Annex K

Report of the Standing Working Group on Environmental Concerns

1. CONVENOR'S WELCOME AND OPENING REMARKS

Reilly welcomed the participants and noted that after a two year absence from the Scientific Committee he looked forward to an interesting meeting.

2. ELECTION OF CHAIRPERSON

Against his better judgement, Reilly was elected Chairperson.

3. APPOINTMENT OF RAPPORTEUR(S)

Krahn, Friday and Simmonds agreed to contribute as rapporteurs.

4. ADOPTION OF AGENDA

The agenda was adopted as shown in Appendix 1.

5. REVIEW OF AVAILABLE DOCUMENTS

The following documents were identified as relevant to the business of the Standing Working Group: SC/55/E1–E11, SC/55/E14-E21, SC/55/Rep1, SC/55/O19, SC/55/IA4, SC/55/SH14, SC/55/SH17, Taylor in press (SC/55/FI2), Širović *et al*. in review (SC/55/FI5), Thiele 2002 (SC/55/FI7), Hofmann *et al*. 2002 (SC/55/FI8), Matsuoka *et al*. 2003 (SC/55/FI39).

6. MODELLING CETACEAN-FISHERIES INTERACTIONS, INCLUDING RESULTS FROM INTERSESSIONAL WORKSHOP

Northridge presented SC/55/Rep1, the report of the modelling workshop on cetacean fishery competition held at the Southwest Fisheries Science Center (SWFSC) at La Jolla, California, USA in June 2002. He thanked the SWFSC for having been able to host the meeting at the last minute, after the invitation for the original venue had been withdrawn. The workshop had been held in response to a request by the Commission (Resolution 2001-9, p. 58).

At the 52nd meeting of the Scientific Committee a central question, to be the main objective of future deliberations of the SC had been established. This questions was 'how are changes in abundance of cetaceans likely to be linked (in the short- and long-term) to changes in fishery catches?' Initially a Symposium and Conference had been proposed to address this question but funding was not obtained to pursue this. Instead this more focused workshop on modeling methods and data requirements had been proposed. The agreed terms of reference for the workshop were to:

(a) review existing modeling approaches that might be useful to address the overall objective

(b) identify the constraints and data requirements in the existing models or modeling approaches that limit our ability to answer the above question

(c) describe the advantages and disadvantages of the various approaches, bearing in mind the areas for which they were developed

(d) identify those approaches that seem most likely to be able to answer the above question, and provide guidelines as to when and where they might be used (e.g. depending on the likely level of data availability).

The workshop was attended by 13 invited participants and 10 members of the Scientific Committee. The workshop lasted for three days, but shortage of time meant that the participants had agreed that the report would be circulated and approved electronically. There were 13 working papers submitted.

The workshop began with an overview of existing modeling approaches by John Harwood, and went on to consider data requirement and availability. Topics covered included cetacean population size and structure, fisheries assessment data, the population size and structure of prey and competitor species, cetacean consumption rates, diet composition, inter-species linkages, and uncertainty in data.

The workshop reviewed all the available major modeling approaches that deal with top predators and multi-species fisheries interactions. These included ECOPATH and ECOSIM (as the Ecosim with Ecopath package), Minimum Realistic Models such as MULTSPEC and SEASTAR, Bioenergetic Trophodynamics and models of Antarctic Systems, including a newly described index of Predator Influence that is more widely applicable outside the Antarctic.

A shortage of time restricted the conclusions of the workshop to some general points, including a list of important issues for further consideration.

The Workshop concluded that despite recent advances, most multi-species models are still at development stages. It therefore agreed that no single approach could be recommended at this stage to provide reliable information of value to consideration of cetacean dynamics in an ecosystem context. However this does not necessarily rule out the possibility that useful inferences might be drawn if a number of different modeling approaches were to yield qualitatively similar results. The workshop also agreed that despite these difficulties, the consideration of ecosystem interactions between fish stocks and cetaceans is potentially an important research topic.

The workshop agreed that there is currently no system for which we have suitable data or modeling approaches to be able to provide reliable quantitative management advice on the impact of cetaceans on fisheries or fisheries on cetaceans. If the Commission wishes to pursue this further, the Workshop warned that a considerable investment in time and resources would be required but recommended that:

It would be most sensible to concentrate on those areas or systems where there is most chance of success, based on a number of factors including the simplicity of the system, availability of data, the ability to collect data in the future, and the likelihood that any predictions can be tested in some way.

In terms of model development, further work is needed to incorporate the effects of uncertainty in modeling assumptions and data. It is also important that environmental variability in the short term and the long term should be taken into account.

The workshop also agreed that simulation studies will be required to test the sensitivity of model predictions to uncertainty in the data (and model assumptions) and the ability of field techniques to detect the reliability of predictions. The iterative link between modeling and data requirements requires further investigation. The experience of the Scientific Committee in such work might represent a valuable IWC contribution to co-operative studies in addition to providing cetacean data and expertise.

In terms of data availability, the workshop noted that it is not possible to generalise and that requirements will be case specific. There will be very considerable data requirements (preferably time series) and this suggests that collaboration with other bodies (such as ICES) will be required.

The most important consideration in all modeling approaches concerns the issue of functional responses, and the workshop recommended that these should be looked at in more detail.

The workshop also highlighted the fact that cetaceans are just one part of the system that needs to be modelled, and recommended that the most productive way forward would be for the IWC to seek to collaborate with other bodies with a broader range of expertise in other parts of the system. More specifically, co-operative links would best be established with other long-term ecosystem studies, particularly those that include top predator dynamics as an integral part.

The Standing Working Group (SWG) thanked Northridge and the other members of the steering group for their considerable work in arranging the workshop, and for this very helpful report. It was noted that such workshops, that bring together scientists from within the SC with outside experts, make a substantial contribution to the quality of scientific advice we provide to the Commission.

The Standing Working Group noted that the workshop was not intended to address the possibility of cetacean-fishery interactions for any specific system, but rather to evaluate existing modelling approaches for their potential use in addressing these issues. The SWG agreed with the workshop conclusion that for no system at present are we in the position, in terms of data availability and model development, to provide quantitative management advice on the impact of cetaceans on fisheries or of fisheries on cetaceans. To reach such a position will require a considerable investment in time and resources. However, this does not rule out the possibility that useful inferences might be drawn if a number of different approaches yield qualitatively similar results.

The SWG agreed with the conclusion of the workshop that consideration of ecosystem interactions between fish stocks and cetaceans is a potentially important research topic in a general sense, but there was disagreement as to whether further pursuit of this matter was likely to be helpful to the SC in providing advice to the Commission regarding the management of whale populations.

If the Commission wishes to pursue this further, there are a number of important issues that will need to be explored. Of primary concern are the concepts surrounding functional response curves and choices of these. Other issues to be considered include incorporating behavioural ecology using optimal diet and foraging theory, controlled perturbation experiments on model ecosystems, the large body of theory and empirical research on food webs, and the exploration of theory to see to what extent and under what circumstances model ecosystems show counterintuitive responses to perturbations.

The Standing Working Group agreed that there is considerable expertise on ecosystem modelling outside of the Scientific Committee. Given this, if the matter is to be pursued further, the IWC is probably not the best forum to lead this work. A more productive approach would be to work in co-operation with other bodies to ensure that cetaceans are included in their work. The Standing Working Group recommended that a workshop be held on the issue of functional response curves, but that the IWC might take a secondary role to organisations with more expertise that should take the leading role.

Walløe drew the SWG's attention to two workshop reports from the North Atlantic Marine Mammal Commission (NAMMCO 2002, 2003), which address similar subject matter.

SC/55/SH17, by Mori and Butterworth, presented results of an initial model of minke whale – blue whale – krill interactions, developed as a first step in investigating the major predator-prey interactions in the Antarctic. Blue whales and minke whales both feed mainly on krill, and they share a similar feeding range in the Antarctic. In the early 20th century, the large baleen whales in the Antarctic were heavily harvested, some to near extinction. Blue whales were taken for almost 60 years, before being officially protected in 1964. Harvesting of the smaller minke whales commenced only in the 1970s. The population probably increased during the mid 20th century, likely in response to increased krill abundance following the depletion of the large baleen whales. Recent studies show recoveries of some of these large baleen whale species in response to protection, and also a possible recent decrease in the minke whales as the larger whales recover. SC/55/SH17 investigates whether the abundance trends indicated by survey and other information for these species can be explained by considering only harvesting and the predator-prey interactions between these species. Using the historical catch data for blue whales and minke whales, a simple age-aggregated model including species interactions is fitted to the observed abundance estimates for these species. Uncertainties in the abundance estimates and the biological parameters are taken into account in this process by considering plausible ranges for their values. The trends indicated in the abundances of the species can broadly be replicated by the model provided the parameter values show certain features. These include: (i) blue whales are able to maintain their birth and krill consumption rate until krill abundance drops to relatively low levels, and (ii) both minke and blue whales show relatively high growth rates if krill is abundant, but the minke growth rate falls more rapidly as krill abundance drops. The model suggests two interesting features of the dynamics of these species:

1. A substantial decrease in krill biomass from the 1970s to the 1990s due to the rapid increase in minke whale abundance, and hence krill consumption, following the depletion of the larger baleen whales.

2. A recovery of blue whales in spite of the recent minke whale decrease and impact on krill abundance, because blue whales are better able to tolerate decreased krill abundance.

Future projections for these species show a gradual increasing trend in blue whale abundance, with a gradual decrease in minke whale abundance, and with large amplitude oscillations superimposed. Long term monitoring of biological parameters and abundance are essential to provide a basis for verification or otherwise of such predictions. For future work, the authors are considering refining the model structure, incorporating age-structure, some other major predator species that feed on krill, and some spatial structure.

In discussion, concern was raised that SC/55/SH17 predicts large fluctuations in krill, minke whale and blue whale biomass and that the model might be inherently unstable. Butterworth replied that mathematically the model has a stable coexistence equilibrium. This is a preliminary analysis designed to give qualitative results. In future analyses, additional complexity to be added to the model will dampen the fluctuations. Nevertheless, he considered that the oscillations are real, although the amplitude of these oscillations indicated by the model is too large.

M. Taylor asserted that the evidentiary basis of SC/55/SH17 was weak. He pointed out that blue whales have barely recovered even to an estimated 1% of their pristine population size and is only one of many species in the large guild that feeds on krill. Thus it is highly implausible that this tiny population recovery could elicit a functional response in such a wide range of far greater biomass consumers. Classic ecology recognises that, for there to be competition, guild level consumption must exceed prey productivity; this is unlikely in an already depleted system. Evidence for interspecific competition has rarely been shown, and it's generally found that species consuming the "same" prey species, partition their feeding niches behaviourally, spatially, or temporally and avoid direct competition. Also lacking is evidence for the presumed krill surplus, the presumed competitive release of minke whale populations following depletion of blue whales, and the presumed crabeater seal declines. Other putative competitors like Antarctic fur seals have been growing.

M. Taylor also argued that the models do not even approach capturing the complexity of the krill food web and present little new information. They are simple two species competition models with differential functional response, and model behaviour which can easily be tuned to mimic the supposed population changes, has been well known for some decades.

The authors explained that the recent (from about 1970) low levels of krill and the decline of minke whales in the model is unrelated to the increase in blue whale abundance. Blue whale abundance is currently too low for them to be a major component of the Antarctic food web. Current krill and minke whale declines are due to the oscillatory nature of their predator-prey dynamics. They argued that the Antarctic is an ideal place to attempt this type of modelling because of the relatively simple food web and the large magnitude of the perturbation from earlier whaling. There is indirect evidence for a krill surplus after declines in the abundance of large whale species which can be inferred from the behaviour of other species: fur seals increased in concordance with minke whales (Payne 1977), whaling vessels in the 1940s and 1950s report increased sightings of minke whales (Ash 1962), there is evidence of changes in age-at-maturity for minke whales over this period consistent with a density dependent response (Thomson *et al*. 1999), and catch at age analyses (Butterworth *et al*. 1999) support the increase of minke whales during the 1940-1960 period. The authors disagreed that tuning such models to reflect likely blue and minke whale abundance trends was readily and easily achieved.

There was general agreement that the current model should be extended to include additional species (such as humpback whales and pinnipeds) to more accurately model the Antarctic food wed. However, there is enormous uncertainty in estimating the abundance of other predators of krill, such as fish, seals, birds, and other whales.

Concern was also raised that the current model is not easily extended in this way, and that the assumptions of this model are not the typical food web assumptions of niche partitioning and niche overlap. For further work, a qualitatively different model is needed. Butterworth reiterated that this is an initial model and that future models will incorporate additional food web complexity and spatial structure to address these issues.

Concern was raised that there is no discussion of the krill fisheries and whether the decrease in krill biomass might be related to this fishery. Krill biomass in the Scotia Sea has fluctuated and no correlation with predators has been found except for local effects. Butterworth cautioned that data on krill biomass is from a short time period and over small areas. The present krill fishery is also located in a limited area and negligible by comparison with krill abundance at the circumpolar level. The magnitude of these local fluctuations in krill biomass may be of negligible consequence on the circumpolar level.

Watkins informed that SWG that analysis is being conducted on the Discovery expedition data and other historical surveys to attempt to provide information on past krill density. The general impression at the moment is that krill density was higher in the first half of the last century than it was in the second half.

The SWG thanked the authors for their presentation, agreed that no conclusions can be made at this time, and encouraged them to extend their model to better capture the Antarctic food web.

Branch presented SC/55/IA4 which is a speculative hypothesis about the impacts of killer whale predation on marine mammal populations in the Southern Hemisphere, arising out of a similar hypothesis from the North Pacific and Bering Sea (Estes *et al*. 1998). Killer whales prey on a wide variety of different species, including all large cetaceans in the Southern Hemisphere. Industrial whaling caused major declines in these whale populations, reducing their biomass to perhaps 20% of original levels. It is possible that killer whales consequently increased their predation rates on other marine mammal species (notably southern elephant seals, southern sea lions and Antarctic minke whales), resulting in declines in their populations. An estimated 2% of the current diet of 'Type A' killer whales consists of large whales, although this estimate is crude, and is dependent on just a few stomach contents. Perhaps 10% of killer whale diet may, therefore, have been large cetaceans before reductions caused by industrial whaling; in turn, this would imply that the proportion of pinnipeds in their diet may have increased from 24% to 25% from World War II to the 1960s. This paper uses simple population models and estimated consumption rates for killer whales, to show that observed declines in some populations of southern sea lions and southern elephant seals can be explained by a 1% increase in year-round killer whale diets. However, an appreciably lower recent estimate for Antarctic minke whales (Branch and Butterworth 2001) would require too many additional deaths to be caused by increased killer whale predation.

According to SC/55/IA4, killer whale predation on young minke whales could explain the under representation of young age classes in JARPA catch records. However, it was questioned whether calves migrated far enough south to be at risk of killer whale predation. Branch noted, however, that only a small percentage of calves need to be taken for this hypothesis to fit, and they could be taken at lower latitudes.

Gales expressed a number of concerns with SC/55/IA4. First of all, the evidence for diet composition is unreliable, based mainly on a few older papers with doubts about species identification. In addition, there are considerable problems in inferring diet composition from stomach contents when (as Branch and Williams note) many killer whales could have scavenged on carcasses. Also there are major temporal and spatial issues here, with killer whales almost certainly feeding mostly on ice seals in the Antarctic pack ice, and this likely comprises most of the pinniped

component of the diet. Second, the decline of southern elephant seals on Campbell Island is most likely due to predation by New Zealand sea lions, which have been observed removing almost entire cohorts of this small and declining population. Third, the declines in southern elephant seals are most likely linked to trophic changes driven by large scale, long term changes in ocean processes. A large body of literature exists on this subject, and the only site where killer whale predation is thought to possibly influence southern elephant seals at the population scale is on Marion Island where the population is small and has actually increased in recent years according to SC/55/O19. Finally, declines in southern sea lions have been linked strongly to issues associated with bycatch, direct human take, and consequences of limiting foraging options to the benthos. Evidence for killer whale predation operating at a population scale is extremely weak.

Brownell noted that population trends for southern elephant seal species seem to be more complex than is easily described by killer whale predation. The population on South Georgia is approximately 55% of the world population of breeding females (100,000 seals) and is not declining. Although, the southern sea lion population at the Falkland Islands is depleted, killer whales are unlikely to be the reason for the decline. Finally, the population of southern sea lions and southern elephant seals at Peninsula Valdes, Argentina are increasing despite killer whale predation. In general, regime shifts and climate change are the most parsimonious explanations of southern elephant seal declines.

Branch agreed that diet composition data for killer whales are limited. However, data on trophic changes are also limited, and there are no good data on the total abundance of prey. He disagreed that Marion Island is the only area where killer whale predation influences southern elephant seals at a population level.

Cooke noted that the relationship between killer whale predation events, sightings of these events, and killer whale diet composition may be complex. Uncertainty exists in estimates of how much meat and blubber are obtained from each kill. Comparisons of estimated mortality and observed predation events would be useful.

