Annex K1

Report of the Working Group on Ecosystem Modelling (EM)

Members: Gales (Convenor), Acquarone, Apostolouki, Best, Borsani, Bøthun, Butterworth, Cañadas, Charrassin, Childerhouse, Choz, Constable, Cooke, Donovan, Double, Ferguson, Gerber, Gunnlaugsson, Hakamada, Hammond, Hatanaka, Ivashchenko, Kanda, Kitakado, Kock, Leaper, Lens, Lockyer, Matsuoka, Miller, Moon, Moore, Morissette, Okada, Okamura, Palka, Polacheck, Punt, Ridoux, Rogan, Shimada, Simmonds, Stachowitsch, Víkingsson, Wade, Walløe, Zerbini.

1.1 Introductory items

1.1.1 Convenors opening remarks

Gales welcomed the participants to the meeting. He further noted that this year the most important item of business was the forthcoming IWC-CCAMLR Workshop to be held in August 2008. He noted that EM had been allocated only five sessions in which to complete its work.

1.1.2 Election of Chair, appointment of rapporteurs

Gales was elected Chair. Childerhouse and Double agreed to act as rapporteurs.

1.1.3 Adoption of Agenda

The adopted Agenda is given in Appendix 1.

1.1.4 Review of documents

Documents considered were SC/60/EM1-6.

1.2 Planning for the Joint CCAMLR/IWC Workshop on modelling Antarctic krill predators

SC/60/EM6 was presented by Constable, co-Convenor of the CCAMLR/IWC Workshop. The paper reports preparations for the CCAMLR-IWC Workshop to review input data for Antarctic marine ecosystem models. The paper reports that the Joint Steering Group has modified the allocation of the budget to provide for a greater number of experts at the Workshop, primarily as a result of no expenditure being needed in preparation of the papers by the expert groups. A meta-database has been established at the Australian Antarctic Division to act as a repository of the metadata being collated by the expert groups. The metadata will then be forwarded to CCAMLR and IWC Secretariats. The report notes that the Workshop is open to members of the SC-CCAMLR and SC-IWC and their working groups and that many relevant experts have been invited. Options for reporting on the outcomes of the Workshop are presented, including general questions to be addressed on uncertainty in the data and the possibility of combining the reports of the expert groups and the Workshop into a book.

In discussion, the Terms of Reference (TOR) for the Workshop, outlined in SC/60/EM6, will be the focus of discussions at this meeting. These TOR have been agreed by the joint CCAMLR/IWC Workshop Steering Group. All of the expert groups (toothed whales, baleen whales, pack ice seals, fur seals, penguins, flying birds, fish, squid, krill, protests, zooplankton, sea ice, ocean processes) are progressing well, except for the group on flying birds. The Co-convenors indicated that strategies are being set in place to ensure that the work on flying birds will undertaken, with as much progress as possible being reported to the Workshop. It was noted that the flying birds group covers a large and diverse range of species and it has been difficult to engage a single person to undertake this coordination. A discussion is underway with ACAP (Agreement on the Conservation of Albatrosses and Petrels) to establish a flying birds expert group in time for the Workshop.

There are no specific TOR for expert groups but a general template of what information has been developed and provided to the groups for guidance in undertaking the review. An important issue is clarification of the northern boundary of the study area. There was considerable discussion about this issue by the Workshop Steering Group. SC/60/EM5 includes details of the kinds of data that are being sought from the expert groups. There was a degree of flexibility given to the groups as there is considerable variation in spatial context of the available data. With respect to spatial scales, CCAMLR and IWC use different statistical areas (SC/60/EM5: fig. 6 shows CCAMLR management areas; Fig 7 shows IWC management areas). The CCAMLR northern boundary is consistent with the Antarctic Convergence and/or Polar Front. A key focus of the Workshop will be how to adjust data sources at differing scales to obtain comparability.

There was a request for additional explicit guidelines for the expert groups. Some models in the past have suffered from data quality and comparability issues. Understanding what data are available and how to interpret them correctly is key. This will be a focus of the Workshop. Differing model approaches by CCAMLR and the IWC were summarised in SC/60/EM5. There needs to be agreement on common inputs. An upcoming CCAMLR Land-based predator Workshop will aid in determining inputs for future modelling and will provide useful information for the August Workshop. Another output of the Workshop will be a summary of differing modelling approaches. This will also include a discussion of the data needs for each model type and potential strengths and weaknesses of them.

