responses are hampered reproduction and changes in the functioning of the immune system. Those processes are often only noticed in an advanced stage of a chronic exposure.

The use of blood chemistry and haematology of marine mammals might allow one to relate blood parameters to physiological condition and environmental variables. However, extensive data on baseline values of several parameters are required from animals whose history is known. This implies that next to kinetics of pollutants, data on, for example, feeding patterns, migration/dispersal and metabolism have also to be obtained.

The feasibility of such a concept will be exemplified by consideration of the effects of PCB's on common seals *Phoca vitulina* in the Wadden Sea.

ORGANOCHLORINE POLLUTANTS AND CETACEANS: A PERSPECTIVE

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Organochlorine compounds are synthetic chemicals which came to be used after the Second World War for a variety of agricultural and industrial applications. Because of their low water solubility factor and therefore high lipophilicity (Ernst, 1980), the two groups of organochlorines most ubiquitously found in cetaceans are the DDT complex (DDT, TDE and DDE) and the polychlorinated biphenyls or PCB's, especially the forms with a higher chlorine content.

In the fifties and early sixties, DDT enjoyed its widest use and found its way into the oceanic food webs. However, its hazardous nature was soon demonstrated and, from the mid-seventies, it has been banned in most developed countries. As a consequence, current environmental concentrations in most areas of the North Atlantic are displaying a slow but decreasing trend, and the DDT that still remains is increasingly composed more of metabolized forms, mainly DDE (Aguilar, 1984). By contrast, PCB's have become common in biological samples from the late sixties onwards and at present their concentration in the tissues of marine mammals seems to be steady, or on the increase, depending on the regions.

Given the lipophilicity of DDT's and PCB's, they move freely through all the body compartments and their distribution among the different body tissues is highly correlated with the fat content of each tissue or, more precisely, with its triglyceride content (Aguilar, 1985). One particular case is the nervous system, in which organochlorine residue levels are much lower than in the rest of the body, because its lipid constituents are highly polar (mostly phospholipids) and therefore have a low capacity for retaining organochlorines.

The chemical structure of organochlorines grants them high stability. Because of this, intake usually exceeds metabolization or excretion, and both DDT's and PCB's tend to increase with age in males and juvenile females. In adult females, however, organochlorine compounds are transferred in substantial quantities to offspring and the increasing age-related trend can be leveled off or even reversed, depending on the biological characteristics of the species. Transfer during lactation seems to represent a much higher unloading for the female than that occurring during gestation.

Interspecific variation in organochlorine pollutant loads traditionally has been said to depend on the food chain level occupied by the species involved. However, recent research suggests that other biological parameters such as metabolic rate, and therefore body weight, are also important to determine tissue concentrations. This explains, for example, why top predator sperm whales *Physeter macrocephalus* have DDT and PCB levels which are more similar to those of the plankton-feeding baleen whales than to those of smaller whales or dolphins, which also feed at the end of the food web.

The effects of current environmental concentrations of organochlorines on cetaceans are unknown, and most suggestions in this respect are based on extrapolation from other mammals. However, it has been shown recently that the ability of small cetaceans to metabolizer PCB's is extremely low when compared to that of birds and terrestrial mammals (Tanabe *et al.*., 1988). Other surveys have also reported that blood testosterone levels in Dall's porpoises *Phocoenoides dalli* may be increased by high organochlorine tissue concentrations (Subramanian *et al.*, 1987a) and, in a number of cases, organochlorine contamination has been claimed to be the main cause of population declines (Martineau *et al.*, 1987). Nevertheless, the causative effect of organochlorines in these and other cases still has to be proved.

Finally, the potential application of organochlorines to the study of biological processes is discussed and examined with two examples: the discrimination of cetacean populations with partially overlapping home ranges (Aguilar, 1987), and the determination of lactation length using an interspecific relationship between male-female differences in pollutant loads and duration of lactation (Subramanian *et al.*, 1987b).

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ENVIRONMENTAL POLLUTANTS AND CHROMOSOMAL ABERRATIONS IN MINKE WHALES *Balaenoptera acutorostrata*

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INTRODUCTION Among the rorquals, the minke whale *Balaenoptera acutorostrata* is the smallest and the most common. The species has a worldwide distribution and is still hunted by some nations. During spring, animals from the northeast Atlantic stock migrate northwards, to the highly productive arctic waters (Stewart and Leatherwood, 1985). Part of this food migration occurs off the Norwegian west coast. The minke whale in the northern hemisphere is an opportunistic feeder, feeding on a great variety of organisms, mainly fish.

The coastal waters off Europe and the North Sea are among the most heavily contaminated regions in the world. This is due to intensive industry, agriculture and offshore petroleum activities (Drescher *et al.*, 1977; Aguilar and Jover, 1982; Aguilar, 1983). Studies on animals from arctic regions reveal that chemical contaminants are continuing to increase (Norstrom *et al.*, 1988).

Even though the mechanisms of bioaccumulation of contaminants are far from completely understood, it appears that contaminant levels tend to increase proportionally with the trophic level and metabolic rate of the organism (Aguilar and Jover, 1982; Muir *et al..*, 1988). Thus, like other marine mammals, the minke whale can be regarded as a good indicator of chemical pollution in the marine ecosystem. It is a long-lived species (> 33 years - Christensen, 1981) and situated at the top of the marine food chain, reflecting the pollution load of the environment in which it lives.

Most studies concerning accumulation of environmental pollution in marine mammals have focused on seals and small toothed cetaceans. Data from baleen whales from the northern hemisphere are limited. As pointed out by Evans (1987), most studies of pollutants in marine mammals are based on sampling from few individuals. Since these animals have also often been found dead or stranded, the levels of pollution may not reflect "normal" levels. More knowledge of present levels of pollutants in baleen populations is therefore valuable.

From the southern hemisphere, Japanese scientists have reviewed the present levels of different chemicals in southern minke whales (Honda *et al.*, 1987; Tanabe *et al.*, 1986).

OBJECTIVES AND PERSPECTIVES The aim of the present project was to establish a synopsis of the internal distribution of different contaminants in minke whales from the northeast Atlantic stock and to investigate chromosomal aberrations in lymphocytes from the same individuals. This will hopefully provide:

*Baseline data on pollutant levels in minke whales. Such information is vital as a reference for studies carried out on stranded individuals, and for future monitoring of pollutant loads in the northeast Atlantic population of minke whales.

*Information on internal distribution of contaminants. This will ease the use of biopsy in future monitoring.

*Information about the possible genetic impact caused by today's pollutant exposure.

*A relationship between contaminant levels and age, sex, reproductive status, etc.

MATERIALS AND METHODS This project is part of the scientific whaling program organized through the University of Tromsø. Tissue samples were collected from two vessels during August 1988 off the coast of Vesterålen, Nordland (approximate position 68^{o} N). Samples from blubber, muscle, bone, heart, liver, kidney, pancreas and gonads were collected from 29 minke whales (predominantly males). Blood for chromosomal aberration analyses were sampled from 12 individuals.

Chromosomal aberrations

Chromosomal aberrations in lymphocytes are known to be a sensitive indicator of genetic damage in mammals. In the USA the method has been used to map mutagenesis in small mammals living in heavily polluted environments (McBee *et al.,* 1987). The study of chromosomal aberration in minke whales demonstrated that the laboratory facilities on board the vessel were unsatisfactory. Thus, only 10-20% of the samples can be analysed, compared to 70-90% under normal laboratory conditions. Future studies within this field should therefore take place ashore.

Unfortunately we have not been able to obtain financial support to carry out the chemical analyses. However, the intentions are to analyse different tissues for petroleum hydrocarbons, organochlorines, heavy metals and radioactive nucleids.

Petroleum hydrocarbons

Information on effects of hydrocarbons on cetaceans are limited, especially with regard to baleen whales. There is some suggestion that whales are supposed to and may accumulate petroleum hydrocarbons. A study by Geraci and St. Aubin (1979) on 13 species of stranded odontocetes and mysticetes revealed that petroleum hydrocarbons were present in several tissues. Levels were within a low ppm range, with highest levels recorded in blubber.

Organochlorines

High levels of organochlorine contaminants (primarily DDT and PCB's) have been reported in several species from different areas in the world. In general, levels tend to be lower in sperm whales and baleen whale species than in small odontocetes. DDT and PCB's are lipophilic compounds and tend to accumulate in the blubber where they probably cause little harm. However, during lactation and/or starving periods the residues may be released and affect the animal.

Heavy metals

A relatively large amount of data concerning levels and accumulation of heavy metals in marine mammals has been reported. Except for the study of Honda *et al.* (1987) on the southern minke whale in the Antarctic, few studies have focused on baleen whales. Relatively high concentration levels of heavy metals have been found in cetaceans from different waters.

Radioactive nucleids

The nucleids which seem to be of greatest importance in the marine environment are radiocaesium, radiostrontium and plutonium-isotopes. These isotopes may be released from nuclear power plants and reactor fuel reprocessing plants, and may pose a future hazard to marine mammals. Detectable levels have been found in teleost fish from the North Sea.

CONCLUSIONS Environmental pollutants pose a severe threat to marine mammal populations in many areas. As marine mammals represent the top level in the food chain, they may accumulate high concentrations of contaminants and are therefore suitable as indicators of marine pollution levels. In the management of the marine environment in general, and marine mammal populations in particular, monitoring of contaminant levels in marine mammals is one useful approach. Additional investigations of chromosomal aberrations may demonstrate interesting connections between contaminant levels and physiological and structural effects on the cell level. In turn this will hopefully increase our understanding of the ecological significance of pollutant loads in marine mammals.

Scientific research concerning problems related to marine pollution is at an early stage of its development. The influence of chronic and acute exposures to environmental contaminants is not known, but may be important from physiological and ecological considerations (Engelhardt, 1985; Evans, 1987).

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ECOTOXICOLOGICAL STUDY OF THE CONTAMINATION OF *Stenella attenuata* BY HEAVY METALS (Hg, Cd, Cr, Cu, Mn, Ni, Se, Zn) AND ORGANOCHLORINE COMPOUNDS (sDDT, PCB)

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The basis of our research is the study of the contamination of Delphinidae by micropollutants (André, 1983, 1988; André *et al.*, 1985). Pollutant concentration and content in the different organs are quantified then considered in relation to several biological and ecological factors. The results are based on 65 dolphins from three species: *Stenella attenuata, Stenella longirostris* and *Delphinus delphis* , caught in the eastern tropical Pacific Ocean. The dolphins were frozen whole and, during an expedition to the USA in 1984 (Southwest Fisheries Centre, La Jolla), we collected from each individual 18 organs or tissue samples, producing about 1,200 samples. We also measured total weight, total length and the weight of each organ taken. These biometric data were supplemented with various information relating to the date and place where the animals were caught. The age of each individual was estimated from the layers of dental growth (Centre National d'Etude des Mammifères Marins, La Rochelle).

Total mercury was quantified in all samples by atomic absorption spectrometry without a flame (Department of Fundamental Ecology and Ecotoxicology, University of Bordeaux I). Seven other metals, Cd, Zn, Cu, Se, Ni, Cr, Mn, were also analysed using this technique (electrothermy-Zeeman effect; Department of Ecotoxicology, University of Nantes) and also the organochlorine compounds, sDDT and PCB (gaseous phase chromatography, capillary column; Department of Organic Micropollutants, IFREMER, Nantes). A large volume of data was collected (more than 15,000 items) and to analyse this required a methodological approach, adapted to the study of the accumulation of micropollutants in Delphinidae.

The first stage of this procedure was to define contamination levels in each individual and organ by all the metals and organochlorines. This enabled us to establish the links between our results and published information on Delphinidae and Pinnipedia, and also to draw attention to any values which seem "unusual" in relation to the body of data. We can assume that, generally speaking, the contamination levels in our sample are more or less midway between all the extremes of variation published.

After this first essentially descriptive stage, we analysed in more detail the distribution of contaminants throughout the organism, based on average concentration and content readings. Figure 1a shows average total mercury concentrations in twelve organs. This graph clearly shows the wide differences between the distribution of this metal within the organs: for example a factor of about 200 between average mercury concentrations in liver and melon fat. The second graph (Fig. 1b) represents the "average content" and shows clearly the influence of organ weight, revealing some results which are very different to the previous analyses. The organs can be divided into three groups: fat, liver and muscle, where relative content becomes very much higher; at the opposite end of the scale are the spleen and, to a lesser extent, the brain, the two stomachs and the pancreas; in the middle are the lungs, intestine and kidneys which hold an intermediate position between these two groupings.

After studying the distribution of the metal, we looked at the influence on contamination levels in the organs of various factors for which we had some fairly specific data. Among the main conclusions to be drawn is the influence of the variable "sex", giving higher levels of contamination by mercury in the females. When considering the relationship with place of capture, we observed that latitude is very important. The mercury accumulation in the organs increases significantly in individuals from nearer the Equator.

The last stage of our research consisted of producing a synthesis incorporating the ten contaminants selected initially. By applying multi-dimensional methods (factor analysis of relationships and analysis into main components), we were able to confirm the influence of different factors already analysed - age, sex, geographical origin - and to draw similarities or common characteristics between contaminants. For example, mercury and selenium have similar "behaviour" with respect to their bioaccumulation by dolphins, and this enabled us to quantify relationships between the two metals more precisely, and to link them with actual knowledge of other species (terrestrial mammals, fishes). In the same way there are very close links between PCB's and sDDT, also between copper and zinc. However, unlike some studies that have been carried out, results from our work do not show any clear relationship between cadmium and zinc. One last point that should be mentioned is that this approach does show some very specific points in relation to nickel and chromium, which require more detailed analysis.

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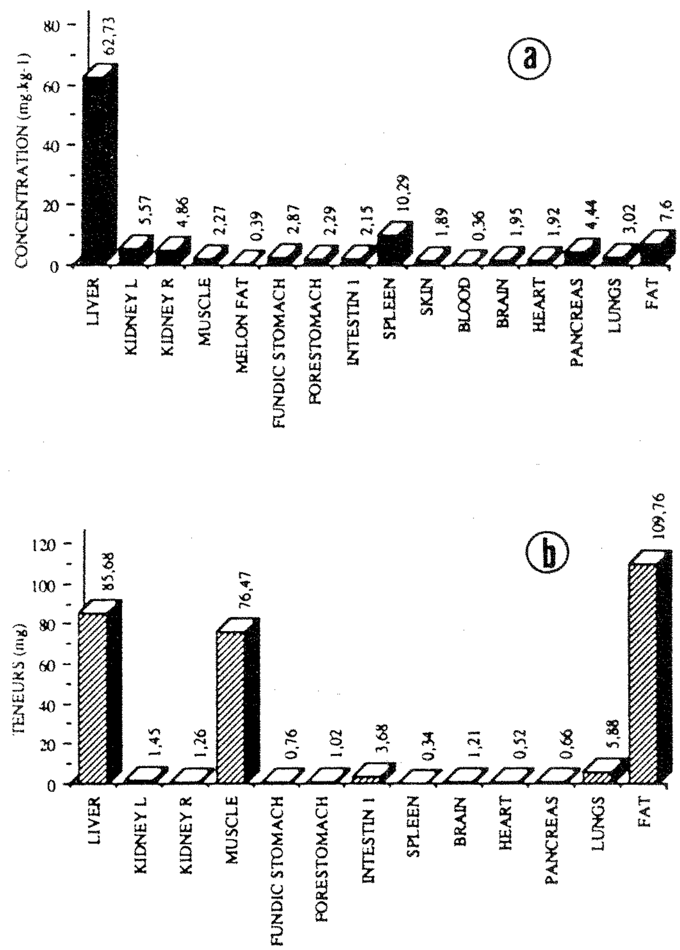

Fig. 1. Average total mercury concentrations (a) and contents (b) in each of the studied organs and tissues (*Stenella attenuata*).

PRELIMINARY RESULTS ON THE PRESENCE OF INORGANIC, ORGANIC MERCURY AND SELENIUM IN STRIPED DOLPHINS *Stenella coeruleoalba* FROM THE LIGURIAN SEA

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INTRODUCTION In this paper are reported the preliminary results obtained during a survey of the distribution of inorganic mercury, organic mercury and selenium in several tissues and organs of striped dolphins *Stenella coeruleoalba* from the Ligurian Sea.

Specimens analysed were dolphins stranded in different sites of the Ligurian coast (Fig. 1); they were collected, classified and dissected by Dr. R. Poggi of the Natural History Museum of Genova.

Muscular tissue was analysed for all samples, and, when possible, liver, heart, spleen, kidney, lung and brain were also taken into consideration.

ANALYTICAL METHODS Before analysis samples were homogenized and aliquots of homogenate were used for the various analyses. The remaining homogenate was freeze-dried and stored for further study.

Total mercury and selenium content were determined by atomic absorption spectrometry (AAS) on the solutions, obtained by mineralizing the sample with 90% nitric acid, using the cold vapours (CVAAS) and hydride generation (HGAAS) techniques, respectively.

Organic mercury was determined by CVAAS after extraction in toluene and back-extraction in L-cysteine solution (Capelli *et al.*, 1979).

The fresh weight/dry weight ratio was obtained by drying an aliquot of the homogenate in an oven at 105° C until a constant weight was reached.

Solvents and reagents used were analytical grade: 90% nitric acid was distiled just before its use. Working standard solutions were prepared daily from stock solutions commercially available. Special care was taken in cleaning the glassware which was washed with 1.5 M nitric acid.

For the analysis a Perkin-Elmer Model 560 AAS and an IL 951 AA/AE Spectrophotometer were used. Cold vapours and hydride generation accessories were studied and built by the authors.

All analyses were carried out in duplicate and for each run, two or more "blanks" obtained by the same procedure, were analysed in order to check the purity of the reagents and possible contaminations.

Accuracy for total mercury and selenium determinations was verified using Standard Reference Materials.

The analytical methodology for the organic mercury determination was verified by comparison with other laboratories.

RESULTS AND DISCUSSION An exponential correlation exists between live weight (W in kg) and length (L in m):

$$W = 14.11\ L^{2.4648} \quad (r = 0.97;\ 9\ \text{samples}),$$

which is similar to the one reported by Viale (1985):

$$W = 13.25\ L^{2.6025}\ .$$

Results obtained so far are summarized in Table 1, with the maximum and minimum values given for each of the parameters considered. These show that the total mercury concentration in striped dolphins, which are at the top of the foodchain, is very high.

Total mercury concentration increases with the size of the organism (Fig. 2), in accordance with the findings of Thibaud (1986) and Itano *et al.* (1984).

The speciation of chemical forms of mercury reveals that in fishes it is mainly present in an organic form, while in dolphins the inorganic form is predominant. This is clearly shown in Fig. 3 where organic and inorganic mercury concentrations are plotted against total mercury.

These results, if confirmed by further determinations, are very interesting because they show that the behaviour of mercury in striped dolphins is different from that suggested for tuna (Bernhard, 1985) and from that found for Atlantic bonito (Capelli *et al.*, 1987).

Figure 4 shows a similar behaviour in the liver, where the concentration of organic mercury is very high and the contribution of inorganic mercury is very low and practically constant.

Figure 5 shows a very good correlation between the molar concentration of mercury (both total and organic) and the molar concentration of selenium in the liver. This is in good agreement with data reported in the literature (Thibaud, 1986).

Research on this subject is still progressing and further results are needed in order to confirm this behaviour and to have a better understanding of the fate of mercury in the marine ecosystem.

ACKNOWLEDGEMENTS This study has been supported by the "Regione Liguria" and the "Commission of the European Communities".

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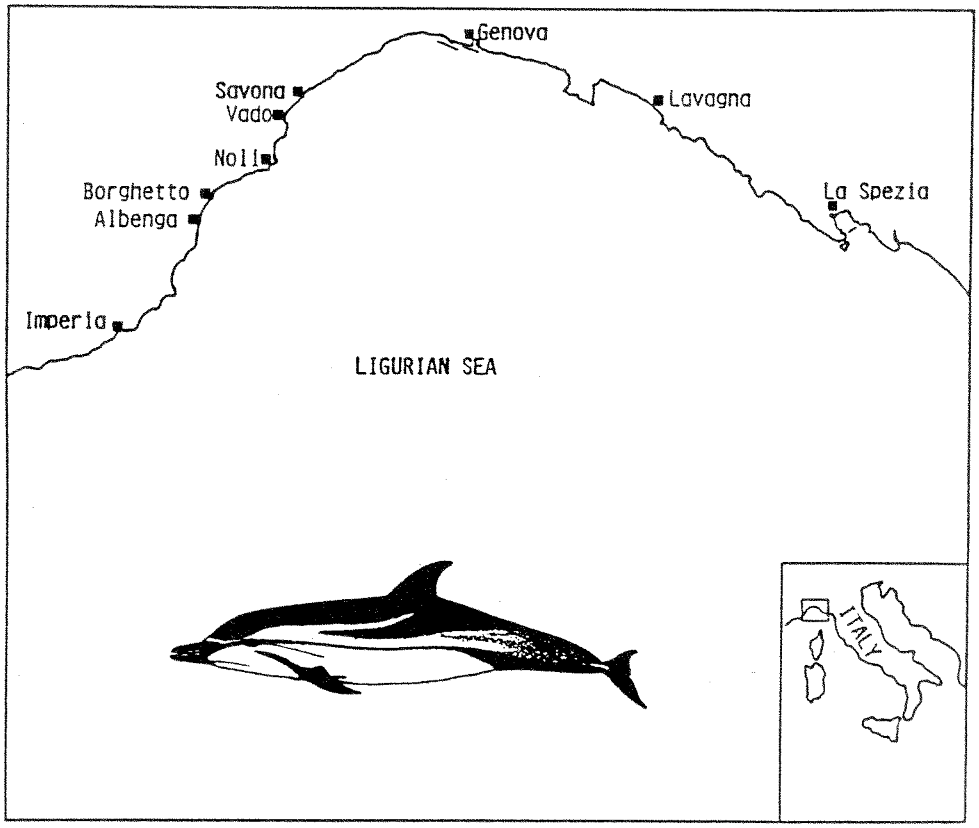

Fig. 1. Map of the study area.

Sample code	Site	Date	Sex	Weight (Kg)	Length (cm)
D005	NOLI	12/11/86	F	19	110
D004	GENOVA-QUINTO	5/13/87	M	38	159
D007	GENOVA-BOGLIASCO	6/10/87	F	74	185
D006	LAVAGNA	7/08/87	M	76	198
D001	NOLI	7/19/87	M	51	175
D002	ALBENGA	7/28/87	F	68	198
D003	BORGHETTO S.SPIRITO	11/11/87	F	51	179
D008	VADO LIGURE	5/09/88	M	91	188
D009	GENOVA-BOCCADASSE	9/10/88	F	17	108

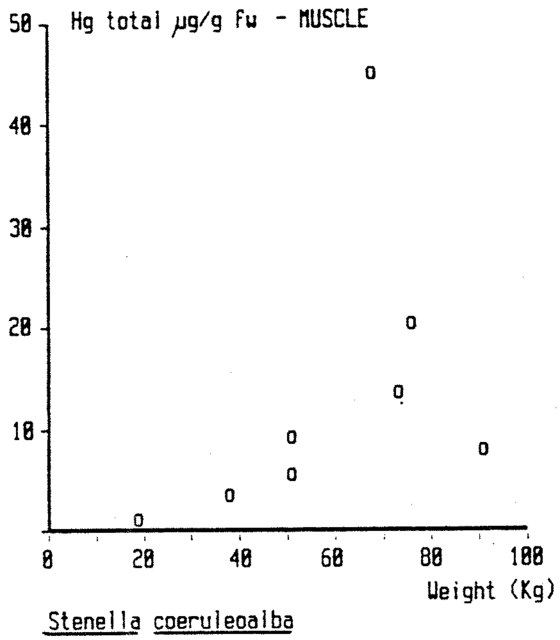

Fig. 2. Total mercury (µg/g fresh weight) versus weight (kg).

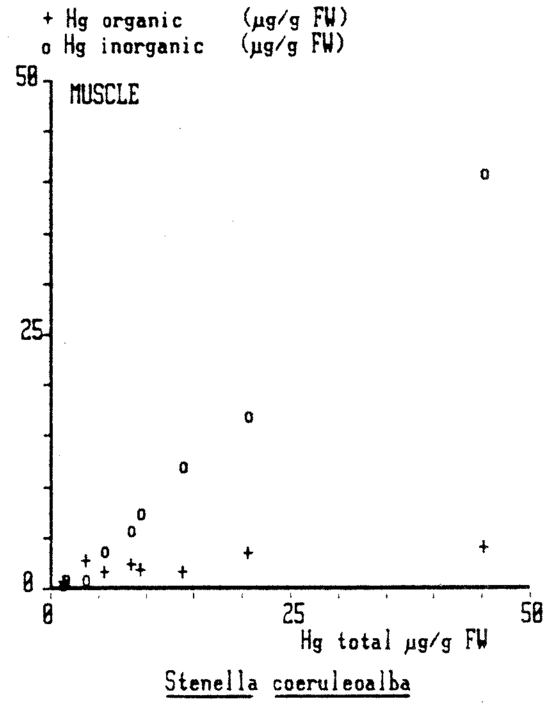

Fig. 3. Organic mercury and inorganic mercury (µg/g fresh weight) versus total mercury (µg/g fresh weight).

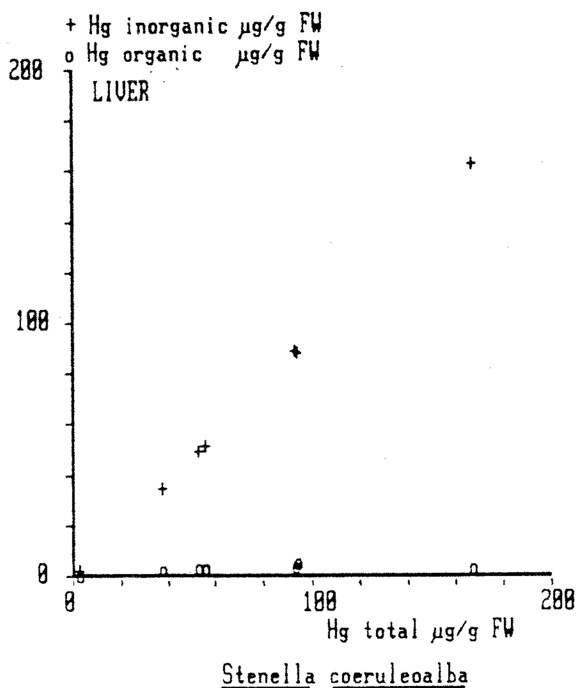

Fig. 4. Inorganic mercury and organic mercury (µg/g fresh weight) in liver versus total mercury (µg/g fresh weight).

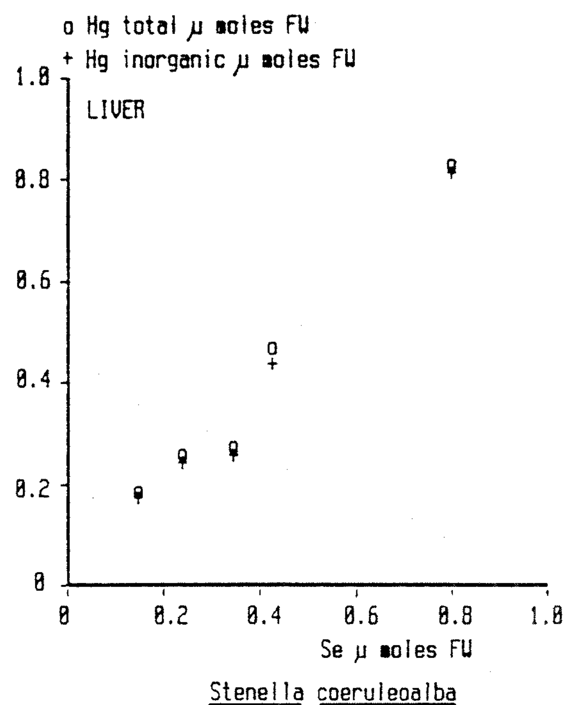

Fig. 5. Total mercury and inorganic mercury (µ moles fresh weight) in liver versus selenium (µ moles fresh weight).

Table 1. Maximum and minimum values of metal concentrations of various tissues/organs

Tissue/organs analysed		FW/DW	Hgt	Hgo	Hgi	Se	%Hgo
				μg/g fresh weight			
MUSCLE (9)	min	3.564	1.40	0.49	0.60	0.24	9
	max	4.128	45.5	4.15	41.0	19.1	77
LIVER (7)	min	3.448	3.30	0.95	2.35	11.8	2.5
	max	4.237	167	6.30	163	63.0	28.9
BRAIN (5)	min	3.564	0.56	0.42	0.14	1.20	12.7
	max	5.017	16.5	2.15	14.5	7.50	75
HEART (4)	min	3.956	1.14	0.68	0.46	-	31.5
	max	4.561	13.5	5.15	8.60	-	59.5
LUNG (5)	min	4.650	0.52	0.35	0.17	-	6.5
	max	4.946	44.5	2.8	41.5	-	67
KIDNEY (4)	min	4.744	1.20	0.58	0.64	-	13.3
	max	5.197	20.5	2.95	17.5	-	47.5
SPLEEN (3)	min	4.032	5.05	1.65	3.40	2.00	3.1
	max	4.381	110	3.50	106	49	32

The numbers (n) of aliquots of the sample analysed are given in brackets.

MERCURY, METHYLMERCURY AND SELENIUM IN ITALIAN STRANDED ODONTOCETES

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Every year, along the coast of Italy, approximately 150-200 cetaceans are found stranded, the most common species being small odontocetes (Centro Studi Cetacei, in press).

Apart from deaths caused by the nets of fishermen and by ingestion of plastic materials, we are unable to explain this phenomenon.

Our work can be considered the initial phase of a research project aimed at measuring the quantity of Hg, Hg(CH) and Se found in organs and tissues of cetaceans stranded on the Italian coasts in order to determine if mercury pollution can damage the health of Mediterranean cetaceans.

We have carried out a study of organs and tissues from five delphinids found stranded along the Tyrrhenian coast: 4 *Stenella coeruleoalba* and 1 *Tursiops truncatus*.

The results presented in Tables 1-3 are compared with those from other investigations (FAO, 1985) and with the results of a study of the levels of mercury in five odontocete species: 1 *Physeter macrocephalus*, 1 *Tursiops truncatus* and 3 *Stenella coeruleoalba*, stranded on the Adriatic coast (Fabbri *et al.* , in prep.) (see Table 4).

MATERIALS AND METHODS To determine the quantity of methylmercury, the Westoo and Magos method, as modified by Capelli *et al.* (1979), was used.

To determine the total quantity of mercury, the atomic absorption flameless method was used (Analytical Methods Committee, 1977).

RESULTS Analysis of the data revealed that the average amount of total mercury in Adriatic cetaceans (Table 4; Fabbri *et al.*, in prep.), was substantially higher than that found in the Tyrrhenian specimens (Table 1).

Whereas the highest value of total mercury in the liver of Tyrrhenian specimens was 53.6 ppm, in the livers of Adriatic specimens it was 857.6 ppm. This is probably caused by geomorphological differences between the Tyrrhenian basin and the Adriatic basin.

The percentages of methylmercury in the total amounts of mercury frequently differed from the values found in other studies (FAO, 1985), the former generally being higher than the latter.

In the only case in which the brain was analysed, the percentage of methylmercury of the total mercury content was found to be 70.5% (Table 3). This is particularly alarming because Hg(CH) constitutes the toxic form of Hg in living organisms.

The fact that methylmercury percentages are higher than expected could be related to the lack of linearity between the mercury contents, theoretically calculated by Koeman's equation relating mercury and selenium levels (Koeman *et al.*, 1973), and the values obtained experimentally.

CONCLUSIONS We believe that further, more detailed, studies should be carried out of all cetacean species found on the Mediterranean coasts, and that in order to better evaluate the effects of pollutants, further information from the specimens (for example age, weight) should be added.