Brownell stated that killer whale predation has been hypothesized to have caused the decline of sea otter populations in the Aleutian Islands (Estes *et al*. 1998). However, there are few actual sightings of killer whale predation on sea otters, and eagle predation of sea otter pups and pollution have not been explored by these authors. In addition, sea otter populations in the Commander Islands have not declined. Other data on the status of western North Pacific pinniped populations also do not support this hypothesis.

Wade raised a concern that the data in Figure 1 of SC/55/IA4, which describes catches of large cetaceans and declines in harbour seals, Steller sea lions and sea otters in the North Pacific, are more complex than actually described. The sea otter trend data are from the Aleutian Islands. The trend data for harbor seal abundance comes from a single island near Kodiak in the Gulf of Alaska, which is approximately 1000 miles from the Aleutians. Finally, there are no Steller sea lion data available prior to 1980 so it is unknown whether the decline of this population began in 1980 or prior to that date.

Gales presented SC/55/E16, on DNA-based identification of prey species represented in whale faeces. The diet of whales is an important aspect of their ecology. The authors have previously demonstrated that the krill component of blue whale diet can be identified to species level from krill DNA that survives digestion by the whale and can be purified from whale faeces (Jarman *et al*. 2002). In SC/55/E16, we describe experiments that demonstrate that the DNA of any prey item can be potentially identified. A 'universal' method for detecting eukaryotic DNA was applied to fin whale faeces, and DNA sequences from distantly related eukaryotes were characterized from this sample. Our prey DNA detection methods were also tested on faecal samples from a range of whale species and shown to be effective. The use of DNA-based methods for examining whale diet is widely applicable and potentially more accurate as a means of reconstructing the species composition of whale diet than morphology-based methods.

Investigations of diet are central to the study of theoretical and applied ecology, and a suite of methods has been developed, each of which is tailored to the system and species under study. In SC/55/E15, the authors developed a two stage simulation/empirical model that examines the potential biases that result from three methodological approaches for determining whale diet; two rely on an examination of remains in the whale's forestomach, and one relies upon the identification of prey from DNA remains in whale faeces. The authors used minke whales (*Balaenoptera acutorostrata*) from the northeast Atlantic as an example. The simulation results show that a simple measure of presence or absence of prey DNA in faeces provides the most accurate and precise estimator of proportional importance of prey types. The model also provides some estimates of the degree to which analysis of prey remains in whale forestomachs may bias an estimate of the proportional contribution of different prey. Further applications of this model will be used to determine the sensitivities of the various methodological approaches to changes in foraging behaviour and performance. The utility of genetic prey identification for powerful qualitative diet studies (measuring hard and soft bodied prey) has been previously demonstrated (Jarman *et al*. 2002). This study demonstrates the approach is also a powerful quantitative approach.

Haug expressed surprise that diet composition results might be more reliably obtained by sampling DNA after the prey has passed through the digestive tract than by sampling stomach contents. He also reported that, for North Atlantic minke whales, relative frequency of occurrence is used to estimate diet composition because frequency of occurrence can be imprecise. A disadvantage of DNA based identification of prey species is that consumption is not estimated. Finally, Haug and Murase raised concerns that it might be difficult to collect faecal samples, and effort data would be helpful for evaluating the efficiency of sample collection.

Markers are being used in captive feeding studies to confirm that heterogeneity in the transit time of material through the digestive tract is reduced when samples are collected at the end of digestion rather than at the beginning. Relative frequency of occurrence will be explored in future work. To date, effort has only been expended in developing the DNA technique. Faecal samples have been collected opportunistically, and future fieldwork is necessary for collecting effort data.

7. SOUTHERN OCEAN CLIMATE CHANGE EFFECTS ON CETACEANS

Cooperation with SO GLOBEC and CCAMLR

Thiele and Moore had arranged to provide a substantive update on joint activities with both Southern Ocean (SO) Global Ocean Ecosystems Dynamics Program (GLOBEC) and Convention on Antarctic Marine Living Resources (CCAMLR) by inviting guests from each of those programs to give formal spoken presentations to the SWG on recent progress and findings of their multidisciplinary programs. However, the mini-symposium that was originally planned was presented on a smaller scale due to funding short falls.

Jon Watkins of the British Antarctic Survey (BAS) gave a presentation summarizing BAS – CCAMLR studies, and Eileen Hofmann of Old Dominion University (USA), and chair of International SO GLOBEC, summarized work of that program. Summaries of their presentations follow. A set of posters on related subject was made available for the SC outside the meeting rooms. Authors and titles of posters are listed in the References section of this report.

Jon Watkins (co-author Eugene Murphy of BAS) – How interannual and long term changes are likely to affect Antarctic krill populations

Antarctic krill, *Euphausia superba*, are found throughout the Southern Ocean with particularly high densities found in the Scotia Sea. Time series of krill abundance between 1991 and 2002 at several localities within the Scotia Sea indicate that there is marked interannual variation, with suggestions of cyclical patterns and some degree of consistent changes between sites. There are marked interactions between the physical environment and population dynamics of krill. For example, current hypotheses of krill population dynamics in the Scotia Sea suggest that sea ice conditions impact population dynamics of krill through effects on egg production and larval survival through the first winter as well as on regional immigration of young adults into the South Georgia population. Simple population models can be used to reproduce the general patterns of fluctuation in biomass caused by variation of year class strength as a result of environmental variations.

Long-term environmental variation can be seen in sea ice and air temperature data over the last century in the South Orkney region. There has been a marked change in the probability of encountering cold years since 1950. Using such data within the krill model leads to a change in krill biomass over the last century with a reduction in biomass occurring between 1950 and 1970. In addition to long-term change, at the circumpolar scale spatially coherent physical variability is manifest through the Antarctic Circumpolar Wave. Modelling krill variability at this scale results in cycles in the population biomass although apparent correlations as a result of the cyclical physical variation can be misleading and changing the frequency of perturbations has major impacts due to interactions between the year class structure of the population and the physical periodicity.

Future climate change scenarios for the Southern Ocean remain somewhat unclear due to the relatively unpredictable effect of sea ice. However changes in temperature, sea ice extent, water mass structure, current speed and frontal positions are likely to have profound effects on krill reproduction, recruitment, biomass and distribution.

To better understand possible changes we need to not only maintain present long term data sets but also extend these to increase coverage through the Southern Ocean. In particular there is now a need for improved understanding of circumpolar processes that can only come through international collaboration to conduct large scale observations and develop suitable large scale models.

Eileen Hofmann - Southern Ocean Global Ocean Ecosystems Dynamics Program

It is the strong linkage to climate and close coupling between trophic levels that resulted in the choice of the Southern Ocean as a study site for the Global Ocean Ecosystems Dynamics (GLOBEC). Southern Ocean GLOBEC (SO GLOBEC) has as a primary objective understanding the physical and biological factors that contribute to enhanced Antarctic krill (*Euphausia superba*) growth, reproduction, recruitment, and survivorship throughout the year. This objective includes the predators and competitors of Antarctic krill, such as penguins, seals, cetaceans, fish and other zooplankton. The emphasis on habitat and top predators, as well as Antarctic krill, is a first in international interdisciplinary Antarctic science. A strong focus of SO GLOBEC is on understanding processes in the austral winter, especially the processes that allow krill to overwinter and survive.

The SO GLOBEC field program consists of multidisciplinary oceanographic research programs that are focused near 70°E, in the southeastern Weddell Sea, the Scotia Sea-South Georgia region, and along the western Antarctic Peninsula. The SO GLOBEC studies in the first three regions are part of the Australian, United Kingdom, and German Antarctic programs. The SO GLOBEC field programs in the western Antarctic Peninsula region were undertaken by the United States and Germany.

The US SO GLOBEC field studies are focused on Marguerite Bay and environs, along the western Antarctic Peninsula. During 2001 and 2002 the US SO GLOBEC program undertook 11 cruises: four process cruises, four survey cruises, and three mooring deployment/retrieval cruises. IWC observers participated in eight of these cruises. The mooring cruises deployed current meter mooring and Acoustic Recording Packages for recording whale sounds. The moorings remained in the water for one year, were retrieved, and redeployed for a second year. These represent the first long-term moored current and acoustic measurements made in Antarctic continental shelf waters.

The US SO GLOBEC survey cruise studies are based on data collected from conductivity-temperature-depth (CTD) casts, Acoustic Doppler Current Meter measurements, a Multiple Opening/Closing Net Environmental Sampling Sensing System (MOCNESS), and a Bio-Optical Multifrequency Acoustical and Physical Environmental Recorder (BIOMAPER II). These data provide repeated realizations of hydrographic structure, upper water column currents, nutrients, phytoplankton, micro-zooplankton and mesozooplankton, and Antarctic krill distributions. Seabird and cetacean surveys were done during daylight hours and sonabuoys were deployed for listening to cetaceans. Other activities consisted of Remotely Operated Vehicle (ROV) operations and deployment of surface drifters.

The US SO GLOBEC process studies provide focused studies of several days duration at specific sites in and around Marguerite Bay. Studies on the process cruises consisted of ship-based laboratory experiments of zooplankton and Antarctic krill physiology, under-ice diving to characterize the sea ice habitat, sea ice biota, and to collect animals for experiments, and focused net tows. Additional efforts on the process cruises consisted of placing satellite tags on Adelie penguins and crabeater seals, physiological studies of these animals, and characterization of the environmental structure.

Preliminary results from the US SO GLOBEC program show the importance of Circumpolar Deep Water in structuring the marine food web along the west Antarctic Peninsula. This water mass provides heat, salt and nutrients to the continental shelf. Areas where this water mass are found are characterized by higher phytoplankton production, increased krill abundance and increased abundance of top predators, such as humpback and minke whales. There is strong correlation between presence of whales and hydrographic boundaries produced by the onshelf intrusion of Circumpolar Deep Water.

Planning is now ongoing for a follow-on program to SO GLOBEC. Details of the current state of planning for this program, which is entitled, Integrated analyses of Circumpolar Climate interactions and Ecosystem Dynamics in the Southern Ocean (ICCED), are given in SC/55/E14. It is hoped that the IWC will participate in this program, as was done for SO GLOBEC.

Hofmann closed by noting that the total cost of the US SO GLOBEC program was about $20 million USD. This includes the costs of 11 cruises, mooring arrays, and scientific support for about 40 science investigators. The IWC did not contribute significant financial support to SO GLOBEC, but should consider doing so, to collaborate effectively in future oceanographic programs (see Appendix 2).

In discussion of both presentations the following points emerged:

The proposed ICCED program will begin in 2007 and continue for at least 10yrs. It will include extensive deployment of remote instrumentation to measure a broad suite of variables, and if funding can be secured, acoustic recorders to detect whale calls. The instrument locations will be linked via ship-based studies.

El Nino – Southern Oscillation effects may occur in the Southern Ocean ecosystem but they would be very difficult to detect among the other complex interannual patterns present. In answer to a question as to what constitutes "long term" in the analyses presented, Watkins mentioned that existing series of direct measurements are generally 20 yrs or less, but that investigators were looking back 100 yrs or more from indirect or proxy measurements.

The current krill fishery takes less than 100 mt/yr, but it took nearly 500K mt/yr during the mid-1980s. Given the substantial total krill biomass such takes are unlikely to contribute to krill conservation problems, but local depletions are possible and the fishery is managed by CCAMLR to avoid such negative effects on either the resource or its predators.

The time series of krill biomass (estimated as a function of ice extent) that Watkins presented for the 20th century through the present indicated staged but overall and in some periods dramatic declines, with current levels at 50% or less in relation to levels estimated for the 1950s. It was noted that if this model result reflects true patterns, it could contribute to an explanation of putative declines in minke whale abundance during the past 30 yrs, and may have other substantial implications for the management advice provided by the SC on Southern Hemisphere whales.

Concern was expressed that these model results not be taken as documented evidence of actual pattern change in krill biomass, especially given the difficulties encountered in attempts to link fish recruitment or biomass changes to environmental measures. Watkins noted that of course direct measurements of krill biomass for this long period and throughout the Antarctic did not exist. He explained that this model of changes in krill biomass was based on a strong association observed in the Scotia Sea during recent decades, but like all models it was a simplification of patterns that may have occurred. In this case it must be assumed that the observed relationship between krill biomass and ice extent from recent years holds throughout the Antarctic and for the duration of the 100+ yrs examined. The model and its results are currently in review for journal publication.

Perryman and colleagues had reported to this meeting (SC/55/BRG2) and in previous SC reports that gray whale calf production is highly correlated with patterns of seasonal and interannual ice formation in the Bering and Chukchi Seas where they feed. It was queried whether such associations might occur for Antarctic baleen whales. Watkins replied that sea ice provides important habitat for krill, and consequently variation in sea ice extent effects krill recruitment. This in turn may affect baleen whales and other krill predators, but such a relationship for the whales has not been examined.

Thiele and Moore then summarized a number of separate documents to the meeting reporting on activities and results arising from IWC–CCAMLR and IWC–GLOBEC collaboration.

Thiele (2002) provides an update of the collaboration between the International Whaling Commission and Southern Ocean GLOBEC in the Western Antarctic Peninsula. The 2000/01 Antarctic season marked the start of field collaboration between the IWC and Southern Ocean GLOBEC. The IWC (SC/48/Rep2 and relevant Commission resolutions) had identified a major objective to be pursued using a multidisciplinary ecosystem approach to data collection, analysis and modelling through collaboration with GLOBEC and CCAMLR:

> "Define how spatial and temporal variability in the physical and biological environment influence cetacean species in order to determine those processes in the marine ecosystem which best predict long-term changes in cetacean distribution, abundance, stock structure, extent and timing of migrations and fitness".

The IWC collaborative program in the Western Antarctic Peninsula (WAP) conducted visual survey from ships, small boats and helicopters, tissue biopsy and individual photo identification studies. This work was conducted in close collaboration with scientists from Scripps Institute of Oceanography and the USA National Oceanic and Atmospheric Administration (NOAA) involved in the deployment of new passive acoustic monitoring tools. We have formed a core group and developed a broader joint program (Acoustic recording packages (ARP's) around the Antarctic) which builds on the IWC-SO GLOBEC-CCAMLR collaborativbe framework. This program has real potential to directly address some of the critical gaps in our understanding of the ecology of baleen whales in the southern hemisphere, with a focus on blue whales. Some of these questions can only be answered with a very large (hemisphere) scale approach. This program plans to address ecological objectives and major gaps in our knowledge of basic distribution, movement, and variability issues through an integrated southern hemisphere scale program. While a major component of the program is the large scale deployment of ARPs around the Antarctic, and in the southern hemisphere ocean basins, this will be done in parallel with a series of fine scale research foci sites in each of the five oceanic regions in Antarctica: east Antarctica (Australia), Antarctic Peninsula (USA), Weddell Sea (Germany) and others.

The Marguerite Bay Western Antarctic Peninsula (WAP) study provided an unprecedented opportunity to use a range of historical and new cetacean research tools within a multidisciplinary research framework. The preliminary results are interesting: baleen whale distributions were strongly associated with bathymetric features and hydrographic fronts; humpback whales remain in the WAP throughout autumn; minke whales remain through the winter; fin whales occur over a relatively short season; and blue whales occupy the region almost year round.

A further development of the program is reported in SC/55/E14, discussed above in the summary of Hofmann's presentation.

Thiele then presented SC/55/E9 which reported on IWC participation in five multidisciplinary research cruises in the Southern Ocean since the 2002 Annual Meeting. As an integral part of participating in these national SO GLOBEC and CCAMLR filed programs, we also took part in planning meetings, pre-analysis collaboration meetings, and proposal development and presented our work at international conferences, particularly at the 2nd International GLOBEC Open Science Meeting in Qingdao, China, October 2002. Two cetacean papers are to be published in late 2003 in the first volume of the US SO GLOBEC special issue of Deep Sea Research. The IWC is invited to continue its participation in national and international efforts in the Southern Ocean in the next few years through collaborative synthesis and analysis projects and field work. In the longer term the IWC is well placed to build on recent collaboration and to ensure whale ecology becomes a core component of the next major phase of

marine science focus in this region (i.e., OCEANS/ICCED initiative). The development of the ARP's around the Antarctic initiative is an important component in a circum-Antarctic approach to investigating the connections between whale ecology and the variability and dynamics of Antarctic ecosystems.

Continuing, Thiele presented SC/55/E10 on collaboration between the IWC and national programs conducting multidisciplinary ecosystem research in the Antarctic under SO GLOBEC and CCAMLR. IWC/SC participated in five national program cruises between April 2002 and April 2003. Visual survey, passive acoustic and tissue biopsy work was conducted by IWC observers and collaborating passive acoustics scientists. Reported here are the preliminary results from these cruises: mapped distribution patterns of cetaceans from visual survey sighting data; individual photo identification records; species identification and positions of animals recorded on sonobuoys; and descriptions of environmental conditions observed or recorded as part of the multidisciplinary effort.