The Workshop is open to any member of IWC or CCAMLR scientists. The Joint Steering Group has selected potential invited experts and invitations have gone out. Mori and Moore are unable to attend and T. Kitakado, H. Okamura, and N. Friday were suggested as potential alternates. Once the experts who are able to attend the Workshop have been confirmed, the remaining funding available will be assessed and additional experts will be selected by the Joint Steering Group. The budget is for the Workshop, and the publication of the Workshop's immediate outputs. Funding for work after the Workshop will need to be found.

The Australian Antarctic Division has a database that may be used for the storage of meta-data that will be used for this project. A description of data fields is outlined in tables at the end of SC/60/EM5. The meta-data will be evaluated once the individual data has been reviewed by the expert groups. It is critical that all data sources must be clearly tagged as to whether it is raw or derived from models. CCAMLR has discussed this and concluded that it is the estimates of parameters that are important, but noted that such estimates must include details of the raw data. This Workshop scoped with reviewing all raw data, as well as modelled parameters.

Predator-prey relationships are the focus of the CCAMLR/IWC Workshop but the databases and models will potentially be useful for other projects (e.g. habitat degradation, IPCC). Once the data useful for predator-prey models has been reviewed and summarised, it will then be possible to expand the application into other areas (e.g. climate change). It was noted that there will be representation from people working on other models (e.g. MALTSPEC) who will have some input into this process. Collaboration between IWC (Whales) and CCAMLR (other ecosystem parts) will bring together experts from the areas necessary to cover most of the components of the ecosystem in question.

There was some discussion about what are likely products of the Workshop, accepting that it won't be the final step in the process. There will be a Workshop Report that will include (i) a description of the process moving into the future (i.e. issues that can be resolved now, in the near future, and priorities for future work that will be required to fill data holes), (ii) data sets and descriptions of these, and (iii) what models are available and could be used. The Report from the Workshop will include comprehensive reports from each expert group. The Report will also include a synthesis paper. Seven broad categories identified in SC/60/EM6 will serve as a starting point for the structure of the report. A draft Agenda was discussed (including potential items for consideration). This will be considered further and agreed by the Joint Steering Group. There will be a full discussion of the final form of output (e.g. Joint IWC/CCAMLR Report, book) from this project this at the Workshop.

1.3 Review of progress in the development of ecosystem models

1.3.1 Review of papers to be presented at the CCAMLR/IWC Workshop

SC/60/EM5 was presented by Constable and provided a draft introduction to the Workshop on the data requirements for modelling in CCAMLR and the IWC. It summarises background to the use of ecosystem models in CCAMLR and the IWC and a history of the developmental work in those organisations. It also provides an outline of the nature of modelling for these purposes and the general issues that need to be considered in parameterising a model, providing input data for those models and for addressing uncertainties in this process. Lastly, it summarises the modelling platforms being developed in CCAMLR and the IWC and the manner in which uncertainties surrounding data inputs to these models are being addressed by the joint CCAMLR-IWC Workshop to be held in August 2008. It also provides as attachments, draft tables for summarising metadata and descriptions of their attendant uncertainties and biases being used as a guide by the expert groups in collating data for the Workshop. An example of what information might be included in those tables is provided in Appendix 2.

Discussion of this paper has been incorporated into the discussion of SC/60/EM6 covered in Section 1.2.

SC/60/EM2 was presented by Leaper and summarised the results of the group reviewing data on odontocetes. The review briefly considered the main types of data identified by the Workshop steering group (abundance, distribution, population dynamics, feeding ecology, and exploitation). Eight species were identified as being most likely to be ecologically important south of the CCAMLR boundary. There is generally less information on the odontocetes of the Southern Ocean than for baleen whales. Analyses to generate abundance estimates from visual surveys are complicated by the duration of deep dives and inconspicuous surface behaviour of many species. These factors make it difficult to quantify values of $g(0)$ which are often considerably less than 1. In addition some species show considerable responsive movement. The paper reviewed a number of potential sources of abundance estimates and possible sources of bias. These include IDCR/SOWER, JARPA and regional multi-disciplinary cruises.

