Annex H

Report of the Standing Working Group on Environmental Concerns

Members: Reilly (Convenor), Albert, Baker, Berggren, Best, Bjørge, Bravington, Brown, Carlson, Cipriano, Clark, Clarke, da Silva, Deimer, DeMaster, Donoghue, Donovan, Ensor, Fabbri, Findlay, Friday, Fujise, Fulford, Givens, Gordon, Grønvik, Hakamada, Hammond, Hatanaka, Haug, Hedley, Ichii, Joseph, Kasuya, Kato, Kawachi, Kawahara, Kim, Kingsley, Kock, Komatsu, Last, Lauriano, Leaper, Lens, Matsuoka, Moore, Morishita, Moronuki, Nishiwaki, Northridge, O'Hara, Ohsumi, Okamoto, Okamura, Palka, Parsons, Peddemors, Pérez-Cortés, Perrin, Perry, Polacheck, Rambally, Read, Reeves, Reijnders, Reilly, Robineau, Rogan, Rojas-Bracho, Rose, Rowles, Ryan, Senn, Shimadzu, Simmonds, Skaug, Stachowitsch, Suydam, Tamura, Tanaka, E., Tanakura, Tarpley, Thiele, Tomita, Urbán-Ramirez, Van Waerebeek, Walløe, Walters, Yamamura, Zhu.

1. CONVENOR'S OPENING REMARKS

Reilly welcomed the participants and noted that he anticipated an interesting meeting. In his view the priorities for the meeting were to advance the two research proposals (POLLUTION 2000+ and SOWER 2000), begin serious discussions toward the next research initiative on the Arctic and continue the other ongoing subjects that the Working Group had adopted as part of its regular agenda.

2. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Reilly was elected Chairman. Rowles, Clark, Moore and Palka acted as rapporteurs.

3. REVIEW OF AVAILABLE DOCUMENTS

Documents relevant to the Standing Working Group (SWG) included SC/51/E1-17, SC/51/Rep2, SC/51/Rep3, SC/51/O1, O9, O12, O13 and O17, SC/51/SM47, SC/51/AS30 and AS31, and Tamura and Ohsumi (1999), Parsons *et al.* (1999) and Young (1999).

4. ADOPTION OF AGENDA

The agenda adopted is given in Appendix 1.

5. POLLUTANT AND CONTAMINANT ISSUES

5.1 Report of intersessional planning workshop

Reijnders gave a brief synopsis of SC/51/Rep3, the report of the 'Planning workshop to develop a research programme to investigate pollutant cause-effect relationships in cetaceans - POLLUTION 2000+' (IWC, 1999b).

The Planning Workshop was held in Barcelona, 14-17 March 1999. An outline research proposal, Aguilar *et al.* (1999), had been agreed by the Scientific Committee and the Commission in 1997. Subsequently, the proposal was strongly endorsed by ASCOBANS and the ICES Working Group on Marine Mammal Habitats. The Barcelona Workshop was a direct result of the proposal and its Terms of Reference were to develop and update the outline into a full field and analytical programme.

POLLUTION 2000+ is the first stage in an ongoing, and necessarily iterative, process. Stages in such a process include:

(1) examining the relationship between tissue levels and biomarkers;
(2) examining the relationship between biomarkers and effects;
(3) examining effects on individuals;
(4) examining how the effects on the individual affect population dynamics.

The first part of the programme comprises two stages: (1) examination of a number of biomarkers (of exposure to and/or effect of PCBs) to determine whether a predictive and quantitative relationship with PCB levels in certain tissues exists; and (2) validation/calibration of sampling and analytical techniques to address such questions for cetaceans. Examination of the first requires relatively large sample sizes, and to the extent possible, controls for known variables such as age, sex and reproductive condition. It does not require extremely detailed pathology at this stage. Harbour porpoise bycatches appear to be one of the few cases where such large sample sizes might be obtained. Examination of the second may require lower sample sizes but considerably more information. Two important sub-objectives of Stage (2) are:

(1) determination of changes in concentrations of variables with post-mortem times;
(2) examination of relationships between concentrations of variables obtained from biopsy sampling with those of concentrations in other tissues that can only be obtained from fresh carcasses.

The Workshop stressed that the development of the IWC programme should not be seen as suggesting that other research on pollutants and cetaceans is not important. The IWC programme should be seen as a 'core' programme to address some fundamental questions. Its value is immeasurably enhanced by cooperation with existing programmes and as a context for the development of new programmes.

Following the elaboration of the objectives, the Workshop discussed: (a) the identification of variables to be measured; (b) analytical techniques used to measure those variables; (c) sampling and storage (by species, area and variable); (d) responsible laboratories; and (e) organisation and coordination including timetable, budget, funding and reporting.

The following biomarkers were chosen: sex hormones; enzyme induction; thyroid hormones and vitamin A levels; indicators of immune status; porphyrins and luciferase. The biological variables that need to accompany the tissues sampled are body length, sex, age, reproductive condition and nutritive condition. Clinical examination of all necropsied and sampled animals is required to assess the overall 'health' of an individual and to try to distinguish effects of contaminants from those caused by other known stressors. The analytical and pathological techniques required to measure the respective variables are described in detail in the Workshop Report (IWC, 1999b).

Of the four species previously identified in the report (bottlenose dolphins, harbour porpoise, white whale and Amazon river dolphin) the Workshop agreed to focus on two. For both the white whale and the Amazon river dolphin, it became clear that insufficient samples could be obtained in a reasonable timeframe to address the objectives of the programme. Bottlenose dolphin tissue samples from live-captured (Sarasota Bay) and remote biopsy sampled (Mauritania, Bahamas and Mediterranean) will be obtained. Some tissues from live-captured harbour porpoises will be obtained from the northwest Atlantic and Denmark (North Sea); tissues obtained from necropsied harbour porpoises will be collected in Iceland and the central and northern North Sea, (Norway, Denmark and Germany).

A tentative workplan was drawn up that included: establishment of field protocols; logistics of sample handling and archiving; coordination of analysis of results from sub-projects; reviewing results; synthesis of sub-project data; review and evaluation of a final report; and planning for future phases. The need for workshops to be held at various stages during the programme was identified. Intermediate progress reports will be presented to the Scientific Committee and a final report reviewing the results should be completed and presented after a final Workshop to be held in 2005.

The Workshop developed a list of potential collaborating institutions and recognised the need to consult with these before a budget can be developed; any such budget would have implications for the design and priorities of the programme. It was also recognised (as it had been in Aguilar *et al.*, 1999) that the budget would be larger than that likely to be funded solely by the IWC and that investigation of other funding sources was essential.

It was believed unlikely that fieldwork would begin before the year 2000. Therefore, the Workshop agreed to appoint a Steering Group to address the ongoing and outstanding issues at both a scientific and logistical level. It was agreed that Reijnders should act as coordinator and that the Group should further consist of representatives from the sub-projects: Donovan, Rowles, plus a statistician/modeller, a biomarker expert and an expert with an overview on cetacean biology (toxico), pathology and veterinary medicine.

The Workshop strongly believed that the POLLUTION 2000+ project represents fundamental research necessary if the effects of pollutants on cetaceans are to be determined. Therefore, in addition to central IWC funding it urges IWC member governments to consider providing support to this project at the national level.

Annex C (Reijnders *et al.*, 1999) to the Workshop was developed by those members of the Steering Group present in Grenada as well as two national sub-project leaders. It presents a budget and revised workplan based on the results of the replies from potential collaborating institutes. This is discussed in detail below.

5.2 Proposal to Commission

After discussion and clarification of a number of issues raised in SC/51/Rep3 and, in particular, the first draft of Annex C (Reijnders *et al.*, 1999) to the Workshop Report, the Annex was expanded. The revised Annex contains the details of the agreed proposal, and its key points are summarised below.

The Barcelona Workshop (IWC, 1999b) addressed the request of the Commission, its Scientific Committee and the SWG on Environmental Concerns (SWGEC) to further develop the research proposal on cetaceans and pollutants, hereafter called POLLUTION 2000+. The starting point for the Workshop was established by the SWGEC, Scientific Committee and Commission as given in SC/49/Rep6 (Aguilar *et al.*, 1999), in which the measured variables and the target species had been identified and agreed upon.

PCBs were chosen as model compounds due to their overwhelming anthropogenic origin, very high concentrations in some cetacean populations, recognised effects upon wildlife and the substantial background information already available on patterns in variation, geographical distribution, tissue kinetics and mechanisms of action. By analysing PCBs it was recognised that from the same samples, for no extra costs, information can be obtained on a series of other organochlorines including DDT, DDE, DDD, dieldrin, endrin, eldrin, HEPOX, lindane, hexachlorobenzene, chlordanes and mirex.

The biomarkers and other indicators previously agreed were discussed and described in more detail in the reports referred to above. These biomarkers are essentially indicators of the possible effects on reproduction, early development, the immune system and general health status related largely, but not exclusively, to PCB exposure.

Although sample size considerations precluded the inclusion of the white whale and the Amazon river dolphin, studies on these species (and indeed others) are important and may be included in future phases of this iterative project. Interested groups are encouraged to undertake such studies. The collection and at least archival of samples from these populations should be encouraged by the IWC.

Last year, the SWG stressed that the programme was intended to specifically address the main recommendation of the IWC Pollution Workshop (IWC, 1999b). Researchers are encouraged to address the other recommendations of that Workshop and consider other species and sources of samples. The programme is intended to produce a model for studies of other contaminants in other species and areas, by bringing together biologists, toxicologists, pathologists, toxico/pathologists and others in a multidisciplinary, collaborative programme.

Samples will be archived for further analyses outside the core programme following the guidelines listed in table 2 of the Barcelona Workshop. The SWG encourages auxiliary projects to be undertaken by national groups and other institutions, for example the assessment of new or recently found compounds in cetaceans, such as organotins and polybrominated biphenyls.

Based on SC/51/Rep3 (IWC, 1999b) the following two short-term objectives were identified for POLLUTION 2000+:

(1) to select and examine a number of biomarkers of exposure to and/or effect of PCBs and determine whether a predictive and quantitative relationship with PCB levels in certain tissues exists;
(2) to validate/calibrate sampling and analytical techniques to address such questions for cetaceans, specifically: (i) determination of changes in concentrations of variables with post-mortem times; (ii) examination of relationships between concentrations of variables obtained from biopsy sampling with those of concentrations in other tissues that can only be obtained from fresh carcasses.

Given these objectives and the levels of resources and effort necessary to examine them, the SWG agreed that the work should be divided into two phases; information from Phase 1 is important in providing the calibration/validation tools necessary to improve the focus and design of Phase 2. Data from Phase 1 will provide information not only essential for completing Phase 2 but also of fundamental importance to many research programmes examining issues of chemical pollutants and cetaceans. Phase 1 concentrates largely on objective (2) above and comprises two sub-projects: (i) the effect of post-mortem time; and (ii) the relationship between information obtained from biopsy samples with that obtained from live-captured animals or carcasses (either from bycaught or freshly stranded animals). Highest priority is to be accorded to sub-project (i). Changes in levels of contaminants and indicators of exposure are known to occur after death due to the inevitable physiological changes and breakdown of tissue (e.g. see Barcelona Workshop report). It is essential that these changes are quantified to determine the effect of post-mortem time on contaminant levels in various tissues in order to interpret levels in animals whose time to death is uncertain.

The post-mortem experiment can be carried out on a selected subset of the biopsy calibration experiment animals. The absence of a suitable source of fresh carcasses of bottlenose dolphins means that the calibration experiments will be carried out on harbour porpoises. The choice of sampling area(s) needs to be decided by the Steering Group.

Phase 1 includes the field research component as well as analyses of the bottlenose dolphin sub-project in Sarasota Bay and the field research component of the bottlenose dolphin sub-project in Mauritania, Bahamas and the Mediterranean; however, only the PCB analyses are being undertaken as part of Phase 1. The rationale for this is that: (a) it takes advantage of existing field work; and (b) it will enable selection of a single 'unpolluted' area to focus the Phase 2 segment. The remaining indicator analyses from the samples collected in Phase 1 will be undertaken as part of Phase 2, depending upon the findings of Phase 1.

Phase 1 data will be analysed initially in a specialist workshop, before embarking on Phase 2. This will result in a revised programme to be presented to the Committee and the Commission.

Estimated costs for Phases 1 and 2 are given in Tables 1 and 2, respectively. Those for Phase 2 are more uncertain (as they depend on the outcome of Phase 1) but are presented to indicate the overall cost of the programme.

Table1

Budget for Phase 1 of Pollution 2000+.

(1) Harbour porpoises: post-mortem calibration study. (Five animals in each class).

Samples	Variable	Tissue	Cost per sample (£)	Total (£)
180	PCBs	Blubber	105	18,900
120		Blood	105	12,600
180	Vitamin A	Blubber	85	15,300
180		Liver	85	15,300
180		Blood	85	10,200
120	Porphyrines	Blood	65	7,800
180		Liver	65	11,700
180		Urine	65	11,700
120	Immune system	Whole blood	256	30,762
180	Thyroid hormones	Serum	8	1,435
180	P450	Skin	0	0
180		Liver	66	11,932
120	Luciferase	Blood	216	25,888
180		Blubber	232	41,819
180		Skin	332	59,741
120	Sex hormones	Blood	10	1,200
Sub-total				276,278
Field costs				25,000
Sub-project cost				**301,278**

Notes: Due to the ability to sample blood, it is assumed that analyses will only be carried out for 0, 3, 6 and 24hrs (i.e. during necropsy). In order to obtain sufficient 0hr specimens for the various age-sex classes, it is necessary to sample more widely. For those animals sampled that are not freshly dead, tissue will be archived for analysis under Phase 2 of the programme. The number of sampled animals necessary to obtain sufficient animals in each class is difficult to determine, but for the purposes of the budget it is assumed that about 120 animals will be sufficient. Sampling may occur in Iceland, Norway, Denmark, USA, Germany.

(2) Bottlenose dolphin sub-project.

Sample size	Field costs (£)	Analysis	Tissue	Total (£)
Mauritania				
15	12,900	PCBs	Blubber	1,575
Bahamas				
15	5,000	PCBs	Blubber	1,575
Mediterranean				
15	10,600	PCBs	Blubber	1,575
Sub-total				33,225
Sarasota Bay				
30	6,000	PCBs	Blubber	3,150
30			Blood	3,150
10			Milk	1,050
30		Hormones	Blood	300
30		Enzyme induction	Skin	1,071
30		Porphyrines	Blood	1,950
30			Urine	1,950
30		Immune sSystem	Whole blood	7,691
30		Thyroid hormones	Serum	239
30		Luciferase	Blood	6,472
30			Blubber	6,970
30			Skin	9,957
30		Vitamin A	Serum	2,550
30			Blubber	2,550
Sub-total				55,050
Sub-project cost				**88,275**

(3) Administration: this is an extremely important item if the project is to succeed. £20,000 is required.

SC/49/Rep6 (Aguilar *et al.*, 1999, p.427) noted that the project would be a very large, cooperative programme, one that the Commission alone would be unable to fund. The level of support already expressed for this proposal is

Table 2

Tentative budget for Phase 2. Note that Phase 2 is dependent on the results from Phase 1. This is thus illustrative of the levels of costs.