IWC commenced collaborative research with CCAMLR in the Southern Ocean during the 1999/2000 austral summer as part of the SOWER2000 prrogram (Reilly *et al*. 2000; Hedley *et al* 2001). The IWC then developed collaboration with SO GLOBEC in a series of multi-season and multi-year cruises. The SO GLOBEC program provides a focussed framework for multidisciplinary ecosystem studies and involves the participation of many national programs.

Cruises under the United States (US) SO GLOBEC program were multidisciplinary and comprised standard mooring cruises, line transect surveys over a constant grid, and process studies at selected locations, all within the Western Antarctic Peninsula (WAP) study region around Marguerite Bay. These began in March 2001 and were completed in March 2003. A total of eleven cruises were conducted under US SO GLOBEC, and the IWC participated in eight of these.

The initial German SO GLOBEC effort comprised one cruise in April/May 2001 to the WAP study area, and an ice covered area to the south. The IWC participated in this cruise. The major German SO GLOBEC effort will commence in March 2004 with the first in a series of three cruises to a study area in the Weddell Sea. The IWC is participating in these cruises. The United Kingdom (UK) British Antarctic Survey (BAS) contribution to SO GLOBEC comprised joint SO GLOBEC/CCAMLR objectives in a survey in the Scotia Sea in early 2003. Members of the IWC SC participated in this cruise. Preliminary findings have been detailed in the papers, posters and reports noted in SC/55/E9.

Two SO GLOBEC cruises were conducted by Australia in the East Antarctic study area. One cruise took place in January 2001 and the second took place in the same area in January 2002 (see SC/55/E17). The IWC did not participate in these cruises, however the long-term cetacean research program run by Thiele (Southern Ocean Cetacean Ecosystem Program, SOCEP) did participate (see SC/55/E17).

Thiele presented SC/55/E17 describing Australian SO GLOBEC surveys conducted in the same study area off the Mawson coast in the Australian Antarctic Territory (AAT) in 2000/01 and 2002/03. Krill abundance, krill distribution, whale diversity and distribution differed between years and within the survey period. There were obvious differences between the two surveys in terms of patchiness and density of krill, with the 2002/03 Antarctic Marine Living Resources (AMLR) survey having very low abundance relative to the 2000/01 KACTAS survey. The KACTAS survey showed a high degree of clumping of krill and much greater density and biomass overall than KAOS. The reasons for these vast differences in krill density are not yet understood, however a number of avenues of analysis are being pursued. Also, penguin diet and foraging changed between the two surveys. Despite results confounded by differing methodologies between surveys, marked differences in the spatial pattern and species diversity of cetacean sightings were apparent. The large differences between survey years, as well as unexpected differences in krill and whale distributions in the same area within a very short time are important examples of variability and the dynamic nature of this system.

Thiele presented SC/55/E8 (for further detail see Appendix 3). A system to include comprehensive sea ice data collection within cetacean line transect surveys in the Antarctic was developed and trialled in the 2002/03 season. Some issues were identified during field trials concerning the use of the two data collection systems simultaneously, generally concerning doubling up of data entry across systems. These issues are relatively simple to resolve, and we propose here a series of steps to address these and complete the final version of one integrated sea ice and whale survey logging program for final trials in 2003/04. The results of the field trials and an integrated system for recording cetacean line transect survey data and sea ice data will be presented to the SC next year (IWC 56).The development of a simple, yet comprehensive field system should ensure maximum adoption across programs and platforms, and provide directly comparable data sets.

Following the presentations on SO GLOBEC and CCAMLR by Watkins and Hofmann, and Thiele's summaries of visual surveys conducted during eight of eleven SO GLOBEC cruises, Moore described the results of cetacean detections via passive acoustic methods (SC/55/SH14 and Širović *et al*. in review). As part of the coordinated visual and acoustic sampling for cetaceans that was integrated to the broad-scale SO GLOBEC oceanographic program, eight passive Acoustic Recording Packages (ARPs) were deployed offshore the Antarctic Peninsula from March 2001 through February 2003. ARPs are self-contained weighted instruments that rest on the seafloor and record all sounds in the 5-250Hz frequency band (i.e., 500Hz sampling rate) for periods of up to 400 days. Because there are very few IWC sighting records for blue (n=10) and fin (n=27) whales offshore the Antarctic Peninsula (roughly, Area I) over the past 20 years, the ARPs exceeded all expectations in recording a total of 258,706 calls from blue whales and 72,194 calls from fin whales during the two year deployment. Calls from both species exhibited strong seasonal pattern, with greater variability seen in the 8-day windowed call histograms from blue whales. Blue whale calls were recorded between September and May (average of 177 days/year), with peak calling in March and April. Fin whale calls were present between February and May (average of 51 days/year), with peak calling in May. Of note, blue whale calls were recorded nearly year-round on the northernmost ARP (located at 62.17°S latitude, 62.10°E longitude, Širović *et al*. in review, figure 1, S1). Overall, more blue whale calls were tallied in 2002, a year when the study area experienced relatively heavy sea-ice cover, compared to 2001 when the study area had a 60-d shorter sea-ice covered period.

These results complement the physical and biological data from the SO GLOBEC program and provide first-ever full-year records of blue and fin whale occurrence in this sector of the Antarctic. These data will be correlated with oceanographic parameters during the analysis and synthesis phase of SO GLOBEC, anticipated for 2004-06, and the authors plan further deployments of ARPs around the Antarctic if funding can be secured.

Moore also presented two related papers that describe blue whale calls recorded world-wide (SC/55/SH7), and solely in the Antarctic (SC/55/SH5). The Antarctic-type blue whale call is one of nine regionally-specific call types (song) described for blue whales in the world ocean. Blue whale songs are stereotypic signals consisting of two to three diagnostic units. Songs range from those containing only simple frequency-modulated (FM) units (usually recorded in oceanic basins) to those comprised of FM and complex units containing pulsive sounds and harmonics (usually recorded in continental shelf habitats), with songs exhibiting the greatest number of complex units recorded in the Indian Ocean basin. While the behavioural significance of blue whale song remains poorly understood, it is suggested that song be used as provisional stock identifiers until genetic or other data can be brought to bear on the question of population boundaries. Moore noted that an analysis of blue whale genetic samples from the

southern hemisphere (SC/55/SH9) showed distinct differences among three geographic regions that complement distinct song-types as presented in SC/55/SH7. The results in SC/55/SH5 provide further support that the Antarctic blue whale song type is unique to waters surrounding the continent, and attributable to 'true' blue whales.

In discussion of the reports presented by Thiele and Moore, it was noted that the multidisciplinary cruises covering seasons not previously studied, and in particular the new acoustic approaches will now allow scientists to form a much broader view of whale distribution than has to date been possible, and will improve our understanding of both temporal and spatial scales of distribution. In addition, the combination of acoustic and genetic investigations will now allow improved resolution of related questions of population structure and habitat use.

However, scientists are still far from able to interpret acoustic detections as records of abundance. No distinction can yet be made between a few whales calling many times and many whales calling a few or only a single time. Work is in progress on this important subject for blue whales off California.

It was noted that while only a single blue whale sighting was detected visually during the IWC – GLOBEC cruises, the acoustic devices had recorded blue whale occurrence for a duration of 9 months and in a broad part of the area. The locations where blue whale calls were recorded were inshore of the area searched during ship-board sightings surveys. Given the relatively small number of instruments and their spatial deployment it was not possible to triangulate specific locations within the study grid. It is hoped that follow-up studies (e.g. ICCED) will be able to deploy many more ARPs to make this possible.

The acoustic threshold defined for detecting blue whale calls was set relatively high to produce conservative results (Širović *et al*. in review). It was noted that if this threshold was lowered a reasonable amount there likely would be an even higher number of blue whale detections.

Possible implications of results to date for interpreting data from the IDCR/SOWER cruises were briefly discussed. It was noted that most of the sightings and all of the acoustic records of minke, blue and other whale species from these efforts had occurred farther south, closer to and within the ice, than the area covered by the IWC sighting surveys. This may have substantial implications, depending upon the timing of whale migration to and from the ice edge zone and timing of the IWC surveys. If the whales (primarily minke) recorded as overwintering in the ice in fact spend entire years there, they would not be detected by the sighting surveys.

Hofmann recounted the observation made in her presentation that whale distribution showed a strong association with hydrographic boundaries produced by the onshelf infusion of Circumpolar Deep Water where it impinges on the shelf. These areas are also known to support populations of other krill predators and should be examined more closely if we are to better understand patterns of baleen whale distribution in the Southern Ocean.

Members of the SWG expressed appreciation to SO GLOBEC for the considerable amount of time and effort spent on collecting and analyzing data for this extensive and important project. The SWG recommended that the IWC-GLOBEC collaboration be continued.

Thiele presented SC/55/E19 on Antarctic ice edge definition. During discussions at IWC 54 it became apparent that the term 'ice edge' had not been defined for use in cetacean analysis and/or discussions. This caused some confusion with interpretation. The ad hoc Working Group was tasked with providing the Scientific Committee with the accepted definition of the ice edge as used by other marine science disciplines in the Antarctic.

Satellite-based analyses of Antarctic sea ice cover have defined sea ice extent as 'the cumulative area of all gridded cells having at least 15% sea ice concentration' (Zwally *et al*. 2002). In addition, comparisons of ship data of the Antarctic ice edge location with Special Sensor Microwave/Imager (SSM/I)-derived (i.e., satellite-derived) ice edge locations for the same dates and longitudes show that the 15% threshold typically used for satellite data is a good estimate of the true ice edge location (Worby and Comiso 2001). For analyses of sea ice anomalies, Kwok and Comiso (2002) also relied on sea ice extent from satellite passive microwave data provided by the National Snow and Ice Data Center (NSIDC); they defined the mean ice edge as 'the mean latitudinal location of the SMMR (Scanning Multichannel Microwave Radiometer) and SSM/I ice edge over 1º sectors around the Antarctic continent'. For use in combined oceanographic analyses of cetacean distribution and density, a similar definition of Antarctic sea ice extent (or ice edge) of ice concentration > 15% would be useful to complement the climatological definition. Sea ice area is defined as 'the cumulative area of the ocean actually covered by sea ice and is calculated by summing the product of the area of grid cells and their sea ice concentration' (Zwally *et al*. 2002).

In discussion it was noted that the currently used IWC definition for ice edge was developed given information available during the cruises, and that the more general definition given above may not be easily applicable in the field. It was concluded that the most important matter here is to always define explicitly which definition is being used when reporting results, so that others are not misled. It would be beneficial for the IWC to adopt the more general definition to bring it into concordance with most other institutions studying the ice edge and its effects, but the SWG was not in full agreement as to whether this would be possible or advisable given the logistic issues noted above.

Matsuoka *et al*. (2003) reported on the relationship between large whale distributions and the southern boundary of the Antarctic Circumpolar Current (ACC) using JARPA-1997/98 survey data. Longitudinal distributions of humpback (*Megaptera novaeangliae*), southern right (*Eubalaena australis*), large male sperm (*Physeter macrocephalus*) and southern bottlenose (*Hyperoodon planifrons*) whales were concentrated between 80°E and 110°E during austral summer in the Antarctic (south of 60°S). Results of XCTD (eXpendable CTD) analyses in this area indicated a large meander of the southern boundary of the ACC that seemed to be moving north along the continent rise to 61°S and then slowly moving down to 63°S between 80°E and 120°E. It was considered that this longitudinal section was a high productivity area formed by large-scale up welling with nutritious bottom waters due to the effect of the southern Kerguelen Plateau. High-density areas of humpback whales were observed along the large meander of the southern boundary of the ACC between 80°E -110°E. Southern right, large male sperm and southern bottlenose whales were also concentrated in this longitudinal section, although they were distributed on the Antarctic continental slope. Several whale species, especially humpback, southern right, large male sperm and southern bottlenose whales used this section as their key feeding area, although it seemed that they were segregated from each other in their feeding habits. Abundance estimates of humpback and Antarctic minke in this cruise were 11,739 (CV=0.45) and 19,342 (CV=0.22) individuals, respectively.

The SWG thanked Matsouka for his contribution and encouraged future analyses of cetacean distribution versus oceanographic variables.

8. HABITAT-RELATED ISSUES

POLLUTION 2000+. Reijnders reported in SC/55/E21 that progress with Pollution 2000+ has been hindered by postponement of a principal investigator/Steering Group workshop scheduled in March 2003 in Boston due to travel concerns resulting from the Iraq war. The interim report presented was, therefore, a status overview rather than an in-depth report of results.

Many analyses have been completed for the bottlenose dolphin sub-project. Preliminary findings on Cytochrome P450 (CYP1A1) immuno-histochemistry analyses show that CYP1A1 expression was seen in endothelial cells, vascular smooth muscle, and nerve cells, but not in connective tissue, epidermis and adipocites. Surprisingly, CYP1A1 expression is apparently not related to sex, age, length or weight. This is important because it may imply that interpretation of CYP1A1 expression could be made without knowledge of those parameters. Statistical analyses of the relationship between Cytochrome P450 expression and contaminant concentrations are underway.

Preliminary findings of immunological analyses found stress-associated perturbations in animals' immune profile. Changes found were a drop in total white blood cell count, loss of memory T lymphocytes, and a reduced cell function of B lymphocytes. These stress responses were supported by elevated levels of cortisol and glucose. The degree of these stress-associated changes need to be compared to contaminant loads, as it is hypothesised that the healthiest animals will demonstrate the least changes in some or all immunological parameters.

For the harbour porpoise subproject, progress has been made on immunohistochemistry analyses. However, low CYP1A1 expression has been found and it is therefore questionable whether additional analyses of enzyme activity should be conducted.

Reijnders described plans for completion of Pollution 2000+ subprojects. For bottlenose dolphins (1) in-depth integration and interpretation of all biomarkers data and contaminant concentrations will be conducted following completion of analyses of individual project components; and (2) additional sampling of animals from a relatively low polluted area (Charlotte Harbor) and a relatively high polluted area (Mediterranean) is needed. For the harbour porpoise subproject (1) analyses of samples obtained thus far must be completed; and (2), and after the results are analyzed, decisions must be made about further sampling and analyses.

A workplan and related budget for 2003-2004 was presented. After prioritising the planned activities, a request has been put forward to the IWC, to co-fund the project with an amount of £52,000.

Discussion of this paper centered on expected products from the Pollution 2000+ project. Reijnders reported that he expects at least 4 papers from the bottlenose subproject to be presented at the IWC SC next year, including papers relating contaminants to retinol, immunohistological, enzyme induction and immunological biomarkers. In addition there will be a major multivariate analysis undertaken to integrate results from all the biomarkers that should provide another paper. However, it was noted by Reijnders that the ability to attract additional funding for this project will ultimately determine the products that are completed and the project success.

Several in the group expressed concern about the lack of funds for finishing the project and the chair suggested that Reijnders prepare a document for next year's meeting summarizing the problems associated with lack of funding and what the Commission has to gain by completion of this project. Reijnders indicated that this is actually part of the work plan for 2003/2004 and will be undertaken at next year's meeting.

There continues to be strong support for the Pollution 2000+ initiative and the SWG endorsed its continuation.

Fossi presented SC/55/E18 wherein the authors used skin biopsies in a preliminary assessment of the ecotoxicological status of a SW Mediterranean segment population of striped dolphin (*Stenella coeruleoalba*). A geographical trend of contamination has been found for striped dolphin, with PCB and DDT levels decreasing from north (Ligurian Sea) to SE (Ionian Sea). Ten striped dolphins were sampled with a biopsy pole during a survey of the Eolian area in summer 2002. Levels of CYP1A activities in biopsy samples from the Aeolian population were three time and five time lower, respectively, than the levels previously found in the Ligurian and Ionian striped dolphin groups. Moreover, OC levels were significantly higher in the Ligurian samples compared to the Aeolian group. These results suggest that the non-lethal approach (skin biopsy) is suitable for investigating bioaccumulation of OCs, as well as CYP1A induction in free-ranging Mediterranean striped dolphin. In addition, CYP1A induction may be an early sign of exposure to OCs, including those with endocrine disrupting capacity.

Discussion focused on whether biopsy samples used for pollutant analyses could also be used to look at the genetics of the dolphins to see if there are some subpopulations present as might be indicated from some of the contaminant results. Fossi indicated that the entire biopsy sample is usually used for chemical analyses, but in future samplings, some of the skin might be made available to answer this question.

8.1 State of Cetacean Environment – consider form of SOCER

The preliminary version of the State of the Cetacean Environment Report (SOCER) SC/55/E7, was presented by its editors: Rose noted that this was produced in response to a request from the Commission for such an overview (Resolution 1997-7 and 2000-7) meeting last year the format and process of SOCER production had been reviewed. The long-term goal is to produce a document that is well informed, up to date and accessible to the Commission.

