Global
Ocean
Observing
System

Intergovernmental Oceanographic Commission
Reports of Meeting of Experts and Equivalent Bodies

IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS)

Third Session
Talcahuano, Chile
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GOOS Report No. 83

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Abstract

The third session of the Living Marine Resources Panel of the Global Ocean Observing System (LMR-GOOS-III) was convened in Talcahuano, Chile, 8-11 December 1999. At this session the Panel designated five LMR contributions to the GOOS Initial Observing System, and identified three LMR-GOOS pilot projects. Additional discussions focused on the initial design of the LMR-GOOS Strategic Design Plan, and the Panel approved a preliminary outline. An important element of the session was a Stakeholders' Meeting, intended to collect input on LMR-GOOS from the national and local user communities. A number of Chilean government agencies and private sector interests were represented, and their recommendations are included in the report.

SC-2000/WS/67

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1. WELCOME AND INTRODUCTIONS

The meeting was brought to order at 0900 on 8 December 1999 at the Instituto de Investigaciones Pesca (INPESCA) in Talcahuano, Chile. Dr. Dagoberto Arcos, Director of INPESCA and co-chair of the LMR-GOOS Panel welcomed the panel on behalf of his institute. Apologies were noted for Mike Sinclair, Bodo von Bodungen, Kwame Koranteng, John Pope, Katherine Richardson, and Daniel Lluch-Belda. Mike Sinclair was represented by Kees Zwanenburg. Sonia Batten was welcomed as a representative of the Sir Alister Hardy Foundation for Ocean Science, and Roger Harris was welcomed as the representative of International GLOBEC. It was explained that Carlos Garcia had resigned from the Panel and would be replaced at the next meeting by Trevor Platt.

The panel thanked the Food and Agriculture Organization of the United Nations (FAO), the IOC and NOAA for their support of the meeting. The U.S. GOOS Office at Texas A&M University, and Maureen Reap in particular, were thanked for providing travel support for meeting participants.

Dagoberto Arcos explained the meeting schedule and transportation arrangements. Ned Cyr, Technical Secretary for LMR-GOOS, explained the reporting arrangements. Sonia Batten was designated rapporteur for the meeting.

2. OPENING REMARKS

Warren Wooster, Panel co-chair, offered some personal thoughts on the development of a strategic design and implementation plan. These views do not necessarily represent panel consensus.

How shall we proceed from the conceptual (strategic) design to an implementation (tactical) plan? It is a temptation to remain at the strategic level because it is possible to generalize and thus avoid the heterogeneity of innumerable local plans. An acceptable future monitoring scheme would lead to useful products – at least now-casting (the description of the current state of the ecosystem) and eventually forecasting of future states. What sort of forecasting might be expected?

The output of a practicable monitoring system might include *routine* information on the time and space variability of the surface layer physical conditions (e.g., T, S, wind forcing, circulation), primary production (derived from remotely-observed surface color), and community structure of larger zooplankton (from CPR), plus *irregular* information on the abundance and distribution of higher trophic levels (from observers and from fishery data). Using this output, a centralized mechanism for data compilation and analysis should be able to provide useful now-casting.

To produce forecasts will require the use of models relating knowledge of the present state of the ecosystem, including the history of its development and rate of change, with the production (including recruitment and growth) of species of interest. Development of such models is a necessary ingredient of research (e.g., GLOBEC) that supports the development of GOOS. As in the case of now-casting, data compilation and analysis is a necessary function of regional analysis centers.

Questions of scale and allocation of responsibility arise in considering the implementation of the LMR observing system. For example, although the reports of LMR-GOOS I and II stated that information on reproduction of species of interest should be included, monitoring these processes seems more appropriate for national fishery laboratories, except to the extent that reproductive products (e.g., eggs and larvae) are sampled as zooplankton. More generally, monitoring of individual fish stocks, and analysis of fish catch data required for detailed operational use by fishing fleets and by managers of the fishing activities of those fleets are the responsibility of national fishery agencies or, collectively, of FAO.

What then is the nature of the forecasts that LMR-GOOS hopes will result from the monitoring system it is proposing? This question should be addressed by the panel.

3. REPORTING ON RELEVANT ACTIVITIES

Successful implementation of GOOS will depend on strong linkages to ongoing research programs, routine observing systems and international organizations with mandates to conduct ocean observing. Liaison with a number of these, such as GLOBEC, FAO, SAHFOS, ICES and PICES has been continuous throughout planning for LMR-GOOS. It is stressed that linkages between these programs and LMR-GOOS must continue through the planning phase and into implementation.

The following programs presented brief status reports to the panel.

3.1 GOOS – STATUS OF OVERALL PLANNING

Significant progress has been made in planning for the four GOOS strategic design modules. The Climate module remains the most advanced, with the GODAE experiment and its supporting Argo project serving as advanced pilot projects. C-GOOS and HOTO-GOOS have completed their design strategies and are considering the development of their implementation plan. The LMR-GOOS, C-GOOS and HOTO-GOOS panels will merge in late 2000 and produce a joint implementation plan.

The IOC, in conjunction with the World Meteorological Organization, has undertaken a new initiative called the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). JCOMM will integrate mechanisms for the collection and management of data from the upper ocean and atmosphere.

Regional GOOS bodies continue to develop. To date, there are NEARGOOS, EuroGOOS, MedGOOS, Pacific GOOS, Africa GOOS and IOCARIBE GOOS. Most of these regional bodies are concerned with coastal physical observations. None has yet included in its observing programs the ecosystem observations that are required for LMR-GOOS. Panel members were encouraged to work with relevant regional GOOS bodies to ensure that they reflect GOOS priorities in all four strategic design modules, not merely coastal and climate.

The Joint Data and Information Management Plan (JDIMP) was reviewed by the LMR panel in July 1999, and generally found to be insufficient for the panel's needs. The JDIMP is being revised and the next draft will be provided to the panel for review in early 2000.

The first GOOS Commitments meeting was held in Paris, 5-6 July 1999. This was an opportunity for representatives of governmental, intergovernmental and non-governmental organizations to commit the observing systems that are intended to be included in GOOS. A number of ongoing observing programs were identified as contributions, and most were concerned with physical observations, though some included biological monitoring systems.

The International Ocean Color Coordinating Group (IOCCG) has agreed to advise GOOS on system requirements for ocean color observations. In order to provide consideration of ocean color requirements in the LMR-GOOS design strategy, and to provide the LMR panel's input to the IOCCG, the chair of the IOCCG, Trevor Platt, has been requested to join the LMR-GOOS panel.

3.2 INTERNATIONAL COUNCIL ON THE EXPLORATION OF THE SEA (ICES)

The 87th ICES Annual Science Conference was held in Stockholm in late September 1999. There were a number of resolutions that were adopted by the delegates that are very relevant to LMR-GOOS. These are discussed in Annex VI.

3.3 NORTH PACIFIC MARINE SCIENCE ORGANIZATION (PICES)

PICES has planned or underway a wide range of monitoring and research relevant to LMR-GOOS. PICES main scientific program is the Climate Change and Carrying Capacity Program (4-Cs). One aim of this program is to understand the processes that govern climate change in the subarctic Pacific. Because large-scale sampling of physical, chemical, and biological regimes on climate time scales is inadequate, in 1998 PICES established the MONITOR Task Team to develop a climate monitoring program. The monitoring elements developed by the MONITOR Task Team could be considered for incorporation into the GOOS-LMR plan.

The MONITOR Task Team met in Vladivostok, Russia in October 1999. The following items of discussion from that meeting are relevant to LMR-GOOS.

- Shipboard climate sampling - Sampling currently conducted by survey and research vessels in the north Pacific generally covers some physical, chemical and biological variables, but is not uniform among the various ships. The suite of variables measured is not standardized and different measurement techniques are employed. Also, there are significant differences in the east-west coverage.

- Zooplankton monitoring plan - At the first Task Team meeting in 1988, the team recommended that systematic, large-scale measurements of interannual variability of N. Pacific zooplankton composition and abundance be initiated. In 2000 a two-year CPR sampling program will begin. Two lines will be run initially. PICES would like to see this program imbedded in the initial GOOS plan. PICES also intends to work with GOOS to develop a long-term strategy for a zooplankton database.

- Array for Real-Time Geostrophic Oceanography (Argo) - The Task Team strongly endorses the Argo plan. PICES hopes that Argo measurements in the subarctic will be initiated soon. It is recommended that PICES facilitate deployment of the array.

- Deployment of ecological moorings - The Task Team was supportive of the pilot studies that have been initiated to moor suites of meteorological and oceanographic instruments in the subarctic. A two-year program has been undertaken by the Pacific Marine Environmental Laboratory of NOAA near ocean Station PAPA. The first mooring was deployed in September 1998 and a second in September 1999. The Task Team concludes that there will be a large scientific payoff for these efforts and recommends that these scientific and engineering studies be continued.

- Calibration studies of sampling gear - Calibration of various systems must be undertaken to resolve sources of error. The Task Team is undertaking a survey of the scope of the problem. Results of a comparison of the performance of two plankton sampling nets was presented at the 1999 meeting. The initial sampling design of this study showed that about 40 pairs of measurements were needed to successfully compare net performance. The Task Team will facilitate further critical comparison studies.

3.4 SIR ALISTER HARDY FOUNDATION FOR OCEAN SCIENCE (SAHFOS)

Since the LMR-GOOS-II meeting in March 1999 the Continuous Plankton Recorder (CPR) survey has become part of the GOOS Initial Observing System. The SAHFOS Council has also approved a draft data policy for CPR data which fully complies with the developing data policy of GOOS. Although details of the data licence agreement are still being finalised, CPR data are free of charge to the user with only a nominal computing charge levied for the cost of processing and delivering the data product.

In July of 1999 a new project began with SAHFOS as the main partner, supported by the UK Department of the Environment, Transport and the Regions, to further develop the U-Tow into an operational instrument for Ship of Opportunity (SOOP) use. This project involves polling the ships that currently deploy the CPR to obtain comments and identification of problems from their perspective with deploying the U-Tow. Further trials on SOOPs will also be undertaken and comparisons made between the sampling characteristics of the U-Tow and the CPR. At present the U-Tow has proved reliable and capable of undulating to depths of approximately 60m at speeds of up to 16 knots but it has not yet been towed unaccompanied. This project will move towards that goal.

A proposal was submitted, and funding received, during 1999 for a two-year program of CPR tows in the NE Pacific. This project was proposed by the MONITOR Task Team of the PICES Climate Change and Carrying Capacity program. Sampling will start in the spring of 2000 and further details can be found in section 5.2.1, where it is described as a potential Pilot Project.

SAHFOS also proposes that data for two plankton indices will be posted on its Web site, and updated monthly as part of its commitment to GOOS. Phytoplankton Colour and the abundance of the copepod *Calanus finmarchicus* have both shown strong links with northern hemisphere climate variables and clear long-term trends. Colour has proven to be a reasonable proxy for phytoplankton abundance and *C. finmarchicus* is probably the most abundant copepod in the north eastern Atlantic. The Colour index is assessed almost as soon as the samples are returned to the laboratory and so data could be posted within a few weeks of sampling. The copepod abundance will take longer to determine for the entire sampled area, however, it is hoped that data would be made available within a year of collection, as a maximum, and probably often on a shorter time scale. It is expected that data will be available beginning in 2000.

3.5 GLOBAL OCEAN ECOSYSTEM DYNAMICS (GLOBEC)

Roger Harris reported briefly on GLOBEC developments since LMR-II, with emphasis on aspects of particular relevance to LMR-GOOS. The Implementation Plan for the IGBP/SCOR/IOC International GLOBEC Program has been published as IGBP Report 47. The GLOBEC Focus I (Retrospective analyses and time series studies) and Focus 3 (Predictive and Modeling capabilities) were highlighted as being of special common interest between the two programmes, while the Foci on Process Studies (Focus 2) and Feedbacks from Changes in Marine Ecosystem Structure (Focus 4) also have some potential for linkage with GOOS.

At many places in the GLOBEC Implementation Plan there are specific references to GOOS-GLOBEC linkage. For example, Task 3.3.3 “Make available the observations and modeling methodologies for development of the Global Ocean Observing System (GOOS) particularly the Living Marine Resources (LMR) module” has the objective of transferring relevant GLOBEC sampling and modeling methodologies to GOOS. GLOBEC is also developing a series of cross-cutting framework activities which require attention from all components of international GLOBEC. These are the efforts which will provide the “value added” of the co-ordinated international program and will ensure that, at the end of the GLOBEC program, results from all the regional studies and national programs can be compared and integrated to obtain the global synthesis that is the ultimate goal of the project. These Framework Activities also are potentially highly relevant to LMR-GOOS, especially the series of initiatives on “Sampling and models: protocols and intercomparison”.

This work which aims to ensure that the measurements made by, and models used in, GLOBEC are as comparable as practically possible, thus aiding global synthesis, will be of benefit to the GOOS. Again there is explicit reference to this in the Implementation Plan. For example, subtask 5.1.2 has as its objective, to “Develop collaborations with GOOS efforts, especially those of the LMR and Coastal modules”. Task 8.3 states that "To underscore the importance of this GLOBEC activity, other evolving and future programmes (e.g., GOOS-LMR) will likely base some of their observational methodologies and standards as well as modeling components upon the framework of the GLOBEC program”. Having emphasised the common interest of the two programmes, it is recognised that linkages between GLOBEC and GOOS need to be established early, both to develop information flow and to evaluate potential GOOS protocols, locations, and sampling designs.

To this end it was agreed that a GOOS-GLOBEC Liaison Group be established to explore and develop opportunities for mutual support between LMR-GOOS and GLOBEC. This group would work with the GLOBEC International Project Office in Plymouth, particularly through the IPO Director Dr. Manuel Barange and the recently appointed Data Manager, Hester Willson.