Sub project	Area	Sample size	Field costs	Shipping etc.	Biological analysis	Analysis	Tissue	Cost per sample Low	Total cost Low
Tursiops	Sarasota Bay	70	£9,500	?	?	PCBs	One	£105	£7,350
		70				Hormones	Blood	£10	£700
		70				Enzyme induction	Skin	£36	£2,500
		70				Porphyrines	One	£65	£4,550
		70				Immune System	Whole blood	£256	£17,945
		70				Thyroid hormones	Serum	£8	£558
		70				Luciferase	One	£232	£16,240
		70				Vitamin A	One	£85	£5,950
								£797	**£65,293**
Tursiops	Unpolluted	30	£21,000	£1,500	£1,000	PCBs	Blubber	£105	£3,150
		30				Vitamin A	Blubber	£85	£2,550
		30				P450	Skin	£36	£1,071
		30				Luciferase	Blubber	£232	£6,970
	Mediterranean	30	£18,500	£1,300	£1,000	PCBs	Blubber	£105	£3,150
		30				Vitamin A	Blubber	£85	£2,550
		30				P450	Skin	£36	£1,071
		30				Luciferase	Blubber	£232	£6,970
			£39,500	£2,800	£2,000				**£71,782**
Phocoena	Iceland	90	£6,000	£2,000	£300	PCBs	One	£105	£9,450
		90				Porphyrines	One	£65	£5,850
		90				Immune System	Whole blood	£0	£0
		90				Thyroid hormones	Serum	£8	£718
		90				P450	One	£36	£3,214
		90				Luciferase	One	£232	£20,880
		90				Sex hormones	Blood	£10	£900
									£49,312
Phocoena	Norway	90	£4,500	£450	£32,000	PCBs	One	£105	£9,450
		90				Porphyrines	One	£65	£5,850
		90				Immune System	Whole blood	£0	£0
		90				Thyroid hormones	Serum	£8	£718
		90				P450	One	£36	£3,214
		90				Luciferase	Blood	£232	£20,880
		90				Sex hormones	Blood	£10	£900
									£77,962
Phocoena	Denmark	60	£20,000	£0	£7,000	PCBs	One	£105	£6,300
		60				Porphyrines	One	£65	£3,900
		60				Immune System	Whole blood	£0	£0
		60				Thyroid hormones	Serum	£8	£478
		60				P450	One	£36	£2,143
		60				Luciferase	Blood	£232	£13,920
		60				Sex hormones	Blood	£10	£600
									£54,341
Phocoena	USA	100	£6,300	£500	£6,500	PCBs	One	£105	£10,500
		100				Porphyrines	One	£65	£6,500
		100				Immune System	Whole blood	£0	£0
		100				Thyroid hormones	Serum	£8	£797
		100				P450	Skin	£36	£3,571
		100				Luciferase	One	£232	£23,200
		100				Sex hormones	Blood	£10	£1,000
									£58,869
Post-mortem if needed		180				PCBs	Blubber	£105	£18,900
		120					Blood	£105	£12,600
		0					Milk	£105	£0
		120				Porphyrines	Blood	£65	£7,800
		180					Liver	£65	£11,700
		180					Urine	£65	£11,700
		120				Immune System	Whole blood	£256	£30,762
		180				Thyroid hormones	Serum	£8	£1,435
		180				P450	Skin	£0	£0
		180					Liver	£66	£11,932
		120				Luciferase	Blood	£216	£25,888
		180					Blubber	£232	£41,819
		180					Skin	£332	£59,741
		120				Sex hormones	Blood	£10	£1,200
									£**235,478**
Administration									**£40,000**
Grand Total									**£653,037**

extremely encouraging. The programme as outlined in SC/49/Rep6 was strongly endorsed by ASCOBANS at its Meeting of Parties. The recent Advisory Committee meeting of ASCOBANS also endorsed the Barcelona Workshop report on the basis of the summary prepared by Reijnders (the Committee's rules meant that the written report could not be submitted as a document to that meeting). SC/49/Rep6 was also endorsed by ICES and used by them to develop a similar programme for pinnipeds.

Although it has not been possible to calculate the exact value of the 'in-kind' funding offered by the cooperating institutions, even a crude estimate reveals that over £200,000 is being offered and probably considerably more. Further potential funding sources include: the European Commission; the joint USA-EU programme; the Nordic Council of Ministers and certain Fishermen's Associations. It is to be hoped that IWC member nations may also offer direct or indirect funding in addition to any core IWC funding. Similarly, one might hope that various non-governmental organisations might be prepared to contribute. A major task for the coordinator of POLLUTION 2000+ will be to follow up on these and other sources of funding.

The SWG **endorses** and **strongly recommends** approval of POLLUTION 2000+. It also encourages the Commission to fund as much as it can of the costs and work with national governments and other organisations to secure the rest of the funds.

In addition, some members added the following suggestions for the calibration study: it should test the assumption that PCBs are representative of the general contaminant load; that there is no synergistic effect from other contaminants upon potential biomarkers; and that correlations between PCBs and biomarkers are independent of other bio-accumulating POPs and trace elements. Reijnders pointed out that the biomarkers proposed in the revision will allow discrimination between dioxin compounds and PCBs to help differentiate between the effects of different contaminants, and that the toxicity (expressed as toxic equivalents) of Oc-contaminants generally found in cetaceans is to a high extent represented by PCBs.

5.3 Other topics

The first three papers considered under this section included general overviews of environmental concerns for cetaceans, with parts of their content applying to other agenda items as well.

Simmonds presented paper SC/51/E14 and noted that, as in previous submissions to the Committee (i.e. Simmonds, 1997; Simmonds and Von Bismarck, 1998) the authors had endeavoured to identify important developments in the cetacean environment that had arisen since the last meeting. These included increased concerns about organotin and polybrominated compounds particularly since ubiquitous environmental contaminants are being increasingly detected in cetaceans, and the discovery of an association between disease and contaminant burdens in harbour porpoises sampled in the UK. The mean PCB level in porpoises that died as a result of physical trauma was 1.3 mg/kg (wet weight) compared to 29.4 mg/kg (wet weight) in those with infectious disease. Other 'new' contaminants of concern noted in SC/51/14 included tris (4-chlorophenyl) methane and tris (4-chlorophenyl) methanol which have been detected in a Baltic Sea food web. Both compounds biomagnify to an even higher degree than DDT.

Simmonds also reported that:

(1) the United Nations Environment Programme (UNEP) is beginning negotiations between 120 countries on a global, legally-binding ban on 12 persistent organic pollutants, including the PCBs;
(2) the *Exxon Valdez* Oil Spill Council issued a progress report in 1999, ten years after the spillage of 11 million gallons into Prince William Sound, Alaska – the majority of animals affected are not considered to be fully recovered including the local killer whale population; and
(3) a morbillivirus infection has recently been detected in a fin whale stranded in Belgium (the first such infection detected in a baleen species).

SC/51/E14 also noted that concerns had been raised over the death rate of gray whales in Mexico (discussed under Item 7.5) and that abnormalities had been suggested by the media during the gray whale migration. The SWG urged the authors to use caution in using media reports as sources of scientific information. It noted that SC/51/E14 was useful in identifying issues and suggestions as to how the SWG might develop its work. It was suggested that one of the roles of the SWG could be to monitor these types of reports on mortality events in order to determine the facts. The Chair noted that the actual causes or contributing causes for the gray whale mortalities this season in Mexico are still being examined. It was also noted that SC/51/AS30 reported on the die-off of gray whales in the lagoons referred to in SC/51/AS14.

In regard to the concerns raised in SC/51/E14 on the effects on gray whales from the proposed salt works construction at San Ignacio Bay, Baja California, it was noted that the revised environmental impact study had not been completed (IWC, 1996, p.41; IWC, 1997b, p.66), and that until the study becomes available it is premature to judge the likely effects of the proposed salt works (see Item 7.3).

Concern was expressed that the apparent correlation of increased strandings and pollutant levels might not be supported by the data, and that a statistical assessment of these correlations is needed. This should include detailed assessments of specific effects or exposure biomarkers, and not be limited to tissue residue levels and mortality. Donoghue reported a die-off of sea lions in the Auckland Islands in 1998 which had occurred in a major right whale habitat. New Zealand might designate this area as a critical habitat for marine mammals, in particular for the New Zealand sea lion and the southern right whale.

Parsons presented SC/51/SM47 which noted the great potential for environmental degradation and contamination in the coastal waters of Asia and, therefore, adverse impacts on Asian populations of coastal cetaceans (e.g. *Sousa, Orcaella, Neophocaena* and coastal *Tursiops*). The paper identified several areas which were a cause for concern. These included concentrations of organochlorine contaminants in Japan and Hong Kong, which in the latter, have been linked with a high level of neonatal mortality in coastal cetaceans. The fact that a high proportion of the total DDT in cetacean tissues from Hong Kong was present as unmetabolised DDT suggests a recent input of this contaminant into the marine ecosystem despite the fact that use of the chemical is banned in this region. Other contaminants were also noted to be of concern in Asia, for example, mercury is present in concentrations high enough to cause organ damage in some coastal cetaceans.

The paper highlighted the potential for butyltin contamination, especially in major Asian ports, such as Shanghai, Hong Kong and Singapore. The potential impacts of sewage pollution on coastal cetaceans in Hong Kong were also reviewed; it has been estimated that cetaceans in this area are exposed to faecal coliform concentrations (through ingestion) which are 1,000 times greater than levels which would be considered a health risk for humans. In addition, SC/51/SM47 highlighted other pollutant sources: polycyclic aromatic hydrocarbons (PAHs) from the combustion of fossil fuels and as a by-product of forest fires in Malaysia and Indonesia, and nitrogenous pollutants which could cause eutrophication and algal blooms.

Other forms of environmental degradation discussed in SC/51/SM47 included an increase in boat traffic (both recreational and commercial) and habitat loss resulting from development projects, e.g. reclamation, deforestation and dam construction. In summation of his paper, Parsons noted that in Asia there are many areas where information is lacking, but also areas where available data have shown that there is cause for considerable concern with respect to environmental degradation and pollution. Therefore, research, monitoring and mitigation of environmental threats in the coastal waters of Asia should be considered a priority to ensure the continuation and conservation of cetacean populations.

Perry presented SC/51/E3, which provided background information on the anthropogenic environmental changes that may affect cetaceans. It addressed a range of concerns including climate change, ozone depletion, pollution and effects of fisheries. The paper reported that the IPCC have suggested decades to centuries as realistic time scales for restoration or rehabilitation of damaged or disturbed ecosystems. Polar regions, and therefore polar cetaceans, are extremely vulnerable to climate change, especially those cetaceans that feed at the ice-edge. El Niño events are likely to become more frequent and stronger under existing future climate predictions. These events have been linked to reports of mass marine mammal mortalities and changes in migration patterns.

The paper emphasised information on the development of a severe Arctic ozone hole and an increase in the severity and duration of the Antarctic ozone hole. The predicted peak in Arctic ozone depletion has been revised to 2015-2019, to take account of the impact of climate change on ozone depleting processes. UV-B is a major ecological determinant that affects primary production and cetacean prey sources such as krill. Although emissions of most gases regulated by the Montreal Protocol have decreased substantially over the past 10 years, the atmospheric burden of halon 1211 ($CBrClF_2$) has continued to increase in recent years, despite a ban on production and sale in developed countries since 1994. This is of concern because bromine is about 50 times more efficient at depleting ozone in the stratosphere than chlorine, and because of the long atmospheric lifetime of this gas. The consequent atmospheric accumulation of this halon is retarding the decline of ozone-depleting halogens in the atmosphere more than any other gas. In regard to the effects of pollution, the author stated that high contaminant levels in cetaceans have been linked to immune system abnormalities, high levels of calf mortalities, and may play an important role in morbillivirus epizootics.

SC/51/E3 also stated that commercial fisheries are in crises, and that mass over-fishing will certainly affect cetaceans, if not directly through depletion of prey sources, then through ecosystem alterations resulting from the removal of certain prominent species from the food web.

In discussion it was noted that comments in SC/51/E3 regarding apparent changes in gray whale migration, based on media reports, are not supported by the available data (SC/51/AS11 and AS12).

Fujise presented SC/51/E4 on accumulation levels for organochlorines in southern minke whales using 12 blubber samples collected from the 1994/95 JARPA programme. This was an update of SC/49/O22. In the 1994/95 samples, PCBs were predominant followed by DDTs, HCB, CHLs and HCSs. This order was slightly different from the results of the previous studies in which DDT and HCS were highest among the organochlorines measured. Temporal trends were examined for these organochlorines. Residue levels of DDTs, HCB, CHLs and HCHs were observed to be similar in the samples taken from the 1984/85 and the 1994/95 seasons. However, elevated concentrations of PCBs were observed in the 1994/95 samples. This suggests the PCB accumulation levels are increasing by calendar year, and this pattern is different from patterns observed in marine mammals from the Northern Hemisphere. Possible reasons for the increase include the continuous discharge of PCBs in the Southern Hemispheres and/or different routes of atmospheric transport and distribution kinetics of these compounds between Southern and Northern Hemispheres. Another possibility is to assume that the quantity of food consumed by southern minke whales has increased in recent years, since several studies have suggested that the growth rate of southern minke whales has increased.

The compositions of DDTs, CHLs and HCH show that p,p’-DDE and trans-nonachlor are dominant, and a relatively lower proportion of p,p’-DDT and oc-HCH were observed in minke whales collected in the 1990s when the levels were compared with samples from the 1980s. Declining features of their composition might imply lower fresh input of these contaminants into the Antarctic environment as compared to the Northern Hemisphere. PCB concentrations for southern minke whales were collected from 1985 to 1994/95.

In discussion, concern was expressed about any conclusions regarding trends in these data, because regression analyses were not used; the authors were asked to consider consulting a statistician for methods to test for trends and to determine if the sampling regime is appropriate for this purpose. It was also noted that the differences in levels are on a log scale so the differences are larger than they first appear in the graph. Although a careful interpretation is needed on this issue, temporal trends and global distribution features of organochlorines in the Southern Hemisphere could be studied by monitoring on an appropriate time scale. The SWG was pleased to receive these detailed data on contaminant loads, and encouraged continuation of pollution monitoring. The level of potential harmful effects to cetaceans is unknown, but that on a relative scale the levels reported here were lower than those in white whales, and comparable with those in bowheads. It was further stressed that health effects in cetaceans should be examined on the basis of chronic exposure, not just on observed levels. Polar regions are typically less contaminated compared to more urbanised and industrialised regions (i.e. the St Lawrence Estuary). However, significant bioconcentrating mechanisms do allow for the accumulation of some environmental contaminants in Arctic cetaceans and these levels tend to be much lower for the Arctic populations as compared to St Lawrence white whales. In response to an inquiry as to whether the animals reported with reproductive anomalies were included in this study of contaminant loads, the authors replied that those analyses were ongoing, however there is no direct evidence at this time to attribute these anomalies to contaminants. It was mentioned that the putative temporal differences could be related to seasonal patterns. The authors agreed that this and the level of ‘fatness’ must be examined in the future. A question was raised as to how the sample size and selection of individuals were determined. The authors replied that only mature males were selected (January-February) and that the sample size was determined by the capacity of the analytical laboratory, which they regarded as too small.