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Table 1. Hg/tot. content (mg/kg of live weight)

Ref No	LIVER	SPLEEN	LUNG	SUBCUTAN FAT	MUSCLE	HEART	BRAIN	KIDNEY
1	29.40	24.40	4.30	0.47	5.34	1.88		
2	4.35	1.22		0.75				
3	4.05	Tr	4.02				3.25	
4	3.67		1.55	2.45	2.95			
5	53.60	6.00	2.23					8.60

Ref. No.: 1 - *Stenella coeruleoalba* Fregene (RM) 17/6/'85 male
2 - *Stenella coeruleoalba* Ladispoli (RM) 1/11/'85 male
3 - *Stenella coeruleoalba* Fregene (RM) 2/3/'88 male
4 - *Stenella coeruleoalba* Fiumicino (RM) 25/3/'88 female
5 - *Tursiops truncatus* Sabaudia (RM) 18/4/'88 female

Table 2. Se content (mg/kg of live weight)

Ref No	LIVER	SPLEEN	LUNG	SUBCUTAN FAT	MUSCLE	HEART	BRAIN	KIDNEY
1	7.40	1.63	3.24	7.28	4.78	3.88		
2	3.66	0.34		8.16				
3	2.04	0.52	3.87				2.44	
4	4.44		3.54	6.59	1.04			
5	8.34	2.49	1.91					0.44

Ref. No.: 1 - *Stenella coeruleoalba* Fregene (RM) 17/6/'85 male
2 - *Stenella coeruleoalba* Ladispoli (RM) 1/11/'85 male
3 - *Stenella coeruleoalba* Fregene (RM) 2/3/'88 male
4 - *Stenella coeruleoalba* Fiumicino (RM) 25/3/'88 female
5 - *Tursiops truncatus* Sabaudia (RM) 18/4/'88 female

Table 3. Methylmercury content (mg/kg of live weight) (percentage of Hg/total content)

Ref No	LIVER	SPLEEN	LUNG	SUBCUTAN FAT	MUSCLE	HEART	BRAIN	KIDNEY
1	17.60 (59.86)	13.70 (56.14)	2.98 (69.36)	Tr	2.93 (54.86)	1.06 (56.38)		
2	2.48 (57.01)	0.51 (41.46)	Tr					
3	1.83 (45.18)	Tr	2.18 (54.22)				2.29 (70.46)	
4	0.96 (26.15)	0.79	1.07 (50.96)	1.30 (43.67)				
5	24.75 (46.17)	2.06 (34.33)	1.93 (86.54)					3.71 (43.13)

Ref. No.: 1 - *Stenella coeruleoalba* Fregene (RM) 17/6/'85 male
2 - *Stenella coeruleoalba* Ladispoli (RM) 1/11/'85 male
3 - *Stenella coeruleoalba* Fregene (RM) 2/3/'88 male
4 - *Stenella coeruleoalba* Fiumicino (RM) 25/3/'88 female
5 - *Tursiops truncatus* Sabaudia (RM) 18/4/'88 female

Table 4. Hg/tot. content in Adriatic cetaceans (mg/kg of live weight)

Ref No	LIVER	SPLEEN	LUNG	SUBCUTAN FAT	MUSCLE	HEART	BRAIN	KIDNEY
1	15.01			0.16	1.95		3.00	
2			37.00		116.00		140.55	20.75
3					5.70		1.52	
4	89.66		2.30		5.75	6.90	1.15	3.45
5	827.60	287.40	59.77		57.47		26.44	

Ref. No.: 1 - *Physeter macrocephalus* Ortona (CH) 1/5/'84 male
2 - *Stenella coeruleoalba* Ortona (CH) 18/3/'86 male
3 - *Stenella coeruleoalba* Tricase 6/4/'86 male
4 - *Tursiops truncatus* Silvi Marina (TE) 25/3/'87 male
5 - *Stenella coeruleoalba* Giulianova (TE) 7/4/'87 male

MERCURY IN FIN WHALES *Balaenoptera physalus* FROM THE TEMPERATE WATERS OF THE NORTH ATLANTIC

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INTRODUCTION At present there is a lot of information concerning the accumulation of mercury in marine mammals, especially in seals and small cetaceans inhabiting coastal areas.

However, our knowledge of heavy metal incidence in baleen whales, especially those inhabiting pelagic waters, is very poor. This lack of data is mainly due to the difficulties encountered in sampling these species, which mainly come from the whaling industry, except for a few single animals found stranded.

The present work has been conducted on the fin whale *Balaenoptera physalus* inhabiting Atlantic temperate waters off Spain. The specimens studied came from the whaling activities which took place off the northwestern coast of Spain during the whaling seasons of 1983 and 1984. This population has been studied by Aguilar (1985), who made available the biological information such as age and reproductive status of the animals analysed.

The objectives of this study were:

1. To determine the distribution pattern of mercury among tissues involved in the biological processing of the metal.

2. To examine age- and sex-related variation in tissue concentrations of this metal.

MATERIALS AND METHODS Muscle, liver and kidney tissues from 75 fin whales (38 males and 37 females) have been analysed for total mercury content. Ages of the animals ranged between 4 and 84 years for males, and 4 and 49 years for females.

During flensing of the carcass, samples from pectoral muscle, liver and kidney were collected and preserved frozen at -20^{o} C, until the analysis.

Samples weighing approximately 1 g were digested for 6 hours in teflon digestion flasks, hermetically sealed, using nitric acid at 120^{o} C. Determination of total mercury was made by means of flameless atomic absorption spectrophotometry.

RESULTS AND DISCUSSION Among the fin whales examined, the highest concentrations of mercury were found in the muscle tissue followed, in decreasing order, by liver and kidney. The concentrations in the kidney were, in many cases, below the limit of detection of 5 ppm.

The mean concentrations observed in the different tissues are consistent with those found by other authors in baleen whale species (Nagakura *et al.*., 1974; Johansen *et al.*, 1980; Honda *et al.,* 1987) and are low when compared with the values observed in toothed whales and seals. This difference can be explained by the ecological characteristics of mysticetes, which are in a relatively low position in the food web and have pelagic habits.

Regarding the distribution of mercury among the tissues studied, in the fin whale muscle shows the highest concentrations, contrary to the findings for toothed whales, in which the highest mercury concentrations are almost invariably found in the liver. However, when expressed as a function of the total mercury burden, the studies conducted by Itano *et al.* (1984) on *Stenella coeruleoalba* indicate that, from a volumetric point of view, the muscle tissue again accounts for most of the total body burden. In this respect our results agree with those found by that author and indicate that the muscle tissue plays an important role in the storage of mercury, while in the liver and kidney the main role is that of metabolic and excretory processing of the metal.

In examining sexual differences in metal concentrations, no significant differences were found between males and females for any of the tissues analysed.

In the muscle, a significant linear increase in mercury concentrations with age is observed, especially in animals up to the age of 40 years. At older ages there is a decrease in mercury concentrations in this tissue. This decrease has not been observed in other marine mammal species, with the exception of the liver tissue of southern minke whales *B. acutorostrata* (Honda *et al*.., 1987). The reason for this remains unexplained. Honda *et al.* (1987) put forward the hypothesis that the observed decrease must be due to changes in the amount of mercury intake, this being greater in younger animals which consume proportionally more food than older ones, given that there is no evidence for any age-related changes in the rate of loss of mercury.

In the liver, no significant trends were found between mercury levels and age of the animal, concentrations remaining more or less stable during the entire life span. This trend is precisely opposite to what has been observed in toothed whales: the difference is possibly due to the fact that baleen whales are exposed to low concentrations of the metal and the metabolic processes of detoxification carried out by this organ are effective enough to cope with the mercury present in it.

In the kidney, although a large number of animals had concentrations below the detection limit, a significant relationship between metal concentration and age was found. Values below the detection limit were found mainly in younger animals.

A significant linear correlation was found between muscle and kidney concentrations, possibly indicating that the rate of excretion of the metal is closely related to the concentration of mercury in the body.

Table 1. Total mercury (µg/g wet weight) in muscle, liver and kidney tissues of fin whales *Balaenoptera physalus*: mean, standard deviation and range. N excludes animals with concentration values below the detection limit (5 ppm).

	N	Mean +/- S.D.	Range
Muscle	70	0.120 +/- 0.069	0.041 - 0.377
Liver	56	0.083 +/- 0.037	0.030 - 0.197
Kidney	24	0.062 +/- 0.030	0.027 - 0.136

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DYNAMICS OF DDT AND PCB IN EASTERN NORTH ATLANTIC FIN WHALES *Balaenoptera physalus*

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Blubber samples from 166 fin whales (69 males and 97 females) caught in whaling operations off the northwest coast of Spain were collected during the 1982-1985 seasons and analysed for organochlorine residue levels. When a foetus was found, the volumetrically most important organs (blubber, muscle, bone, liver, kidneys) were also sampled and their weight recorded. In lactating females, a sample of milk was collected whenever possible.

For the analysis, the tissue samples were ground with sodium sulphate and their lipid fraction extracted in a Soxhlet apparatus using n-hexane as solvent. An aliquot of the extract containing 1 ml of lipids was treated with sulphuric acid for the clean-up, concentrated and injected into a Perkin Elmer Sigma 3B gas chromatograph equipped with a fused-silica capillary column with a stationary phase SPB-1, an electron capture detector and a computing integrator, following the analytical procedures described in detail by Aguilar and Borrell (1988).

On a lipid weight basis, the concentrations (ppm) of the most important organochlorines found in the blubber were the following:

	Mean	sd	Range
tDDT	0.99	0.66	3.71 - 0.15
p.p. 'DDE	0.36	0.30	1.86 - 0.04
PCB's	1.25	0.67	4.08 - 0.17

These values are very similar to those previously detected in other North Atlantic fin whale populations (Saschenbrecker, 1973; Holden, 1975; Sergeant, 1980), but appear to be extremely low when compared to other cetaceans inhabiting the same waters. This can be explained by the pelagic habits of fin whales, their large body mass and proportionally low metabolic rate, and their feeding regime mostly on *Meganyctiphanes norvegica,* a planktonic crustacean situated low in the food chain.

DDT and PCB levels in sexually immature males were indistinguishable from those of sexually immature females but, from the onset of sexual maturity (7 years old), pollutant loads tended to increase with age in males and to decrease in females ($p<0.01$ in both cases). The relationships were not linear but in both cases tended to reach a plateau. This pattern of variation resulted in much higher overall blubber organochlorine concentrations in males than in females ($p<0.01$).

The decrease in pollutant concentrations in females is explained by transfer of DDT's and PCB's to offspring during gestation and lactation. The total quantity of pollutants passed from the mother to the body of the foetus was estimated from organochlorine tissue concentrations and their associated organ weights in 10 fin whale foetuses. By combining this estimated foetal body load with an observed pregnancy rate for this population of 0.38 (Aguilar, 1985), the average quantity of organochlorines transferred during gestation per year was estimated at 0.078 g for tDDT and 0.074 g for PCB's.

The lactation transfer per year was estimated in a similar fashion. The mean of the concentrations detected in the milk of 12 females was multiplied by the quantity of milk estimated to be produced during a lactation cycle, which for the fin whale is 13,017 kg (Tomilin, 1946). The resulting quantity was again multiplied by the observed pregnancy rate of 0.38. These calculations resulted in an average transfer per year during lactation of 0.32 g of tDDT and of 0.50 g of PCB's.

As expected, transfer occurring during lactation is much more significant to the mother than that during gestation. The decreasing trend in organochlorine blubber concentrations occurs throughout the female's life after sexual maturation. This is taken as an indication that female fin whales remain reproductively active during their whole adult life and senescence does not occur. Given that the decline in pollutant concentrations takes place soon after the onset of sexual maturity, the offspring produced in the first years of reproductive activity of any given female will receive much higher DDT and PCB loads than those being raised later in the life of the same female.

The DDE percentage was found to be correlated with the tDDT body burden, suggesting a more active enzymatic induction at higher organochlorine tissue concentrations. As a consequence of this, the DDE percentage was higher overall in adult males than in adult females. Given the fin whale's highly pelagic habits and its lower position in the food web, the DDE percentage found in fin whales is much lower than in most other cetacean species inhabiting the temperate waters of the eastern North Atlantic.

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VARIATION IN ORGANOCHLORINE POLLUTION (DDT AND PCB) LEVELS IN A NON-PRESERVED STRANDED DOLPHIN

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A large number of organochlorine pollution surveys in cetaceans have been traditionally carried out on samples from stranded individuals, which are found in variable states of freshness and from which the cause of death can often not be ascertained. The objective of the present research is to study the pattern of variation in total DDT (tDDT: p,p'-DDT + o.p'-DDT + p.p'-DDE + p.p'-TDE) and PCB's in the tissues of a fresh dolphin carcass left under outdoor conditions for 55 days.

Blubber and muscle samples (three replicates from each) from a 201 cm, 78 kg stranded female striped dolphin *Stenella coeruleoalba* were collected from the mid-dorsal region of the trunk a few hours after death and immediately analysed for organochlorines. Parallel to this, the rest of the dorsal region of the trunk was left unpreserved outside. At time intervals of 6, 13, 21, 29, 41 and 55 days after the capture date, three further replicate samples of blubber and muscle were collected and analysed.

For the organochlorine analysis, the tissue samples were extracted in a Soxhlet apparatus with n-hexane and the resultant extract treated with sulphuric acid for the clean-up. An aliquot of the purified extract was then injected into a capillary gas chromatograph following the procedures described by Aguilar and Borrell (Mar. Environ. Res., 25 (1988): 195-211).

RESULTS The lipid content of blubber and muscle fluctuated widely over the period of study without following any definite trend. These fluctuations were very likely caused by variation in the water content of the tissue, which was probably affected by the weather conditions on the days of sample collection or the days immediately prior to them, and by the conservation state of the tissue.

When expressed on a fresh weight basis, the organochlorine residue levels fluctuated strictly parallel to the changes in the lipid content of the sample. Therefore, quantification of pollutant concentrations on a fresh weight basis may be strongly affected by the particular environmental exposure conditions of the stranded carcass and should be considered completely unreliable. Pollutant concentrations expressed on the basis of the quantity of extractable lipids in the tissue remained more stable and are thus considered more reliable.

On a lipid basis, tDDT and PCB concentrations in blubber and muscle decreased significantly during the period of study, reaching values which are substantially lower than those originally present in the tissues (see Table 1). Therefore, samples from stranded, definitely non-fresh specimens are unreliable for monitoring organochlorine pollutants in cetaceans.

The pattern of change in concentrations was not identical for all the organochlorines studied. As a consequence of this, the concentration of any given chemical relative to the others varied over the period of time surveyed. The relative concentrations of p.p'-TDE and p.p'-DDE, which are well known by-products of microbial degradation of p.p'-DDT, significantly increased both in blubber and muscle, while the relative concentrations of the other compounds tended to decrease.

The tDDT/PCB ratio remained reasonably constant throughout the whole period surveyed, indicating that the rate of loss was similar for the two groups of compounds.

The concentrations of one organochlorine relative to another are important for understanding ecological processes and for determining patterns of metabolisation, excretion or reproductive transfer, or for establishing geographical differences and trends in pollutant loads in marine mammals. The above findings clearly show that samples coming from badly preserved (or unpreserved) specimens, as stranded cetaceans typically are, are likely to produce altered ratios and should thus be considered unreliable for this type of study.

Table 1. Variation in organochlorine compound concentrations (expressed as ppm on an extractable lipid basis), their associated ratios (x100), and the percentage of the original compounds remaining at the end of the 55 day period, in the tissues of a decomposing striped dolphin. Significant relationships are marked with an asterisk.

	BLUBBER			MUSCLE		
	Day 1	Day 55	% original	Day 1	Day 55	% original
Compounds:						
tDDT (except p.p'-TDE)	19.8	7.7	39 % *	10.4	6.3	61 % *
p.p'-TDE	2.2	3.4	154 % *	2.1	2.8	133 %
PCB	68.1	42.1	62 % *	67.2	39.0	58 % *
Ratios:						
p.p'-TDE/tDDT	11.0	30.8	280 % *	17.3	31.8	184 % *
p.p'-DDE/tDDT	46.3	54.3	117 % *	48.3	54.8	113 % *
tDDT/PCB	29.1	26.5	91 %	18.7	0.9	112 % *

THE WEIGHT OF INTERNAL ORGANS IN THE FIN WHALE *Balaenoptera physalus* AND ITS RELATIONSHIP TO BODY SIZE, SEX AND REPRODUCTIVE STATUS

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Weight of heart, liver, kidneys, spleen and lungs were collected from fin whales *Balaenoptera physalus* taken commercially by the whaling fishery in northwestern Spain between 1982-1985. Their relative size and growth were examined in relation to total body weight, sex, reproductive condition and, in paired organs, tested for symmetry.

During the flensing of the carcasses, organs were separated from adjacent tissues and weighed on a 1 kg precision scale, with the exception of the spleen, which was weighed to the nearest gram. Body weight was estimated for each whale from its total body length by means of the equation:

$$\text{Weight} = 0.0015\ \text{Length}^{3.46} \quad \text{(Lockyer, 1976).}$$

The organ weights of males and females and, in the case of paired organs, of those from the left and right sides, were analysed separately. The existence of asymmetry (in paired organs) and of sex-related differences, were checked by ANCOVA using body weight as a co-variable. When the slopes were not significantly different from zero, differences were checked with a t-test on the unadjusted means. Differences associated with reproductive condition in females were checked with the Newman-Keuls' test for multiple comparisons. Variation in organ weight relative to total body weight was studied by normal regression techniques. Rejection of outliers and statistical significance were set in all cases at $p<0.05$. All calculations were carried out using the BMDP statistical package.

RESULTS AND DISCUSSION Table 1 details the growth formulae adjusted to the organ weight/body weight data and the adjusted means for each organ obtained from the ANCOVA analysis.

The mass of kidneys, lungs, heart and liver increased significantly with total body mass, although they all tended to be relatively smaller in larger animals as a consequence of a reduction in metabolic rate associated with increasing body mass. The growth in weight of the spleen differed from this pattern. Apparently, it increased rapidly in juvenile animals, soon reaching its definitive weight, and remained fairly stable in adults.

Kidneys, lungs, heart and spleen had a similar weight in males and females. On the contrary, the liver was significantly heavier in females than in males, the reason for this being unknown. Fat deposits were observed to occur in kidneys and heart (Aguilar *et al.*, 1988) and, therefore, the weight of these organs was affected (though not greatly) by reproductive and nutritional states.

Both kidneys and lungs showed asymmetrical weights. Left kidneys were larger than right ones. This asymmetry would tend to displace the centre of gravity slightly to the left side and may be significant to the fin whale's habit of swimming on one side while feeding (Mitchell, 1975).

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Table 1. Growth formulae and mean weights for internal organs of fin whales

Organ	N	Equation	Adjusted mean weight (±sd)
KIDNEYS			
Males			
Right kidney	16	y = 11.38 x	61.6 (±2.32)
Left kidney	15	y = 6.673 x	69.9 (±2.40)
Females			
Right kidney	32	y = 8.433 x	68.9 (±2.81)
Left kidney	33	y = 4.662 x	76.8 (±2.77)
LUNGS			
Males			
Right lung	10	y = 538.70 x	110.8 (±5.90)
Left lung	10	y = 57.94 x	97.7 (±5.90)
Females			
Right lung	13	y = 2.441 x	120.4 (±5.87)
Left lung	15	y = 4.368 x	112.6 (±5.46)
LIVER			
Males	43	y = 50.73 x	400.6 (±12.4)
Females	64	y = 37.06 x	463.4 (±10.1)
HEART			
Males	57	y = 21.86 x	169.0 (±3.64)
Females	109	y = 16.91 x	171.9 (±2.58)
SPLEEN			
Males	44	y = 0.198 x	3.71 (±0.24)
Females	59	y = 2.473 x	2.97 (±0.21)

VISUAL ACCOMMODATION IN CETACEANS

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The capability of dolphins to use their eyes in both water and air has puzzled scientists for a long time. The optical properties of both media are very different and would require a powerful accommodative mechanism to adjust the refractive state of the eye to the environment it is used in. However, studies of the anatomy of the cetacean eye complex have shown a complete or nearly complete reduction of the ciliary muscle, which in other mammals indirectly acts on the shape of the lens and thus accounts for changes in focal length of the eye. Additionally, if dolphin eyes are studied under laboratory conditions, none or very slight accommodative changes in focal length of the imaging system can be observed. Those findings have led to the conclusion that cetaceans cannot accommodate and various attempts have been made to explain their capability of amphibious vision without an accommodative mechanism. An investigation of dolphins using their eyes in air under rather natural conditions, however, provided evidence that the animals do accommodate in a way hitherto unknown. Based on the anatomy of the cetacean eye complex, which appears unusual in many respects, we propose a mechanism that can account for amphibious vision.

In terrestrial mammals, the cornea is usually the most powerful optical element of the eye due to the prominent difference in refractive index between the ocular media and air. In water, the situation is different in that the optical densities of water, the cornea and the aqueous humor are similar. In adaptation to the requirements of aquatic vision the cetacean eye has become very fish-like. In order to focus incident light on the retina, lenses of aquatic eyes must account for the entire refractive power of the imaging systems and consequently are very powerful. In dolphins, the lens is nearly spherical and is composed of much denser material than in terrestrial mammals. In parallel with the lenses of fish eyes, the cetacean lens has become rigid and has lost the ability to change its shape.

If an aquatic eye is exposed to air, a considerable amount of refractive power is added to its optical system, since the cornea becomes functional in the same way as in terrestrial eyes. This would lead to severe shortsightedness if there were no accommodative mechanism to compensate for the surplus of refractive power. An elegant way round this problem is a flat cornea that has no refractive power either in water or in air. In dolphins studied under laboratory conditions in air, however, the cornea was found to be considerably curved and its surface was further distorted by an irregular layer of viscous mucus secreted by extraocular glands. In that state, the eye is completely useless for detailed vision.

In our experiments, priority was given to minimal irritation of the animals in order to study aerial vision in dolphins under more natural conditions. One animal in turn was ordered to put its chin in one hand of a trainer such that the eyes were about 30 cm above the water surface. The second hand was shown to the animal at distances from the eye ranging from about 70 cm to less than 20 cm. Reflections on the cornea of a rectangular array of light sources were photographed from a distance of about 70 cm. Local radii of corneal curvature were calculated from the spacings between neighbouring reflections, the dimensions of the apparatus, and its distance to the eye under investigation. Two bottle-nosed dolphins *Tursiops truncatus* kept at Duisburg Zoo, West Germany, were tested in the described way. We concentrated on the more co-operative individual, however, in order to obtain an amount of data large enough for statistical analysis.

Under the conditions of our experiments, distortion of the corneal surface by secretions of extraocular glands was nearly absent, restricted to the very margins of the cornea. Three states of the eye were differentiated by the position of the displayed hand of the trainer and by the behaviour of the animal:

(1) "Far off" viewing distance (>70 cm).
(2) "Close up" viewing distance (>20 cm).
(3) "Blocked" accommodation due to irritation of the animal by close approach of the hand (<20 cm).

The third state of the eye was distinguishable by partial lid closure and by an apparent rotation of the eye.

In the "blocked" state of the eye, our results closely resemble those of other studies in that the corneal curvature was nearly spherical. In the two other states of the eye, however, prominent depressions occurred, leading to regions of much lower curvature in the cornea. Although the restricted amount of data did not allow a detailed reconstruction of corneal shape, we estimate that areas of low curvature roughly coincide with the oblique axes of gaze of dolphin eyes (Fig. 1).

Considerations about the peculiarities of the anatomy of the dolphin eye complex may help to understand how changes in corneal curvature are achieved and why the underlying mechanism could escape notice for such a long time. The rear part of the eye consists of a very thick sclera. Proximally there is a large plexus of vessels embedded in connective tissue, the ocular rete mirabile. The rete is enclosed between the four parts of a strong rectractor bulbi muscle. If the retractor muscle contracts, the rete will be compressed between the muscle itself and the sclera. The resulting raised blood pressure can be transmitted to the interior of the eye via numerous connections existing between the vessels of the rete and the thick, rete-like choroid (Fig. 1).

In an anaesthetized bottle-nosed dolphin, intraocular pressure was found to be extraordinarily high when compared with the human eye. A pressure of 65 to 72 mm Hg, as observed in the dolphin, would cause irreversible damage to the human optic nerve at the lamina cribrosa where the former leaves the eye. However, no such damage could be found. That finding gives further support to the idea that there is an equilibrium of pressure between the interior of the dolphin eye and the ocular rete mirabile behind it. In the case where the retractor muscle is relaxed, pressure in the whole system will drop. Now the cornea is no longer pushed outward and can attain a shape showing the characteristic depressions found in our experiments during undisturbed aerial vision. The assumption that the retractor muscles are relaxed during aerial vision is in agreement with observations that the eyes of dolphins protrude when used in air.

Retraction of the eyes also serves protective purposes. If a dolphin is irritated by close inspection of the eye or by translocation to the laboratory, it may retract its eyes and thus block the mechanism that makes aerial vision possible. That seemed to occur in our experiments when the hand of the trainer came too close to the eye. Correspondingly, the cornea was as curved as found in studies dealing with dolphins under laboratory conditions.

With the exception of some freshwater species, the anatomical features crucial to the proposed mechanism have been found in all cetacean eyes studied to date. It therefore appears to be a common achievement for both odontocetes and mysticetes.

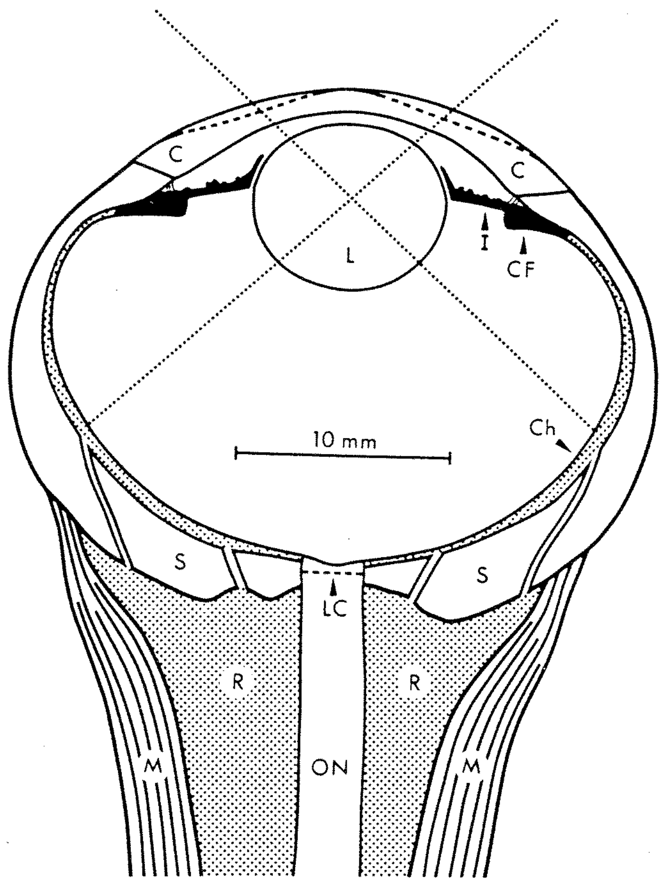

Fig. 1. A horizontal section through the harbour porpoise *Phocoena phocoena* eye, schematically drawn on the basis of histological slices and measurements of intact eyes. Though smaller, the harbour porpoise eye is very similar to that of the bottlenose dolphin *Tursiops truncatus*. Dotted lines represent the two directions of gaze in each eye as derived from distribution of ganglion cell density. The broken line gives a qualitative impression of the outer contour of the cornea during vision in air.

C: cornea, **Ch:** choroid, **CF:** ciliary fold, **I:** iris, **LC:** lamina cribrosa, **M:** musculus retractor bulbi, **ON:** optic nerve, **R:** ocular rete mirabile, **S:** sclera.

THE BEHAVIOURAL AUDIOGRAM OF THE BOTTLE-NOSED DOLPHIN

Tursiops truncatus - A SURVEY OF METHODS AND PROBLEMS

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Suggestions for a standard recording method Dolphins have to rely on a very advanced hearing system to analyse their own echolocation sounds. There are many aspects of hearing that need to be studied in order to get a better understanding of these capacities. All of them should be based on the hearing sensitivity for continuous tones: the basic audiogram.

Many factors can cause unwanted variation in a behavioural audiogram. For this reason the recording methods should be strictly standardized to be able to make reliable comparisons:

(1) The ambient noise levels in the experimental pool should be recorded together with the audiogram, in a standard band width (e.g. 1/3 octave), to estimate their masking effect.

(2) Echoes can cause variations in the sound pressure field around the dolphin's head. They can be reduced by projecting the sound beam at an angle with the walls, and by using sound-absorbing materials.

(3) The duration of the test tone appears to be of influence on the hearing thresholds (Johnson, 1968): with increasing tone duration the hearing thresholds decrease until an asymptotic value is reached. To obtain the asymptotic value for each frequency, the tone length should not be shorter than 1 sec.

(4) Sound transmission in dolphins occurs through the external auditory meatus as well as through the fat-filled mandibular canals in the lower jaw. For the latter pathway there appears to be an optimum angle of incidence for sounds. To be able to compare audiograms, the angle of incidence should be standardized.

(5) To be able to test many dolphins, the training and testing method should be reliable and easy. The "go/no go" procedure in which the dolphin is required to respond immediately on hearing the test tone, turns out to be a satisfactory standard method.

(6) The definition of the hearing threshold as "the intensity level at which the subject gives a positive response in 50% of the presentations, assuming that it is trained to respond in 100% of the cases in which it hears the tone", should be made universal.

Comparison between three audiograms of *Tursiops* Figure 1 represents the three behavioural audiograms of *Tursiops* that are recorded so far. Although there seems to be some variation between them, especially in the lower-frequency region, at least part of this variation can be explained by the different methods and definitions used. The audiogram recorded by Van Pijlen (1989) is higher overall than that recorded by Johnson (1966). However, the hearing angle used in the former study was far from optimal, and in cases where the dolphin was allowed to choose her own hearing angle the obtained thresholds are in closer agreement with the audiogram given by Johnson. The fact that the audiogram recorded by Ljungblad *et al.* (1982) is overall much higher than the two other audiograms may be partly caused by the different definition of the hearing threshold that was used by Ljungblad *et al.*

Conclusions So far there seems to be only little intraspecific variation in the audiogram of the bottle-nosed dolphin, since at least part of the existing variation can be explained by the different methods and definitions used. However, we can only be sure of this when the recording methods are strictly standardized. Maybe this will enable us to understand a little more about one small aspect of the "Mystery called Dolphin.........."

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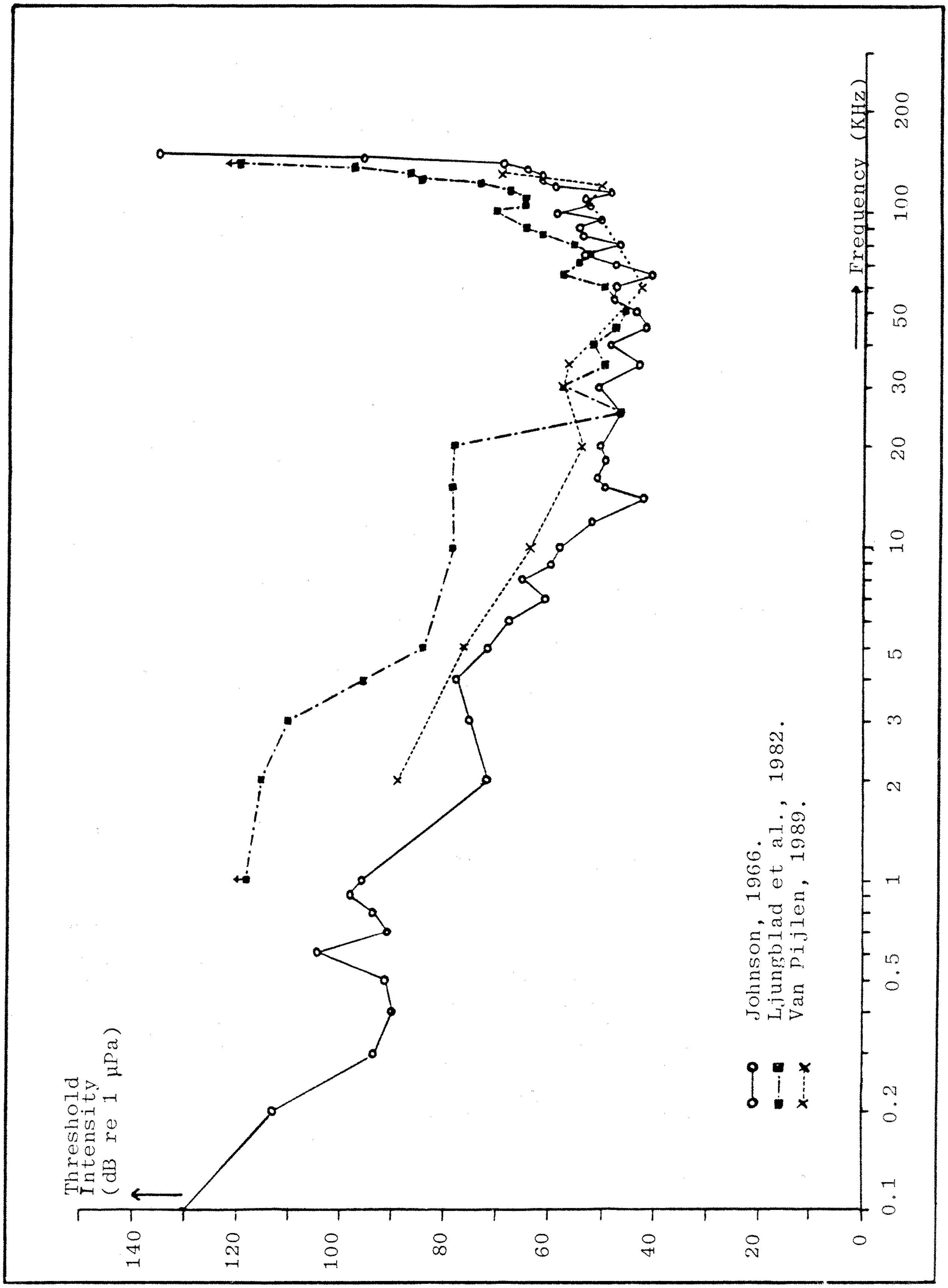

Fig. 1. Comparison of behavioural audiograms of *Tursiops truncatus*.

FURTHER EVIDENCE FOR THE CETACEAN MAGNETIC TRAVEL STRATEGY

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INTRODUCTION The cetaceans (whales, dolphins and porpoises) appear to use the flux density of the earth's magnetic field in two ways as an aid to travel. The topography of the local field is used as a map, with the animals generally moving parallel to the contours. A timer, based on the regular fluctuations in this field, allows the animals to monitor position and progress on this map. The animals do not use directional geomagnetic information, for example as we do with our magnetic compasses.

Statistical evidence for this travel strategy has come from the positions and timing of live strandings around the UK coast and from similar studies elsewhere (Klinowska, 1988). The question of a suitable receptor for such geomagnetic information has yet to be solved, despite early hopes for a system based on magnetite. Behrmann's (1988) recent report of structures in the tongue similar to the electroreceptors of some fish is interesting. Unfortunately the published histological supporting evidence is inadequate, but the idea may be worth following up.

