FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNITED NATIONS ENVIRONMENT PROGRAMME

REPORT OF THE ADVISORY COMMITTEE ON MARINE RESOURCES RESEARCH

WORKING PARTY ON MARINE MAMMALS

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, March 1977

PREPARATION OF THIS REPORT

The ACMRR Working Party on Marine Mammals approved its Report at its final session held in La Jolla, U.S.A., 21-25 January 1977. It agreed that the Report and various parts of its three Annexes A, B and C are of interest to different groups of users and that it therefore would be of advantage if these parts were issued separately, after the necessary editing as agreed at the session. Accordingly, the Report appears with four supplements, as follows:

Report of the ACMRR Working Party on Marine Mammals
Annex A. Terms of reference and members of the Working Party and its *ad hoc* Groups

Supplement 1

Annex B. Proceedings of the Scientific Consultation on the Conservation and Management of Marine Mammals and their Environment
- Appendix I List of Documents
- Appendix II List of participants, secretariat, international intergovernmental organizations represented at the Scientific Consultation, organizations invited but not represented at the Scientific Consultation
- Appendix III Tasks and Conveners of Working Groups (WGs)
- Appendix IV Report of *ad hoc* Group IV on Ecological and General Problems
- Appendix V Opening Plenary Meeting

Supplement 2

Appendix VI Pinniped Species Summaries

Supplement 3

Appendix VII Report on Sirenians

Supplement 4

Annex C. Programme of research relating to marine mammals

In addition, selected papers submitted to the Working Party and its Scientific Consultation will be issued separately.

The present volume contains the edited Report of the Working Party and the terms of reference and membership.

Distribution:

FAO Fisheries Department
FAO Regional Fisheries Officers
ACMRR
Members of ACMRR Working Party on Marine Mammals and its *ad hoc* Groups
Participants at Scientific Consultation
Selector SM
UNEP
IUCN
IWC
UN and other organizations concerned
COFI
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Contents

1. PREFACE

Over the last eighty million years or so a number of separate groups of mammals, originally terrestrial animals, returned to the ocean to live. An abundant food supply in inshore waters, and the possibility of escape from predators or climatic extremes may have provided the conditions for such evolution. It has even been suggested that, much later, similar conditions led the primate ancestors of man to begin a similar move to the sea margins, staying long enough to leave marks on our anatomy. However that may be, successful adaptation to the marine environment called for major anatomical, physiological and behavioural changes. Some few of these mammal groups moved into fresh waters, which required further adaptation.

While posing special problems for the survival of an air-breathing, warm-blooded animal, the ocean has its advantages as a habitat. Climatic changes and associated environmental disruptions, which so stress the lives of terrestrial animals, are buffered by the ocean. The great mobility of most of the re-entrant mammals helps them. The waters provided food for all of them. Some have become as free of the land - though not of access to the atmosphere - as the fishes always have been, but others must still return to land, or to ice, for reproduction and perhaps for rest.

We do not know where the marine mammals evolved for aquatic life, but they probably did so at many places, and certainly different groups emerged at different times. The cetaceans (whales and dolphins), the pinnipeds (seals and sea-lions) and the sirenians (manatees, the dugong and the extinct sea-cow) represent extremes of mammalian evolution. Their respiratory, circulatory, locomotory, thermo-regulatory and communicative systems are all significantly different from the typical terrestrial mammalian pattern. Some mustelids (a few otters and the now extinct sea mink) also joined the movement to the sea, although they remain coastal and do not yet appear to be so specialized for ocean life as are the whales and seals. Only the polar bear, among living mammals which depend virtually exclusively on marine food sources, we do not consider here as a *marine mammal*; it is, like the seals, still dependent on a solid substrate, and although a good swimmer is not yet greatly modified for aquatic life, and can feed on land.

Man, from his earliest times, was probably familiar with some of his aquatic relatives. He realised that the whales and dolphins were very different from the fishes amongst which they swam; he also learned that these animals were good sources of food, clothing, fuel and other useful things. For at least five thousand years, human societies developed which hunted the marine mammals and at the same time revered them. Dolphins were among the first symbolic animals in the maritime cultures of western civilization. The large whales have stimulated imagination and awe wherever they have been closely observed. Other marine mammals are recurring creatures of cultural traditions and myth. Wherever people have taken to the sea they have found value and significance in the mammals they met there.

Man had, at first, little power to affect the whales, dolphins, seals and sea-cows. Then, gradually, the range of hunting vessels was extended, until baleen whaling in the north, sperm whaling in the tropics and subtropics and sealing for furs and oil in both hemispheres began to affect some animal populations in ways visible to the hunters. Finally, the replacement of sail by engines, of muscle by explosives, and of artisanal preserving methods by freezing, extraction and reduction, accompanied by the opening of world-wide markets, led to the drastic reduction in the numbers and range of many of the one hundred and fifty living species of marine mammals, and even to threaten the survival of some of them. Fortunately, these events have been accompanied by a growing consciousness that the living resources on which expanding human populations depend for food, shelter and amenities are ultimately finite. When the finite nature of wild living resources is ignored, the continued existence of industries based on them becomes uncertain, and human societies dependent on those industries are disrupted. Such has been the main course of man's relationship with the marine mammals for the past one hundred years.

Consciousness of limits generates science to measure those limits, to reveal what fixes them and to seek ways of manipulating to human advantage the natural objects concerned. This process itself raises questions in our minds about the *values* of the objects, not only to us but also to the natural system of which they are integral parts. We ask what are the *rôles* of the various groups of marine mammals in the web of ocean life, and what do we do to that web when we catch them or compete with them for food? This leads to further questions, the answers to which we are likely to be seeking for many years to come: What other values for modern man do marine mammals have, to what extent are they all compatible with each other? What other effects on the living system of the ocean does man now have - other, that is, than by harvesting it - and how do these affect the other mammals, and interact with each other? What are the consequences for man of his multiplying interactions with his marine relatives?

In the 1970's, interest in the marine mammals began to spread beyond the groups traditionally concerned with them, that is to say beyond the commercial whalers and sealers, small surviving societies dependent on marine mammals, specialists investigating them and a persistent few who worked to ensure that no more animal species became extinct because of overhunting and that if hunted they were killed humanely. Thirty years earlier, some restraints had been agreed, in principle, on the operations of whaling factory ships in the Antarctic and on some sealing operations. In the years following the Second World War attempts were made further to regulate internationally the hunting of some whales and seals. These were partially successful, but a few important species continued to decline. In the thirty year period important scientific advances were made. Techniques of analysing the dynamics of animal populations flourished and were applied to marine mammals. Adaptations to diving and to water pressure were studied, and exploitation of the acoustic properties of sea water was revealed. Some scientists were enthralled by the beauty of their songs and the subtlety of their sonar. Some species of smaller cetaceans were, at last, kept in captivity and their sensitive and complex behaviour observed. Divers swam with and photographed whales and seals, thus carrying such observations into their home territory. The living form was seen to be unlike that usually portrayed - more elegant and more functional.

It is not clear to what degree the publication of these discoveries, or the new familiarity acquired in some countries through oceanaria, contributed to a wider public awareness of the marine mammals. Whatever the causes, this emergent consciousness coincided with the growth of the view expressed by governments that what had been called *common property resources* of the ocean should be managed with an eye on the future, and that all was not well with the existing arrangements to that end. Whatever their status as *property* - and this is changing, for many species, as a result of developments in the law of the sea - the very vulnerable marine mammals are a common heritage, and the problems caused by humanity's lack of knowledge and misuse of them are global in extent. It follows that efforts to solve these problems must be international and that all humanity would benefit from their success. Perhaps not all would benefit equally; they certainly do not at present. Many species of marine mammals, including the most spectacular of them, spend all or much of their lives in the colder seas; they have been, and continue to be, exploited by peoples possessing ships that can penetrate such regions and are usually able to travel great distances, or by those few who have found ways of living continuously in Arctic conditions. Nevertheless, some of the marine mammals are known to practically all coastal dwellers and we may look forward to a time when everyone will have the opportunity to enjoy them in one way or another.

A list of the benefits to be derived from increased knowledge and more rational *use* - both consuming and non-consuming - of marine mammals could be drawn up in many different ways; the following list recalls the great range of benefits that have been discussed:

a) Marine mammals yield meat, furs, blubber, oil, tooth ivory, bone and other products. Some sustain important industries; others support entire, though small, human communities. Notwithstanding the depletion of many of them, the direct economic value of marine mammals is still significant and could increase, at least for some uses.

b) Some marine mammals have been trained to conduct underwater, mainly military, operations. It may be hoped that in future they may cooperate with man in rescue, fish herding, mariculture and other peaceful uses of the sea.

c) Because of some physiological resemblance to human beings, marine mammals are important sources of knowledge concerning respiratory and cardiac problems, the effects of pollutants upon mammalian systems, and many other topics relevant to human health and well-being. As humanity participates more in the life of the sea, people can benefit from the knowledge of the evolutionary experience of their relatives who have long lived there.

d) The contribution of marine mammals to processes in the sea is still little known; given their positions in food-webs and their mobility, it is likely to be important. Without much improved ecological knowledge, it will be difficult to avoid making mistakes in the exploitation of other, economically more valuable, living marine resources such as fishes.

e) Marine mammals are advanced animals participating in complex biological processes extending over the greater part of the earth's surface. Study of their behaviour, of the sequence and timing of periodic events on which they depend, of the evolution of species and of processes, and of many other aspects of their lives, greatly benefits science and thus the intellectual development of humanity.

Because many marine mammals - particularly the cetaceans - are cerebrally well developed, their exploitation or control raises special ethical questions. Serious consideration of these questions should in itself contribute notably to humanity's ethical advance. Both the ethical and the ecological problems are difficult when recognition is given to some harmful effects of marine mammals on human activities in the sea, particularly fishing. Thus they quite often damage or rob nets, and of course some of them eat large quantities of the kinds of fishes that man also captures.

For most of the long history of humanity's relationship with marine mammals, knowledge of them remained slight and partial, being limited to those parts of their lives spent at the sea-air or sea-land/ice interfaces. Perhaps most of the time this deficiency did not matter; cultures that depended on marine mammals probably had inherent controls that compensated for lack of knowledge and limited the exploitation of the resources. Today, we know much more about the marine environment, and are acquiring the power to change it, though not yet to control it. Man prides himself on being the predicting animal, but has not yet found sure ways of predicting the consequences to the ocean environment of maritime and coastal actions. If and when such ways are found man will be in a better position to consider whether, where and how he wishes to pursue those actions.

Meanwhile, national boundaries are being extended far into the oceans, boundaries that are not recognized by marine mammals, so that, in the absence of a fuller understanding of their ecology, the potential for control offered either by broadened national jurisdiction or by international regulation remains small.

Many species of marine mammals are widely distributed; many are also migratory. They are significant components of extensive physical and biological systems, but only in this century, as human activities in the sea have been multiplied and extended by new technologies, has it become both possible and necessary to study marine environments in detail. Impressive and sometimes astonishing discoveries have been made, yet the sciences concerned with marine mammals must still be considered to be in their infancy. Enough has been learned, however, for it to be evident that many actual and potential crises exist for the mammals in the sea.

Pollutants of terrestrial and atmospheric origin are altering marine environments, to the detriment of marine mammals. In many parts of the world ocean, human activities pose threats to marine mammals which could drastically alter their patterns of living or even lead to extinction. Apart from their individual vulnerability to man while resting, breathing, playing, breeding or feeding at an interface, populations of marine mammals are vulnerable by virtue of their universally low birth-rates and, in many cases, by the time pattern of their lives which features, in the case of the whales, late sexual maturity and relatively close and prolonged dependence of the young on adults. Although many species undertake regular migrations over vast distances, and much wandering in search of food, some of them depend critically on the continued existence of certain limited habitats for their survival; such habitats as estuaries and lagoons are among the most easily altered or destroyed by man of all the aquatic habitats. It has even been suggested that the success of some groups, and especially of the great whales which appear to have, except perhaps for the *killer* whale (*Orcinus orca*) practically no enemies, has left them with little sense of fear, and hence curious rather than cautious with respect to man and his vessels. This would of course tend to increase their vulnerability, but it seems possible that they might learn sufficiently from their mistakes - to counterbalance curiosity - provided the mistakes are not fatal ones!

The inadequate state of knowledge for realizing the goals of modern society of better conservation of marine mammals and management of the human activities which affect them must be emphasized. As this report shows, information is needed about home ranges and migrations, the causes of movements, the nature of social bonds; about critical habitats, and the relations between biological production and ecosystem structure; about density-dependent changes in population characters, and evolutionary adaptation. Notwithstanding the fact that certain kinds of data pertaining to some exploited marine mammals are voluminous, existing data come nowhere near to meeting these requirements.

The research programme proposed in this report represents an effort to broaden the data base so that possible present and future objectives of society may be more easily determined on the basis of facts about the natural world and man's relation with it. The programme is still not comprehensive, and no doubt the priorities suggested will change with experience.

Overexploitation and pollution of the sea are evident threats to marine mammals. The principle of countering them is fairly well understood; it is, basically, to reverse the causal actions and hope the biological processes are also reversible. The collective short-sightedness of men in groups, whether expressed by the human life-span or the duration of governments, continues to endanger marine mammals and their habitats, notwithstanding the frequent use of the word *sustainable* in treaties and theses. Ignorance, too, is a persistent danger, to them and to us, whether in the form of scientific

uncertainty, or more generally, as when people recently killed a beached whale calf thinking it was a dangerous shark. A less violent result of ignorance is the harrassment of animals even by well-intentioned sightseers.

At present *conservation* and *management* of marine mammals are only possible in a very few cases in the same sense that those terms are used with respect to terrestrial animals. The terms imply habitat manipulation and care, for which we do not possess the means in the sea. Modern terrestrial management implies action, based on research, to improve or perpetuate the species, or to maintain the ecosystem of which it is a part. The best we can do today with respect to the sea is to manage human affairs so as to interfere with ecosystem processes as little as possible; and if marine mammals are to be exploited to do so under rigorous control *and with great restraint*. Meanwhile, no marine mammal can be considered secure as man's habitation of the entire planet expands and its effects become more complex. National and international controls, laboriously achieved, and minimal as most of them are, will be fragile in the face of growing demands for food by expanding human populations and for luxuries by more affluent ones. The problem of deriving action from knowledge, as applied to marine mammals, will become the problem of maintaining the health of the ocean itself. This idea was expressed succinctly by the Governor of the State of Colorado in March 1976: "... as the whales go, so go the oceans, and as the oceans go, so goes the environment, causing the whales to become the symbol of the international environment movement." The International Whaling Commission has also played a symbolic rôle; it has certainly been the subject of more critical studies than has any similar institution. It was remarked, during a period of crisis in the early 1960's, that if the Commission failed in its task, the regional commissions for fisheries management might be weakened and, perhaps, in turn, other arrangements between governments for the regulation of ocean activities.

Beginning with symbols, and here returning to them, we are reminded of a continuing complex relationship between man, the dominant terrestrial animal, and the marine mammals which are so conspicuous in the seas. Some of the scientists who assisted the Working Party expressed the view that current and looming problems concerning marine mammals and their environment are directly related to the increase in human population and, further, that solutions to those problems will only be found when that increase is halted. Others, while not disagreeing that population pressure is important, felt that humanity's increasing *per capita* consumption rates of natural resources are at least of equal importance. The Working Party offers comments on this matter elsewhere in this report, but I will conclude by quoting an anonymous writer[1/]:

> "*Temporal imperialism* is the exploitation of one generation (of humanity) by another. The victims have no defence as they are not yet born. They are exploited by the removal of unrenewable resources ... and by the erosion of environmental integrity. We exploit them by consuming more, by producing more waste, and by producing more children. By *species imperialism* I mean that, when there is a conflict of interest between another species and our own, we always opt for our own interest, no matter how trivial. Most of the troubles we are causing to other species are not, I suspect, the spectacular ones. They are private pains which we can only know about through the occasional accidental discovery."

He gave the humpback whale as one of his examples, observing that not only had the species been hunted to the verge of extinction, but that the survivors could perhaps hardly hear each other's voices through the background noise of motor vessels. The conservation ethic and practice may be the counter to both these imperialisms.