O'Hara introduced SC/51/E6 in which pollutant loads were compared among three of the five different Alaskan white whale stocks (Eastern Beaufort Sea, Eastern Chukchi Sea and Cook Inlet). The males of each stock had higher organochlorine levels in the blubber than the females, and the levels increased with age. Levels of organochlorines were generally highest in males from the Eastern Chukchi Sea, followed by the Eastern Beaufort Sea, and lowest in the Cook Inlet white whales. No age differences between the stocks of sampled animals were noted. Principal components analysis (PCA) showed that the pattern (not levels) of OCA differed by stock. In comparison with white whales from the St Lawrence Estuary, the levels in Alaskan whales were 2-7%, 1-5%, 8-37%, 25-95%, 10-42% and 1-6% for PCBs, DDTs, chlordanes, HCB, dieldrin and mirex, respectively. The blubber of white whales is a source of organochlorines to human consumers although no reliable consumption rate data exist. Chlordanes were the most restrictive for suggested human consumer exposures based on Canadian guidelines. However, the edible portion (i.e. maktaaq) is not 100% blubber and consists of a significant portion of skin (i.e. epidermis). The authors commented that the significant cultural and nutritional benefits must be kept in mind when considering human exposure. More information on serving sizes and consumption rates are needed before making an exposure assessment.

Givens commented that the PCA conducted was unlikely to be the best suited for the question asked. The PCA results were dominated by large contributions of PCBs. He suggested normalisation of values using another method and indicated that he would consult with the authors. It was asked if the pattern of differences among stocks was an artifact of the data transformation. Givens responded that distinct stocks would likely still be distinguishable, but from different patterns of contaminants.

It was asked what can be learned about consumption rates or patterns from harvest data. O'Hara indicated that locally collected harvest data are complicated by the fact that food is shared between communities and therefore different consumption rates are likely by household and possibly by season.

Ichii presented SC/51/E2 for the authors who were not present. Levels of artificial radionuclide ^{137}Cs and natural radionuclide ^{40}K concentration in Dall's porpoise (*Phocoenoides dalli*) taken off the Pacific coast of northern Japan in 1996 were investigated. Concentrations of ^{137}Cs in muscles of two male Dall's porpoises were 0.153±0.011 and 0.234±0.016 Bq-kg^{-1} wet weight; those of ^{40}K were 104.0±0.3 and 107.8±0.09 Bq-kg^{-1} wet weight respectively. Concentration factors (CF, concentration in animal/concentration in sea water) for the two porpoises were 59 and 90 for ^{137}Cs, respectively. These levels of concentration and CF indicate that the trophic position of Dall's porpoises is similar to that of the large-size piscivorous fishes among the marine organism community in coastal waters of Japan.

Reilly welcomed the paper, and thanked the authors for its valuable contribution. He inquired as to whether the levels reported were hazardous to consumers. O'Hara noted that levels are 1,000 times higher in Arctic caribou.

O'Hara presented SC/51/E11 which discussed levels of non-radioactive (i.e. heavy metals) and radioactive elements (i.e. radionuclides) in tissues of white whales from Alaska. Radionuclide levels were low and of little concern to the health of white whales or to subsistence users who consume white whale tissues. Silver-108(m) accumulates in the liver of white whales and this accumulation is unique among other mammals and fish studied in this region. Most heavy metals are at levels of little (human) health concern in the tissues studied. Mercury (Hg) is at levels of concern as some tissue levels exceed published allowable levels for human consumption (i.e. 0.5ppm wet weight), however the potential effects of these levels in white whales is not known. It is important that the form of Hg is considered, organic versus inorganic (less toxic form), and that these 'recommended' levels are for daily lifelong exposure. Hg residues in liver and kidney are predominately composed of inorganic Hg, whereas epidermis and muscle residues are in the organic form. The presence of increasing levels of selenium (Se) with increasing Hg in some tissues may offset toxicoses (i.e. Se may protect from Hg toxicoses). The highest levels observed for some elements (Hg, Se, Ag and Cd) were associated with the oldest animals harvested at Point Lay, Alaska. Age dependent accumulation of these metals is well known. However, statistical comparison of the varying tissue levels by location of harvest (i.e. stock) was not possible due to the small sample size, analytical methodology differences and widely varied animal ages. The authors are currently increasing their sample size and the number of animals of known age to make a location/stock comparison. A better understanding of the interaction of certain elements (Hg, Ag, Se) is required before white whale responses to these measured levels can be assessed. Accurate measures of exposure (i.e. consumption) of subsistence users is required to perform an adequate risk assessment. In doing such an assessment it is important to consider the nutritional, cultural and spiritual benefits of hunting and eating white whales when giving advice on contaminant exposure. Human exposure assessments are not adequately addressed here due to a lack of consumption data. With respect to 'high' levels it must be emphasised that this is mostly in comparison with domestic and laboratory species which is not an appropriate comparison. It is likely that adaptations exist in these marine mammals that allow for tolerance of such levels.

It was asked if during starvation the elements would be mobilised and redistributed. O'Hara commented that mobilisation is known to occur for OCs, however, inorganics are not as easily mobilised due to the binding of elements to large proteins and possibly to inorganic complexes. Redistribution is likely for essential nutrients, but less is known regarding the toxic elements.

O'Hara summarised SC/51/AS13, which outlined an unusual type of large whale study. As noted above, some cetaceans have shown the capability to tolerate 'high' levels of select elements, such as Cd, Hg and Se. The National Aeronautic and Space Administration (NASA) is interested in the mechanism of tolerance to these elements because long-term space travel in an enclosed environment will require recycling of materials and a high potential for undesired exposure to these toxic elements. This study was designed to determine the mechanisms used by bowhead whales to resist these elements by attempting to recover and grow viable cetacean cells in space, exposing them to toxic elements and studying the biochemical and physiological responses in order to determine whether this knowledge can be applied to human health and the rigors of space travel. The study is still in progress, but to date, cells of liver, kidney and brain of bowhead whales have been grown in tissue culture.

The SWG found this novel study to be most intriguing. Reilly asked when the cells will be sent into space. O'Hara responded that it should occur within a couple of years, and that further results will be reported when they are available.

Simmonds presented SC/51/E13 which commented that considerable concern exists regarding the implications of the ubiquitous pollutants that bioaccumulate in the food chains of marine top predators, and the implications for both cetacean health and the health of consumers of cetacean products. Table 3 lists the health effects in cetaceans that have been associated with particular contaminant values to date.

SC/51/E13 reviewed published information concerning organochlorine (principally PCBs and DDT data) and mercury residue levels from two regions where cetaceans are still consumed: Japan and the Greater Caribbean. In addition, new data on pollutants from meat purchased in Japan in 1999 were presented. Cipriano briefly summarised sample collection methods from SC/51/O9. Commercial whale products purchased in Japan were subsampled for a collaborative project: DNA analysis of product identity (SC/51/O9) and coincident pollutant analysis (SC/51/E13); this allowed pollutant loads to be associated with the species of origin and advertised identity. Products ($n = 130$) were purchased with a maximum of 2-4 products of different types purchased at each outlet to avoid duplicate samples from the same source. Products were sub-sampled under clean conditions to prevent cross-contamination; one sub-sample from each product was forwarded to a Japanese pollutant laboratory for analysis, the other sub-sample was subjected to DNA analysis procedures as reported for previous market surveys (e.g. Cipriano and Palumbi, 1997; Lento *et al.*, 1998).

SC/51/E13 concluded that considerable research on contaminant levels had been conducted in Japan, leading to the recognition of well-established patterns of contamination in cetacean species. Simmonds noted that new contaminants of concern in odontocetes have been identified in Japan. The new contaminant data from the Japanese meat market are very similar to the published information and may also be compared with regulatory limits established for food products. High levels of contamination were found in the odontocetes identified and SDDT levels were also relatively high in minke whales from the North Pacific. Further data will be forthcoming from these meat samples in a subsequent paper. The authors of SC/51/E13 concluded that the contaminant data raised health-related concerns for cetaceans and for human consumers of cetacean products. While a considerable amount of research into contaminants in cetaceans has been conducted in Japan, it was not apparent from the literature that human health implications have been considered in recent years. In the Caribbean region, no directly relevant data have been collected in the last two decades, and therefore such data should be collected from fresh-stranded and bycaught animals and where appropriate by biopsy. The authors noted that urgent consideration should be given to health implications.

It was noted in discussion of SC/51/E13 that the authors did not specify whether mercury reported was in the organic or inorganic form. Simmonds replied that these forms were not distinguished, but that this would be considered for future analyses. Simmonds noted that there appeared to be a great deal of consideration of the Alaskan/Arctic food chain, including human consumers, compared to the Caribbean or Japan with regards to tissue residue levels in cetacean products.

Parsons presented the results of Parsons *et al.* (1999) which reported contaminant levels in an immature female pygmy Bryde's whale from the South China Sea. Concern was raised about the concentration of lead in the animal's organs, which has also been seen in coastal cetaceans in the region. Concentrations of total PCBs were 1.79ppm, chlordanes and total DDT were 0.28ppm and 33.01ppm respectively (all wet weight). The ratios of DDT to its metabolites was 21%, which was relatively high for a baleen whale suggesting relatively recent input of the chemical, although not as high as has been recorded in coastal small cetaceans from the same area (see SC51/SM47), suggesting a greater temporal or spatial distance from the source. Parsons drew attention to the fact that this is the only study of contaminant levels of this species from southeast Asia and that the contaminant levels recorded were much higher than levels previously recorded in other baleen species. Considering that the animal was immature, Parsons suggested that adults from this population would probably have higher contaminant loads.

Reilly inquired as to how these levels compare to levels in other baleen whales. O'Hara referred to the table presented in SC/50/E5 for comparisons with bowhead whales sampled in Alaska. Parsons noted that this animal had tissue residue levels several orders of magnitude higher than those in the bowhead on a wet weight basis. It was noted that trend data from Japan showed that some compounds were declining and some were persistent. In addition, the problem is complicated by the appearance of new environmental pollutants.

Human health effects

Last year the Commission passed a Resolution (IWC, 1999a, p.47) inviting member and non-member governments to provide reliable information to the IWC relating to the possible human health effects resulting from consumption of cetacean products. The SWG considered its role in this regard, and concluded that at present there is insufficient technical and specialised expertise in the SWG to provide any informed consideration of human health matters. Therefore, the SWG suggested that the Commission consider convening a group of specialists through its Technical Committee (as done previously for Humane Killing Methods). The SWG could then forward to this Group any technical information it received relevant to the issue. The Technical Committee could then meet periodically, as decided by the Commission. If this Technical Committee Group recommended, and the Commission decided it was appropriate, the SWG could alter its work to consider some specific aspects relating to

Table 3

Problems in cetacean populations associated with contaminants.

Species	Problem	Associated contaminant level in ppm	Source
Dall's porpoise	Reduced testosterone	5.62-17.8 PCBs (blubber) 7.61-16.5 DDT (blubber)	Subramanian *et al.* (1987)
Bottlenose dolphin	Immune dysfunction	0.0127-0.5363 p,p'DDE (blood)	Lahvis *et al.* (1995)
Harbour porpoise	Increased infectious diseases	29.4 PCBs (blubber)	Jepson *et al.* (1998)
Bottlenose dolphin	Liver disease	50-61 mercury (liver)	Rawson *et al.* (1993)

human health effects from consuming cetaceans, e.g. reviewing reported contaminant levels. This would require member governments to regularly send experts in the field to Scientific Committee meetings. However, some members commented that in their view this topic was outside the competence of the IWC.

6. CLIMATE CHANGE AND HABITAT

6.1 SOWER 2000

6.1.1 Report of intersessional Workshop

Hammond provided an overview of the SOWER 2000 Workshop Report (SC/51/Rep2). The Workshop was held from 1-6 March 1999, at Heriot-Watt University, Edinburgh, Scotland. Its primary aim was to develop proposals for the IWC component of collaborative work in the Antarctic between the IWC, CCAMLR and SO-GLOBEC, in order to address the aims of the SOWER 2000 research programme. The overall long-term objective of the SOWER programme (IWC, 1997b) is to

> Define how spatial and temporal variability in the physical (e.g. sea surface temperature, salinity, mixed layer depth, upwelling, extent of ice cover) and biological (e.g. prey availability) 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 Workshop considered background information on relevant survey programmes and on relevant analysis methods prior to developing research proposals. The CCAMLR large-scale survey was aimed primarily at estimating the standing stock of krill in Area 48 (the Atlantic sector of the Southern Ocean). This survey (known as the CCAMLR-48 survey) will be undertaken during January 2000, will involve three vessels acoustically surveying a set of parallel transects across the Scotia Sea, and by placing cetacean observers onboard the vessels, will provide an opportunity to simultaneously survey cetaceans and krill over a large area.

The SO-GLOBEC work is aimed at addressing questions on the interactions between Antarctic krill and top predators. Work will be focused in the Antarctic Peninsula area and in the area known as 70°E. Field studies will collect a wide range of data including, but not limited to: hydrographic measurements (CTD, nutrient, oxygen); hydroacoustic measurements for krill biomass and distribution; net samples for zooplankton/krill; chlorophyll/primary production measurements; top predator (e.g. penguin) distribution and biomass, and possibly predator diet samples. Other relevant work to the discussion included the IWC Antarctic surveys, the Australia Antarctic Division surveys, tropical multidisciplinary studies, seabird surveys and surveys by Brazil and the British Antarctic Survey.

Relevant analysis methods included surveys from platforms of opportunity, oceanographic surveys, active acoustics, spatial modelling from line transect data, double platform methods, adaptive sampling, passive acoustics, aerial surveys, multivariate ordination, small scale studies of relationships between whales and their prey, and integrating process models and survey data.

6.1.1.1 CETACEAN COMPONENTS OF THE CCAMLR AREA 48 SURVEY AND SO-GLOBEC SURVEYS

A specific objective of the SOWER 2000 programme is to 'relate distribution, abundance and biomass of baleen whale species to the same for krill in a large area in a single season.' Conducting sightings surveys from the CCAMLR vessels in 2000, and from SO-GLOBEC vessels in 2000/1 will help achieve this objective. While details of the data collection methods will need to be finalised at a future planning meeting, the Workshop recommended the framework of a broad design to accomplish this.

SC/51/Rep2 described this framework and some details of cetacean observation methods and platforms, school size and species identification, activities during oceanographic sampling, passive acoustics and biopsy sampling. A number of recommendations were made as detailed in SC/51/Rep 2, item 4.1.

