REPORT OF THE NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON THE ECONOMIC ASPECTS OF MARINE MAMMAL - FISHERIES INTERACTIONS

Marine Research Institute, Reykjavik, Iceland, 1-2 March 1998

At its Seventh Meeting in Tórshavn in May 1997, the Council requested that special attention should be paid to studies related to competition and the economic aspects of marine mammal - fisheries interactions.

To address this request, the Scientific Committee agreed to establish a special Working Group, under the chairmanship of Gunnar Stefánsson (Marine Research Institute, Iceland). The Working Group met from 1-2 March in Reykjavik at the Marine Research Institute. Participants are listed in Appendix 1.

1.-3. OPENING PROCEDURES

The Chairman of the Working Group, Gunnar Stefánsson, welcomed participants to the meeting. The agenda, as contained in Appendix 2, was adopted. Secretariat staff functioned as rapporteurs and it was agreed that relevant members of the group would also assist with the drafting of relevant sections of the report.

4. HISTORICAL BACKGROUND

The Working Group noted that the hunting of marine mammals has long been a part of the traditional economic use of marine resources across the North Atlantic. Lower levels of marine mammal utilisation in many areas in recent years compared with previous decades, combined with increasing pressure on fish stocks from fisheries, has introduced new factors into discussions related to the management of marine mammals, with an emphasis on the need to better understand the interactions of marine mammals and fish in the marine ecosystem. Such factors include, in particular, concerns in the fisheries sector about the potential effects of growing marine mammal populations on fish stocks. The Working Group further noted that in some sectors there were also concerns related to the possible effects of marine mammal utilisation on other economic activities, such as whale watching operations, although these were not directly related to either fisheries or whaling and sealing activities.

The Working Group agreed that an analysis of the economic aspects of marine mammal-fisheries interactions should encompass all aspects of the situation, including both potential losses in fish resources due to increases in marine mammal populations, as well as the estimated revenues from whaling and sealing weighed against the potential losses in other sectors.

5. MULTISPECIES MODELS FOR MARINE MAMMALS AND FISH

Several multispecies models have been developed to describe interactions between marine mammals and fisheries (NAMMCO Scientific Committee 1997:35-52). MULTSPEC (Bogstad *et al.* 1998) and Bormicon (Stefánsson and Pálsson 1998) are spatially disaggregated models containing a high level of detail. Aggregate models such as AGGMULT (Tjelmeland 1995) and the TSB-model (Flaaten 1988) have been developed for the Barents Sea, and similarly aggregated models have been developed and used for the Icelandic shelf and adjacent areas (Stefánsson et al. 1998; Daníelsson *et al.* 1998). MULTSPEC has been used to describe interactions between several species including marine mammals in the Barents Sea, but only aggregate models have been used for this purpose for Icelandic waters.

The present meeting has these various models as a background and it appears a natural way forward to use some of these with additional economic components.

In addition to these models, alternative economic models are described in section 6, where different underlying biological models are assumed. Such different approaches provide interesting possibilities in terms of comparing overall results.

6. BIOECONOMIC MULTISPECIES MODELLING FOR MARINE MAMMALS AND FISH

6.1 Background

An oral presentation based on Flaaten (1996) discussed some of the advantages and disadvantages of bioeconomic multispecies modelling, as well as the obstacles likely to be encountered in changing from single species to multispecies modelling and management. This was done by use of examples from North Atlantic fisheries, and use of basic bioeconomic theory.

All modelling of economic and biological systems is costly, especially data collection by research vessels. The initial contribution from economists in some cases should be simple cost-benefit analysis of marine research to get a rough idea whether it is likely or not that more complex and detailed models can improve management. However, if a biological multispecies model already exists, it is a good investment to let (resource) economists extend it into a bioeconomic multispecies model.

6.2 Putting a price on predation

Flaaten and Stollery (1996) developed a bioeconomic model to analyse the costs for the harvesters of prey species resulting from a permanent increase in the stock of a natural predator. The theoretical analysis showed that the economic losses depend critically on the type of management of the prey stock, although the measures are equal when the stock is managed at the maximum sustained economic yield from the prey species. The model was applied to the case of the Northeast Atlantic minke whale's consumption of fish. Using fish harvest costs and revenues derived from the Norwegian fisheries directorate, the estimates of

average predation cost per minke whale under three different assumptions about whale predation range from US$ 1,780 to US$ 2,370 or NOK 12,500 to NOK 16,600. A ten percent increase in whale stocks was estimated to cause a loss of almost US$ 19 million to the fisheries of the prey species. In discussion, these predation cost estimates were compared with those arising from the much more complex MULTSPEC model of Barents Sea fish and mammal interaction which derived predation costs per whale of NOK 5,600. They were reconciled in that the simpler bioeconomic model assumed predation over a wider area and over both summer and winter.