1/ Participant in a 1971 Conference on Young Scientific Workers and Contemporary Society, recorded by Robin Clarke in an anthology "Notes for the Future". (1975)

In submitting this Report to the ACMRR the Working Party has asked me to express its wishes as to the further treatment of the document. The Working Party's recommendations regarding publication and distribution are given in Section 9 (Recs. 11 and 12). It is hoped that the Report, together with the Advisory Committee's comments on it and any further comment by the FAO Secretariat, will be made available as soon as possible to the FAO Committee on Fisheries, which should be urged to initiate appropriate actions regarding the recommendations. At the same time the Report and, eventually, the ACMRR commentary should be transmitted to UNEP which has played the major rôle in financing the entire study project and which, it is understood, is awaiting particularly the recommendations and the draft research programme contained in Annex C before proceeding with its own actions in furtherance of implementation. It is expected that the actions by UNEP and by FAO will be complementary, these organizations having consistent policies.

The Working Party is aware that there is some repetition in its report, especially as between the main text and Annex B. This is deliberate, with the intention that different parts of it may be read separately, by different readers. The Report is directed to a mixed readership and is not therefore written throughout in the language that scientists might prefer. The Report may seem somewhat unbalanced with respect to formulation of various parts of the research programme (Annex C), largely because the proposals for whales, for small cetaceans, for sirenians and for pinnipeds were compiled by different groups of specialists in rather different ways. The Working Party has not attempted to bring these to consistent form, but believes the substance of these proposals is well-considered in all cases, irrespective of the format adopted.

Santa Cruz, California
1 February 1977

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2. INTRODUCTION

In April 1972 the inter-governmental Committee on Fisheries (COFI) of the Food and Agriculture Organization of the United Nations (FAO), responding to expressions of widespread public concern, requested that an independent review be made of the status of whales, dolphins, seals and other marine mammals. The Director-General of FAO referred the request to his Advisory Committee on Marine Resources Research (ACMRR) which acted by establishing a Working Party on Marine Mammals. The terms of reference of the Working Party are given in Annex A.

At a planning meeting, held on 15-16 February 1973 in Vancouver, Canada, members of the Working Party agreed that the terms of reference were so comprehensive that it would be essential to seek the assistance of many specialists, to ask them to provide data, prepare review documents, attend meetings of subsidiary groups and help in other ways. In the following three years, very many people freely contributed their time and in some cases their research resources. If this ACMRR activity is judged to be successful, such success should be largely attributed to the willing help given by students of marine mammals the world over.

In Annex A are listed the members of the Working Party, and scientists from whom the Working Party subsequently received specialized assistance, mainly through four *ad hoc* Groups which it created. These Groups all met at least once, and some of them on several occasions. The reports of these *ad hoc* Groups, as amended by the Working Party itself, taking account of the Scientific Consultation in Bergen (see below) provided the basis for Sections 3 to 8 of this Report. The Working Party held three formal sessions, the first was in London, 29 June - 3 July 1973; a report was issued by FAO (ACMRR:WPMM/73/1, 13 September 1973). The second and third meetings were held on the island of Svanøy, Norway, 11-14 September 1976, and in La Jolla, California, 21-25 January 1977, respectively. On these occasions the Working Party was served by three members of the FAO Secretariat: S.J. Holt, L.K. Boerema and J.J. Goodman. In the three intervening years members of the Working Party were able to meet several times informally, particularly on the occasions of sessions of *ad hoc* Group IV of which they were themselves members, *ex officio*.

In the absence of specific guidance from ACMRR, but having examined the record of the COFI discussion which gave rise to this study, the Working Party agreed, in principle, to consider all living cetaceans, pinnipeds and sirenians, including those inhabiting fresh waters, but only the two strictly marine species of otter, and not the polar bear. It was decided to use, with a few exceptions, the scientific and English vernacular names given in a list of marine mammal names eventually issued by the U.S. Marine Mammal Commission in July 1976 (ACMRR/MM/SC/Inf.10).

It was originally decided that the draft Report of the Working Party would be "discussed at a technical seminar (workshop) to be convened by FAO". This discussion took the form eventually of the Scientific Consultation on the Conservation and Management of Marine Mammals and their Environment, held in Bergen, Norway, 31 August - 9 September 1976. Instead of a draft Report of the Working Party, the Bergen Consultation reviewed the reports of its four *ad hoc* Groups, as well as all the background material which had been assembled. Interest in this project was so lively that nearly 200 specialists eventually participated. Nevertheless, it proved possible for the Consultation to retain the character of a workshop by adopting the device of breaking up for most of the time into a total of 25 Working Groups, with overlapping memberships, with occasional joint meetings and intermittent plenary sessions. The main task of the Working Party at Svanøy and La Jolla then became to take account of the reports and commentary generated in Bergen. The Proceedings of the Scientific Consultation are given, in full, in Annex B of this Report.

It did not prove practicable, without further prolonging a long drawn-out activity, to make available the draft Report of the Working Party, as the terms of reference provide, to "national and international mammal committees and bodies for their consideration". The Working Party hopes, however, that its final Report will be so made available together perhaps with the comments of the ACMRR itself (see Section 9, Rec. 11).

In its terms of reference the Working Party was enjoined to cooperate with, and to take account of the activities of, other international organizations. A list of organizations invited to cooperate is given in Appendix I of Annex B; many of them designated representatives at Bergen, and representatives of some of them also participated, in accordance with their interests, in meetings of the four *ad hoc* Groups.

A study on this scale was an expensive undertaking. It was made possible, apart from the work of the FAO Secretariat, by substantial financial support from the United Nations Environment Programme (UNEP) and from the Governments of Australia, Canada, Norway and the United States of America. The International Union for the Conservation of Nature and Natural Resources (IUCN) and the World Wildlife Fund (WWF) also contributed financially and in kind.

According to the timetable originally established in July 1973 - already more than a year after the request by COFI - the Scientific Consultation would have been held late in 1975, and the final session of the Working Party in spring 1976. The desired schedule could not be kept, partly because of initial slowness in raising funds, but mainly because, despite their interest and willingness to help, specialists have, of course, other pressing demands by their employers, many of whom are university authorities and other non-governmental agencies, and many of them spend much of their time in field work. It was therefore often difficult to assemble a sufficient number of the key people for a group meeting. The practical response of the Working Party to this delay was to arrange that progress reports be submitted regularly to COFI and to ACMRR. Interim statements were made to other interested organizations, particularly to UNEP and to the International Whaling Commission (IWC).1/ Subsequently, the Scientific Committee of the IWC established an *ad hoc* subcommittee to examine an interim report on the work of *ad hoc* Group I (Large Whales) and has since published its findings and acted along the lines of several of the suggestions made.2/

At the initial planning meeting of the Working Party it had been suggested that FAO should build up a comprehensive system for access to documentation about marine mammals, and information about research workers in this field and their current investigations. This matter was not subsequently discussed but the proposals made at the first session of the Working Party, and given in the report of it, are repeated here in Section 9. At its first session the Working Party expressed concern "about the inadequacy of reliable information about marine mammals and their management flowing from scientists to the general public, who were very interested in this subject". While it was agreed that members of the Working Party and of its *ad hoc* Groups could help individually in this regard, it was also decided that a more coherent effort should formally be undertaken. This subject was considered by Working Group 22 during the Scientific Consultation, and the proposals by that group have been accepted by the Working Party. A third matter considered at the first session of the Working Party was the compilation and publication of statistics of commercial use of marine mammals; the recommendations then made are reformulated in Section 9.

A considerable effort has been devoted to the task of examining "past and existing research programmes and their results" and "identifying significant gaps and weaknesses in these in the light of decisions by organs of the United Nations system and other intergovernmental bodies". This has led to a greater emphasis on plans for future research and its coordination than probably was originally envisaged by COFI and ACMRR. The Working Party felt, however, with increasing conviction as its review progressed and as the gaps and weaknesses in present arrangements became more and more evident, that its most important task might be to draw up a detailed outline of such research plans, with exemplary projects, indications of priorities and costs, and suggestions for the arrangements to implement them. During the period of its work small groups of consultants have met from time to time to prepare syntheses of research proposals regarding particular systematic groups of marine mammals. These were eventually assembled in the form given in Annex C to this Report.

At the Seventh Session of ACMRR, in October 1973, it was suggested that a review should be made "of what is known about pesticides and other contaminents in the organs of marine mammals and effects on their biology". The Working Party has not been able to make such a review. Other data are now available in documents submitted to Bergen, and also in the FAO Fishery Data Centre as a result of an FAO/UNEP project on contaminants in aquatic organisms. ACMRR may wish to consider whether this matter should now be pursued further and an appropriate recommendation has been made to this end.

A list of the acronyms of international organizations and projects referred to in this Report is given in Appendix II of Annex B.

Throughout the period of activity the Working Party has kept in close touch with, and received help and advice from the chairman of ACMRR - first G. Saetersdal and then D.L. Alverson. Many members of the staff of the FAO Department of Fisheries assisted this activity; special mention should be made, however, of G. Corbellini who, over the last two years of intensive work, was mainly responsible for keeping in order the documentation, while D. Dearing looked after the very voluminous correspondence and assisted in assembling the final version of the Report.

1/ See IWC (1975). Twenty-fifth Report of the Commission, pp.253-260

2/ See IWC (1976). Report and Papers of the Scientific Committee of the Commission, 1975, pp.26-30

3. STATUS OF SPECIES AND POPULATIONS OF MARINE MAMMALS

3.1. Large whales

All species of baleen whales except the pygmy right whale (*Caperea marginata*) and most if not all of the stocks of each species are, or have been, exploited to some extent at various times. The more easily catchable species - the right (*Eubalaena*), bowhead (*Balaena mysticetus*) and gray (*Eschrichtius robustus*) whales were all reduced to very low levels of abundance by the beginning of the twentieth century. No species has, however, been exterminated by whaling, although the gray whale in the North Atlantic is extinct.

Modern whaling very dramatically reduced stocks of humpbacks (*Megaptera novaeangliae*) and blue (*Balaenoptera musculus*) whales by the middle of this century, and, in general, only relict populations of these populations survive. Regulation in recent years has, however, prevented the decline of fin (*B. physalus*) and sei (*B. borealis*) whales to the same degree, as far as can be determined, although both species, and particularly fin whales, have been depleted. Bryde's whales (*B. edeni*) in the Southern Hemisphere are believed to be only lightly exploited so far, although there is a long history of exploitation of this species in the North Pacific. Minke whales (*B. acutorostrata*) have been exploited for decades in the Northern Hemisphere, but they have only recently been hunted in the Southern Hemisphere.

The sperm whale (*Physeter catodon*) has the longest history of exploitation of all the whales still hunted commercially. This species now provides most of the world catch by number and by weight, though not by value. The precise states of the stocks are still open to question. However, the number of female sperm whales have not been greatly affected by modern whaling except in the eastern South Pacific. The males, which grow appreciably larger than the females, have been subjected to longer and more intense hunting, and have been significantly reduced in number in most areas.

Present application of the new management policy of the IWC is such that commercial exploitation of *sustained management stocks* and *initial management stocks* is permitted under quota for fin, sei and Bryde's whales in some areas, and for minke and sperm whales in most areas of their distribution for those stocks which have been classified as sustained management stocks or initial management stocks. Blue, pygmy blue (*B.m. brevicauda*), right, humpback, gray and bowhead whales are protected world-wide, except for aboriginal hunting of the last three species. None of these measures - protection and quota regulations - apply to hunting by vessels flying flags of states not members of the IWC.

The only stock which has demonstrably recovered under protection is the California gray whale. It is still too early to detect with certainty whether blue whale stocks have been increasing since they were protected, because of the inherent low rate of increase of large whales and the difficulties of obtaining sufficient survey coverage to measure a significant change in abundance. Some humpback and some right whale stocks do show evidence of increasing in recent years. There are also difficulties in measuring whale abundance with sufficient precision to determine if stocks thought to be near chosen levels are indeed being maintained at those levels. These questions are discussed further in Section 3.6. Subject to these reservations, the present biomass of large whales is estimated to be about twenty-three millions tons; it was, before modern whaling began early this century, perhaps about three times as high. The numbers of all species, including juveniles, have declined less than the total biomass and are now thought to be about two million.

3.2. Small cetaceans

In general, knowledge of the identity and distribution of the small cetaceans is far behind that of the large whales and that of the pinnipeds. The small cetacean faunas of large ocean regions remain virtually unknown. In addition, there remain many important taxonomic problems at the species and generic levels with respect to these animals, and even more difficult problems in the identification of separate populations. It can be expected that the number of identifiable management stocks will eventually run into the hundreds.

The states of those stocks of small cetaceans for which some evidence is available range from being severely endangered or even perhaps extinct, to being little affected by human activities, but the states of many stocks are little known. Species which are subject to direct fisheries and for which more population studies and assessments are, to varying degrees, urgently needed include the northern bottlenose whale (*Hyperoodon ampullatus*), Dall's porpoise (*Phocoenoides dalli*) in the northwestern North Pacific, striped dolphin (*Stenella coeruleoalba*) on the Pacific coast of Japan, bottlenose (*Tursiops truncatus*) and common (*Delphinus delphis*) dolphins and harbour porpoise (*Phocoena phocoena*) in the Black Sea and Sea of Azov, harbour porpoise in the Baltic Sea, white whale (*Delphinapterus leucas*) in various areas containing separate populations and narwhal (*Monodon monoceros*) in some areas.

Various gillnet fisheries around the world take incidentally substantial numbers of small cetaceans, in particular Dall's porpoise, the franciscana (*Pontoporia blainvillei*) and species of the Genera *Phocoena* and *Lagenorhynchus*. The magnitude and extent of these incidental takes, and their probable impact on the dolphin populations remain to be evaluated. Annual incidental kills of spinner (*Stenella longirostris*) and spotted (*Stenella spp.*) dolphins in the international tuna purse seine fishery in the eastern tropical Pacific currently exceed 100 000 per year by American flag vessels, and an unknown number by other vessels. These kills are known to have caused some stocks to decline and a major effort is urgently needed for further evaluation of this situation.

Habitat deterioration through oil exploration and extraction may threaten the narwhal - catches of which have increased recently in some areas - and the boutu (*Inia geoffrensis*) in major South American river basins. Of the other fresh water dolphins, opinions vary greatly about the state of the Ganges susu (*Platanista gangetica*) - it may or may not be endangered. The Indus susu (*Platanista minor*) appears to be facing the threat of immediate extinction by hunting and habitat modification; its numbers are critically low and its range greatly restricted. The white fin dolphin (*Lipotes vexillifer*), which is restricted to the Yangtze basin, is reported to be very rare but strictly protected.

3.3. Pinnipeds

There are about thirty million pinnipeds in the world; nearly half of these are the ice-dwelling crabeater seals (*Lobodon carcinophagus*) of the Antarctic. The total biomass is thought to be about five million tons, of which over two-thirds are in the Southern Hemisphere.

All stocks of pinnipeds in inhabited parts of the world have been affected by man. Different species which have been depleted have shown very different rates of recovery. The ice-dwelling seals of the Antarctic have remained practically unexploited, total catches amounting to no more than a few thousand. Phocids in the Northern Hemisphere have all been, and in some cases still are, affected by aboriginal hunting, and it is not possible to estimate original stock levels. Harp (*Phoca groenlandica*) and hooded (*Cystophora cristata*) seals in the North Atlantic and White Sea have both been greatly reduced by commercial hunting in the past hundred years. There are grounds for believing that stocks in the White and Barents Seas have now been stabilized. The status of the harp seal in the western North Atlantic is a matter of serious dispute which the Working Party has been unable to resolve, although the numbers are definitely far below initial levels. In view of this uncertainty, the Working Party believes that a conservative management policy should be adopted. In the North Pacific, larga (*Phoca largha*) and ribbon (*P. fasciata*) seals are hunted commercially and stocks have possibly declined. The very abundant ringed seal (*P. hispida*) may be regarded as near original levels, with the exception of some lake-dwelling forms of this species and of the population in the Baltic, which are at low or very low levels and should be regarded as threatened. The range of the very widely distributed harbour seal (*P. vitulina*) has been reduced by habitat disturbance and casual hunting. However, it is still an abundant species and over its range as a whole is probably stable. The grey seal (*Halichoerus grypus*) has, with the exception of one population, increased greatly in numbers in the last fifty years, and this trend continues. It is not known how the size of present population compares with that of the original stocks. The Baltic Sea population is declining rapidly.