Other sources of information on cetacean behaviour are being explored in order to gain further insights into this travel strategy. Among these are records of the drive fisheries for long-finned pilot whales (*Globicephala melas* - formerly known as *G. melaena*) in the North Atlantic.

The fishery in the northern British and western Irish islands, which died out about the turn of this century, may be as old as that in the Faroe Islands, but is far less well documented (Klinowska, 1987). The earliest written records are in the Court Book of Shetland (1602-1604). Later information comes from scattered references, including a few eye-witness accounts. However, even these limited data indicate a minimum annual take of a similar order of magnitude to that in the Faroes.

MATERIALS AND METHODS The thirty named driving beaches in Orkney and Shetland provide the opportunity to explore their geomagnetic characteristics in a simple quantitative manner. All except three of these beaches are shown on the Ordnance Survey maps to have a sandy area and all have some kind of land access and a settlement in the vicinity. As a control, the entire coastline of islands with at least one named driving beach was examined and all other beaches with sandy areas, land access and a settlement in the vicinity noted. There were 90 such beaches in total. Another person (with no knowledge of which were driving beaches or control beaches) scored each beach as to whether there was access from the sea if animals moved parallel to geomagnetic contours.

RESULTS Of the 27 named sandy driving beaches, 22 (81%) were scored as having access via parallel contours and 5 (19%) without. Of the 90 control beaches, 63 (70%) were scored as having such access whilst 27 (30%) did not. Chi-square (with one degree of freedom) was 5.52 ($p<0.05$), showing that the driving beaches were significantly more likely to have access via parallel geomagnetic contours.

DISCUSSION Two detailed eye-witness accounts of whale drives further illustrate the situation. Gorrie (1886) was staying with the minister while visiting the island of Stronsay, Orkney in the early 1860s. Their breakfast was interrupted one morning by the news that the bay was full of whales. The minister and his guest ran to the garden, to see a crescent of boats about a mile from the shores of Mill Bay below, with a school of pilot whales in front. More boats were arriving and people flocked to the shore. Unfortunately, when the whales were only a quarter of a mile away, some lads dashed out in a small rowing boat in front of the animals. At this, the school turned, rushed past the line of boats and away around the Odness headland. The boats followed and, having reached a new vantage point, Gorrie saw the whales calmly swimming in front of the boats towards Lamb Head. The minister said that they were "almost certain to take a snooze in Rousholm Bay, which is the best whale trap I know in Orkney". The gentlemen then retired to a nearby farmhouse, where they "quenched" their thirst with "liberal draughts of home-brewed beer" and borrowed ponies to ride to Rousholm Bay (Bay of Holland on modern maps). On arrival, they saw some 150 whales were rounding Torness Point, while the rest had disappeared west into Stronsay Firth. At the entrance to the bay the whales again appeared ready to flee, but instead of turning and rushing to the open sea, they dashed rapidly forwards on to the beach where the killing took place.

Figure 1 shows that there is access to Mill Bay from the northwest following parallel geomagnetic contours, which seems to lead towards the southern corner of this bay, just below the minister's house. The flight path out to Odness crosses the contours, but once clear of land, the contours could be followed north or south. Perhaps the boats to the north encouraged the whales to move south on this occasion. Unfortunately, the observers seem to have been having their beer when the turn at Lamb Head was reached, and we have no information as to whether any difficulty was experienced in persuading the animals to move west rather that continue south, as would be expected from the set of the geomagnetic contours. One might also expect there to have been some difficulty in keeping the whales away from the sandy beaches between Lamb Head and Torness. However, the loss of part of the school to the west after this area was passed does fit in with the run of the contours, as does the slight difficulty described in persuading the animals to take the contour route into the bay. It is perhaps interesting to note that 90-100 pilot whales were live-stranded in this bay on 22 April 1950 (Klinowska, 1987).

Hibbert (1822) had just landed at Burravoe on the island of Yell, Shetland in 1820 or 1821, when a fishing boat arrived with the news that a school of pilot whales had entered Yell Sound. The usual excitement followed and the whales were soon seen at the entrance to the Sound, swimming quietly before a semi-circle of boats which followed them at a distance of about 50 yards. A second group of boats waited to intercept the whales, should they change their course. "The sable herd appeared to follow certain leaders; who, it was soon feared, were inclined to take any other route than that which led to the shallows (at Hamnavoe) on which they might ground. Immediately, the detached crews rowed with all their might, in order to drive back the fugitives, and, by means of loud cries and large stones thrown into the water, at last succeeded in causing them to resume their previous course". This happened again before the animals could be compelled to enter Hamnavoe harbour. Despite shouts and stone-throwing, the whales again turned several times and had to be driven back before some could be beached, and the rest followed.

It is not entirely clear from the description whether the whales entered the part of Yell Sound in the vicinity of Hamnavoe from the south or from the north. However, the difficulty in driving the whales into Hamnavoe can be understood, because the geomagnetic contours do not lead in this direction (Fig. 2). Indeed, the entire route from the entrance to the beach crosses contours. This is, however, the only sandy beach in the southern part of the island, and this is probably why the local people went to so much trouble to drive the whales in here. The fact that, almost uniquely in descriptions of pilot whale drives in the North Atlantic, two groups of boats were used, indicates that the people were familiar with the difficulties and had learned to overcome them. No subsequent live strandings of pilot whales are recorded in Hamnavoe (Klinowska, 1987).

From these descriptions it can be seen that, although in general, driving was easier when the animals were moved parallel to the geomagnetic contours (and thus the preference for driving beaches with this characteristic), it was quite possible for experienced crews to drive the whales wherever it was required. Since the whales will flee without reference to the geomagnetic contour routes when alarmed, disturbance of schools could be another way in which animals can take the "wrong turnings" which may lead to live strandings. Since they can be driven by experienced crews without reference to the geomagnetic contour route, this method could also be used for averting live strandings or for rescue purposes.

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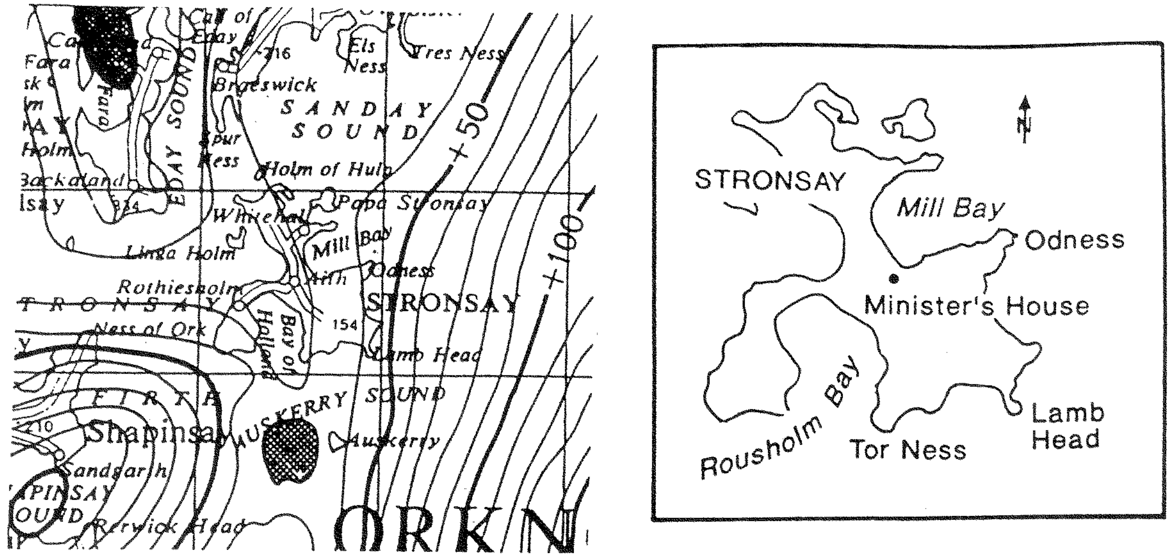

Fig. 1. The island of Stronsay, Orkney. Place names mentioned in the text are shown in the sketch map on the right. The left-hand map is a section from the British Geological Survey Aeromagnetic map. Geomagnetic contours are at 10 nanoTesla (nT) intervals and grid squares at 10 km intervals.

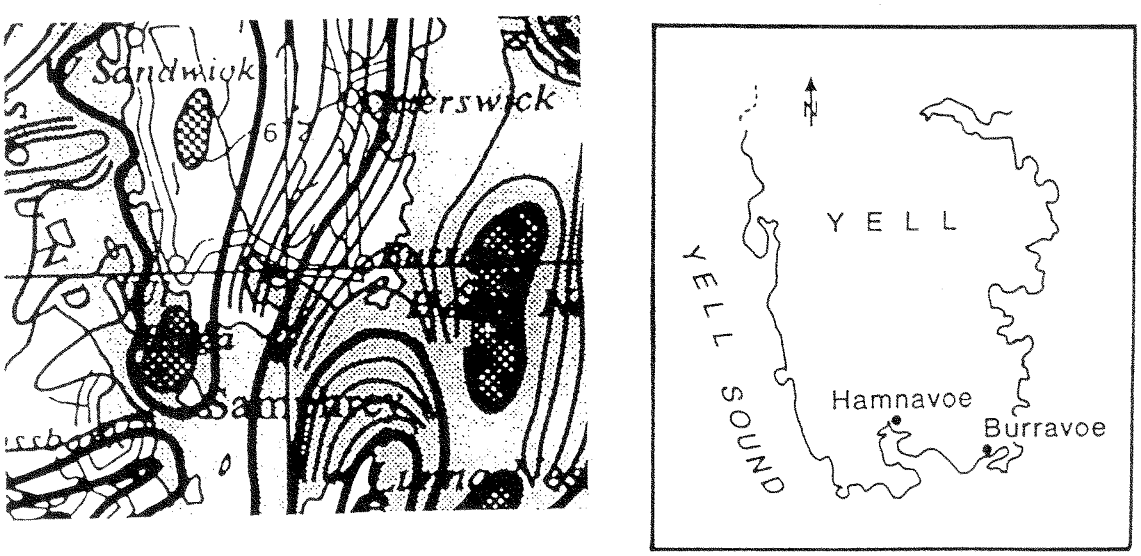

Fig. 2. The island of Yell, Shetland. Place names mentioned in the text are shown on the sketch map on the right. The left-hand map is a section of the British Geological Survey map magnified to demonstrate the situation more clearly.

ESTIMATING CETACEAN POPULATION PARAMETERS FROM INDIVIDUAL RECOGNITION DATA

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Individual recognition has been used for a long time as a way of following particular animals in behavioural studies. In cetacean research, animals are "marked" by a photograph of their natural markings. Sets of photographs taken in the same time period in the same area can be used as samples of a population allowing the techniques of capture-recapture analysis to be employed. If sufficient data are available and the assumptions of the statistical models are satisfied, individual recognition data can provide us with estimates of abundance, survival rate and rate of population increase. That such information can be obtained from whale populations in this way has been increasingly realized over the last few years, and in 1988 the International Whaling Commission co-sponsored a conference and workshop on the subject.

Using markings as natural tags has several advantages over conventional tagging methods such as branding, mutilation or the attachment of an artificial object. Most importantly for whales, the animals do not have to be physically handled. The marks are natural and therefore cannot affect behaviour. In the case of whales, they cover a large area, making them much easier to see than a man-made tag. The markings are permanent and cannot fall or wear off. There are disadvantages too; the markings could change with time, rendering a photographed animal unrecognizable at a later date; there is the chance that two or more animals are so similarly marked that they are effectively indistinguishable, and the process of recognition and matching takes longer and is potentially more likely to result in errors.

The advantages are important ones. Conventional tagging studies are frequently adversely affected by the need to handle the animals, by the reaction of the animals to the tag itself, and by tag loss. The disadvantages are real too, but have so far not proved too much of a problem. Studies of right and humpback whales have found that changes in markings over time were small and insufficient to prevent recognition of a previously recognized animal by a skilled researcher. It has also been found that although errors are made in identification, they are rare and would not significantly affect analysis of the data. The probability of "twins" in the population is a function of population size and the amount of information in the markings. Although there seem to be relatively few distinguishing marks on some species of whales, there is redundant information in most that have been studied so far.

Photo-identification studies of cetaceans began in earnest in the early 1970s with research on right whales at Peninsula Valdés, Argentina. Work on killer whales in coastal waters of British Columbia and Washington State, and on humpback whales in the western North Atlantic began soon afterwards. These are the three best known studies, but there are many others of potentially equal importance which have begun during the last 10 years.

MIGRATORY ROUTES AND POPULATION IDENTITY The ability to identify an individual animal allows patterns of movement and migratory pathways to be explored simply by photographing samples of animals at different places. This may also provide information on the identity of sub-units within populations. The best example of this is the humpback whale.

In the North Atlantic, extensive studies by several workers have established that humpbacks migrate annually from breeding grounds in the Caribbean to several distinct feeding grounds in higher latitudes. Individual whales mix together on the breeding grounds but consistently return to the same feeding ground. In the North Pacific, humpbacks migrate annually between breeding grounds off Hawaii and Mexico, and feeding grounds off California and Alaska. Our current state of knowledge indicates that whales from each breeding ground may migrate to each feeding ground, and vice versa, but that individuals are faithful to a particular ground at both ends of the migration.

POPULATION SIZE Photo-identification data are ideally suited to fit within the framework of capture-recapture analysis and estimates of population size have been made for several species of cetaceans using these methods. Humpback whale abundance has been estimated by several researchers. Estimates have also been made for right whales, bowhead whales, blue whales and bottle-nosed dolphins.

The population must be defined properly in capture-recapture studies. Sampling must be representative. It may be less obvious that every effort should be made to try to ensure that all animals have an equal probability of being captured during any one sampling occasion. Unequal capture probabilities as a result of inherent differences among individuals (often referred to as heterogeneity) is probably a factor in any capture-recapture study. The greater chance of recapturing animals with high capture probabilities biases the number of recaptures upwards and leads to underestimates of population size.

SURVIVAL RATES The Jolly-Seber open population model is also an ideal basis for estimating survival rates. These are calculated as ratios between successive pairs of population estimates, taking account of births. It is again important that model assumptions are satisfied and, as with population size, the most important considerations are heterogeneity of capture probabilities and temporary emigration.

Buckland has described a method of minimizing the effects of heterogeneity in estimating survival rates for Gulf of Maine humpback whales. The method involves selecting cohorts of animals seen for the first time in a given year and following their capture histories in subsequent years. The earliest and latest survival estimates are likely to be biased and are discarded. Buckland calculated an average survival rate per annum of 0.95 (95% confidence interval of 0.93 - 0.97) for Gulf of Maine humpbacks - the best estimate so far available of survivorship for a large whale. Buckland was able to obtain such a good estimate of survival rate only because there was a long series of data available (1979-1986) and because the average probability of sighting was high. Such data sets are currently rare but, as time progresses and existing studies continue, they will become more common.

Juvenile survival Humpback fluke patterns have been found to change in the first year or two of life and animals are not usually considered part of the marked population until they are two years old. Consequently, estimates of survival rates calculated from such data are not applicable to young animals. As in all mammals, juvenile survival is expected to be lower than adult survival. How can this be estimated?

One suggestion, for species which follow an annual north-south migration, is to see whether females identified with calves on the breeding grounds still have their calves with them when they are re-identified on the feeding grounds some six months later. This is currently being investigated for North Pacific humpback whales and for California gray whales. If juvenile survival can be estimated in this way it will only be for the first six months of life, but this would be a good start for a population parameter which has so far only been guessed at for large whales.

POPULATION RATE OF CHANGE Individual recognition data provide information from which two useful reproductive parameters can be estimated: birth interval and age at first reproduction. Birth intervals are obtained from series of sightings of cows with or without calves. Age at first reproduction is obtained from observations of animals as calves and subsequently with calves themselves for the first time. Clearly, long series of data are necessary to estimate these parameters, but this has been done for Gulf of Maine humpback whales and southern right whales.

A theoretical study by Barlow has put these data into the framework of a model to estimate population rate of change; that is, rate of growth or decline. The model also requires estimates of survival rate such as calculated by Buckland. Barlow found that the variability in his estimates of rate of change due to the reproductive part of the model was quite small for long series of data with high capture probabilities.

Despite the early stage in development, it is already clear that we can be optimistic about the likelihood of being able to use such models to estimate population rates of change in the future. This will be most useful for monitoring the recovery of severely depleted populations such as the right whale.

CONCLUSIONS It is evident that in order to calculate estimates of population parameters using photo-identification data from whales, long series of data are necessary. Estimates become less biased and more precise the longer the data set. Some data sets are already long enough to attempt analyses (Argentine right whales, Gulf of Maine humpback whales, Gulf of St Lawrence blue whales) and with continued commitment others will become so. High average probability of capture is also important to allow precise estimation. That is, as many animals should be photographed as possible. Currently, few data sets satisfy this condition but if interest in photo-identification studies continues to increase and more resources are made available, sample sizes should also increase. There is more work to be done to develop the most appropriate models to estimate cetacean population parameters from photo-identification data. An encouraging trend is the development of specialized models for particular populations using all available information. I believe that, in ten years time, with the continuation of the advances already made, photo-identification data and perhaps other individual recognition data will regularly be used to estimate whale population parameters. As a result, cetacean biologists will, for the first time, be in a position to consider population models for certain species in which many of the critical population parameters are more than just educated guesses.

HISTORICAL STATUS CHANGES OF CETACEANS IN BRITISH AND IRISH WATERS

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INTRODUCTION There is a long tradition of interest in natural history in Britain and Ireland. Indeed, a number of local natural history societies have been in existence for one hundred years or more, publishing regular local journals. This has provided a very useful literature source of information on cetaceans in past times. In an attempt to reconstruct historical status changes of cetaceans in Britain and Ireland, we have carried out as exhaustive a review as we could of archival material (Evans and Scanlan, 1989). The bulk of the literature searches was done by Gina Scanlan.

METHODS All local natural history societies, museums, and county archivists were approached for historical records; very many books and selected local newspapers were scanned as well as complete series of all the journals we could think of that might be relevant. This latter task involved checking through several thousand issues of over a hundred journals. All records were put onto a computer data base, and filed regionally by species. Where possible, records were separated into strandings, bycatches, directed captures and sightings.

RESULTS Records in some cases dated back to the tenth century. However, for the present analysis we have confined ourselves to the period from 1840 to the present.

Since 1913, the British Museum (Natural History) has managed a scheme for the recording of strandings (Harmer, 1914-27; Fraser, 1934, 1946, 1953, 1974; Sheldrick, 1976, 1979). This considerably improved the coverage although our review was able to add a number of records, particularly from Scotland. Nevertheless, there will obviously still be some omissions from the literature search, and there may be various biases which are to a large extent unknown and therefore impossible to correct (see Klinowska, 1985 for a review). However, despite dealing with a crude data set, we believe that one can at least identify **large** status changes, note patterns between species, and make some sense of those changes at least for particular species.

Large baleen whales Many of the large whales were subject to intensive exploitation in the region during the latter part of the last century and early part of this century (Thompson, 1928; Brown, 1976). Catches increased rapidly and then in most cases fell dramatically, and it was concluded that stocks of those species had been over-exploited.

Whaling stations started up in Scotland (in Shetland and the Outer Hebrides), and in Ireland (on the coast of Co. Mayo). Fin whale *Balaenoptera physalus* was the main species taken. Together with sei whale *B. borealis* and blue whale *B. musculus*, they showed a decline in catches from 1903/4 to 1914 when the war provided a respite. Catches then increased temporarily but quickly dropped again before the whaling stations ceased operating at the end of the 1920s. Catches of humpback *Megaptera novaeangliae* and right whales *Eubalaena glacialis* were much lower, populations probably having already been much depleted by the start of modern whaling.

Strandings of fin, sei, blue and humpback whales all peaked during the period of local whaling activities although they were probably under-recorded during the nineteenth century, due to uncertainty of identification. Indeed, a number of strandings were reported with insufficient details to verify specific identification, and so were not included in the present analysis. There have been no strandings of blue or right whales since the 1920s although there has been one recent humpback stranding.

Other whales When whaling for the large baleen species ceased or became reduced, activities in the region shifted to smaller species such as minke whales *Balaenoptera acutorostrata* and northern bottle-nosed whales *Hyperoodon ampullatus*. This involved primarily Norwegian and Icelandic vessels although they hunted also in UK waters, and anyway very probably removed individuals from the populations summering around Britain.

Minke whales showed a steady increase in strandings during the present century. This may reflect a true population increase after relaxed competition, with the reduction in numbers of its larger competitors. During much of this century, numbers of northern bottle-nosed whale strandings in Britain have varied little, except most recently when there has been a decline. If this reflects a real population change, it might be the result of over-exploitation after intensive whaling by Norwegians although clearly other factors cannot be excluded. Both species, being large and conspicuous, are unlikely to be greatly overlooked and so we can probably be confident that the records are a good representation of numbers coming ashore.

The sperm whale *Physeter macrocephalus*, being large and conspicuous, is probably another well- recorded species. There are in fact documented records of this species, accompanied by drawings, going back to the tenth century. During the last two decades there has been a substantial increase in strandings. This is unlikely to be a by-product of the whaling industry, since whaling activities largely ceased over this recent period. It is also paralleled by a recent increase in sightings in the region.

Bias due to under-recording is also unlikely to be a major problem for the long-finned pilot whale *Globicephala melas,* except perhaps in western Ireland. This species has also shown substantial increases in strandings since the 1960s, which correspond closely with quantified effort sightings data (see Fig. 1). However, both strandings and sightings indicate a decline during the 1980s. Major fluctuations in numbers have occurred in previous centuries when the species was hunted mainly in the Northern Isles and the Outer Hebrides. Similar fluctuations have been reported for the Faroe Islands by Høydal (1985) (see also Evans and Nettleship, 1985: 442).

Dolphins and porpoises Biases through under-recording are likely to be a much greater problem with smaller cetaceans. In the nineteenth century, prior to the British Museum stranding scheme, there were rather few documented records. A number of species, notably common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba,* Cuvier's beaked whale *Ziphius cavirostris*, and True's beaked whale *Mesoplodon mirus,* all showed peaks in numbers stranding during the 1920s and 1930s. Significant oceanographic changes were taking place at this time, with a stronger inflow of Atlantic water to the North Sea and Channel, along with higher sea surface temperatures. Such changes have been well documented (Southward, 1980; Russell *et al.,* 1971; Russell, 1973; Southward *et al.*, 1975; Cushing, 1982) and several people have linked cetacean strandings to those changes (see for example Fraser, 1934; Sheldrick, 1979). These conditions were reversed from the 1940s to the 1960s but have returned to the previous conditions since then (Southward, 1980; Colebrook, 1985). Strandings of those species also declined during the 1940s to 1960s, increasing again since then.

Both the white-beaked dolphin *Lagenorhynchus albirostris* and Atlantic white-sided dolphin *L. acutus* also showed peaks in strandings during the 1920s and 1930s, followed by a decline in the 1940s and 1950s, then subsequent increases.

The bottle-nosed dolphin *Tursiops truncatus* is another species which showed peaks in strandings during the 1920s and 1930s. Peaks in numbers recorded for various dolphin species during this period may help to account for widespread anecdotal comments by older people living along the coast who so regularly remark on the relative absence of dolphins nowadays compared with when they were young (i.e. just at the time of the peaks). During recent decades, we may therefore have been simply returning to the status quo after unusually favourable conditions. Since the 1940s, many regions have seen declines in bottle-nosed dolphins recorded, although in some cases they suggest a shift in distribution. The species appears to have become rare along the south coast of England and in the northern Irish Sea. On the other hand, it is not uncommon around the Channel Islands, Normandy and Brittany coasts, and in Cardigan Bay in the southern Irish Sea.

Most data exist for the harbour porpoise *Phocoena phocoena,* the most commonly recorded and widely distributed cetacean in British and Irish coastal waters. It is probably also the most under-recorded of stranded species, particularly along Atlantic coasts and in the Northern Isles. Like other small cetaceans, the harbour porpoise shows peaks in strandings in most regions during the 1920s and 1930s. These were followed by declines during the 1940s and 1950s, followed by increases once more along the Atlantic coasts and in the northern North Sea but continued declines in the southern North Sea, the Irish Sea and Channel.

Using our substantial sightings data set (see Evans *et al.,* 1986) we have been able to identify where porpoises are concentrated around UK coasts, and from quantified effort data collected through the year, we can determine the seasonal peaks in occurrence. Those results are summarized in Fig. 2 and coincide closely with areas identified by fisheries biologists as known concentrations of spawning herring *Clupea harengus.* Although the relative importance of various fish species in the diet of porpoises is not well known, herring have certainly figured highly in stomach contents examined by various observers (see for example Lindroth, 1962; Rae, 1965).

In past centuries, North Sea herring formed an important basis for the economy of most West European nations (see Hodgson, 1957; Hardy, 1965). During the early years of the present century, huge fleets numbering some two thousand drifters operated in the southern North Sea from Yarmouth and Lowestoft. With continued intensive exploitation, there were spectacular declines in catches (and stock size) particularly during the 1950s and 1960s.

Three major herring stocks are recognized in the North Sea. Each shows status changes at different times depending upon the stock. Using population curves derived from fisheries biologists (see Burd, 1978; Saville & Bailey, 1980), we have picked out the major periods of increase or decline of the different stocks, taking data also for the stocks in the western Channel and northern Irish Sea. These are plotted along with peaks and troughs of porpoise strandings for those coastal areas occupied by a particular stock of herring (Fig. 3). They show a surprisingly good correspondence, and lead one to suspect that the major changes in herring numbers were at least partly responsible for the observed status changes in coastal porpoises over the last fifty years or so. Very recently, herring stocks have been showing signs of recovery, following protection from exploitation, and if they are playing a role in the presence of porpoises in British coastal waters, then we might predict increases in porpoises observed in those regions in the coming years. It should be noted incidentally that changing status of porpoises is not necessarily equivalent to a change in population size. It may simply reflect a movement elsewhere, out of these coastal areas.

CONCLUSIONS We believe that strandings data can be useful in detecting status changes of some cetaceans. They are obviously better for large cetaceans than small ones where numbers reported may be seriously biased by various factors which are difficult to control. To overcome the problem of increasing numbers stranding reflecting increased mortality, we think that in the absence of hunting the greatest bias comes from bycatches from fishing activities, and we recommend that these should be distinguished where possible from other strandings. Finally, such strandings data are best used to complement monitoring schemes using sightings data where biases of effort, etc. can be more readily quantified and corrected. Consideration should also be given to the effects of increasing effort in reporting of strandings, which will obviously influence results and may lead to an increase in strandings.

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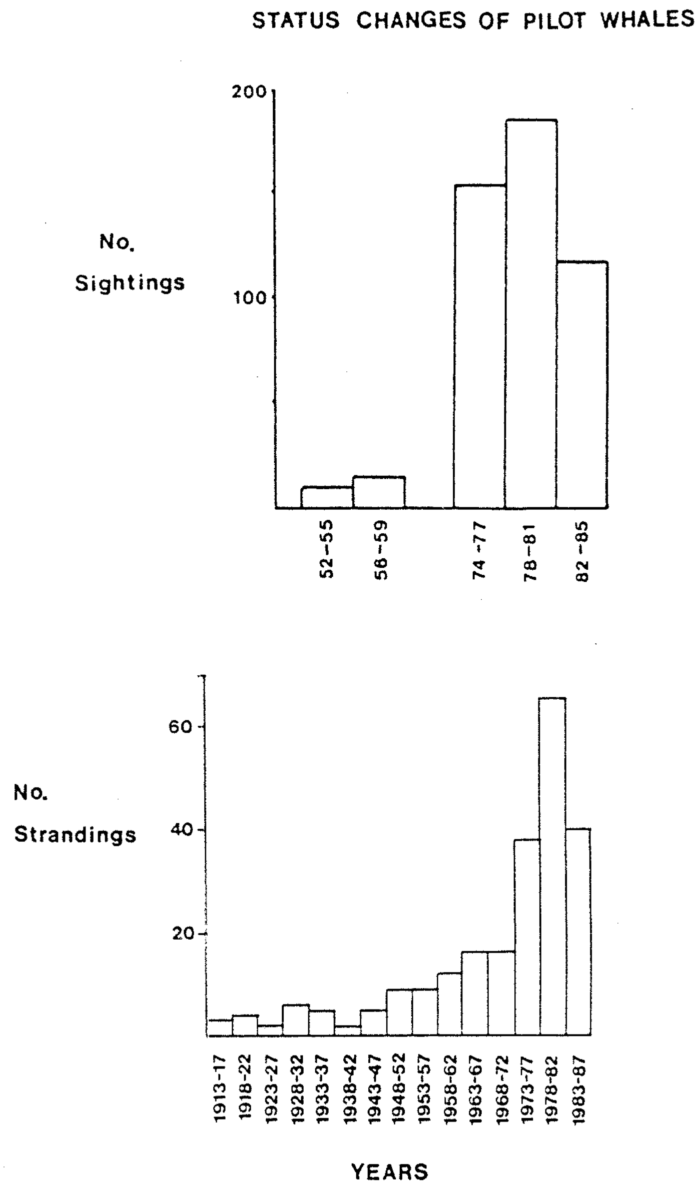

Fig. 1. Status changes of pilot whales.

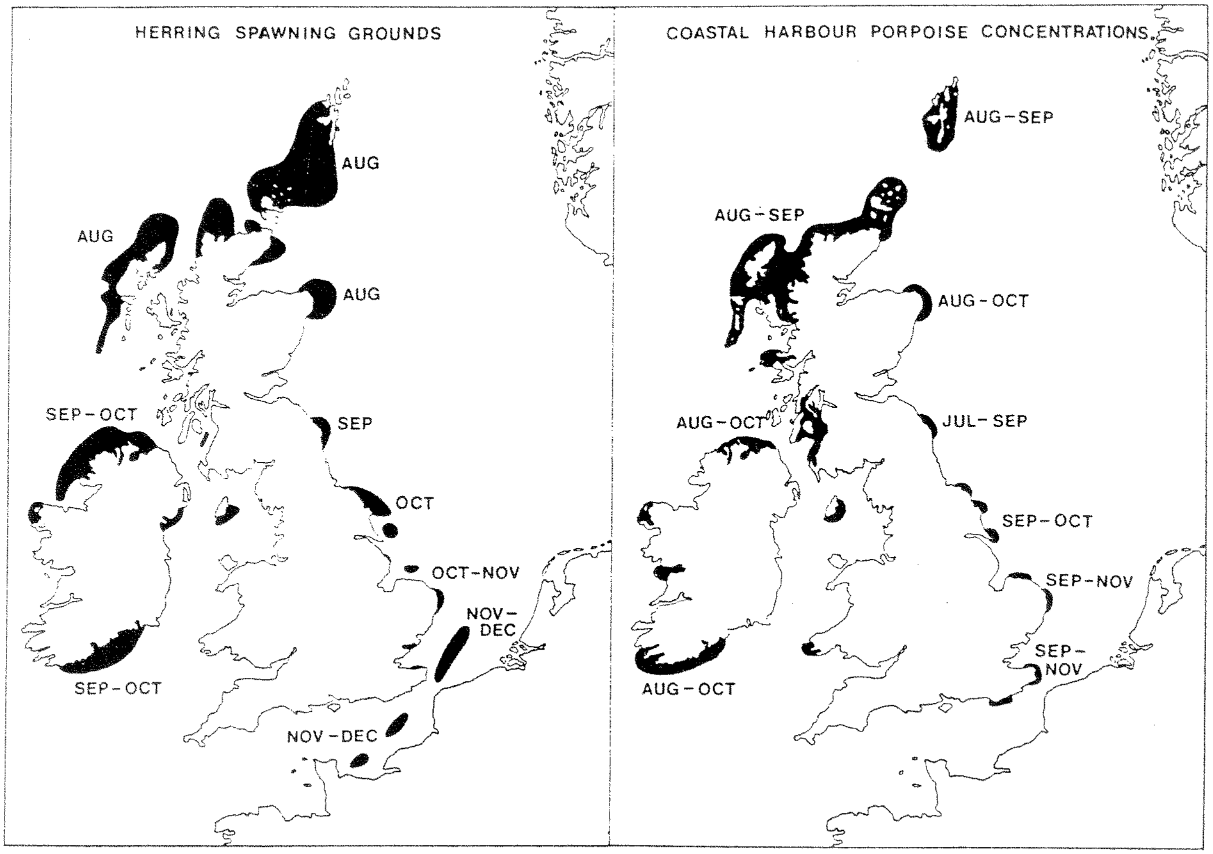

Fig. 2. Herring spawning grounds (left) and coastal harbour porpoise concentrations (right).