The WG Chair and Joint Steering Group thanked the group for compiling this information. This summary document is exactly the direction that they were hoping the groups would go when summarising information for the Joint Workshop.

The boundaries for the areas that are reported in Table 1 need to be clarified. It would be useful to have estimates for the area that was surveyed and also an estimate extrapolated up to the CCAMLR boundary. It is critical that for all data, the area to which they apply is stated clearly. It was also suggested that there needs to be more detail in the feeding section, including listing the date of each observation. The authors agreed to expand on the feeding section. The authors will also look into treating the three ecotypes of killer whales separately. JSV data is another source of information that may be useful for extrapolating north of 60°S.

For some species and areas there is no life history data available. In the absence of data, modellers will seek a proxy from elsewhere. It will be useful for the expert group to suggest potential proxies that may be available to fill holes in the data. Where data on feeding ecology are unavailable, energetic requirements can be used to bound predator-prey relationships. For this to be effective, information about spatial and temporal partitioning will be critical to modelling predator prey relationships. It was noted that these topics will be an important aspect of the workshop discussions.

The choice of species that were selected was discussed. The authors responded that these 8 species were selected as these were considered the most important species but agreed that other species may also be important but there are no data for them. It was noted that some species may be regionally important e.g. spectacled porpoise. Also data may be lacking for species in the lower latitudes of the region where sighting conditions are generally worse. Information gaps are also likely for the more cryptic species.

There is a need for consistency between units in the reporting of feeding ecology and comparable and standardised estimates will be required by modellers. It will also be useful to know if uncertainty has been quantified and what it is.

Sampling uncertainty has been listed but there has been little accounting for bias in estimates other than to identify potential sources and possible directions. The expert group might need to provide some quantification of these e.g. probability distribution so that they can be understood. The expert group should be cautious in assessing biases based on data and where no data are available, they should say so. It would also be useful for expert groups to describe methods that have been used to investigate and report variability. It is important to note that their have been considerable work investigating bias in surveys for Antarctic minke whales, and that this is a good source of information on sources and direction of biases in abundance surveys.

Paper SC/60/EM3 was presented by Zerbini and describes a preliminary review of population parameters of baleen whale populations in the Southern Hemisphere. The paper attempted to fulfil two objectives: (1) provide a review information on baleen whales that could be used as model inputs and (2) provide a commentary on the uncertainties and limitations in the use of estimates of abundance and trends in abundance for baleen whales. It was presented at IWC 60 to inform members of the Sub-Committee of its progress, to discuss its format, and to request input from the Sub-Committee in regard to additional information that should be incorporated in the review. The paper contained a description of sources of data on the biology, ecology, abundance and trends of baleen whales, including whaling operations and various research programs. Emphasis was given to information obtained in

the Antarctic (summer/feeding grounds), but in some cases data from low latitudes (winter/breeding grounds) was included to complement or contrast what is known from feeding grounds and include information on whales throughout their range. Stock specific information on seasonal distribution, habitat utilisation, movements, abundance and trends, catches, and foraging ecology of baleen whales was summarized. SC/60EM3 also discussed possible uncertainties in estimates of population size and rates of increase from two of the most comprehensive studies on baleen whales in the Southern Hemisphere: the IWC IDCR/SOWER and the JARPA research cruises in the Antarctic. Potential biases in parameter estimates were reported in light of extensive discussions regarding limitations of these surveys conducted by the IWC Scientific Committee in previous years (IWC, 2005-08). Information on consumption rates and life history parameters shall be incorporated in the paper before the workshop in Hobart.

The WG Chair and Joint Steering Group thanked the group for compiling this information.

The data used for the catch history was discussed. In particular, how to handle catch data for southern right whales, as there is a longer record and varying quality of information during the early stages on whaling. The degree to which a species has been exploited is important to consider when modelling and southern right whales are a good case. The approach used in this review will be to define catch histories for the period when it is considered reliable but also to provide a commentary about what other data are available and its quality.