3.6 INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (IOC)

The IOC has a number of activities related to LMR-GOOS activities. Large Marine Ecosystem (LME) monitoring and assessment projects continue to be developed. Four projects are now in implementation, or have received project development funds from the Global Environment Facility (GEF). The Gulf of Guinea LME project is the most advanced, and has been in operation since 1995. The project is based on observations in three modules – productivity, fish and fisheries and ecosystem health – which are implemented in six West African countries. Phase II of the project is now planned, in which additional countries would be included, as would two additional modules – socioceconomics and governance. A project is also in planning for the Benguela Current LME. South Africa, Namibia and Angola received a GEF planning grant and are in the process of preparing a Transboundary Diagnostic Analysis (TDA) and a Strategic Action Program (SAP) for the project, which intends to employ the same five-module strategy as the Gulf of Guinea Phase II. This project has been selected as an LMR-GOOS pilot project. The Yellow Sea LME project (People’s Republic of China, Republic of Korea and Democratic People’s Republic of Korea) has also received GEF project development funds and plans to employ the same five-module strategy as the Gulf of Guinea LME and Benguela Current LME projects. A Humboldt Current LME project has applied recently for GEF Block B funds.

In response to a request by the LMR- and C-GOOSpanels, the IOC has undertaken an inventory of existing marine observing programs globally. It is intended that this inventory will help the panels to identify where regional observing capacities exist, and where they require augmentation. The inventory is being approached on two fronts. First, a letter was sent to all IOC Member States asking them to identify their observing systems which are relevant to GOOS. Second, an IOC consultant has been hired to review web sites of governmental, intergovernmental and non-governmental organizations relevant to GOOS to identify ongoing observing programs. The results of both searches are being put into a map-based information system that will allow the observing systems to be identified by country or region, or to be searched by subject area.

3.7 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)

The FAO representative submitted the following statement.

FAO’s intended contribution to GOOS (FAO meta-assessment of fishery statistics, the FIGIS information system, the system of sustainability indicators currently under development, and the biennial FAO Review of the State of World Fishery Resources) remains the same as that reported from LMR-I and LMR-II.

The recent information that the question of status and trends in "critical coastal habitats" (large tropical estuaries, mangrove forests, seagrass beds, etc.) other than coral reefs is not being covered in the GOOS Coastal Module, as earlier understood to be the case, is an item of concern. These issues were cited by FAO very early in the LMR-GOOS module development process as perhaps the item of foremost interest to FAO in terms of information to be gained from GOOS in support of FAO’s basic activities.

It is suggested that the Coastal Panel’s neglect of these issues will need to be remedied by action of the LMR Panel in order to avoid this important set of issues "falling through the cracks" of GOOS planning module development.

The advent of the idea of development of LMR-GOOS "regional analysis centers" may involve some potentially problematic issues of mandate and responsibility within the UN system. FAO is the UN agency with the mandate for fisheries and fishery resources status and trends issues. It is important that the development of this idea be done very carefully, and in full consultation with FAO in order to ensure that the UN continues to speak with a unified, coherent voice on fishery resource status and trend issues. Clearly, FAO is currently the only UN agency with adequate dedicated resources and professional staff with required experience and competence to handle this class of issues responsibly and consistently. The impending amalgamation of the LMR-GOOS Module with the Coastal and HOTO (Health of the Ocean) modules raises further concerns as to the potential for diffusion of UN focus and responsibility on LMR issues. It is very important that FAO be consulted and fully involved in these developments at the policy level as well as at the scientific level, in order that LMR-GOOS and FAO reach an effecting working relationship that can serve to benefit global living marine resources management. This matter requires substantial immediate attention. FAO continues to be committed to support of the development of the LMR-GOOS planning module though its projected "lifetime" (i.e., year 2000).

4. REPORTS ON INTERSESSIONAL WORK

A number of assignments were made at LMR-II for intersessional work, and panelists reported on progress.

4.1 LMR-GOOS CONTRIBUTIONS TO THE GOOS-IOS

At LMR-II, panelists were requested to identify ongoing programs that were consistent with the general principles of GOOS and with the approach of the LMR-GOOS panel. These programs would then be considered by LMR-III as candidates for the GOOS-IOS. The following programs were presented and discussed at LMR-III, and have been nominated by the panel as candidates for the IOS.

An additional project, The East Coast of North America Strategic Assessment Project (ECNASAP) was presented as a candidate for the IOS. ECNASAP provides an excellent example of the information and analytical capabilities required to support assessment of climatic and anthropogenic impacts on living marine resources from an international perspective. However, because data collection ceased in 1994, the project cannot be considered an existing observing system. Information on ECNASAP is included in Annex V, and ECNASAP will be considered as a potential model for the activities of the proposed Regional Analysis Centers.

4.1.1 California Cooperative Oceanic Fisheries Investigations (CalCOFI)

The California Cooperative Oceanic Fisheries Investigations (CalCOFI) is a collaboration of the Marine Life research Group of the Scripps Institution of Oceanography; the Coastal Fisheries Resources Division of the Southwest Fisheries Science Center, NMFS/NOAA; and the Marine Division, California Department of Fish and Game, Resources Agency. The program has routinely sampled the physical, chemical, and biological properties of the California Current System during the last 50 years. Recent data are available on the Web site, [http://www.mlrg.ucsd.edu/calcofi.html].

The sample pattern and suite of properties measured on the 'core' time-series cruises has changed several times over this period. Initially an extensive grid of stations from the tip of Baja California to beyond Cape Mendocino was covered monthly. From 1961 – 1965, sampling was quarterly, and between 1966 and 1985 it was at three-year intervals. Since 1985 the frequency of sampling has been quarterly and sampling has focused on the region between Point Conception and the U.S. border with Mexico. The sample grid covers 94,000 square miles with 66 stations spaced at 20 to 40 nautical mile intervals. Each station consists of a series of 3 net tows [oblique bongo, Manta (neuston) tow, vertical pairovet (fish egg) tow], a CTD-Rosette cast (continuous measurements of T, S, PAR, fluorescence, O_2, transmittance) and 20-24 10 liter rosette bottles are tripped in the upper 500 m for chemical determinations (S, 02, chlorophyll, nutrients). Primary production is measured once per day at the station coincident with local apparent noon. In addition to the station work, continuous measurements are made with ADCP (currents and backscatter), underway sampling system (T, S, chl-fluorescence, PAR), and the CUFES fish egg sampling system.

The CalCOFI hydrographic data are processed rapidly and are distributed in printed data reports and via the web (where the entire 50-year data set is available and can be searched). CalCOFI plankton samples are sorted by National Marine Fisheries Service (USA) for biomass and the abundance of fish eggs and larvae, and the data are curated there. The plankton samples for the entire 50-year time-series are stored at the Scripps Institution of Oceanography (USA) as part of the planktonic invertebrates collection where they are accessed by many researchers.

4.1.2 Ocean Station P and Line P

Ocean Station P (50^{o}00’N, 145^{o}00’W) was operated as an ocean weather station from 19 December, 1949 through 20 June, 1981. Initially, observations consisted of twice-daily bathythermograph casts, but in July 1956 hydrographic casts and plankton hauls were added, with sampling through alternate six-week periods. In April 1959, sampling was added on stations between the coast and Station P, on the track known as Line P, and the number of stations was increased to 12. The weathership program ended in the summer of 1981. Since then, observations at Station P and Line P are made 3 to 4 times a year by the staff of the Institute of Ocean Sciences.

Condutivity-Temperature-Depth (CTD) casts have been conducted at 26 stations on Line P since 1982. From 1992, hydrocasts are made at five of these stations, to measure dissolved oxygen, nitrate, phosphate, and silicate. Primary productivity, chlorophyll concentration, and zooplankton tows (vertical bongo) have also been taken. At Station P, primary productivity and POC have been measured and sediment traps used for approximately 20 years. Onboard analysis of nutrients has been done at Station P since 1987.

For further information, see Whitney, F.A. and H.J.Freeland. 1999. Variability in upper-ocean water properties in the NE Pacific Ocean. Deep-Sea Research II 46, 2351-2370; also [http://www.pac.dfo-mpo.gc.ca/sci/Pages/linep.htm].

4.1.3 Commission for the Conservation of Antarctic Marine Living Resources, CCAMLR

The Commission for the Conservation of Antarctic Marine Living Resources, CCAMLR, implemented its Ecosystem Monitoring Program (CEMP) from 1987. CEMP involves monitoring selected predator, prey, and environmental indicators of ecosystem performance in order to detect changes and to determine whether these changes are due to natural events or to resource harvesting activities. The core of the program is the acquisition, centralized storage and analysis of standardized monitoring data, along with empirical and modeling-based research. Since 1987, CEMP has collected data on six bird and seal species at 15 sites around the Antarctic. Up to 14 parameters of predator performance and 10 parameters of prey and environmental performance are collected at each site.

The program is described in the following publication: Agnew, D.J. 1997. The CCAMLR Ecosystem Monitoring Program. *Antarctic Science*, 9, 235-242. Further information is available on the Web site [http://www.ccamlr.org].

4.1.4 Program for Ocean Ecosystems Observing and Fisheries Change (ECOFISH)

Living marine resources are of significant importance to the economies of maritime nations such as Chile and to the well-being of their inhabitants. Furthermore, national investment in coastal and oceanic fishing is often significant.

In Chile, a program has been developed to provide information to better manage critical marine resources. The “Program for Ocean Ecosystems Observing and Fisheries Change (ECOFISH), implemented by the Fisheries Research Institute (FRI), has since 1990 provided a framework for gathering information on Chile’s marine systems (monitoring), generating derived products to detect the ecosystem changes and their effects on the large fisheries (modeling), and providing the necessary training (capacity building) to study the coastal upwelling ecosystems off the coast of Chile.

Applied fishery research conducted by FRI has focused on analysis of regional and local fisheries, and involves monitoring selected fisheries (e.g., horse mackerel, hake, sardine, anchovy, patagonian grenadier) and environmental indicators of their habitats. FRI has collected data on: fisheries Statistics (catch, effort) on a daily basis; length-frequency (daily); length-weight relationships; trophodynamics (weekly); fleet activity monitoring (daily); and ground fish monitoring (daily). FRI also analyzes SST and remotely-sensed meteorological information (daily), records wind, atmospheric pressure, temperature, and humidity at a local scale (hourly), and collects environmental information, e.g., oceanographic data (T, S, σ-t, DO and chl-*a* from CTD casts). FRI also collects phyto-, zoo- and ichthyoplankton samples on spawning and groundfish fishing areas using research and fishing vessels. This information is deposited in a central database. Standardized monitoring data are used for modeling-based research.

ECOFISH provides information that will allow:

- description of ecosystem changes time, particularly fluctuations in abundance and spatial distribution of fish resources;
- interpretation of observed changes in relation to factors such as natural environmental variability, anthropogenic climate changes, and fishing activities;
- forecast of future marine ecosystem states along the coast of Chile.

ECOFISH results have been used to improve the forecasting and predictive capabilities of principal regional fisheries, to provide precautionary criteria for environment conservation, to promote the sustainable use of the marine resources, and to improve long-term planning in the industrial fishing sector.

4.1.5 Japanese LMR observing system

The Japanese Fisheries Agency has been conducting monthly egg and larval surveys of target fish species during the main spawning season, combined with hydrographic observations and phytoplankton and zooplankton sampling, in cooperation with prefectural fisheries experimental stations since 1978. Coastal and offshore monitoring stations are made to assess egg production of the Japanese sardine, anchovy and mackerel off the southern coast of Japan. In addition to these monthly surveys, intensive surveys are carried out by the National Fisheries Research Institutes during the main spawning season (February to April), on an annual basis.

4.1.6 Korean LMR observing system

Since 1961, on a bimonthly basis, regular oceanographic surveys for water temperature, salinity, and DO have been made at each of 175 stations on 22 lines around the Korean coast, with surveys of nutrients and zooplankton made at every other station. After 1994 an additional two lines (315 and 316) and 26 stations were sampled four times a year, and after 1993 an additional one line (500) and 17 stations were sampled one or two times a year. Since 1967 air and water temperatures and meteorological parameters have been measured at 40 fixed stations.

NOAA satellite data have been received since 1989, and SeaWiFS satellite images have been received since 1997.

4.1.7 Alg@line

The following information was provided by Alg@line project coordinators.

The Finnish Institute of Marine research is carrying out operational monitoring of the Baltic Sea environment through a joint effort of research institutes and shipping companies through Alg@line. Alg@line is a forerunner in the field of monitoring research. Alg@line monitors the fluctuations in the Baltic Sea ecosystem in real-time using several approaches.

Alg@line combines studies onboard research vessels with high frequency automated sampling on several merchant ships, CPR transects, satellite imagery buoy recordings and traditional sampling in coastal waters. Ecosystem models are under development.

Without the high frequency observations from ships of opportunity, rapid fluctuations in the Baltic Sea ecosystem could not be monitored. Alg@line is the only research project which utilises the ship-of-opportunity technique in the monitoring of the state of the environment on this scale. Alg@line has analysers and sample collectors on five ships.

Unattended recordings and water sampling, including CPR tows, on board ships of the Silja Line and Transfennica are the basis of the system. Satellite imagery (NOAA/AVHRR) provides basin-wide information on the distribution of surface accumulations of blue-green algae and the temperature of surface waters. Aerial surveys by frontier guard pilots record visible blooms. Research vessels perform specific case studies. Buoys record fluctuations in environmental parameters of high temporal resolution at fixed positions. Analysis of water samples provides information on phyto- and zooplankton species composition and nutrient composition. Toxicity of blooms is also determined. The CPR to collects zooplankton from ships of opportunity.

Alg@line provides on-line information. The information based on the unattended recordings on the ships is available in real time at Web site “Alg@line Database”. The Alg@line Database provides information in Finnish, Swedish, Estonian and English. The Web address is [http://meri.fimr.fi].

Ecosystem models will be used to predict short and long-term changes for various parameters.

The main products are:

– weekly/daily reports on the state of the marine environment,
– annual assessments on the state of the marine environment,
– plankton species reports,
– long term and seasonal variation in plankton, nutrients, oxygen, etc.,
– taxonomic phytoplankton sheets,
– phytoplankton image gallery.