Paper SC/6/EC/4 extended the model of Flaaten and Stollery, which estimated the direct cost of predation for a fishery exploiting a prey species, to the case of a fishery competing for prey with a mammalian predator. An attempt was made to apply the model to the Northwest Atlantic harp seal predation on capelin in NAFO division 2J3KL, in competition with Atlantic cod, but the estimates of predation costs are very unreliable.

Preliminary results shown in SC/6/EC/8 indicate that predation costs of harp seals in the Barents Sea could be in the range of NOK 150-500 per seal. However, some of the biological and economic data used are rather uncertain and the paper requires more work.

6.3 Economic factors to be taken into consideration

The management of a marine mammal predator should ideally include all relevant economic factors such as:

i) harvest revenues (fur, meat, blubber etc.)
ii) harvest costs (vessel, crew, fuel etc.)
iii) predation costs incurred by prey fisheries due to competition to these fisheries (needs costs and earnings data etc. for the prey fisheries to derive net value per unit prey in the sea)
iv) costs incurred by prey fisheries production due to seal worms etc.
v) the positive effects of fish stocks on growth, reproduction, etc of marine mammals
vi) non-use values:
-positive: seal/whale watching, existence value, precautionary value etc.
-negative: predatory killing of non-use valued prey; for example walruses and killer whales killing seals.
Methods of estimating non-use values exist, but should be used with great care (e.g. travel costs, and survey techniques such as contingent valuation methods and conjoint analysis).
vii) Boycott and trade sanction costs to the fishing industry and other industries of the whaling and sealing nations or regions.

7. THE ECONOMICS OF UNCERTAINTY

Sources of uncertainty in predictions of economic yield range from the obvious uncertainty in recruitment to the various stocks through assessment uncertainty to uncertainty in market and cost aspects of the various predators.

Given some management regimes, a price can be attached to these various sources of uncertainty. For example, if fishing operations are limited so as to ensure that biomass of the fish stock is above Bmsy with e.g. 95% probability, then a high degree of uncertainty will lead to an under-utilisation of the resource. In this case there is a cost associated with uncertainty and this cost can be evaluated in economic terms.

Including marine mammals in multispecies models has been seen not only to reduce the predicted yields from the fish resources but also to increase the degree of apparent uncertainty associated with these yield predictions. The change in economic yield due to the increased uncertainty has not been evaluated in conjunction with these economic models. In part this is due to the fact that it is not obvious at the outset how the uncertainty affects the management regimes. For example, in Icelandic waters the harvest control rule (HCR) for cod is simply to catch 25% of the biomass and for capelin it is to leave 400,000 tonnes for spawning.

In order to evaluate the cost of uncertainty the definition of the harvest control rules needs to be written out more explicitly. For cod in Icelandic waters the HCR was originally taken as "25% of available biomass but no less than 165,000 tonnes", where the lower bound has not been used after the first year. The reason for this particular choice of lower bound was to ensure a very low probability of further decline in stock size (less than 1% in simulations with fish species only). In this case it is clear that a reduction in uncertainty might have led to a less severe reduction in initial catches. Similarly, if marine mammals are included, then this will lead to greater apparent uncertainty and thus a need for a further reduction given this criterion.

This approach may possibly lead to a method for estimating the cost associated with uncertainty in this particular ecosystem and should be investigated further, since this may eventually provide a relevant price to pay for collecting minke whale stomach content data in order to reduce uncertainty in yield predictions for cod.

8. AVAILABILITY OF RELEVANT COSTS AND EARNINGS DATA

8.1 Cost and earnings data for fisheries

Fisheries cost and earnings data exist at varying levels of detail. For some areas and fishing sectors these data are available down to the level of a vessel. When such data are available it is possible to estimate costs and earnings associated with the fishing operations in a very detailed manner.

In other areas it may be better to use overall estimates of income, such as the first-hand value per kg of fish or marine mammal and then use an overall estimate of current profits from the harvesting operations. This then yields estimates of current costs which can be scaled with respect to (inverse) stock size in forward predictions.

8.2 Costs and earnings data from whaling/sealing operations

In Norway, the average price of minke whale meat obtained in 1997 was 30 NOK/kg, and on average, about 1.5 tonnes of meat was obtained from each whale. The price obtained for blubber was 1.97 NOK/kg in 1997, compared to 0.10 NOK/kg in 1996 and 23.11 NOK/kg in

1995. For harp seals, the average price was 195 NOK for age 0 seals and 120 NOK for age 1 and older seals. This includes the value of skin, meat and blubber, but not of seal penises. The data on harvesting costs for minke whale show that they are much lower than the revenues. For harp seal, data on harvesting costs were not available, but the seal catch has been subsidised in recent years.