Of the three monk seals, the Caribbean monk seal (*Monachus tropicalis*) is almost certainly now extinct and the other two species - the Mediterranean (*M. monachus*) and Hawaiian (*M. schauinslandi*) monk seals - are now very rare and still decreasing in abundance. Monk seals are not now exploited, but are still occasionally killed illegally. Their original stock sizes are not known.

Both the southern (*Mirounga leonina*) and northern (*M. angustirostris*) elephant seals were heavily exploited in the nineteenth century but are recovering in all parts of their range relatively rapidly, and some island populations may have recovered nearly to original levels.

Among the eared seals, all fur seals - the northern fur seal (*Callorhinus ursinus*) in the North Pacific and the eight species of the Genus *Arctocephalus*, of which all but one are confined to the Southern Hemisphere - have been heavily exploited beginning in the eighteenth century, and many populations were exterminated. So far as is known, no species has become extinct. However, the Juan Fernández (*A. philippi*) and Guadalupe (*A. townsendi*) fur seals have recovered only to very small populations; they were so rare that they were, until quite recently, thought to be extinct. Other species are currently increasing rapidly but are still well below original numbers.

The Antarctic fur seal (*A. gazella*) has increased at South Georgia from a few hundred animals in the 1930's to the present number of about 350 000 animals. The closely related species living on the islands to the north of the Antarctic Convergence, the sub-Antarctic fur seal (*A. tropicalis*) has recovered more slowly.

The other eared seals, the sea lions, were also exploited, though not so relentlessly as fur seals. The Japanese form of the California sea lion (*Zalophus californianus*) has become extinct. The Australian (*Neophoca cinerea*) and New Zealand (*Phocarctos hookeri*) sea lions are now few in number but were perhaps never very abundant. The South American sea lion (*Otaria flavescens*) in the Falkland Islands (Islas Malvinas) has shown a remarkable decline in abundance in the last thirty years; the cause is unknown, but it was not hunting. The southern limit of the range of the Steller sea lion (*Eumetopias jubatus*) appears to be moving northward, but this species is regarded as being near original levels in Alaska.

The walrus (*Odobenus rosmarus*) has been heavily exploited, both commercially and by aboriginal hunters. However, the species appears to be recovering throughout its range, with the exception of West Greenland. All Atlantic populations are still probably much below original levels, whereas Pacific populations are now high.

3.4. Sirenians

Four species of this group survive: three species of manatees (*Trichechus*) and the dugong (*Dugong dugon*). Steller sea cow (*Hydrodamalis gigas*) is thought to have been hunted to extinction within about thirty years of its discovery in 1741 in the Bering Sea. Sirenians are all shallow water nearshore animals. The dugong is exclusively marine; the Amazonian manatee (*T. inunguis*) occurs exclusively in fresh water, while the Caribbean (*T. manatus*) and West African (*T. senegalensis*) manatees live both in fresh waters and in the sea. The total number of sirenians in the world is not known but it is known that all living species have been seriously reduced in numbers by exploitation for meat, oil and other products.

The dugong occurs in the Indian and western Pacific Oceans. It is rare over most of its range and approaching extinction in some areas. Sizeable populations are found in some areas off Australia and Papua New Guinea.

Numerical data are not available for the West African manatee, but it is rare and appears to be declining throughout its range. Likewise, the total population size of the Caribbean manatee is unknown, but it is probably declining over most of its range. Less than one thousand individuals were located in a recent survey in Florida. The Amazonian manatee is sparsely distributed throughout the Amazon basin. Large numbers were taken during the period of commercial exploitation which continued until quite recently.

3.5. Marine otters

The sea otter (*Enhydra lutris*) is fully adapted to marine life. This species once occupied extensive shallow areas nearshore, along the shores of the North Pacific Ocean. The South American marine otter (*Lutra felina*) is also considered here because as far as is known all individuals of this species are inhabitants predominantly of Pacific coastal marine areas.

Prior to 1741, the beginning of exploitation in the Bering Sea for the fur trade, sea otters numbered several hundred thousand animals. By 1911, when the species was first protected, it had been eliminated from most of its range and reduced to a few thousand animals or less. Following protection, these remnant populations increased and have gradually reoccupied 30-40% of their former range. Thriving populations now occur on the northern and western shores of the Gulf of Alaska and the Aleutians but have not become re-established in most of their original range to the south, except off central California. The species is now thought to number more than 100 000 animals and some populations are no longer increasing.

South American marine otters, which were once abundant, have been reduced to scattered remnant populations in Chile and Peru; unconfirmed estimates give a total of less than 1 000. The species is listed as *endangered* in the IUCN *Red Data Book* and in *Appendix I* of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

3.6. Problems in determining status of stocks and populations

The term population is here applied to a group of individuals of a species or a subspecies which is sufficiently reproductively independent from other subsets that they are able to maintain their genetic identity. A stock, which is the term used for a management unit, and is commonly defined on a geographical basis, may comprise one or more populations or parts of these. Many species of marine mammals are distributed in a number of more or less self-contained populations, which have different distributions, although they may mix to a greater or lesser extent in feeding areas or during migrations. Different populations may have different parameter values and they are likely to be affected to different extents by environmental changes and by human activities. The status should therefore be assessed for each population separately, if possible, and in any case for each stock separately. Population separation is insufficiently known for most of the large whales, and very little is known at all for the small cetaceans. With respect to the large whales, geographical subdivisions of the oceans have been adopted by the IWC as a basis for stock assessments. Biochemical and morphometric characters may aid in the distinction between populations of one species, and also in the determination of the taxonomic status of some small cetaceans. Stocks are not, however, necessarily genetically distinguishable, so other methods, including extensive tagging on breeding grounds, are needed to improve understanding of this matter. Even the past and present occurrence and total distribution of many species of marine mammals is insufficiently known.

A number of techniques are available for determining population size. Problems of measuring vital rates, and of observing and predicting their changes under exploitation, make it difficult, if not impossible, to identify desired stock levels or to appraise the present levels in relation to desired ones. Other factors which affect the evaluation are possible trends in abundance due to natural causes or to human factors other than exploitation, such as pollution or coastal developments, about the effects of which very little is known. These drawbacks and difficulties associated with them are described in the Proceedings of the Scientific Consultation, where attention is drawn to biases or other errors needing appropriate calibration and correction for the particular method and species concerned. An international programme for data collecting and analysis is also suggested therein, and it is noted that aircraft, including helicopters, have despite some difficulties great value as survey platforms. Incidental data collected from platforms of opportunity have some value in supplementing the regular planned collection of data from ships.

With respect to catch per unit effort used as an index of abundance of whales, it can be affirmed that catch data for whales are generally fairly reliable insofar as they refer to the numbers and sizes taken, although a few countries which catch them still do not report these data promptly, adequately or even at all. The statistics of whaling effort are much more difficult to standardize and to evaluate. Changes in species preference by whalers, shifts in whaling grounds, variations in effective day length, weather conditions, technical changes in catcher efficiency and the skill of crews, all need to be taken into account but are often difficult to quantify. For these reasons, it is essential that more direct methods be used to estimate population sizes. Sightings by research cruises require an enormous input of time and effort adequately to cover the ranges of the large and small cetaceans so as to provide reliable indices of abundance. Deriving estimates of abundance then requires considerable additional information about sighting distances, probabilities of sightings and blow frequencies.

Mark-recapture techniques for marine mammals also require large-scale effort to apply sufficient tags - or to take sufficient photographs - and to provide sufficient numbers of recoveries to give useful estimates. Thus, for the large whales this effort has not yet been sufficient to give useful measures of the size of any stock. Colour-coded visual marks offer the opportunity for repeated sightings of live animals, rather than the returns of internal marks from dead animals. Radio tags used on a large scale hold particular promise for providing additional information on movements and behaviour.

Indirect methods for estimating population sizes, and for predicting yields, employ models incorporating values of the vital parameters of populations. The sex ratio, age at maturity and pregnancy rates are relatively easily determined from the catches of exploited whales, but pregnancy rates are particularly difficult to determine in pinnipeds. Other parameters, notably natural mortality rates, are very much more difficult to measure. The proportion of males that must be left alive to ensure reproduction in polygynous species is particularly important to determine for predicting sustainable yields from such species. The values of the parameters corresponding to various population levels can only be found when the populations reach those levels, so there is potential merit in experimental management strategies for determining density-dependent changes and the dynamics of exploited populations. Close monitoring of stocks recovering under protection is also important in this regard.

Some types of population models do not require knowledge of all the vital rates separately, of the changes in these with density or of changes in behaviour. These so-called biomass models, however, provide little insight into the population dynamics of the stocks; for example, it is difficult to take account in them of time-lags in density-dependent population effects.

Studies of behaviour and social structure are particularly important if changes in population parameters under different regimes of exploitation are to be understood, and to evaluate the effects of disturbances by other human activities. There are few quantitative or experimental data, and the responses within and between species to similar disturbance are variable.

Historical studies are important for assessing and understanding the present status of several species of marine mammals. Such data may provide information about the original sizes of stocks and resolve such questions as whether the stocks at the beginning of modern exploitation were at or near the original levels, or if they were still in the process of recovery, both in numbers and in age composition, from exploitation in the ninteenth century and earlier.

In the above account, many of the gaps and deficiencies in the knowledge of the state of marine mammals and in the methods of research and assessment used have been illustrated. The statements made regarding the state of the stocks are, for most species, only rough approximations. These statements are very much less accurate than are needed by agencies which make management decisions. Scientists, at the present stage of the subject, rarely can calculate ranges of statistical error in the estimates on which the statements are based, nor can they be sure that there are no serious biases in them. The assessment of the states of stocks and populations is a continuing process which will lead, with increasing data and improvement in the methods used, to greater precision and accuracy in the estimates and to the elimination of biases. This is, of course, particularly necessary for exploited and endangered species.

4. ROLE OF MARINE MAMMALS IN MARINE ECOSYSTEMS

4.1. This subject of the rôle of marine mammals in marine ecosystems may be approached in a number of related ways. Firstly, one may undertake a general examination of the identity and evolution of the ecosystems in which the marine mammals occur; secondly, one may consider the effects of marine mammals on their ecosystems; thirdly, one may examine the effects of ecosystem alteration upon the mammals; and lastly, one may attempt to evaluate the capabilities of marine mammals to deal with ecosystem changes. Conservation and management actions must, by and large, take into account the results of all such approaches if specified objectives are to be achieved.

4.2. System identity and evolution

In spite of their different lengths of geological history, the various groups of marine mammals all display a high degree of morphological, anatomical and physiological adaptation, directly linked to their survival in a medium to which their air-breathing ancestors were not adapted for continuous living. Time scales of evolution are long, but they nevertheless have direct bearing on problems of our time. Evolutionary strategies by which the mammals adapted to particular characters of the marine environment must be understood so that techniques of exploitation, management and conservation are not inappropriate to those adaptations.

Marine mammals are basically adapted to environments which undergo seasonal changes but are, in general, otherwise relatively unvarying. Such adaptation has been called *K selection* with reference to the parameter K, which in simple population models of the logistic family defines the carrying capacity of a particular environment for each species. Another view of this strategy is that marine mammals are constrained to low reproductive rates by virtue of having evolved from K-selected terrestrial mammals. This is in contrast with species of other groups of animals which evolved to take advantage of fluctuating, randomly changing, *unpredictable* features of environments through selection for high reproductive rates; such species are said to have adopted an *r selection* evolutionary strategy, r being the parameter in models which defines the maximum net rate of population increase. In this connection, some members of the Working Party felt that the functional view of ecosystems had not been emphasized sufficiently in the discussion of unit ecosystems during the Scientific Consultation. An ecosystem consists of biotic and abiotic components, but present theory and field research indicate it is also a functional unit which itself evolves so that efficiency is maximized, net production is low, materials are recycled and homeostasis ensured. Ecosystems may naturally fluctuate, but about equilibrium states, and in this respect they may be called resilient. The survival of K-selected species depends on such equilibria. Resilient ecosystems may not functionally be altered by elimination of one or more species. The food webs in which marine mammals take part are complex and highly structured as a result of interspecific competition. If a marine mammal population is removed, the system may move to another stable state. Thus, in the Southern Ocean a shift has taken place in the relative abundances of species sharing the same food base (krill). Consequently, the recovery of a species of large whale may be slower, less likely or less complete than would be predicted if changes in the system were disregarded.

Critical questions are whether a variety of stable states may be reached in marine ecosystems which have been exploited by man, and whether the systems will return to their original states if exploitation stops. In this connection we must consider not only the total biomass of each trophic level but also the time-space relationships of members of an ecosystem which depend upon the same food base. Answers to these questions cannot yet be given.

A further problem arises from the fact that many - if not most - species of marine mammals migrate between ecosystems at different phases of their lives; an example is the gray whale which occupies subtropical lagoons for calving, and sub-Arctic seas for feeding. Thus it is essential to take account of life cycle events which link two or more ecosystems. We do not yet know which phases of the life cycles are controlled by fixed behaviour and which by learning.

The Scientific Consultation was invited to identify and review "unit ecosystems of which marine mammal populations are elements, and regarding the main functional relationships within these". Regrettably, this task was not accomplished. The Working Party believes that there is still need for such a review, with particular attention to the fact that many marine mammals may have functional rôles in several ecosystems.

4.3. Effects of marine mammals on ecosystems

If a marine mammal population is depleted or eliminated, an ecosystem in which it is playing a rôle will come to a new state, which may or may not be stable. Possibly the most obvious cases involve those marine mammals which feed benthically and where the effects of grazing or predation can be seen. Sea otters re-structure the communities in which they live by their foraging on benthic invertebrates. Sirenians graze on shallow-water plants and this may produce effects similar to those of terrestrial grazers. The nature of a benthic community may be determined in some sea areas largely by the presence of walruses, which plough the sediments. In none of these cases is the biomass of the marine mammals necessarily the most relevant measure for comparison with other components. The large whales feed in the Southern Ocean in very different ways from the birds and seals with which they compete in some areas. The time-space relationships of such competition, in addition to the relative biomasses or rates of flow of materials and energy, may determine the community structure. This structure could therefore be expected to change substantially even with less drastic changes in whale numbers than have been caused by whaling.

In evaluating the energetics of marine mammals, participants in the Scientific Consultation stated that "after basic information about the bioenergetics of individual animals has been learned, numerical population models can be translated into energetic population models, providing a quantitative basis for studying energy transfer between different trophic levels within ecosystems." The Working Party believes that this is a particularly fruitful subject of investigation, and that the current development of methodology should be supported.

4.4. Effects of changes in an ecosystem on marine mammals

That marine mammals are adapted principally to relatively unchanging environmental patterns does not mean that these stable environments do not fluctuate; high-latitude marine environments change seasonally, and marine mammals have adapted to these regular changes. Critical life history events appear to be synchronized with environmental events. The degree to which the timing of life history events can be altered is an indicator of the type of evolutionary strategy followed, and investigation of synchronies can throw light on the coevolution of species and ecosystems. Such investigation, which forms the discipline of phenology, can also reveal how marine mammals can serve as monitors of environmental quality.

In exploiting the sea, and in managing this exploitation, adequate account has not hitherto been taken of many characters of ecosystems, even though these characters are now becoming clearer. Difficulty comes with the application of emerging theory to what some conceive as the *real world* in terms of the regulation of exploitation. Nevertheless, some change in attitude is apparent. For example, the effect on marine mammals of man-made changes in their food base as a result of fishing is now being studied in the cases of the northern fur seal and the harp seal. Again, the competitive advantage given to the crabeater seals by the reduction in baleen whales is presumably substantial. In none of these cases, however, have satisfactory models yet been constructed and applied.

Other man-made changes of the ecosystem through every form of marine pollution may profoundly affect marine mammals by changing mortality rates, growth rates and reproductive capacity, but these questions have been even less explored.

4.5. Capabilities of marine mammals to deal with changes in their ecosystems

We do not yet know how to measure biological stress as far as marine mammals are concerned. Such measurement involves an identification and description of ecological niches. Difficult as this may be, the Working Party believes it is not as difficult as might appear from the Proceedings of the Scientific Consultation. Thus perturbations of various kinds will affect natural mortality and reproduction, and hence survival; niche qualities may be revealed through studies of diet and of critical habitat, by measuring physiological parameters, and through phenology.