4.2 LMR-GOOS PILOT PROJECTS

4.2.1 CPR Tows in the Northeast Pacific

The MONITOR Task Team of the PICES Climate Change and Carrying Capacity (CCCC) program recommended that large scale measurments of zooplankton species composition and abundance be initiated in the NE Pacific. The CPR represented the best choice of instrument to sample now, since it has a proven record in the Atlantic and its sampling characteristics, although with some problems, are well known. In March 2000 a two-year sampling program will begin that will occupy two transects, as suggested by the Task Team. The first, from Prince William Sound, Alaska to Long Beach, California will be run five times a year, with approximately monthly spacing from March to August, and the second, a great circle route from Vancouver Island, Canada to the Bering Sea will be run once per year. The first line will sample Prince William Sound, the offshore region feeding the downwelling zone on the shelf, close to the centre of the Alaska Gyre (crossing Line P) and will intersect the CalCOFI grid off California. The second line will cross the first and also run parallel to Line P. In the short term this research will provide data on the structure of plankton variability along these lines and will be used to design a long-term zooplankton sampling program for the NE Pacific. This future program would reflect improvements in the technology avaliable to estimate plankton abundance and will enable the monitoring of climate change variability. PICES would like to see the CPR program as a Pilot Project within GOOS and would hope to work with GOOS to develop a long-term strategy.

4.2.2 The BENEFIT Program/Benguela Current Large Marine Ecosystem Program

The BENEFIT (Benguela Environment and Fisheries Interactions and Training) Program was initiated in 1998 after four years of planning. It is a cooperative initiative between Angola, Namibia and South Africa, supported by fisheries institutes in the three countries and with financial support from Norway, Germany, the African Development Bank, the FAO, Japan, France, Iceland and the World Bank with the following goals:

To develop the enhanced science capability required for optimal and sustainable utilisation of the Benguela System’s living resources by:

1. Improving knowledge and understanding of the dynamics of important commercial stocks, their environment, and linkages between environmental processes and stock dynamics.
2. Building appropriate human and material capacity for marine science and technology in the countries bordering the Benguela ecosystem.

A science plan and implementation plan have been compiled and the first research and monitoring projects have been started. Target species are hake, sardines, anchovy, horse mackerel, sardinella and rock lobster and the principal environmental parameters are temperature, winds, oxygen, zooplankton and top predators such as birds and seals. Transboundary issues, principal fish habitats and frontal zones are the initial focus of research and monitoring activities.

4.2.3 Biological Action Centers (BACs)

It is recognized that certain coastal regions, particularly those where different water masses are dynamically mixed, are far more productive than the open ocean. Even these highly productive coastal regions are not uniform. Some areas of smaller spatial scale stand out because of the higher abundance of most species at several trophic levels. This abundance demonstrates the relevant contribution of these small spots to the overall system productivity. Some of these areas sustain high levels biological activity throughout the full year, while in others this activity is seasonal.

Along the eastern boundary region of the North Pacific, within 160 km or less of the coast, biological activity is high in some relatively small areas. These areas are fixed in space because of coastal geography, and thus can be characterized as Biological Action Centers, or BACs. The high abundance of marine organisms found here at multiple trophic levels appears to be mostly a consequence of the increased concentration of primary producers.

BACs may represent an opportunity to improve the efficiency of LMR-GOOS sampling, by concentrating observations in these small areas of high biological activity. It is proposed that a pilot study be initiated to investigate BACs and their role in marine ecosystems. Specifically, the pilot project would: (1) identify existing BACs; (2) determine the extent to which observations in BACs can be extrapolated to surrounding areas; and (3) investigate the extent to which BACs provide an indication of climate change. Additional information is available in Annex III.

4.3 STATUS OF DATABASE INVESTIGATIONS

Successful implementation of LMR-GOOS will rely on the utilization of existing databases. Availability of fish databases is relatively well known, but for other ecosystem components, comprehensive datasets may not exist. LMR-II requested that panelists investigate the availability of biological datasets globally with respect to several ecosystem components: zooplankton, sea birds, sea turtles and marine mammals. The results are presented here. These datasets will be particularly useful to the Regional Analysis Centers which are envisioned to be the primary implementation mechanism for LMR-GOOS.

It was noted that recent technological developments may allow large biological datasets to be archived more easily than in the past. Several decades ago, ocean data centers decided not to archive biological data because such data were too diverse, not amenable to simple standardized data formats, too demanding in terms of accompanying qualitative information, etc. Some members of the Panel wondered whether, in view of the enormous recent strides in development of data movement and transformation tools and of metadata management systems (for enterprise-scale data warehouses supporting business intelligence systems, etc.), it might be useful to contact one or more technically qualified experts for advice as to whether advancing technology might have by now effectively overcome what a generation ago may have been viewed as an insurmountable problem.

4.3.1 Marine mammals

For pinnipeds, there are quite good population assessments for many species and populations while breeding on land or ice. However, except for the coastal or freshwater species, the distribution at sea when not breeding is generally poorly understood (and may vary quite a lot). The data on population census tends to be maintained by individual countries and quite often by institutes or even individual researchers. D. Bowen (Canada) and D. DeMaster (USA) could be contacted for meta-data on pinniped data sets around the world.

For cetaceans, there are few good population estimates (with CVs <0.2). The best distribution and density estimates are for US coastal, shelf and slope waters where there have been good surveys; for the Antarctic where the International Whaling Commission has coordinated surveys; for the Eastern Tropical Pacific where the Inter-American Tropical Tuna Commission (IATTC) has coordinated surveys along with the Americans; and for Icelandic and Norwegian waters where quite good surveys have been carried out. Experts in each of these organizations could be contacted for meta-data.

For much of the rest of the world there are no well-run surveys. Whaling data has some use for some species and some areas (ironically it is probably best for 19th century sperm, right and bowhead whaling as the whalers were free to go wherever they wanted and had no reason to falsify their records; in contrast modern whalers have been much more restricted and dishonest, so their data are less useful).

4.3.2 Sea turtles

(The following is a preliminary compilation of sea turtle databases, November 1999, submitted by George H. Balazs and R. Michael Laurs, U.S. National Marine Fisheries Service)

Considerable interest exists in the life history, ecology, conservation and management of sea turtles due to their threatened status, economic value and global distribution principally in tropical and sub-tropical waters. Meylan and Meylan (1999) provide an excellent overview as follows:

“Seven species of sea turtles representing two families, Cheloniidae and Dermochelyidae, are the only living members of what has been a large and diverse marine radiation of cryptodiran turtles. These seven species include the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp’s ridley (*Lepidochelys kempii*), olive ridley (*Lepidochelys olivacea*), flatback (*Natator depressus*), and leatherback (*Dermochelys coriacea*) turtles. An eighth species, the black turtle or East Pacific green turtle (*Chelonia agassizii*), is recognized by some biologists, but morphological, biochemical, and genetic data published to date are conflicting, and the black turtle is currently treated as belonging to *Chelonia mydas*.

Sea turtles inhabit every ocean basin, with representatives of some species found from the Arctic Circle to Tasmania. Hawksbills are perhaps the most confirmedly tropical of the sea turtles, whereas leatherbacks are known to make forays into colder, sometimes polar, waters. With the exception of Kemp’s ridley and flatback turtles, sea turtles are cosmopolitan in distribution. Kemp’s ridley is restricted principally to the Gulf of Mexico and the eastern seaboard of the United States, with some individuals occasionally found along the shores of the United Kingdom and western Europe. The flatback is endemic to the Australian continental shelf."

During the past two decades, the research of sea turtles has expanded and intensified to unexpected proportions resulting in an array of data and new biological information; for example, see Hirth, 1997. The growing and widespread computerization of these data has resulted in numerous structured, definable sea turtle databases (Briseno-Duenas and Abreu-Grobois, 1999). Most of these databases are founded upon the tagging of individual animals (Balazs, 1999), with accompanying morphometric, nesting and other detailed information. However, the incorporation of GIS data, telemetric data, and oceanic environmental data from satellites is becoming increasingly common.

It is estimated that as many as 100 formal databases may now exist worldwide. There is no easy way to rapidly locate all of these entities, but good progress has been made and details are available for 35 of the databases (contact Dr. Mike Laurs, NOAA/NMFS Honolulu Laboratory for further information). When completed, this project will be the first of its kind to assemble such information.

4.3.3 Sea birds

In considering possible changes in marine ecosystems, the top predators must be taken into account. Two specialists, George Hunt (University of California at Irvine) and John Piatt (U.S. Geological Survey in Seattle) were asked about the status of databases that could be used to assess changes in bird populations. Various data sets exist for pelagic seabird abundance and distribution for the North Atlantic and North Pacific, but none are easily accessible. A comprehensive database is under development for bird data from California to Alaska, including the Bering Sea. The British Antarctic Survey has included bird data in their BIOMASS database; other Antarctic data are archived in Hobart. A cooperative North Sea database that covers much of the ICES region is run out of Aberdeen by the Seabirds at Sea Group. There are Canadian databases for the coast of British Columbia and for off Newfoundland. Bird data are available for George's Bank, and there is an IUCN book and supplement on the distribution and size of seabird colonies worldwide. In summary, there are scattered large holdings of seabird data, but there has as yet been no success in assembling them in a comprehensive global meta-data base that could be used to assess changes in seabird populations.

4.3.4 Zooplankton

Zooplankton data sets are potentially complex, as they may involve large numbers of taxonomic categories, and in the case of groups such as copepods each species may be subdivided into up to twelve developmental stages. For this reason zooplankton data until recently have often not been deposited in, or accepted by, large oceanographic databases. Assembly of these dispersed data will present some problems for LMR-GOOS. Advances in database systems, and the increasing and widespread computerisation of zooplankton abundance data has resulted in numerous structured zooplankton databases many of which can be accessed through the internet.

A paper surveying plankton time series data is currently being compiled by Dr. Chris Reid of the Sir Alister Hardy Foundation for Ocean Science (SAHFOS). This work, when completed, should provide a valuable source of information on the location of zooplankton data sets. The results of this survey will be presented to the LMR Panel at its next meeting. In the survey, literature, citations describing zooplankton and phytoplankton time series have been grouped into geographical regions, and source information tabulated. Data sets which provide long-term (more than three years) and seasonal information are categorised. A preliminary conclusion of this work is that the vast majority of data sets are for coastal regions, and that the Southern Hemisphere is very poorly represented.

However, many historical records from past surveys and field programmes, in particular original data records, exist in paper copies but not in electronic formats, or only in outdated computer formats. These records generally reside with individual researchers and risk becoming lost as assignments change and personnel retire. The process of "data rescue" requires that appropriate editing and quality control procedures are implemented, and that "rescued" data themselves be made available to the wide international community. This activity can be fostered by the IOC GODAR (Global Oceanographic Data Archaeology and Rescue) project.

GLOBEC has a strong interest in zooplankton data sets, ongoing and planned, both as part of retrospective analysis and as the products of GLOBEC field programmes. GLOBEC will use a decentralised data management and distribution system. The centralised components (for example, centralised under the supervision of the International Project Office) will be a comprehensive inventory of GLOBEC and GLOBEC-like data holdings with pointers to the location and key contact person. It is likely that this activity will aid in the identification of zooplankton database information on an international scale. Within project (during the funded lifetime of GLOBEC programmes) data management and data exchange is viewed as a critical component of each national and regional GLOBEC program (see GLOBEC Implementation Plan, IGBP Report 47). This emphasis on data management should further the organisation of zooplankton databases in relation to LMR-GOOS. For example the US GLOBEC program has selected the Joint Global Ocean Flux (JGOFS) data management software (Flierl *et al*., http:/lake.mit.edu/datasys/jgsys/html). This provides a distributed, flexible, extensible and data-driven methodology to store and serve data and information about the data (metadata). The JGOFS system takes advantage of the hypertext transmission protocol (http) to exchange data between servers and clients. This enables the JGOFS system to use any UNIX or PC/Windows based computer as a server. Any networked computer system running a Web browser (such as Netscape or Internet Explorer) is a supported client and has access to the on-line data and information. It is not necessary to know where the data are stored to access it, rather the system takes care of automatically generating the necessary hypertext links on the Web page each time data is requested. For further information see, [http:/globec.whoi.edu].

In summary, zooplankton databases are relatively dispersed at present, and some significant data sets are probably not even in electronic form. However, advances in database systems together with some current database surveys, and international initiatives, shall result in much better interrogation and availability of zooplankton data in the future, to the potential benefit of LMR-GOOS.

4.4 FISH HABITAT REQUIREMENTS FOR LMR-GOOS AND C-GOOS– STATUS OF PLANNING

The LMR-GOOS and C-GOOS panels were charged by the GOOS Steering Committee to "identify 2-3 members who will form an *ad hoc* joint committee to address the issue of habitat loss from a fisheries perspective (i.e., incorporating into the C-GOOS design observations required to assess and predict the effects of habitat loss on the capacity of coastal systems to support fisheries)". In response, the LMR-GOOS panel appointed Mike Laurs and Bodo von Bodungen to the joint committee. The following statement reflects their initial views.

A key element in achieving sustainable fisheries is the identification, conservation, and restoration of fish habitat. Healthy habitat is a basic requirement for the reproduction, growth, migration, and livelihood of sustainable fishery stocks. Essential Fish Habitat (EFH) may be defined as those waters and substrate necessary for spawning, feeding or growth to maturity and includes the associated physical, chemical, and biological properties that are used by fish and are necessary to support a managed level of fish biomass production.

The management of commercial fishery resources has historically focused on single species and concentrated on assessing stock size and controlling fishing mortality. However, the EFH concept is based on an ecosystem approach to comprehensive fisheries management and includes the conservation and management of fishery habitat as important elements. However, for most species, present knowledge is poor about what habitat must be included in identifying EFH. Accurately delineating the EFH of a fishery species, or a particular life stage, will require detailed and comprehensive assessment of where these animals live along with the associated marine environmental conditions.

A sizable proportion of commercial coastal pelagic and demersal fish stocks are dependent at some stage of their lives on estuaries in addition to coastal waters. For example, estuarine wetland areas are EFH for many fishery species that live and spawn in coastal waters and have young that migrate into estuarine nursery grounds where they grow into subadults. The EFH characteristics for demersal fishery species in coastal and open ocean waters often include structure, hydrodynamics and general hydrology. The EFH for pelagic species in both the coastal and open ocean waters is often linked to dynamic oceanographic characteristics, features, processes, and structures. In tropical areas, coral reefs and related environments form EFH for many fishery resources. Anadramous fish species, such as salmon, have EFH requirements in marine waters, as well as, in freshwaters.