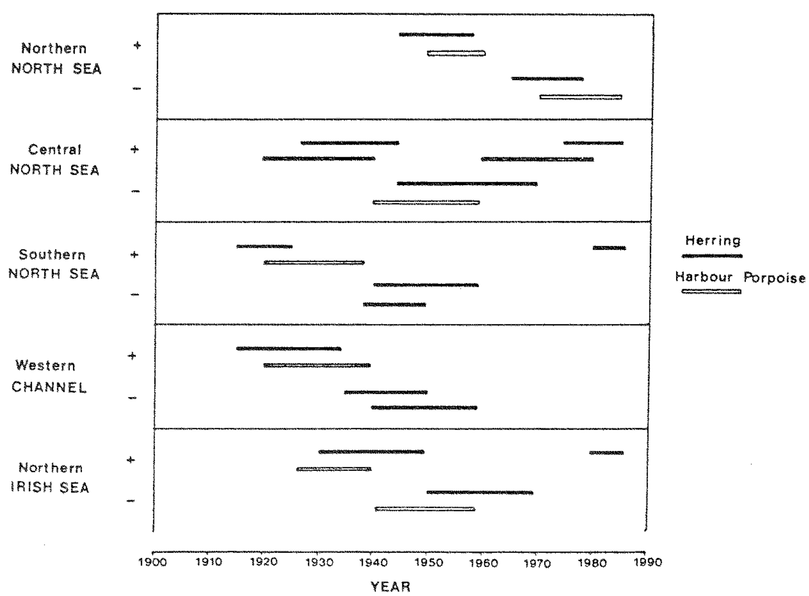

Fig. 3. Timing of major changes in herring stocks and harbour porpoise strandings.

RESEARCH ON ORCAS *Orcinus orca* OFF THE MID-NORWEGIAN COAST

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INTRODUCTION The orca *Orcinus orca* regularly occurs along the Norwegian coast. When herring *Clupea harengus* concentrate in the fjords to spawn and winter, orcas follow their path to feed. For this reason orcas were hunted up to 1982, so that the herring could be reserved for human consumption. The size of the orca stock and how it was influenced by this hunt, is at present unknown.

Nord-Val was started in September 1986 by a group of enthusiastic biologists and biology students, who wanted to contribute to our knowledge of Norwegian orcas. The methods used, photographic and acoustic identification of free-living whales, have been copied from the successful work carried out by Michael Bigg and his co-workers in Vancouver, Canada.

Our first season in the Møre area (1987/88) has given us a lot of practical experience and some field material.

OBJECTIVES The primary objective is to repeatedly identify the orcas in the area by means of photographic and acoustic identification, thereby increasing our knowledge of the whales in the area and their population dynamics.

The results from the Canadian research, which show stable pod units that migrate regularly, are not automatically the same in Norway. However, there are sufficient similarities in feeding habits and vocalization patterns to assume similar models for the organization of orcas in Norway.

Closely associated with our main objectives are aspects of social structure, interrelations between pods, behaviour and vocalizations in general.

PHOTOGRAPHIC IDENTIFICATION Our field work in the winter season 1987/88 consisted of several trips north of Kristiansund, in the area between Vinjefjorden, Auresundet and Gjerdesvika. We had a total of three encounters with orcas, and group sizes ranged up to 20 individuals.

The photographic field data provided 4 ID-photos of "scientific" quality, and another 10 photographs (catalogued as second order ID-photos), from which further individuals can be identified. One whale has been positively re-identified between the first and the last trip, i.e. November and January.

ACOUSTIC RECORDINGS The Canadian work on orcas reports each pod as having a repertoire of stereotyped pulsed calls that to some extent is pod-specific, and the degree of similarity in vocal repertoires reflects the degree of association between pods.

Such stereotyped calls are highly represented in all the recordings, especially those obtained when the whales were feeding.

In our first acoustic analysis we have found the same type of sound categories that by "Canadian" standards are categorized as pulsed calls, indicating the possibility of acoustic identification of the whales in the area.

CONCLUSIONS Though Nord-Val is an ideal way to organize orca research, totally depending on the participating biologists' enthusiasm, this group's main importance is that it is one of the pioneer working groups in "benign" cetacean research in a nation dominated and influenced by commercial whaling. Nevertheless, the work and the aims are built upon a scientific basis with the objective that the project, with time, will establish a well-working and more traditionally founded research program on Norwegian orcas.

The program has been redesigned, not using the expensive sailing vessel "Norem", which was used during the pilot test trip to Norway in September 1987. Instead, kind assistance has been given by the Fisheries Control Service of the Norwegian Institute of Marine Research in Kristiansund and Nord-Val. Hopefully such teamwork will make orca research in Norway more efficient and economic and at the same time encourage new approaches even more suitable for similar research on cetaceans in this part of the world.

DISTRIBUTION OF BOTTLE-NOSED DOLPHINS

Tursiops truncatus IN NORMANDY (1979-1988)

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The analysis of 500 sightings and 24 strandings of bottle-nosed dolphins *Tursiops truncatus* in Normandy during ten years (1979-1988) shows that the species is regularly present on the west coast of Cotentin but very rare on the eastern side.

Tursiops travel and feed following the depth contours from 0 to 10 m. Groups, comprising often more than ten individuals, alternate periods of gathering and dispersion. They gather in areas ranging from 1 to 20 km^2, but occupy a total area of about 2600 km^2 in summer.

In winter, bottle-nosed dolphins are rarely seen around the islands and reefs. They move towards the continental shore in spring and the travel southward. In summer, they use the whole area but in autumn return to the northwest, away from coastal waters.

It appears that a correlation exists between the presence of bottle-nosed dolphins and of some seabirds, and also with specific boat activities.

During the same season, or during several successive seasons, subadults used the whole area studied, whilst at the same time an old adult stayed within a small area of 70 km^2.

In the Bay of Mont Saint Michel, depending on the time of the tide, the dolphins follow a curved route whose pattern, proximity to the shore and direction change with the tide coefficient.

Strandings may occur throughout the year, but do not correspond with the geographical seasonal distribution of sightings: they occur in the southern part of the area from January to June while the dolphins are sighted in the north, whilst strandings occur in the middle quarter from July to October when they are mainly sighted further south (40% are fresh carcasses probably coming from the local population).

In spite of the large number of sightings analysed, many parameters remain to be studied to explain the distribution of bottle-nosed dolphins in Normandy, in particular why they are so rarely observed off the east coast.

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SOME SIGHTINGS OF CETACEANS IN THE WESTERN MEDITERRANEAN SEA

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Although the common species of cetaceans in the Mediterranean Sea are well known, it is still difficult to specify their geographical and seasonal distribution and to estimate their population size. This paper presents the first stage of a program intended to improve our data on Mediterranean dolphins and whales, and conducted in co-operation with the Centre National d'Etude des Mammifères Marins of La Rochelle.

METHODS Sightings are made from a 30' sailing vessel with a crew of two or three persons. From March to November 1988, ten weeks have been spent on station and 49 days at sea, in an area covering the southeast coast of France and the surroundings of Corsica and Sardinia, 5 to 20 miles off the coast. The techniques for observation include minimal use of the inboard motor, and intensive use of photography, while emphasis was put on maintaining contact whenever the sea state and animals allowed such an approach.

Thirty identifications have been recorded from 10 July to 27 November; they include four sightings of *Balaenoptera physalus,* 12 of *Stenella coeruleoalba* and 11 of *Tursiops truncatus*, while *Grampus griseus* and *Globicephala melas* were met once and a probable *Delphinus delphis* also once.

RESULTS Fin whales *Balaenoptera physalus* were observed until 30 October west of Corsica, either singly or in groups of two or three individuals. Sightings took place over depths of 400 to 2500 metres and at distances of 6 to 45 miles from the Corsican coast; a subadult was recorded east of Cap Corse, heading north at a speed of 6-8 knots, while other animals were stationary or cruising slowly. A group of three individuals, including one of 8 m long, showed a strong interest in the ship and allowed contact for 50 minutes.

Striped dolphins *Stenella coeruleoalba* were observed up to 27 November in groups averaging fourteen animals with a maximum of approximately 40 individuals. Sightings took place over depths of 500 to 2500 metres and at distances of 6 to 50 miles from the coast. Calves were visible in eight schools, a group on one occasion being composed only of mother and calf pairs. Several groups have been spotted chasing fish, other groups interacting strongly with the ship and her crew, breaching together close to the ship's bow. When the motor was used to keep contact, the dolphins were reluctant to come very close; on the contrary, while sailing, even mothers with newborn calves approached the bow. Lobtailing was observed but it remains unclear whether this behaviour was caused by the ship's presence close to the group.

Bottle-nosed dolphins *Tursiops truncatus* were observed in July and August off the east and west coasts of Sardinia, and the east coast of Corsica, in groups ranging from one to eight individuals. Sightings occurred over depths of 40 - 180 metres and distances to the coast ranged from one to fifteen miles. Calves were observed in five schools, and one group was swimming amidst trawlers; two relatively large schools were met close to important harbours (Alghero and Bastia). They appeared to enjoy the ship's proximity and seemed to be fearless when our motor was used; interactions consisted of breaching and protracted presence near the ship's bow.

Risso's dolphins *Grampus griseus* were observed in August, six miles off Cap Corse over a depth of 1000 metres. The prolonged contact provided the opportunity for a detailed determination of the group's structure: there were two mother-newborn calf pairs, two subadults and two large individuals. Various scars occurred on the adults' back, while two of them had a very distinctive dorsal fin. The animals demonstrated curiosity towards the ship and her crew, showing interest as we dived among them. During the contact they maintained a very low speed even when we decided to use our motor.

Long-finned pilot whales *Globicephala melas* were observed on 30 October, 12 miles west of the Corsican coast over a depth of 2500 metres. Bad sea conditions prevented us from making good contact, one large animal coming close to the ship and two other individuals being visible at a distance. The school was heading south, moving fast against the wind.

DISCUSSION AND CONCLUSIONS Animals were observed in their usual habitats. However, our sighting of three fin whales in late October leaves us to cast doubt upon the seasonal migrations of *Balaenoptera physalus*; at least part of the population must migrate very late in the season. The program will be continued from March 1989.

Table 1. Cetacean sightings in the western Mediterranean Sea, 1988

Date	Ref. No.	Sp.	Gp Size	Depth (m)	Shore Dist.(m)	Wind	Sea	Calves	Notes
10.7	1	S.c.	6/8	2000 +	40	2	Good	Yes	
10.7	2	D.d.	4/5	2000 +	50	3	Good	No	uncertain identity
23.7	3	T.t.	7/8	55	2.5	1	Calm	Yes	
24.7	4	T.t.	3	100	1.5	2	Good	No	
01.8	5	T.t.	3	80	3	1	Calm	Yes	
02.8	6	T.t.	5	150	3.5	0/1	Calm	Yes	amid trawlers
02.8	7	T.t.	3	150	4.5	3	Good	No	diving
07.8	8	T.t.	1	70	2	2	Good	No	feeding
07.8	9	T.t.	7	40	3.5	0	Good	Yes	near a harbour
09.8	10	T.t.	6	90	3.5	2	Good	No	
10.8	11	T.t.	3	180	15	2	Good	No	
13.8	12	S.c.	15/20	600	6	3	Good	?	
15.8	13	T.t.	6	100	5	0	Calm	Yes	
15.8	14	T.t.	8/10	80	1	3	Good	Yes	near a harbour
16.8	15	B.p.	1	400	6	0	Calm	No	sub-adult
16.8	16	S.c.	30/40	500	6.5	1	Good	Yes	feeding
18.8	17	S.c.	16/20	2000	16	4	Rough	Yes	mothers & calves
19.8	18	G.g.	8	1000	5	1	Good	Yes	diving
26.8	19	S.c.	3/6	800	7	5	Rough	?	
26.8	20	B.p.	2	2500	42	3	Good	Yes	
27.8	21	B.p.	1	2500	45	1	Good	?	moonlight
27.8	22	S.c.	6/8	2500	45	1	Good	?	moonlight
28.10	23	S.c.	12/15	2000 +	15	0	Calm	?	moonlight
28.10	24	S.c.	15/18	2500	50	0/1	Calm	Yes	
28.10	25	S.c.	14/16	2500	50	0/1	Calm	Yes	
30.10	26	G.m.	3/8	2500	12	5/6	Rough	?	
30.10	27	B.p.	3	2500	20	4	Rough	Yes	1 hour contact
30.10	28	S.c.	12	2500	30	3	Good	?	feeding
27.11	29	S.c.	8	1500	6	1	Calm	Yes	
27.11	30	S.c	6	1000	6	0	Calm	Yes	motor used

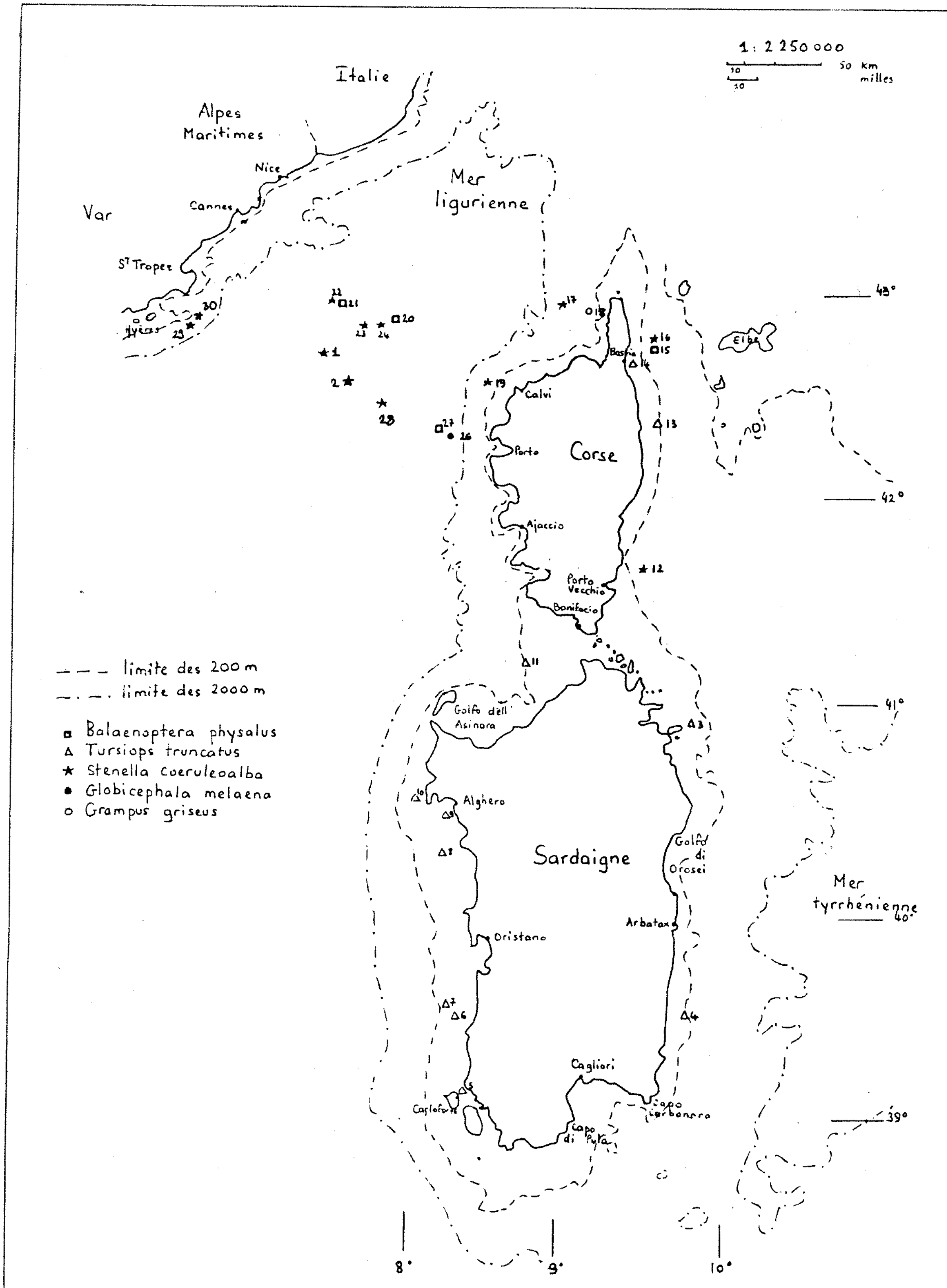

Fig. 1. Distribution of sightings in the western Mediterranean.

FALSE KILLER WHALE *Pseudorca crassidens* - A RARE STRANDING FOR THE ITALIAN COAST

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The false killer whale *Pseudorca crassidens* is assumed to be a species of the Mediterranean fauna; nevertheless, data relating to the occurrence of this toothed whale are extremely fragmentary and rare.

If we consider the strandings recorded on the Italian coasts, we have few records to report. The first one dates back to 1877, at Palermo (Sicily); only the skull was preserved (Riggio, 1982). A second specimen was found near Genova (northern Italy) in 1883 (Vinciguerra, 1926; Arbocco, 1969); the skeleton is exhibited in the Natural History Museum of Genova; until 1988 it was the only complete skeleton of this species in Italian *natural history museums. In 1900, two specimens were caught in Sicilian waters* (Vinciguerra, 1926); the skulls were preserved in the Natural History Museum of Calci (Pisa). In 1926, another stranding on the Calabrian coasts (southern Italy) was reported (Vinciguerra, 1926); unfortunately no skeletal material was collected or preserved. A possible bycatch of two specimens was reported in 1978 in the southern Tyrrhenian Sea (Di Natale, pers. comm., Progetto Cetacei); since neither photographs nor skeletal material were collected, we lack evidence on the specific identification. On 20 May 1988, a false killer whale, 460 cm long, stranded on the beach of Gela, in the southern part of Sicily.

The specimen had died some time before; the typical dark pigmentation of the species had completely disappeared. Injuries on the body, which might have explained the cause of death, were not found. The local authorities organized the immediate removal of the animal from the beach, and the Natural History Museum of Milano was later alerted through the centralized network of the Centre for Cetacean Studies. After a few days, the false killer whale, buried in a rubbish dump, was disinterred under our supervision.

The specimen, a male, was in an advanced state of decay. The caudal portion of the body appeared strangely deformed: the dorsal line showed a slightly sigmoid shape back to the dorsal fin. This was due to a malformation of the backbone. The last lumbar vertebrae (8-9-10 L) and the first caudal ones (1-2-3-4-5-6-7 Ca) showed imposing arthritic processes that had caused the deformation of the spinal column, and its irregular line.

During the autopsy, we found that the first stomach was full of food remains. Most of them consisted of bony parts of different fish; we also found some Cephalopoda beaks of considerable size. We are still analysing this material in order to provide an accurate description.

After the osteological studies, the skeleton was assembled for exhibition to the public.

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UNUSUAL NUMBER OF CETACEAN BYCATCHES IN THE LIGURIAN SEA

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Since 1983 we have collected data concerning the cetaceans of the Ligurian Sea, particularly in the western part of the area shown in Fig. 1.

In this connection, last summer, we collected data on the interactions between cetaceans and fisheries, the results of which have given rise to concern. In fact, in just two months, many cetaceans were found either still alive, entangled in nets, or dead because of them. The facts reported in this paper could, with certainty, be related to one particular type of fishing gear: drift nets. In Table 1, the events are listed chronologically; they occurred mainly in August and September, with a total of 37 specimens. In some cases (number 1,7,13 and 27), the cetaceans were carried to the harbour and studied at the Museum of Milano.

The numerous by-catches occurred only in summer months in the Ligurian Sea because it was only during this period that boats using drift nets were operating in the area. In fact, if we observe the distribution of the sightings of animals entangled in or injured by the nets (Fig. 1), we can see that they are concentrated in an area where forty boats were present. Beside this, the start and end of cetacean bycatches in this zone coincide with the arrival and departure of the fishing boats using drift nets.

The situation is worsened by the fact that most of these boats operate in the Ligurian Sea just when the concentration of cetaceans is particularly high.

Last summer there was a great increase in the number of bycatches, correlated with the recent increase in the number of fishing boats using drift nets. However, the data in our possession are only a portion of the many by-catches which certainly have occurred.

A summary of the bycatches, divided by species, is given in Table 2. Thirty-seven specimens were caught in only two months. The most numerous species caught was the striped dolphin *Stenella coeruleoalba* which is also the most frequent cetacean in this area. Nevertheless, large cetaceans, such as sperm whales *Physeter macrocephalus,* were also found entangled in the drift nets. The smaller odontocetes were usually found dead, whereas the medium- and large-sized ones were released still alive when a timely action was possible (for example the sperm and pilot whales). Unfortunately, only a small percentage of the total number was found still alive and promptly saved.

We know that these bycatches are numerous elsewhere along our coasts where fishing boats with drift nets operate, but the low number of collaborators prevents us from having a detailed and updated view of the situation.

The list of data collected by Italian researchers concerning cetacean strandings and bycatches are published yearly through the Centro Studi Cetacei reports.

In 1988, the number of bycatches with drift nets in our area, 37 specimens, represents 50% of the total number of animals entangled in all Italian seas. It is a very serious problem if we consider that in our area we have only a low percentage (6%) of the 700 boats operating in the Italian seas. Since drift nets are legally authorized in our country, we have few possibilities to stop them and to avoid these bycatches.

We are trying to promote a restriction on the use of drift nets in order, at least, to reduce the number of bycatches, and European action on this matter is urgently needed.

Table 1. Cetacean bycatches in August , September and October 1988 in the Ligurian Sea

Number	Date	Co-ordinates	Species	No. of specimens	Notes
01	11.08.88	43° 17' N 007° 45' E	*Globicephala melas*	3	still entangled in the net; one dead, two released
02	12.08.88	43° 24' N 007° 37' E	*Globicephala melas*	1	still alive, entangled in net; released
03	12.08.88	43° 23' N 007° 29' E	*Globicephala melas*	1	still alive, entangled in net; released
04	16.08.88	43° 03' N 007° 35' E	*Stenella coeruleoalba*	2	dead
05	17.08.88	43° 05' N 007° 24' E	*Stenella coeruleoalba*	2	dead
06	17.08.88	43° 35' N 008° 04' E	*Stenella coeruleoalba*	1	dead
07	17.08.88	43° 38' N 008° 03' E	*Stenella coeruleoalba*	1	dead
08	18.08.88	43° 32' N 007° 50' E	Delphinidae indet.	1	dead
09	27.08.88	43° 15' N 007° 19' E	*Stenella coeruleoalba*	1	dead
10	27.08.88	43° 21' N 007° 38' E	Delphinidae indet.	1	dead
11	27.08.88	43° 30' N 007° 38' E	*Stenella coeruleoalba*	1	one calf, dead
12	27.08.88	43° 06' N 007° 18' E	*Stenella coeruleoalba*	2	dead

Number	Date	Co-ordinates	Species	No. specimens	Notes
13	10.09.88	43° 33' N 007° 47' E	*Stenella coeruleoalba*	1	forepart of a calf collected
14	10.09.88	43° 31' N 007° 30' E	*S. coeruleoalba* *G. melas*	4	*1 S. coeruleoalba*; 3 *G. melas* entangled in net, dead
15	10.09.88	43° 26' N 007° 38' E	*Stenella coeruleoalba*	1	dead
16	10.09.88	43° 26' N 007° 30' E	*Stenella coeruleoalba*	1	dead
17	10.09.88	43° 33' N 008° 11' E	*Stenella coeruleoalba*	1	dead, forepart sighted
18	15.09.88	43° 05' N 007° 07' E	*Stenella coeruleoalba*	1	dead
19	21.09.88	43° 27' N 008° 36' E	*Grampus griseus*	1	dead, still entangled in net
20	22.09.88	43° 32' N 007° 52' E	*Stenella coeruleoalba*	1	dead
21	22.09.88	43° 39' N 007° 52' E	*Globicephala melas*	1	dead, still entangled in net
22	22.09.88	43° 18' N 007° 19' E	*Physeter catodon*	1	still alive, entangled in net; released
23	26.09.88	42° 41' N 006° 22' E	*Physeter catodon*	1	still alive, entangled in net; released
24	27.09.88	42° 55' N 008° 17' E	probably *B. physalus*	1	still alive, entangled in net; fate unknown
25	28.09.88	42° 42' N 006° 28' E	*Physeter catodon*	1	still alive, entangled in net; released
26	29.09.88	43° 18' N 007° 59' E	Delphinidae indet.	1	dead
27	04.10.88	43° 34' N 007° 43' E	*Stenella coeruleoalba*	1	dead
28	09.10.88	43° 40' N 007° 40' E	*Grampus griseus*	1	dead
29	Oct. 88	43° 41' N 007° 44' E	Delphinidae indet.	1	dead

Table 2. Number of bycatches by species

Species	Number of specimens	Dead specimens	Living specimens	Fate unknown
Balaenoptera physalus	1	-	-	1
Physeter macrocephalus	3	-	3	-
Globicephala melas	9	5	4	-
Grampus griseus	2	2	-	-
Stenella coeruleoalba	18	18	-	-
Delphinidae indet.	4	4	-	-
TOTAL	37	29	7	1

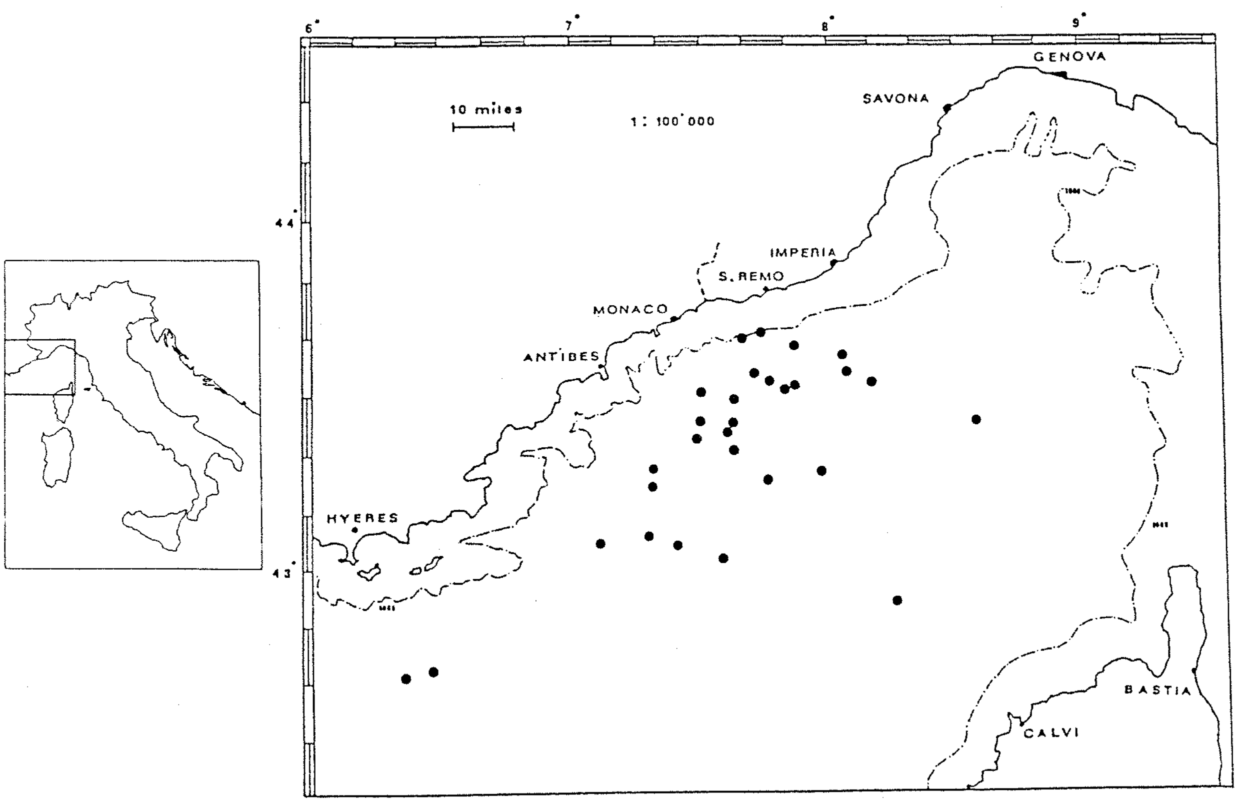

Fig. 1. Distribution of bycatches in the Ligurian Sea listed in Table 1.

SIGHTINGS AND BEHAVIOUR OF CETACEANS
OFF THE CANARY ISLANDS

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The study of marine mammals was the theme of a seven months expedition organized by Le Taillevent from October 1987 to April 1988. The school sailing boat Fleur de Lampaul sailed to Portugal, Madeira and the Canary Islands and spent fifty days at sea. The crew made 52 sightings of cetaceans of eight species.

On the way to the Canary Islands and back to France we made 24 sightings of common dolphins *Delphinus delphis* and striped dolphins *Stenella coeruleoalba*. In the Bay of Biscay we saw a large school of long-finned pilot whales *Globicephala melas* in association with bottle-nosed dolphins *Tursiops truncatus*.

Among the sightings of cetaceans in the Canary Islands, the most interesting were:

Minke whale *Balaenoptera acutorostrata* - On 29 January we watched three minke whales for a period of 50 minutes from a beach on La Graciosa. The whales came into the bay at a depth of 15 metres.

Killer whale *Orcinus orca* - On 25 February we encountered a school of six killer whales off the east coast of Lanzarote. We were able to follow them for 105 minutes; they swam southwest, at a speed of 3 knots, following the edge of the continental shelf at a depth of 200 metres, 2 miles from the coast. We dived close to them several times to study their reactions to human presence. At first, they showed no interest; but after 1 hour, their behaviour began to change. Their respiration cycle was at first 5-minute dives between which they breathed three or four times. These increased to 10-minute dives during which they swam 500 metres underwater. They then breathed five to ten times during 1 or 2 minutes. Finally they disappeared, probably disturbed by the noise of the outboard engine.

Short-finned pilot whale *Globicephala macrorhynchus* - For 16 days in March, we studied an area off the southwest coast of Tenerife. Short-finned pilot whales and bottle-nosed dolphins have lived there, often in association, all year round for a very long period, according to fishermen. Larger whales are quite numerous in this area during their migration, especially in autumn and spring. We made two sightings of a fin whale *Balaenoptera physalus* fishing close to pilot whales and bottle-nosed dolphins. Short-finned pilot whales did not approach coasts within a depth of less than 100 metres; instead, they stayed at depths from 100 to more than 2000 metres.

There are at least 60 short-finned pilot whales in the area, probably many more. We never observed more than 22 grouped whales. Some young animals were among them, maybe one for every six adults. The smallest were 1.5 metres long, whitish in colour. Some groups contained both young and adults. Others were composed of only medium-sized animals, still others of only a few large adults (6 metres).

Behaviour in human presence We tried many ways of approaching them, with the purpose of studying their behaviour. The approaches were made with Fleur de Lampaul (we could sometimes follow them for 9 hours) with the dinghy, by windsurfing, swimming and skin-diving. Two main remarks can be made:

- Pilot whales were less disturbed by slow and calm ways of approaching them.

- The success of the approach depended more upon the animals' mood than on the technique we used.

We noticed that their mood varied according to different factors:

1. *Time of the day* Before 10 am and after 4 or 5 pm, pilot whales were normally swimming very slowly in no particular direction. They did not seem to be occupied in any particular activity and were much more curious towards the boat and divers.

2. *Their activities* After 10 am the whales generally left a certain small area located 2 miles southwest of Los Cristianos harbour, where they would be found every morning. They then swam northwest at a speed of 2-3 knots. During this period, they generally avoided contact and readily dived.

The short-finned pilot whales were not frightened by boats, but they did not like the sound of outboard engines. They generally avoided the divers, but sometimes showed some curiosity towards them. They stuck their heads out of the water for a glance or turned themselves on their backs underwater to see what was above them. They sometimes allowed us to swim very close to them, even to touch them. When they wanted to avoid contact, they dived at a perpendicular angle to the surface and increased their speed by one or two knots, which was enough to outdistance humans.

Bottle-nosed dolphin *Tursiops truncatus* - During our sailing off Tenerife we often saw bottle-nosed dolphins, from 1 to 15 animals at a time. They occupied the same area as the short-finned pilot whales, but went closer to the coast, even entering the bays. We did not notice any young animals among them. Their behaviour was quite normal for this species.

Reactions to human presence Each time the dolphins came close to the boat, we went into the water as quickly as possible and swam near the boat. For the whole of the first week the simple fact of entering the water made them disappear immediately. But after numerous tentative approaches, they began to show some curiosity towards us. An increasing number came to look at us underwater, coming closer to us each time we dived. Thus their behaviour changed as they became more trusting.

Interspecies associations Several times a day, the bottle-nosed dolphins joined the short-finned pilot whales for a few minutes or more. Underwater, we noticed that the two schools did not mix. It was interesting to note that in the morning the two species were in the same small area near Los Cristianos; later in the day they were usually further to the north. They fed upon the same squid species and a wide variety of fish. The fishermen told us they had often noticed pilot whales also eating tuna.

The behaviour of each species possibly changed a little when they were associated. The pilot whales swam faster and looked more agitated; the dolphins may have been less frightened by human presence underwater.

CONCLUSIONS During Fleur de Lampaul's cruise, the crew made the following sightings: Two fin whales *Balaenoptera physalus,* one minke whale *B. acutorostrata,* one balaenopterid species, one killer whale *Orcinus orca,* ten short-finned pilot whales *Globicephala macrorhynchus*, one long-finned pilot whale *G. melas,* thirteen bottle-nosed dolphins *Tursiops truncatus,* five common dolphins *Delphinus delphis,* twelve striped dolphins *Stenella coeruleoalba* and six delphinid species.

GOOSE-BEAKED WHALES *Ziphius cavirostris* MASS STRANDINGS IN THE CANARY ISLANDS

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Goose-beaked or Cuvier's whales *Ziphius cavirostris* have been described as particularly social animals (Caldwell and Caldwell, 1966). The normal social unit seems to be an extended family pod of around fifteen individuals though solitary males are sometimes also seen (Watson, 1981).

Despite their social habits, most of the strandings reported during the last 25 years have been single strandings (Aloncle, 1967; Filella, 1971, 1975; Ross and Tietz, 1972; Robineau, 1975; Duguy, 1976, 1977; Mead, 1979; Grau *et al.*, 1981; Pelegri, 1981; Casinos, 1981). During this period only three cases have been reported as mass strandings:

(1) Van Bree & Kristensen (1974) described the stranding of four "bloated and already decomposed" goose-beaked whales on the Island of Bonaire (off the coast of Venezuela), suspecting that they had become victims of some kind of underwater explosion related to Navy manoeuvres which took place prior to the stranding.