SO-GLOBEC (Southern Ocean-Global Ocean Ecosystem Dynamics) has a project on investigating the distribution and densities of cetaceans in the Antarctic and there are some obvious overlaps with this project. There was discussion of including data being compiled by the SO-GLOBEC project in the CCAMLR/IWC Workshop. Zerbini and Tynan will co-ordinate over the potential availability of SO-GLOBEC data for the CCAMLR/IWC Workshop.

There are three main phases of work for the Workshop: (i) synthesis of existing work, (ii) consideration of data that will be available soon, and (iii) other work that is not immediately available but which would be advantageous to have. It is also important that only data that have been carefully considered is provided for the Workshop and that other data that have not been carefully considered, should still be identified so that the data can be added when ready. It is important that the data held by SO-GLOBEC are summarised and these summaries are made available to Workshop, even if those data are not available for the Workshop.

The suitability of JARPA abundance estimates has been discussed extensively in the SC. It was agreed to refer to the statements in the JARPA review report when discussing the suitability of using JARPA data in any models. It was questioned how JSV data will be used, especially with respect to fin and sei whales. It was clarified that it will include a summary of the JSV data available in published sources and will refer to any issues identified by the IWC. It was noted that the data may be useful for extrapolation north of 60°S.

The aggregation of information was considered. For example, there are many estimates of the rate of population increase for different humpback whale stocks. It is important to state whether informative or non-informative priors were used when considering information derived from Bayesian models. It was suggested to combine all data on rates of increase into a single model for each species and use this to investigate the overall rate of increase with a non-informative prior constrained within agreed demographic bounds. Such information on rate of increases can be used as an input to the model but can also be used to investigate the performance of the model. It was agreed to use the data in both ways.

Another piece of information that would be useful to the Workshop is the proportion of time that species spend north of the CCAMLR region boundary because many species move in and out of the area. Related to this is a need to describe and define influences on population processes that occur outside of the southern ocean e.g. reproductive performance may be related to processes in tropical breeding group.

There was a discussion about how meta-data would be entered into the summary tables in SC/60/EM5. An example of a meta-data summary for Pack Ice Seals was considered. Some examples of commentaries included discussion of bias and how this might influence abundance estimates. Other commentaries included issues such as habitat utilisation, population growth rate, and foraging. Commentaries should also include suggested proxies for where data in unavailable and also identification of where proxies would be inappropriate.

Predator-prey relationship models can be explored in a more general framework where specific diet composition is not known but some data (e.g. proportion of time in a specific area, depths of feeding) can be used to begin to characterise feeding habitat. Other factors that can aid in this process include the characterisation of prey size and behaviour (e.g. aggregating spp.), whether a species is an obligate feeder, status, and whether general or specific linkages are required. Again, it is critical to clearly state where data are being used to determine diet and where model inference is being used.

The process from here is to finalise the general advice from this WG to the expert groups compiling the reports. Work leading up to the Workshop should focus on what was in the original request to the expert groups and getting the data summaries into shape. Broader discussions about datasets and how they will be used will be further considered at the Workshop in August.

1.3.2 Review of other papers

Morissette and Gerber presented SC/60/EM1 which described progress towards the development of ecosystem models to examine the trophic interactions between marine mammals and fisheries in Northwest Africa, the Caribbean and the tropical South Pacific. The food web models are being constructed using ECOPATH with ECOSIM to examine the potential impact of a reduction in the abundance of great whales on fishery yield. An extensive literature search is being conducted to synthesise available data about the ecological parameters and trophic interactions for marine mammals, fish and invertebrates to parameterise models for the three study areas. Models will allow characterisation of the structure and function of these ecosystems in terms of biomass, mortalities, consumption rates, food habits and fisheries. Faced with sparse data for the study regions, the approach explicitly accounts for uncertainty in input data, ecosystem structure, model accuracy, marine mammal feeding rates, abundance estimates and consumption in breeding areas. In addition, the authors are conducting extensive sensitivity analyses to examine the effects of model parameters and changes in model assumptions. The predictability of the models will be validated with time series of biomass and catches for important species of the system. The models will be used as a predictive framework for examining the ecosystem impacts of changes in the abundance of large whales, including changes in fishery yield.