A key element in the EFH process is the identification of existing and potential threats to habitat, and the conservation and enhancement measures necessary to eliminate or minimize these threats. The nature and extent of particular threats to EFH will vary by region and usually depend on habitat type, exposure, and other environmental variables. Habitat degradation, e.g., destruction of wetlands, eutrophication, harmful algal blooms, and direct degradation or alteration of the environment, is a critical threat to EFH.

There is an immense opportunity for the GOOS program to make vital contributions to global fisheries management by providing marine environmental information essential to define and monitor EFH, as well as to eventually assess and predict the impacts of marine environmental variability on EFH.

4.5 LINKS TO CONVENTION SECRETARIATS

LMR-GOOS has been asked to interact with the secretariats of the Convention on Biological Diversity (CBD) and the Convention on Straddling Fish Stocks and Highly Migratory Fish Stocks to determine if they have information needs which LMR-GOOS could help meet. Informal consultations were held with the Secretariat of the Convention on Biological Diversity and with FAO for the Straddling Stocks Convention, for which there is not currently a Secretariat.

There is significant overlap between LMR-GOOS’ interests in biodiversity and the CBD’s information needs. Several ideas were suggested to incorporate consideration of biodiversity into the LMR strategic design. These include: establish reference areas (MPAs) to serve as baselines against which biodiversity changes could be measured; initiate surveys of seamounts which have high rates of species endemism and are being increasingly affected by trawling; and encourage development of biodiversity indicators (e.g. change in trophic structure. These approaches will be discussed with the CBD Secretariat).

FAO indicated that the information needs for the Convention on Straddling Stocks and Highly Migratory Species have not yet been identified, and that it would be best to consult with regional intergovernmental fisheries bodies (such as the North Atlantic Fisheries Organization (NAFO) as they would likely be charged with implementing the convention. Representatives of both conventions will be invited to the next meeting of the panel.

4.6 LMR ACTION ITEMS FROM GSC-II

The panel reviewed progress on actions requested by the second session of the GOOS Steering Committee.

ACTION 18: LMR panel (i) to get in touch with the Secretariat of the Biodiversity Convention, and the Convention office responsible for Straddling Stocks, and (ii) to consider sports fisheries and artisanal fisheries, so as to determine the requirements of these potential users.

Progress: (i) see section 4.5; (ii) Observations for sports and artisanal fisheries are included inherently in the observing program design. The LMR-III stakeholders meeting provided an opportunity for direct consultation with representatives of artisanal groups.

ACTION 21: LMR panel to expand its effort to include the fisheries of coastal seas (estuaries, sounds, seas).

Progress: The panel discussed the issue, and concluded that such an effort is beyond the scope of its expertise. A special panel should be formed in the future to develop requirements for a coastal fisheries observing system.

ACTION 22: LMR and Coastal panels to each identify 2-3 members who will form an *ad hoc* joint committee to address the issue of habitat loss from a fisheries perspective (i.e., incorporating into the C-GOOS design observations required to assess and predict the effects of habitat loss on the capacity of coastal systems to support fisheries).

Progress: see section 4.4.

ACTION 23: HOTO panel to take the lead on developing indices of stress and response status, starting by formulating guidelines for the identification and development of indices. LMR and Coastal panels report will assist in this process, starting by nominating two representatives each to participate in the GIPME indices workshop organised for November 1999.

Progress: Although LMR is interested in this topic, it was not possible for panelists to attend the GIPME indices workshop. The report of the GIPME meeting was not available in time for discussion at the LMR-III meeting.

ACTION 24: Coastal, LMR and HOTO panels to follow the schedule set out in agenda item 4.3.2 to develop a plan and timetable for the integration of HOTO, LMR and Coastal modules.
Progress: LMR is following an accelerated schedule to prepare for the merger, with meetings December 1999 and March 2000. A draft LMR implementation plan will be discussed at LMR-IV.

ACTION 29: (i) LMR to begin discussion with NEAR-GOOS about eventual broadening of NEAR-GOOS to incorporate LMR issues.

Progress: Representatives of NEAR-GOOS have been consulted, and NEAR-GOOS plans to incorporate some biological measurements into their delayed-mode database in the near future.

ACTION 51: All advisory panels should invite private sector representatives to work with them on GOOS design.

Progress: Private sector representatives attended, and provided input to, the LMR-III stakeholders meeting in December 1999. A further stakeholders meeting is planned for LMR-IV.

4.7 GLOBEC AND LMR-GOOS PILOT PROJECTS

LMR-GOOS and GLOBEC have established a Liaison Group to explore and develop opportunities for mutual support between LMR-GOOS and GLOBEC. The Liaison Group could identify the GLOBEC research that could be applied to the outputs of a monitoring system to transform them into useful products. For example, how can measures of ecosystem change, such as variations in zooplankton abundance, be linked in a predictive way to changes in abundance and distribution of fish stocks? The Liaison Group could also suggest ways whereby the monitoring system being considered by LMR-GOOS could include variables that would support GLOBEC research. It would also be useful for the group to evaluate the proposal from LMR-II, that LMR-GOOS and GLOBEC pursue joint pilot projects in areas where GLOBEC supports research. Such an approach could be mutually beneficial in that: 1. GLOBEC could conduct research that helps to identify important processes for routine monitoring and assessment; and 2. LMR-GOOS could help to operationalise the research conducted by GLOBEC.

4.8 CAPACITY BUILDING IN LMR-GOOS

A GOOS Capacity Building Panel has been formed and Dr. Kwame Koranteng will represent the LMR-GOOS panel. This panel will interact with the LMR panel regarding capacity building requirements.

4.9 GLOBAL OPPORTUNISTIC SAMPLING IN GOOS (GOSLING)

GOSLING is an approach that might allow a cost-effective way of assessing decadal scale variability in ocean basins. Hare and Mantua (1999) examined approximately 100 time series in the North Pacific and showed that biological time series, principally based on fish catch data, were inherently more stable than most climate variables and hence more likely to be useful in revealing interdecadal variability and regime shifts. However, catch data tend to show a lagged and slow response to climate signals and fishery effects are often confounded with those of environmental change. This suggests that somewhat lower trophic levels, not exploited directly by a fishery, could be used to track changes in the states of ecosystems, since they should show a rapid response to environmental change but still have some of the stability of the fish data. Rather than measure biomass of most of the community it might be most useful to follow distributions in time and space of a few selected indicator species. The CPR type of approach, utilising ships of opportunity acoss ocean basins might be the most promising and if the species selected were chosen according to the sampling characteristics of the device, then the limitations of the sampler (fixed depth for example) would not necessarily present a problem.

The Expandable Bathythermograph (XBT) SOOP program already utilises a network of shipping routes that cover most of the ocean basins of the world (see www.ifremer.fr/ird/soopip) and in effect the only region not well covered by shipping routes is the Southern Ocean. The "infrastructure" therefore already exists for this approach. Existing CPR data from the North Atlantic, the CalCOFI program and Line P time series present an opportunity to test this hypothesis and studies are underway to evaluate this concept.

4.10 DATA MANAGEMENT AND ANALYSIS

Regional Analysis Centers

The analysis of data resulting from the LMR components of GOOS will require bringing them together with relevant data from other sources in a description of the changing regional ecosystem of concern and of the processes causing the changes. The compilation and interpretation of data in a holistic analysis of an ecosystem is an essential element of a monitoring system. It is proposed that such analyses be made in regional analysis centers, where scientists of appropriate disciplines from participating countries would undertake the work. Work in these centers could also serve a central role in capacity building.

Such an analysis center would receive climate, oceanographic, and fisheries data from national and international sources and on a regular basis would prepare descriptions of the current state of the ecosystem and recent and longer term changes therein, including climate forcing, ocean physical conditions and circulation, and abundance and distribution of various biological components of the system. To the extent that available data and understanding of the system permitted, forecasts would be made of probable future conditions of these same ecosystem components. The products of the now-casting and forecasting analyses would be regularly provided to participating countries and organizations and would be made widely available on the Web. Results of the analyses would also be used for improving the observational system.

As a first step in the development of regional analysis centers, it was proposed to request the GFCM, ICES, HELCOM, PICES, and the Benguela LME program to initiate discussions of design and possible implementation of such centers in their regions of interest. These discussions should include assessment of present exchange arrangements for climate, oceanographic, and fisheries data relating to those regions.

4.11 RETROSPECTIVE EXPERIMENTS

Retrospective experiments were proposed during the first meeting of the panel whereby the concept of monitoring, analysis, and prediction could be tested in several well-sampled regions. Detailed descriptions of two of these experiments, in the southern part of the California Current region and on the eastern Scotia Shelf, are included in the report of LMR-II. A joint Korea-Japan project in the East Sea/Japan Sea and East China Sea will be initiated in September 2000.

The utility of this approach had been demonstrated, and it should be incorporated in the design studies for regional monitoring systems as they are developed. Such studies can be conducted at the national level and would also be an appropriate function for regional analysis centers.

5. FINAL LMR-GOOS DESIGN STRATEGY

The panel discussed the general approach to be taken in developing the final LMR-GOOS design strategy. Significant progress has been made by the panel in defining the generic observations that should be made globally and regionally by LMR-GOOS. The Alpha and Beta tables produced by LMR-II provide a set of possible observations and products that might form the basis of regional LMR-GOOS observing systems. Retrospective studies have in a sense 'ground-truthed' the generic regional observing approach by indicating how comprehensive ecosystem-based observing programs have successfully provided information required for resource management. These retrospective studies also have shown the importance of research, namely process studies and retrospective analyses, as a means to identify critical observations.

Recognizing that observations in coastal areas will necessarily be more spatially and temporally frequent than those in the open ocean, the panel developed a "Three-system approach" which concentrates observations in coastal areas and relies on remote sensing and ships of opportunity to sample the open ocean. This system, and the panel's strategic design outline, is presented below.

5.1 THREE-SYSTEM APPROACH

Monitoring systems for the open ocean, the coastal ocean, and inshore will differ significantly in the frequency of observations in time and space and to some extent in the variables observed. These differences will reflect the nature of the time and space gradients of these properties as well as the uses to which the data will be put. In order to obtain a useful description of the variability, sampling frequency will normally increase in passing from the open ocean to the inshore. While the physical variables of interest will be much the same offshore and inshore, the numbers and types of necessary biological observations will also increase towards inshore.

The demand for products, and hence the funding, of monitoring systems can also be expected to be greatest inshore. Therefore, it seems appropriate to speak in general terms of three nested monitoring systems. The open ocean system extends shoreward to where presence of the coastal boundary is felt, generally to the edge of the continental shelf. The coastal ocean system then extends from there to the inshore system where terrestrial influences tend to dominate. These boundaries fall roughly at about 200 miles and about 3 miles from the land-sea boundary. Note that continuity in space between observations can be provided in two dimensions by remote sensing and in one dimension by underway recording or by towed devices. At fixed locations, continuity in time can be provided by recording devices.

In all monitoring systems for LMR purposes, there is a need for information on the atmospheric forcing, ocean velocity field, and distributions of temperature and salinity at the surface and in the surface layer. Such information is also required for monitoring of ocean climate and health of the ocean. In addition, biological studies also utilize information on the distributions of dissolved oxygen and of nutrient substances such as inorganic compounds of nitrogen, phosphorus, silicon, and iron. For assessment of living marine resources, a case might be made for quantitative sampling at all trophic levels from bacteria to whales. The problem is to select from these possibilities the most cost-effective suite of observations that will yield information of direct value to users of living marine resources.

5.1.1 Open Ocean Observing Plan

An ocean basin would be overflown by satellites measuring sea surface height, winds, temperature, and ocean color. Surface weather would be reported by voluntary observing ships reporting to the network. On transects selected to cross major features of circulation or of changes in properties (e.g., ocean fronts), selected merchant and research ships would tow plankton recorders and drop expendable bathythermographs (XBTs) at appropriate intervals (e.g., hourly). In a minimal system, other ecosystem components and conditions would be observed as follows:

Top predators: irregular, reported by observers on fishing and research vessels
Commercial finfish: irregular, reported by fishing and research vessels
Pelagic forage: irregular, reported by fishing and research vessels
Benthos: not observed
Zooplankton: irregular, reported by research vessels
Phytoplankton: irregular, reported by research vessels
Nutrient chemistry: irregular, reported by research vessels
Salinity, dissolved oxygen: irregular, reported by research vessels

A composite picture at quarterly intervals could be built on the framework provided by the satellite data and transect observations, with the irregular biological data inserted where applicable. This analysis, which would provide the basis for elaboration of useful products, would be made at appropriate basin-scale regional analysis centers.

5.1.2 Coastal ocean observing plan

Different sampling patterns will be required in different regions of the coastal ocean. In addition to the open ocean observations, but at selected locations with closer spacing and more frequent observations, other observations would be made. Minimal monitoring plans for selected regions have been developed for illustrative purposes. These regions include eastern boundary current upwelling systems, the Yellow Sea and East China Sea and the Scotian Shelf (see section 5.3).

5.1.3 Inshore observing plan

In view of the heterogeneity and complexity of inshore systems and the lack of specialists in inshore studies at the present meeting, it was decided to recommend establishment of a small working group of inshore experts in cooperation with C-GOOS to explore the development of inshore observing plans.

5.2 DRAFT OUTLINE

The panel agreed to the following draft outline of the strategic plan.