Icelandic fisheries and fishing industry organisations are promoting seal hunting by paying 11,550 ISK (155 US$) for adult grey seals and 2,500 ISK for the skins of grey seal pups. There are other opportunities for selling seal products, and current relevant prices are as follows: skin of common seal pups: 2,000-3,000 ISK, depending on quality; seal meat for human consumption –200-250 ISK per kg; salted seal fat for human consumption – 200 ISK per kg.; seal penises - 500 ISK per penis.

8.3 Other relevant cost and earnings

In addition to obvious and tangible economic factors such as fish and marine mammal yields, there are other sources of costs and income which may vary and should be considered. These include whale watching for which economic data may exist. It should in principle be possible to include such an industry in an economic analysis. Somewhat more complex is the non-use value of the resource, i.e. the value placed on not utilising the resource. Such values have been evaluated through surveys, but a better method for obtaining the correct value would be through the utilisation of transferable quotas which could be bought by parties not interested in harvesting the resources.

9. CASE STUDIES

9.1. Combining MULTSPEC with simple economic models

The work presented in SC/6/EC/5 is based on simulation studies using the Institute of Marine Research (Bergen, Norway) multispecies model for the Barents Sea (MULTSPEC) (Bogstad et al. 1998, see also NAMMCO / SC 1997 etc). This model includes the species capelin, cod, herring, harp seal and minke whale. Harp seal, minke whale and cod are all predators on capelin, herring and cod, and herring is a predator on capelin larvae. The growth of cod is dependent on the abundance of herring and capelin, while the growth and reproduction of marine mammals are assumed to be constant.

The results of these simulations are combined with estimates of price and variable harvesting costs for each species valid for Norway. Price elasticities are assumed for cod, capelin and herring, while for harp seal and minke whale, the prices are assumed to be constant. The variable harvesting costs mainly consist of wages and fuel, and the income to the crew is assumed to depend upon the value of the catch. Different cost functions are used for different fleet groups. For harp seal, the harvesting costs are set equal to the price. The total gross and net revenue from the catch of all species is compared for runs with different harvesting strategies for harp seal and minke whale (equilibrium catch or no catch). The initial values of the harp seal and minke whale stocks are 600,000 and 80,000 individuals, respectively. The population model used gives an equilibrium catch amounting to about 33,000 harp seals and

2,500 minke whales, while the population at the end of the 20-year simulation period, assuming no catch, is 1.1 million harp seals and 144,000 minke whales.

The loss in gross revenue resulting from no catch vs. equilibrium catch is approximately the same for harp seals as for minke whales (about NOK 190 million annually). The average annual loss in net revenue resulting from not catching minke whales is, however, considerably larger than the loss resulting from not catching harp seals (62 vs. 27 million NOK annually). When not catching minke whales, 61% of the loss of gross revenue and 79% of the loss of net revenue are due to the direct loss from no whale catch, while the rest of the loss is due to smaller catches of fish. The loss of revenues when not catching harp seals is only due to smaller catches of fish.

The revenues for each country (Norway, Russia, EU, Faroes, Iceland, Others) are also calculated using the present division of catches between countries according to bi- or multilateral agreements. Norway, as the only nation currently hunting minke whales on a commercial basis, suffers most of the loss of gross and net revenues from not catching minke whales, while the loss due to not catching harp seals is divided among the countries approximately proportionally to their share of both gross and net revenue.

9.2 Economic consequences of harvesting regimes for marine mammals in Icelandic waters

Some preliminary results on the effects of different harvesting regimes for marine mammals are given in Fridjónsson (1997) and in SC/6/EC/6. These indicate that the effects of different harvesting strategies for marine mammals can have considerable economic impacts, but these are to a large extent indirect, such as through increased economic yield from other resources (e.g. cod).

It is further noted in Fridjónsson (1997) that there may be a potential adverse effect of a resumption of Icelandic whaling on other industries such as tourism or fish exports such as through possible reductions in prices etc. The Norwegian experience, however, indicates that this is not likely.

The results to date are very preliminary and need to be examined to a much greater extent before firm conclusions can be drawn.

10. CONCLUSIONS

The group agreed that advice on management of marine mammal stocks should take into account as many economic and biological factors as possible. Analyses which only take into account parts of the economical effects, such as only the revenue side or only the profits from whaling, can be highly misleading in the overall picture.

There is a need to continue the current work, and in particular the current biological and economic models need to be refined. Some of the models presented are still in a developmental stage but show promise and should be developed and tested further.

Comparative bioeconomic studies of the Northeast and the Northwest Atlantic are encouraged.