The thesis has been advanced by some scientists that marine mammals are not essential to any ecosystem, even though they appear to be a very prominent part of some - this perhaps because, moving as they do to the air-sea and sea-land interfaces, they are particularly obvious to man. The balance of evidence reviewed by the Working Party indicated that this thesis is not true. While marine mammals can - and some do - alter systems through energy transfer and in other ways, changes in the rest of the system may more profoundly affect the marine mammals living there. This being recognized, a number of options might exist for ecosystem management to obtain specified goals, regardless of whether these goals are high-consumptive or low-consumptive in character. However, criteria now applied in selecting means to reach such goals are generally based on other considerations than the stability and composition of the ecosystems. Present ignorance of ecosystems calls for greater caution in causing departures from the naturally evolved composition, since this may have attained a high degree of stability and efficiency as a result of evolutionary processes. The *operational biological unit* for conservation and management should be not the species, but the ecosystem. While this may not be practicable in all its implications at present, it should be an aim for the future.

5. EFFECTS OF HUMAN ACTIVITIES ON MARINE MAMMALS

Man has exterminated some marine mammal species and populations. Human activities have had other, in some instances drastic, effects on many surviving species and will affect them more in the future. In many cases, links between observed changes and human activities are not proven, but circumstantial evidence points to human causes.

Some participants at the final plenary meeting of the Scientific Consultation forcefully expressed the view that the continuing increase in human populations posed the greatest threat to marine mammals generally. The Working Party agrees that human population pressure is very important in this respect, and increasingly so, but it also affirms that the continuing *per capita* increase in our use of all natural resources is of similar importance. Expansion and diversification of industrial activities of all kinds, having little correlation with population growth, and increased mobility and affluence of people, are having important consequences for marine mammals. Furthermore, industrialized societies with relatively low birth-rates and high rates of food consumption have been primarily responsible for the most serious impacts on marine mammals in recent times, such as the depletions of baleen whales. It is clear from recent actions by some states and organizations that high density of human population does not *in itself* preclude increasing care for marine mammals, despite the fact that some of them compete with humans for marine food resources and some are themselves significant sources of human food. Nevertheless, it is difficult to fault an opinion expressed by one participant in Bergen that a decline in the rates of resource consumption and of increase of human population would in itself greatly further the survival of marine mammals. We would add that man's impact on the biosphere may already have gone so far that, even with future restraint on wasteful consumption and procreation, very much new scientific knowledge will be required if environmental health is to be maintained or restored; merely reducing the present impact of man on environments may not be enough. The rest of this section is devoted to an examination of particular kinds of perceived impacts.

5.1. Direct causes of death and injury

Marine mammals of all kinds die in direct fisheries all over the world. These range in scope from the *aboriginal whaling* by Alaskan Eskimos for bowhead whales to the pelagic expeditions that still take minke, sei, Bryde's and sperm whales. Large and small direct fisheries for small cetaceans also exist and are broadly distributed. In one of the largest as many as 10 000 striped dolphins are taken annually off the coast of Japan, as well as thousands of individuals of a dozen or more other species. Hundreds of thousands of seals - perhaps more than one million - of several species are harvested in mostly land- or ice-based operations in both hemispheres. Sirenians are hunted for their meat over large parts of their ranges. In most non-commercial operations more individuals die than are actually retained and used. With the exception of commercial whaling, of those that are retained many carcasses are only partially used, for example for oil or for skins.

Between one and one-half million marine mammals are killed annually in the direct, high-consumptive industries. In addition, some marine mammals die even as a result of low-consumptive industries, such as tourism and the running of oceanaria - for example, tourism and outdoor recreation leads to injury and deaths of manatees in Florida through vandalism, harassment and accidental collisions with power boats. For every healthy live animal exhibited in oceanaria, several have died during capture, transportation or acclimation, although the situation has recently improved in some places.

Some harvesting operations directed at other marine animals also incidentally kill marine mammals in large numbers. Tuna purse seining in the eastern tropical Pacific causes the annual death of more than 100 000 pelagic dolphins of the Genera *Stenella* and *Delphinus*, as well as lesser numbers of other genera. Other, smaller purse seine fisheries in temperate regions (e.g. off South Africa) also kill hundreds or thousands of dolphins every year. Gillnets set for salmon, sciaenids, sharks, tunas and other fishes kill seals and small cetaceans, especially porpoises of the genus *Phocoena* in undetermined numbers. Such operations exist in the Gulf of California and the North Pacific, North Atlantic, South Atlantic and Indian Oceans; in the tropics, they result in sirenians being killed as well as small cetaceans. Trawl fisheries also kill small cetaceans, pinnipeds and sirenians. Use of nets for other purposes, such as protecting bathing beaches against sharks in Australia and elsewhere, causes incidental deaths of small cetaceans and sirenians.

In the course of direct harvests or incidental killing of marine mammals, disruption of complex social structure may cause unobserved deaths, especially among small cetaceans and seals. For example, the killing of a part of a family-based social unit may result in subsequent deaths of other animals in the unit, in addition to unweaned young.

When man perturbs the marine environment physically or chemically, marine mammals may die as a direct result. For example, chemical pollution has directly injured and killed large whales in the Mediterranean and seals in the Wadden Sea. A large potential for such direct effects exists in the widespread and rapidly growing exploitation of petroleum resources; seals and sea otters may be especially susceptible to damage by oil spills.

5.2. Changes in behaviour

Human activities cause changes in the behaviour of marine mammals in many situations. The normal northward migration route of the gray whale off southern California may have moved seaward as a result of recently increased small vessel traffic along the coast. Dolphins exploited in the Solomon Islands and some areas of Japan avoid vessels more than do dolphins of the same species in other, unexploited populations. Herding and capture of dolphins in the eastern tropical Pacific tuna purse seine fishery has caused changes in their behaviour, such as increased avoidance of vessels; in fact, running from vessels may constitute a significant proportion of the energy consuming daily activity of the animals during the fishing season. On the other hand, some whales and some species of dolphins follow ships, and certainly some pinnipeds and dolphins are aware of the ease of taking fish where fishing operations are in progress.

Depletion of manatees seems to have led to their being less gregarious. Land-breeding seals are especially vulnerable to perturbation by human activities. Thus breeding units may stampede into the water at even the scent of approaching humans, possibly requiring subsequent reconstitution or reinforcement of the units through complex systems of displays, threats and other behaviour.

Perturbation of the environment also leads to changes in behaviour. For example, creation of artificial warm-water habitat by discharges from power plants has changed the migratory behaviour of manatees in Florida, causing aggregation and overwintering around outfalls.

5.3. Changes in reproductive rates

Several different ways in which man's activities can perturb the reproduction of marine mammals have been identified, not all of them adverse:

(i) direct disturbance of breeding behaviour or the composition of breeding groups and, in the case of cetaceans, of the prolonged parent-offspring relationship;

(ii) harvesting of food organisms important to the mammals, leading to changes in their growth to maturity and their reproductive success when mature;

(iii) population reductions caused by harvesting, leading to changes in reproductive rates;

(iv) adverse effects on reproduction caused by chemical pollutants.

These effects cannot always be directly observed, but in many cases they may be inferred from changes in population size or composition.

Selective capture from breeding herds may have direct effects upon reproduction if, for example, the removal of master males from harems leads to a reduced pregnancy rate. This problem is causing concern with respect to the sperm whale in which only some of the large, socially mature bulls remain in the breeding areas in low latitudes, while the others move into cooler waters. The IWC has prohibited the taking by its members of large bulls in the breeding seasons and areas in the Southern Hemisphere, but an unresolved question is whether it might not be better to take some entire herds and leave the others completely undisturbed.

Direct effects upon reproduction by harvesting the food organisms of marine mammals do not seem to have been reported yet, but the number of situations in which man fishes such organisms intensely are increasing. The recent failure of the northern fur seals on the Pribilof Islands to respond as had been expected to changes in management measures, might have been the consequence of the intense new fishery for pollock and other demersal fish upon which the fur seals feed. There is not yet any evidence whether the expanded fishery for capelin in the western North Atlantic is having an effect upon the minke, fin and humpback whales which also feed upon capelin. Another problem is arising in the Southern Ocean in connection with the development of a krill fishery there. If this fishery reaches a biologically significant scale it will surely have adverse effects on the populations of baleen whales and of other animals which depend upon krill. Present estimates of the magnitude of the krill production suggest, however, that it is unlikely that sufficient quantities will be taken in the

near future to affect the mammals. A more remote possibility in the Southern Hemisphere is that a fishery for bathypelagic squid could be developed to the level where it has a significant effect on sperm whales.

There is evidence that reproductive changes in marine mammals may follow reductions in their populations, presumably as a result of decreased competition for food. In the Southern Ocean, earlier ages at sexual maturity and increased pegnancy rates have been observed in fin and sei whales following the great reduction in the biomass of krill-feeding baleen whales. The changes in sei whales seem to have begun before the catches of this species reached their peak, but the evidence is not clear as to what extent these changes should be ascribed to the effects of the earlier fishery for blue and fin whales. However, in one area the age of attainment of sexual maturity of another krill-feeder, the crabeater seal, also fell from four to 2.5 years in the same period although this species had not been the subject of a significant harvest. The hypothesis of density-dependence response is a plausible one, but the possibility that there had been a natural change in krill productivity cannot be excluded; as is so often the case, there has been no monitoring of the food base which would have permitted discrimination among these hypotheses. A similar example is that the reproductive rates of populations of species of *Stenella* in the eastern Pacific appear to have increased following large incidental kills in the tuna purse seine fishery.

Reductions in the numbers of marine mammals, particularly seals and small cetaceans, seem to be associated with pollution by organochlorines, polychlorinated biphenyls (PCB's) and heavy metals in several areas, particularly in the Baltic Sea. A direct effect on reproduction has been identified in the California sea lion, where increases in the number of premature births and in the mortality rate of the young followed increased levels of DDT and PCB's in the environment. An additional cause of concern in such cases is that the organic pollutants can be transferred to the young during lactation.

5.4 Changes in distribution and abundance

Human activities have greatly affected the distribution and abundance of marine mammals. In some cases the specific causes discussed above can be identified as contributing to these changes, but in many other cases, it can be affirmed with confidence that human activities have caused the changes without it being possible to identify particular mechanisms.

The adverse effects greatly exceed in number and magnitude the beneficial effects. The only unquestionable beneficial effect - and this only a step toward the restoration of the original condition - is the extension of the range of the sea otter through re-introductions. It is possible that populations of some species of *Stenella* and *Delphinus* in the Pacific expanded following a reduction in other populations by the tuna fisheries. The use of manatees for vegetation control in a few localities may also be assisting in the local encouragement of these species.

Two species, Steller sea cow and the Caribbean monk seal, and two major populations, the Japanese race of the California sea lion and perhaps also the Atlantic gray whale, have been exterminated by man, and it is far from sure that several others - the Indus susu, the Mediterranean and Hawaiian monk seal, the North Atlantic right whale and the Asiatic gray whale - will survive. In fact, a large number of local populations of seals and whales have disappeared, although in some cases they may have been subsequently replaced by redistribution from other centres.

A number of species have at some time or other been reduced by man to numbers far below their most productive levels in any sense of the term. These include bowhead, right, blue and humpback whales in all oceans where they occurred, fin and sei whales in many areas, and, in the past, many species of fur seals and elephant seals, particularly in the Southern Hemisphere. Other species have been substantially reduced in numbers by harvesting, but are still at relatively high levels (e.g. sperm and minke whales and northern fur seals). In yet other cases, reduction is known to be substantial but the extent has not been estimated. Thus, there has been a substantial decline in the numbers of three species of small cetaceans in the Black Sea following a fishery there, and the striped dolphin has declined in the western North Pacific.

A crucial question which requires much further study is whether marine mammal populations will revert to their original levels when the causes of depletion are removed, or whether different balances among the species will be attained. The depleted pinnipeds have on the whole recovered more rapidly when intense exploitation has been ended than have the large whales, and some of those pinnipeds which were greatly reduced in the nineteenth century are now again abundant. Among the whales this can be said only of the gray whale in the eastern Pacific.

Serious depletion of widespread or abundant species in the past has been nearly always due primarily to harvesting for industrial purposes. While species vary widely in their ability to survive in close association with man, many which are today in the greatest danger appear to be the victims of a combination of several factors.

Local populations such as those occupying enclosed areas, particularly when close to human communities, have often been adversely affected by hunting, killing by fishermen, pollution, loss of habitat and other environmental changes. Such populations include both species of susu, the harbour seal, several species of monk seals, and seals and porpoises in the Baltic Sea and in Lakes Saimaa and Ladoga. The fresh water habitats of the susu and the manatees are particularly sensitive to environmental changes. Pollution effects are becoming increasingly widespread in industrialized regions, and correlated decreases in abundance of marine mammals have been observed, for example, in the North Sea, Sea of Azov, Bay of Fundy and Tokyo Bay.

Another factor which may contribute to the decline in populations is the harvesting by man of food animals important to the mammals. Off Newfoundland, an observed decline in the number of pilot whales may in part be the consequence of squid harvesting in recent years. Many fishes which are utilized by marine mammals are now being reduced in numbers by heavy exploitation by man, and this may well affect the abundance of mammals dependent on them.

6. EFFECTS OF MARINE MAMMAL ACTIVITIES ON HUMANS

Human activities affect marine mammals, but the converse is, of course, also true. Some effects are immediate and directly observable. Others are more complex or obscure and some can only be inferred.

There is a long history of depredations on fishing operations by marine mammals. These may take the form of reduction of catches and damage to gear. Small whales take tuna from pelagic longlines, causing economic damage. Fur seals enter pilchard seines off South Africa in very large numbers, interfering seriously with the operation and taking part of the catch. Grey seals open lobster pots to remove bait in Canadian waters, and round Britain they take fish from nets and damage them. Removal of fish from trawl catches by dolphins in many parts of the Mediterranean has long been a problem and has led to programmes of technological research aimed at preventing it. Dolphins also steal part of the catch (sometimes also the bait) in other kinds of fisheries, such as pole-and-line and handline fisheries, in many places around the world, doing significant damage in at least some cases.

Some direct effects are beneficial to man. The very close behavioural association in the eastern tropical Pacific between dolphins and yellowfin tuna helps fishermen find and catch the tuna. Furthermore, the association may be symbiotic and allow the existence of larger and higher quality stocks of tuna than would otherwise be possible. Elsewhere, in West Africa for example, small cetaceans may accidentally assist the fishermen by driving fish into their nets. Another beneficial effect is the clearing of waterways by manatees.

With increasing use of the oceans for recreation, collisions between vessels and whales often disastrous to one or both, have increased. The advent of high-speed craft, such as hydrofoils, has greatly increased the potential for such incidents, and in at least one case (around Hawaii) has led to research on the distribution and abundance of whales aimed at minimizing the risk.

Probably the most obvious of the more complex effects of marine mammals on man results from their competition for a third species or species group. There are many examples. Grey seals, white whales and Steller sea lions eat salmon, and harp seals eat cod. Off California, common dolphins may eat 300 000 tons of anchovy annually while the commercial fishery takes only 110 000 tons. A similar situation exists with respect to sea otters and abalones, clams and sea urchins, and it has even been suggested that without some limitation of the number of sea otters profitable fisheries for such invertebrates in the areas concerned may become impossible. An additional level of complexity may exist here, since sea otters, by limiting the number of invertebrates may permit a greater production of kelp, another species valuable to man. The grey seal provides an example of another kind of complexity since it is the intermediate host of the codworm - a parasite on gadoid fishes - and a correlation between the abundance of grey seals and the incidence of wormy cod (i.e. infested by parasites) has been found. Thus it is conceivable that reduction in the numbers of seals could increase the value of the cod catches.

Once recognized, such interactions - as well as complementary uses referred to in Section 5 - raise difficult questions regarding the objectives to which management strategy should be directed. In general, reduction in a marine mammal population might enhance the benefits derived from the resource or activity with which it is in conflict; on the other hand, it will if carried to excess reduce the benefits to be derived from the mammal. One has to be careful, too, that actions are not taken which would be inadvertently detrimental, because of an oversimplified view of the situation. These matters are taken up again in Section 7.