LMR-GOOS STRATEGIC DESIGN – DRAFT OUTLINE

1. Conceptual approach
   - 1.1 Three-system approach (open ocean/coastal ocean/inshore) – can't use standard global approach because of differences in observing system cost/feasibility between open ocean and coastal ecosystems.
   - 1.2 Ecosystems approach – observations must be interdisciplinary and holistic.
   - 1.3 Regional approach – diversity of global marine ecosystems precludes a 'one size fits all' solution.
   - 1.4 Role of research – process studies, life-history studies, retrospective studies, modeling and others help identify observations which should be made routinely, etc.
   - 1.5 Importance of fisheries and why this should be a central focus of the module.
   - 1.6 Design principles
2. Observing system elements
   - 2.1 Open ocean system
     - 2.1.1 approach (cost/feasibility limitations and need for opportunistic sampling)
     - 2.1.2 alpha and beta tables
     - 2.1.3 discussion
   - 2.2 Coastal ocean system
     - 2.2.1 approach (more comprehensive observations feasible; regional ecosystem differences)
     - 2.2.2 alpha and beta tables and discussion
     - 2.2.3 regional examples and tables
       - 2.2.3.1 Eastern Boundary Current Upwelling
       - 2.2.3.2 Yellow Sea/East China Sea
       - 2.2.3.3 Scotian shelf
       - 2.2.3.4 Gulf of Guinea
     - 2.2.4 regional analytical centers
   - 2.3 Inshore/coastal fisheries system
3. Benefits and products
4. Capacity Building approach
5. Data and information management plan
6. Pilot projects/IOS to operationalize the system

5.3 REGIONAL OBSERVING PLANS

Working groups were convened to further develop regional observing plans. For selected regions, working groups were asked to describe minimal initial monitoring plans, consistent with the alpha and beta tables, to provide information, on changes in physical conditions and ecosystem components required for now-casting, and eventual forecasting of the state of the ecosystem and its living resources. The plans should use existing methods to the extent possible and appropriate sampling frequencies in space and time should be suggested. The plans should be practicable, cost-effective and within the capabilities of those concerned with living marine resources in the region.

- <u>Eastern boundary current systems</u>: Bakun, Hutchings, Arcos
- <u>Yellow Sea/East China Sea</u>: Sugimoto, Zhang
- <u>Scotian Shelf</u>: Zwanenberg
- <u>Open ocean</u>: Laurs

Drafts of these plans are included in Annex IV.

6. STAKEHOLDERS MEETING

The meeting was held at the Fisheries Research Institute, Talcahuano. Warren Wooster and Dagoberto Arcos welcomed the participants and Dr. Arcos made a brief presentation on the general goals of GOOS and the status of LMR-GOOS. Dr. Rodrigo Núñez, representative of National Chilean Oceanography Committee (CONA), gave a presentation of the status of GOOS-Chile.

Subsequent discussion yielded the following recommendations from the stakeholders and the LMR panel members.

RECOMMENDATIONS

1. To establish an official network of institutions to collect and disseminate the existing data which are relevant to GOOS.
2. To involve more researchers along the Chilean coast in monitoring.
3. To investigate Biological Action Centers in the Southeastern Pacific Ocean off the coasts of Colombia, Ecuador, Perú and Chile.
4. To involve regional political association such as CPPS (Comisión Permanente del Pacífico Sur).
5. To involve more stakeholders within the national fisheries industries, govermental and non-governmental organizations.
6. To standardize measurements (quantity and quality).

The following Chilean institutions were represented in the meeting:

- UnderSecretariat of Fisheries
- National Marine Fisheries Service
- National Fisheries Commission
- Regional Fishery Association
- Chilean Marine Research Association
- National Oceanographic Committee
- Fish Meal Industry

Participants included:

NAME	INSTITUTION
Tomás Contreras Vergara	Director, Zonal Fisheries Council (V-IZ Regions)
Margarita Díaz	National Fisheries Service
Rafael Mackay Backler	Director, Navy Hydrographic and Oceanographic Service
Rodrigo Núñez Gundlach	Oceanography Dept. Head, Navy Hydrographic and Oceanographic Service
Ramón Ahumada Bermúdez	President, Chilean Society of Marine Science
Raúl Becerra Huencho	Zonal Fisheries Council (V-IX Regions).
Juan Montenegro Salgado	Zonal Fisheries Council (V-IX Regions).
Klaus Stengel M.	Manager of Bíobío Ltda. Fish Meal Industry
Raimundo Gallego	IG-Mar S.A. Fish Meal Industry
Luis Felipe Moncada	Manager, Fish Meal Industrials Association
Marcelo Lupechini	Camanchaca S. A. Fish Meal Industry

7. PROPOSED LMR, COASTAL AND HOTO PANELS MERGER MEETING, AND DEVELOPMENT OF AN LMR-GOOS IMPLEMENTATION PLAN

The panel was informed that once the strategic design plans have been completed, the LMR-GOOS, C-GOOS and HOTO-GOOS panels will be merged into a single panel. This meeting is anticipated to occur in late 2000.

The LMR-GOOS, HOTO-GOOS and C-GOOS panels will develop a joint implementation plan, the framework for which will be developed at a meeting of the panel chairs in April 2000. Discussion of the LMR-GOOS implementation strategy was deferred until LMR-GOOS-IV, which will be held after this framework has been developed.

8. NEXT STEPS

The panel agreed to the following actions:

Action 1: LMR-GOOS and GLOBEC establish a Liaison Group to explore and develop opportunities for mutual support between LMR-GOOS and GLOBEC. Larry Hutchings, Mike Sinclair, and Takashige Sugimoto will represent LMR-GOOS on the group (see section 4.7).

Action 2: LMR-GOOS Co-Chair (Wooster) submits to GSC the following on-going monitoring programs as nominations for the IOS: CalCOFI, CCAMLR, Ocean Station P/Line P, Japan and Korean survey of observing systems, ECOFISH (Chile), and Alg@line (see section 4.1).

Action 3: LMR-GOOS Technical Secretary includes the following as pilot projects in the report of LMR-GOOS-III: BACs (Mexico and eastern boundary current systems), North Pacific CPR Survey, Benguela Current LME (see section 4.2).

Action 4: Noting the need for meta-data bases for sea birds and marine mammals: (1) Canadian LMR-GOOS panelist will obtain information on relevant activities of the IWC concerning large whales; (2) LMR Co-Chair (Wooster) will request Hunt and Piatt to develop a proposal for such a database for sea birds; (3) LMR Co-Chair (Wooster) will ask Bowen and DeMaster to develop a proposal for a pinniped database; (4) all LMR-GOOS panelists will identify appropriate experts to develop a proposal for a database for small cetaceans; and (5). Roger Harris will bring the question of zooplankton databases to the attention of the ICES/PICES zooplankton workshop (see section 4.3).

Action 5: Technical Secretary to arrange consultation with FAO regarding FAO’s role in implementation of LMR-GOOS.

Action 6: Technical Secretary to contact FAO regarding FAO sending ‘policy level’ representative to LMR-IV.

Action 7: Panel to contact technically qualified database experts for advice as to whether advancing technology has overcome problems with archiving large, complex biological databases.

Action 8: Technical Secretary to invite a representative of the Convention on Biological Diversity to LMR-IV.

Action 9: Co-Chairs to request that GFCM, ICES, HELCOM, PICES, and the Benguela LME program initiate discussions of design and possible implementation of Regional Analysis Centers in their regions of interest. These discussions should include assessment of present exchange arrangements for climate, oceanographic, and fisheries data relating to those regions.

Action 10: GSC to consider establishing a panel specifically to develop a coastal fisheries plan for GOOS.

Action 11: LMR-GOOS representative to the GOOS Capacity Building Panel (Koranteng) should bring the GOOS Capacity Building Plan to the LMR-GOOS panel's attention as soon as possible.

9. THANKS AND ACKNOWLEDGEMENTS

The panel thanked Dagoberto Arcos for his generous hospitality and that of INPESCA in helping to make the meeting both enjoyable and successful.

10. NEXT MEETING

The panel's next meeting will be held at the U.S. National Marine Fisheries Service Honolulu Laboratory, Honolulu, Hawaii in May 2000.

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ANNEX I

AGENDA

Wednesday, 8 December

1. Welcome – Arcos
2. Opening Remarks – Wooster and Arcos
3. Objectives of the meeting – Wooster [1. Draft/finalize the strategic design plan for LMR-GOOS; 2. outline the implementation plan; 3. develop an intersessional work plan to complete the draft implementation plan before the next meeting]
4. Working Arrangements – Cyr/Arcos
5. Reports on relevant activities
   Status of GOOS planning overall, including IOCCG – Cyr
   C-GOOS– Malone or rep
   HOTO-GOOS– Knap or rep
   ICES – Sinclair
   PICES – Wooster or PICES rep
   SAHFOS – Batten
   GLOBEC – Harris
   IOC (including survey of observing systems and LMEs) – Cyr
   FAO meta-assessment and FIGIS - Bakun
6. Reports on intersessional work
   6.1 LMR-GOOS pilot projects and contributions to the GOOS IOS – all fisheries-independent assessment surveys as contributions to LMR-GOOS
   6.2 Status of database investigations
       marine mammals - Sinclair
       sea turtles - Laurs
       sea birds - Wooster
       Japanese databases - Sugimoto
       zooplankton - Harris
       results of IOC survey of observing programs – Cyr
   6.3 Fish habitat requirements for LMR and CGOOS, status of planning – Laurs and Von Bodungen
   6.4 Coastal Fisheries requirements for LMR-GOOS – all

Thursday, 9 December

6. Reports on intersessional work (Continued)
   6.5 Links to convention secretariats – Cyr
   6.6 LMR action items from GSC-II
   6.7 GLOBEC and LMR-GOOS, Pilot projects – Sinclair
   6.8 Capacity building final plan – Koranteng introduces
   6.9 Global Opportunistic Sampling in GOOS (GOSLING), an overview – Batten
   6.10 Data analysis and management – all
   6.11 Retrospective experiments - all
7. Final LMR-GOOS design strategy
   7.1 Introduction to three-system approach – Wooster
       7.1.1 Open ocean observing plan – Wooster
       7.1.2 Coastal ocean observing plan – all
       7.1.3 Inshore observing plan – Wooster
8. Stakeholders meeting

Friday, 10 December (half day, afternoon)

7. Final LMR-GOOS Design Strategy (continued)
   - 7.2 Other elements
     - 7.2.1 Capacity building
     - 7.2.2 Research
     - 7.2.3 Modeling
   - 7.3 Next steps to finalize plan

Saturday, 11 December (half day, morning)

8. Implementation plan development – all
9. Proposed LMR, CGOOS, HOTO integration meeting – status and how to prepare
10. Next steps

ANNEX II

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ANNEX III

BIOLOGICAL ACTION CENTERS (BACs)
A Pilot Project Proposal

Introduction

GOOS will develop monitoring systems fundamental to the forecast of changes and their consequences in the ocean. Such monitoring systems should minimize cost and effort, work on as near to a real-time basis as possible, and support prediction of future ecosystem states.

These are difficult tasks, given the enormous size of oceans, the multiple scales of change and the unequal scientific capacity of the various countries. Some space technological developments permit global coverage at low cost and extremely efficient time lag; this is the case, for instance, for global sea level, sea surface temperature and ocean color. Other advances, such as moored buoys, electronic and optical devices, allow for extensive and intensive measurements in very short times, with little or no after processing.

Remote sensing technology may help solve GOOS’ challenge to provide basin-scale synoptic measurements of physical and some chemical variables. However, living resources monitoring remains problematic. Most of marine biology (particularly fisheries science) has proceeded on a population-based approach. However it has become clear that this is insufficient, and many efforts to develop a more holistic approach are now well under way. Unfortunately, little has been done to date to serve as a solid foundation for a monitoring system.

The BACs project has the potential to serve as a strategy for living marine resource monitoring in major ocean areas, at a very reasonable cost and with a comparatively short term implementation time.

The BAC concept

It is recognized that parts of the global ocean are very productive compared to the vast majority of the upper layer of the sea. Neritic regions, particularly those where different water masses are dynamically mixed, are far more productive than the open ocean.

Even these highly productive coastal regions are not uniform. Some areas of smaller spatial scale stand out because of the higher abundance of most species at several trophic levels. This abundance demonstrates the relevant contribution of these small spots to the overall system productivity. Some of these areas sustain high levels of biological activity throughout the full year, while in others this activity is seasonal.

Along the eastern boundary region of the North Pacific, within 100 miles or less of the coast, biological activity exhibit some relatively small areas, fixed in space because of coastal geography, exhibit high rates of biological activity; these can be characterized as Biological Action Centers, or BACs. These multi levelled high abundance associations appear to be mostly a consequence of the increased concentration of primary producers in localized, coastally-fixed spots.

At least some BACs have higher biological concentrations all the time, and since both wind and current regimes are variable within the year, this may suggest that there are topographical features that permanently favor enrichment in small coastal spots, either through upwelling, tidal fronts or other. Increased availability of primary productivity results in elevated abundance of higher trophic level organisms in the vicinity.

Because of their large contribution to the productivity of the total area, they vary in similar fashion to it. Where it has been tested, the predictability of the total coastal area by extrapolating BACs information is high and always significant; this is particularly important if one considers that they are only about 1% of the total area. Because they concentrate not only *in situ* growing organisms (as phytoplankton and zooplankton), but also other higher trophic level species for feeding and spawning, BACs contain concentrated information on space and time variations of some components that may be useful for monitoring.

Beyond their potential utility as monitoring subjects, BACs are unique areas vital to sustaining commercial and recreational fisheries as well as the structure and productivity of marine ecosystems. Enhanced understanding of their function and response to climate changes can have important consequences for the rational use of marine living resources and thereby generate important benefits for society. In particular, their study can assist in developing management approaches based on ecosystem principles, use of multi species management models, and thus can improve the effectiveness of fishery monitoring and research. They may also serve as important indicators of the health of the marine environment and fish populations.

These areas are particularly well fit for comparative studies; one way or another they hold larger biomass than the rest, so there must be at least some common mechanisms involved**.** However, it is also clear that they are not equal.

BACs project strategy

The project is at present an informal, multi institutional initiative for the study of Biological Action Centers along the Pacific coast of North America. BACs included are the Eastern Bering Sea, Shelikov strait, the west coast of Vancouver Island, the Mouth of the Columbia River, Monterey Bay, the Santa Barbara Channel, Punta Eugenia, Gulf of Ulloa, Ballenas Channel and the Gulf of Papagayo. The institutions involved include the Alaska Fisheries Science Center (USA), the Institute for Ocean Science (Canada), University of Washington (USA), Northwest Fisheries Science Center (Oregon, USA), Monterey Bay Aquarium Research Institute (USA), University of Southern California (USA), Instituto Nacional de la Pesca (INP, México), Centro de Investigación Científica y Enseñanza Superior de Ensenada (CICESE, México), Centro de Investigaciones Biológicas del Noroeste (CIBNOR, México), Centro Interdisciplinario de Ciencias Marinas (CICIMAR, México) Departamento de Investigación Científica de la Universidad de Sonora (DICTUS, México), Universidad Nacional Autónoma de México (UNAM, México) and Centro de Investigaciones Marinas de la Universidad de Costa Rica (CIMAR, Costa Rica).