The focus of this year's edition is the Atlantic Ocean, Black Sea and the Mediterranean Sea. The SOCER also includes an additional global section relating information of global importance. As SOCER covers a wide range of topics, a glossary had been added to aid the understanding of non-experts.

Recent results, analyses, events, and developments concerning the marine environment in these regions were summarized in each of five categories: Chemical pollution; climate change; habitat protection/degradation; disease and mortality events; and noise impacts. For each of these categories, both positive (*e.g.,* the creation of marine sanctuaries) and negative (*e.g.,* oil spills) entries were included. All entries were referenced regarding source or submitter – the majority came from peer-reviewed publications. The SOCER is not intended to be exhaustive, but rather a brief 'snapshot' of the cetacean environment for the non-specialist reader. Notable entries for this year included the Prestige tanker oil spill off the coast of Spain, the report in *Nature* of a 90% decline in predatory fish stocks from pre-exploitation levels, and the recent Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) cetacean status review.

A form for contributors to use in sending a contribution to SOCER was finalized and placed on the IWC web site. A solicitation letter and first draft were sent out via the Secretary to members of the Scientific Committee in February (it is intended that such a letter will be sent out earlier next

year). Other requests for information were sent to e-mail lists, including MARMAM. The editors reported a good response from their solicitations and also provided a working paper with seven additions to the draft SOCER to the SWG (i.e., received post May 16th).

The SC Chairperson expressed his thanks to the editors, noting that the emphasis on published papers provided a much-improved review. The Chairperson of the Scientific Committee concurred and asked the editors how they achieved balance between published and unpublished accounts in the report.

The editors noted that emphasis had been placed on published work. They also referred to the SOCER submission forms that the contributors had been asked to use and stressed their role in helping to judge which contributions were important. Whilst the editors had rejected some material originating only from the popular media, they had still felt that some events without a peer-reviewed source should be mentioned, e.g., the Prestige oil spill. Such matters might not reach the scientific literature for some time. They also encouraged would-be contributors to send information earlier in the year and preferably full papers rather than abstracts. Rose offered to be the repository of such submissions, especially reprints sent via post.

Several members of the group said that they had already found the SOCER a useful source of information. Taylor noted in particular the usefulness of reporting the successful application of regulation.

Stachowitsch asked whether the group would like to see a new category added listing "new literature". For example, it had been proposed this year to include mention of a new book on marine mammal toxicology. This idea was supported.

It was concluded that the process leading to the current SOCER draft had been satisfactory and that a useful product had been produced. The SWG recommended that the SOCER should become an appendix to its report.

8.2 Arctic issues

Krahn reported the results of SC/55/E3 in which five parameters (i.e., lipid percent and classes, contaminant concentrations and profiles, fatty acid profiles) were measured by blubber depth in two cetacean species, white and killer whales. The conclusions from this study indicated that blubber biopsy techniques seldom result in samples that give information completely representative of that obtained from full-thickness or even outer layer blubber samples obtained via necropsy. However, if carefully interpreted, biopsy samples can provide useful information for several types of analyses. For example, biopsy samples can provide adequate information on lipid classes present in the sampled blubber layer, but cannot provide information on depth-related changes in the lipid class profile. Because measured contaminant concentrations of biopsy samples are generally within a factor of 2 of those obtained via necropsy for these species, results based on analyses of biopsy samples from monitoring studies may be of sufficient accuracy to determine whether the animals are highly contaminated and thus at risk for contaminant-related health effects. In contrast, fatty acid profiles from outer blubber layers collected via biopsy are substantially different from the metabolically active inner layer and are therefore unlikely to be useful in attempting to make correlations with the fatty acid profiles of potential prey. Thus, biopsy results are best interpreted with caution and in conjunction with results from blubber depth profiling on the same cetacean species.

It was asked if there could be any difference in lipid loss depending on whether or not the animal sampled was dead or alive. Krahn confirmed that this would be the case, temperature affecting lipid mobility. She noted that it would be helpful to design a biopsy dart that could close at the end. The SWG noted there could be implications of this finding for ongoing pollution work. Krahn agreed that the interpretation of some data might need been to be revisited. It was suggested that the standardisation of biopsy darts would help to facilitate comparisons between populations. Although the sample sizes were small, these observations were consistent with what was being seen in bowhead whales. Several group members commended the work and Krahn noted that she planned to continue these investigations.

Moore informed the group that a new research initiative focused on the sub-arctic is taking form under the GLOBEC organizational umbrella. The new initiative is called Ecosystem Studies of Sub-arctic Seas (ESSAS) and will provide opportunities for collaborative studies of cetacean ecology, as described in the SO GLOBEC special session. A science plan should be available later this year via the GLOBEC web site (http://www.globec.org).

8.3 Habitat degradation

Rojas-Bracho presented SC/55/E2 to update the SWG on the current state of the “Nautical Steps” (NS) tourist development. A recent analysis of the project was made by a market research firm (EDAW). The study shows that FONATUR (the developer) overestimated the demand for marina space by 600%. For example, NS reports that more than 60,000 big boats will be attracted from the U.S. to Mexico by 2014. EDAW reports that the demand will support about 10,000 annual boat visits to the coast of Baja California. The study indicated that only 5500 berth will be needed, but FONATUR wants to provide 26,000.

To evaluate this project, detailed specifications will be needed. Unfortunately, FONATUR has not provided project specifications detailed enough to evaluate potential threats to cetaceans and other marine life. Among others, potential problems include: (1) increased vessel traffic and collisions; (2) uncontrolled whale watching; (3) chemical and noise pollution; (4) disturbance of important feeding, breeding and nursing locations; and (5) other ecosystem disturbances or alterations. The distribution of blue whales and the movements of fin whales overlap with potential NS project sites, so disturbance to their habitat and normal behavior is of concern.

Last year, the Committee recommended that (1) the Commission request information of the Government of Mexico on the specific locations and types of construction comprising NS; and (2) the Commission request the Government of Mexico take steps to insure the maintenance of habitat important to cetaceans. The Government of Mexico presented a document (SC/55/O19) that was well received. After considering the available information, the SWG expressed concern about the potential effects of this commercial development on local cetaceans and their habitats. The SWG expressed disappointment that specific information requested last year was not made available in SC/55/O19, and therefore reiterated its request made last year for this information.

M. Taylor gave an update on recent publications relevant to the framework outlined in the Habitat Degradation Workshop Scoping Group Meeting Report (J. Cet.Res Manage 4 (Suppl.) 2002:314 -317). Taylor (in press) was developed from SC/54/E11 and will shortly appear in Conservation Biology as will a response from Shelden *et al*. (in press). Taylor also noted Myers and Worm (2003), which reported on large declines in predatory fish populations resulting from industrial fisheries. Dalla Rosa *et al*. (2002) reviewed orca populations worldwide and the threats from habitat degradation, climate change and other factors. It was produced (as a background paper) to support the listing of orcas under the CMS (Convention on Migratory Species) last year.

Taylor also provided SC/55/E6, as a resource to assist planning and research decisions. Some factors causing habitat degradation are already addressed with IWC research programs, such as Pollution 2000+. Other factors are less well covered. He suggested that a general conclusion is that comparative studies are likely to be the mainstay of research connecting environmental effects with cetacean health and demography by seeking correlations for populations that experience a wide array of different levels of putative factors. As always the key concern is designing studies to be broad enough to cover enough of a range of potential causes that there is sufficient statistical power to avoid bias from confounding factors. Much needs to be done on the interactions and synergies among the multiple stressors affecting cetacean health. Models have been developed, and need to be tested whenever possible. Interactions with climate change are less easy to characterize, and research could fruitfully focus on possible synergies or potentiating effects. Of these, the retreat of polar sea-ice is perhaps the most profound impact in high latitudes, opening up previously remote areas to shipping and extractive industry. (2002 saw the largest contraction of summer sea ice observed to date.)

The relevance of the discussions this year about the at risk status of the three Black Sea Cetacean species in the Small Cetacean Sub Committee was also noted. These populations are threatened by fundamental habitat changes.

It was noted that for several years, the Scientific Committee of the IWC has been contemplating the significance of habitat degradation for cetaceans. A workshop to take this forward has been recommended. Preparation for this conference was progressed at a special "Scoping Group" meeting in Rome in June 2001. The Group considered several potentially complementary approaches to furthering work on cetacean habitat assessment, with a long term view to quantification. It recommended "a broad focus that would bring together habitat evaluation and cetacean population demographics" and provided a revised proposal for a 3 day workshop of some 25 experts to the IWC Scientific Committee. This proposal was endorsed by the 2001 and 2002 meetings of the Scientific Committee. It was also recognised in Resolution 1.9 of the first meeting of Parties to ACCOBAMS and identified as one of the agreement's 18 International Implementation Priorities for the 2002-2006.

The full report of the HDW Scoping Group meeting can be found in IWC (2002, pp. 314 -317) and the full workshop proposal was published in the same volume (pp. 318-319).

The workshop would consider the following points:

1. review and aid development of the concept of a habitat quality index to be used in classifying quality/functioning of marine ecosystems in biological and physical terms;
2. review and aid development of the concept of cetacean critical habitat and the development of quantifiable indices that may be applied to it; including assessment of marine mammal health;
3. develop the concept of cetacean habitat quality indices based on information from 2 and 3 above;
4. review and aid development of modelling approaches as part of a framework and methodology to assess the significance of changes in such measurable parameters, with a view to developing a strategy for:
    (a) monitoring critical habitat quality;
    (b) identifying thresholds which may affect cetaceans; and
    (c) assessing proposals for activities that might affect cetacean habitat.
5. review relevant available information on:
    (a) cetaceans and their habitats and, in particular, studies that allow comparisons to be made between segments of populations that appear to be responding to different levels of environmental stress; and
    (b) studies of major perturbations of cetaceans habitat.

Information of two kinds were identified as potentially of particular importance to the workshop:

1. habitat quality assessment and the use of habitat quality indices. The significance of these indices may be determined for marine mammals by comparing them with "vital parameters" (i.e. population demographics – see figure IWC53/SC/E15: figure 1): and

2. demographics – i.e. consideration of populations where there is an indication in measured population parameters of environmental disruption.

The workshop would be tasked to consider the appropriate "links" – i.e. between environmental changes and changes at the population level. For example, as suggested by the Scoping Group: A. Impact to Habitat; B. Habitat to condition/health of animal; C. Cetacean condition/health to "vital life parameters"; D. Life history to population stability; E. population persistence to community composition. The Scoping Group also recommended that particular consideration should be given to link B and an approach using comparative multivariate analyses. In this approach, several geographically distinct stocks of a species are identified for which good demographic and habitat data are available or readily obtainable. Habitat elements that vary among these sites sufficiently (and which are sufficiently independent of variations in other elements) are selected for multivariate analysis. It may be desirable to create a habitat quality index using principal components that summarise statistically significant variation among sites in the set of habitat elements; including *inter alia* prey abundance/variance, pollutant levels, noise levels, fishing intensity, temperature and salinity.

Funds had not been found to support the Habitat Degradation Workshop last year, despite hopes to the contrary and the SWG reiterated its ongoing support for the Habitat Degradation Workshop and recommended that it should be held if funds were found.

The SWG commented on SC/55/E1. The SWG noted that the authors should consider some apparent limitations of their methods. This study carries out a comparative analysis to investigate whether there is a relationship between inshore vs offshore habitat use and the incidence of skin tattoo lesions. The analysis, based on data in Table 2, fails to control for phylogeny (a requirement of any comparative analysis). To do this, the analysis would be better carried out at the species or even genus level. From the data in Table 2, the analysis could only, therefore, be carried out for *T. truncatus*, where the available sample size is too small to draw any conclusions. This paper could be significantly improved by inclusion of more data within taxonomic level (preferably species level), because it, as yet, does not demonstrate convincingly a relationship between inshore lifestyle and skin tattoo disease.

Wilson described the results of a related study (Wilson *et al*., 1999) on epidermal lesions in ten populations of bottlenose dolphins. The populations were drawn from three oceans and a variety of habitats with widely differing natural and anthropogenic circumstances. Skin condition of the dolphins differed significantly between populations and the study sought to determine whether any factors could be found that were correlated. Of the natural and pollution related factors examined, strong relationships were found between the skin condition of each dolphin population and the local hydrographic conditions (particularly water temperature and salinity). The authors concluded that if epidermal lesions in dolphins were to be used to study the impacts of human related pollution, efforts would be needed to be taken to account of the natural hydrographic factors first. These

findings also raise the possibility that changes in freshwater influx into marine systems or alterations in water temperature might have implications for epidermal health in cetaceans.

Iniguez presented paper SC/55/E20. It describes observations on the impact of the petroleum industry in South-Santa Cruz province, Patagonia, Argentina, an area of high biodiversity and highly changeable weather, often including very strong wind. The paper reported two petroleum-related accidents (in one a tanker stranded and in the other a leak was recorded from a production platform). Some recommendations and actions were presented, including the recommendation that local contingency plans should include an environmental impact evaluation.

The Chairperson asked for thanks to be passed to the author, de Haro, noting that little information had been received from this part of the world previously and that more would be welcome. Inguez noted that oil development at sea in Argentina is a relatively new issue. Weller noted that independent review of oil spill plans was conducted elsewhere and might also be helpful in this case.

8.4 Acoustic issues

Simmonds presented paper SC/55/E4. This paper noted that the development of wind farms in the marine environment is set to expand rapidly in the future as governments strive to meet greenhouse gas emission targets and renewable energy commitments. Marine wind farms constitute a new development in the marine environment and one for which the associated environmental impacts remain largely unexplored. Areas of particular concern, including those related to development within important cetacean habitat, are discussed in the paper. The seventh meeting of the Conference of the Parties to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) had recognised the threat from marine wind farms and its scientific council was instructed to assess existing and potential threats from marine wind farms for the next Meeting of the Parties. However, despite the rapid expansion that is planned for wind farms, to date there is only a relatively small number of reports and papers that relate to their potential environmental impact, as outlined in SC/55/E4.

Some trends in the present and future development of marine wind farms are evident. At present, all marine wind farms are limited to shallow, less than 10m deep, near-shore waters, within approximately 5km of the coast. However, plans are now being made for large-scale development further offshore out to EEZ boundaries. Current marine wind farms have been on a small scale, generally less than 20 turbines, but future plans are considering farms with hundreds of turbines. The largest marine wind farm to date is sited at Horns Reef, Denmark. It came into operation in December 2002 and has 80 turbines. The actual size of the turbines has also been increasing; for example, Germany and the Netherlands are developing a wind turbine in excess of 100m high that produces in the region of 4.5MW. Larger scale development, larger turbines and plans to develop further offshore have wider implications for environmental impact.

As far as the authors of SC/55/E4 are presently aware, there are currently 12 existing operational marine wind farms in the world and all of these are in Europe. World wide, a number of marine wind farms are in various stages of development. There are projects under construction, projects with approval, planned projects that are still under consideration and a number of other project proposals.

Coastal regions of the North and Baltic Seas are set to become hot spots for development because many European countries have extensive plans for future projects near-shore and beyond their respective territorial waters, Germany, Denmark and the UK in particular. Germany has plans to build very large turbines and situate them more than 100km offshore in depths of 20-35m.

The authors of SC/55/E4 urged that marine wind farms should not be developed without due consideration being given to possible environmental consequences and that this should be done via appropriate environmental impact assessments.

A number of SWGEC participants expressed their concerns about marine wind farm development in their region. The SWG noted the large scale of such developments planned in Germany (i.e., 200 square km each) and that fisheries were looking at the potential for deploying set nets amongst the turbines. It was also noted that hundreds of turbines were planned for the US East Coast in the absence of any policy for the outer continental shelf region. There can be a problem of terminology relating to this issue, in that the wind farm industry tends to refer to all marine farms as “offshore”. The SWG also noted the potential threat posed by the electricity cables, primarily to fish, connecting farms to the shore.

The SWG concluded that the rapid development of marine windfarms was a substantial concern and recommended that full independent and publicly-accessible environmental impact assessment should be conducted wherever they are planned. The SWG noted that biological surveys might be needed in many regions to adequately inform the EIA process. Publication in the peer-reviewed literature of studies considering associated impacts was also urged.

In accord with earlier presentations from the same authors to this standing working group, SC/55/E5, presented by Simmonds, provided a brief review of some of the most recent research relating to noise in the marine environment, including studies on particular noise sources (i.e. vessels, aircraft, ocean experiments, acoustic harassment devices, seismic surveys and military activities). It also considered some recent advances in understanding noise impacts and presented some recommendations for future action on noise pollution. Simmonds highlighted that the debate about how powerful noise (military or otherwise) may precipitate strandings or otherwise harm cetaceans continues and a recent event where some coastal cetaceans appeared to be exposed to powerful sonar has added to concerns. The event occurred in Haro Strait (May 5, 2003) and David Bain observed the behaviour of a number of cetacean groups during the passage of a naval vessel (pers comm.). He reported that, after the ship had passed, Dall's porpoises were observed travelling away from it at high speed. Porpoising minke whales (an unusual behaviour for them) were also reported from the locality. In the presence of the vessel, the orcas of ‘J pod’ were observed behaving normally until the sonar became audible in air. They then moved inshore and grouped tightly. Bain described the group's behaviour as "inconspicuous." The sonar "pings" were reported to be so powerful that they could be heard in air by visitors along the shoreline of San Juan Island (OrcaNetwork, 2003).