The different approaches to bioeconomic modelling should be encouraged in the future as the pursuit of different models provides the opportunity to compare results obtained using very different assumptions. Thus there is little need at the moment for standardisation of models.

It was noted that potentially important species such as hooded seals are at present not included in the models used. These may be important predators and cost factors which should be incorporated in future analyses.

Multispecies bioeconomic models have not been developed for the Faroe or Greenland areas. Such models would need to take into account any special considerations for those areas, possibly including social values placed on the hunting process.

11. ADOPTION OF REPORT

The report was adopted on 3 March 1998.

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Appendix 1

LIST OF PARTICIPANTS

Friðrik Már Baldursson
National Economic Institute
Kalkofnsvegi 1
IS-101 Reykjavik
Iceland
Tel.: +354 5699 512
Fax: +354 5626 540
E-mail: fridrikm@centbk.is

Bjarte Bogstad
Institute of Marine Research
P.O. Box 1870 Nordnes
N-5024 Bergen
Norway
Tel.: +47 5523 8425
Fax: +47 5523 8687
E-mail: Bjarte.Bogstad@imr.no

Ola Flaaten
Norwegian College of Fishery Science,
University of Tromsø
N-9037 Tromsø
Norway
Tel.: +47 7765 5544
Fax: +47 7764 6021
E-mail: olaf@nfh.uit.no

Erlingur Hauksson
Icelandic Fisheries Laboratories
P.O. Box 1405
IS-121 Reykjavik
Iceland
Tel.: +354 5620 240
Fax: +354 5620 740
E-mail: erlingur@rfisk.is

Gunnar Stefánsson
Marine Research Institute
P.O. Box 1390
IS-121 Reykjavik
Iceland
Tel.: +354 5520 240
Fax: +354 5623 790
E-mail: gunnar@hafro.is

Ken Stollery
University of Waterloo
Economics Department
Waterloo, Ontario N2L 3G1
Canada
Tel.: +1 519 885 1211
Fax: +1 519 725 0530
E-mail: stollery@watarts.uwaterloo.ca

Droplaug Ólafsdóttir
Marine Research Institute
P.O. Box 1390
IS-121 Reykjavik
Iceland
Tel.: +354 5520 240
Fax: +354 5623 790
Email: droplaug@hafro.is

Dorete Bloch
Museum of Natural History
Fútalág 40,
FR-100 Tórshavn
Faroe Island
Tel.: +298 18588
Fax: +298 18589
Email: doreteb@ngs.fo

Mads Peter Heide-Jørgensen
Greenland Inst.of Natural Resources
c/- National Environmental Research Inst.
Tagensvej 135, 4
DK-2200 Copenhagen N
Denmark
Tel.: +45 3582 1415
Fax: +45 3582 1420
Email: mhj@dmu.dk

Þorvaldur Gunnlaugsson
Dunhaga 19
IS-107 Reykjavik
Iceland
Tel.: +354 5517 527
Fax: +354 5630 670
Email: thg@althingi.is

Gísli A. Víkingsson
Marine Research Institute
P.O. Box 1390
IS-121 Reykjavik
Iceland
Tel.: +354 5520 240
Fax: +354 5623 790
Email: gisli@hafro.is

Tore Haug
Norwegian Institute of
Fisheries and Aquaculture
P.O.Box 2511,
N-9037 Tromsø
Norway
Tel.: +47 7762 9220
Fax: +47 7762 9100
Email: toreh@fiskforsk.norut.no

Lars Witting
Dronning Margrethes Vej 9, 4
DK-8200 Århus N
Denmark
Tlf.: +45 8610 3401
Fax: +45 8612 7191
E-mail: larsw@pop.bio.aau.dk

Appendix 2

AGENDA

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6. Bioeconomic multispecies modelling for marine mammals and fish
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Appendix 3

LIST OF DOCUMENTS

SC/6/EC/1	List of participants
SC/6/EC/2	Agenda
SC/6/EC/3	List of documents
SC/6/EC/4	Ken Stollery: The economic costs of predatory competition. Theory and application to the case of harp seal *(Phoca groenlandica)* predation on fish stocks in the North-West Atlantic
SC/6/EC/5	Bjarte Bogstad: Economic consequences of various harvesting regimes of the marine mammal and fish stocks in the Barents Sea
SC/6/EC/6	Gunnar Stefánsson and Friðrik Már Baldursson: The cost of not exploiting marine mammals.
SC/6/EC/7	Erlingur Hauksson: The Icelandic promotional system for seal-hunting
SC/6/EC/8	Ola Flaaten and Siv Reithe: The predation costs of the Barents Sea harp seal *(Phoca groenlandica)* - some preliminary findings.