6.1.1.2 USE OF IWC SURVEY VESSELS IN 2000/2001

The Workshop anticipated that two dedicated vessels will be available. As discussed last year (IWC, 1999c, pp.196-9) it was reconfirmed that one vessel will conduct feeding ecology studies involving fine-scale studies of the movements and behaviour of individual baleen whales in relation to krill patches. Details of the proposed methods are given in SC/51/Rep 2, item 4.2.1. It was proposed that the second vessel be used to repeatedly survey the wider SO-GLOBEC area which would allow a number of issues to be addressed, including calibration of relative abundance estimates, estimation of the spatial relationships between whales, krill and oceanographic variables, estimation of the spatio-temporal distribution of whales and krill, estimation of the distribution of whale school/cluster sizes and estimation of absolute whale and krill abundance. Details of the recommended broad design for this survey are given in SC/51/Rep 2, item 4.2.2.

6.1.1.3 LONG-TERM OBJECTIVES AND COLLABORATION

The studies proposed for SOWER 2000 in collaboration with SO-GLOBEC and CCAMLR will greatly improve our understanding of many aspects of Antarctic whale ecology. However, they are only a first step towards addressing questions about the present/future dynamics of Antarctic whales necessary to meet the long-term objectives of the SOWER 2000 programme. To make further progress, a variety of practical and theoretical problems must be addressed. The Workshop noted that issues concerning future SOWER cruises would be discussed during the Scientific Committee Meeting. More generally, the Workshop noted that attention must be given to the overall modelling approach required, and how this might inform and focus future scientific objectives; the establishment of a modelling group was recommended.

The Workshop strongly recommended continued close collaboration between the IWC and SO-GLOBEC in the long term. This is essential for the IWC studies of interactions between whales and their environment in the context of long-term environmental monitoring and climate change. It will also facilitate investigation of important issues such as the effects of predators on their prey and whether krill is a limiting resource for some whale species. The Workshop noted that the modelling group established as part of the long-term SOWER programme (see above) should work closely with modelling activities ongoing under GLOBEC.

The Workshop recommended that this collaboration is best facilitated through continued reciprocal representation of CCAMLR scientists on IWC/SOWER working groups and IWC scientists on the CCAMLR Working Group on Ecosystem Monitoring and Management (WG-EMM). It also recommended continued collaboration at the more detailed level of cruise planning for CCAMLR-48.

Collaboration between the IWC and national programmes was already well established in some cases (e.g. Australia). The Workshop recommended that specific links be established between those responsible for IWC work in the SO-GLOBEC area and those knowledgeable about plans for the Brazilian surveys in adjacent waters. The SWGEC would be the appropriate conduit for this. The Workshop also recommended that member governments keep the IWC informed about relevant scientific activities that might incorporate a cetacean component.

The Workshop noted the importance of continuing IWC involvement in CCAMLR and SO-GLOBEC planning, modelling and analysis activities and recommended that the Scientific Committee establish a Steering Group to coordinate the planning exercise.

6.1.2 CCAMLR

Hedley participated on behalf of the IWC Scientific Committee in the CCAMLR Area 48 Planning Workshop (see IWC/51/10, section Eii).

6.1.3 SO-GLOBEC

The Chair of SO-GLOBEC, Dr E. Hofmann, was unable to attend the meeting due to schedule conflicts. She had informed Reilly that there had been an unfortunate change in plans for the SO-GLOBEC field programme in 2000/2001. One of the national programmes had been withdrawn, leaving a gap in coverage during early 2001 when the IWC vessels are expected to be available. As discussed in Item 6.1.4, this requires the SOWER 2000 programme to change its site to the vicinity of 70°E, in conjunction with other SO-GLOBEC operations planned by Australia.

6.1.4 Future plans, including proposal to Commission

Palka enquired as to the flexibility of ship scheduling, and whether it would be feasible for a vessel to be available in February for research off the Antarctic Peninsula. Kato responded that given the limitation of vessel range, the end of February is an absolute limit for surveys. Furthermore, Kato remarked that 70°E is a good alternative site, with a shorter run time. Kock was disappointed with the change of location due to the wealth of comparative data available for the Antarctic Peninsula area, but agreed that the change was unavoidable. Palka queried whether more research time may be available at 70°E, and Kato responded that work may be able to continue through the first week of March.

Hammond noted that the pros and cons of work offshore the Antarctic Peninsula versus 70°E had been discussed at the Edinburgh meeting, and that although not the first choice, the proposed work could certainly be conducted at the 70°E site. Donovan supported Hammond's comments and suggested a recommendation that other countries (e.g. Brazil) be encouraged to conduct research off the Peninsula.

Hedley enquired as to the utility of generating a project to put observers year-round on the SO-GLOBEC krill-study vessels. Reilly responded that proposals to the US National Science Foundation (NSF) for whale observers on year-round SO-GLOBEC vessels were in submission.

Donovan enquired as to whether the group wanted to support the use of pop-ups (acoustic recorders), either at the original study site (Antarctic Peninsula) or at the 70°E study site. The Antarctic krill survey will be ongoing offshore the Peninsula, and acoustic recorders could provide presence-absence data. Moore noted a proposal to NSF in preparation with researchers from Scripps Institution of Oceanography (Hildebrand and McDonald) to deploy passive acoustic recorders offshore the Antarctic Peninsula at the seaward extent of the LTER study area. The results of this proposal effort will not be known until late 1999, at the earliest.

Donovan provided an overview of budgetary components and noted that there was no provision for data analysis. Funds for project organisation, including multiple planning meetings were included, as this had been agreed by workshop participants as fundamental to the success of the research programme. Donovan added that whenever changes to a ship's standard protocol were identified at a planning meeting, advance warning should be given to appropriate parties planning ship logistics. A Budget Group was formed (Kato, Thiele, Leaper, Kock, Donovan) to provide a revised budget detailing functional and time-related components.

The use of autonomous bottom recorders (e.g. pop-ups) was discussed in light of the change in location of the study site. There was strong endorsement for Echo sounder (Option 1), the multiple frequency instrument, even though it represented the highest budget item of equipment. Donoghue emphasised this equipment should be promoted as a long-term investment for future surveys, an added-value to IWC sightings survey capability and that the budget could be redrafted to discount against future expenses. Additionally, he suggested project costs may be reduced on an annual basis by renting some equipment.

Gordon requested that the utility of passive-acoustic recorders (pop-ups) be revisited, as they have the potential to provide some long-term, low frequency monitoring capability. Clark responded that pop-ups could potentially be deployed offshore the Antarctic Peninsula or at the 70°E study site, depending on the objectives of the study; theoretically, deployment and retrieval can be done anywhere. Reilly responded that, as pop-ups would not be included in year one of the project, discussion papers should be prepared for next year's Scientific Committee meeting describing the pros and cons of pop-ups. Thiele asked to be advised as far ahead as possible of any need to deploy equipment from the *Aurora Australis* in conjunction with the SO-GLOBEC study.

Reilly suggested designation of a Steering Group to oversee planning of the SOWER 2000 programme. A provisional Steering Group list includes Reilly, Hammond, Thiele, Palka, Hedley, Clark, Kato, Ichii, Ensor, Donovan and Fabbri.

As convenor of the SWG, Reilly had approached Buckland and Borchers regarding the possibility for the Research Unit for Wildlife Population Assessment (RUWPA) to handle logistics and data management for the SOWER 2000 programme. The resultant proposal (Appendix 2) was summarised by Hedley and a budget was presented for the forthcoming collaboration with CCAMLR. However, the sub-committee recognised that Appendix 2 should also be viewed as a proposal to coordinate logistics for the IWC collaboration with SO-GLOBEC in 2000/2001, and noted that a budget would be presented for this at next year's Scientific Committee meeting. The proposal was generated in response to the perceived need for someone to lead logistics for this multifaceted study. Each vessel will require a unique protocol supported by varying numbers of observers/researchers. To ensure that data are collated in a consistent manner, the administrative details outlined in Appendix 2 must be addressed. RUWPA also maintains DESS (database estimation software system) for the IWC. DESS currently manages sightings data from IWC, IDCR, JARPA, JARPN, NASS and SOWER data and can provide density estimates using DISTANCE software.

Donoghue enquired as to funds budgeted for travel for observers and/or trainers. Donovan responded that details of who would travel where had yet to be resolved. Reilly noted that as the IWC becomes involved in large-scale field work, its choice is to either expand the Secretariat, or to contract out duties described in Appendix 2. From that, Reilly asked if the Working Group could endorse the RUWPA proposal. Hammond indicated his support based on the unique capabilities of RUWPA and estimated costs at roughly 1% of the overall budget (i.e. less than that for the SCANS survey). Donoghue suggested that the administrative/logistic work described might be put out for competitive bid. Perrin noted that the IWC was not required to take that course. Thiele reiterated the unique background and talent available via RUWPA in data management and analyses. Cipriano enquired as to how person-days were calculated in the budget, and Gordon suggested that the line item for the design of new specialist software be open to competitive contract award. Donovan responded that it is difficult to estimate the number of person-days required for tasks identified in Appendix 2 and indicated that the person IWC contracts for DESS database management may be able to help with unforeseeable circumstances in the planning of SOWER logistics. In summary, the SWG **recommends** RUWPA be funded for the task as described in Appendix 2.

Hedley noted that Borchers had offered to convene a Modelling Group to support SOWER 2000, as recommended in the Workshop Report. Members of the Modelling Group include Hammond, Palka, Brown, Bravington, Hedley and Clarke. Reilly suggested this group establish e-mail correspondence in addition to planning meetings.

Hammond enquired as to the budget item for Remote Sensing Devices (SC/51/Rep2: item 4.2.1) noting that a decision on this matter had to be made soon. Reilly described use of similar devices in foraging dynamics work on blue whales offshore Southern California. Donovan and Clark reiterated a need to establish a mechanism for work on these instruments to begin as soon as possible. Reilly closed by summarising that the Working Group had discussed the SOWER 2000 Workshop Report (SC/51/Rep2) and had found the details relating to the programme acceptable.

The SWG wishes the Committee and Commission to keep the following points in mind when considering the SOWER 2000 budget (Table 4):

(1) With respect to many of the equipment items, their value extends well beyond the two-year period of this project. In particular, much of it will be of value to future surveys under the SOWER programme or in conjunction with other collaborative 'platforms of opportunity' work.

In addition, although the development costs of the remote sensing devices are relatively high, the costs of the devices themselves will be of value to many aspects of the Committee's work as well as other research programmes.

(2) Similarly, the value of several of the meetings, particularly the modelling and analysis meetings, is of long-term benefit to the Committee's attempts to address a number of issues related to distribution, abundance and monitoring, as well as to environmental issues. Again, improvements and standardisation of data collection (and subsequent analyses) arising from collaborative 'platform of opportunity' work is of long-term benefit to many aspects of the Committee's work. Linked in with this is the value of having a pool of experienced and well-trained observers.

(3) There is considerable opportunity for national governments to make contributions 'in-kind' to this programme. For example, the costings exclude the enormous contribution made by the Government of Japan in supplying vessels and crew. It would be appropriate for other nations to consider *inter alia* donating or loaning equipment, paying for experts to attend meetings/workshops or paying for observers on vessels.

In summary, the SWG **strongly recommends** endorsement and funding of the SOWER 2000 proposal.

6.2 Habitat

6.2.1 Habitat use patterns (other than SOWER 2000)

Ensor presented SC/51/E1 on the distribution of minke whales in the Bellinghausen and Amundsen Seas with reference to environmental variations. The paper examined the distribution and abundance of minke whales in Antarctic Area 1 (60°-120°W) in relation to sea surface temperature, sea ice extension and sea bed type. The analysis was based on sightings data obtained from the 1982/83 and 1989/90 IWC/IDCR cruises. The mean sea surface temperatures for comparable areas were significantly higher in 1989/90 than in 1982/83. Additionally, the extent of the sea ice in 1989/90 was less than in 1982/83 with the ice-edge 50 n.miles further south. The distribution of minke whales was substantially different between the two surveys, with the density and abundance greater in 1982/83 than in 1989/90. When compared with those seen in 1982/93, the warmer sea surface temperatures and smaller extent of sea ice seen in 1989/90 may be related to the difference in the distribution of minke whales, and it was hypothesised that this may be related to a shift in prey availability.

Ichii commented that the periods 1982/83 and 1989/90 analysed in SC/51/E1 were before and after an oceanographic regime shift in the study area and noted with interest the apparent changes in minke whale distribution in response.

Kock suggested it would be interesting to analyse 1990s data for this region as there has only been one strong year-class of krill since, and that the size of krill declined such that with a third period added to the analysis this pattern may be even more apparent.

Kato noted that the 1999/2000 SOWER cruise was planned for the region 80°W-60°W so that data from that cruise could potentially be applied to the analyses. Bravington suggested that the analytical approach suggested in SC/51/O13 might be applicable.

Hedley presented SC/51/O13 which described two approaches being developed to estimate abundance from line transect survey data and attempts to model large-scale spatial trends and smaller-scale spatial correlations. The methods use generalised additive models to estimate a continuous density surface for the survey area, which is then integrated to provide an estimate of abundance for the entire area. The potential use of these models to help explain cetacean distribution using physical variables was described. It was also noted that spatial models such as those described in this document are likely to be an important component of methods which integrate process models and survey data to relate cetacean distribution to the distribution of their prey. Hedley noted that models could be improved with more covariates and that there was potential value in modelling data from platforms of opportunity.

Ensor noted that analyses relating distribution to environmental patterns should stress underlying

Table 4

Costings for the SOWER 2000 project.