The SWGEC expressed its strong concern about this event.

The issue of potential confusion between Low Frequency Active Sonar (LFAS) and other military sonars was briefly discussed. Clark mentioned that considerable progress has been made in understanding marine noise pollution, including refined acoustic propagation modelling packages that quantify noise and allow impacts on populations to be explored. He further noted that software tools are also becoming available to quantify estimates of noise exposure levels for individuals and populations of animals. These tools provide a conceptual framework for investigating noise exposure as a noise dosage. The challenge remains as to how to interpret the biological impact of physiological or behavioural responses to anthropogenic noise exposure.

Simmonds noted that the Whale and Dolphin Conservation Society (WDCS) has recently completed a review of the marine noise pollution issue (Simmonds *et al*. 2003) and concluded an action plan, as presented in SC/55/E4. Simmonds stressed one aspect of this: "that an independent body should be established to initiate, promote, monitor and fund marne noise research". In addition, the USA Marine Mammal Commission (MMC) had recently received substantial funding to investigate these matters. [1]

The SWG Notes:

- the importance of the emergent threat of noise pollution to cetaceans and other elements of marine ecosystems, including the increase in the deliberate deployment of powerful noise sources that radiate noise over large areas, and
- the potential of the Scientific Committee to assist in the development and interpretation of studies aimed at elucidating the potential consequences of introduced noise for cetaceans, the SWGEC recommends:

(a) that an approach be made by the Scientific Committee to the USA MMC to give consideration to the exchange of information and potentially the development of co-operative research in order to combine the expertise of both bodies;

(b) that workshops generated under the auspices of the USA MMC "noise programme" should include Scientific Committee representation where appropriate; and

(c) that appropriate representatives of the USA MMC should be invited to attend the next scientific committee to discuss progress in this field.

In addition, the SWGEC agrees to establish an intersessional correspondence group to further develop the noise agenda of the group, including identifying topics for future review, such as the demographic or physiological consequences of exposure to loud noise sources and synergistic effects. The intersessional group will also try to identify other bodies (in addition to the USA MMC) that will assist in this.

8.5 Other topics

No other topics were discussed.

9. WORK PLAN AND PRIORITIES FOR COMING YEAR

The following intersessional groups and chairpeople were agreed:

(1) Acoustic Issues: Clark

(2) SO GLOBEC/CCLAMR: Thiele

(3) POLLUTION 2000+: Reijnders

(4) SOCER: Rose and Stachowitsch

(5) Arctic Issues: Moore

(6) Habitat Degradation Workshop: Simmonds

(7) Define focus for 2004 meeting: Gales

(8) Ice edge definition: Thiele

The SWG decided to appoint a correspondence group (composed of Clark , Gales, Moore, Reijnders, Rose, Simmonds, Stachowitsch, Thiele) to define the focus of the SWG's work for next year. Gales agreed to chair this steering group. This correspondence group will contact the convenors of next year's Sub-Committees and attempt to focus the SWG's work on an issue of importance to the other Sub-Committees.

The SWG agreed the following budget request:

Table 1
SWG budget request.

Title	Funds required (£)	Justification
POLLUTION 2000+	52,000	Appendix 4
SO GLOBEC	86,900	Appendix 2
Habitat Degradation Workshop	15,500	Text pp. ??-?? (parts of #8.4)
Preparation for SOCER	3,000	2 months salary, copying charges, phone costs

Simmonds commented that, as was the case in previous years, he and other members of the SWG were hopeful that they would be able to secure additional funds for the Habitat Degradation Workshop from sources outside of the IWC. He also informed the SWG that an offer to host the meeting has been made by the University of Sienna and that the workshop is of interest to ACCOBAMS.

Members of the SWG expressed concerns that there are insufficient funds to support the Invited Participants that are needed for the SWG to complete its work. For example, the Mini-Symposium on High Latitude Climate Change Effects which was scheduled for this year occurred on a

[1] During discussion another event was also noted: on 25 September 2002, a group of marine mammal scientists (including members of the Scientific Committee) found two freshly dead Cuvier's beaked whales with no signs of external trauma. They subsequently learned that a seismic survey was being conducted nearby using air guns (263 dB re 1 microPa(at)1m. This event was the first observation implicating low-frequency seismic exploration in whale strandings.

much abbreviated scale due to limited funds for Invited Participants. This symposium should be attempted again in a couple of years after analysis and synthesis of the joint IWC, SO GLOBEC and CCAMLR work has been completed.

Following completion of scheduled business the SWG discussed ways to improve its effectiveness and methods of operation. Results of this discussion are summarised in Appendix 6.

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US Southern Ocean GLOBEC Scientific Steering Group. The Southern Ocean Global Ocean Ecosystem Dynamics Program II. Poster presented at the 2nd International GLOBEC Open Science Meeting. Qingdao, China 15 – 18 October 2002 (also presented at PICES XI Qingdao, 18 – 21 October 2002 and 21st Meeting of the CCAMLR Scientific Committee, Hobart, Australia 21-25 October 2002).

Appendix 1

AGENDA

1. Convenor's welcome and opening remarks
2. Election of Chairman.
3. Appointment of Rapporteur(s)
4. Adoption of Agenda.
5. Review of available documents
6. Modeling cetacean-fisheries interactions, including results from intersessional workshop
7. High latitude climate change effects on cetaceans, including progress report on SO-GLOBEC/CCAMLR.
8. Habitat-related issues
    8.1. POLLUTION 2000+, including steering group report.
    8.2. State of Cetacean Environment – consider form of SOCER
    8.3. Arctic issues
    8.4. Habitat degradation (including plans for workshop)
    8.5. Acoustic issues
    8.6. Other topics
9. Work plan and priorities for coming year

Appendix 2

IWC COLLABORATION IN THE SOUTHERN OCEAN BUDGET REQUEST

The International Whaling Commission (IWC) has participated in five multidisciplinary research cruises in the Southern Ocean since the 2002 Annual Meeting. The IWC has contributed relatively minor finds towards participation in these multi million dollar multidisciplinary programs. The additional data series available to the IWC from other disciplines as a result of these collaborations includes extensive data on krill distribution, patch dynamics, sea ice extent, type and cover, sea ice formation and structure, krill abundance, currents, tides, productivity, pphy7sical oceanography, biological oceanography, biodiversity of other predators.

As an integral part of participating in these national SO GLOBEC and CCAMLR field programs, we also took part in analysis collaboration meetings and proposal development. We have presented our work in poster form (see Appendix A) and spoken presentations at international conferences, particularly at the 2nd International GLOBEC Open Science Meeting in Qingdao, China, October 2002 (see SC/55/E9). In addition, we have submitted two cetacean research papers to be published in late 2003 in the first volume of the US SO GLOBEC special issue of Deep Sea Research. A considerable amount of new data, of importance to many sub committees (SH, E and IA) has resulted from these cruises, and will continue to be presented to the IWC SC as the synthesis and analysis phase continues.

The IWC is invited to continue its participation in national and international efforts in the Southern Ocean in the next few years through collaborative synthesis and analysis projects and field work. In the longer term the IWC is well placed to build on recent collaboration and to ensure whale ecology becomes a core component of the next major phase of marine science focus in this region (OCEANS/ICCED initiative). The development of the ARP's around the Antarctic initiative is an important component in a circum-Antarctic approach to investigating the connections between whale ecology and the variability and dynamics of Antarctic ecosystems.

We have developed collaboration with many nations and programs, to ensure that the IWC will be involved in the major research efforts in the Antarctic well into the future. The time frames for collaboration require that negotiations, planning, submission of proposals etc be initiated well ahead, often years ahead, of any cruises.

This financial year we have committed to collaboration in the field with the following programs:

German SO GLOBEC Weddell Sea cruise

US Ross Sea mooring cruises

US Western Antarctic Peninsula follow on SO GLOBEC cruise

The German SO GLOBEC cruise is the first in a series of three planned cruises to one study site over 2 years in the Weddell Sea.

The US Ross Sea cruise is the first of two cruises to the same study area in the Ross Sea

The WAP cruise is a follow on to the studies in Marguerite Bay under US SO GLOBEC

All cruises will include visual survey and passive acoustic monitoring with both sonobouy during voyage and the deployment of year round recording devices (ARP's).

Last year a funding allocation of 15,000 pounds sterling was allocated to this project, and an additional amount of 25,477, which had already been allocated from the Environment Research Fund, was brought forward and resulted in a total allocation to the project of 40,477 pounds for 2001/02.

This work directly addresses the following Resolutions from the Commission:

1994 – 13 Resolution on research on the environment and whale stocks

1995 – 10 Resolution on the environment and whale stocks

1998 – 5 Resolution on environmental changes and cetaceans

1998 – 6 Resolution for the funding of work on environmental concerns

1999 – 5 Resolution for the funding of high priority scientific research

2000 – 7 Resolution on environmental change and cetaceans

Appendices 3 and 4 TO COME WHEN I CAN FIND THEM!!!

(*– negative event; + positive event*)

ATLANTIC OCEAN

Chemical pollution

– Oil spills and leakages in Venezuela

Recent oils spills, leakages and other incidents in Lake Maracaibo and the Gulf of Venezuela System have prompted several NGOs to release a statement of concern (available on the website of the NGO Vitalis, see below). This area is the habitat of three species of dolphins; the threat to the tucuxi, whose population status is insufficiently known, is a key concern. At least two tucuxi were found stranded with evidence of human interactions (eviscerated or butchered).
(Submitter: Jaime Bolaños, Venezuela, based on personal observations, symposium abstract and Vitalis website, http://www.vitalis.net/Index2.htm)

– Fuel oil and plastic spill off of Cornwall

A 1,846 tonne cargo vessel, RMS Mulheim, ran aground on the coast of Cornwall (UK). The vessel's ruptured hull spilt over 100,000 litres of fuel oil and a large quantity of scrap plastic. Although much of the oil will disperse, there were serious concerns about the impact of the spilled plastic on marine wildlife, leading to a major effort by authorities and NGOs to remove over 2000 tonnes of the scrap plastic from the wreck. A spokesperson for the Marine Conservation Society stated that if the plastic were to be released from the wreck it could impact the majority of the UK south coast and potentially the northern French coast too.
(Source: Dive magazine, May 2003)

– TBT still widespread a decade after banning

Application of butyltin on small boats (<25m) was banned in the UK a decade ago. However, a study on butyltin concentrations in sediments and mussels in the Thames and Mersey estuaries determined that butyltin residues "remain widespread" and "chronic contamination of sediments appears to be an extensive feature in major industrialized estuaries and seems likely to persist for the foreseeable future".
Maximum contaminant levels
TBT ($mg.kg^{-1}$ dry weight) – 0.173 (sediment) and 0.302 (mussels).
(Source: Harino, H., O'Hara, S.C.M., Burt, G.R., Chesman, B.S., Pope, N.D. and Langston, W.J. 2003. Organotin compounds in Mersey and Thames Estuaries a decade after UK TBT legislation. *J. Mar. Biol. Assoc. UK* 83:11-22)

– The adverse effects of climate change in the Baltic Sea

Climate change models for the year 2100 predict a significant increase in air temperature (by 2.3-4.5°C) and precipitation (by 5-30%) in Estonia. Climate warming due to the enhanced greenhouse effect is expected to significantly impact natural environment and human activity in high latitudes. While it should have a positive effect on human activity, a sea-level rise would flood coastal areas. This would endanger a number of valuable natural marine ecosystems and would cause land-based pollution to enter the marine environment. The most threatening potential source of land-based pollution is the disposal site for the former uranium enrichment plant in Sillamae, which is situated very close to the coastline and could be easily influenced during storms. Flooding of this site could lead to major radioactive contamination of the Gulf of Finland and the whole Baltic Sea. All of these potential impacts would negatively affect Baltic cetaceans.
(Source: Kont, A., Jaagus, J. and Aunap, R. 2003. Climate change scenarios and the effect of sea-level rise for Estonia. *Global and Planetary Change* 36: 1-15)

– "Prestige" oil spill

On 19 November 2002 the oil tanker "Prestige" broke in two and sank off the Galician coast of northwestern Spain. The initial loss of ca. 35,000 tons of oil washed up along more than 1000 km of beaches and rocky shores in Spain and France, in an area limited approximately by the 42° and 45° N parallels and 12° W meridian. This upwelling area has a rich marine fauna and important shellfish and fishing activities. Plans are being developed to deal with the wreck, sunk at 2300 m, but still there is the danger of new surges from the fuel remaining in the wreck. The severity of the event is underlined by its great geographic extent and ecological impact. The above factors, along with the presence of several cetacean species here (including striped dolphin, common dolphin, bottlenose dolphin, harbour porpoise, pilot whale, Risso's dolphin, minke whale, fin whale, and sperm whale), the higher-than-usual strandings of sea turtles and cetaceans, and the temporary closing of fishing activities, indicate the significance of this event for the marine environment.
(Submitter: IWC Scientific Committee member Santiago Lens, Spain, based on report of surveys conducted in 12/02 and 4 web-based sources)

–/+ Pollutant levels in Shannon Estuary (Ireland) bottlenose dolphins

Blubber samples were taken by biopsy in September 2000 from bottlenose dolphins in the Shannon Estuary – Ireland's only Special Area of Conservation for dolphins (designated under the European Habitats Directive). Organochlorine pollutant levels were higher in bottlenose dolphins than recorded in harbour porpoises and common dolphins outside the estuary, but were similar to levels recorded in Ireland-stranded Atlantic white-sided dolphins and bottlenose dolphins from Scotland. Although pollutant levels were elevated, they "were not thought to be a major threat to bottlenose dolphins in the Shannon estuary".
Maximum contaminant levels
Organochlorines ($mg.kg^{-1}$ lipid weight) – DDE: 16.0; trans-nonachlor: 2.30; PCB (congener 138): 7.13 and (congener 153): 10.9.
(Source: Berrow, S.D., McHugh, B., Glynn, D., McGovern, E., Parsons, K.M., Baird, R.W. and Hooker, S.K. 2002. Organochlorine concentrations in resident bottlenose dolphins (*Tursiops truncatus*) in the Shannon estuary, Ireland. *Mar. Poll. Bull.* 44: 1296-1313)

–/+ Radioactive caesium levels in North Atlantic and North Sea minke whales

Tissue samples were taken from minke whales in Norwegian whaling operations in 1998. Most radioactive caesium levels recorded were comparable to levels recorded in contemporary studies. Levels were highest in the North Sea – the elevated North Sea contamination was attributed to outflows from UK and French nuclear fuel reprocessing plants and from the Baltic Sea, the latter containing contamination from the 1986 Chernobyl accident.

Mean contaminant levels (by IWC minke whale stock)

^{137}Caesium (Bq.kg^{-1} lipid weight) – West Greenland: 0.543; East Greenland: 0.589; Jan Mayen: 0.448; Svalbard: 0.298; Barents Sea: 0.569; Vestfjorden/Lofoten: 0.655; North Sea: 1.319.

(Source: Born, E. W., Dahlgaard, H., Riget, F. F., Dietz, R., Øien, N. and Haug, T.. 2002. Regional variation of caesium-137 in minke whales *Balaenoptera acutorostrata* from West Greenland, the Northeast Atlantic and the North Sea. *Polar Biol.* 25: 907-913)

–/+ Proposal for strong new European Directive to control polluting ships

The European Commission has tabled a proposal for a new Directive that would make it a punishable offence for ships to cause marine pollution. Proposed penalties for polluting include jail sentences for whoever is responsible for the polluting offence (whether owner, captain or charter). The proposed directive would also enact punishment regardless of the flag of convenience being flown by the polluting vessel. However, there is some opposition already for the proposed directive from various transport ministers from EU nations with shipping interests.

(Source: Everett, S. 2003. EC law plan on marine pollution. *British Wildlife* 14:298)

–/+ Organochlorine contamination in North Atlantic minke whales

Organochlorine concentrations were analysed in the blubber tissue of minke whales from the North Atlantic stocks. In general, the contaminant levels were similar throughout the North Atlantic region, although there was a slight trend of increasing levels towards the eastern Atlantic. The authors suggested that a reason for these similar levels across the entire region was that, "minke whales appear quite mobile and have multiple feeding areas in the NE Atlantic".

Maximum contaminant levels (by IWC minke whale stock)

PCB (mg.kg^{-1} lipid weight) – West Greenland: 22.8; East Greenland: 1.8; Jan Mayen: 8.6; Svalbard: 5.2; Barents Sea: 11.9; Vestfjorden/Lofoten: 8.0; North Sea: 14.8.