7. CONSERVATION OF MARINE MAMMALS AND THEIR ENVIRONMENT AND THE MANAGEMENT OF HUMAN ACTIVITIES AFFECTING THEM

7.1. Scientific advice and the consequences of error

Many marine mammals, particularly cetaceans, have a cosmopolitan distribution and, moreover are highly migratory; thus their conservation, management of their exploitation and protection of their habitats have global dimensions and are therefore intrinsically difficult. Furthermore, the fact that the open sea environment has been considered no-one's responsibility has led again and again to overexploitation to such a degree that several species of marine mammals have been brought to the verge of extinction. Despite these impediments, some significant international regulatory actions have recently been implemented for some species, although the situation is still, in the opinion of the Working Party, very far from satisfactory. Management has, for historical reasons, been narrow in scope and piecemeal. The scope and scale of research has been such that management has often been based on weak assessments of the states of stocks and even weaker appraisals of the states of ecosystems. It must also be said that until now little attention has been paid by scientists to the relations between marine mammals and their environment, and these are therefore poorly understood. This had made it practically impossible seriously to consider measures for efficient conservation and management on an ecological basis.

The Working Party expresses these opinions with some hesitation. In part, this arises from the fact that some scientists fear that if the situation is revealed explicitly, it may lead to loss of the gains that have been made in bringing order into exploitation and impeding, if not always preventing, further depletions of stocks. Such fears have a basis in experience; expressions of scientific disagreements, or even of consensus regarding uncertainty, have too often resulted in postponement of urgent management decisions, or decisions based on the more optimistic in a range of stock assessments. Much the same may be said about the need for management to be based on ecological knowledge as well as on the arithmetic of populations. Most scientists agree that this need exists. Again, however, while such knowledge is so poor, it may be considered dangerous to insist on the principle. Against this it may be observed that if the principle is not emphasized, the necessary knowledge may never be forthcoming. In any case, there is probably now no tactical choice. The biotic relations in the sea are being brought forcibly to our attention, if by no other way than by the effects of the human actions themselves. These relations must be understood before it can be claimed that management of the exploiting industries is scientific.

This does not mean that the study of population dynamics by current methods or by improved methods should be abandoned. Stock assessments by these methods will always be integral parts of ecological assessments, but must be complemented by broader understanding of the larger systems. Questions of the accuracy and precision of each population assessment may not then be so predominant, nor generate such scientific controversy and tactical debate as they now do. What are the implications of uncertainty even regarding what we think are the better ones among existing stock assessments? Firstly, the emphasizing of uncertainties does not imply that the scientific advice is proportionately worthless, and therefore can be disregarded by management authorities. This is because one can be virtually certain of some elements in the advice if not of others, and management actions should be influenced more by the more reliable elements of this advice than by others. Secondly, although there is as yet no way of determining the statistical error of, say, an estimate of the sustainable yield of a stock, one may be fairly sure about the possible upper and lower bounds of such an estimate. This usually means that the true sustainable yield could not be very much more than a *best* estimate of it (because of the biological limits to reproductive rates) but it could be considerably less than a best estimate. The sustainable yield depends entirely on the vigour of the response of the difference between recruitment and natural mortality rates, (r - M), to change in density, which is extremely difficult to measure, let alone to predict.

Then, thirdly, the practical consequences of erring on the side of *optimism* (optimistic, that is, from the point of view of an industry seeking to maximize its take in the short-term) or on the side of pessimism are entirely different, and in two respects. Too optimistic a view could lead to an irreversible change in the ecosystem - the extinction of a resource - but too pessimistic a view could not. The time required later to make good the effects of excessive optimism, if reversible (which is determined by the natural rate of recovery of a protected stock) will be longer than would be needed to make good the temporary losses of yield from being too pessimistic. For example the historical rates of increase in whaling effort are much higher than net recruitment rates of whales. So it should be understood that when scientists have sought to give *conservative* (i.e. pessimistic) advice, it is not because they have taken the side of the mammal resource as against the industry, but rather because they have perceived the asymmetries of the possible errors and of their consequences in the dynamics of the predator-prey system man-marine mammal.

7.2 Achievements of the Scientific Consultation

The problems of management and conservation were considered in several aspects by a number of Working Groups in Bergen. These addressed the subjects of defining the objectives of management, the theory and practice of management and the institutional arrangements for formulating and transmitting scientific advice for action, including the exchange of information between the scientific community and the public, at all levels and in both directions. Special consideration was given to substitutes for marine mammal products, to low-consumptive uses of marine mammals and to aboriginal hunting of them. An objective study of the decision-making processes, leading from the formulation of objectives to their realization through management action, with consideration of the feedbacks from the entire community to the management agencies and *vice versa*, could have an enormous impact on the future course of research, exploitation and management.

Persons not directly engaged over a considerable period of time in the analysis of data concerning exploited marine mammal populations have great difficulty in undertaking extensive independent assessments. One consequence of this situation is that the evaluation of assessments which was required from the Consultation had to be made by specialists most of whom had contributed to the original assessments. Further, it appears that the procedures by which information is obtained on behalf of management bodies, and considered and made use of by them in the formulation of management plans, does not take full advantage of the general management techniques now available for evaluating alternative courses of action.

The above observations are not directed at the integrity of individuals, but at the institutional structures which may cause them to temper their advice. It is a basic principle of management that accountability should not lie with a unit whose operation is under review. On the other hand scientists would not be able to discharge their tasks with regard to management unless they could participate in the process of formulating the objectives to which the results of their work would be directed. This principle applies at all levels of objective formulation, from the world assembles of the United Nations to the smallest local community.

The fact that the *ad hoc* Groups of the Working Party, and that the Consultation, identified several areas of controversy with respect to objectives and to assessments, and that they were not able to resolve such controversies, mean that the tasks given to the Working Party by ACMRR cannot be finished at this time. We believe, nevertheless, that the work done so far makes it possible now to formulate a plan of action for the present and future care of the marine mammals. The considerations presented in this section of our Report led to a series of recommendations to this end, given in Section 9.

7.3. Objectives for management

A number of possible objectives for the management of marine mammals which are of interest to various groups of people were tabulated during the Scientific Consultation (Annex B, Table 10.1). These were presented in three categories: socio-economic, ecological and ethical. It was realized that considerable overlap exists between these categories, and that the pursuit of any objective has socio-economic, ecological and ethical consequences. Identified objectives tend to cluster in one or other of two groups: those which receive their maximum satisfaction with virtually complete protection of marine mammals, and those which depend on substantial exploitation for their realization. A view was expressed at the Consultation that all objectives can be included in the broad economic category *maximization of net economic benefits to society over the foreseeable future*. However, the difficulties of measuring these are formidable and the Working Party feels that some among them cannot, either in theory or in practice, be validly quantified. Similarly a wide range of specific objectives can be included in the broad aim of *conservation*.

Viewed globally, some objectives are in direct conflict with others. The pursuit of the objective of commodity yield is not compatible with objectives which call for complete protection for marine mammals. If, however, species, regions, nations or local conditions are considered, the likelihood of resolving the conflicts is enhanced. Thus some of the objectives which require complete protection can be partially attained by the establishment locally of sanctuaries or reserves, or by international protection of endangered species, whereas commodity yield can be sought in other places from more abundant species. Obviously a compromise will always be required if most objectives are to be given some degree of recognition. For example, those who totally oppose killing cannot be free to impose their views on peoples of traditional or subsistence cultures whose survival and way of life depend on the taking of marine mammals. Equally, industrially-oriented exploitation cannot be allowed to destroy a resource of great value to other groups in society.

Although it was not possible for the Working Party to go into such detail, there would be value in considering each species or species group separately in relation to objectives which are now considered relevant to their management, and to probable future trends in these objectives. The definition of objectives and of the ways in which these may be realized deserve much more consideration than they have received. In the absence of a clear understanding of objectives both research and management may well be misdirected. In particular most research and management effort has been directed toward the objective of exploitation of marine mammals for food and other products. Relatively little attention has been paid to directing research and management toward other objectives which do not involve harvesting.

7.4. Theory

Most of the theory which has been developed relates primarily to the objective of producing commodity yield sustainably, and models describing populations have been concerned overwhelmingly with numbers or biomass, age structure and intraspecific interactions. Consideration of interspecific interactions, of energy flow and of environmental relations has been quite insufficient; where reference has been made to such factors it has merely scratched the surface of the problems. Even during the Consultation ecological theory was not considered beyond a rather simplistic level and, in particular, little attention was given to heuristic, conceptual models, which can give general guidance to action rather than detailed predictions. Without concurrent examination of the two types of models there is a danger of a spurious self-confidence in the facility with which computers can now be used to make precise predictions using quite complex population models which could, nevertheless, be quite inaccurate, with little possibility of checking their accuracy. A beginning is being made in constructing conceptual models for the Southern Ocean, but much more needs to be done. There is also need to consider population models which take into account that marine mammals are K-selected and thus may be adapted to maintain their population at levels near carrying capacity. The assumption that marine mammals are most productive at reduced population levels may be incorrect and inconsistent with their evolutionary-adaptive strategies. The models at present used are deterministic and rarely include variable environmental parameters. Some density-dependent processes, such as feeding, competition and ecological displacement, are generally considered only implicitly in them, and factors such as the timing of reproduction and environmental influences are hardly ever taken into account. The usefulness of models which provide explicitly for variable factors has been demonstrated in the case of terrestrial animals, and it is expected that they will ultimately be valuable for marine mammals, even though present knowledge may be inadequate for their full application.

The theory relating to protection of species and of ecosystems has not been given sufficient consideration. Few marine reserves are created on the basis of adequate scientific information. Not enough is known about either the minimum or optimum sizes of sanctuaries or the control of ecological processes which affect them, let alone the complex socio-economic processes involved in their long-term protection. There are several examples of depleted species which fail to increase under protection, but not enough is known to explain these failures nor to remedy them. Much more emphasis should therefore be given to gaining understanding of the process of population recovery in marine ecosystems following earlier depletion, if either protection or sustainable yield objectives are to be realized. Such emphasis calls for development of the theory of dynamics of ecosystem as well as of populations.

7.5. Management practices

Control of exploitation involves a variety of techniques intended to prevent exploiters from exceeding certain limits. It would, in any case, be difficult to achieve an ideal situation in this respect, but especially so with respect to common-property resources to which access is open to all who can afford it, and where a great number of national and cultural barriers stand between the would-be controllers and the controlled. Consequently, attempts to find realistic ways of effective international regulation or protection have so far usually been inadequate. The Consultation threw little additional light on these problems, which still await solution. Directions for exploring possible solutions will perhaps be seen from the several national models which now exist.

Reference was made, in Section 6, to the dangers of taking detrimental actions though acting on simplistic theory. This is particularly the case where we are concerned with simultaneous management of fishing and mammal hunting. Thus there has been little environmental management from which marine mammals might incidentally have benefitted, except perhaps for the regulation of exploitation of those species which serve as food, or are competitors or predators of marine mammals and, to a limited extent, the general protection of certain habitats, which, for example, are among other things seal rookeries or whale calving grounds. The steps now being taken, especially internationally, toward the control of marine pollution can be expected to benefit the mammals in the future. Thus a marine

mammal, which eats a type of fish sought by man, may actually also be eating, in greater quantity, another fish less valuable to man, which is itself a competitor with the valued species; deliberate reduction in numbers of the mammal may, in such circumstances, be quite the wrong thing to do. In cases where the mammal is itself harvested to provide a valuable product, a comparison of direct financial returns under various strategies may be possible for 3 or 4 species systems. However, if the less easily quantified, or unquantifiable, values associated with the low-consumptive uses - which, for some mammals may be the only values - are taken into consideration such optimization may be difficult or impossible.

7.6. Scientific advice

Considerable difficulties have been encountered in ensuring an adequate flow of information from field studies through the scientific community to management agencies and the general public. There have been, in particular, serious shortcomings in continuous communication with the general public. In the absence of a smooth flow of reliable, credible and timely information in both directions, the consequences of reversals or major changes of public opinion leading to rather abrupt changes in management policy cannot easily be assimilated, and social conflicts are aggravated. Examples of such changes are to be seen in the passage of the U.S. Marine Mammal Protection Act, the call by the United Nations General Assembly for a ten-year moratorium on commercial whaling, and the signature of the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Particular cases of this question of information flow were considered by the Consultation; examples concerned the IWC and the relation between the North-East Atlantic Fisheries Commission (NEAFC) and the International Council for the Exploration of the Sea (ICES). No concrete suggestions were forthcoming, but the Working Party believes that such analyses must be pursued. Much remains to be done in examining and formulating the various management objectives considered important by various sections of human society. Still more remains to be done in developing the ecological and population theories of which management must take account. Then the social, economic and political task must be faced of devising effective organizational structures through which objectives can be realized, and providing for information flow from scientific bodies and management agencies to and from interested individuals and groups who will influence or determine public policy. This requires attention in future by ACMRR or by other bodies which may continue the efforts of this Working Party, and a Recommendation has been drawn up to this end.

7.7. Future trends

In Section 5 of this Report, it has been noted that continued increase in human populations and growing levels of demand upon resources could lead to conditions under which few, if any, of the conservation-orientated objectives regarding marine mammals could be realized. In the immediate future, an increasing demand for food from the oceans can be expected. Some increasing demand for the use of marine mammals themselves as food is foreseen, but the greater pressure is likely to fall upon those fish and marine invertebrates upon which marine mammal populations depend for food. If this takes place to any great degree, it is likely that marine mammal populations will decrease even if they are not exploited or that they will fail to recover under protection to former levels of abundance.

The maintenance of present population levels of marine mammals, and the possibility of increasing them therefore depend on a levelling off of human population growth and on a decrease in individual demand for products - and not only from marine mammals - for example, as a result of the availability of substitutes. Even if these conditions are satisfied, marine mammals will be adversely affected if levels of marine pollution increase, and perhaps even if present levels are not reduced.

Pollutants have been identified in the tissues of marine mammals, but there are few data regarding either the magnitude of contamination or its significance. Some governments have set limits on the levels of contaminants that are acceptable in human and livestock food and such standards are likely to become more strict and widespread. Contamination may in the future cause meat from marine mammals to become unacceptable. Further, pollutants may be transported from contaminated coastal areas to the open ocean, for examples, in the tissues of migratory fishes such as mackerel and herring, or by the movements of whales. Mammals are sensitive to PCB's. Mink on fur farms have been killed by PCB's in fish meal, and some marine mammals have had their reproductive capacity diminished or destroyed. Such pollution may affect the abundance of certain marine mammals and threaten the continued existence of some populations.

Because of increasing public awareness of marine mammals, it is expected that demands for opportunities to see them will increase; such a trend is now visible, but of course it is conceivable that it could in future reverse with a change in world economic conditions. Satisfaction of these demands depends on maintaining at least present levels of certain marine mammal populations, and probably on increasing the numbers and extending the distribution of others. An increase in recreational use of critical areas of habitat can, however, have adverse effects on the marine mammal populations. Conversely, the possibility cannot be completely discounted that some marine mammals might be husbanded for their produce or for other values, but this, it is thought, will occur, if at all, far in the future except perhaps for the manatees.

Also, because of the increase in public awareness, a continually increasing ethical concern for marine mammals is expected. This may lead to growing demands at least in some countries for cessation of commercial killing, and a demand for the development of more humane methods of killing. Such concern has already had effects on collection of marine mammals for scientific purposes and on the use of live mammals for experimentation and public display.

As against these trends toward more protection, the growing demand is noted, particularly in developing countries, for a more equitable distribution of benefits to be derived from the availability or use of marine resources. This demand will increase and can be expected to affect the exploitation of what have been until now common-property resources. The widespread support for a ten-year moratorium on commercial whaling is in part founded on this demand for a more equitable distribution of benefits in the future, as well as on growing ethical concerns. This same pressure could, however, lead to much greater immediate pressure on marine mammals, including a demand for exploitation to be renewed as soon as some of the now protected stocks show evidence of recovery. It is possible by exploitation to reduce a stock below the point at which it could later support a low-consumptive industry, even if the species as a whole were abundant. It is believed that more information is necessary about the needs of the various low-consumptive industries with respect to the abundance, density and distribution of the species concerned, and hence of the likely impact of different levels of high-consumptive use on the low-consumptive industry. Similarly, if the low-consumptive industries are not controlled, and the effects of interference are not considered by management authorities, stocks of marine mammals could be adversely affected locally by tourists in such a way that both low- and high-consumptive industries would suffer. It is important to note, however, that tourism may be one of the main ways in which some developing nations could share, now and in the near future, in the economic benefits from marine mammals. Most of the benefit from modern whaling and sealing goes to the technically advanced nations - that is, to the nations which as a group have been responsible for the virtual elimination of the largest marine mammal resources. The Working Party agrees with the view of the Scientific Consultation that the benefits of both low- and high-consumptive uses of marine mammals should be available to all nations and that, if this is to occur, the recovery of the stocks must be a primary objective of management policies.