The common objective for the full project is unveiling the structure and functioning of these key small areas which stand out as high biological activity centers from the general coastal areas. Then, by comparison, determine the common characteristics and key features that result in their outstanding features and the manner in which they respond to the different scales of climate change (seasonal, interannual -including ENSO and decadal frequencies- and secular trends).

While there is a sizeable amount of information on some BACs (particularly those in the US and Canada), others will have to be studied to gain equivalent insight. Information should be gathered on the location and general dimensions of each BAC being investigated as well as on the following characteristics which may distinguish it from the neighboring environment:

1. The physical features and mechanisms that lead to their existence.
2. Time-dependent changes in key physical processes, on seasonal to centennial scales.
3. Distinguishing characteristics of the BAC ecosystem at all trophic levels and their changes with time.
4. Characteristics of the associated fishery systems and how they change over time.
5. Associated consequences of change in the structure and function of BAC systems caused by the complete spectrum of human social, cultural, and economic activities.

These features will differ among BACs. Consequently, a comparative study of different BACs will expand our understanding on the origins and dynamics of such systems.

A pilot project for LMR-GOOS

It is recognized that GOOS is not a funding agency, and no support for the project should be expected. Although the ongoing effort is yet unfunded, there are a number of actions that could be taken to examine the potential utility of the BAC concept as a monitoring strategy. If adopted as a potential pilot project, it would gain position and searching for appropriate full financing would become much more feasible. Of course, if it proves its potential this would improve further. For instance, a number of LME projects are in the implementation process; if proven useful for the purposes of monitoring, the BAC concept could be applied widely.

Specifically, there are three lines that could be pursued:

1. *Identification of BACs:* In our original project, we decided on pointing at a number of BACs on the basis of each of the participants experience, but this may not be the case in other areas where research has not been that much intensive. Later, we found that BACs (at least in the southern portion of the California Current) are distinguishable through detecting small spots of higher pigment concentrations, readily detectable in CZCS imagery.

At first glance, this would seem feasible for tropical and subtropical BACs because of the considerable difference with the surrounding region, but this may not be the case for the temperate-cold areas. This would mean the possibility of detecting BACs in less studied areas. The strategy could be based on looking at satellite data and consulting with appropriate scientists from the group.

2. *The extrapolating capacity of BACs:* Again at the southern California Current region, BACs are quite well correlated to the total coastal area in a number of characteristics (for instance, pigment, egg and larvae abundance, etc.). This derives in part from the fact that they hold unusually large concentrations, that make a sizeable part of the total. The issue is critical to the potential utility of BACs.

3. *Detecting climate change in BACs:* Preliminary analysis have yielded some interesting results in this respect, particularly looking at time series of the number of species of fish larvae in various BACs. This matter will require much more attention, but seems quite feasible on a short-term basis for areas with available data series.

Preliminary but indicative results could be available after one to two years, during which specific projects could be designed to be incorporated *as part of normal sampling programs*, including those strategies designed by the Panel. Very little extra effort would be needed to make BAC monitoring projects fully operational.

ANNEX IV

REGIONAL OBSERVING PLANS

1. Monitoring of the Scotian shelf ecosystems – Kees Zwanenburg

The following are some thought on how the ecosystems of the Scotian shelf should be monitored as ecosystems. They assume that present monitoring activities, especially the seasonal research vessel surveys will operate at least the same or at some increased level of activity. At present DFO runs three synoptic surveys of the demersal fishes of the Scotian shelf. These surveys occupy a total of several hundred stations on the shelf (about 200,000 square km). In addition to enumeration, biomass, size composition, and some reproductive information for many fish species, these surveys collect physical data (T/S) at all stations. Detailed descriptions of existing monitoring activities exist and will be incorporated into future versions.

Canada's Oceans Act calls for a scientific perspective on conservation objectives. Fisheries, and other activities within marine ecosystems, now need to be evaluated in relation to properties of the ecosystem as well as the dynamics of the target species. A workshop to develop objectives, performance measures, and reference points for the inclusion of ecosystem considerations in the management of human activities in the Scotian shelf is planned for March of 2000. Although the specific ecosystem objectives are the subject of the workshop, they will contain reference to biodiversity and habitat productivity as overarching principles. Such principles have implications for monitoring activities. These thought may provide some points of discussion.

<u>General Principles</u>

Monitoring of the Scotian shelf should be as comprehensive as feasible. It should include both physical and biological measurements at temporal and spatial scales sufficient to detect both seasonal and annual changes.

Physical (and biological?) oceanographic measurements could be accomplished by a combination of moored samplers augmented with activities on sea-going platforms (research vessel and fishing industry vessels).

Temperature and salinity of the slope water along the Scotian shelf should be monitored at a spatial scale and temporal rate sufficient to detect the presence of and estimate the rate of incursion of Labrador type water onto the shelf. Such incursions are implicated in cooling events with concurrent biological effects.

The rate of influx from the Gulf of St. Lawrence onto the eastern Scotian shelf must be monitored. Again the rate of this influx is implicated in cooling events.

Given the absence of operational linkages between primary, zooplankton, production at higher trophic levels, it is difficult to be prescriptive about sampling. A reasonable initial step might be to obtain synoptic seasonal estimates of zooplankton production at spatial and temporal scales equivalent to those presently used for fish surveys.

Estimates of primary production may be available through analysis of ocean color data. If this is not the case, the preceding principle could be applied.

Present fish survey methods should be modified, or augmented so that they give estimate of "forage species" abundance (i.e. sand lance).

Surveys specifically designed to estimate the abundance of small pelagic species (herring and mackerel) should be considered. These species form a large part of the fish biomass of these ecosystems and are poorly estimated.

Seasonal surveys must be maintained or augmented.

Benthic macro-invertebrates, which form an important part of the shelf ecosystem (i.e. prey for many of the fish species), and for which no synoptic surveys have been carried out, should be monitored. The spatial and temporal scales of such monitoring remains to be determined.

The total removals of fish and other organisms from the Scotian shelf must be monitored. Landings information for commercial fish and invertebrates exist, however, discards and by-catches of non-commercial species are not recorded. As an initial step, detailed records of by-catch and discards could be maintained for all vessels where fisheries observers are deployed.

All monitoring information (both physical and biological) should be presented and interpreted in the context of similar data for adjacent systems (Labrador shelf, Georges Bank, Gulf of Maine). This requires, *inter alia*, establishment of linkages (including data exchange protocols and data products) with responsible agencies in the adjacent systems.

The principle of "piggy-backing" should be adopted. This states that sea-based monitoring platforms, especially research vessels, should be multi-tasked. Fish surveys should collect physical and biological oceanographic information at appropriate spatial scales.

The principle of complete enumeration and identification of organisms sampled for biological oceanographic, fish, and benthic invertebrate surveys should be adopted. This seems essential given the principle of maintaining biodiversity.

2. **Yellow Sea and East China Sea -** Chang Ik Zhang and Takashige Sugimoto

A. Minimal Initial Monitoring Requirements

1) Oceanographic and Atmospheric Information

The oceanographic and atmospheric information for the Yellow Sea and the East China Sea could be collected by observations at coastal stations, by regular oceanographic cruises using research and fishing vessels, and by receiving satellite information for SST and ocean color. The minimal initial monitoring requirements are listed as follows:

- Air and sea temperatures
- Salinity
- Wind stress
- Nutrients
- Currents
- Chlorophyll-a
- Phytoplankton: species composition, distribution, abundance and biomass
- Zooplankton: species composition, distribution, abundance and biomass
- Primary and secondary production (if possible)

2) Fisheries and Fish Biological Information

The fisheries data for commercially important species required to construct a historic time-series should be collected. The minimum data needed for each fish species are as follows:

- Catch in weight or in number
- Catch per unit of effort (CPUE)
- By-catches and discards
- Length measurements
- Weight and sex of individuals
- Otoliths or any other ageing characters
- Gonad samples
- Stomach samples
- Egg and larvae samples
- General biological data for predators

This basic data are used to estimate the following items:

- Length frequency distribution
- Standardized effective fishing effort
- Length-weight relationship
- Age structure
- Abundance or biomass estimation
- Unit stock identification
- Standard stock assessment
- Community structure

B. Existing Methods

Currently, regular oceanographic surveys are satisfactorily conducted in the Yellow Sea and the East China Sea by Korea and Japan. The surveys include temperature, salinity, DO, and phytoplankton at the surface, 20m, 50m, and the bottom layer on a bimonthly basis. Also, surveys of nutrients and zooplankton have been conducted.

However, there are no regular fishery-independent surveys for finfish and shellfish species in this region. Some irregular surveys are conducted by each country for targeting some important commercial species such as three years' demersal fish surveys in the East China Sea by Korea, pelagic fish surveys by Japan, acoustic and bottom trawl surveys by China.

The total removals of fish and other organisms from this region are currently monitored by each country, although the quality of catch data is different by nation. Landings for commercial finfish and shellfish are recorded or reported to each governmental agency, however, discards and by-catches of non-commercial species are not always reported.

C. Appropriate Sampling Frequencies in Space and Time

Fishery-independent surveys of commercial finfish and blue crab should be conducted annually. Especially, during spawning season for commercially important species, data on sea temperature, salinity, phytoplankton and zooplankton are desirable to be obtained monthly in order to study the mechanisms of the recruitment process in early life stages.

Data for estimating abundance of top predators such as birds, seals, dolphins and whales, sharks, tuna should be collected on a yearly basis.

Records of discards and by-catches should be collected, but as an initial step, detailed data of discards and by-catches could be obtained from some sample vessels through observer programs or special surveys on board.

For other categories, the existing methods above could be maintained continuously. Higher-level stock assessments that combined with marine environmental factors would be possibly available by strengthening monitoring efforts mentioned above.

3. Coastal Fisheries in Upwelling Systems: Requirements for LMR-GOOS – Dagoberto Arcos, Larry Hutchings and Andy Bakun

A: INTRODUCTION

Physical Features

Eastern Boundary Systems are elongate systems where cool waters extend into tropical and subtropical waters on the western side of continents and are generally the region of highest productivity in the particular ocean basin. Despite considerable exchanges across their boundaries, they are regarded as distinct ecosystems characterized by high physical and biological variability at all time scales. The high fish yields, abundance of top predators and influence on climate make them extremely important to the economies of coastal states and target areas for monitoring to be selected as part of the GOOS program. The enrichment process is driven by wind-induced upwelling and so is highly variable and subject to large-scale changes in the medium and long term in response to climate change. The open boundary nature of these systems make them sensitive to basin scale variability and intrusions of warm and cool water shift boundaries at the extremities. In addition oceanic water may intrude close to the coast during periods of wind relaxations, considerably altering the habitat range and productivity of the living marine resources.

Dominant Biological Resources

Typically, upwelling systems are dominated by a few species of small schooling pelagic fish, such as sardines, anchovy and jack mackerel. These planktivorous fish feed low down in the trophic foodweb and are subject to extremes in population strength, with marked influences both on lower and higher levels in the food chain. They are therefore the focal point of variability and the food webs are termed “wasp-waist” ecosystems. In addition to the forage fish, demersal species such as hake and pelagic predatory fish such as tuna, sharks and skipjack or bonito are abundant. Top predators such as gannets, cormorants, penguins, pelicans, dolphins, seals and whales feed directly on the small shoaling species. Inshore benthic and intertidal organisms such as rock lobster, abalone, mussels and seaweeds developed high population biomass in the highly productive waters. Low oxygen concentrations develop in the complex recirculation patterns which characterize the shelf regions of upwelling systems and so limit the offshore extent of high macrobenthic invertebrates. Eastern boundary systems are therefore dominated by trophic flow within the pelagic ecosystem.

Population fluctuations

Recruitment fluctuations drive the major changes in population strength of small pelagic species, which have very specific adaptations in each upwelling region to ensure successful spawning and survival. Fish select specific areas and seasons to reproduce and the triad of enrichment, concentration and retention processes have been identified as important mechanisms which influence successful reproduction. The regions where these three factors are optimised in upwelling systems are termed “Biological Action Centers”. Species life history strategies, such as feeding, spawning, recruitment and nursery functions, are closely linked to these active centers. Fish select spawning areas which will minimise offshore losses and ensure the maximum retention of larvae and juveniles in productive areas. Several such optimal habitats may exist within any upwelling ecosystem and usually comprise an active upwelling center, a coastal embayment and a considerable amount of recirculation, with marked fronts and eddies.

While the top predators have sufficient mobility to overcome advective processes in upwelling regions, similar restraints to spawning success apply to the predators which have pelagic eggs and larvae. Birds and seals have land-based breeding areas which provide good opportunities for conducting monitoring of population status.

Environmental Influences on Living Marine Resources

Large scale variability may alter the circulation and productivity of these BACs, or fishing activities may reduce some of the subpopulations using different BACs to extremely low levels, or there may be shifts in dominance form one species to another, e.g. sardines to anchovy. The subdominant species or population group may be subject to the “schooltrap” and be forced to utilise suboptimal reproductive or feeding strategies and so remain at a low population level. Therefore monitoring and modeling the ecological processes within and between these BACs forms the focus of the LMR-GOOS program within eastern boundary currents. Below is the guaranteed recipe for success.

B. MONITORING REQUIREMENTS

The general goal of this observational monitoring have to be considered as the minimum pragmatic requirements for an Upwelling Ecosystems.These systems generally comprise a elongate coastline with a series of Biological Action Centers (BACs) or alternatively, important spawning, transport, nursery and feeding regions. There may be several subregions where enhanced fish production occurs, for example Vancouver Island, southern California Bight and Sebastian Viscayno Bay in the California Current Region; North-central Peru, Iquique-Antofagasta, Coquimbo and Talcahuano in the Humboldt; the Angola-Benguela front, the Palgrave Point Region, St Helena Bay and the western Agulhas Bank in the Benguela and Tan-Tan, Dhakla, Bank d´Aguin and south of Cap Vert in the Canary Current. These areas are the focus of the monitoring and observation activities. The general observational requirements for each variable, must consider an adequate spatial and temporal scales according with the known environmental variability for each region.