		No.	Cost (local)	Cost (£)	Total (£)	Agenda Item	Ist Year applicable	Future also?
EQUIPMENT								
THIS YEAR:	Automated Passive Acoustics System	2		10,000	20,000	4.1.5	1999/2000	yes
	Video Cameras	2	2,000	1,251	2,502	4.1.2	1999/2000	yes
	Remote Sensing Devices (incl. development)	1		35,000	35,000	4.2.1	1999/2000	some
	Ship trials	1		10,000	10,000	4.2.1	1999/2000	no
	Computers (CCAMLR vessels)	2		1,000	2,000	4.1.2	1999/2000	yes
	Binoculars normal (7X50)	6	500	313	1,876	4.2.2	1999/2000	yes
	Binoculars big-eyes	1	12,000	7,505	7,505	4.2.2	1999/2000	yes
	SUB-TOTAL				78,882			
NEXT YEAR:	Automated Passive Acoustics System	1		10,000	10,000	4.1.5	2000/1	yes
	Computers (GLOBEC vessels)	1		1,000	1,000	4.1.2	2000/1	yes
	Binoculars normal (7X50)	3	500	313	938	4.2.2	2000/1	yes
	Binoculars big-eyes	2	12,000	7,505	15,009	4.2.2	2000/1	yes
	Pop-ups	?		10,000	0	4.1.5	2000/1	
	Biopsy guns	3		1,000	3,000	4.1.6	2000/1	yes
	Biopsy darts	60		50	3,000	4.1.6	2000/1	some
	Rigid Hull Inflatable	0			0	4.2.1	2000/1	yes
	Small, Portable Active Acoustic System	1	30,000	18,762	18,762	4.2.1	2000/1	yes
	Echosounder -multiple frequency	1	165,000	103,189	103,189	4.2.2	2000/1	yes
	XBTs (max)	200	80	50	10,006	4.2.2	2000/1	no
	Flow-through oceanographic sampling system	1	30,000	18,762	18,762	4.2.2	2000/1	yes
	ADCP	1	30,000	18,762	18,762	4.2.2	2000/1	yes
	Computers (IWC vessels)	4		1,000	4,000	4.2.2	2000/1	yes
	SUB-TOTAL				206,428			
ORGANISATION, DATA STORAGE AND ANALYSIS								
THIS YEAR:	MEETING PARTICIPATION:							
	IWC modelling group (1)	6			9,000		1999/2000	
	SO-GLOBEC - Planning	2			3,000		1999/2000	
	SO-GLOBEC - Modelling	4			6,000		1999/2000	
	CCAMLR - Planning	1			1,500		1999/2000	
	CCAMLR - Modelling	3			4,500		1999/2000	
	IWC Planning Meeting Specialists	5			7,500		1999/2000	
	IWC Additional planning meeting	15			22,500		June?2000	
	SUB-TOTAL				54,000			
NEXT YEAR:	IWC modelling group (2)	6			9,000		2000/1	
	SO-GLOBEC - Analysis	4			6,000		2000/1	
	CCAMLR - Analysis	4			6,000		2000/1	
	IWC Planning Meeting Normal	5			7,500		2000/1	
	IWC Planning Meeting Specialists	5			7,500		2000/1	
	SUB-TOTAL				36,000			
THIS YEAR:	CRUISE PARTICIPATION:							
	CCAMLR-48	12		9,000	108,000		1999/2000	
	Training (Observers and Trainers)				11,400		1999/2000	
	SUB-TOTAL				119,400			
	SO-GLOBEC	4		9,000	36,000		2000/2001	
	SOWER - sighting	8		9,000	72,000		2000/2001	
	SOWER - foraging	4		9,000	36,000		2000/2001	
	SUB-TOTAL				144,000			
DATA VALIDATION AND STORAGE								
	SO-GLOBEC and CCAMLR-48	0						
	SOWER	0						
DATA ANALYSIS								
	SO-GLOBEC and CCAMLR-48			SUBSTANTIAL*			1999/2000	yes
	SOWER			SUBSTANTIAL*			2000/1	yes
SUMMARY								
	THIS YEAR'S COSTS				252,282			
	NEXT YEAR'S COSTS				386,428			

* It is difficult to specify costings for this until the quality and quantity of data obtained are known.

oceanographic variables associated with features such as fronts and the ice-edge.

Matsuoka presented paper SC/51/E5 on the application of XCTD's during oceanographic survey in Antarctic Area IIIE and IV during the 1997/98 JARPA cruise. Whale habitats were associated with a zone of high productivity associated with the southern boundary of the Antarctic Circumpolar Current.

According to the XCTD oceanographic survey and sightings surveys in the JARPA 1997/98 season, the southern boundary of the Antarctic Circumpolar Current (ACC) appeared to be 63-64°S from offshore Enderby Land (50°E) to Wilks Land (130°E), and there was the large meander that seemed to proceed north along the continent rise to 61°S (between 80° and 100°E). The concentrations of humpback and southern bottlenose whales were clearly linked longitudinally to the meander of the southern boundary of the ACC, especially between 80° and 100°E. Sperm whales also tended to be more or less abundant in the meander. On the other hand, minke whales tended to distribute south of the southern boundary of the ACC, especially near ice-edge line. The distribution patterns of humpback and southern bottlenose whales suggests an abundant occurrence of krill and squid in the meander of the southern boundary of the ACC. It is therefore suggested that the waters in the meander of the southern boundary may be a good habitat and hence a key area for monitoring cetacean populations.

Reilly queried how difficult the XCTDs were to deploy; the answer given was that the instruments were easily used but expensive (*ca* $400US). Peddemors asked whether habitat pattern as described in SC/51/E5 could be incorporated in the survey design. Hedley responded that stratification by expected density is often carried out when tracklines are designed. Ensor noted that the meander noted in SC/51/E5 was a well described interannual oceanographic feature and went on to add that the spatial distribution of sightings during the most recent IWC-SOWER cruise (the 1998-99 cruise) was very similar to that described in SC/51/E5, which relates to the previous year.

Reilly encouraged additional analyses and quantification of the habitat patterns described in the paper. Clark further noted that the temperature/salinity profiles provided in SC/51/E5 are particularly important in the context of dual-mode (acoustic and visual) surveys because the water column profiles can be used to derive sound transmission loss models allowing better prediction of acoustic survey capability.

Palka presented SC/51/E12 on the summer habitat characteristics of cetaceans in the western North Atlantic. The study investigated summer (June-September) habitat usage patterns of cetaceans in the northwest Atlantic Ocean. Data from 10 shipboard sightings surveys conducted between 1990 and 1996 were used to formulate a model of habitat usage patterns. The data from two surveys conducted during 1997 and 1998 were then used to test the predictability of the model. Cluster analyses were used to classify the species into four sub-groups. Within each sub-group logistic regression was used to model the sighting rates with oceanographic and topographic characteristics at the time and place of the sighting. In particular, the characteristics were sea surface temperature, monthly front probability, depth, slope and aspect. The logistic regression model indicated that the distribution of the species is most highly correlated with depth, temperature and slope. In addition, within each sub-group the correlation of the sighting rates between species were used to indicate that some species share the local spatial habitat while other species show local segregations.

Clapham presented SC/51/CAWS3, which reported on a multidisciplinary workshop on right whale distribution held in 1998. The Workshop brought together biological and physical oceanographers, right whale biologists, ecosystem modellers and statisticians to discuss whether it is possible to predict the distribution of right whales (notably the location of concentrations) from remotely sensed environmental data. This would have great value for management, notably with regard to mitigation of entanglement and ship strike mortalities in the western North Atlantic. The primary value of the Workshop was to establish connections among participants from the different disciplines, and to develop recommendations for promising directions for future work. The latter included retrospective studies (with an emphasis on examining major shifts in distribution), field tests of predictions from sea surface temperature frontal or other real-time data, and a variety of related studies on behaviour, foraging, energetics and the importance of scale (both spatial and temporal) to the potential capability of predicting right whale habitat.

Reilly noted that the Workshop had covered many important topics that are of relevance to the work of the SWG. He found it interesting that a statistical approach to the problem was not necessarily the best, in that it was limited by small sample sizes and that some of the other approaches showed promise.

6.3 Long range plan for Southern Ocean Sanctuary

SC/51/O12 reported on a visual survey in the Southern Ocean and Indian Ocean Sanctuaries. A team of four observers was placed on the vessel and observations were made with the naked eye from a single platform. Environmental variables and sightings data were recorded directly to a computer, although no attempt was made to estimate strip widths in the paper. A total of 282 hours of systematic effort resulted in sightings of a number of different species. Humpback whales were the most commonly recorded of the large whales with a total of 28 individuals. Fifteen humpback whales were photographed for identification purposes. The authors commented on the low number of minke whale sightings especially along the Ross Sea ice-edge.

SC/51/O17 described a passive acoustic survey around the island of South Georgia conducted from the British Antarctic Survey vessel RRS *James Clark Ross*. A simple two element hydrophone array, sensitive to frequencies of between 300Hz and 24kHz, was towed on a 400m cable astern of the vessel. A total of 4,200km of acoustic effort was achieved in two small regions around South Georgia and on passage between the Falkland Islands and South Georgia. The equipment was most suitable for detecting odontocete vocalisations with confirmed detections of sperm whales, killer whales, pilot whales and hourglass dolphin. Low frequency sounds that may have come from baleen whales were also detected but have yet to be identified. Ranges to sperm whales were obtained from crossing bearings allowing an estimate of the mean maximum range of 6.1km ($CV = 0.16$) at which sperm whales could be detected. The use of this equipment allowed cetacean data to be collected at the same time as other detailed biological and oceanographic research without any dedicated ship time or the need for a large team of visual observers.

Ohsumi and Moronuki questioned the necessity of the Southern Ocean (SO) Sanctuary for this research, i.e. whether this type of research could be conducted in the absence of a sanctuary. Leaper responded that the research could be conducted without such designation but that it did contribute to the objectives for the sanctuary as designated by the Commission.

Reilly opened discussion on Resolution 1998-3 (IWC, 1999a, pp.42-3) requesting information on long-term study in the Southern Ocean Sanctuary, noting that SOWER 2000 is not yet a long-term research programme (depending upon decisions by the Commission) and that the future of the larger SOWER effort is yet to be determined.

Kock noted that CCAMLR activities were likely to continue in the SO Sanctuary for the next 5-10 years. He encouraged the IWC to continue collaborating with CCAMLR after SOWER 2000 by conducting regular systematic whale sightings surveys as part of CCAMLR's long-term field programmes, including those in its Integrated Study Sites. He noted the US programme on the Antarctic Peninsula as one promising opportunity. Kato indicated that the SOWER programme would continue for at least another four years, but that it might be too early to have helpful discussions on further long-range plans until the third circumpolar survey was completed.

Bravington suggested referring to the SOWER Workshop Report (SC/51/Rep2, item 4.3) as a starting point for discussion. Reilly agreed, but indicated he was also seeking other research options to be identified. Thiele indicated that opportunistic oceanographic information may be available through international Platforms of Opportunity programmes. Reilly suggested that documents proposing scientific objectives for long-term research in the SO Sanctuary need to be prepared for next year's Scientific Committee Meeting to focus discussions on this topic. Donovan suggested that anyone preparing such documents refer to the report from the 1996 IWC Environmental Workshop in Hawaii (IWC, 1997a) as a starting point.

7. OTHER CONCERNS

7.1 Noise

There was discussion concerning the potential effect of acoustic devices on cetaceans. These effects potentially work on two levels: overall sound pollution of the environment, and possible exclusion of cetaceans from important habitats. Various accounts were given indicating that harbour porpoises tolerate exposure to acoustic devices and will also avoid areas where they are operating. Palka mentioned an anecdotal observation of harbour porpoises within metres of nets with seal harassment devices (scrammers not pingers). It was noted, however, that the devices may not have been turned on. Dawson, with clarification from Northridge and Goodson, mentioned an unpublished report of a scientific study by Olesiuk and colleagues indicating harbour porpoise avoidance of harassment devices at ranges of up to 3km.

The distinction was drawn between Acoustic Harassment Devices (AHDs with source level >180 db re 1 uPa at 1m) as used on fixed aquaculture sites to reduce pinniped predation, and Acoustic Deterrent Devices (ADDs with source level typically <150 dB re 1 uPa at 1m) which have the implicit function to deny small cetaceans access to the hazardous area immediately surrounding fishing nets.

Although no clear evidence exists to support the habitat denial hypothesis, it was recognised that there may be risks associated with ADDs used in long-net and multiple-net deployments. Such deployments will require consideration by fishery management, e.g. where a long, pingered gillnet might obstruct access to an important habitat (this problem is addressed in Annex I, item 5.3.3).

Goodson addressed the suggestion that general ocean noise 'pollution' will increase with more extensive ADD pinger usage in fisheries. He stated that the effective range of current commercial ADD devices is known to be very short (typically <200m), and as these devices are pulsed and operate asynchronously, there is no measurable summation of effect to create an increase in overall sound pressure level, and the zones protected remain limited to the displacement radius around each individual device. Other members did not agree, and argued that in fact there is a summation effect given the operational use and deployment of ADDs in gillnet fisheries.

Goodson further noted that louder devices (AHDs) are frequently in operation close to shore, in estuaries, fjords and sea lochs. Evidence so far to suggest these devices can cause unwanted effects on non-target species is equivocal but the potential for this to occur in enclosed waters is recognised. The development of 'interactive' devices to ensure the selective activation of AHDs only when the target predator is known to be present might help reduce unwanted effects.

After some further discussion, Reilly suggested that it appeared to be worthy of more focused attention, which would be advanced by papers on the subject of impacts of acoustic devices on cetaceans.

There was some further discussion as to whether there is a change in echolocation behaviour associated with pingers. Northridge gave an example of this from SC/51/SM48 in which echolocation rates decreased. Dawson reminded the committee of Au *et al.* (1985) which showed a shift in centre frequency for white whale clicks when the animals moved from San Diego to Hawaii which have different ambient noise properties.

Reijnders suggested that seismic survey impacts be incorporated into any overview of noise impacts. Depending on propagation conditions, seismic survey sounds can propagate tens to hundreds of miles so that the scale of the area over which animals are exposed varies broadly. Gordon continued that in some places (e.g. around UK and Norwegian waters) seismic activity could possibly impact sightings survey results if whales were reacting to the seismic noise.

Simmonds presented SC/51/E15 as an update to a previous submission to the Scientific Committee (Dolman and Simmonds, 1998). The paper described the range of potential impacts intense sounds might have on cetaceans. Simmonds noted that evidence had come to light since the last Committee meeting on the disturbance of several cetacean species off the coast of Scotland by seismic surveying. While it has generally been assumed that marine mammals will sometimes move away from loud noises (e.g. gray whales entering near-shore sound shadows) such a response requires the whales to be able to localise the source and recognise it as a threat. Localisation may be confounded by:

(1) several sources operating at the same time in an area (as is sometimes the case in seismic surveying);
(2) sources acting only intermittently; and
(3) sound convergence zones.

Simmonds suggested that further work on noise by the SWG might focus on identification of relevant methodologies, particularly with respect to the biological responses of cetaceans, and noting the overlap between such considerations and the interests of the sub-committee on whalewatching.

Fox provided a brief overview of some of the major issues involved when considering noise impact. This included differentiating between a noise impulse (seismic pulse or short duration ping) and an average increase in ambient noise, a need for better understanding of auditory physiology, the physical acoustics of a particular region and annual distribution and abundance within the region. Clark added that it was important to understand that an animal's response to a noise source can vary considerably depending on the behavioural context.

In summary, the SWG expressed concern over potential adverse effects of anthropogenic noise on cetaceans. The SWG recognises that this is a complex subject and that scientific study on this issue involves the integration of a broad range of disciplines including acoustics, audiology, physiology, behavioural ecology and population biology etc. The SWG further recognised that with the current limited knowledge of cetaceans the risks associated with noise exposure cannot be easily quantified for most species.

Complexities aside, the SWG recognised that mitigation and careful use of sounds are direct and effective mechanisms for reducing potential impact. For example, not conducting noise producing activities (pingers, seismic survey, sonar operations) in a critical habitat at a certain time of year can greatly reduce exposing mothers and calves or breeding animals to high sound levels. It therefore recommends the use of mitigation measures wherever possible and emphasises the need for continued research on this matter.

Given that the SWG has particular interests and expertise in population level effects from human actions on cetaceans, there would be considerable value in the Scientific Committee's continued attention to this matter. For example, the Scientific Committee could most likely provide valuable advice on how to translate research results from noise impact studies into population level effects. Another issue raised was the potential impact of very loud, broad-scale sources (e.g. Navy LFA sonar, shipping, seismic survey) on cetacean surveys, since these acoustic activities might effect sighting rates or distributions if whales are responding to anthropogenic noise.