The demand for industrial oils from marine mammals appears likely to decrease as a result of political actions affecting markets, and of efforts to make vegetable substitutes. Demand for furs is steady or increasing, but this might be balanced by a movement - at present limited to a few countries - against wearing the skins of wild or endangered animals. A movement to conserve the rarer animals is now world-wide with the ratification of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and this may reduce demand for seal skins in certain areas.

In general, substitutes exist for all except one intrinsically valued produce - ivory, whether this be from the teeth of walruses, narwhals or sperm whales - and except for some products used in subsistence communities. There are, of course, numerous alternative protein sources, including vegetable ones. Whale meat as a proportion of marine protein has declined over the past few decades but world consumption of baleen whale meat - mainly in Japan - was still about 160 000 tons even in 1974. The supply has been diminishing and, faced with shortages, the Japanese people appear readily to have turned to other animal proteins. At the same time, it is said that the demand for minke whale meat is high in some other countries, including Brazil and Norway. A significant proportion of the meat obtainable from other marine mammals is at present wasted; carcasses of seals are left on the ice after skinning, and not all sperm whale meat is marketed for human consumption.

There are substitutes for industrial oils from the sperm whale and other toothed cetaceans in all but a few applications. The few exceptions are special lubricants, and substitutes are likely to be available for these in commercial quantities in the near future. These substitutes are derived from vegetable, animal and mineral oils. The oil from the bean of the jojoba (*Simmondsia chinensis*) seems likely to replace sperm oil in all applications because these oils are chemically almost identical; efforts are being made to expand cultivation of the jojoba plant, while the annual supply of sperm oil is expected to diminish as a consequence of new IWC assessments and consequent regulations. Apart from the problem of chemical conversions, it is noted that secondary industry prefers steady to fluctua-

ting supplies and that if they can be obtained from other stable sources, these will be preferred. However, such oils have a considerable storage time, and the speed of replacement will depend on inventories and on relative prices, which cannot yet be predicted.

7.8. An appraisal of the effects of present and possible future management actions with respect to whales

A number of situations with respect to international management of marine mammals could usefully be the subject of independent detailed review by a group such as the present Working Party. Thus the catching of North Pacific fur seals, of the seals of the Antarctic, and of the harp and hood seals of the northwest Atlantic are all currently or shortly to become subject to regulation by international bodies. The problem of the harp seal, for example, has become a controversial one since the Working Party was established. There is disagreement among marine mammal scientists regarding the estimates of stock size and of sustainable yield, and questions raised in the International Commission for the Northwest Atlantic Fisheries (ICNAF) and elsewhere as to whether or to what extent the commercial fisheries might benefit if these seals were reduced by hunting to a level below that needed for the maximum sustainable yield from them, in addition to the ethical consideration raised by the present form of harvest. For various reasons the Working Party has not been able to make such reviews, except with respect to the management of whaling and the conservation of whales. Questions as to the effectiveness of the existing international arrangements for this were raised - though not for the first time - immediately before the Working Party addressed its tasks, and a world-wide public debate on the issue has continued since. It is for this reason, together with recognition of the relatively high economic value of the large whales, that in this Report we give detailed consideration to this issue. However, to correct possible misunderstanding of our view of the general situation, we point out that management related to marine mammals, particularly in its concentration on a species-by-species approach and the scant attention to the total ecosystem of which the resources species form part, has not differed substantially from the approach commonly applied in connection with fish and other marine living resources. Further, we affirm that the international management of marine mammals has been no worse than that of the other resources, and in some cases notably better. This applies to the structure and policies of the management agencies as well as to the development of research programmes, to the application of the scientific results, and to the beneficial effect of regulatory action on the exploited population.

Two major actions with respect to whaling have been the subject of the public debate referred to above. One is the recommendation for a ten-year moratorium on commercial whaling called for by the United Nations Conference on the Human Environment in Stockholm in June 1972 and subsequently adopted by the United Nations General Assembly, the Governing Council of UNEP and the General Assembly of IUCN. The IWC considered this recommendation, but took, instead, the second action: adoption of a new management procedure in principle in June 1974. The procedure was put into effect in the southern summer of 1975/76. This procedure, as at present implemented, calls for the identification of stocks of all species of large whales and their classification according to whether they are considered to be numerically bigger or smaller than, or near to, the size required to give maximum sustainable yield (MSY). The classification is revised annually. More or less automatic rules are then applied: if a stock is judged to be substantially smaller than the level producing MSY a moratorium is declared; if larger, exploitation is permitted under quotas which should allow a controlled reduction of stock toward a level close to that; if it is near the MSY level, annual quotas are set with the intent to maintain the stock at about the same size. The IWC Scientific Committee has proposed, and the Commission has agreed to, supplementary rules for determining catch quotas when stocks are thought to be above or somewhat below MSY levels. These rules provide for caution with respect to possible errors in estimates of MSY (thus, no more than 90% of the estimated MSY can be taken, whatever the classification of the stock) and in estimates of the stock level which can produce MSY. The rules also provide for acceptable rates of catch when there is insufficient knowledge to assess the status of the stock, especially when exploitation has only just begun, and when an unassessed stock has apparently been exploited sustainably for many years but not necessarily at the maximum level of yield.

It has been argued that if there were enough quantitative information about a stock to permit it to be classified, enough would be known to propose reasonable management actions without making the classification. In practice, the essence of the new management procedure is not so much in the classification as in the calculation of catch quotas by a formula the variables in which are only an estimate of the MSY and the size of the stock which, it is judged, would provide that yield.

Subsequently, a third kind of management action was suggested by *ad hoc* Group I of the Working Party. In its simplest form, this would involve establishing a pattern of catch quotas for each set of stocks of a given species in such a way as to provide more scientific information about the dynamics of stocks than might be obtained from either of the other kinds of action. Such experimental management would permit continued and relatively intense whaling on some stocks, while fully protecting others or permitting only relatively light exploitation of them. Apart from the gain in information, such an approach might, in some circumstances, permit different types of management objective, or mixture of objectives, temporarily to be pursued in different areas.

One practical difficulty with the experimental approach to management raised during the Scientific Consultation calls for comment. Due to the slowness of change in whale stocks, and the insensitivity of present monitoring methods, any critical experiment would take a long time - perhaps several decades. Apart from some scepticism expressed as to the stability of political will and of institutions needed for any such experiment to be completed, it was pointed out that over such periods environmental changes could occur, and other human activities develop, which could have considerable effects on the ecosystems and on the stocks of whales involved in the management experiment. Nevertheless, while such disadvantages are real, there are similar and presumably even greater difficulties with policies such as that which is implemented through the new management procedure. If such difficulties are insuperable (as they may well be, particularly for long-lived, slowly maturing species), and if continued whaling, even on a small scale, is judged to be of pre-eminent importance, then there would seem to be no rational choice left but to regulate whaling at a low and steady intensity, in the hope that catches would be held at more or less constant monitored levels. This would imply acceptance that relatively little additional scientific information about such reactions will be forthcoming, and that the sustainable yield obtained may be considerably less than the maximum possible. This, therefore, should be considered as a fourth policy option, to be examined in each specific case, but particularly if exploitation of a stock is just beginning. However, there could be cases in which strong economic arguments may be made against such a course; this is because it is evident that such new exploitation occurs precisely when other stocks have been depleted and when the industry is seeking immediate substantial catches from stocks hitherto not considered worth hunting; examples are the hunting of the pygmy blue whale in the early 1960's and now of the Bryde's whale in the Southern Hemisphere.

The new management procedure is explicitly directed to a management objective of high-consumptive use of the resource, as determined by the International Convention for the Regulation of Whaling, 1946, although it is not necessarily incompatible with all other objectives. As proposed, the experimental action is directed to the same objective, but could be modified to meet another objective or a mixture of objectives. Eventual high-consumptive use after the recovery of protected stocks is not explicit in the ten-year moratorium proposal but is not precluded by it.

The following appraisal of these various actions is based on scientific considerations, in keeping with the terms of reference of the Working Party, although it is recognized that other aspects of them must be taken into account by management bodies. These other aspects may be decisive; they include the socio-economic consequences as well as the ecological consequences of the actions, and the problems of monitoring and enforcing implementation of them.

Factors to be examined in making a scientific appraisal are time scales, risks and opportunities provided for resolving present uncertainties regarding the dynamics of whale populations and of ecosystems in which the whales are important elements. Natural changes in whale populations are slow; sometimes, it seems, very slow. Even ten years is too short a period for rates of change to be measured with fair accuracy using present methods. The annual review of classification provided for under the new management procedure has already resulted in the reclassification of some stocks, but this is due to the application of better models and to the availability of new data and analyses, rather than to actual changes in stocks. On the other hand, reductions in stock numbers as a result of whaling - even controlled whaling - can be much faster than natural increases, though still difficult to measure. Therefore, the periodic review conducted by the IWC Scientific Committee, at short intervals, provides some safeguard for the resources. An effective experimental regime would require a long period of rather stable controlled whaling, which may be politically or economically very difficult to ensure. It would also require adequate provision for monitoring and for prompt remedial action if the experiment appeared either to be threatening the survival of a stock or prejudicing the securing of determined values from the stock by setting in train possibly irreversible changes, or in other ways.

The new management procedure gives the possibility of continued sampling of the whale populations through the biological examination of catches, which the moratorium policy would not give, unless it were supplemented by scientific sampling. Such sampling would need, in practice, to be carried out as a small-scale industrial operation; the economic value of individual whales is such that, once killed, it would be unreasonable not fully to use the products obtainable from them. The experimental method, like the new management procedure, requires continued whaling; indeed, it could enhance industrial efficiency because the experimental design would call for concentration of whaling effort in a few areas rather than its more even distribution as under the new management procedure.

Assessment of the status of stocks of marine mammals involves, at the very least, estimating their numbers, determining their sex and the age and size compositions of populations and measuring reproductive conditions as from size and age at maturity and rates of pregnancy. At present, this information is most readily obtainable from dead whales, whether by retrieving marks, examining earplugs or teeth for determination of age or examining gonads for reproductive condition. In some cases, it has been demonstrated that the necessary research could be done independently of whaling, but it is not in fact yet done, primarily because of the high costs involved. Estimation by sightings is an obvious example, such counts depending at present almost entirely on commercial operations.

It has been argued that because whaling presents research opportunities and because research has hitherto been pursued mainly with respect to high-consumptive objectives, the necessary development of techniques for research on live whales has been impeded. Conversely, it seems unlikely that, until now, governments would have allocated substantial funds for whale research if there had not been a whaling industry. In any case, the whaling industry is, on the whole, declining, as a result of overexploitation of the resources, with a consequent tendency for research funds to shrink. A growing interest in whales unrelated to their value as sources of commodities may be reflected in increasing expenditures for research; the Working Party believes that this is desirable, but, in any case, whaling or no whaling, the important question is how to obtain the most information bearing on the specified objectives. Observations of live whales give data pertinent to improved harvesting; data from at least some dead whales would be needed for the attainment even of low-consumptive objectives. In fact, whatever the objectives of management and the nature of management actions, much more research on live whales is needed in the future. This would be true even if high commodity yield were to remain a primary objective, and if whaling were to continue in the meantime at the low intensity commensurate with the present depleted state of many stocks and species.

Some techniques for population research on live whales are available - estimation of abundance from sightings, for example - but they call for very considerable expenditures if applied independently of whaling operations. Methods for determining sex and size without killing the animal are just becoming available for some species, as also are methods for following migrations. There is, as yet, no widely applicable way of determining the age of large whales except from dead specimens; such determination is necessary for the estimation of mortality rates and of ages at sexual maturity, which express the responses of whale populations to exploitation. Perhaps reproduction rates could be measured and recruitment could be predicted from observations of mothers with calves, but, at present, pregnancy rates cannot be determined from live animals. In future, a biochemical sampling method might be devised; research to this end is at present underway.

Perhaps the greatest difficulties in appraising management actions arise from lack of agreement as to the degree of uncertainty, and the direction and degree of bias, in current assessments of stock states. There is a wide range of opinion among scientists on this question. There is no way, by present methods, of estimating statistically the error in calculations of population size and sustainable yields, or of making sure tests of the predictions made. Although ecological knowledge is growing and models are being improved, there is still great uncertainty as to the quantitative relations among the whales and between them and their competitors, their food organisms and their predators, and as to the reversibility of processes in marine biological systems when perturbed by man or natural causes. Questions also remain regarding the separation of stocks in some species, and the answers to these have great consequences for the success of management actions, particularly perhaps for the interpretation of experimental actions. In these circumstances, one's more or less subjective views of the level of uncertainty in scientific conclusions, of the likely direction of error and of the various risks thereby incurred by alternative actions, colour strongly one's appraisal of those actions. Because opinions regarding uncertainty are largely subjective, appraisals are inevitably tempered to some extent by each scientist's personal view of the economics and ethics of whaling. Objective appraisal is not made easier by the paucity of economic data - or, rather, by their inaccessibility- nor by the extreme positions taken, on the one hand, by some representatives of whaling industries and, on the other hand, by some who wish to stop all whaling now for all time, in both cases for reasons which may have little, if anything, to do with the states of the whale populations. This is an area in which genuine scientific controversy is overlaid with disagreements stemming from fundamental differences of attitude which are not always explicitly stated. This has large policy implications. It suggests that the facts may be revealed better through an adversary procedure in which alternative scientific advisory mechanisms interact, than through the operation of a single - even if carefully balanced and supposedly objective - advisory group, however it is established and composed.

Another possible and complementary approach to the problem of uncertainty might be the historical one. For example, the Scientific Committee of the IWC has, over three decades, constantly reviewed its assessments of the states of whale resources. Such review has not, however, been a smoothly continous process; there have been periods of perhaps two or three years when intense analyses of data for particular species or groups of stocks have been made and have not subsequently been re-examined before several more years have passed. This process has resulted in a number of important revisions in assessments, and a few very substantial changes. A careful historical study would be worthwhile to check the extent to which such revisions have been in a downward direction - that is, how often stock abundance and/or sustainable yields, and hence tolerable catch quotas, have been judged to be lower than had previously been thought. If a trend were found, it would be important to determine how it came about, since this could have profound implications with respect to the procedures for formulating advice, particularly as the members of the Scientific Committee have thought that they were being conservative in their approach.

If a moratorium of limited duration on hunting of all species were accompanied by intense research on live whales (with perhaps strictly limited, internationally planned killing for research purposes), this action would probably best ensure future options for resource use, particularly as most of the stocks of large whales still require total protection to ensure their recovery. However, the particular option of renewed whaling would be somewhat prejudiced by an interruption of whaling, resulting in the loss of skills and experience and the dispersal of capital equipment.

Both the new management procedure and the experimental management proposals seek to effect a balance between present and possible future values; experimental management could yield more scientific information on which to base future actions, and could also accommodate a wider variety of management objectives, even now.

Although opinions differ as to the relative merits of the various possible management actions, there is no doubt that the new management procedure of the IWC is, despite the uncertainty of stock assessments, an improvement over the situation prevailing up to 1974, when the time-lags in the dynamics of whales, and those in the responses of the management system to scientific advice, combined to make precarious the survival of one valuable whale stock after another. The seeds of the new management procedure were sewn in the mid-1960's when the Commission abolished the Blue Whale Unit, placed under protection two species in addition to those protected in the original convention and determined that Antarctic fin and sei whales should be harvested under quotas no greater than the estimated sustainable yields of those stocks. In addition, in that period, and for the first time, a management commitment was, in principle, made for a period of more than one year - a three year period - to permit the industry to accommodate itself to considerable reductions in catch quotas. These features were expanded in the new management procedure. A long-term policy was adopted (even if it is still implemented on the basis of annual decisions); regulation is by species and stock units (even if the stocks are still very difficult to identify), exploitation of each of which is subject to a management regime.