SC/60/EM1 specifically presents preliminary results from a Northwest African fishery model which includes the Large Marine Ecosystem (LME) of the Canary Current, located on the eastern part of the Atlantic Ocean, and bounded by the coasts of Morocco, Mauritania, Senegal, Guinea-Bissau, the Canary Islands, Gambia, Cape Verde and Western Sahara. The model includes 10 marine mammal groups and 17 additional groups comprised of fish,

seabirds, invertebrates, benthos and plankton. Both local and foreign fleets are also included in the model. Preliminary results indicate that: 1) the overlaps between prey species consumed by marine mammals and species target by fisheries is low; and 2) given a wide range of assumptions about whale abundances, diet composition and food consumption in breeding areas , the study consistently found that a) whale consumption is several orders of magnitude lower than fishery catches; b) food intake of whales in the study area is two orders of magnitude lower than the amounts taken by other trophic groups (e.g. pelagic fishes); and c) in preliminary simulations, reducing whale biomass does not influence the biomass of commercially important fish, nor any other species in the food web. While the results are preliminary the authors expect that the results are unlikely to change even with the addition of new data. Also the authors suggest this modelling approach will begin to answer questions about the competition between baleen whales and commercial fisheries in the regions examined, and will allow the identification of data gaps and additional research needs.

The Chair thanked the authors for coming to present their paper.

The region selected for the modelling exercises (e.g. Northwest Africa, Caribbean, and South Pacific) was questioned because they are baleen whale breeding and not feeding areas, and therefore the results are perhaps not surprising. It was suggested that the application of the model to another area where whales are feeding would be more useful in exploring whale-fishery interactions (e.g. North Atlantic). The authors responded that these areas were selected because there has been a lot of discussion about the interactions of baleen whales and fisheries in these areas and, while the conclusions may not be surprising to some, the conclusions have not been widely understood in the regions. They are looking forward to applying this model to other areas where baleen whales and fisheries target some common prey.

There was a discussion of issues related to ECOPATH. It was noted that this modelling approach is a useful way of exploring the extent and relative magnitude of interactions but that these results are preliminary. The authors were complimented on taking account of some issues that had been raised in this WG previously. There needs to be careful consideration of how we integrate the results of these models into the IWC assessment process. This is an important issue and it would be useful for the WG to provide some recommendations about how the IWC might use these models in management advice.

There was discussion about the use of a balanced model as a starting point and whether this is likely to be realistic. There are some good reasons to expect that systems are not balanced and, if this was the case, there needs to be a careful exploration of how balancing the model might affect the results. The authors noted that if information related to the nature and extent to which the system was unbalanced was available, it could be included but this information is generally lacking and assuming balance is a reasonable starting point.

These models might be used to provide management advice but it is generally tactical rather than strategic advice. Given the uncertainties of these models it is important to attempt to quantify the power of these approaches. Simulation testing may be useful way in exploring power within these models. Another useful approach would be in exploring different ecosystem model approaches for the same system and then comparing performance across models. It is important to investigate the effect of changing several parameters at the same time because a combination of parameter changes may give completely different results.

There are three key data inputs - abundance, feeding rates and diet composition. It would be useful to have a detailed table of these values, including estimates of uncertainty. With respect to the estimation of global abundance, it was noted that this estimate contains a large degree of uncertainty. It was important to clarify how the uncertainty associated with the global abundance estimate was carried through when it is used to estimate abundance within a specific region e.g. Northwest Africa. The authors responded that the regions selected for this study are data poor but that where local abundance estimates were available, they were compared to estimates derived at the global level to investigate uncertainty. They also used sensitivity testing by increasing biomass values of some functional groups to account for possible errors in assessment, and noted the corresponding changes in outputs. Sensitivity testing of the most important parameters (abundance, feeding rates, diet composition) will show how these parameters affect the outputs of the model.