(2) Viale (1975) reported three *Z. cavirostris* which stranded during the same week on the northern part of Corsica, as well as a striped dolphin *Stenella coeruleoalba*, showing impacts of bullets (a warship was patrolling the Corsican Channel where two days later one of the cetaceans was found stranded).

(3) Mead (1979) reported, without details, a mass stranding along the eastern coast of the United States.

Except the latter, these cases were reported as passive strandings (not involving living animals).

Vonk and Martin (1988) reported two mass strandings on the Canary Islands:

(1) Along 15 km of the southern coast of the Island of Fuerteventura a group of at least twelve individuals stranded during February 1985. In spite of being an active stranding, and the high number of specimens involved, nearly all of them died and were washed away. It was possible to examine only three animals: two females (435 cm and 612 cm long) and a 553 cm male. At the same time, a 430 cm long male Gervais' or Antillean beaked whale *Mesoplodon europaeus* stranded about 35 km away. This made us initially suspect some kind of relationship between both species.

(2) During June 1986 four goose-beaked whales stranded at different sites along a 25 km section of the north coast of the Island of Lanzarote; only two specimens could be examined: a male (488 cm long) and a female (430 cm long). Apparently there was again a relationship between goose-beaked whales and the Antillean beaked whale since, at the same time, a 457 cm long male of the latter species stranded in this area. There was also a sighting by local fishermen, a few days before the stranding, of a group of "whales" where they could distinguish the presence of a "darker whale" with all the characteristics of *M. europaeus*.

On 25 November 1988, four specimens of Ziphiidae stranded along the southeast coast of the Island of Fuerteventura: three goose-beaked whales and a northern bottle-nosed whale *Hyperoodon ampullatus.* The latter again suggested some relationship between *Ziphius* and another species.

Large schools of dolphins formed by two different species have often been described, e.g. *Globicephala* and *Tursiops, Delphinus* and *Stenella,* but within the family Ziphiidae it has only been reported once (Galbreath, 1963), when the stranding (presumably simultaneously) of two female dense-beaked or Blainville's beaked whales *M. densirostris* and a female *Z. cavirostris* occurred on the Midway Islands (Central Pacific Ocean).

Two of the three mass strandings on the Canary Islands described here involved schools of *Z. cavirostris* with *M. europaeus,* and the third mass stranding involved *Z. cavirostris* with *H. ampullatus*. Although these strandings occurred in different seasons, we might suspect that species like the Antillean beaked whale or the northern bottle-nosed whale join goose-beaked whale schools under certain conditions.

Tomilin (1955) referring to *Hyperoodon* says: "They do not leave an injured companion so long as there is a sign of life". This kind of behaviour, defined as "epimeletic" behaviour by Scott (1958, "Animal behaviour") - "the giving of care or attention" - may be displayed by other Ziphiidae. It may therefore be that epimeletic behaviour occurs between two closely related species (*Z. cavirostris* and *M. europaeus,* or *Z. cavirostris* and *H. ampullatus*) before a situation of panic.

During February 1985 and November 1988, at the same time or a little before the mass strandings occurred, navy manoeuvres were taking place close to the area. Although naval authorities confirmed that no exercises were made with real weapons or firing, there was a strong coincidence with the dates, so we cannot avoid believing in the existence of some relation between the two events. This is particularly the case since on the same date that the mass stranding occurred (25th November 1988), two specimens of the pygmy sperm whale *Kogia breviceps* stranded on the north coast of the island of Lanzarote. It is worth noting the difference between the conditions of the animals described by Van Bree and Kristensen (1974) in relation to a passive stranding, and the active strandings in the case of the mixed schools in the Canary Islands.

Referring to active strandings, we should finally mention Klinowska (1985) who explained live strandings in relation to geomagnetic topography as "mistakes made by animals attempting to use geomagnetic topography for orientation". Although no geomagnetic maps are available of the Canary Islands, the whole archipelago is situated in a geomagnetically quiet zone (Hayes and Rabinowitz, 1975). However, doubtless there are areas with high anomalies, well known to local fishermen and sailors, such as La Bocaina, the area between the islands of Lanzarote and Fuerteventura, as well as the northwest coast of Fuerteventura. There are also probably further areas around the Canary Islands with these characteristics.

ACKNOWLEDGEMENTS We are very grateful to the local authorities of the Cabildos Insulares of Lanzarote and Fuerteventura for their co-operation and support.

[Footnote:
J.P. Sylvestre and V. Valukas (pers. comm.) have reported during the last few years mass strandings in France and Greece respectively. There are two further *Ziphius* mass strandings: La Perguera (Puerto Rico) and Baltra (Galápagos) (J. Mead, pers. comm.).]

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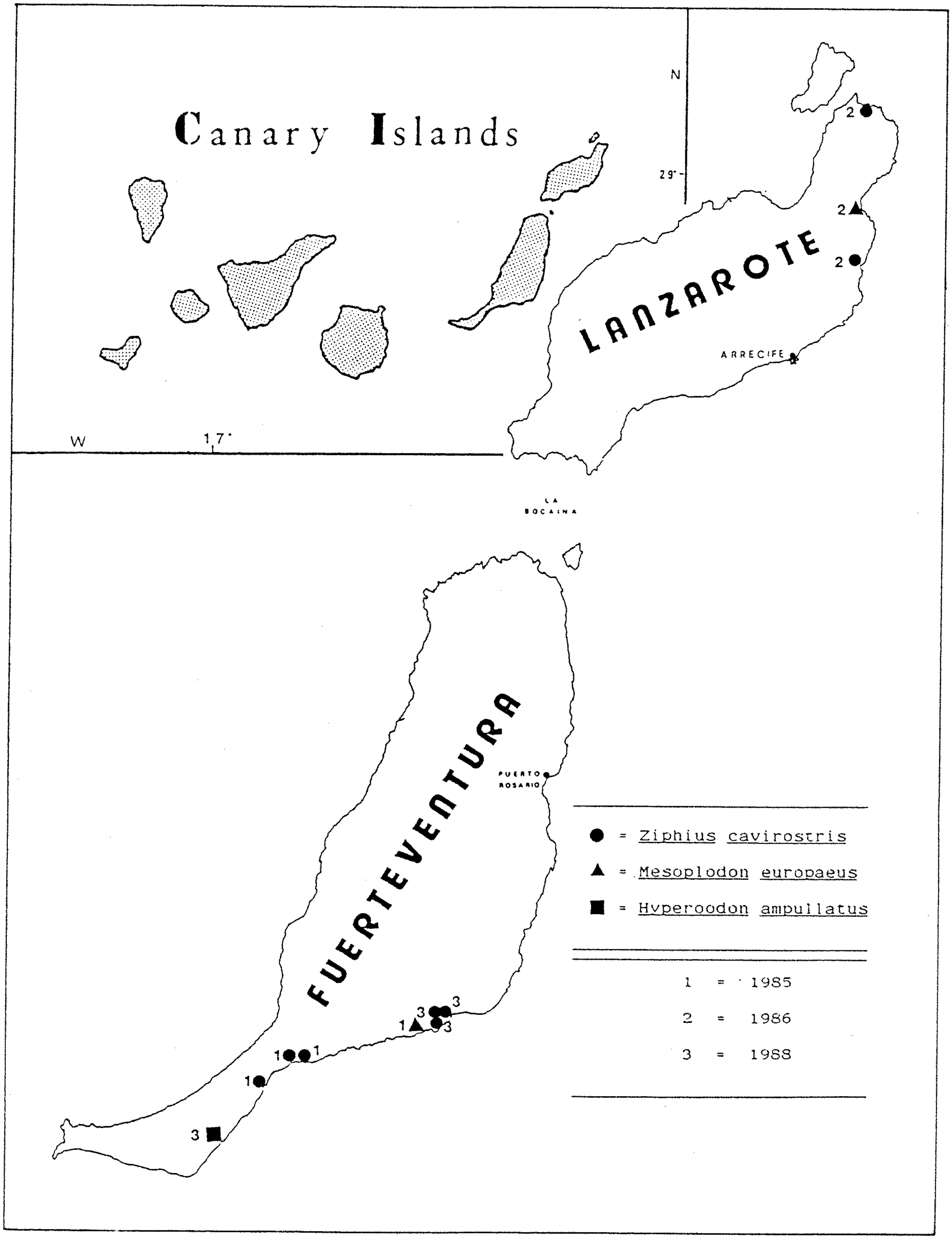

Fig. 1. Distribution of strandings in the Canary Islands.

SPRING BREACHINGS OBSERVED IN *Stenella coeruleoalba* IN THE MEDITERRANEAN SEA

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Cetacean breachings are directly visible to the observer studying behavioural patterns. Can we consider breachings as a form of communication?

Operating exclusively under sail, we were able to photograph and log each encounter observed in the Mediterranean, for subsequent reconstruction and analysis.

In 1984 we noticed that certain movements of the boat (such as circling, or passing through the middle of a dolphin pod) caused *Stenella* to sound. In particular, we observed that when all the dolphins sounded simultaneously, this was preceded by a special form of breaching, where the tail flukes slap the surface of the water on re-entry and immediately before actually sounding. The breachings observed in sexual play, pursuit and swimming in pairs are different again, but neither form bears any relation to bow-riding.

During the summer of 1986, numerous observations showed that breaching with fluke-slapping could occur without the pod of dolphins sounding. Conversely, we also noted cases of sounding not preceded by fluke-slapping. This does not mean that a breaching signal achieves immediate co-ordination of the pod, but it does seem more plausible to speak in terms of gesticulation (see Whitehead, 1985). In other words, we take the view that an acoustic effect is concurrent with fluke-slapping. We hope to confirm this view, in order to explain co-ordination of the dolphin pod.

While each breaching appears to be followed by a given behavioural pattern, we cannot definitely associate a certain form of behaviour (such as synchronized sounding) with breaching. Breaching expresses the emotional state of an individual in the group (see Fig. 1).

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CONCLUSION : BREACHING EXPRESS THE EMOTIONAL STATE OF AN INDIVIDUAL IN THE GROUP. 1984, 85, 86, 87

BREACHING IS ALWAYS AN OBSERVATION FROM THE DOLPHINS

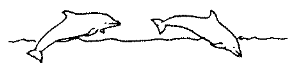
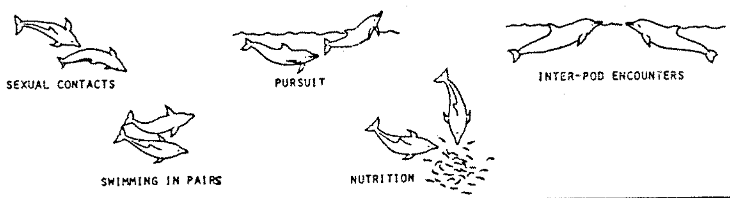
		BREACHINGS:	
BREACHING TYPES	BOW-RIDING 	REPEATED BREACHING BY A NUMBER OF INDIVIDUALS. 	ISOLATED TAIL FLUKE SLAPPING BY ISOLATED INDIVIDUALS. 
ASSOCIATED BEHAVIOUR	APPROACHING A VESSEL OBSERVATION MAXIMUM SPEEDS		SOUNDING 1 AFTER BREACHING BY POD MEMBERS STATIONARY POD WITH NO CHANGE IN SURFACE BEHAVIOUR PATTERNS
INTERPRETATION	ECONOMY OF ENERGY SITUATION WHERE THE POD IS STIMULATED BY SURFACE ACTIVITY	PLAYFUL BEHAVIOUR SOCIAL BONDS: INTRA-POD OR INTER-POD	EMOTIONAL STATES OF AN INDIVIDUAL WARNING THE POD
QUESTIONS	OTHER SITUATIONS ASSOCIATED WITH THIS TYPE OF SWIMMING	POSSIBLE ASSOCIATION OF CERTAIN BREACHINGS WITH PRECISE BEHAVIOUR PATTERNS (EG. SEXUAL CONTACTS) POSSIBLE SELECTION OF A CERTAIN FORM OF BREACHING BY DIFFERENT STENELLA PODS IN A GIVEN AREA AND OVER A GIVEN PERIOD.	WARNING MESSAGES TO OTHER PODS IN THE AREA POSSIBLE EXISTENCE OF OTHER TYPES OF SIGNAL-RELATED BREACHINGS, USED UNDER DIFFERENT CIRCUMSTANCES (CHANGE OF DIRECTION, BUSNEL, 1968, "DELPHINUS DELPHIS")

Fig. 1. Three types of breachings of *Stenella coeruleoalba:*

- Bow riding
- "Repeated breachings"
- "Isolated breachings"

ASSESSING THE CONSERVATION STATUS AND NEEDS OF CETACEANS

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We have not yet driven any cetacean species to extinction, but this may change, and soon. For some species (river dolphins) only a few hundred individuals remain. By any definition such species are endangered, and deserve all the help we can give them. The IUCN Species Survival Commission Cetacean Specialist Group's Action Plan (Perrin, 1988) highlights the most urgent problems for whole species and for populations, and lists projects to address them.

There are, however, many definitions of endangered, threatened and protected species: the IUCN Red Data Books use one set of criteria, the CITES, BERN and CMS Conventions each have their own; the IWC does something different when it defines Protection Stocks; and national legislation may have other priorities for local species. Co-ordination between the various conservation measures is lacking (see Tables 1 - 6; species names are copied exactly from the sources).

A recent meeting (Fitter and Fitter, 1987) discussed the problems of categorizing the status of taxa, particularly when, as in the majority of cases, the classical condition of mortality consistently exceeding reproductive success (and not to be confused with temporary fluctuations) is not clearly evident because of lack of information. The first "milestone" on the "road to extinction" is the discovery and description of species (because if a species is not known to exist, obviously its extinction will also be unknown). Almost all conservation legislation operates at the species (or clearly identifiable taxon) level, except IWC which uses management units within species known as "stocks". It is not clear whether changes in opinion on the naming of species affect their legal protection status, although listing larger taxa (for example, families or orders) is less likely to produce such potential problems, and can even cope with technically undescribed species such as the two newly discovered ziphiids.

Other indicators of conservation problems are over-exploitation, habitat loss, fragmentation or contraction of range, reduced reproductive success and pending catastrophes (for example, plans to build many dams in the Amazonian habitat of river dolphins). A rough guide to comparative status can thus be obtained by simply listing the known problems for each species.

On such a scale it becomes clear that conservation efforts over the past 50 years or so have had some success, notably in saving some of the great whales from extinction through unregulated commercial whaling. Such an example is the eastern Pacific population of the gray whale which has now recovered, and there are very hopeful signs of increase in some humpback and southern right whale populations. With the current moratorium on commercial whaling, there is little more to be done for the depleted species except to ensure that the controls remain effective and that any crucial habitat is safeguarded. The small continuing catches by local people for their own use (with the possible exception of the bowhead), and those under IWC scientific permit, are of no significance for the survival of species. Since the objective of the IWC management system is to maintain whale stocks in a state of "maximum productivity", if such a state is reliably attained there is no danger of extinction (Holt, 1987). IWC stocks are classified with reference to this state of maximum productivity - if they are above or well above this level, commercial whaling would be allowed; if slightly below, they become Protection Stocks and commercial whaling is temporarily stopped. Whaling *per se* is therefore not a threat to species (or indeed to stocks within species) survival, provided that management is effective (although the practical difficulties in providing good management are not to be underestimated).

Unfortunately, in the efforts to "save the whale", the threats to the other cetaceans have received less attention. Most of those in the current IUCN list of threatened species are very little known outside specialist circles (see Table 1). Most of the small species listed are from tropical riverine and coastal waters which are under severe threat from current or planned habitat destruction, although direct and incidental catches also take a toll. Others, such as the vaquita, Hector's and Heaviside's dolphins and the franciscana, have small populations which are under pressure from incidental takes. Commerson's and black dolphins are taken illegally for bait in South American crab fisheries.

The vast incidental kills of dolphins in the eastern tropical Pacific tuna fishery (in the order of 300,-500,000 animals a year - for comparison, the TOTAL blue whale catch in the Antarctic over the years it has been hunted was around 330,000) are depleting some of the local populations, but the species mainly involved are widespread and abundant elsewhere. This situation illustrates the weakness of using the species as a conservation unit. Some of these populations are sufficiently different to be recognizable at sea, yet their plight cannot be highlighted by dubbing them "endangered species".

There is a great deal of existing international and national legislation which could deal with the conservation problems of cetaceans, but there are practical difficulties. Unfortunately a major problem is that the IWC is unable to agree on whether it has responsibility for all cetaceans (although it is widely perceived to do so) (see Table 2). Mexico, one of the nations most heavily involved in the eastern tropical Pacific tuna fishery, has been most active in recent years in efforts to prevent the IWC even discussing the smaller species. The BERN Convention only protects animals from disturbance in their "nests" and "places of rest" and the CMS Convention recently failed to adopt an agreement to protect some North and Baltic Sea cetaceans and abolished its Advisory Committee on Small Cetaceans (although an interest in small cetaceans is still professed). The CITES and EEC efforts to assist conservation through trade regulation have been very successful in curbing the markets for commercial whaling products, but since international trade is no threat to the vast majority of species, this role is now limited.

Effective cetacean conservation now needs to move away from those traditional areas of activity. For the tropical and riverine species, the RAMSAR Convention (which seeks to protect wetlands) and the World Heritage Convention could be invoked to protect their habitat. The various fisheries conventions could also do far more to record incidental takes and monitor populations, following the lead of the IATTC which has contributed greatly to our knowledge of the populations involved in the eastern tropical Pacific tuna fishery. At the national level, each country with cetacean habitat should, as a minimum, survey and assess the status of all cetacean species within their exclusive economic zones, fisheries zones and other waters (including those of any overseas territories), set up effective schemes for monitoring direct and incidental takes by all fishing vessels under their justification, and take action to remedy any conservation problems revealed. Policies should also be implemented to prevent new developments causing problems in future.

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Table 1. IUCN List of threatened cetacean species

Platanista minor	Indus river dolphin	Endangered
Lipotes vexillifer	Yangtze river dolphin	Endangered
Balaena mysticetus	bowhead	Endangered
Eubalaena glacialis	northern right whale	Endangered
Platanista gangetica	Ganges river dolphin	Vulnerable
Inia geoffrensis	Amazon river dolphin	Vulnerable
Phocoena sinus	vaquita	Vulnerable
Eubalaena australis	southern right whale	Vulnerable
Balaenoptera musculus	blue whale	Vulnerable
Megaptera novaeangliae	humpback	Vulnerable
Pontoporia blainvillei	franciscana	Ins.Known
Orcaella brevirostris	Irrawaddy dolphin	Ins. Known
Delphinapterus leucas	white whale	Ins. Known
Monodon monoceros	narwhal	Ins. Known
Phocoena phocoena	harbour porpoise	Ins. Known
Cephalorhynchus commersonii	Commerson's dolphin	Ins. Known
Cephalorhynchus eutropia	black dolphin	Ins. Known
Cephalorhynchus heavisidii	Heaviside's dolphin	Ins. Known
Cephalorhynchus hectori	Hector's dolphin	Ins. Known
Hyperoodon ampullatus	northern bottle-nosed whale	Ins. Known

(Abbreviated) definitions

Threatened categories:

- Endangered (E) - survival unlikely if causal factors continue operating (and where recovery not yet sufficient to justify down-listing).
- Vulnerable (V) - likely to move into the Endangered category in the near future if causal factors continue operating (and where recovery not yet sufficient for down-listing).
- Insufficiently Known (IK) - suspected to be Endangered or Vulnerable.

Other categories:

- NT* - not in a threatened category BUT........
- NT - not in a threatened category.

Table 2. IWC - Species managed by the International Whaling Commission

Balaenoptera borealis	sei whale	NT
Balaenoptera acutorostrata	minke whale	NT
Balaenoptera physalus	fin whale	V
Balaenoptera edeni	Bryde's whale	NT
Balaenoptera musculus	blue whale	V
Megaptera novaeangliae	humpback	V
Eubalaena glacialis	northern right whale	E
Eubalaena australis	southern right whale	V
Balaena mysticetes	bowhead whale	E
Caperea marginata	pygmy right whale	NT
Eschrichtius robustus	gray whale	NT*
Physeter macrocephalus	sperm whale	NT
Hyperoodon ampullatus	northern bottle-nosed whale	IK

Table 3. CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora. In force: 1 July 1975

Appendix I - Endangered species, trade strictly controlled and must not be for primarily commercial purposes.

Lipotes vexillifer	E
Platanista spp.	E + V
Berardius spp.	NT (IWC)
Hyperoodon spp.	IK + NT (IWC)
Physeter macrocephalus	NT (IWC)
Sotalia spp.	NT*
Sousa spp.	NT*
Neophocaena phocaenoides	NT*
Phocoena sinus	V
Eschrichtius robustus	NT*
Balaenoptera acutorostrata	NT (IWC)
Balaenoptera borealis	NT (IWC)
Balaenoptera musculus	V
Balaenoptera physalus	V
Megaptera novaeangliae	V
Eubalaena spp. (E northern r. w., V southern r. w., E bowhead)	
Caperea marginata	NT (IWC)

(IWC) Added to Appendix I in support of the IWC moratorium.

Appendix II - trade controlled to prevent overexploitation of these or similar species: all other species of Cetacea.

Table 4. Netherlands CITES Scientific Authority Proposal (1987) to transfer species from Annex C1 to Annex C2 (EEC Regulation No. 3626/82) because "the biological status is such that they cannot be considered threatened with extinction in such a degree that inclusion in Annex C1 is justified". (The Regulation lists all cetaceans in Annex C1, thus treating them all as if they were listed in CITES, Appendix I).

1. *Tursiops truncatus*	(NT*)	- bottle-nosed dolphin
2. *Tursiops aduncus*	(NT*)	- Indian Ocean bottle-nosed dolphin*
3. *Grampus griseus*	(NT)	- Risso's dolphin
4. *Steno bredanensis*	(NT)	- rough-toothed dolphin
5. *Sotalia fluviatilis*	(NT*)	- Amazon white dolphin**
6. *Sousa chinensis*	(NT*)	- Indo-Pacific humpback dolphin**
7. *Pseudorca crassidens*	(NT)	- false killer whale
8. *Globicephala melaena*	(NT)	- pilot whale
9. *Globicephala macrorhynchus*	(NT)	- Indian pilot whale
10. *Lagenorhynchus obliquidens*	(NT)	- Pacific white-sided dolphin
11. *Orcinus orca*	(NT)	- killer whale
12. *Cephalorhynchus* spp.	(IK)	- short-nosed dolphins (4 species)

* Trade prohibited by Netherlands legislation, not generally recognized as a separate species.

** CITES Appendix I.

Table 5. CMS - Convention on the Conservation of Migratory Species of Wild Animals. In force: 1 November 1983

Appendix I - species at present endangered and needing immediate protection:

Balaenoptera musculus	- blue whale (V)
Megaptera novaeangliae	- humpback whale (V)
Balaena mysticetus	- bowhead whale (V)
Eubalaena glacialis	- right whale (E + V)

Appendix II - species with unfavourable conservation status and those which would benefit from an international conservation agreement:

Delphinapterus leucas	- white whale (IK)

North and Baltic Sea populations of:

Phocoena phocoena	(B)	- harbour porpoise (IK)
Tursiops truncatus	(B)	- bottle-nosed dolphin (NT*)
Grampus griseus		- Risso's dolphin (NT)
Globicephala melaena		- long-finned pilot whale (NT)
Lagenorhynchus albirostris	(B)	- white-beaked dolphin (NT)
Lagenorhynchus acutus		- white-sided dolphin (NT)

(B) Baltic resident species (Aguayo, 1978).

Table 6. BERN - Convention on the Conservation of European Wildlife and Natural Habitats.In force: 1 June 1982

Appendix I - strictly protected endangered and vulnerable plants.

Appendix II - strictly protected endangered and vulnerable animals.

Balaenoptera musculus	- blue whale (V)
Megaptera novaeangliae	- humpback whale (V)
Eubalaena glacialis	- right whale (E + V)
Balaena mysticetus	- bowhead whale (E)
Delphinus delphis	- common dolphin (NT)
Tursiops truncatus	- bottle-nosed dolphin (NT*)
Phocoena phocoena	- harbour porpoise (IK)

Added 1987:

Orcinus orca	- killer whale (NT)
Pseudorca crassidens	- false killer whale (NT)
Grampus griseus	- Risso's dolphin (NT)
Globicephala melaena	- pilot whale (NT)
Lagenorhynchus acutus	- Atlantic white-sided dolphin (NT)
Steno bredanensis	- rough-toothed dolphin (NT)
Stenella coeruleoalba	- striped dolphin (NT)
Hyperoodon ampullatus	- northern bottle-nosed whale (NT)
Mesoplodon mirus	- True's beaked whale (NT)
Mesoplodon bidens	- Sowerby's beaked whale (NT)
Ziphius cavirostris	- Cuvier's beaked whale (NT)

Appendix III - protected animals: all other species of Cetacea.

AGE DETERMINATION AND GROWTH OF THE HARBOUR PORPOISE

Phocoena phocoena IN GERMAN WATERS

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The main aim of this investigation was to age all harbour porpoises stranded or caught by fishermen along the German Baltic and North Sea coasts during the last few decades. This was carried out by counting dentinal growth layer groups (D-GLGs). In the teeth of *Phocoena phocoena* such D-GLGs are of a typical bipartite structure. Each layer is composed of one broad and one narrow band. Since no material of known age was available, the basic problem was to reveal the rhythm of D-GLG-formation before using the teeth for age-determination. In order to enhance the distinctiveness of the dentinal growth layer groups, new staining techniques were employed. In combination with scanning electron microscopy (SEM) and microradiographical investigations of undecalcified teeth, this approach led to the discovery of structural differences between the two main sections of the bipartite incremental growth-layers. A total of 135 specimens were aged (79 from the Baltic including the coastline of the GDR; 56 from the North Sea).

For staining, freeze sections of decalcified teeth from the mid-part of the lower jaw (if available) were processed. Decalcification was carried out in 5% HNO_3 for several hours.

Sections of undecalcified teeth were used in the SEM. After embedding in resin, the teeth were cut and the surface was etched by 10% HCOOH, followed by a short treatment with sodium hypochloride. After drying, any etched section was spattered with a thin gold-cover.

For microradiographical investigation, embedded teeth were ground down to a thickness of 100 micrometers in longitudinal direction.

Two entirely different dyes were used: (a) "Giemsa" (Merck No. 9204) which is composed of methylene blue, azure b and eosine, and (b) a silver methylene amine solution that results in a silver impregnation of the tissue. Both methods proved to be very suitable. Together they offer the opportunity of cross-checking differently stained sections of the same tooth. This is most important in uncertain cases. Additionally the silver impregnation clearly reveals the innermost dentinal layers in great detail in most sections. The first-mentioned dye is most suited to staining fine-scaled sublayers.

DENTINAL GROWTH The decrease of dentine increment with age can best be described by a negative exponential function. Thus supposing the formation of each set of growth layers is annual, a hypothetical average daily growth rate for each successive D-GLG can be calculated. Using these values for daily increment, back-calculation to the date of birth, i.e. the start of formation of the first layer in 0-group specimens, supports the assumption of an annual rhythm in D-GLG-formation. In most cases they led to calculated dates of birth within a time ranging from late spring to summer. This approach can be used to arrive at a hypothetical starting point of the formation of any incomplete D-GLG adjacent to the pulp cavity. The results also confirm that one D-GLG expresses one year's dentinal growth. The growth pattern of the dentine shows no differences between sexes or between the two geographic areas. Another finding confirms the assumed mode of annual D-GLG-formation. A correlation was found between the recently formed D-GLG-zone (narrow or broad) bordering the pulp cavity and the season in which the animal died. It shows that in almost all cases the narrow band was formed in the first half of the year, mainly in winter and spring, whereas the broad zone starts being formed in the middle of the year. The broad zone seems to be laid down within 8 - 9 months; the narrow one in a correspondingly shorter period.

With increased magnification, fine substructures (the so-called "von-Ebner-lines") are distinguishable. They are of the same width (3-4 micrometers) but occur in different numbers in the narrow and broad D-GLG-zones. This argues against a previously assumed difference in growth rate between the two components. Hence retaining the theory of changing growth rates during different seasons would imply that dentine areas of equal size, structure and colour pattern represent different periods of the year. In *Phocoena phocoena,* the "von-Ebner-lines" can hardly express a simple daily increment as is supposed for some terrestrial mammals.

The results of the silver-impregnation compared with those of the two non-staining techniques allow the following conclusion: the second (narrow) part of each D-GLG, formed during winter and spring, seems to have a higher content of collagen-fibres which show a strong affinity to silver staining. Additionally it appears to be more mineralized than the broad zone: this corresponds with previous results from studies of the teeth of *Phocoena phocoena* and basic odontological research. On the other hand, it contradicts an American study on the teeth of the bottle-nosed dolphin *Tursiops truncatus*. The results of the present paper should be discussed further since they show that the part of dentinal tissue formed during winter seems to be more homogeneous. This is important since that part of the year is assumed to be a period of less favourable feeding conditions.

AGE AND GROWTH The maximum age of 14 years found here exceeds previous findings. Furthermore, it obviously does not represent the final state of dentine increment. Layers beyond this age are difficult to distinguish, but they possibly point to a maximum age of approximately 18 years or more. By means of the von-Bertalanffy growth model, a reasonable age/length relationship could be found, at least for the North Sea specimens. Due to the lack of data within age-class 0, the growth curve could not be fitted properly for the Baltic porpoises in the first two D-GLG-classes. There are some indications that Baltic specimens tend to be a little larger than those from the North Sea. This difference is most pronounced in females, but sample sizes are too small for the difference to be statistically significant. In general, maximum length in males ranges between 1.4 - 1.5 m, between 1.6 to just over 1.8 m in females. Compared with data from porpoises of the East Pacific and the Northwest Atlantic, only the Baltic females show conspicuous differences. They tend to reach higher body-lengths, particularly in the upper age-classes. These findings have to be regarded with caution since they are based upon stranded animals and a few bycatches.

CONCLUSIONS A reliable staining technique for decalcified teeth was found. A comparison with methods other than staining may reveal further indications of the histological basis of D-GLG-formation. The dentinal growth pattern indicates an annual rhythm of D-GLG-formation. Finally, the von-Bertalanffy growth model proved to be suitable for giving a reasonable description of the growth.

NEW DATA ON HELMINTH PARASITES OF THE HARBOUR PORPOISE *Phocoena phocoena* IN DANISH WATERS

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INTRODUCTION This study, undertaken by the Department of Animal Biology of Valencia University in co-operation with the Zoological Museum of Copenhagen, attempts to increase the knowledge of the parasite fauna of the harbour porpoise *Phocoena phocoena* in European waters. This work consists of the determination of prevalences, intensities of parasitism, and sex ratios of the parasite species. The comparative analysis of results from different European localities aims at providing new insight into the identification of separate populations of the harbour porpoise. These studies will be based on the use of parasites as biological indicators in a similar way to that carried out in various marine and terrestrial mammals (for example, Delyamure *et al.*, 1946; Waid and Pence, 1988). Preliminary results from Danish waters are presented here.

The parasite fauna of the harbour porpoise is relatively rich: 22 helminth species have been reported from this host, of which 16 have been recorded in European Atlantic waters. The life-cycles of the helminth parasites of the harbour porpoise are unknown, with the exception of diphyllobothriid tapeworms and anisakid nematodes. However, it seems very likely that they all have indirect cycles in which several intermediate hosts are involved.

MATERIALS AND METHODS 21 harbour porpoises originating from strandings or by-catches in Danish waters were studied. Six specimens were completely autopsied; the external surface of the body, blubber, mesenteries, lungs, heart, digestive system, kidneys and one of the air sinuses and tympanic bullae were examined for parasites. In the remaining 15 porpoises, only lungs, heart and digestive system were surveyed. All porpoises were measured and sexed.

RESULTS AND DISCUSSION Seven helminth species were identified: *Pseudalius inflexus, Torynurus convolutus, Halocercus* sp., *Stenurus minor, Campula oblonga, Anisakis simplex* and *Hysterotyhlacium* sp. Parasites were only found in lungs, air sinuses, liver and stomach (Table 1).

Hysterothylacium spp. are anisakid nematodes which are common parasites of teleost fish. Therefore the specimens of *Hysterothylacium* sp. detected in the stomach of a porpoise should be regarded as incidental, ingested with a meal of fish, rather than as true parasites of this cetacean species.

Previous studies seemed to indicate the apparent absence of *Torynurus convolutus* in Danish waters (Clausen and Andersen, 1988). However, our data clearly indicate the occurrence of this lung-worm in Danish porpoises.

Roughly speaking, it appears that nematodes parasitizing air passages and sinuses are the most frequent helminths of the porpoise in Danish waters. *Stenurus minor, Pseudalius inflexus* and *Torynurus convolutus* occurred in the majority of the specimens examined.

Halocercus sp., by contrast, cannot be considered a frequent species though it is not unusual. On the other hand, parasites of the digestive system show a lower prevalence (Table 1).

Bronchial mixed infections due to the lung-worm species *Pseudalius inflexus* and *Torynurus convolutus* occurred in 42.8% of the porpoises examined. In fact, these two lung-worms appeared more often in mixed infections than each species on its own, and when this was the case, it was in very low intensities and only in young porpoises (up to about 1.2 m long). No association between *Pseudalius inflexus* and *Halocercus* sp. was found. Thus it seems that *Torynurus convolutus* and *Pseudalius inflexus* occur separately and in light infections only in young porpoises, whereas these species occur in mixed and severe infections in adults.