Despite these good features, it is evident that the new management procedure imposes extreme demands for reliable assessments, perhaps more than present data, models and methods of research are capable of assuring, particularly with the immediacy required. It is certainly desirable that management policies not be adopted which make demands for scientific advice beyond the capacity of science at that time. The existence of limits to predictive ability at a particular time dictates that a management policy should provide rules for evaluation of all risks and correspondingly careful actions. This, of course, would require a serious appraisal of what predictive capacity marine biological science has acquired and what it has not.

The Working Party emphasizes that in choosing management actions, more account than hitherto should be taken of the possibility that valuable knowledge - even crucial knowledge - may be gained through an appropriate management strategy, whatever are the chosen management objectives.

8. RESEARCH ON MARINE MAMMALS AND THEIR ENVIRONMENT

One major task of the Scientific Consultation and of the preparations for it was the elaboration of a general scheme for the planning and conduct of research on marine mammals. In the preparation of the report of Working Group 20 of the Consultation, on Research, consideration was given to a long list of research projects, and care taken to reduce and order this list so as to eliminate proposals which would lead to useless duplication, and to establish correct research priorities. The list provided gave convincing evidence of the incompleteness of the present account of these resources and testimony of the tenuousness of the basis on which management decisions are often made. Attention was especially drawn to the lack of consensus that inevitably results from this situation. Therefore numerous research projects have been suggested, the results of which may help guide those activities in such a way that humans and marine mammals continue to co-exist. The extent and nature of the problems, and the urgency of their resolution demand that research programmes make the most effective use of funds and manpower. In addition, since many marine mammals are widely distributed, and some migrate throughout the world oceans, few problems can be solved unilaterally.

Research areas that most require international assistance and cooperation include the following (not in order of priority):

a) Research dealing with ecosystemic processes in relation to marine mammals.

b) Research dealing with the population biology of species that roam wide areas of the ocean, especially those being heavily exploited.

c) Research dealing with endangered and threatened species.

A particular research project may of course fall into more than one of these areas, and its importance thereby would be correspondingly enhanced. Essential prerequisites for such research include arrangements for coordination, funding, continuing development and implementation of research.

8.1. Arrangements for the coordination, funding, continuing development and implementation of research

The strategy and programme here outlined is provisional. The programme will necessarily evolve even while particular research projects are being carried out. Arrangements are needed to facilitate such evolution, to guide it in accordance with social objectives regarding marine mammals and to help the scientific community contribute to the formulation of objectives.

These arrangements need to be such that those studying marine mammals, those studying biological systems in which marine mammals participate, and other scientists concerned with relevant investigations, from any country and from any kind of research institution, can contribute. Presentations to the Scientific Consultation included a proposal to establish an international Marine Mammals Council to serve as a general scientific advisory body, an announcement of the establishment by IUCN of the Interim Committee on Marine Mammals and a reference to possible continuation of the FAO/UNEP project activity. The Working Party has not been able to study these and other possibilities in any detail, nor were they examined closely during the Consultation. It therefore *recommends* that the ACMRR, as well as the three international organizations represented at the meetings of the Working Party (UNEP, IWC and IUCN) urgently arrange for such consideration, with a view to proposing an agreed appropriate structure, and suggesting under whose auspices the structure should be created and how it might be funded. Arrangements for coordination and development of the research programme and for distributing international funds must involve as fully as possible existing organizations (such as particularly UNEP, IWC and IUCN) which are already funding, sponsoring, planning and coordinating research and conservation activities concerning marine mammals, although in some cases more limited in scope than are the programmes outlined in this Report. In considering new arrangements these organizations would, we hope, act in concert, and they are advised to bear in mind the following:

a) Because many marine mammals inhabit international waters, or range in areas of several national jurisdictions, and because the research calls for considerable international funding, the arrangements must be linked with and supported by inter-governmental organizations of global scope.

b) FAO and ACMRR should retain their interest in research on marine mammals, while recognizing that the objectives of management and conservation fall only partially within their terms of reference.

c) UNEP, having a very broad interest in all marine mammals, and in most if not all aspects of human relations with them, should be encouraged to play a leading organizational rôle, as well as a continuing financial rôle, in the research programme, either directly or through the wide range of international bodies with which it has working relations.

d) The IUCN Interim Committee could provide a suitable forum for scientists to formulate ideas to be presented to governments and to other organizations, without commitment as to the eventual rôle of IUCN with respect to research coordination.

8.2. High priority areas of research

8.2.1. Research dealing with ecosystemic processes in relation to marine mammals

Man does not yet attempt to *manage* the marine environment as such - as he is beginning to do with some terrestrial systems - except in a very limited way in some coastal waters. There is, however, an immediate need for integrated management of many diverse known activities in the ocean and on land which affect marine mammals, and which are directed toward complex sets of objectives. For such a purpose, knowledge of ecosystem processes is essential.

The Scientific Consultation recognized the value of ecosystem process studies and emphasized the need to encourage this type of research as a basis for future management. The Working Party recognizes that single species or population management, although for many years an acceptable approach to conservation, is now inadequate except in certain limited conditions. Several international organizations and some governments have already endorsed policies to the effect that broader management concepts be used, and that these be applied to marine mammals in a multi-species or ecosystem context. The knowledge needed to apply ecological management concepts is inadequate and this area of research therefore has high priority.

There is an immediate need for a series of case studies of representative ecosystems containing marine mammals and of the processes manifest through their ecological relations and behaviour, for example:

(i) Compartmentalization of food supply and space among the small cetaceans of the eastern tropical Pacific.

(ii) Energetics of ice-inhabiting seals, especially relative to the timing of environmental events.

(iii) Ecological displacement of baleen whales and other animals at the same trophic level in the Southern Ocean.

(iv) Feeding strategies of benthic consumers, such as sirenians, walruses and sea otters, with respect to their rôles in structuring benthic and nearshore communities.

(v) Critical habitats of migratory whales inhabiting more than one ecosystem.

8.2.2. Research dealing with the population biology of species that roam wide areas of the ocean

Research in this area calls for a high degree and new forms of international cooperation, particularly planning of large-scale field investigations. Long-term programmes such as the International Decade of Cetacean Research should be encouraged.

Priority should be given to research of exploited species identified in Section 3. Research should be directed to establishing the identity of populations and stocks, their distribution and abundance, their population dynamics including age structure, and energetics. There is a particular need for studies of living whales, including studies not dependent on whaling operations, and for work on the development of new techniques for this purpose.

8.3. Research dealing with endangered and threatened species

This involves relatively few species of marine mammals, but it has high priority if they are to be saved. In general, they live in island, coastal, estuarine or fresh water habitats. Studies should identify factors preventing the recovery or otherwise threatening these species, and should identify habitats critical for their survival and the measures needed for protection. Research is needed on the ecology and on the habitat of the animals as well as on their basic biology. International organizations should give priority to species in developing countries; other countries should themselves be able adequately to support research.

8.4. Conclusions

Most of the research at present undertaken is tactical in nature, mainly addressing short-term questions generated by the particular statutory responsibilities of management bodies. The relatively little strategic research undertaken has not been part of a planned programme to improve the general scientific basis of management and conservation. The outline of research in Annex C constitutes a basis for the formulation of integrated research programmes that are both tactical and strategic; it remains for these to be developed further.

In further evaluating and setting priorities for the research recommendations and proposals in Annex C, certain logical and logistical guidelines should be considered.

a) There exists a logical progression in undertaking research of the kinds with which this report is concerned. Thus, before ecosystems can usefully be studied with respect to the marine mammals, the identity and natural history of the groups involved must be determined. This was recognised in establishing the three series of working groups at the Consultation, on (1) species, (2) populations, and (3) ecosystems. It is important that priority be given to studies which ensure at least the minimal level of knowledge at each stage of the progression. This should not preclude simultaneous undertaking of general ecosystem studies and conceptual modelling.

b) Careful consideration must be given to the existence of appropriate research technology and methods. Highest priority should be given to (i) projects for which equipment and techniques exist and have been proven, as such projects have a high probability of realization in the short term; (ii) projects for the development of the new techniques which are needed for the resolution of specific important problems.

The Working Party considered and slightly amended the "possible framework of organization of studies of marine mammals and their environment" (given, as amended, in Annex B, Table 12.1 and here reproduced as Table I) and rated the categories of research, falling into one or more of the three areas, by taxonomic grouping, as feasible in short-term, medium-term or long-term, using the above criteria of logical development and logistical practicality (Table II). This exercise was meant to illustrate an approach that might be taken in evaluating specific research proposals.

There must be flexibility in the method of selection of priorities, as conditions will vary for different populations and systems, and neither the objectives nor the facilities available to different organizations and institutions will be the same in all cases.

Table I. Possible framework of organization of studies of marine mammals and their environment.

AREAS OF RESEARCH	RELEVANT BASIC SCIENCE		CONSERVATION AND MANAGEMENT		METHODS AND TECHNOLOGY	
	1. Species and Population Studies	2. Ecosystem Studies	3. Exploitation and Protection Studies	4. Other Applied Studies	5. Methods and Techniques	6. Instrument Studies
GENERAL RESEARCH PROBLEMS	1.1. Stock identification, incl. genetics, morphometrics and taxonomy 1.2. Population assessment 1.3. Population dynamics, incl. models and historical studies 1.4. Energetics 1.5. Life histories and phenology 1.6. Behaviour	2.1. Unit ecosystem identification 2.2. Relevant oceanographic and climatic change 2.3. Food web energetics 2.4. Interactions and niche displacement 2.5. System models	3.1. Yields and models 3.2. Harvest strategies, incl. experimental harvest 3.3. Incidental take 3.4. Low-consumptive use 3.5. Recovery rates 3.6. Sanctuaries and endangered species 3.7. Bioeconomic models	4.1. Social economic and biological impact 4.2. Competition with man 4.3. Aquaculture 4.4. Product substitutes and development 4.5. Pollution	5.1. Communication incl. terminology 5.2. Sampling methods and efficiency, incl. experimental design 5.3. Data collection and management 5.4. Comparisons with non-marine species and systems 5.5. Age determination 5.6. Legislation design 5.7. Interpretation of reproductive material	6.1. Marking 6.2. Remote sensing, tracking and telemetry 6.3. Biopsy darts 6.4. Gear design

RESEARCH PROCEDURE

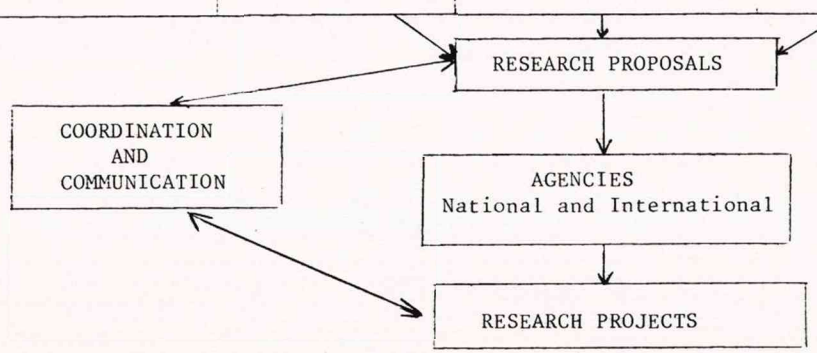

Table II. Significant gaps in knowledge to be considered in assigning priorities to research on marine mammals. (The six areas of research given in the row at the top of the table and the decimal numbers below them correspond with those in Table 12.1 of Annex B.)

Time scale	*Areas of Research* 1. Species and Population Studies	2. Ecosystem Studies	3. Exploitation and Protection Studies	4. Other Applied Studies	5. Methods and Techniques	6. Instrument Studies
			Large Whales			
Short term	1.1, 1.3	2.4	3.1, 3.2, 3.4	4.1, 4.4	5.1, 5.3, 5.4, 5.5	6.1, 6.3
Medium term	1.2, 1.4		3.5, 3.7	4.5	5.2	6.2
Long term	1.6	2.3, 2.5				
			Small Cetaceans			
Short term	1.1, 1.5	2.2	3.3, 3.4, 3.6	4.1, 4.5	5.1, 5.3, 5.5	6.1, 6.2, 6.4
Medium term	1.2, 1.3	2.1	3.1	4.2	5.2	
Long term	1.6				5.4, 5.7	
			Seals			
Short term	1.2, 1.3, 1.4	2.3, 2.4	3.1, 3.5, 3.6	4.2, 4.5	5.1, 5.3	6.1, 6.2
Medium term		2.2	3.2			
Long term						
			Pinnipeds			
Short term	1.1, 1.2, 1.5		3.3, 3.4, 3.6	4.3, 4.5	5.5, 5.7	6.1, 6.2, 6.4
Medium term	1.3					
Long term						
			Sea Otter			
Short term	1.3, 1.4	2.1, 2.4	3.5	4.2	5.5	6.1
Medium term		2.3	3.7	4.5	5.6	
Long term						
			Marine Otter			
Short term	1.2, 1.5	2.1	3.6	4.5		
Medium term	1.3, 1.6		3.5			
Long term						6.1

9. RECOMMENDATIONS

In this section are brought together the recommendations that the Working Party proposes should be transmitted by ACMRR to the Director-General of FAO for his consideration and further action. At the same time it is expected that they will also be considered by the appropriate authorities of the international organizations represented at the final meetings of the Working Party during which the recommendations were formulated, that is of UNEP, the IWC and IUCN.

All the proposals mentioned are referred to and, it is hoped, justified in materials prepared in connection with the FAO/UNEP Marine Mammal Project, discussed at the Scientific Consultation and reflected in other sections of this Report and its Annexes. Realizing that this section is likely, however, to be referred to and perhaps quoted without immediate reference to the rest of the Report a short explanatory statement is given following most of the recommendations. An attempt has been made to arrange the recommendations in an order which progresses from the general consideration of objectives and arrangements for management and conservation, through scientific advisory questions to details of information exchange, and publication and **distribution of materials related to the project,** including of course the Report itself.

●1. Objectives of conservation and management. *It is recommended* that the need for explicit formulation of the many objectives of mankind in relation to marine mammals be brought to the attention of the governing organs of FAO and of UNEP, with a view to initiating urgently intergovernmental action to this end within the United Nations system. *It is further recommended* that existing international bodies concerned in one way or another with the conservation and management of marine mammals and their environment, as well as the United Nations Conference on the Law of the Sea (UNCLOS), be informed that the need for examination of inconsistencies among the objectives embodied in various conventions and agreements dealing with marine mammals is perceived by the scientific community.

The scientific community is conscious that existing formulations of these objectives, as embodied in various conventions and agreements, are not all consistent with each other, and may not in all cases be appropriate in changing situations with respect to living resources nor reflect evolving human attitudes toward those resources and to the biosphere as a whole. The planning and implementation of a research programme adequate in scale, and appropriate in disciplinary scope and orientation, requires clear understanding of the objectives the programme is intended to serve.

●2. Endangered and threatened species. Considering that several species of marine mammals are endangered, and that others are in a threatened state, *it is recommended* that nations and international organizations concerned accord priority to research projects and management actions aimed at restoring the viability of populations of the several species of endangered marine mammals and of the other species that are in a threatened state. These projects and actions should:

(i) Identify the factors causing decline or preventing increase in the numbers of each endangered or threatened species, where these factors are not yet known, and provide means for alleviating their effects.

(ii) Identify habitats critical for the survival of threatened species and provide protection for those habitats.

(iii) Develop criteria for the establishment and management of sanctuaries for marine mammals, including reserves in international waters, bearing in mind that it is seldom sufficient to establish such areas unless attention is given also to the ecological processes which affect them.

(iv) Pay due regard to research projects and management actions relating to exploited species with the aim of ensuring that no additional populations become threatened.

It is further recommended that governments and intergovernmental organizations be urged to give general support to the major campaign for the conservation of marine species and habitats launched by IUCN and WWF in December 1976, and, as opportunities arise, that governments facilitate the implementation of specific projects.

●3. Register of legislation. *It is recommended* that FAO consult with the UNEP Secretariat and the IUCN Environmental Legislation Unit with a view to a continuing inventory being maintained of information sources about national legislation and international agreements and decisions which concern marine mammals directly, or the application of which may affect them or their habitats.