It is also important to understand how the balancing process often required within ECOPATH affects the selection of values for which there are no data. It was noted that seeking a balanced model is a useful first step, but that it is only useful in seeing how the elements relate to each other. If a balanced model is used to provide preliminary management advice, then it is important to be cautious and to fully articulate potential caveats (e.g. there may be no competition if a system is unbalanced). Quantifying uncertainty, particularly for providing tactical advice, is critical and relying simply on the “pedigree” of the data may not be that useful. Any artificial constraints on uncertainty need to be clearly defined and understood.

Factors such as prey resource limitation, diet overlap, and temporal and spatial overlaps in distribution need to be understood before conclusions about competition can be drawn. It was questioned how the model accounts for the differing use of resources between functional components in time and space. One potential method to explore this could be through the use of ECOSPACE. This hasn’t been used in the preliminary modelling in EM1, the proportion of time that each functional group is in the model area has been used instead.

There was a discussion of issues related to ECOPATH. It was noted that despite considerable research over the last 20 years on ecosystems such as the North Atlantic, it has been difficult to determine feeding function and magnitude. This can be explored using the ARENA model.

There was additional discussion of sensitivity testing and quantifying uncertainty. One possible approach was to use the MONTECARLO tool to add a range of variation to each parameter and varying them at the same time. This would produce a range of outputs for each parameter. However, this assumes that uncertainties are not correlated. There may be correlation amongst parameters in sensitivity testing. In some cases, there may be proxies for density dependence. There is a need to be cautious that these proxies are being characterised correctly.

The functional relationships between groups can be difficult to estimate. In many cases, these relationships are pushed into fitting the available data using vulnerability parameters. However, there should not be a focus on vulnerability but rather examining at the different functional relationships.

The model complexity was raised, particularly with respect to models that have a large number of parameters many of which cannot be measured or for which there are no data. Given the lack of data available in many regions, it was suggested that simpler models, along the lines of those used by Iceland or Norway, may be more appropriate. It was suggested that these simpler approaches should be encouraged as well as more complex models such as ECOSIM and ECOPATH. In particular it was noted that the ecosystems that we are attempting to model are extremely complex and dynamic, so a wide

range of modelling efforts should be applied. The WG does consider a range of models in its work and welcomes all forms of models, both simple and complex. The WG was reminded that at an intersessional meeting in 2002 the IWC agreed that currently no models are able to predict the relationships between baleen whales and fisheries. It may be some time before this situation changes.

The authors were appreciative of the all comments and feedback that they had received. They agreed that testing differing models on the same ecosystem for which good data are available would be a good way to investigate the sensitivities of different models.

1.4 Other

1.4.1 Report of the FAO Ecosystem modelling Workshop

SC/60/EM4 was presented by Butterworth and summarised the conclusions from a FAO workshop on modelling ecosystem interactions for informing an ecosystem approach to fisheries in July 2007. In response to increasing global acceptance of the need for a wider ecosystem approach to fisheries (EAF) assessment and management, and the associated requirement for methodologies that go beyond conventional single-species approaches for the provision of scientific advice, FAO convened a meeting of leading practitioners in the development of aquatic ecosystem modelling as a tool for the provision of management advice. The group of 19 scientists invited from around the world, which met in Tivoli for four days, included four regular and four occasional attendees of IWC Scientific Committee meetings. The group focused on the development of 'best practice' guidelines intended to assist users in the construction and application of ecosystem models for EAF. These guidelines were considered under nine groupings. The group recognised the considerable uncertainties in the predictions provided by ecosystem/multi-species models, but also that management decisions need to taken concerning ecosystem issues. They stressed that in the context of EAF, the best available scientific advice, based on ecosystem models which rest on explicit and principled arguments, needs to be offered; this is to avoid the situation of decision makers having to resort to their own mental models which may frequently be subjective, untested and incomplete. The group considered that ecosystem models are not yet at the stage where a single model of this type could be selected as a 'management model', and be reliably used to provide tactical management recommendations (e.g. concerning catch limits) in a particular case. Rather they considered that the immediate use for such ecosystem models was to provide a range of operating models for testing simpler models (one example would be the IWC's RMP) for providing management advice, so as to confirm that these provided satisfactory and robust performance in the presence of ecosystem interactions and objectives related to ecosystem aspects.