According to the data available, the harbour porpoise begins feeding independently at an age of 5 to 8 months which roughly corresponds to a body length of about 1.1 m. Prevalences are usually higher in individuals whose body length exceeds 1.2 m than in those whose body length is equal to or less than this. This suggests an increase in prevalence soon after the onset of independent feeding (Table 1).

It must be noted that the prevalences of *Pseudalius inflexus* and *Torynurus convolutus* in porpoises over 1.2 m long are extremely high. Therefore, it is assumed that these two lung-worms are abundant in hosts older than one year. *Halocercus* sp. is the only species that shows an opposite trend since only younger porpoises were parasitized. This fact could indicate a different strategy from that of the other species, which could be due to interspecific competition with other lung-worm species. However, in view of the small number of hosts studied, we must await the examination of further individuals to verify this hypothesis.

As for the intensities of infestation, it is clear that *Torynurus convolutus* shows the highest average values. However, *Stenurus minor* probably shows higher intensities if one bears in mind that only one of the sinuses and tympanic bullae were examined per host. Therefore, this species seems to be the most frequent and the one which appears in highest numbers per porpoise in the area studied. By contrast, the lowest intensities were found in *Pseudalius inflexus* and *Campula oblonga.* The large size and width reached by *Pseudalius inflexus* (13 to 19 cm long and over 1 mm wide) could account for its low intensities, in view of the limited space available in the lumen of the bronchi (Table 1).

Further studies will be based on material from Denmark, Greenland and Britain. This will allow a comparative study at both qualitative and quantitative levels of the parasite fauna of the harbour porpoise in these three areas. This will provide the opportunity to assess the degree of parasite differentiation related to differences in food habits, behaviour, etc. as a possible indicator of the degree of isolation of these porpoise populations. In addition, it will allow us to increase our understanding of the evolution of infestations in relation to various biological parameters of the hosts.

ACKNOWLEDGEMENTS This investigation has been supported by the CICYT of the Spanish Government (Project No. PB87 - 997). J.A. Balbuena holds a grant from the Conselleria de Cultura Educació i Ciència de la Generalitat Valenciana.

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Table 1. Prevalences and intensities of infestation of the parasite species of harbour porpoises in Danish waters. N = 21 except for *Stenurus minor* where N = 6

		Prevalence (%)			Intensity of infestation		
Species	Site	A	B	total	range	mean	± SE
C. oblonga	liver	9.09	60.00	33.33	8-81	23.00	9.82
A. simplex	stomach	9.09	80.00	42.86	3-621	128.22	64.24
adults		9.09	70.00	39.10	2-218	58.25	26.48
larvae		9.09	80.00	42.86	3-403	76.33	43.63
S. minor	air sinuses	-	-	83.33	24-302	141.40	47.57
P. inflexus	bronchi	27.27	100.00	61.90	1-42	17.85	4.30
T. convolutus	bronchi	27.27	90.00	52.38	2-609	144.18	51.70
Halocercus sp.	bronchi	36.36	0.00	19.05	1-9	4.00	1.78
Hysterothylacium sp.	stomach	-	-	4.76	-	-	-

A - Prevalence in porpoises up to 120 cm long.

B - Prevalence in porpoises over 120 cm long.

ON THE REPRODUCTION, DIET AND PARASITIC BURDEN OF THE HARBOUR PORPOISE *Phocoena phocoena* IN WEST GREENLANDIC WATERS

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INTRODUCTION Although the harbour porpoise *Phocoena phocoena* is widely distributed along the west coast of Greenland and there is an annual take of approximately 800 animals in connection with subsistence hunting and bycatches in salmon gill net fisheries (Kapel, 1975, 1983), knowledge on its biology and ecology is poor. According to Gaskin (1984) there seems to be a high degree of separation between the Greenlandic and Canadian harbour porpoises, indicating the existence of a separate Greenlandic stock. Published information on reproduction and diet only gives a very general picture. Newborn calves are reported in June and females contain embryos in October (Eschricht, 1849). A very tiny embryo (2.5 cm) from Klaushavn, Disko Bay, was reported in Kükenthal (1893 - foetus no. 1). Females apparently give birth to one calf per year (Fabricius, 1780). The diet consists of "all kinds of small fish" (Fabricius, 1780) such as capelin (*Mallotus villosus*), arctic cod (*Boreogadus saida*) herring (*Clupea harengus*) and sand eel (*Ammodytes* sp.) (Eschricht, 1849; Winge, 1902; Vibe, 1981), and squid and long-tailed decapods (Eschricht, 1849). Hitherto no information has been available on the parasitic burden of Greenlandic harbour porpoises. This lack of information calls for more research and this paper presents the results of a pilot project conducted in West Greenland during the summer of 1988.

MATERIALS AND METHODS The material for this study was collected from June through September 1988 from local game markets in Maniitsoq (Sukkertoppen) (33 specimens), Nuuk (Godthåb) (1 specimen) and Qeqertarsuaq (Godhavn) (1 specimen) (Fig. 1). Of some of the specimens (14 animals) only the head could be secured, thus only allowing investigation for parasites of the ear sinuses. Twenty sets of reproductive organs and eighteen stomachs were collected. Lungs, liver and other organs were examined on site and parasites were collected. The parasitic burden was assessed using a three plus rating: O = no infection, + low infection, ++ medium infection, +++ heavy infection (Clausen and Andersen, 1988).

RESULTS **Reproduction** Four near- or full-term foetuses were collected, measuring 74, 81, 84 and 84 cm, respectively. The first and smallest foetus was retrieved from a 148 cm female on 30 June, whilst on 3 July an 84 cm male foetus was collected from a female of similar size. This particular female was shot during birth as the fluke of the foetus had already hardened. The remaining two foetuses were collected on 13 and 14 July, respectively, with no information on the female. The calving season therefore appears to extend from late June to the middle of July, and a length at birth of between 75 and 85 cm is indicated. Males longer than 130 cm were sexually mature at ages of 3 dentinal growth layer groups or more (Table 1). Probably females longer than 140 cm are sexually mature at the age of 4 GLGs, but the sample size is too small for detailed discussion (Table 2).

Diet Of the 18 stomachs collected, 18 (100%) contained capelin (*Mallotus villosus*), 5 (28%) Greenland halibut (*Reinhardtius hippoglossoides*), 2 (11%) Norway haddock (*Sebastes marinus*), and 1 (5.5%) a species of codfish (Gadidae sp.) hitherto unidentified.

Squid of the species *Gonatus fabricii* was found in two stomachs and the long-tailed decapod *Sclerocrangon ferox* in a single stomach. Most of the fish remains originated from specimens between 10 and 15 cm long. The estimated length of the decapod was 12 cm.

Parasitic burden The ear-worm *Stenurus minor* was found most frequently, occurring in all non-foetal animals (29 specimens). Fifteen of 18 (83%) animals contained *Anisakis simplex* in the stomach. *Campula oblonga* was found in 9 of 14 (64%) animals, in the liver and, on one occasion, in the first stomach. Lung-worms, *Pseudalius inflexus* and *Torynurus convolutus,* were found in 5 of 14 (36%) animals only. A tapeworm (cf. *Diphyllobothrium latum)* was retrieved from a single animal, but as the intestines were not systematically examined, no comment on its frequency can be made (see also Table 3).

DISCUSSION The basic data on reproduction presented here are in good accordance with accounts from other areas (see Møhl-Hansen, 1954; Fisher and Harrison, 1970; Gaskin *et al.*, 1984). The findings on the diet quantify earlier general accounts, whilst two new fish species (*Reinhardtius hippoglossoides* and *Sebastes marinus*) hereby are reported as prey items of the Greenlandic harbour porpoise. The major part of the diet consists of pelagic fish, but bottom dwellers are also taken, indicating rather coastal feeding habits. The parasites found in Greenlandic harbour porpoises are the same as reported for European and American Atlantic waters (e.g. Gaskin *et al.*, 1974), though the burden in general seems to be lower in Greenlandic waters (Table 3). However, there is a markedly higher infection rate of *Stenurus minor* in Greenlandic harbour porpoises. The present results are preliminary and further sampling is required.

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Table 1. Reproduction data on males

No.	Date	TL (cm)	sperm (+/-)	age/GLG
CN 545	13.7.88	131	+	7
CN 548	13.7.88	129	+	1
CN 549	13.7.88	150	+	7
CN 550	13.7.88	108	-	1
CN 552	13.7.88	134	+	8
CN 553	14.7.88	108	-	1
CN 554	14.7.88	109	-	2
CN 557	24.7.88	130	-	2
CN 565	24.7.88	131	-	3
CN 566	24.7.88	125	-	2
CN 567	24.7.88	126	-	2

Table 2. Reproduction data on females

No.	Date	TL (cm)	E	L	CL	CLr	CA	GLG
CN 541	03.7.88	c. 150	+	+	1	0	6	9
CN 547	13.7.88	148	-	-	0	1	7	6
CN 551	13.7.88	123	-	-	0	0	0	2
CN 568	24.7.88	148	-	+	0	1	5	4

E embryo, L lactating, CL corpus luteum, CLr regressive corpus luteum, CA corpus albicans, GLG dentinal growth layer groups.

Table 3. Parasitic burden of Greenlandic harbour porpoises compared to Danish conspecifics. Rating after Clausen and Andersen (1988). 0 = no infection, + low infection, ++ medium infection, +++ heavy infection

	Denmark	Greenland
Stenurus minor		
	Denmark	Greenland
0	123 animals (83%)	0 animals (0%)
+	9 animals (6%)	18 animals (62%)
++	4 animals (3%)	6 animals (21%)
+++	12 animals (8%)	5 animals (17%)
Anisakis simplex		
	Denmark	Greenland
0	57 animals (49%)	3 animals (17%)
+	20 animals (17%)	15 animals (83%)
++	23 animals (20%)	0 animals (0%)
+++	17 animals (14%)	0 animals (0%)
Pseudalius inflexus/Torynurus convolutus		
	Denmark	Greenland
0	41 animals (28%)	12 animals (71%)
+	30 animals (20%)	5 animals (29%)
++	36 animals (24%)	0 animals (0%)
+++	40 animals (28%)	0 animals (0%)
Campula oblonga		
	Denmark	Greenland
0	76 animals (52%)	5 animals (36%)
+	31 animals (21%)	8 animals (57%)
++	26 animals (18%)	0 animals (0%)
+++	14 animals (9%)	1 animal (7%)

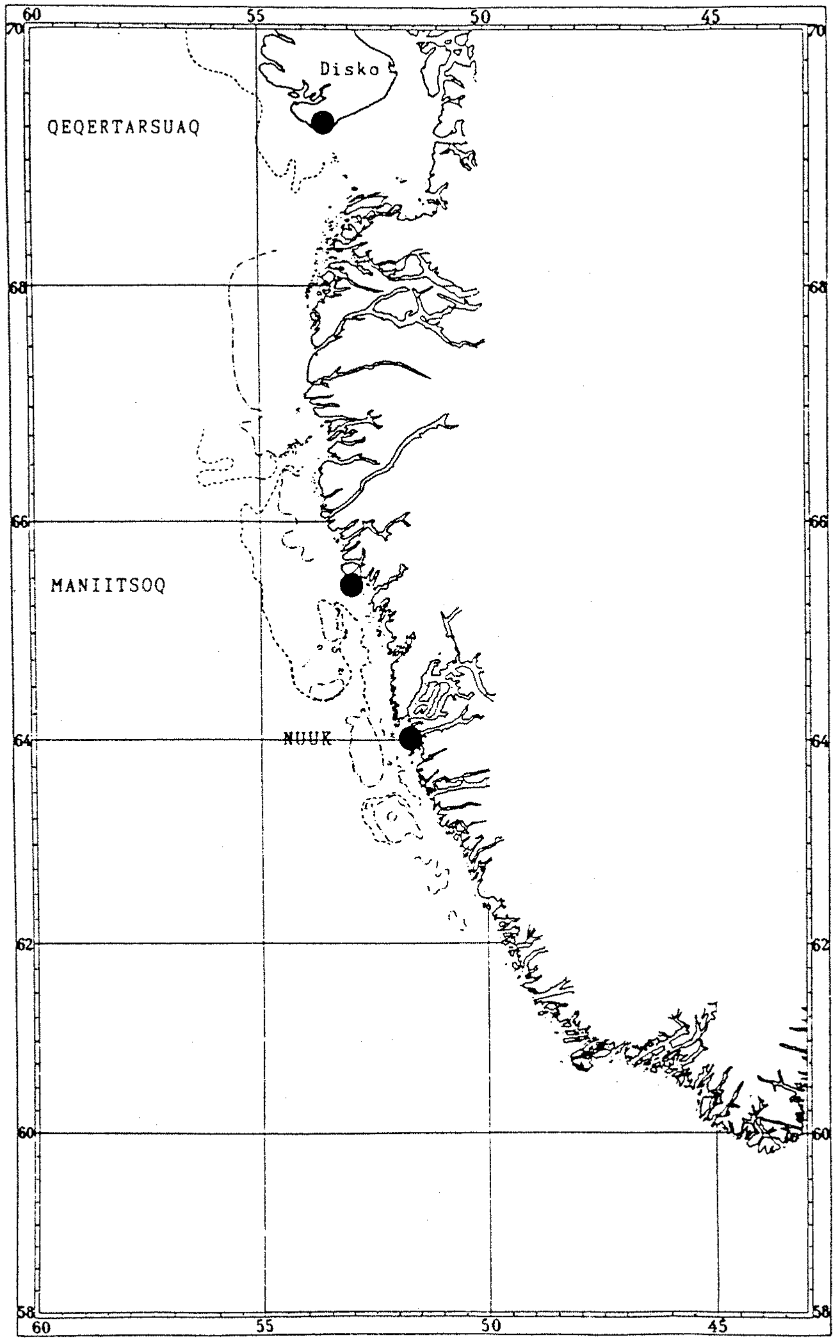

Fig. 1. Map of West Greenland showing the study area.

INCIDENTAL CATCH OF HARBOUR PORPOISES *Phocoena phocoena* IN SWEDISH WATERS IN THE YEARS 1973-1988

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INTRODUCTION The harbour porpoise *Phocoena phocoena* is regarded as a valuable species in Sweden. Since 1973 it has become Crown property when found dead; such animals should be reported to the police authorities and are collected by the different museums of natural history.

Fishermen are allowed to keep porpoises found dead in their fishing gear, but they are supposed to report the animals. As a result, quite a number of incidentally caught harbour porpoises have been collected by the museums since 1973.

METHODS An evaluation of records of harbour porpoises found in the period 1973-1987 and collected by Swedish museums was made. Data were kindly put at our disposal by the Museum of Natural History in Stockholm, the Museum of Natural History in Göteborg, and the Zoological Museum in Lund. Further data were provided by personal communication with the finders of the animals. Interviews with fishermen were made to evaluate the actual size of the incidental catch of harbour porpoises in Swedish fisheries. In the summer of 1988 a project was started with the aim of collecting all dead harbour porpoises found in Sweden. Information was sent to fishermen, police authorities, coast guards, fishery officials, etc. A small financial compensation of 150 Skr (ca. 13 pounds sterling) is offered for animals that are collected. The material is at present collected by the Museum of Natural History in Göteborg.

RESULTS AND DISCUSSION In the period 1973-1987, 239 specimens were collected; 149 animals were found in fishing gear and 65 on beaches or drifting in the water. In 25 cases it is not yet known how the animal was found. There has been an increase in the number of animals found in fishing gear (see Fig. 1) from an average of five animals per year in the period 1973-79 to 16 per year in the period 1980-87. Of the 149 animals found in fishing gear, 128 (86%) were taken in gill nets, the rest mainly in trawls. Porpoises were taken in all the main types of gill nets used in Swedish fisheries. However, most of the animals were taken in large-meshed nets (used for cod, flatfish, pollack and lumpfish), which are set at depths between 10 and 60 metres (see Fig. 2). The catch of harbour porpoises in drift nets was considerably smaller, possibly reflecting the fact that the fishery with large-meshed drift nets for salmon is confined to the Baltic Sea, where the harbour porpoise nowadays is rather rare. Several specimens are reported from gill nets set at depths of more than 60 metres.

The number of animals caught in the gill net fishery for cod and lumpfish shows a peak in April. This indicates an increased occurrence and/or movement of the species in coastal Swedish waters during this month, since the catch effort in these fisheries is approximately the same in March and April.

Interviews with fishermen confirmed that bycatches of harbour porpoises mainly occur in the coastal gill net fishery along the west coast of Sweden. The interviews also showed that most catches were not reported.

In June 1988, the numbers of porpoises collected greatly increased, both of animals caught in fishing gear and of those found dead on beaches or drifting in the water. The results of the first seven months of this work are shown in Fig. 3. During the period June - December 1988, 114 harbour porpoises were collected; of these, 23 were found in fishing gear. This is approximately twice the mean value for the corresponding months in the years 1985-87.

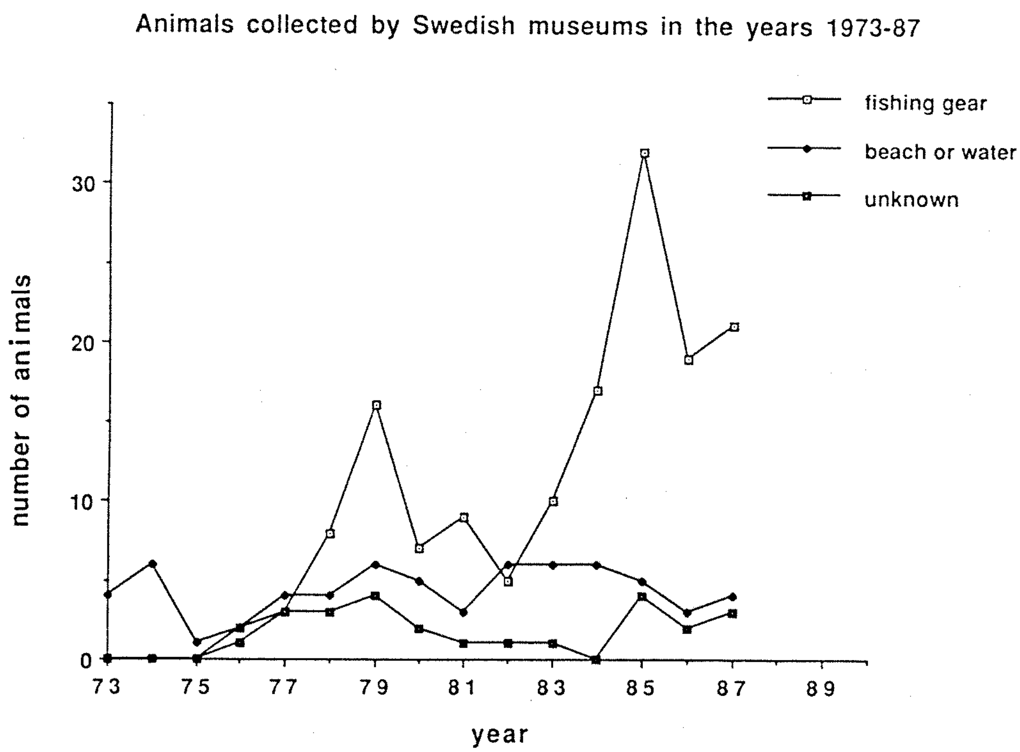

Fig. 1. Animals collected by Swedish museums in the years 1973-87.

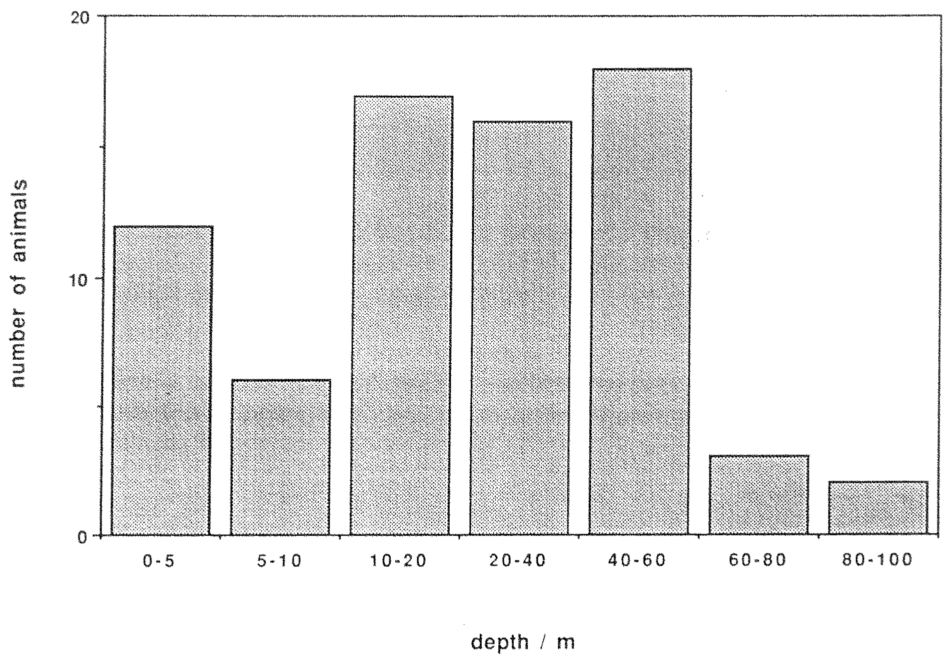

Fig. 2. Catch of animals at different depths.

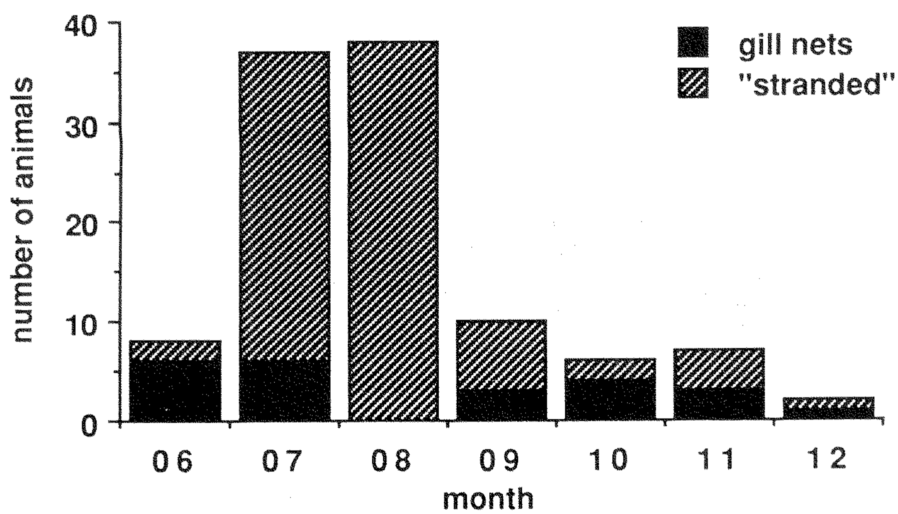

Fig. 3. Animals collected, June-December 1988.

FIELD STUDIES OF HARBOUR PORPOISES *Phocoena phocoena* IN NORTH SCOTLAND

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INTRODUCTION Concern has been expressed in recent years over widespread declines in harbour porpoises *Phocoena phocoena* in Northwest Europe, particularly in the southernmost North Sea and English Channel (Kröger, 1986; Evans *et al.*, 1987; Smeenk, 1987). During the 1980s, this decline has also occurred in regions of the northern North Sea, as revealed by data from quantified effort sites (Evans *et al.*, 1986).

There are two obvious potential causes of such a decline in the northern North Sea. The first is incidental catches in fishing nets. Large numbers have been reported drowning in nets set by the Danish fishery (Andersen & Clausen, 1985; Kinze, 1987); these may include segments of the UK population, whilst the extent of offshore catches in the northern North Sea is virtually unknown but may contribute to further mortality.

Another possible cause of a decline is a lack of food. Since the demise of herring after over-exploitation in the first half of this century, there is evidence that relaxed predation has allowed sand-eel and sprat populations to increase (Sherman *et al.,* 1981). However, since the 1960s, fisheries have turned increasingly to those species for fishmeal, so that during the 1970s catches increased rapidly (Hempel, 1978). This has been followed by a sharp decline in catches of sprat and, most recently, by similar declines in sand-eel catches in some areas (Johnson, 1984; Gauld *et al.*, 1986). Both fish species are energy-rich and form the prey of porpoises (Evans, 1987; Evans, pers. observs).

One of the most important areas for porpoises in UK are the Shetland Isles, north of Scotland (Evans *et al.*, 1986). These waters, however, have witnessed a dramatic increase in sand-eel fisheries during the last ten years followed by equally dramatic declines and poor recruitment (Bailey & Gauld, 1984; Kunzlik, 1989). With these concerns in mind, we started a field project on the harbour porpoise in Shetland.

METHODS During June to October 1988, land-based watches were concentrated in four areas: Noss Sound, Mousa Sound, Hamnavoe, and St Ninian's (Fig. 1). These were supplemented by some boat transects. Most of this work was carried out by Mary-Rose Lane, with boat transects also involving Martin Heubeck, Mike Richardson, Dave Bird, and Gina Scanlan.

In previous years (1977-87), boat transects were carried out by Martin Heubeck, Pete Kinnear, Mike Richardson and Peter Evans, with effort mainly around Noss and Mousa but also including Yell Sound and the region around Out Skerries and Whalsay. Land-based observations around the coasts of Shetland were also made by Pete Ewins during 1982 and 1983.

RESULTS Boat transects, carried out in different years in mid-August to mid-September, indicate declines in harbour porpoises observed at three separate areas in Shetland (Fig. 2). The declines are particularly marked since 1982. Data are corrected for effort and apply only to calm weather conditions (sea state 2 or less), so the abundance indices should be directly comparable between years. The standard error bars are relatively large and probably reflect short-term variation in local conditions.

Throughout the years 1982 and 1983, the entire coastline of Shetland was regularly covered by Pete Ewins as part of a seabird survey (inshore counts of black guillemots *Cepphus grylle*). All porpoise sightings were noted. These are plotted in Fig. 3. They show that porpoises occur over much of Shetland although there are definite concentrations: East Yell Sound, Whalsay area, Mousa and Quendale Bay (the last particularly between November and April). Additional sightings in subsequent years support these findings and show that those areas are used from year to year.

Using data gathered from 1982-83 throughout twelve months, it is possible to calculate the mean number of porpoises seen per day of observation for each month of the year. The results show that porpoises are present in Shetland waters throughout the year although there is a peak in numbers between July and October (Fig. 4). There is some indication of a decline in numbers in May and June, and this may reflect an offshore movement to breed since we know from other evidence that this is the main calving period (Evans *et al.*, 1986; Evans, unpubl. data; Kinze, 1988), and adults with young calves start to appear in coastal waters from late June onwards. Similar seasonal peaks occur elsewhere in UK although the precise timing may vary between July and October.

Results of several cruises at different depths indicate that during July - September, porpoises are mainly found in shallow waters of 50 metres depth or less, particularly in this region between 20 and 30 metres depth. This may be related to the undersea shelf topography around Shetland, which slopes steeply to the 30 metre contour but then shows a much more gradual decline into deeper water. It is possible that fish are concentrating along slopes rather than over uniformly flat ground. Less than 5% of all sightings were made in depths of 50 metres or more, despite 68 out of 163 half-hour periods having been sampled at these depths.

No consistent pattern in diurnal presence of porpoises could be discerned for the different closely watched sites. Although in any one day, porpoises would be present only at particular times such as early morning or late afternoon and evening, these varied between days, so that when the results from different dates were combined, no strong activity pattern resulted, at least for Noss and Mousa Sounds. At St Ninian's, porpoises were present mainly during the morning although there were few sightings there anyway.

When the same data were used but compared with different states of the tide, some clear patterns emerged. At each site there were more or less two peaks and two troughs in the presence of porpoises. The troughs tended to be around high and low tides and the peaks in between, although the timing varied between sites with stronger fluctuations at Noss and St Ninian's than at Mousa. Although the state of the tide has an influence on the strength of current flow at a particular spot, this will vary between localities according to the pattern of current flow around the islands. Unfortunately, this information is not available for these particular localities. However, we have been able to examine this elsewhere, in the Minches of Northwest Scotland where detailed measurements of current flow have been taken throughout the area for different tidal conditions. They were all made in calm conditions of sea state 2 or less, so that viewing conditions should not affect the results. They showed that porpoises (and other cetaceans) positioned themselves mainly in slack water at the head of inflowing currents. These change position as the currents change flow (Fig. 5). This is further supported by an analysis comparing the proportions of sightings occurring in situations with different current strengths. Significantly more sightings of cetaceans (and feeding concentrations of seabirds) occurred in slack waters (0.5 knots or less)[Chi-square = 9.6, $p < 0.01$].

DISCUSSION AND CONCLUSIONS We have made a little progress in seeing how porpoises are distributed around Shetland and identifying some of the factors influencing their distribution. As yet, we do not know the importance of sand-eels in their diet relative to other fish species, although throughout the 1970s and early 1980s, sand-eels dominated the prey of ten species of seabirds in Shetland (Heubeck, 1989). Our next task will be to try to relate the ecological distribution of porpoises to various potential prey species, so as to identify which fish may be most important. Most of the areas with porpoise concentrations are close to sand-eel fishing grounds, but sand-eels may also concentrate in regions where fishing cannot take place. Our greatest need therefore is for information on the distribution of different fish species which, to date, fisheries research has been unable to provide adequately.

ACKNOWLEDGEMENTS We thank the British Ecological Society for funding the project in 1988, and also the local help provided by Mike Richardson and Paul Harvey of the Nature Conservancy Council, Martin Heubeck (Shetland Bird Club), Gina Scanlan and Dave Bird, as well as many fishermen and other Shetlanders who so willingly provided sightings records.

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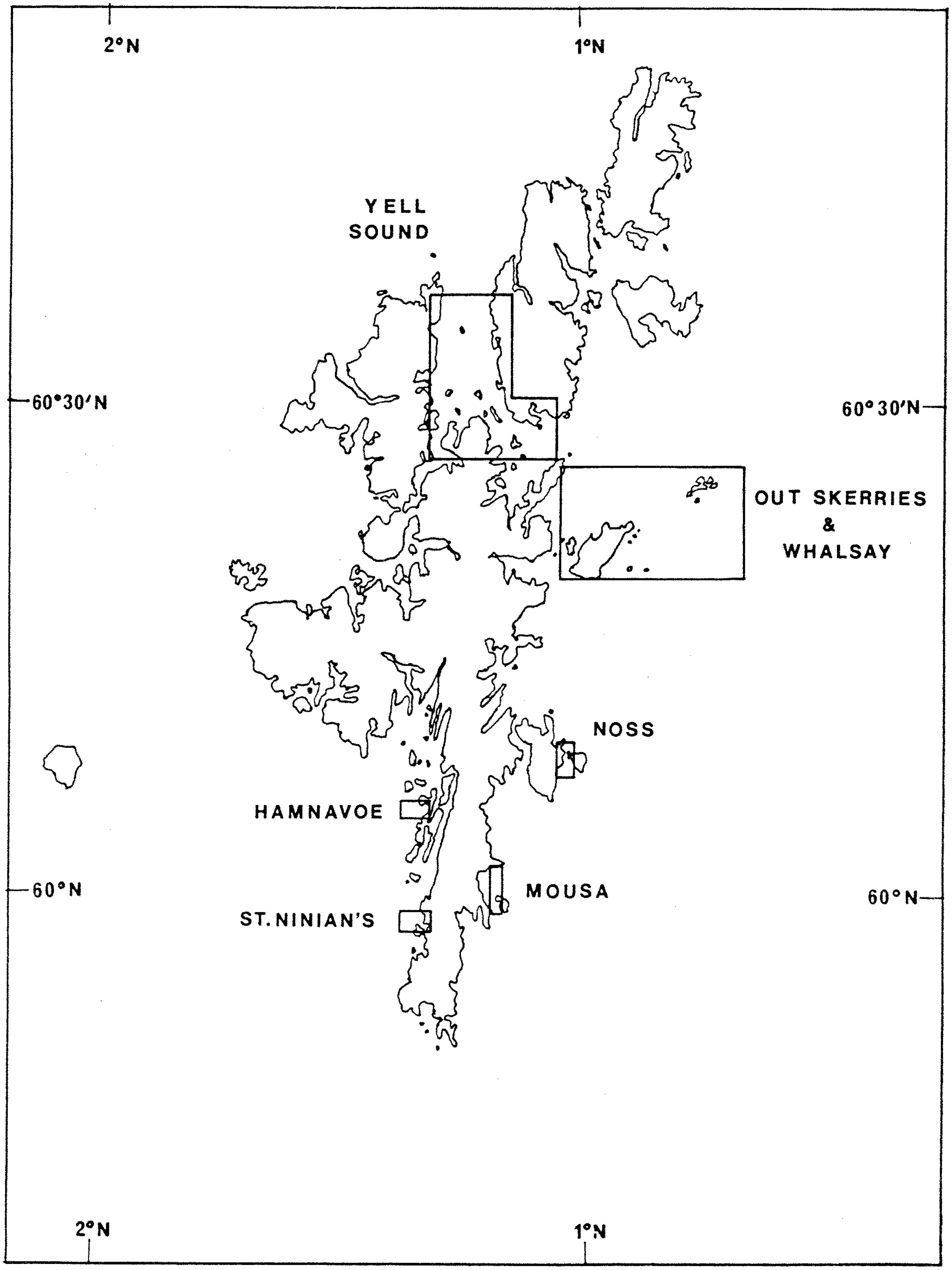

Fig. 1. Map of the Shetland Islands showing the main study areas.