The question arose as to how the Committee becomes better informed on the subject of anthropogenic noise impacts on cetaceans without expending unnecessary amounts of time and energy. Over the past few years there have been several workshops and special meetings as well as several major research efforts on this subject. One important result of the workshops and research has been that some agreement has been reached on the most important concerns (usually a combination of audiology, behavioural ecology, acoustic propagation and the parameters of the noise source) and the most critical research needs. One possible constructive step for next year's meeting would be to have an overview of these newer materials as well as copies of the pertinent reports and papers. The SWG does not recommend covening a special IWC workshop on this topic in the near future since it would not be an effective use of IWC resources. It noted that the Acoustic Society of America will hold a technical session at its Autumn 1999 meeting and that there will be a bioacoustics workshop preceding the Marine Mammal Conference in Autumn 1999, Hawaii.

7.2 Ozone depletion and UV-B

No papers were presented focusing on the topic of ozone depletion, although Moore briefly summarised a recent publication (Waibel *et al.*, 1999) indicating that chemical processes that underlie ozone depletion in the Arctic are not the same as in the Antarctic. Even though CFC emissions are decreasing it is expected that there will be a continued loss of atmospheric ozone over the Arctic for at least 15 more years due to nitrification processes. Perry pointed out that in addition, certain other halons are increasing in the atmosphere and will also contribute to ozone depletion.

7.3 Habitat degradation

No papers were received focusing primarily on this topic, but aspects of three documents previously discussed (SC/51/E3, E14 and SC/51/SM47) were relevant.

Concern was expressed regarding the possible habitat degradation for gray whales if a proposed salt works is constructed at San Ignacio Lagoon, Baja California Sur, Mexico, one of the three main breeding grounds for the eastern Pacific gray whale.

In 1994, Exportadora de Sal (ESSA) asked for a permit seeking to extend operations, initiated in 1954 at Ojo de Liebre (Scammon's lagoon), to San Ignacio salt flats, surrounding the lagoon and within the buffer zone of El Vizcaino Biosphere Reserve established in 1988. In accordance with Mexican law, a Statement of Environmental Impact was presented by ESSA in 1994. Due to insufficiencies in the statement, the Mexican authorities denied the corresponding permit. ESSA then lodged an appeal of dissent against the negative decision.

The Mexican Government approached the IWC in order to request assistance in selecting scientists that would take part in the review process (IWC, 1996, p.41). An advisory group made up of seven scientists from different countries and areas of expertise was established. After consultation with the IWC, three well known gray whale scientists, including Reilly, were nominated to the Scientific Advisory Committee, they participated in a number of meetings which developed scientific Terms of Reference for a more detailed Environmental Impact Assessment (IWC, 1997b, p.66). The development of the new Environmental Impact Assessment is underway but to date, no new statement based on the rigorous Terms of Reference provided by the advisory group has been presented. The project has not been approved and thus there is no development towards it at San Ignacio.

*7.3.1 Workshop proposal (Resolution 1998-6) (*IWC*, 1999a, pp.44-5)*

The SWG received a revised proposal for a Workshop on Habitat Degradation (Appendix 3), which was presented by Simmonds. After some discussion, the SWG agreed to continue development of the proposal. An intersessional Steering Group was established comprising Simmonds, Leaper, Parsons, Peddemors, da Silva, Stachowitsch, Thiele, Gordon, Donoghue, Fabbri, Perry and Lauriano. They will work by correspondence to bring a final proposal to the next Annual Meeting, with a tentative plan to conduct the Workshop during the 2000-2001 intersessional period.

7.4 Effects of fisheries

No papers were received primarily focusing on this topic, but aspects of three documents previously discussed (SC/51/E3, E14 and SC/51/SM47) were relevant.

7.5 Disease and mortality events

In response to document SC/51/E14, Pérez-Cortés summarised information on gray whale mortality in the breeding grounds of the Baja California peninsula, as presented in document SC/51/AS30. During the previous winter season (1998/99) strandings of gray whales had attracted public attention, particularly after two whales were found dead close to San Carlos, a small town at Magdalena Bay, from where whalewatching is being conducted. Much concern was expressed in both the local and international media. Local authorities even considered the possibility of implementing an environmental contingency plan. After preliminary analysis of the data presented in SC/51/AS30 the environmental contingency was not declared and the news of the issue suddenly stopped. Although analysis of the data is still underway it was pointed out that the search effort for dead gray whales during this season was more complete than in any previous year. One partial and one complete aerial survey were conducted specifically directed to search for stranded whales. Additionally, beaches with high whale stranding rates were covered using all-terrain vehicles. By the end of the season a total of 89 stranded whales had been recorded.

The distribution of whales had been very different in the past two years due to the effects of El Niño and La Niña (as presented in document SC/51/AS31). During winter 1999 the whales were relatively more abundant at the southern most lagoon (Magdalena Bay complex). While in past studies a difference was not seen in the frequency of stranded males and females, this year a significantly higher number of dead females was recorded. While in normal years (without the effects of La Niña or El Niño) the number of stranded calves predominated, during the last season the dead adults predominated. Mass strandings caused by single agents (for example severe poisonings) may involve several species of marine mammals among other fauna and might be restricted both in space and time. In this case and in opposition to the media suggestions like those recounted in SC/51/E14 the strandings of gray whales are considered neither a single event nor cause for alarm. They occurred during the winter season and along the gray whale range and do not appear different from the past La Niña years.

It was inquired whether more animals had died during El Niño years. Pérez-Cortés responded that the situation was not entirely clear, but some dead animals appeared to be in poor body condition, and there also appeared to be a change in distribution during those years. In combination this may increase strandings in some locations over those observed in non-El Niño years. This subject was also considered in Annex F.

7.6 Community-level effects

Haug introduced SC/51/E7 and SC/51/E8 which considered diets of northeast Atlantic minke whales in the Barents Sea. SC/51/E7 highlighted the dynamic nature of minke whale feeding habits in relation to large-scale changes in prey abundance. Substantial changes have occurred in the Barents Sea ecosystem over the past 30 years, the most conspicuous being related to the rise and fall of stocks of the two dominant pelagic shoaling fish species: capelin (*Mallotus villosus*) and herring (*Clupea harengus*). Thanks to extensive annual studies since 1992, effects of these large-scale ecological changes on the diet and food consumption of minke whales can be assessed. Following a collapse in the capelin stock in 1992/1993, minke whales foraging in the northern Barents Sea apparently switched from a capelin-dominated diet to one almost completely comprised of krill (*Thysanoessa* sp). The recent prominent role of krill as whale food in the northern areas is consistent with the current status of the Barents Sea ecosystem which, after the capelin collapse, has been characterised by relatively large standing stocks of krill. Krill is the major food of capelin, and there are strong indications of a predator-prey inter-relationship where krill populations to be controlled by capelin predation. The southern region of the Barents Sea includes important nursery areas for the Norwegian spring spawning herring. Good recruitment to this stock gives strong cohorts and large numbers of young, adolescent herring (0-3 years old) which serve as the main food for minke whales feeding in the area. This characterised the period 1992-1994. Recruitment failure with subsequent weak cohorts of herring, as seen in the period 1993-1997, seems, however, to reduce the availability of adolescent herring to such an extent that minke whales switch to other prey items such as krill, gadoid fish and capelin. Even though minke whales are rather euryphageous and flexible in their choice of prey, the observations made in the Barents Sea may indicate that krill represent an important food alternative for the whales in periods when their more preferred food, such as capelin and herring, occur more scarcely.

Using the results from the annual studies of whale diets in the Barents Sea since 1992 in combination with results from annual acoustic surveys of herring in the Barents Sea, paper SC/51/E8 assessed in more detail the dynamics in minke whale predation upon this important forage fish. The abundance of immature herring year classes in their nursery areas in the southern Barents Sea has been highly variable. One or a few strong year classes are usually followed by several years of poor year classes. In the period 1992-1995, the northeast Atlantic minke whale appeared to have consumed 610,000 tonnes of adolescent Norwegian spring-spawning herring annually in the Barents Sea area. The major part of this belonged to the very strong 1991 and 1992 year classes. The observed variations in herring importance as whale food seems to relate closely to the fate of the herring stock in the sea in the same period. An example of this was when the major part of the 1992 year class migrated out of the Barents Sea in 1995. Since all subsequent herring cohorts (1993-1997) are weak, this was followed by a severe reduction in the dietary importance of herring in the following years. Folkow *et al.* (2000) had reported that during the period 1992-1995, minke whales may have consumed as much as 1.3-1.4 and 0.8-1.0 million tonnes of the two strong herring year classes of 1991 and 1992, respectively. Parsons suggested that the SWG should have access to this paper to better evaluate these figures and Haug pointed out that the paper had been submitted to the Scientific Committee two years ago.

In response to Stachowitsch's question on the reasons for the collapse of the Barents Sea capelin stock in 1992, Haug replied that as yet there was no clear answer to that question and that information would become available in the future on the body condition of minke whales feeding on less preferable prey.

There followed a discussion on the topic of what was referred to as a 'top-down' predator-prey system. This was stimulated by the SC/51/E7 results indicating that minke whale stomach contents changed in relation to the fluctuations in abundance of the prey items herring, capelin and krill. Haug clarified that a top-down predator-prey relationship had been identified for capelin and krill in the Barents Sea. Data availability was, however, insufficient to assess whether similar top-down relationships existed between minke whales and their prey.

Ichii presented SC/51/O1 which investigated species diversity and biomass of the whale community in relation to the distance from the ice-edge in the Indian Ocean sector of the Antarctic. The species diversity was the lowest near the ice-edge and increased to a constant level in waters beyond 60 n.miles away from the ice-edge. The density and biomass showed an opposite trend, as their values were the highest near the ice-edge and decreased with distance away from it. Thus, fewer species with larger numbers and larger total biomass were featured in the high-productivity region near the ice-edge, while more species with lower numbers and lower total biomass were featured in the low-productivity region away from the ice-edge. Species diversity in the regions where the depleted large whales are recovering have increased with time (primarily as a result of an increase in humpbacks) suggesting that the baleen whale community appears to be moving towards a new balance of species diversity in its recovery from past whaling.

DeMaster questioned whether it was appropriate to reference Laws (1985) as the primary supporting document for the conclusion that stocks of Antarctic minke whales doubled as a result of the decrease in blue whale abundance due to commercial whaling.

Tamura presented Tamura and Ohsumi (1999). In this paper, levels of annual food consumption by cetaceans were calculated for the world's oceans based on recent abundance estimates of cetaceans. These levels were calculated using three estimation methods in the oceans of the Southern Hemisphere, North Pacific and North Atlantic. The conclusion was that the estimated total annual consumption of cetaceans was calculated to be between 143 and 269 million tonnes in the Southern Hemisphere, between 65 and 99 million tonnes in the North Pacific and between 63 and 129 million tonnes in the North Atlantic. The total annual food consumption by cetaceans was estimated to be between 280 and 500 million tonnes, and is equivalent to 3-6 times the recent total worldwide catch by marine commercial fisheries. Because of this, in recent years, increasing attention is being paid to interactions between commercial fisheries and cetaceans. This information paper pointed out that cetaceans are top predators in the marine ecosystem, play an important role in the food web since they feed on both vertebrates and invertebrates, and also compete with fisheries. This competition occurs directly when whales target fish as their food, or indirectly when they prey on marine organisms (e.g. krill) that are eaten by fish.

Tamura noted the need for more information about cetacean abundance as evidenced by the lack of abundance data for many species of cetaceans. As a result of this he concluded that the total annual food consumption by all cetaceans in each ocean area is likely to be larger than indicated in his paper. Also lacking are sufficient data on the seasonal, local and annual distributions of cetaceans and their prey. He pointed out that the objective is to build up a global, multi-species understanding of marine organisms including cetaceans, to allow development of a reliable fisheries management strategy that includes long-term sustainability of the marine ecosystem in the world's oceans.

DeMaster stated that the estimate for the North Pacific sperm whale abundance used by Tamura and Ohsumi was both out of date and based on data techniques no longer considered reliable. He recommended that delegates only use abundance estimates that are scientifically defensible. Parsons questioned the validity of the conclusions in Tamura and Ohsumi (1999). He noted that the paper had assumed that baleen whales consumed prey species 365 days a year, which is known not to be the case in many species. He also noted that the estimate of the number of minke whales in the North Atlantic exceeded the estimate recognised by the IWC and would therefore cause a considerable over-estimation of fish consumption. Finally, in the calculations conducted in the paper the authors assumed in many cases that all animals were adults. This would cause an additional overestimation as demographically a large proportion of the animals will be calves and juveniles which would consume considerably less prey than adults. In response to a question, the author clarified that the paper referred to the consumption of prey species by cetaceans, rather than food that might otherwise be used as food for humans.

Donoghue presented Young (1999). This paper was produced by CSIRO Australia, to investigate the likely potential of present or future populations of large whales having a significant impact on commercial fishing in the South Pacific Ocean, either directly (by consuming commercial species such as tuna), or indirectly (by competing for prey resources). A fundamental point made in the paper was that a lack of understanding of the complexities of marine ecosystems meant that controls at one end may give vastly different results to those expected at the other end.

The populations of baleen whales in the South Pacific have been heavily impacted by commercial whaling during the twentieth century, and have been reduced to less than 10% of initial biomass. In the South Pacific, whales and tuna occupy different trophic niches, and the food webs that support them are generally quite different. Although they may overlap both in time and space, whales and tuna rarely compete for the same food. Most of the baleen whales found in the region migrate annually to the Southern Ocean to feed on krill, and fast during their time in tropical latitudes. Bryde's whales, the only true resident of the region, appear to eat euphausiids rather than small fish. Even in those other oceanic areas where there appears to be a greater degree of overlap between marine mammals and commercial fisheries, the amount of fish eaten by predatory fish is an order of magnitude higher than that eaten by marine mammals. In terms of competition for primary production, marine mammals appear to mainly exploit feeding niches that are not exploited by commercial fishing operations, targeting species such as deep-water squids and lantern fish. The available evidence therefore suggests that, particularly in the South Pacific, there is little direct competition for food resources between whales and commercial fisheries. It was noted that there have been reports of killer and pilot whale interactions with longline fisheries, although the problem of shark predation on hooked fish is currently far greater. The cyclic nature of environmental fluctuations in marine ecosystems, however, far outweighs any possible changes brought about by competition and predation.

The paper concludes that:

(1) protecting whales from hunting will not lead to a disruption of the marine ecosystem;
(2) there is little evidence of overlap between whales and commercial fishing in the South Pacific Ocean;
(3) an increase in the number of whales in the South Pacific will not lead to a reduction in the number of tuna.

Haug expressed concern with conclusion (1) which appeared to extrapolate the results from the South Pacific Ocean studies to other areas which he regarded as inappropriate.

Moronuki expressed his concern that the paper by Young was prepared with very little scientific evidence regarding cetaceans in the South Pacific region, and pointed out that no conclusions can be drawn at this stage concerning the competition between baleen whales and fishery activities in the region without information on the feeding ecology of cetaceans in the region. He also pointed out that most of the information used in the paper was old, especially the data by which Young concludes that there is no competition between whales and fisheries. Moronuki believed that since 1988 both fisheries activities and number of whales have significantly increased and that it is probable that the competition among them is now much more serious than in 1988.