DDT (mg.kg^{-1} lipid weight) – West Greenland: 3.3; East Greenland: 0.7; Jan Mayen: 4.7; Svalbard: 1.9; Barents Sea: 5.3; Vestfjorden/Lofoten: 6.3; North Sea: 7.8.

Chlordane (mg.kg^{-1} lipid weight) – West Greenland: 1.7; East Greenland: 1.4; Jan Mayen: 1.1; Svalbard: 0.7; Barents Sea: 2.1; Vestfjorden/Lofoten: 1.3; North Sea: 1.5.

(Source: Hobbs, K.E., Muir, D.C.G., Born, E.W., Dietz, R., Haug, T., Metcalf, T., Metcalf, C. and Øien, N. 2003. Levels and patterns of persistent organochlorines in minke whale (*Balaenoptera acutorostrata*) stocks from the North Atlantic and European Arctic. *Environ. Poll.* 121:239-252)

–/+ PCBs and organochlorine pesticides measured in St Lawrence River Estuary beluga whales

For the first time, organochlorine (OC) contaminants were measured from blubber biopsies from free-ranging beluga whales of the St Lawrence River Estuary and compared to contaminant levels recorded in previously stranded dead belugas. PCBs, DDTs, toxaphene and chlordane-related compounds were the major OC contaminants detected in 44 belugas biopsied between 1994 and 1998. Taken together, results from both biopsied whales and previously studied stranded belugas indicate that PCB and OC pesticide contamination of St Lawrence beluga whales may occur across a broader range of levels than previously thought, at least for males, which formed the largest group in this study, possibly due to different degrees of dietary exposure. It also appears that measuring contaminant concentrations only in stranded whales may overestimate OC levels in the population as a whole, especially for highly chlorinated OCs.

(Source: Hobbs, K.E., Muir, D.C.G., Michaud, R., Beland, P., Letcher, R.J. and Norstrom, R.J. 2003. PCBs and organochlorine pesticides in blubber biopsies from free-ranging St. Lawrence River Estuary beluga whales (*Delphinapterus leucas*), 1994-1998. *Environ. Poll.* 122: 291-302)

+ PCB-153 levels declined in polar bear plasma in northeast Atlantic in 1990s

PCB-153 decreased significantly in plasma collected from polar bears at Svalbard, Norway, during the 1990s. The authors conclude that plasma is the preferred medium from which to measure PCB levels, as levels are less variable than in fat or blood cells. Long-term sampling on a regular basis is essential to determine reliable trends in pollutant levels. This study may indicate a recent trend of decreasing levels of certain organochlorine contaminants in the north Atlantic marine environment.

Mean contaminant level

PCB-153 (ng g^{-1} wet weight) – 33.

(Source: Henriksen, E. O., Wiig, Ø., Skaare, J. U., Gabrielsen, G. W. and Derocher, A. E. 2001. Monitoring PCBs in polar bears: lessons learned from Svalbard. *J. Environ. Monit.* 3: 493-498)

+ "Prestige" oil spill

The sinking of the "Prestige" oil tanker had a major negative impact on the marine environment (see above). The fact that the ship involved was 27 years old and single-hulled, however, prompted transportation ministers from 15 EU nations to agree on a total ban of single-hulled oil tankers over 23 years old. Prohibition of all single-hulled tankers (whatever their age) will be phased in by 2010; for the largest ships, the ban will start in 2005. The ban applies to all ships using EU ports and to vessels flying European flags and is expected to become effective in July 2003. This accelerated phase-out is expected to decrease the risk of major oil spills in European waters.

(Submitter: IWC SC member Michael Stachowitsch, Austria, based on EU Commission document "Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EC) No. 417/2002 on the accelerated phasing in of double hull or equivalent design requirements for single hull oil tankers and repealing Council Regulation (EC) No. 2978/94", along with press and web-based sources)

HABITAT PROTECTION/DEGRADATION

– Dolphin responses to boat traffic
A positive correlation between boat traffic and breathing synchrony was recorded in bottlenose dolphins from the Moray Firth, NE Scotland. The authors speculate that the impacts of cumulative short-term responses to boat traffic in the Moray Firth may result in a significant impact for the bottlenose dolphins inhabiting the area.
(Source: Hastie, G.D., Wilson, B., Tufft, L.H. and Thompson, P.M. 2003. Bottlenose dolphins increase breathing synchrony in response to boat traffic. *Mar. Mamm. Sci.* 19:74-84)

– Change in the North Atlantic Ocean and Potential for Rapid Climate Change Events (RCCEs)
RCCEs have been well documented in earth history. One such significant RCCE that began and ended within a decade or less was the Younger Dryas, during a period of receding glaciers in the North Atlantic region. This RCCE triggered near-glacial conditions, including colder and drier tropical and subtropical climates and a shutdown of the 'conveyor belt' of dense, deep water that drives global ocean circulation. This recognition that dramatic and rapid changes in ocean circulation and climate can occur has heightened a need to monitor changes in the water circulation of the North Atlantic. This includes changes in the amount of freshwater input via increased precipitation directly to the ocean, via river discharge to the Arctic or via melting ice. In one RCCE-scenario, global warming would arrest deep-water formation in the North Atlantic with a 'cap' of fresher water, rapidly leading the earth into a colder climate. The North Atlantic region would experience severe winters for decades or centuries. In fact, over the past 40 years the North Atlantic has been freshening dramatically, especially in the past decade. Further, the flow of cold, dense water from the Norwegian and Greenland Seas into the North Atlantic has diminished by at least 20% since 1950. These findings, coupled with reports of increasing river discharge to the Arctic Ocean, are signs that a slowdown in the 'conveyor' may already exist. This would ultimately broadly impact ecosystems from polar to tropical regions, and consequently would impact cetaceans reliant on those ecosystems. In 2002, the U.S. National Academy of Sciences reported that, "available evidence suggests that abrupt climate changes are not only possible but likely in the future, potentially with large impacts on ecosystems and societies".
(Submitter: Cynthia Tynan, USA, based on work conducted at the Department of Physical Oceanography, Woods Hole Oceanographic Institution, and various published sources)

+ Reducing interactions between vessels and rights whales in Bay of Fundy, Canada
In April 2002, Transport Canada submitted a proposal to the International Maritime Organization (IMO) to amend the existing Traffic Separation Scheme (TSS) for vessel traffic in the Bay of Fundy, to reduce the potential for interaction between right whales and vessels. The TSS provides for the separation of vessel traffic between the southeastern entrance to the Bay of Fundy and the port of Saint John, New Brunswick. About 800 ships use the TSS annually, primarily tankers, bulk carriers, tugs, container ships, cruise ships and government vessels. The impact of ship strikes on right whales include massive wounds such as fractured skulls, severed tails, and large propeller slashes; collisions have been responsible for a number of deaths. A mean relative probability analysis of right whale sighting data showed that a shift in shipping lanes by about 3.9 nautical miles to the east would reduce the relative probability of a ship-whale interaction by 80%. Implementing the Transport Canada proposal will shift the traffic lanes of the northern segment to the east through areas where the population density of right whales is considerably lower. The proposal was reviewed at the 48th session of the IMO Sub-Committee on Safety of Navigation in July 2002. The proposal was approved by the Sub-Committee and forwarded to the December 2002 meeting of the Maritime Safety Committee (MSC) for adoption. The MSC adopted the proposal on December 5, 2002 and Transport Canada and the Department of Fisheries and Oceans will implement the amended TSS on July 1, 2003.
(Submitter: Moira Brown, USA and Canada, based on personal observations, the web site www.coastalstudies.org, and *Wild Earth: The Journal of the Wildlands Project*. Endangered right whales: under the shadow of ships. Volume 12 (4):49-53)

DISEASE AND MORTALITY EVENTS

– Strandings of beaked whales in the Canary Islands
On 24 September 2002 12 beaked whales, including Cuvier's beaked whales, Gervais' beaked whales, and Blainville's beaked whales, stranded in the Canary Islands. NATO naval exercises were reportedly being conducted in the area at that time.
(Source: V. Martín, post to MARMAM listserve, 28 September 2002)

+ Recovery Plan for Baltic Harbour Porpoises
The harbour porpoise is the only cetacean species native to the Baltic Sea. Its low estimated population size (600 individuals) and continued losses due to fisheries bycatch have prompted ASCOBANS to develop a Recovery Plan for Baltic Harbour Porpoises (Jastarnia Plan). By implementing precautionary management measures to reduce the bycatch, developing recovery targets and generally improving knowledge, it hopes to avert a further decline of this population. A potential future oil spill here involving antiquated single-hulled Russian oil tankers operating in winter and heavy ice has been identified as a potential threat.
(Submitter: Viivi Koomson, Finland, based on ASCOBANS website)

MEDITERRANEAN and BLACK SEA

General

– Known and potential threats to cetaceans in the Mediterranean and Black Seas
In February 2002 a review presented to ACCOBAMS determined that cetacean mortality inflicted by human activities included:
(i) Intentional and directed takes, (ii) fishing gear/activities, (iii) ship strikes and (iv) general habitat degradation, which included:
(i) Prey depletion, (ii) contamination by chemical pollutants, (iii) oil pollution, (iv) marine debris, (v) noise pollution, (vi) disturbance, (vii) ecosystem and climate change and (viii) epizootics.
The factors considered to be major and secondary threats to various species are summarized below:
Mediterranean and Black Sea
Fin whale: vessel collisions (primary);
disturbance (secondary).

Sperm whale:	fishing gear/activities, vessel collisions (primary); disturbance (secondary).
Cuvier's beaked whale:	noise pollution (primary); disturbance, marine debris (secondary).
Long-finned pilot whale:	fishing gear/activities (primary); disturbance (secondary).
Risso's dolphin:	disturbance (secondary).
Striped dolphin:	fishing gear/activities, chemical pollution (primary); directed takes, prey depletion, disturbance (secondary).
Mediterranean Sea	
Bottlenose dolphin:	directed takes, prey depletion, chemical pollution (primary); fishing gear/activities, disturbance (secondary).
Common dolphin:	prey depletion, chemical pollution (primary); fishing gear/activities, disturbance (secondary).
Black Sea	
Bottlenose dolphin:	ecosystem and climate change (primary); directed takes, fishing gear/activities, marine debris, disturbance (secondary).
Common dolphin:	fishing gear/activities, prey depletion, chemical pollution, ecosystem and climate change (secondary).
Harbour porpoise:	fishing gear/activities, chemical pollution, disturbance, ecosystem and climate change (primary); Prey depletion (secondary).

(Source: Notarbartolo di Sciara, G., Aguilar, A., Bearzi, G., Birkun, A., jr and Frantzis, A. 2002. Overview of known or presumed impacts on different species of cetaceans in the Mediterranean and Black Seas. In *Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies* (ed. G. Notarbartolo di Sciara), Section 17, Report to the ACCOBAMS Secretariat, Monaco)

CHEMICAL POLLUTION

– Effects of endocrine disrupters in striped dolphins, common dolphins and fin whales of the Mediterranean Sea

Levels of endocrine (hormone) disrupting PHAHs in a top predator of the Mediterranean, the striped dolphin, were 1-2 orders of magnitude higher than in Atlantic and Pacific individuals of the same species. Non-lethal skin biopsies were used to look at contaminants and biomarkers in Mediterranean cetaceans. BPMO (Benzo (a)pyrene monoxigenase) activity in biopsy samples was found to be a good indicator of levels of DDTs, *pp*'DDE, *op*'DDT, total PCBs and PCB congener 153 in male specimens of common dolphins. The results also suggest that endocrine disrupting compounds may be a major stress factor for common dolphin populations in the Mediterranean Sea. Similar results were obtained in fin whales sampled in the Ligurian Sea from 1992 to 1995, between BPMO activity and organochlorine levels in skin biopsy specimens for males (but not females or males and females together).

(Source: Fossi, M.C. and Marsili, L. 2002. Effects of endocrine disrupters in aquatic mammals. SCOPE/IUPAC International Symposium on Endocrine Active Substances, November 17-21, 2002, Yokohama, Japan. 13 pp)

– Ecotoxicological status of a SW Mediterranean population of striped dolphins

A geographical trend of contamination was found for striped dolphins with PCB and DDT levels increasing from the SE (Ionian Sea) to the north (Ligurian Sea). Skin biopsies were used to investigate bioaccumulation of organochlorines and toxic PCDDs (polichlorodibenzo-p-dioxins), PCDFs (polichlorodibenzofurans) and trace elements (Hg, Cd, Pb), as well as investigate levels of BPMO (mixed function oxidase) activity (a biomarker for pollutant contamination) in cetaceans around the Eolian Islands in summer 2002. The BPMO activity value (and therefore level of pollutant contamination) was approximately 3 times higher than the values found in the Ionian and 5 times lower than values recorded in Ligurian Sea cetaceans.

Mean level

BPMO activity (A.U.F.g tissue^{-1}/h) – 43.40.

(Source: Fossi, M.C., Marsili, L., Lauriano, G., Fortuna, C., Canese, S., Neri, G., Ancora, S., Leonzio, C., Romeo, T. and Jiménez, B. 2003. Preliminary assessment of ecotoxicological status of a SW Mediterranean segment population of striped dolphin (*Stenella coeruleoalba*) using skin biopsy. Paper presented at PRIMO (Pollution Responses In Marine Organisms) 12, Florida, U.S.A., May 2003)

– Evaluating toxicological hazards of organochlorine contaminants in Mediterranean cetaceans

Significant differences in total levels of organochlorine (OC) contamination with endocrine (hormone) disruption potential were found between toothed and baleen whales. Highest mean levels were found in striped dolphins, followed by bottlenose dolphins, then common dolphins. Differences in organochlorine bioaccumulation, metabolic responses and consequently potential risk from endocrine disruption were primarily related to different positions in the marine food chain. In addition, high levels of a DDT metabolite that is a potent oestrogen-mimic and anti-androgen were detected in fin whales and this could affect the already low reproductive rate of this whale species. Total DDT levels (5169 ng.g^{-1} wet weight) in Mediterranean Sea fin whales were over 12 times higher than found in bowhead whales from Barrow, Alaska that exhibited pseudohermaphroditism, emphasising the potential threat that hormone-disrupting organochlorine pollutants pose to these marine mammals.

Maximum contaminant levels

OC-EDCs (µg.g^{-1} fresh weight) – Striped dolphins: 40.0; bottlenose dolphins: 24.3; common dolphins: 15.0.

(Source: Fossi, M.C., Marsili, L., Neri, G., Natoli, A., Politi, E. and Panigada, S. 2003. The use of a non-lethal tool for evaluating toxicological hazard of organochlorine contaminants in Mediterranean cetaceans: new data 10 years after the first paper published in MPB. *Mar. Poll. Bull.*: in press)

– Elevated lead levels in small cetaceans

Tissue samples were analysed from long-finned pilot whales and bottlenose dolphins, striped dolphins, Risso's dolphins and common dolphins stranded on the Corsican coast. Levels of cadmium, copper and zinc were generally comparable to concentrations recorded in animals from UK or Australian waters, although cadmium concentrations in the Mediterranean pilot whales were considerably lower. Lead concentrations in the Mediterranean animals, however, were often an order of magnitude higher than the studies used in comparison.