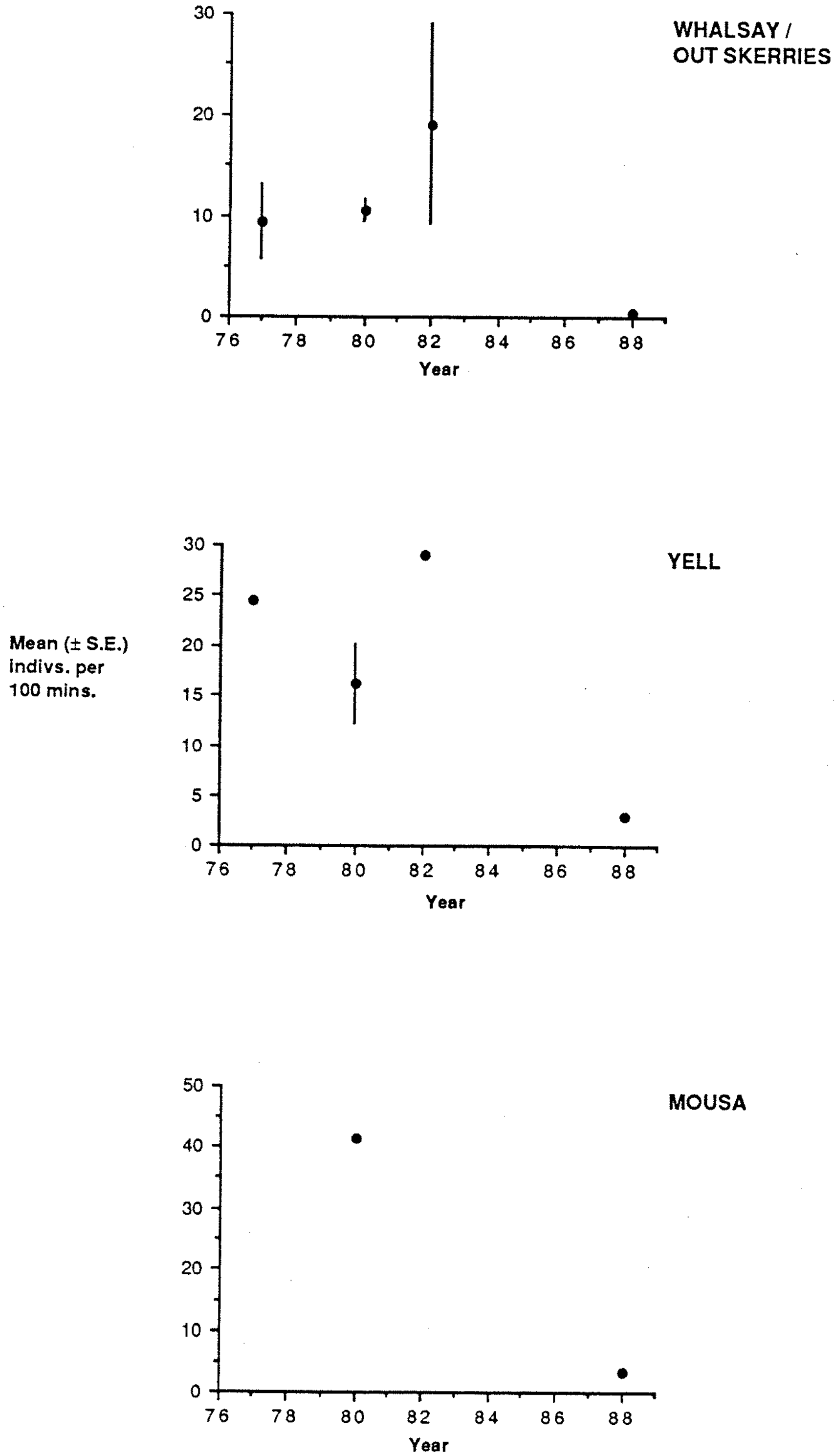

Fig. 2. Status changes of the harbour porpoise in Shetland, 1977-88.

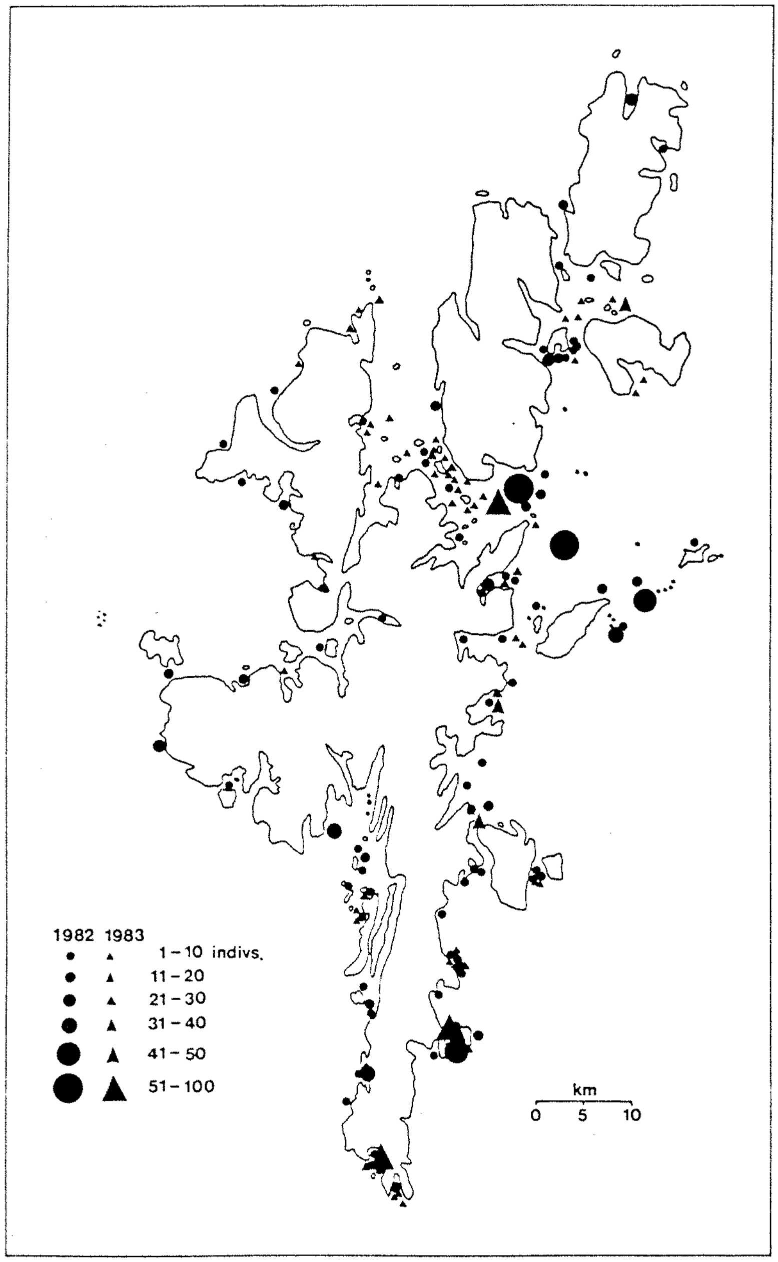

Fig. 3. Porpoise sightings in Shetland, 1982-83.

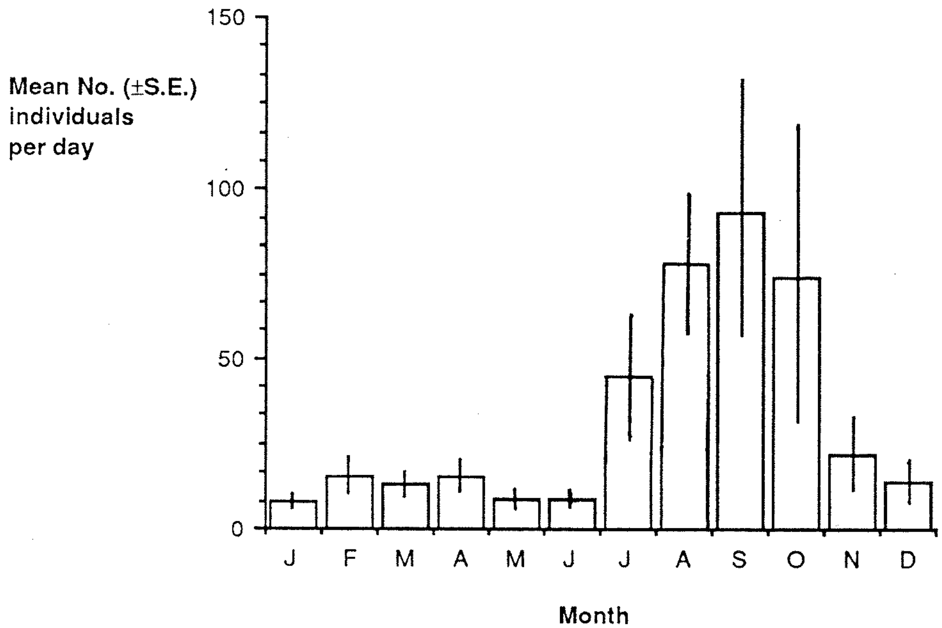

Fig. 4. Seasonal changes in the relative abundance of harbour porpoises in Shetland.

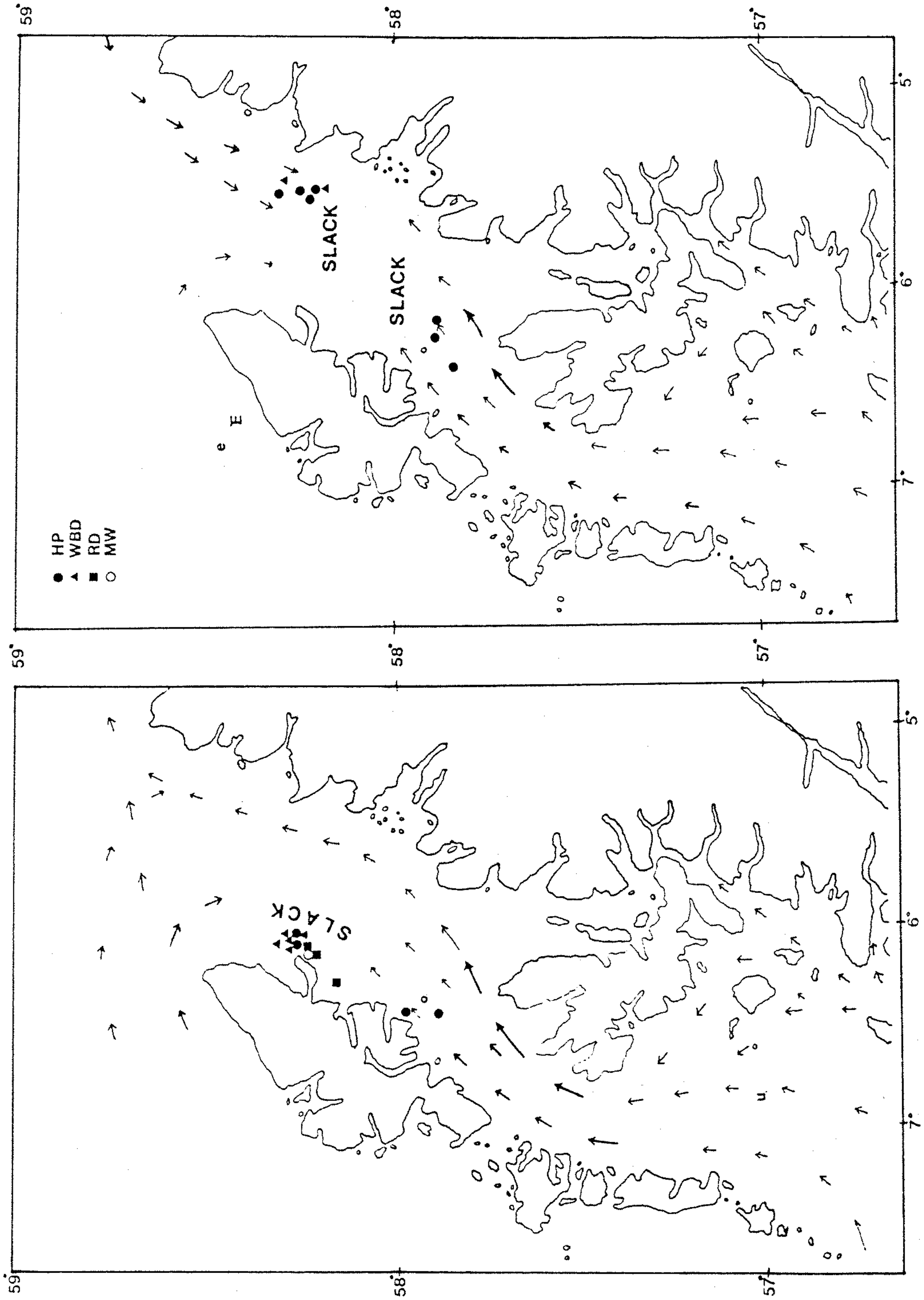

Fig. 5. Distribution of cetaceans in relation to different tidal conditions (data summed over several dates).

PRELIMINARY SIGHTING RECORDS OF HARBOUR PORPOISES

Phocoena phocoena IN SWEDISH WATERS

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INTRODUCTION During the last four decades a ten-fold decline has been recorded in the number of sightings of harbour porpoises in Swedish waters. Four factors are thought to be mainly responsible for the decline: pollution, depletion of important prey, "bycatches" and disturbance by human activities. In order to study this, two main approaches have been tried:

(1) Sightings - a network of observers;
(2) Field study.

SIGHTINGS

Methods In 1986, the Swedish Harbour Porpoise Working Group was formed to improve our knowledge of the status, distribution and ecology of harbour porpoises in Swedish waters. A network of observers was organized, and they were encouraged to report sightings on a regular basis, on standardized forms. This scheme operates today with 200 fishermen, coastguards, merchant seamen and ornithologists.

Results During May to October 1988, our observers reported 134 sightings of porpoises around the shores of Sweden. The total number of porpoises sighted was 383 animals. This gives an average of 2.9 animals per sighting. The majority of these observations were made on the west coast (Fig. 1, areas 1 & 2).

Almost all animals were adults or subadults. Only five females with calves were seen. The geographical distribution of sightings during this season extended from the Norwegian border to Västervik in the Baltic Sea. Figure 2 shows the number of sightings per observation day at sea for each month, and for different areas. Zero-observations are also included.

Discussion On the west coast, porpoises show seasonal onshore-offshore movements. This movement from the North Sea in spring appears to be related to coastal feeding and breeding in shallower waters. Porpoises seem to move about in all areas on the west coast but seldom penetrate further than the Belts and the Sounds between Sweden and Denmark. In autumn, there are fewer sightings in all areas, which may be due partly to poorer sighting conditions.

The harbour porpoise is present in very low numbers in the Baltic Sea (Fig. 1, areas 4 & 5). Only a few sightings were made during the summer, which confirms that the number of sightings in the Baltic has declined dramatically, particularly since the early 1960s.

FIELD STUDY

A 6-week cruise, 15 June - 31 July 1988, was conducted along the west coast of Sweden (Fig. 1, areas 1, 2 and 3). This cruise had two main goals: (1) to test techniques for field studies including photo-identification, sound recordings and behavioural studies; and (2) to inform observers and the public about the ecology of porpoises.

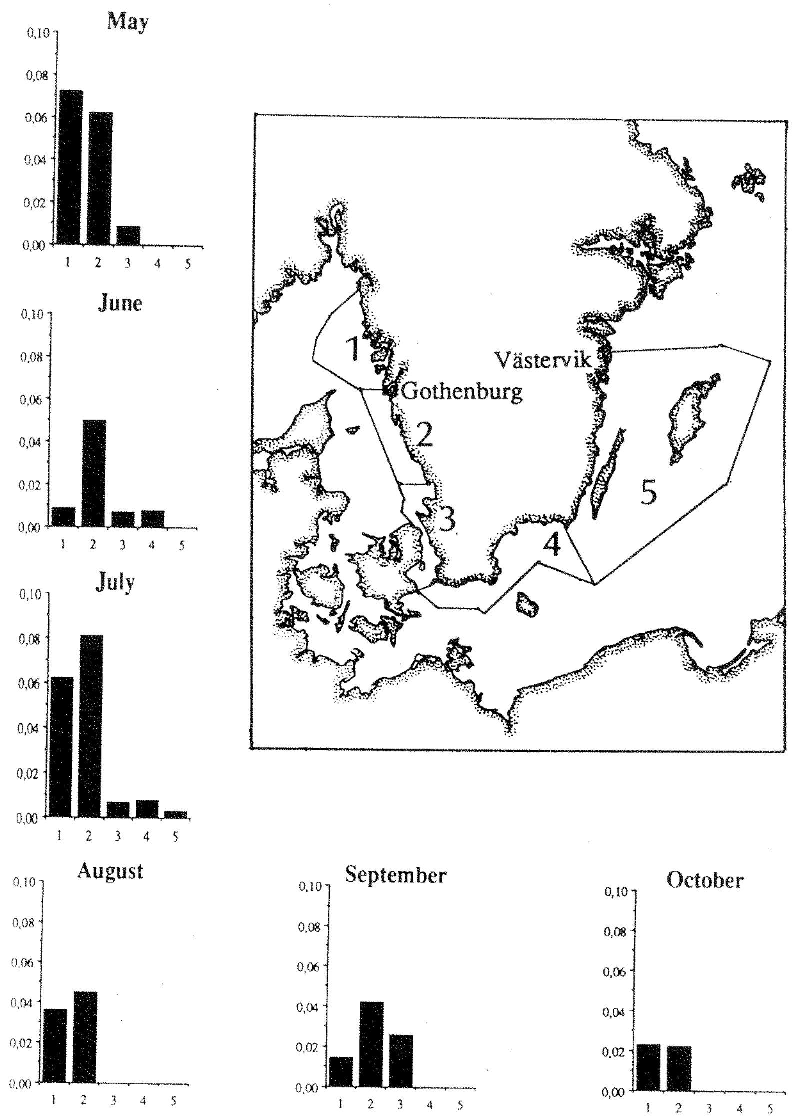
Methods and results

Aims	Methods	Results
To find porpoises	Sailing along transects. VHF-radio contact with observers	8 porpoises in 20 days
Photo-identification	Camera with 300 mm telephoto lens	Possible
Sound recordings	Hydrophone, amplifier and tape recorder	No recording
Behavioural studies	Field forms	Short observation periods
Information to public	Posters in harbours	Very successful

Discussion and problems at sea Due to bad weather conditions it was only possible to spend twenty out of 42 days at sea. On these twenty days, 400 nautical miles were sailed, and 100 hours of observation were made in search of porpoises.

When we found porpoises, we had difficulty in following them. Even in perfect conditions they showed the ability to simply disappear. We observed porpoise resting behaviour at the surface for periods > 30 seconds.

Our field study shows that it is possible to study porpoises in Swedish waters. In order to make the field study in 1989 more successful, we will use another study period, to carry out the cruise in combination with aerial surveys, and make video recordings of sightings. Eventually, we also hope to use radio-tracking. Collectively, these modifications should greatly increase our ability to follow, identify and study porpoises so that survey time will be more efficient and profitable.



In the graphs, the x-axis represents different areas (see map), and the y-axis represents number of sightings per day.

Fig. 1. Sightings of harbour porpoises in Swedish coastal waters. In the graphs, the x-axis represents different areas (see map), the y-axis represents the number of sightings per day.

STRANDING RECORDS OF THE HARBOUR PORPOISE
Phocoena phocoena IN THE NETHERLANDS: 1970-1987

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In 1970, a new and more intensive recording scheme for cetacean strandings on the Dutch coast was set up by the zoological museums of Leiden and Amsterdam (since 1981, Leiden has run this alone). The methods of data-collection have been fairly consistent ever since, so we have nearly twenty years of accumulated information comprising 355 reported harbour porpoises. For more details of the recording scheme and the occurrence of the harbour porpoise in the Netherlands, see Smeenk (1987). The data from the period 1970-87 will be analysed here. A Chi-square test was applied to those data suited to statistical analysis.

During the first years after 1970 we observe a gradual but significant increase in reported strandings ($p < 0.05$). This is best illustrated when the data are arranged in periods of six years (Fig. 1). This increase almost certainly is the result of an increasing observer effort. In recent years the numbers have leveled off, indicating that our coverage of the coast has become more or less constant.

For a further analysis, the Dutch coast has been divided into three sections: the Wadden Sea area in the north, the mainland coast, and the Delta area in the southwest (Fig. 2). It is not very easy to correct for coast length. For our calculations the Wadden Sea and Delta areas have each been treated as if they formed an uninterrupted coastline. After correcting for the differences in coast length between the three areas, we find that the number of porpoise strandings increases significantly from south to north ($p < 0.002$). When the mainland coast is considered separately, we again find significantly more strandings in the northern half of this area ($p < 0.01$). The information on live sightings of harbour porpoises in Dutch waters shows a similar pattern, with most sightings off the northern part of the country (Baptist, 1987).

Since the Delta area and mainland coast are better covered for strandings than the Wadden Sea area, the real difference between the latter section and the rest of the Dutch coast would be even more pronounced than appears from our figures: relatively more animals are missed in the Wadden Sea area than elsewhere.

In order to trace any seasonal pattern, the year has been divided into four seasons: winter (January - March), spring (April - June), summer (July - September) and autumn (October - December). Counting all porpoise strandings including animals of unknown sex, we find a significant increase during the autumn/winter period ($p < 0.05$, Fig. 3a) despite the reduced observer effort in this season as compared with the other half of the year. This increase may perhaps partly be explained by the prevailing on-shore winds during this time of the year.

The sex-ratio of stranded porpoises shows a significant excess of females ($p < 0.005$, Fig. 3b). However, when looking at the separate seasons, we find that in summer and winter there is an almost equal sex-ratio whereas in spring and autumn there is a significant predominance of females (Fig. 3c). The excess of females in spring is the result of a decrease in stranded males. In autumn the same effect is caused by an increase in stranded females.

For a further discussion of the subject, we refer to Addink and Smeenk (in prep.).

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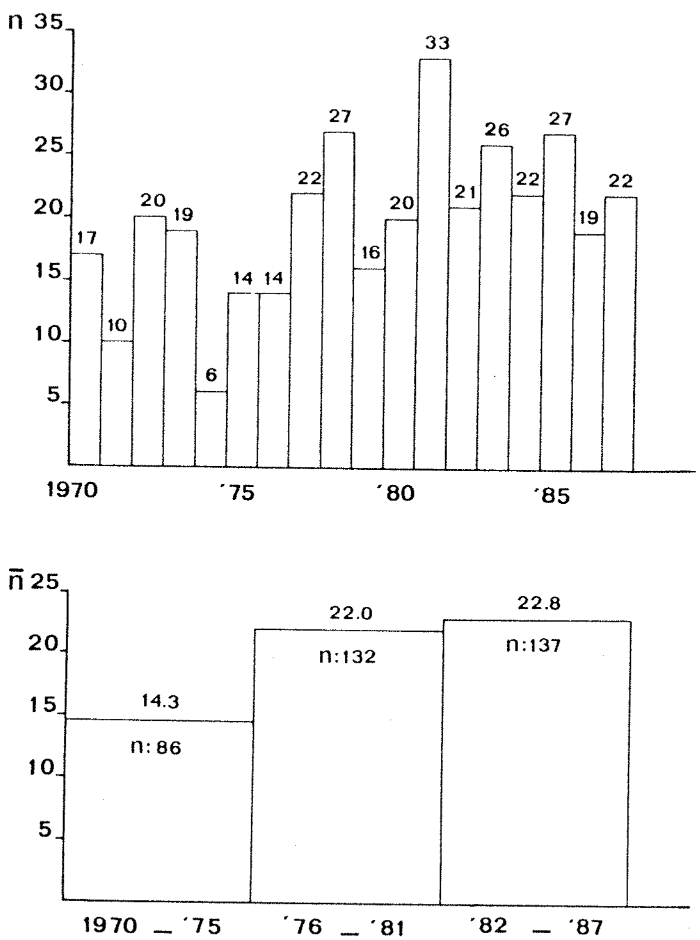

Fig. 1. The numbers of stranded harbour porpoises on the Dutch coast reported over the period 1970-87. Above: annual numbers; below: averages (n) over periods of six years.

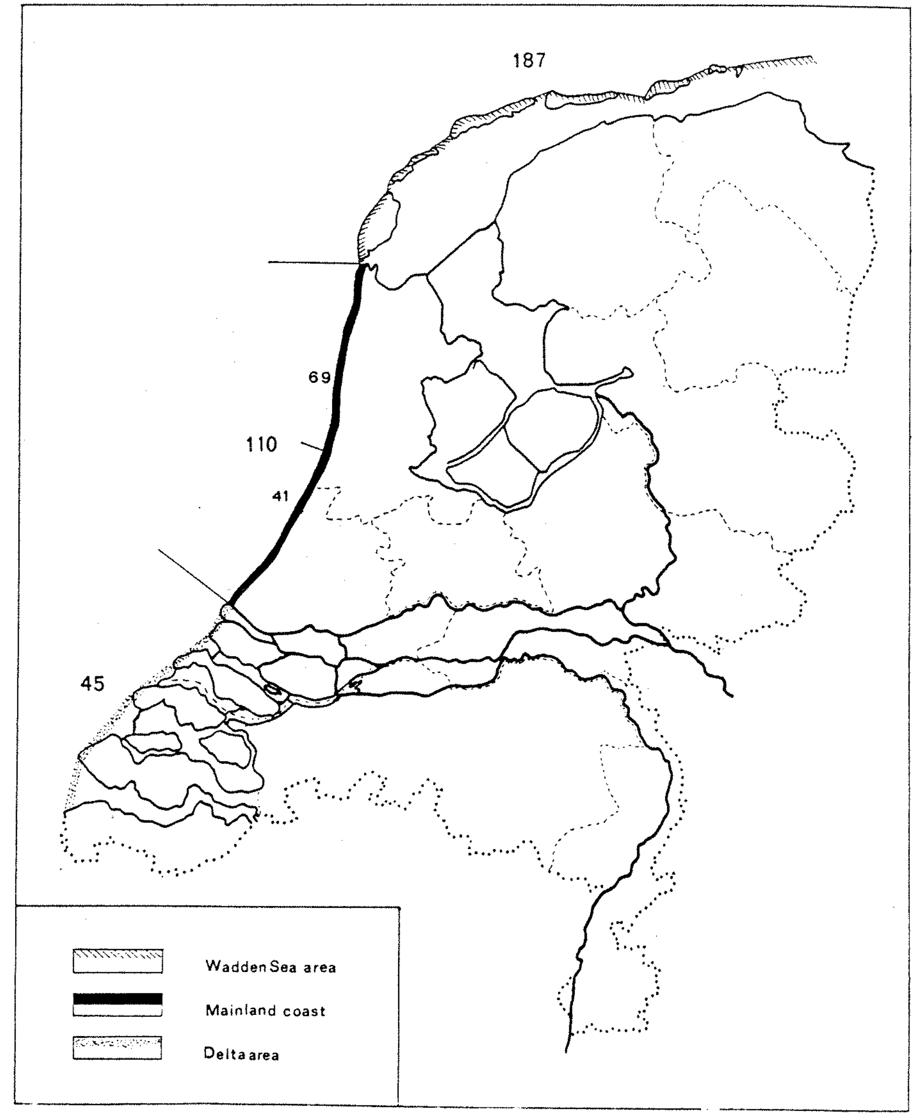

Fig. 2. The three sections of the Dutch coast. For each section the total number of stranded harbour porpoises reported over the period 1970-87 is given. The mainland coast is divided into a northern and southern sector. The total number given here is slightly lower than in Fig. 1 as the localities of some animals could not be traced.

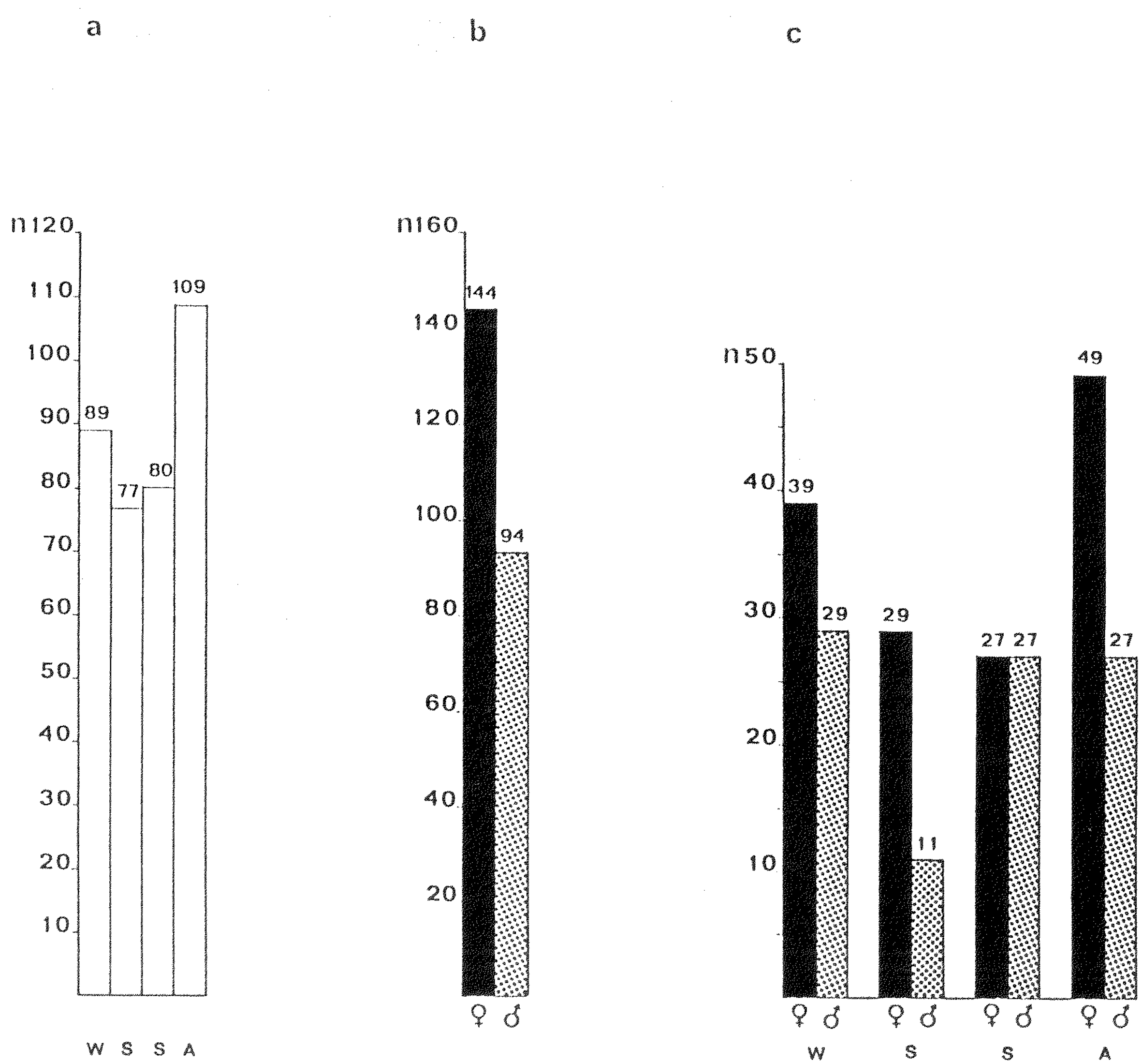

Fig. 3. (a), Total numbers of stranded harbour porpoises reported over the period 1970-87, arranged according to season; (b), total numbers of males and females registered over the same period; (c), the same data for each season.

ECTOPARASITES AND EPIZOITS OF THE LONG-FINNED PILOT WHALE *Globicephala melas* OFF THE FAROE ISLANDS, WITH SPECIAL REFERENCE TO *Isocyamus delphinii* (AMPHIPODA: CYAMIDAE)

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INTRODUCTION The fauna of ectoparasites and epizoits of the pilot whale comprises four crustacean species. Two of them are cirripeds: *Conchoderma auritum* and *Xenobalanus globicipitis:* the former has a cosmopolitan distribution whereas the latter seems to prevail in warm to temperate waters. One is the copepod *Pennella* sp. which appears to be more common in warm or temperate waters; and the remaining species is the amphipod *Isocyamus delphinii,* a member of the family Cyamidae.

The cyamids, commonly known as whale-lice, show a variety of particular biological adaptations resulting from their life as ectoparasites on whales and dolphins. Some of these adaptations are meant to ensure attachment to the skin, particularly in areas sheltered from the currents generated by the swimming movements of their hosts.

The biology of the whale-louse species is hardly known, although there is evidence that these external parasites have a simple life-cycle without free-swimming stages. Thus transfer from one host to another can only occur during bodily contact between individuals. This peculiarity offers good possibilities to utilize these parasites as potential biological indicators as has been done for the sperm whale *Physeter macrocephalus* (Best, 1969).

MATERIALS AND METHODS From August 1987 to March 1988, 152 pilot whales from eight different schools taken in the Faroese drive fishery were surveyed. The skin was scrutinized for ectoparasites and/or epizoits, paying special attention to natural openings, scars, wounds, marks, etc. Specimens collected in the Faroes between 1984 and 1988 were also studied.

All hosts were measured and sexed. Based on previous studies of the biology of the pilot whale carried out by Sergeant (1962) in Newfoundland, Martin *et al.* (1987) in Britain, and Bloch (1987) in the Faroes, the whales were divided into several groups according to size, which are thought to roughly correspond to different reproductive stages.