The SWG was reminded that although the topic was worthy of greater discussion, there was neither the time nor sufficient information to embark on such an exercise. Shimadzu acknowledged efforts made by Tamura and Ohsumi, and emphasised that cetaceans do play important roles in marine ecosystems, that multiple species such as blue whales and minke whales in the Antarctic do compete for common food resources, that whales do compete with fisheries for some of these resources and hence that further studies should be conducted. Stachowitsch requested that any quantification of the resources consumed by whales today be put in the framework of the estimated consumption by whales prior to their commercial exploitation.

DeMaster reminded the SWG that significant progress had been made in recent years on whale population abundances and that any work on this subject must incorporate these new abundance estimates and not regress to using old, discredited figures.

Reilly commented that if this topic is to be considered for a future meeting of the SWG, it should be identified as such far in advance, that sufficient expertise and papers should be made available, and that a quantitative modelling framework should be considered.

8. ARCTIC

The SWG received two companion documents, SC/51/E9 and E10, which together presented the basis for an Arctic Initiative that will address both climate change and pollutant concerns. These documents were prepared in response to requests by the SWG and Scientific Committee at the 1997 and 1998 Annual Meetings (IWC, 1997b, p.66; IWC, 1998, p.63).

Moore presented SC/51/E9 which commented that over the past decade, monitoring and predicting the effects of global climate change (GCC) has become the focus of a variety of national and international workshops and scientific research plans (e.g. AMAP/CAFF (Arctic Monitoring and Assessment Programme/Conservation of Arctic Flora and Fauna), 1998; ARCUS (Arctic Research Consortium), 1998; Grebmeier, 1998). Specifically, the IWC sponsored a Workshop in 1996 to address concerns regarding the potential effects of climate change on cetaceans (IWC, 1997a, pp.293-319).

Marine mammals have been suggested as effective bio-indicators of GCC because of their: (1) dependence on ice as substrate-habitat (ice seals and polar bears); and (2) association with the ice-edge and other areas of comparatively high productivity in their role as apex predators (cetaceans and pinnipeds) in Arctic trophic models. In SC/51/E9 and SC/51/E10 the authors focused on this critical role of whales as bio-indicators of climate change in the Arctic.

Bowhead, gray and white whales have been suggested as the ‘best’ cetacean species to serve as indicators of climate change in the Arctic because they sample the environment at three distinct trophic levels (SC/51/E9). Bowheads feed primarily on zooplankton in the water column, gray whales suction epi- and in-faunal crustaceans from the benthos, and white whales prey on a variety of nekton including crustaceans, cephalopods and fishes. Because each of these apex predators must feed in areas of comparatively dense prey, their patterns of distribution and abundance indicate areas of high productivity for planktonic, benthic and pelagic organisms. To this list of indicator-species, SC/51/E9 adds fin, humpback and northern right whales, especially for research conducted south of Bering and Fram Straits. Each of these species would provide unique insight into ecological processes, via differences in their feeding habits and by virtue of differences in population status. In addition, the authors would retain focus on gray whales during research south of the Bering Strait to include bio-indication of benthic prey/productivity.

Arctic oceanographic research is often focused at sites where researchers hope to capture the essence of the dynamic forces that shape basin-scale patterns of hydrography and circulation. Bering Strait, Long Strait, Barrow Canyon and the Bering Sea shelf are four such sites in the western Arctic that have been the focus of extensive study (SC/51/E9).

Recent research indicates that oceanographic processes in the North Pacific and Bering Sea are changing, with concomitant variability in abundance of productivity of marine birds and mammals mediated by food web dynamics. Specifically, anomalous oceanographic conditions on the Bering Sea shelf were described during the summer of 1997.

A better understanding of whale ecology and responses to climate change in the Arctic will require coordination among cetacean-focused and oceanographic-focused research programmes. A fundamental problem in relating patterns of cetacean occurrence to climate change models is one of scale. Specifically, Global Climate Models (GCMs) are typically constructed at atmospheric and oceanic basin-scales, while cetacean research is usually conducted at meso- or regional scales. Introducing sub-models to GCMs that incorporate the ecosystem responses to physical oceanographic processes, from phytoplankton productivity through to cetaceans population status, is the central goal of this initiative.

The Arctic Council (AC), established in 1996, is a multinational forum to promote cooperation among the eight Arctic states. Two AC programmes have particular relevance to the development of an IWC/Arctic research initiative: (1) the Arctic Monitoring and Assessment Program (AMAP); and (2) the Conservation of Arctic Flora and Fauna (CAFF). The former is charged with reporting on sources, levels and effects of environmental pollutants in the Arctic, while the latter serves as a forum for scientists, indigenous peoples and managers to exchange data and to collaborate on sustainable utilisation and conservation of shared species and habitats.

O’Hara presented SC/51/E10, which concluded that tissue and exposure contaminant levels (and likely the expression of adverse health effects), and nutrients are dependent upon:

(1) trophic level;
(2) geographic region; and
(3) biological variables (body condition, stock, prey selection, etc.).

These three important factors are proposed to be vulnerable to environmental change and would affect contaminant exposure and health of cetaceans.

Changes in oceanographic and atmospheric contaminant input will alter levels at the base of the food web and ultimately the exposure to the cetacean, either as a krill- or fish-based food web, or both through various bioconcentration mechanisms. River discharges and associated changes in contaminant loading to coastal environments must be considered if climate change results in increased precipitation and subsequent runoff. It is uncertain how this will affect productivity, nutrition and cetacean health, however it should be examined.

Ongoing efforts that address this issue need to be recognised; the Arctic Environmental Protection Strategy (AEPS) programme and two groups within this organisation, the Arctic Monitoring and Assessment Program (AMAP) and the Conservation of Arctic Flora and Fauna (CAFF), are examples. These groups need to consider both krill/invertebrate and fish-based food webs in addition to top predators when doing their assessments of climate change and pollutant impacts on ecosystems and human health. Concerns in this area result from biological and cultural issues related to: contaminants; recognition of geographical differences in contaminant levels and patterns; the need for better understanding of natural variability (age, gender, etc.); and consideration of special adaptations of Arctic cetaceans and the need to study the species of concern directly. The authors highlighted that changes in oceanographic and atmospheric processes will effect contaminants and nutrient input and cycling, and that this is critical to the proposal to better understand the linkages to cetacean contamination and health.

The three indicator species proposed (bowhead, gray and white whale) will 'sample' the three trophic levels as reported in Part 1 of this initiative. The criteria used to select these indicator species represent a unique component of the food web (i.e. food habits), Arctic residence time, subsistence importance, accessibility of study and potential sensitivity to environmental change. Additional indicator species (i.e. minke whale) may be included and the participation of eastern Arctic scientists and countries is strongly encouraged.

In discussion, concern was expressed that the proposed programme's design appeared to require sampling over a very long time period in order to detect any climate-related changes, and that this was unlikely to be realised. It was suggested that in its next revision the proposal be recast in a framework similar to SOWER 2000, where the field studies will be viewed as establishing baselines. The baseline patterns will then be used in conjunction with models of environmental change constructed by climate specialists. The authors agreed with this suggestion and will build such a framework into the proposal.

There was some discussion regarding expansion of the programme to include North Atlantic minke whales. Haug commented that the developing understanding of minke whale ecology in this area makes it a good candidate for inclusion. Simmonds disagreed as in his view North Atlantic minkes did not constitute an appropriate model and he recalled the recommendations of the Bergen Workshop discussed under Item 5. The authors agreed to investigate the possibility of including minke whales by consulting Haug and his colleagues. Belikov suggested that the programme could be enhanced substantially by inclusion of biodiversity measures. The authors acknowledged the merit of this suggestion and will look into its feasibility.

Some concern was expressed about possible effects of subsistence removals on the programme's ability to link population changes to environmental changes. This was not regarded as a likely problem for either bowhead or gray whales given their migratory behaviour and the relatively small take rates. It might be a concern for white whales, depending on location and the extent of local exploitation. The authors will keep this in mind when developing the more detailed aspects of the programme.

Regarding the proposed pollutant studies, it was noted that the measured values in the existing data were quite variable, and this variability should be accounted for in formulating the programme's sampling plans. It was agreed that a quantitative sampling design was needed.

It was commented that the downstream effects of pollution from rivers and streams can be very difficult to identify and separate from other patterns. The authors agreed this would be a challenge and noted plans for process studies to help clarify the matter. This will be addressed in subsequent submissions to the Committee.

Urbán-Ramirez and Pérez-Cortés supported the proposal, and noted the potential value of the programme for understanding the ecology of gray whales, a species of special concern to Mexico. They expressed willingness to provide data, results of analyses and tissue samples from stranded whales for pollutant and nutrition studies.

The SWG thanked the authors of SC/51/E9 and SC/51/E10 for their contributions and fully supported its further development, especially considering the discussions reported above. The SWG **recommends** continued development of the Arctic Initiative, and invites presentation of the revised framework at next year's meeting.

During discussion of SC/51/E9 and SC/51/E10, Perrin suggested that a proposal for Arctic research be drafted, using the SOWER 2000 workshop report as a template. In response to that suggestion, Moore convened a small working group to outline an approach to prepare an Arctic Initiative proposal, provisionally named ARCTIC 2000+. Members of the ARCTIC 2000+ intersessional working group (Moore, O'Hara, Rowles, Urbán-Ramirez, Pérez-Cortés, Haug and Belikov) outlined available background information from their regions and agreed to work intersessionally (via e-mail) to produce a draft ARCTIC 2000+ proposal by next year's Scientific Committee meeting. Born, Belkovich, Bogoslovskaya, Tynan and Melnikov were added to the working group *in absentia*, and participation by other members was welcomed.

9. LONG-TERM PRIORITIES AND DIRECTIONS

Many members of the SWG expressed concern that in attempting to address such a varied and complex set of issues each year, the group's effectiveness may become compromised. There was general agreement that in future the group should identify one, or at most, two priority topics for each meeting, following the approach used by the Small Cetaceans sub-committee.

Topics suggested for next year included: habitat degradation in coastal areas (e.g. for river dolphins, to match the Small Cetaceans sub-committee focus on river dolphins); ozone depletion; disease and mortality events; definition and estimation of cetacean habitat use patterns; and issues related to oil exploitation. It was not possible to come to a decision given the time available. However, the SWG convenor will consult with the Scientific Committee Chair and other convenors, and inform the SWG members by e-mail, as soon as possible after the meeting.

A suggestion was put forward for the SWG to compile an annual summary on the 'State of the Cetacean Environment' (Appendix 4). The SWG agreed to try this on an experimental basis for the next meeting, and established a correspondence group to be led by Stachowitsch (members: DeMaster, Fabbri, Palka, Pérez-Cortés, Perry, Rowles, Simmonds and Thiele). They will present the first summary next year.

10. WORK PLAN

1. SOWER 2000
    - 1.1 Conduct 2000 field programme with CCAMLR
    - 1.2 Prepare for 2001 field season with SO-GLOBEC
2. POLLUTION 2000+
    - 2.1 Begin calibration study and field collections for Phase 1
    - 2.2 Prepare and plan for Phase 2
3. Complete proposal for Habitat Degradation Workshop
4. Complete proposal(s) for Arctic Initiative
5. Develop 'State of Cetacean Environment' report

11. OTHER BUSINESS

Reilly announced that he would resign after this meeting as Convenor of the Standing Working Group and thanked the participants for their hard work and enthusiasm. The SWG thanked him for his wise leadership.

12. ADOPTION OF REPORT

The report was adopted at 9:30pm on Tuesday 11 May, 1999.

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Appendix 1

AGENDA

1. Convenor's opening remarks
2. Election of Chair and appointment of rapporteurs
3. Review of available documents
4. Adoption of Agenda
5. Pollutant and contaminant issues
   - 5.1 Report of intersessional planning workshop
   - 5.2 Proposal to Commission
   - 5.3 Other topics
6. Climate change and habitat
   - 6.1 SOWER 2000
     - 6.1.1 Report of intersessional workshop
       - 6.1.1.1 Cetacean components of the CCAMLR Area 48 survey and SO-GLOBEC surveys
       - 6.1.1.2 Use of IWC survey vessels in 2000/2001
       - 6.1.1.3 Long-term objectives and collaboration
     - 6.1.2 CCAMLR

Appendix 2

PROPOSAL TO COORDINATE LOGISTICS AND TRAINING FOR THE CETACEAN COMPONENT OF MULTIDISCIPLINARY SURVEYS IN THE SOWER 2000 PROGRAMME

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Introduction

The SOWER 2000 Workshop Report (SC/51/Rep2) examines the potential use of placing IWC cetacean observers on board multidisciplinary survey vessels. In particular, attention is focused on future collaborative work with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and with the Southern Ocean Planning Group of the International Global Ocean Ecosystem Dynamics Program (SO-GLOBEC).

In January and February 2000, three CCAMLR vessels will conduct a near-synoptic survey for Antarctic krill (*Euphausia superba*) in CCAMLR Area 48, in the Scotia Sea. The forthcoming field programme for SO-GLOBEC was to include a year-round field effort in the West Antarctic Peninsula region near Marguerite Bay, but it has recently come to light that the SO-GLOBEC vessel planned to be in that area at the time of the principal IWC collaboration with SO-GLOBEC has been withdrawn. Nevertheless, it is envisaged that the principal IWC collaboration with SO-GLOBEC will take place in the austral summer of 2000/2001, although this may now be elsewhere in the Southern Ocean. The long term objectives of the SOWER 2000 programme (presented in IWC, 1998) can only be addressed by extending the collaboration with CCAMLR and SO-GLOBEC (and indeed other organisations conducting field studies in the Antarctic) over an extended time frame. Therefore, whilst the immediate objective is to consider how to proceed with the collaborative work with the CCAMLR survey in the year 2000, this document should be viewed as a proposal to coordinate logistics and training on all future multidisciplinary surveys in which the IWC is involved.

‘Piggy-back’ surveys

Although the IWC has been committed to dedicated cetacean surveys in the Antarctic for many years, first through the IDCR surveys and latterly as part of the SOWER programme, the logistics of operating cetacean observations on multidisciplinary survey vessels (hereafter referred to as ‘piggy-back’ surveys) present their own problems. Each vessel is different, there may be different numbers of IWC berths on each vessel, protocols may differ between vessels, and so on. In addition, analyses may be non-standard, depending on the protocol adopted on each vessel.

An efficient method for successful collection of cetacean data on these piggy-back surveys is to have one body organise all the logistics involved prior to the surveys, that body being responsible for everything from platform installation through to entry of data into the IWC database, DESS (Database and Estimation Software System). The Research Unit for Wildlife Population Assessment (RUWPA) was responsible for convening the SOWER 2000 Workshop and besides the considerable line transect sampling expertise within the group, is currently involved in developing methodology for the analysis of data from the SOWER 2000 programme. In addition, the two-platform asymmetric survey protocol first proposed in Buckland and Turnock (1992) and used for example, in the 1994 SCANS survey (Hammond *et al.*, 1995), is recommended in SC/51/Rep2 for the piggy-back surveys, and members of RUWPA have both practical and analytical experience with this method. Therefore, in consultation with the IWC, RUWPA is in an excellent position to take on the responsibility for the successful conduct of the IWC component of the piggy-back surveys, and would be committed to this role for the foreseeable future.