Maximum contaminant levels
Trace elements (mg.kg^{-1} dry weight) – bottlenose dolphin: Cd: 10; Cu: 46; Pb: 18; Zn: 1107; striped dolphin: Cd: 27; Cu: 28; Pb: 18; Zn: 660; Risso's dolphin: Cd: 63; Cu: 11; Pb: 10; Zn: 874; pilot whale: Cd: 47; Cu: 31; Pb: 21; Zn: 1472; common dolphin: Cd: 5.2; Cu: 30; Pb: 18; Zn: 971.
(Source: Frodello, J.P. and Marchand, B. 2001. Cadmium, copper, lead, and zinc in five toothed whale species of the Mediterranean Sea. *Int. J. Toxicol.* 20: 339-343)

– Elevated mercury levels in Cuvier's beaked whale
Tissue samples were analysed from a single Cuvier's beaked whale stranded on the coast of Corsica. Unremarkable concentrations of lead, cadmium, copper and zinc were recorded, with cadmium levels being lower than those found in the same species in other locations. Total mercury concentrations were very high, higher than previously reported for this species. The authors stated that the high levels of mercury found in the whale may have "play[ed] a part in the death" of the animal.
Maximum contaminant levels
Trace elements (mg.kg^{-1} dry weight) – Cd: 46; Cu: 34; Hg: 27; Pb: 4.2; Zn: 688; Hg: 4730.
(Source: Frodello, J. P., Viale, D. and Marchand, B. 2002. Metal levels in a Cuvier's beaked whale (*Ziphius cavirostris*) found stranded on a Mediterranean Coast, Corsica. *Bull. Environ. Contam. Toxicol.* 69: 662-666)

– Fluorinated hydrocarbons in cetaceans from the Mediterranean Sea
Toxic pollutant PFOS (Perfluorooctanesulfonate; $C_8F_{17}SO_3^-$) and related fluorinated hydrocarbons were detected in bottlenose dolphins, striped dolphins, common dolphins, fin whales, and long-finned pilot whales from the Italian coast of the Mediterranean Sea. Concentrations of PFOS in blood were higher in bottlenose dolphins than fish such as tuna or swordfish. A significant positive correlation existed between the PFOS concentrations in liver and blood, which indicates that blood can be used for non-lethal monitoring of PFOS concentrations in other organs. FOSA (Perfluorooctanesulfonamide; $C_8F_{17}SO_2NH_2$) was also found in 14 of 19 livers or blood samples of marine mammals from the Mediterranean Sea. The highest concentration of FOSA was found in the liver of a common dolphin. PFOS was a widespread contaminant in marine wildlife from the Baltic and the Mediterranean Seas, while FOSA and PFOA (perfluorooctanoate; $C_7F_{15}CO_2^-$) had a sporadic spatial distribution, whilst the fluorinated hydrocarbon PFHxS (perfluorohexanesulfonate; $C_6F_{13}SO_3^-$) was not found in most of the samples analysed.
Maximum contaminant levels
Fluorinated hydrocarbons (ng .g^{-1} wet weight) – PFOS: 940; FOSA: 878; PFOA: <72; PFHxS: 6.8.
(Source: Kannan, K., Corsolini, S., Falandysz, J., Oehme, G., Focardi, S. and Giesy, J.P. 2002. Perfluorooctanesulfonate and related fluorinated hydrocarbons in marine mammals, fishes, and birds from coasts of the Baltic and the Mediterranean Seas. *Environ. Sci. Tech.* 36:3210-3216)

– Elevated heavy metal concentrations and ingested plastic bags in a Risso's dolphin stranded on the coast of Israel (eastern Mediterranean)
High concentrations of the trace elements Hg, Cd, Zn, Fe and Sc were reported the tissues of an initially live-stranded Risso's dolphin. Although the cause of death was attributed to bacterial bronchopneumonia in combination with endotoxemia, plastic bags found in its stomach contributed to the dolphin's poor physical condition. However, no connection was found between the high concentrations of trace metals in the internal organs and the cause of death.
Editor's note: This study presents data from an area where there has been relatively little information collected on cetacean contaminant loads.
(Source: Shoham-Fridler, E., Amiel, S., Roditi-Elasar, M. and Kress, N. 2002. Risso's dolphin (*Grampus griseus*) stranding on the coast of Israel (eastern Mediterranean): autopsy and trace metal concentrations. *Sci. Total Environ.* 295:157-166)

– /+ Polycyclic aromatic hydrocarbons (PAHs) in Mediterranean striped dolphins and fin whales
Potentially toxic and carcinogenic polycyclic aromatic hydrocarbon (PAH) levels were examined in free-ranging Mediterranean cetaceans. In 1991, in the Mediterranean Sea, in the area of the newly established International Sanctuary for Cetaceans, two oil spills occurred, discharging between 46,000 and 66,000 tonnes of crude oil in 12 hours. PAHs are derived from fossil fuel products; therefore, PAH values in cetaceans were measured after these spills. Blubber samples were collected by biopsy from live specimens of fin whales in the Ligurian Sea and striped dolphins in the Ligurian and the Ionian Seas. PAH concentrations in striped dolphins were higher than in fin whales, probably due to the different positions they take in the Mediterranean food web. PAH concentrations seemed to be strongly related to the presence of high levels of PAHs still present in the environment, less than 18 months after the oil spills in the Ligurian and Tyrrhenian Seas.
MAXIMUM CONTAMINANT LEVELS
Total PAHs (ng.g^{-1} fresh weight) – fin whales: 1970 [carcinogenic PAHs 89.90]; striped dolphins: 29,500 [carcinogenic PAHs 676.00].
(Source: Marsili, L., Caruso, A., Fossi, M.C., Zanardelli, M., Politi, E. and Focardi, S. 2001. Polycyclic Aromatic Hydrocarbon (PAHs) values in the subcutaneous biopsies of Mediterranean cetaceans. C*hemosphere* 44: 147-154)

–/+ Levels and toxicity of PCBs in the blubber of the South Adriatic bottlenose dolphin
PCB congener concentrations were determined in the blubber of nine bottlenose dolphins stranded along the southeastern Italian coast. On the basis of the levels of total PCBs, there was considered to be no health risk to the individuals. However, the concentrations of some toxic (non-ortho coplanar) PCBs in the samples analysed were higher than those associated with the morbillivirus epizootic in the Mediterranean Sea. The potential toxicity (TCDD equivalent or TEQ) of the PCB congeners was also calculated. Overall, these results suggest that although the levels of total PCB are quite low, the potential risk of pollution for cetaceans remains high, because of the consistent high toxicity (TEQ) value. However, this study only looked at a sub-set of the possible toxic pollutants, and did not look at the toxic effects combinations of chemicals might have.
Total contaminant levels
PCB (µg.g^{-1} wet weight) – 3.53 to 24.4; TEQ (pg.g^{-1}) – 45596.
(Source: Storelli, M.M. and Marcotrigiano, G.O. 2003. Levels and congener pattern of polychlorinated biphenyls in the blubber of the Mediterranean bottlenose dolphins *Tursiops truncatus*. *Environ. Internat.* 28:559-565)

HABITAT PROTECTION/DEGRADATION

– Increasing levels of human activities in the Mediterranean

In February 2002 a report presented to ACCOBAMS stated that the "concentration of human populations and activities around the Mediterranean present considerable threats to the marine and coastal environment…the situation, however, is likely to get worse."

- It is estimated that the current population of Mediterranean states (450 million) will rise to 520-570 million by 2030, and 600 million by 2050.
- Although the Mediterranean comprises only 0.8% of the world's surface, it carries 15% of the world's shipping and 30% of all ship-transported oil.
- Between 1980 and 1992, the number of fishing vessels increased by 20%.
- Between 1984 and 1996, aquaculture production increased from 78,000 tonnes to 248,500 tonnes.
- 60% of urban waste dumped in the Mediterranean is still untreated.
- "The rate of introduction of foreign, often noxious substances cannot be overcome by its water turnover rate."

The report also stated, "The Black Sea is widely recognized as one of the regional seas most damaged by human activities". The United Nations Black Sea Environment Programme noted "particularly acute problems have arisen as a result of pollution (notably from nutrients, faecal material, solid waste and oil), a catastrophic decline in commercial fish stocks, a severe decrease in tourism and an uncoordinated approach towards coastal zone management. Increased loads of nutrients from rivers caused an over production of phytoplankton leading to extensive eutrophication and often extremely low dissolved oxygen concentrations. The entire ecosystem [is beginning] to collapse". The report stated that cetaceans were exposed to a variety of threats deriving from human activities including: (i) direct exploitation, (ii) bycatch, (iii) competition and culls, (iv) habitat loss and degradation, (v) contaminants and (vi) disturbance from boat traffic. In addition new or previously unrecognised factors were highlighted including: (i) the effects of global climate change, (ii) reduced prey availability, (iii) contamination of the food web by algal toxins, (iv) vessel collisions, (v) noise pollution and (vi) disturbance by unregulated whale watching. It was pointed out that "threats to cetacean survival can be particularly severe in the Mediterranean and Black Seas, due to the enclosed and semi-enclosed natures of such basins, and to the human density and intensity of activities".

(Source: Notarbartolo di Sciara, G. 2002. Conservation problems: overview. In *Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies* (ed. G. Notarbartolo di Sciara), Section 4, Report to the ACCOBAMS Secretariat, Monaco, February 2002)

+ Re-emergence of harbour porpoise stock thought locally extirpated

Although historically recorded in the 19th century, no harbour porpoises were thought to remain in the northeastern Aegean Sea/Mediterranean basin. However, several strandings discovered since 1997, including a March 2003 stranding, and several undocumented sightings in recent years seem to indicate a remnant stock remains in the NE Aegean.

(Source: Aimilia Drougas, Greece, post to MARMAM listserve, 28 March 2003)

+ Black Sea bottlenose dolphin population given zero quota at CITES

A proposal was submitted at the 2002 CITES meeting to list the declining population of the Black Sea bottlenose dolphin – a population depleted by direct takes, habitat loss, and a decline in habitat quality – on Appendix I of CITES. This would have banned all commercial trade in animals taken from this population. Although the proposal was defeated, the population was retained on Appendix II with a zero quota on the export of live dolphins wild-captured in the Black Sea (for primarily commercial purposes).

(Source: Simmonds, M.P. 2003. The Black Sea bottlenose dolphin – what next? Paper SC/55/SM12 presented to the IWC Scientific Committee, Berlin, Germany and ACCOBAMS web page)

+ Establishment of marine reserves in Spain

Two new marine reserves have been established in Spain. The first is located in the Atlantic Ocean: the Marine Reserve of La Palma (Tenerife), Canary Islands. The second is located in the Mediterranean: the Marine Reserve of Cabo de Gata-Nijar (Almeria). These two relatively small (< 100 km²) reserves will be provided with surveillance and maintenance services and be protected from fisheries, an action that is recognized worldwide to boost invertebrate and fish populations both within and outside reserve boundaries. This is expected to have a positive effect on marine organisms higher up in the food chain, including cetaceans.

(Submitter: IWC SC member Santiago Lens, Spain, based on a report of the Spanish Ministry of Agriculture, Fisheries and Food)

GLOBAL

Chemical pollution

– Heavy metals can be transferred to bottlenose dolphin calves via milk

This study demonstrated that the metals mercury, lead, copper and zinc can pass from the tissues of a bottlenose dolphin mother to her calf via her milk.

Editor's note: This finding could potentially have important consequences effecting calf mortality and cetacean recruitment rates in cetacean species in contaminated environments.

(Source: Frodello, J.P., Viale, D. and Marchand, B. 2002. Metal concentrations in the milk and tissues of a nursing *Tursiops truncatus* female. *Mar. Poll. Bull.* 44: 551-576)

– Tributyltin (TBT) exposure may aggravate PCB effects

PCBs affect levels of the enzyme cytochrome P450. A study on fish exposed to TBT demonstrated that cytochrome P450 content decreased with increasing TBT concentration. The study suggested that TBT contamination could aggravate biochemical effects of chemicals such as PCBs. This result has direct and indirect implications for marine mammals, including cetaceans.

(Source: Shim, W.J., Jeon, J.K., Hong, S.H., Kim, N.S., Yim, U.H., Oh, J.R. and Shin, Y.B. 2003. Accumulation of tributyltin in olive flounder, *Paralichthys olivaceus*: its effect on hepatic cytochrome P450. *Archives Environ. Contam. Toxicol.* 44:390-397)

– Mercury pollution worldwide

A report was released by UNEP on mercury and its chemistry, toxicology, human exposure, impacts on the environment, sources and cycling, production and uses, prevention of release and control measures, as well as an identification of information gaps and future issues regarding all types of mercury globally. Although the report does not focus on cetaceans, it documents the effects of mercury on other species and impacts to all ecosystems. It also points out the potential of newly flooded areas to aid in the mobilisation of mercury though increased methylation and stresses that, as a result, aquatic food chains tend to have higher Hg levels. Accordingly, whales are shown to have the largest range of Hg levels in muscle, liver and kidney tissue. The report notes that mercury levels in beluga whales in the Arctic have quadrupled in a 25-year period.
(Source: UNEP. 2002. *Global Mercury Assessment.* UNEP Chemicals, Geneva, Switzerland)

+ Arsenic levels in marine mammals measured for first time

Arsenic concentrations were determined in livers of 226 individuals representing 16 different marine mammal species, to elucidate its accumulation with age, sex and feeding habits. Samples were taken from the Black Sea, Atlantic Canada, Lake Baikal and the Caspian Sea, as well as from the Pacific. The authors believe that this is the first comprehensive comparative examination of arsenic levels in marine mammals. Future studies should compare their values to those found in this study in order to observe potential trends in contaminant levels.
MEAN CONTAMINANT LEVEL *(FOR ALL CETACEAN SPECIES EXAMINED)*
Ar (μg g^{-1} dry weight) – 2.77 ± 1.17
(Source: Kubota, R., Kunito, T. and Tanabe, T. 2001. Arsenic accumulation in the liver tissue of marine mammals. *Environ. Poll.* 115: 303-312)

+ New technique development: a biomarker to assess dioxin and PHAH susceptibility

In order to assess susceptibilities to concentrations of the highly toxic dioxin TCDD (2,3,7,8- Tetrachlorodibenzo-*p*-dioxin) and related PHAHs (planar halogenated aromatic hydrocarbons), the characteristics of AHR (Aryl Hydrocarbon Receptor) – a regulatory protein that binds to and mediates the effects of TCDD – were investigated in the harbour seal. The study discovered that seal AHR (which was closely related to beluga whale and human AHR) bound to PHAHs, suggesting that harbour seals may be susceptible to PHAH effects. The study suggested that AHR characteristics can be used as a biomarker to investigate susceptibility to dioxin-like compounds and make an "assessment of the risk of these compounds to marine mammals and other protected animals".
(Source: Kim, E. and Hahn, M. E. 2002. cDNA cloning and characterization of an aryl hydrocarbon receptor from the harbor seal (*Phoca vitulina*): a biomarker of dioxin susceptibility. *Aquatic Toxicol.* 58: 57-73)

Climate change

– 2002 was the second hottest year on record

In December 2002 the World Meteorological Organization determined that 2002 was the second warmest year on record (with 2001 being the third warmest year). The year 1998 remains the warmest (for both land and sea surface areas) since records began in 1860. The trend for increasing world temperatures has implications for the distribution and status of cetaceans and their prey species.
(Source: Environment News Service, 18 December 2002 and ACCOBAMS website)

– Global warming already causing visible changes in world's ecosystems

Despite being only at an early stage of the projected increase in the world's temperature through global warming, there is now ample and visible evidence of ecological changes as a result of climate change, from polar caps to tropical marine environments. The level of impact for these changes in ecosystems ranges from single species to entire ecological communities and have significant implications for the marine environment.
(Source: Walther, G.R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T.J.C., Fromentin, J.M., Hoegh-Guldberg, O. and Bairlein, F. 2002. Ecological responses to recent climate change. *Nature* 416: 389-395)

– Hypoxia as a growing problem for the marine environment

Hypoxia is a reduction in oxygen contained in water typically caused by algal blooms and usually the result of human-related introductions of excess nutrients into the aquatic environment. Hypoxia currently affects thousands of km^2 of marine waters all over the world. The severity, frequency occurrence and spatial scale of hypoxia have increased in the last few decades and the situation is likely to worsen due to rapid human population growth and global warming. Hypoxia reduces growth and feeding, which may debilitate animals or completely eliminate sensitive species, thereby causing major changes in species composition of benthic, fish and phytoplankton communities. Decreases in species diversity and species richness are well-documented results of hypoxia. Moreover, the phenomenon has caused mass mortality of marine animals and a decline in fisheries production in many places in the world. Such impacts on prey communities will directly affect cetaceans.
(Source: Wu, R.S.S. 2002. Hypoxia: from molecular responses to ecosystem responses. *Mar. Poll. Bull.* 45:35-45)

Disease and mortality events

– Elevated levels of trace element linked to mass mortality involving Caspian seals

Tissue samples were taken from healthy Caspian seals in 1998 and compared to animals infected with canine distemper virus that stranded in 2000 on the coast of the Caspian Sea. Concentrations of many toxic elements in the stranded animals were comparable or lower than healthy animals. However, levels of zinc and iron were much higher in diseased animals. In addition, decreasing seal blubber thickness was correlated with increasing zinc levels in kidney tissue. The results "indicate a disturbance in Zn homeostasis in these animals".
Editor's note: These results have global application to marine mammals.
Maximum contaminant levels
Trace elements (mg.kg^{-1} wet weight) – Ag: 0.083; As: 0.33; Cd: 20.3; Co: 0.043; Cr: 0.252; Cu: 11.0; Hg: 27; Org-Hg: 2.8; Mn: 12.5; Mo: 0.737; Pb: 0.084; Se: 13.0; Tl: 0.056; V: 0.24; Fe: 1800; Zn: 166
(Source: Anan, Y., Kunito, T., Ikemoto, T., Kubota, R., Watanabe, I., Tanabe, S., Miyazaki, N. and Petrov, E. A. 2002. Elevated concentrations of trace elements in Caspian Seals (*Phoca caspica*) found stranded during the mass mortality events in 2000. *Arch. Environ. Contam. Toxicol.* 42: 354-362)

NOISE IMPACTS

– Noise from whale-watching boats

High-speed boats could contribute to permanent hearing loss in killer whales. A model used to predict the effects of noise generated by boats on killer whales predicted that, for boats travelling faster than 10 knots, the distances from the source for sound to be audible, have a masking effect and to induce a behavioural response were 16km, 14km, and 200 metres respectively. The exposure time required to cause a 5dB temporary threshold shift in hearing was an estimated 30-35 minutes, for animals within 450 metres of the vessel. These effects would be reduced for boats travelling at lower speeds. It was postulated by the author that exposure to boat noise for prolonged periods had the potential to induce permanent hearing loss. Thus, high-speed vessels circling animals were considered to be a cause for concern.