It was noted in discussion that there were similar conclusions from FAO as previous IWC ecosystem modelling Workshop.

1.5 Work Plan

The members of the expert groups on baleen and toothed whales will be focusing on completing their review papers, ready for the August Workshop. Future work of this WG will be framed by the discussions that will be held at the Workshop and at the intervening CCAMLR meetings.

Appendix 1

AGENDA

1. ECOSYSTEM MODELLING (EM)
   - 1.1 INTRODUCTORY ITEMS
     - 1.1.1 Convenors opening remarks
     - 1.1.2 Election of Chair, appointment of rapporteurs
     - 1.1.3 Adoption of Agenda
     - 1.1.4 Review of documents
   - 1.2 Planning for the Joint CCAMLR/IWC Workshop on modelling Antarctic krill predators (SC/60/EM6)
   - 1.3 Review of progress in the development of ecosystem models
     - 1.3.1 Review of papers to be presented at the CCAMLR/IWC Workshop (SC/60/EM5)
     - 1.3.2 Review of other papers (SC/60/EM1)
   - 1.4 Review of data relevant to parameter estimation and ecological interactions
     - 1.4.1 Review of papers to be presented at the CCAMLR/IWC Workshop (SC/60/EM2, 3)
     - 1.4.2 Review of other papers
   - 1.5 Other
     - 1.5.1 Report of the FAO Ecosystem modelling Workshop (SC/60/EM4)
   - 1.6 Work Plan

Appendix 2

EXAMPLE METADATA SUMMARY FOR PACK ICE SEALS

(Example draft only – not for distribution or use in models)

Draft population abundance tables. Examples showing input for two largely coincident survey efforts in the Indian Ocean (for illustration purposes only, data needs to be checked; each survey effort has a separate table).

PACK-ICE SEAL POPULATION ABUNDANCE ESTIMATES AND COMMENTARY	
Survey effort	Separate survey efforts by Erickson
Region/sub-regions	E Indian
Survey region boundaries (east to west)	90°E-160°E
Survey region boundaries (north to south)	Fast-ice edge to pack-ice edge
Survey region area	203,500 n. miles^2
Month	January
Year	1973 and 1974
Methods	Sighting surveys of on-ice abundance from ship and aircraft collecting strip transect data. Non-random transects due to ice and weather constraints on ship and aircraft operations. Haulout probability estimated by observation
Estimated abundance (with upper and lower 95% limits)	Crabeater: 938,903 (no uncertainty given) Ross: 52,096 (no uncertainty given) Leopard: 67,969 (no uncertainty given) Weddell: 69,190 (no uncertainty given)
Estimated density (with upper and lower 95% limits) and area can be applied to	Crabeater: 4.6148 n. miles^2 Ross: 0.2560 n. miles^2 Leopard: 0.3340 n. miles^2 Weddell: 0.3400 n. miles^2
Factors incorporated into uncertainty estimate	No uncertainty given
Possible biases	1. Haulout probability derived from observation results in a negative bias in crabeater abundance estimates of around 20%. 2. Haulout correction for Ross and leopard seals based on crabeater haulout data which may not be accurate for other species. 3. Use of strip transects may result in a slight negative bias in on-ice abundance.
References	
PACK-ICE SEAL POPULATION ABUNDANCE ESTIMATES AND COMMENTARY	
Survey effort	AAD APIS survey
Region/sub-regions	E Indian, W Indian
Survey region boundaries (east to west)	64°E-150°E
Survey region boundaries (north to south)	Fast-ice edge to pack-ice edge
Survey region area	1,500,000 km^2 of pack-ice with >1/10 ice cover
Month	December-January
Year	1999/00
Methods	Sighting surveys of on-ice abundance from ship and aircraft collecting mark-recapture line transect data. Non-random transects due to ice and weather constraints on ship and aircraft operations. Dive recorders attached to sample of seals to estimate haulout probability
Estimated abundance (with upper and lower 95% limits)	Crabeater: 946,000 (726,400-1,396,700) (definite plus probable sightings) Ross: 55,900 (27,700-187,500) (definite plus probable sightings, weighted mean surface model) Leopard: 12,100 (7,100-23,400) (definite plus probable sightings, weighted mean surface model) Weddell: No estimate; fast-ice not surveyed
Estimated density (with upper and lower 95% limits) and area can be applied to	Crabeater: 0.6307 (0.4843-0.9311)/km^2 Ross: 0.0373 (0.0185-0.1250)/km^2 Leopard: 0.0081 (0.0047-0.0156)/km^2 Weddell: No estimate; fast-ice not surveyed Density estimates can only be applied to survey region
Factors incorporated into uncertainty estimate	Detection probability, haulout probability, extrapolating from sampled to unsampled regions, species identification
Possible biases	1. Possible false negatives (seals present on the ice in sampled strip but undetected). Resulting bias in abundance estimate would be negative in direction, and likely to be largest for leopard seal and least for crabeater seal. 2. Sample of seals for estimation of haulout probability was not representative of total population (those most likely to be hauled out selected). Resulting bias in abundance estimate likely to be negative in direction, and largest for leopard seal and least for crabeater seal. 3. Spatial model used to predict abundance from sampled strips to total region may not account for non-random sampling without bias; direction of possible bias unknown.
References	