Males:

Group 1.	Body length less than 401 cm.	Immature individuals
Group 2.	Body length between 401 and 500 cm.	Adolescent individuals
Group 3.	Body length more than 500 cm.	Mature individuals

Females:

Group A.	Body length less than 351 cm.	Immature individuals
Group B.	Body length more than 351 cm.	Mature individuals

RESULTS AND DISCUSSION Three parasitic or epizoitic species were found: *C. auritum* on the teeth; *X. globicipitis* attached to the skin; and *I. delphinii* in wounds or around the genital slit. These three species can be regarded as typical for the host and the geographical area studied. Despite the fact that available data are fragmentary, our observations from the Mediterranean Sea seem to indicate that *X. globicipitis* occurs more frequently and abundantly in the Mediterranean than in the Atlantic Ocean. Moreover, *Pennella* sp. which occasionally occurs on pilot whales and other odontocetes in the Mediterranean Sea, has not been discovered in Faroese waters.

The most common species found was *I. delphinii* : 45 of the 152 whales were infested with this whale-louse (29.61%) whereas *X. globicipitis* appeared on only two hosts (1.3%). A single specimen of *C. auritum* was collected in previous surveys by G. Desportes, but this species was not found during the present investigation. Therefore, we assume that *X. globicipitis* and *C. auritum* are rare on pilot whales off the Faroes.

Males were more often infested with *I. delphinii* than females (Chi-square = 11.2731, 1 df, $p < 0.01$). There was no significant difference in the prevalence of whale-lice between females of groups A and B (Chi-square = 2.02, 1 df, $p > 0.05$). By contrast, males from groups 1, 2 and 3 showed very different prevalences (Chi-square = 18.075, 2 df, $p < 0.0001$), the highest being that in group 3 (mature males).

Intensities of infestation were usually low. *X. globicipitis* occurred only with one to two individuals per host. *I. delphinii* had a wider range, from one to several hundred individuals on a single host. However, only three hosts, all of these mature males, had more than twenty lice. High intensities of infestation seemed to be less frequent in females than in males, since there were never more than ten lice on the former, and only in five out of 21 (about 24%) on the latter. Likewise, only males in groups 2 and 3 seem to have relatively high intensities.

Variations in prevalence and intensity of infestation between males and females, and between young and adult males may be explained by behavioural differences. Previous studies (Bloch, 1987; Martin *et al.*, 1987) indicate that fighting marks occur more frequently on males than on females, and on adults more than on juveniles. Thus social interactions seem to be more frequent among mature males, which would increase the probability of transfer of *I. delphinii*. In addition, severe wounds caused by fighting might provide additional shelter for whale-lice, thus accounting for the high intensities occasionally observed on adult males.

The location of ectoparasites and epizoits on pilot whales off the Faroes seems to be typical for these species. The site selection of *I. delphinii* has been studied in detail. The genital slit was by far the most preferred site of *I. delphinii*.. This is a zone of contact between individuals, especially during mating, which could facilitate the transfer of whale-lice. However, occasionally the highest intensities occurred on the back, dorsal fin and flanks, and were related to the occurrence of unhealed wounds in mature males.

ACKNOWLEDGEMENTS We wish to thank Mrs. D. Bloch, Dr. G. Desportes, personnel of the Faroese Museum of Natural History, and all researchers and volunteers involved in the international programme on the biology of the pilot whale in the Northeast Atlantic for their great help with the field work. This study was financed by the Faroese Local Government, the CICYT of the Spanish Government (Project No. PB87-997), and supported by grants of the Conselleria de Cultura, Educació i Ciència de la Generalitat Valenciana to J.A. Raga and J.A. Balbuena.

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NAMES OF WHALES, DOLPHINS AND PINNIPEDS

Odile and Alexandre Gannier

LATIN	FRENCH	ENGLISH	GERMAN	DUTCH	DANISH
Eubalaena glacialis	Baleine franche noire, Baleine des Basques	Black right whale	Nordkaper	Noordkaper	Nordkaper
Balaena mysticetus	Baleine franche du Groenland	Bowhead	Grönlandwal	Groenlandse walvis	Grønlandshval
Balaenoptera musculus	Rorqual bleu	Blue whale	Blauwal	Blauwe vinvis	Blåhval
Baleanoptera physalus	Rorqual commun	Fin whale	Finnwal	Gewone vinvis	Finhval
Balaenoptera borealis	Rorqual de Rudolphi	Sei whale	Seiwal	Noordse vinvis	Sejhval
Balaenoptera acutorostrata	Rorqual à museau pointu, Petit rorqual	Minke whale	Zwergfinnwal	Dwergvinvis	Vågehval
Megaptera novaeangliae	Baleine à bosse, Mégaptère	Humpback	Buckelwal	Bultrug	Pukkelhval
Steno bredanensis	Sténo	Rough-toothed dolphin	Rauhzahn-delphin	Snaveldolfijn	Rutandsdelfin
Stenella coeruleoalba	Dauphin bleu et blanc	Striped dolphin	Blauweisser Delphin, Streifendelphin	Gestreepte dolfijn	Stribet delfin
Delphinus delphis	Dauphin commun	Common dolphin	Gemeiner Delphin	Echte dolfijn, Gewone dolfijn	Almindelig delfin
Tursiops truncatus	Grand dauphin, Souffleur	Bottle-nosed dolphin	Grosser Tümmler	Tuimelaar	Øresvin
Lagenorhynchus albirostris	Lagénorhynque à bec blanc	White-beaked dolphin	Weissschnau-zendelphin	Witsnuitdolfijn	Hvidnæse
Lagenorhynchus acutus	Lagénorhynque à flancs blancs	Atlantic white-sided dolphin	Weissseiten-delphin	Witflankdolfijn	Hvidskæving
Pseudorca crassidens	Faux-orque	False killer whale	Falscher Schwertwal	Zwarte zwaard-walvis	Halvspæk-hugger
Orcinus orca	Orque, Epaulard	Killer whale	Schwertwal	Zwaardwalvis, Orka	Spækhugger
Grampus griseus	Dauphin de Risso	Risso's dolphin	Rundkopf-delphin	Grijze dolfijn, Gramper	Rissos delfin, Halvgrindehval

SWEDISH	NORWEGIAN	ITALIAN	SPANISH	PORTUGUESE	GREEK
Nordkapare	Nordkaper	Balena nera, Balena dei Baschi	Ballena de los Vascos	Baleia negra	
Grönlandsval	Grønlandshval	Balena di Groenlandia	Ballena de Groenlandia	Baleia de Groenlandia	
Blåval	Blåhval	Balenottera azzurra	Rorcual azul	Baleia-azul	Galázia phalaina
Fenval	Finnhval	Balenottera comune	Rorcual común	Baleia-fina	
Sejval	Seihval	Balenottera boreale	Rorcual boreal, Rorcual norteno	Baleia-sardinheira	
Vikval	Vågehval, Minke	Balenottera minore	Rorcual aliblanco	Baleia-anã	
Knölval	Knølhval	Megattera	Yubarta	Jubarte	Kampoúra phalaina
Näbbdelfin		Steno	Delfín de dientes rugosos	Caldeirão	
Strimmig delfin	Stripedelfin	Stenella striata	Delfín rayado	Golfinho riscado	
Delfin	Vanlig delfin	Delfino comune	Delfín común	Golfinho	Delphini koino
Flasknosdelfin, Öresvin	Tumler	Tursiope	Delfín mular	Golfinho-roaz, Corvineiro	Delphini
Vitnos	Kvitnos	Lagenorinco rostrobianco	Delfín de pico blanco	Golfinho de bico branco	
Vitsiding	Kvitskjeving		Delfín de flancos blancos		
Falsk späckhuggare	Falsk spekk-hugger	Pseudorca	Falsa orca	Falsa-orca	
Späckhuggare	Spekkhugger, Staurhval	Orca	Orca	Roaz de bandeira, Orca	Orka
Rissos delfin	Rissos delfin	Grampo	Delfín de Risso, Calderón gris	Grampa	Grizo delphini

LATIN	FRENCH	ENGLISH	GERMAN	DUTCH	DANISH
Globicephala melas	Globicéphale noir	Long-finned pilot whale	Grindwal	Griend	Langluffet grindehval
Globicephala macrorhynchus	Globicéphale tropical	Short-finned pilot whale	Tropischer Grindwal	Tropische griend	Kortluffet grindehval
Phocoena phocoena	Marsouin	Harbour porpoise	Schweinswal	Bruinvis	Marsvin
Monodon monoceros	Narval	Narwhal	Narwal	Narwal	Narhval
Delphinapterus leucas	Bélouga	White whale, Beluga	Weisswal, Beluga	Witte walvis, Beloega	Hvidhval
Kogia breviceps	Cachalot pygmée	Pygmy sperm whale	Zwergpottwal	Dwergpotvis	Dværgkaskelot
Physeter macrocephalus	Cachalot	Sperm whale	Pottwal	Potvis	Kaskelot
Mesoplodon bidens	Mésoplodon de Sowerby	Sowerby's beaked whale	Sowerby-Zweizahnwal	Spitssnuit-dolfijn	Næbhval
Mesoplodon mirus	Mésoplodon de True	True's beaked whale	True-Zweizahnwal	Spitssnuit-dolfijn van True	True's næbhval
Ziphius cavirostris	Ziphius	Goose-beaked whale	Cuvier-Zweizahnwal	Dolfijn van Cuvier	Cuvier's næbhval
Hyperoodon ampullatus	Hyperoodon boréal	Northern bottle-nosed whale	Entenwal	Butskop, Hille	Døgling
Halichoerus grypus	Phoque gris	Grey seal	Kegelrobbe	Grijze zeehond	Grå sæl
Phoca vitulina	Phoque veau marin	Harbour seal	Seehund	Gewone zeehond	Spættet sæl
Phoca hispida	Phoque annelé, Phoque marbré	Ringed seal	Ringelrobbe	Stinkrob, Ringelrob	Ringsæl
Phoca groenlandica	Phoque du Groenland	Harp seal	Sattelrobbe	Zadelrob	Grønlandssæl
Erignathus barbatus	Phoque barbu	Bearded seal	Bartrobbe	Baardrob	Remmesæl
Cystophora cristata	Phoque à capuchon	Hooded seal	Klappmütze	Klapmuts	Klapmyds
Monachus monachus	Phoque moine	Monk seal	Mönchsrobbe	Monniksrob	Munkesæl
Odobenus osmarus	Morse	Walrus	Walross	Walrus	Hvalros

SWEDISH	NORWEGIAN	ITALIAN	SPANISH	PORTUGUESE	GREEK
Grindval	Grindehval	Globicefalo	Calderón común	Boca de panela	Mavrodelphini
		Globicefalo di Gray	Calderón tropical	Boca de panela tropical	
Tumlare	Nise	Focena	Marsopa	Bôto	Phokaina
Narval	Narrhval	Narvalo	Narval	Narval	
Vitval	Hvithval	Beluga	Beluga	Beluga	
Dvärgkaskelot	Dvergspermhval	Cogia di de Blainville	Cachalote enano	Cachalote-anão	
Kaskelot	Spermhval	Capodoglio	Cachalote	Cachalote	Phisetiras
Sowerbys näbbval	Spisshval	Mesoplodonte di Sowerby		Baleia de bico de Sowerby	
Trues näbbval	Trues spisshval	Mesoplodonte di True		Baleia de bico de True	
Småhuvudval		Zifio	Ballenato de Cuvier, Zifio	Zifio	Rampho-phalaina
Näbbval	Nebbhval	Iperodonte boreale			
Gråsäl	Gråsel, Havert	Foca grigia	Foca gris	Foca-cinzenta	
Knubbsäl	Fjordsel, Steinkobbe	Foca comune	Foca común	Foca	
Vikare	Ringsel	Foca dagli anelli	Foca anelada	Foca anelada	
Grönlandssäl	Grønlandssel	Foca della Groenlandia	Foca de Groenlandia	Foca de Groenlandia	
Storsäl	Storkobbe, Blåsel	Foca barbuda	Foca barbuda		
Blåssäl	Klappmyss	Foca de cresta	Foca de crista		
Havsmunk	Munksel	Foca monaca	Foca monje	Foca-monge, Lobo-marinho	Phokia
Valross	Hvalross	Tricheco	Morsa	Morsa	

SIGHTINGS WORKING GROUP

Peter G.H. Evans

(Chairman)

An informal meeting of the Sightings Working Group was held on 26 February. Its aims were (a) to review sightings activities in different European countries; (b) to identify members' interests and concerns; and (c) to formulate useful proposals to improve and standardize sightings schemes in Europe. About forty persons attended, representing twelve countries.

A questionnaire was distributed to collect information on sightings activities in the various European countries. It was divided into three sections, relating to the three main types of sightings programs. These were (a) mapping surveys, contributing positive information of sightings, not necessarily corrected for effort; (b) monitoring programs including both land- and sea-based information, corrected for effort/visibility, that can lead to an index of abundance; and (c) population estimates derived generally from dedicated boat or aerial surveys, using belt transect sampling and appropriate correction values.

A summary of those results, presented at the meeting and in correspondence with the chairman, is given below.

COUNTRY BY COUNTRY SUMMARY

Iceland The Marine Research Institute in Reykjavík (Jóhann Sigurjónsson, Thorvaldur Gunnlaugsson *et al.*) has been participating in the North Atlantic Sightings Survey during the years 1987 and 1988, and there are plans for further surveys in 1989. These have involved both ship and aerial surveys using line transect techniques. They are aimed primarily at deriving population estimates for large cetaceans (although small cetaceans are also recorded).

Norway The Institute of Marine Research in Bergen (Nils Oien *et al.*.) is also participating in the North Atlantic Sightings Survey during the years 1987-89, using the same methods as described above. Incidental sightings reported by letter or telephone have also been logged on computer by the Institute since 1967, and by its own research vessels, coastguard vessels, and some whaling and fishing vessels since 1978. In the latter cases, information on effort has not been collected but the resulting data are useful for mapping distribution. Whale-watching cruises (Morten Lindhard & Lars-Erik Knutsen) have also started from Andenes, and contribute sightings data with corrections for effort.

Sweden Bernt Dybern reported that a sightings scheme was initiated in 1988, involving about 200 fishermen and coastguards. Effort is not quantified nor are environmental data collected. However, a six-week dedicated cruise took place in 1988 along the Swedish Kattegat coast (Per Berggren and Fredrik Pettersson, see this volume), with two more planned for May and September 1989, along with some aerial surveys. Sightings are corrected for effort by nautical miles travelled or minutes/hours of observation.

Denmark Carl Kinze reported that a sightings scheme was started in 1983, using observations from ferries. In 1984, it was expanded to include sightings from yachts, and from 1987 there has been regular monitoring of a possible harbour porpoise breeding area. Data are stored on an IBM compatible ALR personal computer. Four seabird cruises using small, dedicated fishing vessels have been undertaken since autumn 1987 in the Danish sectors of the the North Sea and Kattegat (Finn Danielsen, Henrik Skov and Jan Durinck), during which cetacean sightings are recorded. Sightings are corrected for effort by nautical miles travelled or minutes/hours of observation. Preliminary population estimates have been derived (for harbour porpoise) using the calculated area of coverage along belt transects.

Faroes The North Atlantic Sightings Survey (1987-89) has included Faroese waters in its sampling program, using transects by both ship and plane (contact persons Kjartan Høydal and Dorete Bloch).

Greenland The North Atlantic Sightings Survey conducted aerial surveys in 1988 off West Greenland and to a limited extent off East Greenland. Aerial surveys are also planned for both coasts for summer 1989 (contact person Finn Larsen).

Finland, USSR, Poland, German Democratic Republic No information.

Federal Republic of Germany A preliminary sightings scheme was established in 1988, operating on the German North Sea coast. This has led to increased information about harbour porpoises indicating their presence at times of year previously unreported. In the Wadden Sea, a problem has been lack of co-operation from sailors who fear further restrictions to their sailing areas if these are found to be good for harbour porpoises (contact persons Hartwig Kremer and Harald Benke).

United Kingdom Opportunistic sightings records have been collected since 1958, but were not co-ordinated nationally until 1973 when a sightings scheme was organized by the Cetacean Group of the UK Mammal Society (Peter Evans). Since then the scheme has grown to a network of 750 observers (marine and fisheries biologists, ornithologists, coastguards, lightkeepers, weather ships, sailors, ferry operators, and the general public). Observations are mainly either land-based or sea-based, although some records come from coastguard air patrols. Many sightings are opportunistic and uncorrected for effort, although environmental details are usually provided. However, about thirty sites/observers now operate through the year (or large parts of it) with effort quantified. Sightings are stored in Oxford on a computer data base (mainframe VAX and Apple Mac Plus personal computer), with analytic and plotting programs in Fortran/Basic.

In 1979, another sightings scheme (Denis McBrearty, International Dolphin Watch) was started, operating not only in UK waters but also internationally. Observers were mainly sailors and sightings were stored on a computer data base in Cambridge. This scheme was discontinued in 1988.

A dedicated cruise, along the Atlantic seaboard and in the northern North Sea, was conducted in summer 1980, investigating the effects of different oceanographic conditions on cetacean distribution. Several small-scale boat surveys (Pete Kinnear, Martin Heubeck, Pete Ewins and Peter Evans) have also been conducted since 1976 in the Shetland Isles, with additional surveys in the Minches (Peter Evans). Since 1980, the Nature Conservancy Council's Seabirds at Sea team (Mark Tasker, Peter Hope Jones and Andy Webb) have conducted cruises in the northern and central North Sea and, more recently, off Northwest Scotland. Most are directed at seabird sightings but cetacean observations are also made. In all those surveys, effort is quantified and accompanying environmental data collected.

More intensive land- and sea-based sightings surveys have been conducted since around 1985 on particular species. These include bottle-nosed dolphins in Cardigan Bay (primarily by Steve Hartley and other local observers, and Bob Morris/Marianne Wilding), the Moray Firth (Stuart Wright and other observers, Peter Evans and Greenpeace), and Jersey (local observers, Trevor Copp). Photo-identification is carried out for all three populations. Harbour porpoises are being studied in the Shetland Isles (Mary-Rose Lane and Peter Evans, see Evans and Lane, this volume), whilst a dedicated cruise was conducted in 1987 in the southern North Sea and along the eastern English coast (Simon Northridge and Kees Lankester). White-beaked dolphins and Risso's dolphins have also been studied using photo-identification in the Minches on an irregular basis since 1980 (Peter Evans).

Eire The sightings scheme (Peter Evans) operating in UK has included observers in Irish waters, and six observers/sites provide quantified effort data. Sightings records are logged on the Oxford computer data base, whilst since 1981, several incidental sightings have been reported annually in the Irish Naturalists' Journal.

In summer 1968, a seabird dedicated cruise off Southwest Ireland also recorded cetacean sightings (Peter Evans and Pete Kinnear), whilst cetacean records have been logged systematically from Cape Clear bird observatory since 1958. Other small-scale boat transects (Peter Evans) were carried out in Southwest Ireland from 1969-71 and in 1985, whilst the 1980 dedicated cruise included the Atlantic seaboard of Ireland.

The Netherlands Sightings data come from three main sources, all of which are also involved with mapping seabird distribution, mainly only in existence since 1985. One of these is organized by Kees Camphuysen and concentrates upon land-based seawatches although data also come from ship cruises; another is organized by Mardik Leopold and includes ship surveys in the Dutch sector of the North Sea; and a third involves aerial transects in the same region, carried out by Henk Baptist. Attempts are at present being made by Rombout de Wijs and Chris Smeenk to co-ordinate these activities to form a single unified national scheme.

Although such data are used primarily for mapping distribution uncorrected for effort, aerial transects and some ship cruises collect information on effort (usually expressed as number of kilometres travelled). In the case of aerial transects, the area of coverage is recorded and, with appropriate corrections, it is hoped to derive preliminary population estimates.

Belgium No sightings scheme exists at present. Some sightings records have been collected opportunistically by Guido Rappé, from personal observations and those of ornithologists, although there are often uncertainties over identification. Plans are underway to start a co-ordinated scheme in 1989.

France Three sightings schemes exist, covering different regions of the French coasts. The first is organized by the Groupe Mammalogique Normand (Jo Pourreau, Anne & Jacky Marin) and operates off the Channel coast of Normandy. It is both land- and sea-based, concentrating upon the bottle-nosed dolphin although other species are also recorded (see Pourreau and Marin, this volume). Photo-identification of this species is carried out and may be used to derive a preliminary estimate of population size. The second scheme is run by the Groupe d'Etude des Mammifères Marins (Claude Clementz) and operates in a 40 km sea area of the Bassin d'Arcachon (Bay of Biscay). It also concentrates upon the bottle-nosed dolphin using land- and sea-based incidental observations from reserve wardens, sailors and fishermen, and dedicated cruises, with photo-identification which are intended partly to provide population estimates. These two schemes at present operate independently but attempts will now be made to co-ordinate activities. The third scheme started in March 1988 and operates in the French sector of the Western Mediterranean under the auspices of CNEMM (Alexandre and Odile Gannier, see this volume). It involves dedicated ship surveys and coverage is intended to span all seasons with about 90 days spent at sea in a year. All three schemes collect data on card file but plans are in progress to set up computer data bases. Incidental sightings are also collected by the Musée Océanographique, La Rochelle (Raymond Duguy, Anne Collet), those from the Mediterranean forming part of the CIESM computer data base in Monaco, detailed below.

Monaco Under the auspices of the CIESM, a data base for sightings in the Mediterranean was set up in 1985 at the Musée Océanographique in Monaco (Jacques Maigret). This aims at collating observations from the Musée Océanographique in La Rochelle (France), the University of Barcelona (Spain) and the University of Messina (Italy).

Spain On the north coast, opportunistic sightings mainly of large cetaceans are sent in by tuna fishermen to Carlos Nores. However, specific identification of these is often not possible. Since 1987, a data collection program for small cetaceans has started for the coast of Asturias, N. Spain, though without quantified effort (Carlos Nores and Concepción Pérez). Between 1981 and 1987, six sightings cruises were conducted from the north coast of Spain in conjunction with whale marking experiments, and three other ship research cruises were conducted (Luis Jover, Carolina Sanpera, Alex Aguilar). Sightings cruises will continue as part of the North Atlantic Sightings Survey. In the Mediterranean, transects by ferry boat were carried out in Gibraltar Strait over a period of two months in 1986, and there are plans to continue these observations in summer 1989 (Dean Hashmi, Luca Marini and Boris Adloff). Effort will be quantified and accompanying environmental data collected.

Canary Islands During March 1988, a sightings cruise (Charlie Hervé-Gruyer, see this volume) was conducted by sailing boat with effort and environmental information quantified. There are plans to continue these surveys in 1989.

Portugal Ship surveys (Antonio Teixeira and Raymond Duguy) were started in 1980, when a Naval mine sweeper was used along the mainland Portuguese coast. From February 1987, five further cruises (Marina Sequeira and Antonio Teixeira) have been carried out using trained observers on oceanographic vessels. These have operated over much of the Portuguese continental shelf and adjacent areas in Iberia. Three aerial surveys (Manuel dos Santos, M. Lacerda and Marina Sequeira) were also conducted in September 1986, February and March 1987. Both aerial and ship surveys have continued through 1988. Effort is quantified and accompanying environmental data are collected. A central computer data base is planned in Lisbon, though at present records are stored on card index file. Since 1986, bottle-nosed dolphins have been studied intensively in and around the Sado esturary by land- and sea-based observations (Manuel dos Santos and Stephan Harzen). Photo-identification should allow preliminary population estimates to be made.

Azores In the summers of 1987 and 1988, IFAW (Jonathan Gordon, Tom Arnbom *et al.)* has had a research vessel operating in coastal waters of the Azores, carrying out sightings and acoustic surveys of cetaceans, particularly sperm whales and Risso's dolphins with photo-identification of both species. Plans are underway to supplement this with a second vessel (Vassili Papastavrou) in 1989.

Italy The most comprehensive sightings scheme is that organized by Giuseppe Notarbartolo di Sciara (Istituto Tethys, Milano). Formed in 1986, it now has c. 550 observers involved, operating both from land and boat. Records are accepted only from known observers or others if accompanied by photographs or video to verify species identity. Sightings are stored on an Appleworks data base. Plans are underway to expand the network to include sailors, and to carry out dedicated boat surveys. In 1988, cruises were carried out in the Adriatic Sea to determine the distribution of bottle-nosed dolphins there. In previous years, Antonio di Natale carried out cruises in the Mediterranean. Since 1987, Michela Podestà and Luca Magnaghi have been collecting casual observations from sailors, and carrying out studies of fin whales, striped and Risso's dolphins in the Ligurian Sea. At present, there is no single co-ordinated national sightings scheme.

Yugoslavia, Albania No information.

Greece No sightings scheme exists at present but the University of Thessaloniki (Vasilios Valukas) is setting one up, and has distributed an identification handbook to fishermen and coastal authorities.

Turkey No information.

CONCLUSIONS AND RECOMMENDATIONS Most sightings schemes in Europe are still at the basic mapping stage. Few collect effort data in a manner sufficiently systematic to monitor population changes, and surveys dedicated to deriving population estimates are confined primarily to large cetaceans by the North Atlantic Sightings Survey. Methodology used by the latter could usefully be employed on a larger scale elsewhere, particularly in coastal European waters. There is a need for better co-ordination of sightings activities between countries, and in some cases, within countries. Sightings records are stored on computer in only a minority of cases, and although there are efforts in northern Europe and the Mediterranean to facilitate data transfer and co-ordinated analyses, these rarely could be interfaced with one another. The need for developing a larger body of trained observers was recognized. To this end, it was thought that it would be very helpful for sightings schemes if the working group were to produce a slide program to help train observers in identification. Finally, a workshop reviewing sightings methodology was suggested, and this is planned to take place sometime during the next twelve months. If anyone has corrections to this review, additional information, or queries relating to methodology, please write to Peter Evans, UK Mammal Society Cetacean Group, c/o Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS (Tel. No. (0)865-727984).

SECOND ANNUAL REPORT

OF THE EUROPEAN CETACEAN SOCIETY: 1988

The European Cetacean Society continues to grow and now has over three hundred members from 26 countries (21 European). A successful conference was held in Tróia, Portugal between 5th and 7th February, at which over a hundred members from 11 countries attended. The abstracts from that meeting together with working group reports were published as proceedings.

Between 29th November and 1st December, a harbour porpoise workshop was held at Cambridge, to review and standardize procedures for studies of stranded and by-caught animals. Thirty-two persons attended, including some from the United States and Canada. The results of the workshop will be produced as a special issue of the newsletter.

Kees Lankester, representing the working group on the UNEP Convention on Migratory Species, attended a meeting in Geneva to review proposals for its enactment. Both the strandings and sightings working groups prepared questionnaires for circulation to interested parties, and the results of these will be published in the proceedings of the 3rd Annual Conference or a future newsletter.

Three newsletters were produced reviewing recent research with bibliographies from a number of countries, reporting the activities of different working groups, conservation issues and local news, reviewing cetacean publications, and including requests for information or biological material.

Finally, the European Cetacean Society provided advice to a number of government departments and non-governmental organizations in various European countries.

Peter G.H. Evans
Hon. Secretary

REPORT OF THE ANNUAL GENERAL MEETING,

25th FEBRUARY 1989,

LA ROCHELLE

1. Annual Report. The above report was outlined, followed by a notice that it was hoped to hold the next annual conference in Spain, otherwise the Netherlands or the German Democratic Republic.

2. Financial Report. The Treasurer presented the financial report for the year 1988 (see below). Credit amounted to c. HFl 19,000. With debits standing at just over HFl 11,000, this left a credit balance of about HFl 8,000. It was felt important that the society should aim at building up a reserve of at least HFl 20,000, bearing in mind the present subsidizing of newsletter production and circulation, which cannot continue for much longer.

3. Changes to Council. Carl Kinze stepped down from the Chairmanship and this role was taken by Alex Aguilar. Ronald Kröger stood down from the Council due to pressure of work. The Secretary expressed appreciation for all the efforts he had put into building the society. Phil Hammond was nominated to take his place, and the motion was carried. So that there were not too many departures from Council once the first term was up, it was proposed that one other (to be decided) retire midterm, and be replaced by Harald Benke.

4. Future Activities. Newsletter. A request was made by the Secretary for members to contribute cetacean news and reports of their work for circulation in the newsletter. Appreciation was expressed for the efforts of the two editors Juliet Vickery and Gina Scanlan who had worked so hard on previous newsletters.

Other activities. Frank Niehaus suggested that it would be useful if job placements could be advertised in newsletters and at conferences. Jan-Willem Broekema suggested a fund-raising working group might be worth establishing. The role of working groups was raised by the Secretary since they had taken up a great deal of time during the annual conference without necessarily having a need to resolve particular issues. It was recommended that the Council reviewed how they should function. A discussion then followed on whether it would be better to hold the ECS conference annually or biennially (the latter to alternate with meetings of the American-based Society for Marine Mammalogy). A vote was taken and 29 were in favour of annual meetings, 12 were in favour of biennial meetings, and the remaining abstained. It was felt that this last suggestion is best considered by the membership at large and members are therefore invited to write to the Secretary with their views.

Peter G.H. Evans
Hon. Secretary

ECS - FINANCIAL REPORT OVER 1988

Credit

Credit balance 1987	HFl	3,998.22	
Subscriptions		6,013.37	
Conference fees Tróia		8,865.27	
Credit interest		126.80	
Various		58.00	

			19,061.67

Debit

Board expenses		1,916.46	
Postage newsletters and proceedings		1,405.34	
Conference expenses Tróia		1,470.77	
Printing proceedings Tróia		3,876.24	
Workshop harbour porpoise, Cambridge		1,856.57	
Meeting Convention Migratory Species, Genève		432.80	
Bank charges		165.57	

			11,123.75

Credit balance 1988		HFl	7,937.92
Credit balance French bank account 1988		FF	900.00

Chris Smeenk
Treasurer

EUROPEAN CETACEAN SOCIETY

The **European Cetacean Society** was formed in January 1987 at a meeting of eighty cetologists from ten European countries. A need was felt for a society that brought together people from European countries studying cetaceans in the wild, allowing collaborative projects with international funding.

AIMS (1) to promote and co-ordinate the scientific study and conservation of cetaceans;

(2) to gather and disseminate information to members of the society and the general public.

ACTIVITIES The society has set up six international working groups concerned with the following subject areas: sightings schemes; strandings schemes; bycatches of cetaceans in fishing gear; computer data bases that are compatible between countries; the harbour porpoise (a species in apparent decline in Europe, and at present causing serious concern); and a regional agreement for the protection of small cetaceans in Europe (in co-operation with the United Nations Environment Program/Convention on the Conservation of Migratory Species of Wild Animals Secretariat in Bonn, Federal Republic of Germany). The names and addresses of chairpersons for all the working groups are given at the end of this notice.

Contact persons have been set up in each European member country to facilitate the dissemination of ECS material to members, where appropriate carrying out translations into the language of that country. Their names and addresses are also given at the end of this note.

A newsletter is produced three times a year for members, reporting current research in Europe, recent publications and abstracts, reports of working groups, conservation issues, legislation and regional agreements, local news, and cetacean news from other parts of the world.

There is an annual conference with talks and discussion sessions on various projects, and at which the annual general meeting is held. The results are published as annual proceedings. The contents of the 1987 conference, held at Tróia, Portugal, form the 1988 proceedings.

Membership is open to *anyone* with an interest in cetaceans. The annual subscription is **30 HFl** for members over 25 years, or **15 HFl** for those who are 25 years of age or younger, full-time students, or unwaged.

Payment should be made in Dutch Guilders (HFl) either in the form of cash or by any type of cheque made payable to *The European Cetacean Society* (Bank Account no. 49.65.83.646, Amro Bank, Leiden, The Netherlands). Subscriptions should be sent to the Treasurer, **Dr. C. Smeenk, c/o Rijksmuseum van Natuurlijke Historie, PO Box 9517, 2300 RA Leiden, The Netherlands.** Payment in excess of membership fee will be gratefully received as a donation.

Officers & Members of Council

Chairman	Carl Kinze
Secretary	Peter Evans
Treasurer	Chris Smeenk
Council	Alex Aguilar
	Anne Collet
	Geneviève Desportes
	Phil Hammond
	Michela Podestà

Working Group Chairpersons

Strandings Michela Podestà and Luca Magnaghi, Museo Civico de Storia Naturale, Corso Venezia 55, 20121 Milano, Italy.

Sightings Peter Evans, Cetacean Group, c/o Zoology Dept., University of Oxford, South Parks Road, Oxford OX1 3PS, UK.

Bycatches Simon Northridge, Imperial College, Centre for Environmental Technology, 48 Princes Gardens, London SW7 1NA.

Computers Jan-Willem Broekema, Klipperwerf 16, 2317 DZ Leiden, The Netherlands.

Harbour Porpoise Carl Kinze, Zoologisk Museum, Universitetsparken 15, 2100 København Ø, Denmark.

UNEP/CMS Agreement Kees Lankester, 1e Helmersstraat 183-III, 1054 DT Amsterdam, The Netherlands.

National Contact Persons

Denmark Carl Chr. Kinze, Zoologisk Museum, Universitetsparken 15, DK-2100 København Ø.

Faroe Islands Geneviève Desportes, Náttúrugripasavn, FR-100 Tórshavn.

Federal Republic of Germany Ronald Kröger, Max-Planck-Institut für biologische Kybernetik, Spemannstrasse 38, D-7400 Tübingen 1.

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