I. ATMOSPHERIC AND OCEANOGRAPHIC INFORMATION

1. ATMOSPHERIC INFORMATION

- Time series can show the large-scale variability of atmospheric pressure and winds. Smaller scale variations can be derived from models.
- Calculations drawn from the above variables can be use to construct a time series of Wind stress, Ekman transport, Upwelling indexes, anomalies, etc.
- Basin-scale atmospheric indices can be derived, for example: North Atlantic Atmospheric Index, SOI, and ENSO.

2. OCEANOGRAPHIC INFORMATION

The oceanographic information could be collected either in a coastal station arrangements (time series) and/or by regular oceanographic cruises using research or fishing vessels, and ships of opportunity (spatial information) and a minimal number of strategically placed buoys. Satellite information of SST and Ocean Colour are also necessary.

- Physical & Chemical Variables: Temperature, Salinity, Dissolved Oxygen, Chlorophyll-a, ocean colour and particle size. It is necessary to establish the temporal and spatial distributional patterns of physical and chemical variables in upwelling system, on adequate scales of observation, to relate with atmospheric forcing and, on the other hand, with biological observation of the ecosystem.

- Currents. If it is possible, it would be desirable to know general circulation pattern inferred from the geostrophic field, direct currentmeter measurement, ADCP measurements or hydrodynamics models applied for an specific upwelling region.

II. PLANKTON INFORMATION

The planktonic information could be done similar to the oceanographic information, using a nearshore regular time series and oceanic regular cruises carried out simultaneously with the physical data or during fisheries surveys. Crude measurement of phytoplankton and zooplankton size distributions are useful indicators of community changes, but detailed more time-consuming identification of species is required to adequately characterise the changes. On monitoring transects through selected regions, the following information is necessary:

- Phytoplankton: species composition and distribution (abundance and biomass)
- Zooplankton: species composition and distribution (abundance and biomass)
- Primary and secondary production (if it is possible)

III. FISHERIES INFORMATION

The fisheries data required to construct a time series could be originated from:

- fishing fleet local discharge (all species present);
- distribution of catch and effort;
- on-board fishing vessel (all species present in each fishing cast, including discard species); It is desirable to coordinate on board sampling of some basic physical and biological information. For example T/S profiles, plankton, acoustic scattering layers, presence of predators, etc.;
- fishery-independent observation, i.e., fishery research vessel or regular fishing boat dedicated to conducting oceanographic and biological cruises.

The minimum fish data needed for each fish species present are: catch (ton), length, weight, sex, macroscopic sexual maturity states, stomach contents, otholiths, and gonad weight.

The basic fish data could be used for estimate:

- Length-frequency (in time and space if it is possible)
- Length-weight relationship
- Fishing effort
- Recruitment variability
- Direct and indirect stock assessments (i.e., acoustic, EPM, VPA)
- Discard
- By-catch
- Stock units identification

IV. FISH BIOLOGICAL INFORMATION

- Reproductive aspects (i.e., spawning area and period)
- Early developmental stages variability
- Physiological index
- Feeding behaviour
- Fish schools behaviour (i.e., migration rates)
- Shoal composition

V. PREDATOR MONITORING

- Population strength (at rookeries)
- Breeding or fledging success
- Diet composition
- Sightings
- Capture rates

VI. MONITORING SCHEME

The essence of the monitoring scheme is to detect changes in abundance of dominant organisms, in the distribution of spawning habitat, and in ocean structures and processes. Many pelagic species expand and contract their habitat range as population biomass alters and this is one of the most important diagnostic parameters in Eastern Boundary systems.

- Satellite observations of boundary and frontal features on daily, weekly, seasonal, interannual and inter-decadal scales. The minimum temporal scale can be determined by the frequency of cloud-free images available.
- Monitoring of selected transects in important habitat areas (BACs) at monthly or bi-monthly time scales for oceanographic and biological parameters.
- Surveys of spawner or recruit biomass or egg abundance and distribution of pelagic species throughout their range, with complementary environmental and biological information.
- Demersal surveys of trawlable stocks, with acoustical surveys above the bottom boundary layer once or twice per annum with complementary environmental and biological information. Species identification and length frequencies of the entire sample to be done.
- Fishery-independent surveys of other benthic species, e.g. crabs, lobster, abalone, intertidal organisms annually .
- Monitor species composition, length-frequency and landings of artisanal net and line-fisheries at daily/ weekly intervals.

Assess abundance of top predators such as birds, seals (aerial photography), dolphins, (sightings) sharks, tuna (catch records) at annual intervals.

These measurements can be assessed against the background of basin-scale indices such as ENSO, Southern Oscillation Index (SOI), North Atlantic Oscillation (NAO), changes in zooplankton indicator species which are readily available over the Internet. However the Internet is a necessary, but not sufficient source of monitoring information for Eastern boundary Currents.

C. MODELING REQUIREMENTS

Modeling serves principally as a diagnostic tool. In the future data assimilation techniques and predictive models need to be developed in order to anticipate changes in ecosystems.

- Physical simulation models of the essential dynamics of each BAC system, into which can be nested Individual-Based Models (IBM).
- Monthly Sequential Population Analysis
- Growth Modeling
- Larval Growth and Mortality
- Stock-Recruitment Modeling
- Trophodynamic Modeling
- Zooplankton stage-based population models

D. CAPACITY BUILDING REQUIREMENTS

- Acoustic technique training (fish and plankton)
- Otholith reading – age validation and quality control
- Reproductive staging skills

4. Specific Observational Needs for Fisheries within an Open Ocean Ecosystem

A. Introduction

Physical Features

Generally homogeneous, the open ocean system is characterized by large basin-scale semi-permanent convergent frontal features that form the primary biogeographic boundaries in the otherwise featureless open ocean. Often dominating the flow field at these large scale fronts are mesoscale meanders, eddies, and frontal jets that serve as localized regions of higher productivity and aggregation for many of the dominant biological resources.

Dominant Biological Resources

Top predators include highly migratory finfish, marine mammals, and some sea turtles. Densities of smaller surface pelagics such as sauries, squid, and pomfrets, as well as some sea turtles and seabirds may dominate in regions adjacent to fronts. The smaller pelagic fishes typically form the forage base for aggressive predators (sharks, billfish, large tunas, toothed whales) with high energetic requirements. For most other top predators (e.g., baleen whales, dolphins, seabirds), vertically migrating micronekton (ca. 10-100 cm in length) form the forage base.

Population Fluctuations and Environmental Influences on Living Marine Resources

In the open ocean system, populations of dominant biological resources are most subject to natural large fluctuations on varying temporal scales (e.g., decadal and multi-decadal). Strong correlations have been shown to exist between interannual and decadal climate variability of water masses and circulation and "booms and busts" in the stocks of fish species.

B. Monitoring Requirements

The monitoring system that follows is intended as a minimal system, however, because of the enormous vertical and horizontal scales involved in the open ocean, observational monitoring will required considerable integration of resources. A composite picture at quarterly intervals could be built on the framework provided by the satellite data and transect observations, with the irregular biological data inserted where applicable. The spatial scale of *in situ* observations made in the vicinity of open ocean boundary features should be much closer, e.g., 100 km or less, than in the central ocean gyre regions, e.g., 300 km or more. Analyses, which would provide the basis for elaboration of useful products, would be made at appropriate basin-scale regional analysis centers.

I. ATMOSPHERIC AND OCEANOGRAPHIC INFORMATION

1. Atmospheric information

- As with the coastal monitoring, time series of atmospheric pressure and wind patterns to enable monitoring of basin-scale and long-term variability. On smaller scales, satellite remote sensing and numerical models can be accessed.

- Surface weather reported by voluntary observing ships reporting to the WMO network.

- Basin-scale atmospheric indices (e.g., Pacific Decadal Oscillation (PDO), North Atlantic Atmospheric Index, ENSO) are computed and monitored for clues to identify regime changes.

2. Oceanographic information

The horizontal and vertical expanse of the open ocean requires multiple platforms for oceanographic monitoring. The program would integrate information from space-borne satellite remote sensing (e.g., SST, sea level height (SLH), ocean color), (bio-)physical oceanographic moorings (e.g., NPac series, TAO array), shipboard sampling, and numerical models. Shipboard sampling includes regular oceanographic research cruises (transects/time series (e.g., HOT, BATS)), fishing vessels, and ships of opportunity. On transects selected to cross major features of circulation or of changes in properties (e.g., ocean fronts), selected merchant and research ships would tow plankton recorders and drop expendable bathythermographs (XBTs) at appropriate intervals (e.g., hourly). For monitoring, time series of selected parameters for all platforms will be constructed and maintained.

- Physical Variables

Minimally, the temporal and spatial distributional patterns of the physical thermohaline variables (temperature, salinity, density) and ocean currents must be monitored throughout the world’s oceans where major fisheries operate. This is especially true in the vicinity of high gradient oceanic fronts and mesoscale perturbations (e.g., meanders, eddies, jets) that create boundaries in an otherwise featureless environment. Ocean currents on the large scale can be inferred from satellite altimeters or ocean circulation numerical model output. On smaller scales, direct observations (e.g., ADCP) or moored currentmeters will provide data.

- Chemical Variables

Nutrient availability in lighted open ocean surface waters are generally tightly coupled to prevailing physical oceanographic conditions, especially in the vicinity of fronts. Information on the macronutrients, principally N, P, and Si, available to primary producers is necessary for modeling efforts and understanding patterns of productivity and geochemical flux and balance. In open ocean environments, ambient dissolved oxygen concentrations are important to the distribution of high energy animals, e.g., tunas. Collection of nutrients and dissolved oxygen information is seen to be collected on an irregular basis by research vessels.

II. PLANKTON INFORMATION

- Phytoplankton: species composition and distribution (abundance and biomass)

Ocean color from multispectral spaceborne satellite sensors (e.g., SeaWiFs, MODIS) will provide large scale (global-, basin-) surface phytoplankton information in the open ocean. Additional near surface data will be supplied by optical drifters, particularly on the mesoscale, and in line fluorometric sensors aboard research vessels. Phytoplankton dynamics through the water column are examined through shipboard surveys and biophysical moored arrays. Minimally, chlorophyll measurements (in vivo or extracted) would be made through fluorometry or spectrophotometry to estimate phytoplankton biomass. Where possible, phytoplankton composition can be characterized through visual taxonomy or from diagnostic markers through high performance liquid chromatography (HPLC).

- Zooplankton: species composition and distribution (abundance and biomass)

Information on zooplankton would be irregularly collected through net sampling and where available, electronic plankton counters (EPCS) principally by research vessels and plankton recorders on research vessels and ships of opportunity. As much as possible, net sampling should be standardized and would be advantageous to maintain some consistency with internationally accepted zooplankton sampling protocols. Where possible, information on species composition and abundance of epi- and meso-pelagic micronekton (1-10 cm in length) needs to be collected; particularly in their role as pelagic species forage.

- Primary and secondary production.

Numerical models, particularly for primary production, perform well in open ocean systems and will continue to improve. Where available, empirical production estimates will be applied to groundtruth model output.

III. FISHERIES INFORMATION

Most information on the abundance and distribution of open ocean top predators and commercial exploited resources (nekton) will be reported by fishing (or fishery observers) and research vessels. As with environmental parameters, time series of patterns need to be constructed and maintained. Minimal data includes fleet catch and effort, landings, distribution of catch and effort, and discards for commercial species and incidental bycatch (including protected species). Additionally, basic fishery data information on length, weight, and sex for individual animals is necessary.

IV. FISH BIOLOGICAL INFORMATION

Coupled with the fisheries information is the necessity to collect life history and ecology information. These include biological samples to address reproduction and maturation (gonads), age and growth (otoliths, statoliths, etc.), feeding (stomachs), and movement/migration.

V. PREDATOR MONITORING

Similar information are required for other top ecosystem predators (marine mammals, sea turtles, seabirds, etc.) including population strength, reproductive success, feeding ecology, sightings, and capture rates. These data are typically difficult to come by and usually will require dedicated efforts.

VI. MONITORING SCHEME

- Satellite observations of large-scale oceanographic (frontal) features over varying temporal scales.
- Establish and maintain time series transects that will represent “cross” regional characterization.
- Assess abundance of living marine resources annually and assess against the background of basin-scale indices.

C. Modeling Requirements

Traditional population assessment and simulation models need to better incorporate environmental information. Future data assimilation techniques should move towards an ecosystem-based model.

D. Capacity building requirements

- Hydroacoustic technique training (fish and plankton).

- Expanded capabilities in image processing and applications of satellite remote sensing to oceanography and fisheries.

- Expanded GIS capabilities.

- Ecosystem-based modeling skills.

ANNEX V

THE EAST COAST OF NORTH AMERICA STRATEGIC ASSESSMENT PROJECT (ECNASAP)

The East Coast of North America Strategic Assessment Project (ECNASAP) was originally designed to examine the feasibility of developing and sharing information necessary for strategic planning and management of living marine resources along the east coast of North America. Specifically, the program was to provide the information and analytical capabilities needed to support assessment of climatic and anthropogenic impacts on living marine resources.

It was considered that the products of ECNASAP would give decision-makers the information and tools required to assess the impact of local or regional decisions at a broader scale, and to evaluate the impact of the broader system on local or regional processes. The project was designed around two case studies, one inshore and one offshore. Only the development and results of the offshore case study are presented here.

Although initially very broad the objectives of the offshore study evolved to:

1) defining the community structure of fish populations of the east coast of North America; and

2) determining the stability of this community structure over time, especially in light of changes in ocean climate observed since the mid-1980s

The offshore case study concentrated on compiling five main data sets:

- Bottom trawl survey data from Canada and the USA
- Bottom temperature and salinity data for the same period and area
- Seabird distribution and abundance
- Surficial geology of the area (digital)
- Bathymetry (digital).

Only the bottom trawl survey data (including both bottom temperature and salinity collected simultaneously) were collected synoptically, using relatively consistent (and documented) sampling protocols, over a long period of time. These surveys have long histories and are supported by extensive data processing infrastructures both in Canada and the USA as a consequence of their roles in the management of fisheries resources in both countries. The other data sets do not have such histories.