This inventory should include, *inter alia*, sources specifying regulations of harvest, other controls of resource use, and measures for protection or regulation of use of critical habitats.

●4. Scientific advice for management. *It is recommended* that arrangements be made for independent monitoring of the scientific advice given to international management authorities. *It is further recommended* that procedures be improved for monitoring the application of management rules and regulations, since it is only from knowledge of what is actually happening, rather than of what is supposed to be happening, that the effectiveness of scientific advice can be evaluated.

The arrangements referred to must include access to all statistical and scientific data, and to full information about the methods of analysing those data by all those who wish to engage in such monitoring, whether on a regular or on an *ad hoc* basis. The most urgent cases for application of the above proposals are those of the whales and the heavily exploited seals. The Survival Service Commission (SSC) of the IUCN has established the Interim Committee on Marine Mammals and charged it, *inter alia*, to examine these matters and to make detailed proposals. This initiative is welcomed by the Working Party. ACMRR and the organizations whose representatives participated in the final meetings of the Working Party are advised to contribute to such examination.

●5. Statistics of commercial use of marine mammals. *It is recommended* that total weights of annual whale catches, as well as numbers, be published, by species and area, in the FAO *Yearbook of Fishery Statistics* and included in the FAO total figures for marine production. *It is further recommended* that FAO, in cooperation with other organizations that are concerned, seek improvement in commodity statistics for whale products, particularly meat, and in the at present very poor statistics for catch and accidental kill of small cetaceans, pinnipeds and sirenians. *Lastly it is recommended* that the FAO *Yearbook of Fishery Statistics* include total weights of seals killed, even though the carcasses are often not fully utilized.

The conversions from reported numbers to equivalent live weights should be made by FAO, until such time as this is routinely done by the Bureau of International Whaling Statistics (BIWS) and/or the IWC. Compilation of historical statistics, by weight, should be completed and published. Members of the Working Party and of its *ad hoc* Groups are ready to assist in providing conversion factors for seals to live weight equivalents.

●6. Arrangements for international cooperative research. *It is recommended* that the various suggestions for arrangements for the funding, coordination, continuing development and implementation of an expanded research programme on marine mammals and their environment which have been made at the Scientific Consultation (partially summarized in Section 8 and in Annex C of this Report) be considered with a view to determining an appropriate structure, deciding under whose auspices it should be created, and how it might be funded. *It is further recommended* that FAO, UNEP, and the other organizations whose representatives participated in the Working Party, consider the creation of an International Fund for Marine Mammal Research and Conservation to which they and other sources, national and international, official and private, could contribute.

In implementing this recommendation the following should be borne in mind:

(i) Because many marine mammals inhabit international waters, or range in areas of several national jurisdictions, and because the proposed research calls for international funding, the arrangements must be linked with, and supported by, intergovernmental organizations of global scope.

(ii) Arrangements for coordination and development of the research programme and for distributing international funds should involve as fully as practicable existing organizations which are already sponsoring international research and conservation activities on marine mammals but more limited in scope than is the programme here outlined.

(iii) FAO and ACMRR should retain their active interest in marine mammals, even though the objectives of managing and of conserving them fall only partially within the terms of reference of ACMRR and the statutory responsibilities of FAO.

(iv) UNEP, having a very broad interest in all marine mammals, and in most, if not all, aspects of human relations with them, should play a leading organizational rôle, as well as a continuing financial rôle, in the research programme, both directly and through the wide range of international bodies with which it has working relations.

(v) The research programme relating to marine mammals should be declared to be a component of the Long-term and Expanded Programme of Ocean Research (LEPOR) decided by the United Nations General Assembly, and the Intergovernmental Oceanographic Commission (IOC) which has primary responsibility for coordination of LEPOR should be so informed.

●7. International Decade of Cetacean Research (IDCR). *It is recommended* that the initiative of the IWC, following a resolution of the United Nations Conference on the Human Environment, in planning the IDCR be welcomed, and that the Director-General of FAO be advised to take appropriate steps to encourage financial support for IWC/IDCR projects on the understanding that they are concerned mainly with large whales, and provided he is satisfied that opportunity will be given for participation by scientists from all interested nations, irrespective of whether these nations are Members of the IWC, and that the projects supported are not inconsistent with the research proposals of broader scope outlined in this Report.

●8. Marine mammal project activity. *It is recommended* that FAO and UNEP be advised to act to ensure continuation of the initiative represented by the charge to the Working Party, by the Scientific Consultation and by the FAO/UNEP Marine Mammal Project.

The appropriate steps should be taken immediately so as not to lose the interest of governments and enthusiasm of scientists that have been generated. This might be achieved by a new UNEP-funded project in two phases. In the first, preparatory, phase the recommendations made here, and the research proposals given in Section 8 and in Annex C, would be converted into a detailed plan of action. During this phase, the Director-General of FAO, COFI, the Executive Director of UNEP and its Governing Council would have the opportunity to consider the recommendations, so that account of their policies and views would be taken in the action plan. The first phase of the project would include the description and costing of specific activities, the development of a timetable for their implementation and the establishment of criteria for determining priorities among them. The action plan should suggest which organizations, nations and institutes would be responsible for implementation, and the appropriate sources of funds. Implementation of such a plan would require not only more funds than are at present committed to research of marine mammals but also more scientists than are at present available. The plan should therefore include proposals for the training of more young scientists and increase the involvement of experienced scientists in this field, thus continuing the process of learning and involvement manifest at the Scientific Consultation. The second phase of the project would consist of the implementation of the action plan. In this phase, the cooperation of governments, international organizations, scientists and others should be secured and substantial funds provided, for the conduct of the research and for the conservation and management activities proposed.

●9. documentation and information. *It is recommended* that the FAO Secretariat re-examine the adequacy of existing abstracting and bibliographic services, newsletters and other vehicles of scientific communication with respect to marine mammals and their environment and submit proposals for their improvement to ACMRR for review.

When this matter was considered by the Working Party in 1973, it was apparent that the FAO services such as *Aquatic Sciences and Fisheries Abstracts*, the *Register of Experts in Aquatic Sciences and Fisheries*, the *Register of Research Institutions*, the *Register of Periodicals for Aquatic Sciences and Fisheries* and other compilations were inadequate in their coverage of marine mammals. Such services are essential to assist the implementation of an expanded plan of research on a global scale.

●10. Contaminants in marine mammals. *It is recommended* that continuing arrangements be made for compiling and reviewing information about biocides, heavy metals and other contaminants in the tissues of marine mammals, about the effects of these contaminants on the animals concerned, and about occurrences of deaths and injuries to mammals caused by, or presumed to have been caused by, pollution.

The marine mammals are physiologically man's closest relatives in the ocean and most of them feed at high trophic levels and therefore accumulate persistent contaminants. Evidence was made available to the Working Party of effects of some contaminants on birth-rates and reproductive organs of seals, of declines in numbers of marine mammals in polluted sea areas and of physical damage to large whales from corrosive chemicals. The systematic review proposed should include information about the transfer of contaminants to predators on marine mammals, including man, and the routes by which the contaminants reach the marine mammals. The system should provide for improved exchange of information about current research on this subject.

●11. Publication of Report. *It is recommended* that this Report, including its Annexes, be published. *It is further recommended* that arrangements also be made for a shorter, less technical version of this Report to be written and published.

Copies of the Report should be provided by FAO as soon as possible to participants in the Scientific Consultation; to those scientists who had been invited to participate but were not able to do so; to international organizations invited to collaborate with the Working Party and to designate representatives to the Scientific Consultation; to agencies in all states members of FAO or of the United Nations concerned with research on marine mammals and their habitats, and with their conservation, management and utilization; to members of ACMRR; and to delegations to COFI and UNCLOS. Such distribution might be made in each case under cover of an appropriate letter, accompanied by a synthesis of such comment as may be made by the officers of ACMRR and those members designated by the chairman of ACMRR to review the Report in detail. Additional copies should be offered for sale and suitably advertized. Annex B with Appendices I to VII and Annex C might each be issued as separate fascicules as they may require somewhat different distribution from the main body of the Report.

●12. Other publications. *It is recommended* that arrangements be made for selected papers, from those contributed to the Scientific Consultation, to be published as a book. *It is further recommended* that the summary accounts of pinniped species (Appendix VI of Annex B) be revised and published as a reference book, including photographs and distribution maps. *Finally, it is recommended* that a short popular book on the subject of fishermen and marine mammals be prepared.

A committee consisting of the chairman of the Working Party, the officer-in-charge of the FAO/UNEP Marine Mammal Project and the chairman of ACMRR or another designated by him has been established to select contributions for publication. The Committee will consult with other members of the Working Party, as it finds necessary, regarding the selection of particular contributions. Papers selected for publication would not include those already published in scientific journals or submitted for publication elsewhere, but in these cases abstracts of them would be included, so that the collection is a more or less comprehensive source of information. Authors would be advised in due time to correct and revise their contributions, provided this did not unduly delay publication. The popular book should be directed especially to the fishing industry and administrations to provide information about the ways the marine mammals affect and are affected by fishing operations. It would be based mainly on information contained in the documentation of the Consultation. An interested publisher has been identified; the FAO Secretariat should seek an author.

ANNEX A

Terms of reference and members of the Working Party and of its *ad hoc* Groups

The terms of reference given by ACMRR to its Working Party on Marine Mammals were as follows:

To examine and report to ACMRR on: the identity, distribution and status of stocks of marine mammals which are, have been or might soon be subject to exploitation by man, killed accidentally when fishing for other marine living resources, or which are affected by other human maritime activities.

The Working Party should examine past and existing research programmes and their results and, in the light of relevant decisions or recommendations of the IWC, COFI, the UN Conference on the Human Environment and the UN General Assembly, identify any significant gaps and weaknesses in these. The Working Party should seek to cooperate with, and take account of, the activities of the above bodies and of the IUCN, SCOR, fishery councils and commissions concerned with marine mammals and other intergovernmental bodies. The effects of present and possible future management actions should be appraised, as well as any known or likely effects of marine pollution. Any evidence of relationships between the stocks of marine mammals and other marine resources ecologically linked with them, such as the organisms on which they feed, should be appraised.

The Working Party should examine the distribution and nature of present exploitation and of the products insofar as these bear on the evaluation of likely future exploitation and management regimes. The Working Party should decide itself on the priorities within its task and should take account of ecological and behavioural and other biological investigations, as well as research on the dynamics of mammal populations.

To this end the Working Party should consult scientists, industrial operators and other groups concerned, as widely as practicable. Its draft report will be made available to national and international mammal committees and bodies for their consideration, and will also be discussed at a technical seminar (workshop) to be convened by FAO, of which FAO will seek co-sponsorship by other interested organizations.

Three *ad hoc* groups were each given the above tasks, with specific reference to large whales (Group I), small cetaceans and sirenians (Group II) and pinnipeds and marine otters (Group III). In addition, *ad hoc* Group IV on general and ecological problems was established, with the following terms of reference:

To undertake a systems analysis, to the level which the available data will allow, of the relation of marine mammals both to relevant aspects of the marine ecosystem and to the human community. The specific object of the analysis to be the development of an approach to ascertain:

a) the place of marine mammals in the ecosystem and the overall effects on it of man-induced changes in their numbers;

b) the influences, both deliberate and incidental, of human activities, present and future, on the numbers of the various marine mammal populations;

c) possible future trends in the utilization of marine mammal resources;

in order to provide a basis for optimum policies for management and conservation of marine mammals and their environment.

The original membership of the Working Party, as determined by the officers of ACMRR, was as follows:

S.J. Holt (Chairman)
K.R. Allen
A.S. Bogdanov
P.A. Larkin
O.A. Mathisen
M. Nishiwaki
G.C. Ray

After the planning meeting of the Working Party in February 1973 circumstances prevented A.S. Bogdanov and P.A. Larkin from further contributing to the work, so they withdrew. Also, S.J. Holt returned to service with FAO and was appointed as Officer-in-Charge of the FAO/UNEP Marine Mammal Project. Until the Scientific Consultation, the planned studies were carried out by the four *ad hoc* Groups. During the Consultation, it was decided by D.L. Alverson, chairman of ACMRR, in consultation with G. Saetersdal, former chairman, and with H. Kasahara, director of FAO Fishery Resources and Environment Division, to invite the following additional scientists to membership of the Working Party:

W.N. Bonner
R.M. Laws
C.P. McRoy
W.F. Perrin

The Working Party elected R.M. Laws as its new chairman. It met with this new membership immediately following the Scientific Consultation on the Norwegian island of Svanøy from 11-14 September 1976 and held its last meeting from 21-25 January 1977 in La Jolla, California, to finalize its Report and the Proceedings of the Consultation. At both these meetings, K. Curry-Lindahl represented UNEP, R. Gambell represented the IWC and R.F. Dasmann represented IUCN, these organizations being the major collaborators with respect especially to formulation of a comprehensive programme of research and conservation. D.L. Alverson also attended the final meeting of the Working Party.

The membership of the four *ad hoc* Groups was as follows:

Group I

R. Gambell (convener until May 1976)
P.B. Best (convener from May 1976)
*A.A. Berzin
A. Jonsgard
S. Ohsumi
R.S. Payne

Group II

E.D. Mitchell (convener until November 1975)
W.F. Perrin (convener from November 1975)
G.C.L. Bertram
R.L. Brownell, Jr.
I. Christensen
W.H. Dawbin
W.E. Evans
G.E. Heinsohn
S. Jones
*T. Kasuya
R. Praderi
P.J.H. van Bree
A.V. Yablokov

Group III

H.D. Fisher (convener)
W.N. Bonner
A.M. Johnson
Y. Naito
*L.A. Popov
D.B. Siniff
R. Vaz Ferreira
R.M. Warneke

O.A. Mathisen (contact with Working Party)

Group IV

Members of the Working Party (K.R. Allen served as convener)
Conveners of *ad hoc* Groups I, II and III

C.W. Clark
M.J. Dunbar
Y. Fukuda
*G. Leach
A.R. Longhurst
C.P. McRoy
*V.V. Menshutkin

* Did not attend meetings

In addition to the above membership and participation by various members of the Working Party itself, the following scientists attended one or more meetings of the *ad hoc* Groups.

Group I

A. Aguayo L.
W.H. Dawbin
Y. Fukuda
J.A. Gulland
C. Holloway
R.M. Laws
E.D. Mitchell
W.F. Perrin
A.V. Yablokov

Group II

D.L. Alverson
H.W. Campbell
D.P. Domning
S.L. Husar
B. Irvine
J. Joseph
V.M. Kozicki
J.S. Leatherwood
D.M. Magor
E. Markoff
J.G. Mead
K.S. Norris
D.K. Odell
D.W. Rice
T.D. Smith
W.A. Walker
V.A. Zemsky

Group III

M.A. Bigg
C.M. Brenton
D.G. Chapman
A.W. Erickson
C.H. Fiscus
G.Y. Harry, Jr.
K.W. Kenyon
R.H. Lander
D.M. Lavigne
R.M. Laws
B.R. Mate
B. McAlister
T. Øritsland
V.B. Scheffer
D.E. Sergeant
I. Stirling

Group IV

J.A. Gulland
R.M. Laws
D.E. Sergeant
D. Viale

All meetings of the Working Party and of the *ad hoc* Groups were attended by L.K. Boerema, Technical Secretary of the Working Party, and S.J. Holt. Some participants in meetings of the Working Party and its groups were designated by interested international organizations as observers on their behalf. Many other specialists contributed to the work of the Working Party by correspondence and through summary documents prepared for the *ad hoc* Groups.

The names of other contributors to the Scientific Consultation will be found among the authors of working papers - see Appendix I of Annex B. In addition, the following persons who neither attended the Consultation or preparatory meetings, nor prepared working papers for them, nevertheless assisted by sending written comments on the documentation, or in making data available to the *ad hoc* Groups of the Working Party.

V.M. Adams
F.L. Bunnel
H.P. Castello
J. Cushing
W. Edwardson
I. Everson
D.C. Fonda
F. Fukuhara
G. Hardin
G. Leach
W.F.J. Mörzer Bruyns
B.B. Parrish
J.S. Pearse
V.I. Privalikhin
G.A. Sacher
R. Salm
R. Sandland
S.C. Sherman
R. Trumble
J. Verwey
N.J. Wilimovsky