Draft population trend table format.

PACK-ICE SEAL POPULATION TREND ESTIMATES AND COMMENTARY	
Region/sub-regions	E Indian
Year range	1972-83 and 1999/00
Trend estimate/commentary	Crabeater: Abundance point estimates of 938,903 in 1972-83 and 946,000 in 1999/00 Ross: Abundance point estimates of 52,096 in 1972-83 and 55,900 in 1999/00 Leopard: Abundance point estimates of 67,969 in 1972-83 and 12,100 in 1999/00 Weddell: Abundance estimate for a single time only: no trend information available
Possible biases and uncertainties in trend estimation	Survey regions similar but not entirely coincident (90E-160E in 1972-83 vs 64E-150E in 1999/00). Different methodologies (strip vs line transect, observational haulout data vs dive recorder haulout data, non random transects with design-based vs model-based inference) makes comparison difficult. Uncertainties in abundance estimates only available for 1999/00 data, and given size of uncertainty estimates, only very large changes would be reliably detectable. Only two points in the time series limits inferences about trends
References	

Draft habitat utilisation table format. Example of horizontal utilisation information from survey data.

PACK-ICE SEAL HABITAT UTILISATION COMMENTARY	
Region/sub-regions	E. Indian, W. Indian
Month	September-October
Species	Crabeater
Horizontal habitat use	Probability of presence highest at moderate ocean depths of 2,500-3,500m, corresponding with a band extending 1.5-5°N of the shelf break
Vertical habitat use	
Movement	
References	

Draft habitat utilisation table format. Example of vertical habitat utilisation and movement information from dive recorder data.

PACK-ICE SEAL HABITAT UTILISATION COMMENTARY	
Region/sub-regions	E. Indian
Time of year (month)	December-January
Species	Ross
Horizontal habitat use	
Vertical habitat use	Most dives (86%) >150m. Maximum depth 372m.
Movement	Moved southwards after capture to the continental shelf. Stayed over the shelf until instruments stopped transmitting data in January
References	

Draft population growth rate table format.

	PACK-ICE SEAL POPULATION GROWTH RATE COMMENTARY
Region/sub-regions	
Species	
Individual growth rates	
Reproductive output	
Recruitment	
Mortality rates	
Carrying capacity	
References	

Draft foraging table format.

PACK-ICE SEAL FORAGING COMMENTARY	
Region/sub-regions	*Sampling area*
Time of year (month)	*Time of year (proportion of year)*
Species	*Crabeater*
Diet	*List of types of prey (taxon) and relative importance in diet*
Sampling method	*Scats – body lengths and isotope analysis*
Estimation method	*Unweighted fraction*
Description of uncertainties	*Diet data only relevant for previous 24 hours and near to site of haulout* *Highly uncertain as to proportions of prey in space and time*
Inter-specific competition	*No data*
Selectivity or foraging functions	*consistent size of prey in diet – selectivity function may be able to be derived (medium uncertainty)* *foraging function of feeding success given prey density is unknown*
References	