(Source: Erbe, C. 2002. Underwater noise of whale watching boats and potential effects on killer whales (*Orcinus orca*) based on an acoustic impact model. *Mar. Mamm. Sci.* 18:394-418)

– Underwater noise from wind farms and harbour porpoises

Sound levels produced from 3 different types of wind turbines were compared with a harbour porpoise audiogram. For the harbour porpoise the noise level at 315Hz from a 450kW Bonus turbine, was 17dB above the expected porpoise hearing threshold. It was estimated that the maximum detection distance for porpoises from the turbines at that frequency was 50m. It was noted that noise from different wind turbines will be audible at different distances over different frequencies and detection distances would also be dependent on local conditions and ambient noise.

(Source: Henriksen, O.D., Teilmann, J., Dietz, R. and Miller, L. 2001. Does underwater noise from offshore wind farms potentially affect seals and harbour porpoises? Poster presented at the 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, Canada, November 2001)

– Acoustic harassment devices (AHDs) displace killer whales from preferred habitat

Two independent studies on the natural history of killer whales monitored the occurrence of killer whales from January 1985 through December 2000 in two adjacent areas: Johnstone Strait and the Broughton Archipelago in British Columbia, Canada. Extremely loud acoustic harassment devices (AHDs) were installed and operated through 1993 on salmon farm net pens in the Broughton Archipelago, to deter harbour seals from the nets. When the AHDs were in use, whales were displaced from the Archipelago (declined significantly in number) to the Strait (increased significantly in number). In 1999, AHDs were removed, and whale occurrence returned to pre-1985 baseline levels. This study concluded that the deliberate introduction of loud noise to their environment displaced killer whales. This result has universal application to marine mammals in a number of environments with introduced noise sources.

(Source: Morton, A.B. and Symonds, H. 2002. Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada. *ICES J. Mar. Sci*. 59:71-80)

– AHDs cause a decline in porpoise abundance

Harbour porpoise abundance declined precipitously when AHDs ('seal scrammers' or scarers) were activated in British Columbia, Canada. Studying porpoise movements suggested that the few porpoises that ventured into the study area spent less time within it when the AHD was activated. No porpoises were observed within 200m of the AHD when it was activated. The effect of the AHD diminished with distance. The number of sightings and re-sightings observed when the AHD was activated was less than 0.2% of the number expected had there been no AHD effect at a range of 200-399 m. Even at a range of 2,500-3,500 m from the AHD, only 3.3% of the number of expected sightings was recorded. These data strongly suggest that the impact of AHDs on harbour porpoises extends beyond 3.5 km from the site of an AHD. This study illustrates the "law of unintended consequences" when AHDs are used to deter seals.

(Source: Olesiuk, P.F., Nichol, L.M. and Ford, J.K.B. 2002. Effect of sound generated by an acoustic harassment device (AHD) on the relative abundance and distribution of harbour porpoise (*Phocoena phocoena*) in Retreat Passage, British Columbia. *Mar. Mamm. Sci.* 18: 843-862)

– Stranding of two Cuvier's beaked whales after seismic testing

On 25 September 2002, five marine mammal scientists were vacationing in the Gulf of California (Mexico), when they found two freshly dead Cuvier's beaked whales. The animals showed no signs of external trauma. The researchers subsequently learned that the R/V *Maurice Ewing* (operated by Columbia University, Lamont-Doherty Earth Observatory) was nearby conducting a seismic survey using an airgun array. The animals originally live-stranded on 24 September. One animal was necropsied on 27 September, but was already in an advanced state of decomposition. However, this observation joins a growing number of strandings correlated with high-intensity anthropogenic acoustic activities/events. The seismic research associated with this event in the Gulf of California produced higher intensity sounds (263 dB re: 1µPa at 1m) than the tactical sonar involved in a mass beaked whale stranding incident in the Bahamas in March 2000, although the frequencies involved were lower (circa 100 Hz). This event was the first observation implicating low-frequency seismic exploration in whale strandings. The potential risk to beaked whales is greatly increased if both low and mid frequencies prove injurious.

(Submitter: IWC Scientific Committee member Barbara Taylor, USA, based on personal observations)

–/+ Underwater sounds from human activities in a cetacean marine protected area

Sounds were recorded near Sha Chau island, Hong Kong, China, an important habitat for Indo-Pacific humpback dolphins. The results of the study showed that "the Sha Chau area is normally noisy underwater, with the lowest broadband levels measured corresponding to those expected during a storm at sea (sea state 6)". Noise came from the directly adjacent Urmston Road shipping channel and from tankers for an aviation fuel-receiving terminal situated on the coast of Sha Chau. Dolphin conservation measures require that fuelling terminal vessels should not produce noise levels greater than 110 dB (re 1µPa^2/Hz) at frequencies above 330Hz, at distances of greater than 300m. The authors noted "the Sha Chau area…is a highly noisy environment, and we suspect that hearing threshold shifts, physiologic damage to hearing, and masking of biologically meaningful sounds may well be occurring simultaneously". Few studies have been conducted in such detail on anthropogenic noise pollution in coastal waters, and this is one of the first studies looking at this issue in a marine protected area for cetaceans.

Tanker noise levels

141 dB re 1µPa at 100Hz, 100m from the sound source

146 dB re 1µPa at 10-20 kHz broadband, 100m from the sound source

Editor's note: The study area was within the Sha Chau/ Lung Kwu Chau Marine Park, a protected area established to conserve Indo-Pacific humpback dolphins in Hong Kong.

(Source: Würsig, B. and Greene, C.R. jr. 2002. Underwater sounds near a fuel receiving facility in western Hong Kong: relevance to dolphins. *Mar. Environ. Res.* 54: 129-145)

HABITAT PROTECTION/DEGRADATION

– Vessel collisions and the risk to cetaceans

A review of data detailing collisions between vessels and whales was conducted. In order of frequency, from highest to lowest, fin whales, right whales, humpback whales, sperm whales, and gray whales are commonly hit. Ships equal to or greater than 80m in length cause most lethal or severe injuries. Most lethal or severe injuries involve ships travelling 14 knots or faster. Ship strikes can significantly affect small populations of whales, such as the North Atlantic right whale.

(Source: Laist, D.W., Knowlton, A. R., Mead, J.G., Collet, A.S. and Podesta, M. 2001. Collisions between ships and whales. *Mar. Mamm. Sci.* 17: 35-75)

`– World fish stocks critically depleted

A study analysing decreases in fish biomass around the world determined that current large predatory fish biomass is at only 10% of pre-exploitation levels. Furthermore, the study noted that it took a mere 15 years of exploitation for fish biomass to decline by 80%. Severe declines were particularly noted in just 3-5 years for fishing operations on continental slopes and seamounts. South Georgia was highlighted as an area that was effectively fished down within 2 years of the start of exploitation. The authors conclude that, "declines of large predators in coastal regions have extended throughout the global ocean, with potentially serious consequences for [marine] ecosystems".

(Source: Myers, R.M. and Worm, B. 2003. Rapid worldwide depletion of predatory fish communities. *Nature* 423:280-283)

Species glossary

Sperm whale	*Physeter macrocephalus*	Harbour porpoise	*Phocoena phocoena*
Blue whale	*Balaenoptera musculus*	Dall's porpoise	*Phocoenoides dalli*
Fin whale	*Balaenoptera physalus*	Burmeister's porpoise	*Phocoena spinipinnis*
Minke whale	*Balaenoptera acutorostrata*	Tucuxi	*Sotalia fluviatilis*
Bowhead whale	*Balaena mysticetus*		
Gray whale	*Eschrichtius robustus*	Caspian seal	*Phoca caspica*
Right whale	*Eubalaena borealis*	Harbour seal	*Phoca vitulina*
Cuvier's beaked whale	*Ziphius cavirostris*	Ringed seal	*Phoca hispida*
Gervais' beaked whale	*Mesoplodon europaeus*		
Blainville's beaked whale	*Mesoplodon densirostris*	Polar bear	*Ursus maritimus*
Beluga (white) whale	*Delphinapterus leucas*		
Long-finned pilot whale	*Globicephala meleas*	Sea otter	*Enhydra lutris*
Kill whale	*Orcinus orca*		
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Rhesus monkey	*Macaca mulatta*
Dusky dolphin	*Lagenorhynchus obscurus*		
Bottlenose dolphin	*Tursiops truncatus*	Tuna	*Thunnus* spp.
Common dolphin	*Delphinus delphis*	Swordfish	*Xiphias gladius*
Risso's dolphin	*Grampus griseus*		
Striped dolphin	*Stenella coeruleoalba*	Common mussel	*Mytilus edulis*
Indo-Pacific humpback dolphin	*Sousa chinensis*		

GLOSSARY OF TERMS

ACCOBAMS: Agreement on Conservation and Cetaceans in the Black and Mediterranean Seas.
Ag: Silver
AHDs: Acoustic harassment devices, loud noise sources used to deter (displace) predators such as seals or sea lions from fish concentrations of interest to people, such as in fish farm pens or by dams.
Algal bloom: A sudden increase in concentration of aquatic plant life (algae). Often associated with increased nutrient levels resulting from human activities. See eutrophication.
Androgen: A male hormone.
Aquaculture: Finfish or shellfish farming.
As: Arsenic
ASCOBANS: Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas.
Benthic: Referring to the ocean bottom.
Biomass: The mass (weight) of all living material in an ecosystem. Can be subdivided, *e.g.*, fish biomass, plant biomass.
Biopsy: Removal of tissue or cells from the living body for non-lethal examination or study, especially for diagnostic purposes.
Bq: Becquerel, a measure of radioactivity based on number of nuclear disintegrations per second.
BPMO: Benzo (a)pyrene monoxigenase.
Bronchopneumonia: A lung disease caused by bacteria.
Butyltin: Chemical used in paints formulated to prevent the growth of algae and the settling of marine animals on ship hulls – a variant is tributyltin.
Carcinogenic: Cancer-causing.
Cd: Cadmium
Chlordane: An organochlorine pesticide.
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.
Co: Cobalt
Congener: Chemically, any one of up to several hundred different forms of a particular class of chemical, *e.g.*, PCBs.
Cr: Chromium
Cs: Caesium. The radioactive isotope of the element caesium (Cs 137) is not naturally present in the environment and is therefore often used as an indicator of radioactive pollution (nuclear weapons testing, nuclear reprocessing plants) in the marine ecosystem. It has a half-life of 30 years.
Cu: Copper
Cytochrome: A class of enzymes important to metabolic functions.
dB: Decibel, a measure of sound level (volume or intensity), measured in a logarithmic (geometric) scale. An increase of 10 dB indicates a 10-fold increase in loudness; an increase of 20 dB indicates a 100-fold increase in loudness.
DDE: 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene. A product of the breakdown of DDT.
DDT: The organochlorine pesticide [1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane] that tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.
Dioxin: A class of extremely toxic organic compounds.
Dry weight: Dry weight, as opposed to wet weight, is a basis of measurement whereby concentrations of a substance are compared with dry content (*i.e.*, all water is removed) of a material.
Endotoxemia: A condition associated with the presence of certain toxins and bacteria in the blood. Can lead to shock.
Epizootic: The animal equivalent of a disease 'epidemic'.
Eutrophication: An enrichment of the aquatic environment with nutrients (frequently the result of human activities), typically resulting in excessive plant growth and a resulting deficiency in oxygen. See algal bloom.
Fe: Iron
Hg: Mercury
Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second.
Immunotoxic: Damaging to the immune system.
kW: Kilowatt, a measure of energy output.
Lipid weight: A basis of measurement whereby concentrations of a substance are compared with the lipid (fat) content of a material.
MARMAM: Moderated email discussion listserve, established in 1993, which focuses on marine mammal research and conservation, run through the University of Victoria.
Mn: Manganese
Masking effect: In the context of this report, the phenomenon by which biologically important sounds are 'drowned out' by man-made noise.
Methylation: The addition of an organic methyl (CH_3) group to a molecule.
µPa: Micropascal, a unit of measurement for pressure, typically used when measuring sound levels in decibels.
Mo: Molybdenum
Morbillivirus: A family of viruses that are typically highly infectious and pathogenic – the family includes measles, dog distemper and dolphin morbillivirus. A number of mass mortality events have been associated with viruses from this family.
NGO: Non-governmental organization.
Non-ortho coplanar: A class of shapes taken by some organic compounds, *e.g.*, some PCBs. These types of PCBs are of concern, as they have toxic effects similar to dioxins.
OC-EDCs: Organochlorine endocrine disrupting compounds.
Oestrogen: A female hormone.
Organochlorines: Organic compounds that contain chlorine. Many are toxic and are used as pesticides. Most of these compounds persist in the environment (are not biodegradable) and also tend to accumulate in fatty tissue (*e.g.*, blubber) of cetaceans and other marine organisms.
Organotin: An organic molecule containing tin, *e.g.*, TBT.
Pb: Lead
PCBs: Polychlorinated biphenyls (209 different forms or congeners that contain differing numbers of chlorine atoms arranged in various positions on the aromatic rings) are industrial organochlorines that were manufactured to be used in electrical transformers and other applications. These man-made chemicals do not occur naturally and all traces reflect pollution.
PHAHs: Planar halogenated aromatic hydrocarbons.
Phytoplankton: The plant (photosynthesising) component of plankton (free-floating marine organisms – the animal component is zooplankton).
Plasma: Fluid (non-cell) component of blood. Mostly water, but also contains hormones, antibodies, some nutrients and various enzymes.
Sc: Scandium
Se: Selenium
Taxon (sing.)/Taxa (pl): Category/categories for classifying animals with regard to their evolutionary relatedness.
TBT: Tributyltin. See butyltin.
TCDD: Tetrachlorodibenzo-p-dioxin, a highly toxic dioxin.

Temporary threshold shift: A temporary, usually mild, loss of hearing, such as experienced after listening to loud music. Hearing is fully recoverable after a short time, but a series of temporary threshold shifts over time can lead to permanent hearing loss.
TEQ: Toxic Equivalent. The overall toxicity or environmental threat posed by a set of closely related pollutants.
Tl: Thallium
Toxaphene: An organochlorine used in pesticides.
Upwelling: An upflowing mass of water, usually rich in nutrients, and usually very biologically productive. Often associated with continental shelf edges, submarine slopes and coasts.
V: Vanadium
Wet weight: See dry weight.
Zn: Zinc

Appendix 6

WHERE TO GO FROM HERE? A SYNTHESIS OF AN INFORMAL DISCUSSION HELD 2 JUNE, 2003

Steve Reilly and Nancy A. Friday

There are many potential issues of concerns for cetaceans which are driven by human induced environmental changes. The SWG on Environmental Concerns is the only forum for the SC to address these issues. In combination, this has resulted in a very diverse agenda. Although progress has been made on many of the issues that currently comprise our agenda, attempting to cover all topics in all years runs the risk of not covering any topic well. This issue is not a new problem for Sub-Committees of the SC. Although it is important to keep a few standing issues on our agenda, particularly those mandated by the Commission, limiting our focus to a single topic each year would help us to make noticeable progress on individual issues. This yearly focus could be a geographic area, a single species or group of species, or an environmental issue.

The SOCER may be an avenue for keeping the SWG up to date on environmental issues of concerns for cetaceans and while allowing the SWG to focus its attention on a specific topic each year. In addition, in years when the SWG focuses on a geographic region, the SOCER could be used as an introduction to issues of concern in that area.

As much as possible, the yearly focus should relate to topics being discussed or of major interest in other Sub-Committees of the SC. This connection to other Sub-Committees has a number of benefits. First, it will allow the SWG to inform the SC and the Commission about environmental issues which are directly related to SC topics that are generally explored without considering the environment in which the species occur. In addition, coordinating with other Sub-Committees may alleviate the difficulty of supporting sufficient Invited Participants to address the SWG's work as these Invited Participants would be able to contribute to multiple Sub-Committees.

Each year, the SWG should coordinate with the conveners of the other SC Sub-Committees in order to identify an issue to which the SWG could contribute in a meaningful way with data and/or analyses. In this way, the SWG would be able to increase the cohesion of the SC. Two possible topics for future meetings are multispecies issues and the Southern Hemisphere ocean processes that may affect the SC's advice on minke whales.

Finally, it is suggested that a major review article of the yearly topic be produced each year, during the intersessional period. This review article could be used as a starting point for that year's discussion, and it would update the Commission and the general scientific community on the topic at hand. After completion of the SC discussion, this review article should be submitted to *The Journal of Cetacean Research and Management* for publication.