The remainder of this document is structured in such a way as to form a provisional plan of the organisational issues that must be addressed prior to, and on completion of, any future piggy-back surveys.

Tasks to be completed in advance of a survey

(a) Selection of researchers

It seems sensible to incorporate this task with the selection of researchers for the IWC-SOWER Antarctic minke whale cruise. It is not envisaged that RUWPA would be responsible for the hiring of researchers for the piggy-back surveys, however some involvement in the selection would be preferable.

(b) Description of survey protocols, design of data forms and preparation of usage notes

RUWPA would provide a detailed description of the survey protocols and data entry procedures, which would likely include computerised data entry. A key element of this task is to ensure that the protocols are as similar as possible across all vessels.

(c) General logistics and coordinating the collaboration

RUWPA would be responsible for determining suitable platform locations and arranging any necessary construction on board the vessels with this regard to ensure that the assumptions behind the analyses are met as far as possible. RUWPA would also take responsibility for the installation of any necessary equipment on board the vessels, such as high-powered binoculars and angleboards. RUWPA would ensure that all other equipment necessary for the survey is on board the vessels, and in the case of any computer software, that this is compatible with the particular vessel's system and instrumentation.

(d) Data access and collaborative analyses

The question of data access, storage location and collaborative analyses between the organisations must be addressed. We propose that RUWPA takes responsibility for IWC data collection, validation and storage (presumably in DESS), and for coordinating the exchange of data between the IWC, CCAMLR and SO-GLOBEC, as appropriate.

Tasks to be undertaken immediately prior to a survey

(e) Completion of modifications to the vessels

It is not envisaged that funds will be available for an appropriate person from RUWPA to visit each vessel well in advance of a survey, nor is this likely to be feasible in all cases, so modifications to the vessels will have to be arranged by looking at plans and diagrams. However, we do believe it is necessary for either a RUWPA member, or an experienced researcher nominated by RUWPA, to board the vessel prior to departure to ensure that any required modifications have been completed satisfactorily (for example, the platforms meet the required assumptions of one-way visual and audible independence).

(f) Training of observers

Whilst it is desirable that all the researchers selected for participation on the multidisciplinary surveys would be experienced in line transect surveys for cetaceans, RUWPA would take responsibility for training the researchers specifically for the piggy-back surveys. It is expected that this training would be carried out at the pre-cruise meeting. Training would include some material on the necessary basics of line transect methods, data recording methods, survey protocols (including scheduling of on-effort periods), and possibly species identification and school size determination. The latter two items are important since the survey will be conducted entirely in passing mode, but the necessity of them would depend on the experience of the researchers selected.

On completion of the survey

(g) Data collection and storage

In collaboration with the IWC Secretariat, RUWPA would be involved in data validation and entry into DESS.

DETAILED TASK LIST AND PROPOSED BUDGET

Selection of researchers

(1) It is proposed that this task will largely be undertaken by the IWC.

Design and description of survey protocols

(2) Design and production of data forms.
(3) Preparation of Usage Notes.

Data acquisition software

(4) Investigation of availability and compatibility of existing software (with little or no modification).

IWC requirements on CCAMLR vessels

(5) Arrangements for installation of 'Big Eyes' on CCAMLR vessels.
(6) Determination of platform locations.
(7) Designing and arranging the installation of angleboards.
(8) Vessel modifications, if any.

General logistics

(9) Acquisition of any necessary equipment items (such as 7×50 binoculars, timing devices, radios for communicating between vessels).
(10) Arranging shipping of biopsy equipment.
(11) Other shipping arrangements (computers, printers, etc).

Liaison with CCAMLR scientists

(12) Obtaining agreement for data access, storage location and how collaborative research will be undertaken.
(13) If there is some direct data acquisition, liaising with appropriate persons to ensure the software can be linked to the systems on board the vessels.

Training of observers

(14) Preparation and presentation of material at a workshop in St Andrews.

Data validation and entry into DESS

(15) It is proposed that these tasks are completed under the 6-month rolling contract between RUWPA and the IWC, with allocation of specific tasks as in the SOWER cruises.

Travel costs

These are not included in this proposal. All necessary travel is to be approved by the IWC Secretariat and travel and subsistence costs paid by the IWC.

	£	VAT @ 17.5% £	Total £
Selection of researchers	0.00	0.00	0.00
Design and description of survey protocols	2,000.00	350.00	2,350.00
Data acquisition software	2,000.00	350.00	2,350.00
IWC requirements on CCAMLR vessels[1]	1,750.00	306.25	2,056.25
General logistics	1,000.00	175.00	1,175.00
Liaison with CCAMLR scientists	1,250.00	218.75	1,468.75
Training of observers	1,500.00	262.50	1,762.50
Data validation and entry into DESS	0.00	0.00	0.00
Total	**9,500.00**	**1,662.50**	**11,162.50**

[1]Completion has been budgeted at a level assuming all vessels will already be suitable for conducting cetacean sighting surveys. If vessels require substantial modification, then an appropriately revised budget will be submitted to the IWC Secretariat.

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Appendix 3

REVISED PROPOSAL FOR AN INTERSESSIONAL WORKSHOP ON HABITAT DEGRADATION

Simmonds, Reijnders, Perry, Stachowitsch, Parsons, Cipriano, Fabbri, Peddemors and Van Waerebeek

This is based on a proposal from last year's meeting from Von Bismarck, Notobartolo di Sciara, Senn, Simmonds, Slooten and Stachowitsch (Von Bismarck *et al.*, 1999).

1. Background

In Resolution 1998-5, the Commission commended the Scientific Committee for the identification of: (1) physical and biological habitat degradation; and (2) Arctic issues as next priorities (International Whaling Commission, 1999, p.40), and directed the Scientific Committee to continue to produce proposals for 'non-lethal research to identify and evaluate the impacts of environmental changes on cetaceans in all priority areas'.

A practical way to address part of the outstanding agenda is an intersessional workshop to consider biological and physical habitat degradation.

We also note the recommendation from the Right Whale Workshop, held in Cape Town, South Africa from 19-25 March 1998:

> It [the Workshop] noted the increasing importance the Scientific Committee has placed on environmental change and habitat studies (e.g. International Whaling Commission, 2000). In this context it recommends that the Committee considers convening a workshop to develop approaches to quantify key features of whale habitats, including trophic structure; right whales should be considered as potential key species.

2. Objectives

The proposed broad objectives of the workshop are:

(1) to describe the parameters which define cetacean habitat; and
(2) evaluate how these parameters affect cetaceans, particularly with respect to physical and biological degradation.

These are the first steps in a process which is intended to:

(1) identify and develop objective criteria to measure such changes;
(2) determine methodology to assess the significance of habitat degradation including cumulative effects.

(The objectives are further defined in Adjunct 1).

The longer term aim is to develop a Habitat 'Action Plan' for the evaluation and quantification of the effects of habitat degradation on cetacean stocks.

3. Study areas

Examples to inform the process will be drawn from the Mediterranean and Black Sea region because:

(a) the Mediterranean is subject to intense human impact resulting in substantial coastline modifications, large-scale eutrophication and major algal events, extensive invasion of alien species and major shipping;
(b) the Mediterranean is also home to an estimated 4,000 fin whales which may be endemic;
(c) the Black Sea is a well-documented example of an 'ecosystem-flip' - where alien species (i.e. ctenophores) now dominate - with potentially associated problems for cetaceans;
(d) the semi-enclosed nature of this basin also facilitates the accumulation of pollutants discharged both directly and indirectly by industrial facilities within the catchment basin, and also untreated and urban sewage;
(e) the meeting is likely to take place in the Mediterranean in Italy c/o ICRAM, see Item 4.

As the forthcoming 52nd Meeting of the IWC Scientific Committee will be held in the southern hemisphere, examples and participation will also be sought from the southern hemisphere to include open ocean environments and areas where rapid industrialisation and nearshore habitat degradation are ongoing.

Contributions from developing nations will also be solicited for review at the workshop, as many of these countries have also recently undergone rapid industrialisation with accompanying habitat degradation. Consideration may also be given to examples from riverine systems.

This broadening of the regional focus for the workshop from the that of the original proposal will:

(1) allow a more comprehensive review of coastal habitat degradation issues for both semi-enclosed and open marine ecosystems;
(2) extend the range of habitat examples, thus broadening the relevance of findings to a much wider area;
(3) facilitate contact, communication and collaboration between researchers in this field at local, regional and international levels;
(4) provide a focus on particular areas and progress/outcomes for those areas, and include benchmark studies to maintain the relevance of the workshop to scientists from a wide range of coastal types;
(5) assist with habitat degradation problems in developing countries.

4. Meeting arrangements

The draft budget is estimated at £29,500 to cover costs of administration, communication and invited participants. For details see Adjunct 2.

Italy has again offered to host this workshop c/o Giuseppe Notobartolo di Sciara, President of Istituto Centrale Ricerce Ambiente Marino.

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Adjunct 1. General Objectives of Proposed Workshop on Cetacean Habitat Degradation

(1) To determine a framework and methodology to assess the significance of changes in the biological and physical habitat of cetaceans.

(2) To facilitate the eventual development of an action plan for the evaluation and quantification of cetacean habitat degradation.

Outline of Workshop

The workshop would focus on the following two points:

(1) (a) Review available information on studies of cetaceans and their habitat (e.g. recent work on North Atlantic right, fin and sperm whales).
(b) Review available information on studies of major perturbations of cetacean habitat.

(2) Identify key biological and physical features of cetacean habitat, paying special attention to the:

(a) areas important for breeding, calving, rearing, feeding and migration;
(b) qualitative assessment of potential effects on cetaceans of changes in these key features (with consideration, as appropriate, to eventual quantification).

The results from the Intersessional Workshop will facilitate consideration of several other points integral to the problem of habitat degradation in the longer term.

(3) Identifying measurable variables to quantify the key features mentioned in (2) above and changes in these features.

(4) Identifying key environmental perturbations known or likely to affect the features described in (2), for example:

(a) physical (e.g. climate change, coastal development, dredging, marine debris, etc.);
(b) biological (e.g. eutrophication, algal events, introduction of alien species, etc.);
(c) other (e.g. contaminants, etc.);
(d) consideration of synergistic interactions of above.

(5) Identifying measurable variables to quantify these perturbations.

(6) Determining a framework and methodology to assess the significance of changes in these parameters, both singly and in combination, with a view to developing a strategy for:

(a) monitoring critical habitat quality;
(b) identifying thresholds which may affect cetaceans;
(c) assessing proposals for activities that might affect cetacean habitat.

Adjunct 2

We will develop this proposal further intersessionally, including identifying sources of funding.

Draft Budget (based on three day workshop)

Venue hire	£1,000
Administration	£1,500
Stationery	£2,000
Invited participants	£20,000 (£1,1000-£1,5000 per invited participant day)
Publication of proceedings	£3,000
Secretarial support	£1,000
Contingency	£1,000
Total budget	£29,5000

Appendix 4

AN 'ANNUAL STATE OF THE CETACEAN ENVIRONMENT' REPORT

Stachowitsch, Fabbri, Lauriano

This paper aims to provide some more concrete considerations on the annual cetacean environment report. The basic idea behind the concept is to tally all known potentially negative developments for cetaceans in the sea, centred around the eight topics the Commission has directed the Environment Working Group to consider, namely: (1) climate/environmental change; (2) physical and biological habitat degradation; (3) chemical pollution; (4) effects of fisheries; (5) Arctic issues; (6) impact of noise; (7) disease and mortality events; and (8) ozone and UV-B radiation.

The report would be done by geographic area. It is meant to be absolutely neutral, which is underscored by the fact that both anthropogenically related and natural events would be included.

The first step would be to define types of developments/impacts that would be included. These criteria might include the following:

(1) Area affected (some objective scale needs to be introduced, such as accepted surface areas for so-called local, regional, global impacts).
(2) Duration of impact (long-term, chronic, short-term, acute).
(3) Severity of impact. An important step here is to specify what impacts are to be included, perhaps beginning with the eight issues that the SWG on environmental concerns has identified.
(4) Recurrent nature of event (repeated disturbance with known or unknown periodicity).
(5) Location of impact. Specifically, (a) is the area known to be sensitive to perturbation, or (b) are the cetaceans there known to be sensitive or depleted?
(6) Synergistic effects. Is the impact known to go hand in hand with other impacts or to boost the effect of other disturbances?
(7) Direct cetacean mortality or disease (mass strandings, epidemics).

After criteria are defined, the next step would involve deciding how many criteria need to be fulfilled before an event can be 'put on the map' (as well as what criteria are severe enough that they alone need to be fulfilled). An alternative would be to assign colour codes and a scaled terminology to specify that an increasing number of criteria have been met.

The sources for such a report could be scientific journals, government reports, environmental impact statements, cetacean specialists from countries in which IWC meetings are held, etc. The idea would be to build a team of 'conduits' who would forward this information to a coordinating office. The report/map could then be made available to IWC member states, Commissioners, interested governments, NGOs, internet, etc. after presentation and approval by the Scientific Committee.

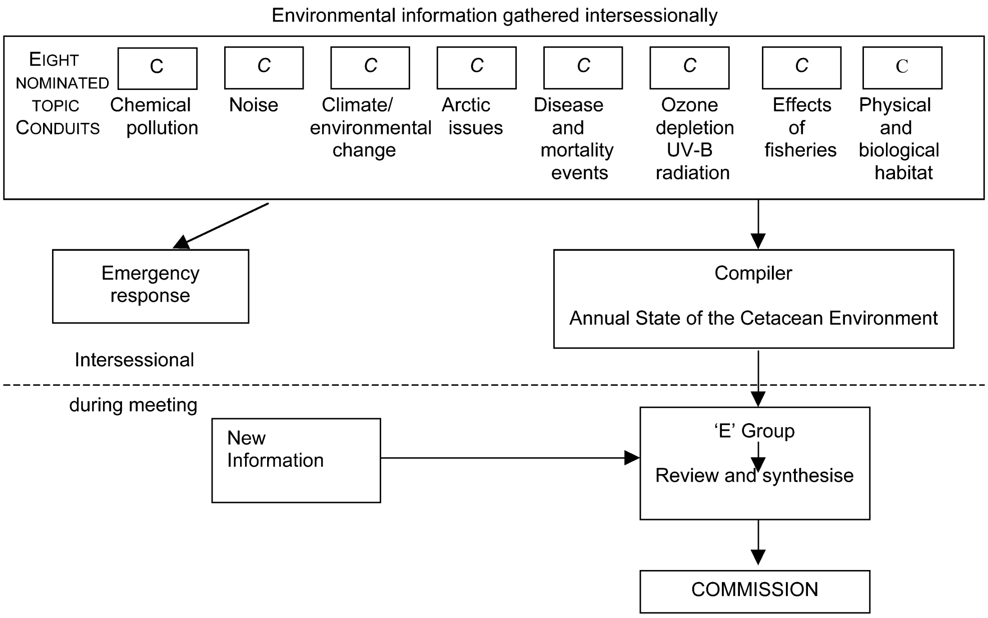

Fig. 1. Suggested mechanism for providing an 'Annual State of the Cetacean Environment' report.