Resistance to data sharing due to uncertainty regarding the ultimate use of the data, or a sense of “ownership” by individual institutions, was initially a hindrance to the development of the integrated trawl survey data set. Once specific objectives were developed this barrier was removed.

The ECNASAP survey data set now consists of some 55,000 trawl hauls taken from Cape Hatteras (North Carolina) to Cape Chidley (Labrador) at depths of 50 to >200m, for the period from 1970 to1994. Some 400 species of fish and invertebrates are represented in the data set.

At present only weights and numbers of all species caught per trawl haul are included in the data set. Size composition is available (from the contributing institutions) for most species. The data set is static and ends with information for 1994. It was not intended to be made dynamic.

Although these were the most consistently collected (and documented) data there were significant problems in data standardization due to differences in vessel characteristics, sampling gear, and sampling design.

The value of the data set, even though it does not extend beyond 1994, has been significant for several reasons:

- The data for demersal fishes were analyzed to determine the degree of spatial associations between species, and whether or not these were persistent over time. Such analyses would have been impossible without this extensive data set. This has demonstrated that there is significant structure in the spatial associations of demersal fishes at this scale, and that this structure is reasonably constant over time.

- Changes in the boundaries between species associations, and changes in the composition of species groups, were found to occur concurrently with changes in environmental conditions and with changes in human exploitation.

- The geographic and temporal scope of the integrated data have allowed changes in distribution and abundance of individual fish species to be tracked over their entire geographic range. Measures of distribution and abundance are being considered as performance measures for ecosystem components such as fishes. Determining the geographic range of ecosystem components is essential to defining the scale at which either anthropogenic or environmental impacts need to be evaluated (Sinclair's nested approach).

- Including information on size composition allows consideration of another suite of ecosystem level performance measures (e.g., change in integrated community size structure and change in average size of specific ecosystem components).

Lessons learned from ECNASAP which may be relevant to LMR-GOOS:

The ECNASAP integrated trawls survey database was an extremely successful venture in that it provided (at least for the demersal fishes) a broad scale context within which to evaluate local or regional observations or actions.

Future endeavours that pull together survey data should work hard on negotiating agreement to making the integrated data set dynamic. A static data set, although valuable, soon becomes irrelevant to now- and fore-casting.

Size structure should be a part of the integrated data set from the outset. All ecological processes are size dependent to some extent and many of the proposed ecosystem performance measures are size related.

In integrating trawl or other fish survey databases, special attention should be given to species identification protocols employed in their collection. Maintenance of biodiversity is one (poorly defined but generally agreed upon) ecosystem objective. Most trawl surveys were designed to estimate abundance of commercially important fishes and variable degrees of care were taken to identify the uncommon species.

Since many trawl survey time series exist globally, developing an integrated global trawl survey database would be an extremely cost effective manner of providing "new" information with which to examine effects of environmental and anthropogenic change on the fish portions of ecosystems.

Trawl surveys give some indication of distribution and abundance of benthic macro-invertebrates. This is important, because these are among the most poorly sampled ecosystem components.

ANNEX VI

REPORT ON RELEVANT ICES ACTIVITIES SINCE MARCH (1999) LMR-GOOS MEETING

The 87th ICES Annual Science Conference was held in Stockholm in late September 1999. There were a number of resolutions that were adopted by the delegates that are very relevant to LMR-GOOS.

1. Report of the workshop on Gadoid Stocks in the North Sea during the 1960s and 1970s, the Fourth Backward Facing Workshop, edited by Mike Heath will be published in the ICES Cooperative Research Report Series. This report should be useful in evaluating monitoring strategies for fish population fluctuations (i.e. as part of the retrospective analysis for the North Sea).

2. A Study Group on Discard and By-catch Information (Chair: Dr. J. Cotter, UK) will be meeting at ICES Headquarters from 20 – 22 March 2000. The results of this meeting should be useful in defining approaches to monitoring of discards in fisheries.

3. The Working Group on Ecosystem Effects of Fishing Activities (Chair: Dr. J. Rice, Canada) has met at ICES Headquarters from 22 November to 1 December 1999. Of particular interest is agenda item e:

   - to begin consideration of the development of integrated management objectives as a basis for our ecosystem approach to management, integrating fisheries and environmental effects.

   Such objectives will be helpful in defining the performance measures that could be a key component of LMR-GOOS.

4. The ICES/IOC Steering Group on GOOS (Co-Chair: R. Saetre, Norway and an IOC representative) will meet in Southampton, UK from 21 – 23 February 2000 to:

   a) develop the ICES-GOOS Implementation Plan described in the report of WKGOOS (CM. 1999/C:14) including:

      (i) develop co-operative arrangements to enhance mutual awareness with IOC and EuroGOOS.

      (ii) develop an ICES-Ocean Observing System (I-OOS) based on the ICES Ocean Climate Summary and other relevant products and to find ways to produce and tailor products exploiting the results of the ICES Ocean Observing System.

      (iii) investigate possible ways to establish a co-ordinated and harmonized observation network and design a system for operational oceanography on appropriate time scale for the North Sea (in co-operation with EuroGOOS).

      (iv) develop and oversee the North Sea IBTS quarterly surveys in the Initial Observing System of GOOS, and liaise with and report to GOOS bodies as appropriate.

   b) advise and support the Secretariat on GOOS-related matters.

   c) define and promote the role of ICES in GOOS taking into account input from ICES Advisory and Science Committees;

d) identify a program of workshops to facilitate the implementation of ICES-GOOS and to improve awareness of GOOS in ICES, including special sessions at the ICES Annual Science Conference;

e) identify those IOC-GOOS design panels and committees of relevance to ICES-GOOS with a view to proposing the appropriate ICES representative at these meetings, with the approval of the ICES Council, and to prepare the briefs for these representatives.

It is important to expand the agenda of this group in future meetings to include LMR-GOOS issues.

5. The Working Group on Marine Data Management (Chair: R. Gelfeld, USA) will meet in Hamburg, 10 – 13 April 2000. The activities of this WG are of importance to the next stages of LMR-GOOS.

6. The Working Group on Zooplankton Ecology (Chair: Dr. L. Valdes, Spain) will meet in Hawaii, USA from 17 – 19 April 2000. There are several agenda items of interest, in particular item e:

- continue to develop with PICES colleagues operational uses for monitoring activities and environmental indices, in collaboration with fisheries and assessment groups.

The use of CPR will form part of this discussion.

7. The Working Group on Phytoplankton Ecology (Chair: Dr. D.K. Mills, UK) will meet from 4 – 8 April 2000 in Narragansett, Rhode Island, USA. Agenda items c and g are of particular interest:

- assemble a list of long time-series of plankton and associated environmental variables and to discuss the possible developments of an ICES-wide database on these parameters,

- consider, and where feasible develop, data products and summaries that can be provided on a routine basis to the ICES community via the ICES webpage.

8. The ICES/GLOBEC working group on Cod and Climate Change (Chair: Dr. K. Drinkwater, Canada) will meet in Dartmouth, Nova Scotia, Canada, from. 11 – 13 May, 2000, to:

a) review and evaluate work carried out to date on Cod and Climate Change by the workshops (environmental Data in Stock Assessment, Decadal-Scale Ocean Climate Fluctuations, Backward Facing III and IV) and subsequent follow-up activities;

b) produce a short synthesis of the major findings from the program and prepare a plan for a more complete synthesis of results;

c) plan and prepare workshops to be held over the next two years on ‘Applying Environmental Data in Stock Assessments’ (possibly examining the transport of cod larvae between Iceland and West Greenland as a specific example) and on ‘Long-Term Climate Change and Prediction’:

d) consider, and where feasible, develop data products and summaries that can be provided on a routine basis to the ICES community via the ICES website;

e) examine the 1999 Oceanography Committee Working Group reports 2000 TORs to identify where intergroup input could be provided or required with the view to formulating key questions requiring interdisciplinary dialogue during concurrent meetings of the Committee’s Working Groups in 2002.

All of the agenda items should be relevant to long-term monitoring for fish population fluctuations.

9. The Study Group on Marine Habitat Mapping (Chair: Dr. E. Jagtman, Netherlands) will meet in The Hague, Netherlands, form 10 – 13 April 2000 to:

a) review recent developments in marine classification, in particular, review in detail the outcome of the OSPAR/ICES/EEA Workshop on Habitat Classification and Biogeographic Regions (WKCLAS) and the Aquatic Restoration and Conservation (ARC) Workshop on "Habitat Classification"; this review should be passed to WGEXT;

b) report on progress made in the joint OSPAR/ICES/EEA proposals on habitat mapping projects (habitat map of the North Sea or Wadden Sea, deep sea map, OSPAR area map to level 3 of the EUNIS classification system) made at WKCLAS, and discuss whether SGMHM can coordinate the proposed projects;

c) work closely with WGEXT to comment on present-day mapping technologies in relation to the requirements of ICES;

d) assess whether further development of (parts of) the standing classification is feasible, provided that there is enough expertise within SGMHM, and if so, take action to build further on this classification.

e) assess whether and how BEWG should be involved in validating the biotopes already proposed;

f) finalize details of a Theme Session at the 2000 Annual Science Conference on Classification and Mapping of Marine Habitats.

10. The Benthos Ecology Working Group (Chair: Dr. K. Essink, Netherlands) will meet in Walpole, Maine, USA from 26 – 30 April 2000. Agenda items d and g are relevant to LMR-GOOS:

- further provide guidance to ACME on Quality Assurance procedures for benthic studies [OSPAR 2000/1.1] through:

  (i) agreeing on a final draft of general guidelines for QA for biological monitoring,

  (ii) finalizing an extended review of standard operating procedures in use in ICES Member Countries,

  (iii) further reviewing QA schemes for benthic studies;

- discuss data banking and related QA matters, including data exchange, with the ICES Environmental Data Scientist; this should include final review and approval of the Biological Data Reporting Format and data entry program.

11. A Study Group on Ecosystem Assessment and Monitoring (Chair: L. Foyn, Norway) has been established, and will meet from 8–12 May 2000 at ICES Headquarters to:

a) reflect on the scientific framework for an ecosystem approach for the sustainable use and protection of the marine environment, including living marine resources (based on the reports of the North Sea Conference’s Oslo and Scheveningen workshops, and an ICES discussion document on ecosystem management of the Baltic Sea);

b) review the methodology and proposals for Ecological Quality Objectives for the North Sea;

c) evaluate the use of results from monitoring programmes and their effectiveness to support integrated (ecosystem) assessments in the ICES area using *inter alia* the OSPAR regional and 2000 Quality Status Reports for the North Sea, and the HELCOM Third Periodic Assessment of the Baltic Sea;

Again the ecosystem objectives identified will be useful for evaluation of the LMR-GOOS monitoring strategy/template.

12. Finally, a Study Group on the Scientific Basis for Ecosystem Advice in the Baltic has been established (Co-chairs: Prof. T. Osborn, USA and M. Plikshs, Latvia) and will meet in Copenhagen, Denmark for 3 days in June 2000 to:

a) prepare a recommendation for a workshop on “The Scientific Basis for Ecosystem Advise in the Baltic” to be held in 2001;

b) review progress in understanding of Baltic ecosystem structures and dynamics in relation to human impact and driving environmental forces, including a review of the present state of the art of ecosystem modeling and modeling of important system components;

c) review present ability of giving ecosystem oriented advice on various human activities affecting the Baltic systems and identify potential key areas for ecosystem advice to be requested from ICES in future;

d) outline necessary actions to enhance the understanding and functioning of the Baltic systems as scientific basis for giving sound ecosystem-oriented advice;

e) outline necessary actions to establish modeling tools for conducting simulations on the impact of human activities and regulatory enforcement;

f) consider the present and potential role of international organisations and ongoing major international programmes with respect of implementing a framework for ecosystem oriented advice.

It is noteworthy that a wide range of activities of ICES are relevant to the goals of LMR-GOOS and that monitoring in support of ecosystem objectives for integrated oceans management is an emerging priority.

ANNEX VII

LIST OF ACRONYMS

4-Cs	Climate Change and Carrying Capacity Program
ACME	Advisory Committee on the Marine Environment (ICES)
ADCP	Acoustic Doppler Current Profiler
ARC	Aquatic Restoration and Conservation
Argo	Array for Real-Time Geostrophic Oceanography
AVHRR	Advanced Very High Resolution Radiometer
BACs	Biological Action Centers
BATS	Bermuda Atlantic Time-series Study
BENEFIT	Benguela Environment and Fisheries Interactions and Training
BEWG	Benthos Ecology Watering Group (ICES)
CONA	National Chilean Oceanography Committee
CPPS	Comisión Permanente del Pacífico Sur
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources,
CEMP	Ecosystem Monitoring Program
C-GOOS	Coastal GOOS
CIBNOR	Centro de Investigaciones Biológicas del Noroeste, México
CICESE	Centro de Investigación Científica y Enseñanza Superior de Ensenada, México
CICIMAR	Centro Interdisciplinario de Ciencias Marinas, México
CIMAR	Centro de Investigaciones Marinas de la Universidad de Costa Rica, Costa Rica
CPR	Continous Plankton Recorder
CPUE	Catch per unit of effort
CTD	Conductivity Temperature-Depth
CZCS	Coastal Zone Color Scanner
DFO	Department of Fisheries and Oceans (Canada)
DICTUS	Departamento de Investigación Científica de la Universidad de Sonora, México
DO	Dissolved Oxygen
ECNASAP	East Coast of North America Strategic Assessment Project
ECOFISH	Ocean Ecosystems Observing and Fisheries Change
EEA	European Environment Agency
EEZs	Exclusive Economic Zones
EFH	Essential Fish Habitat
ENSO	El Niño - Southern Oscillations
EPCs	Electronic Plankton Counters
EPM	Egg Production Method
EuroGOOS	European GOOS
FAO	Food and Agriculture Organization (UN)
FRI	Fisheries Research Institute, Chile
GFCM	General Fisheries Commission for the Mediterranean
GIPME	Global Investigation of Pollution in the Marine Environment (IOC)
GLOBEC	Global Ocean Ecosystem Dynamics
GODAE	Global Oceanographic Data Archaeology and Rescue
GOOS	Global Ocean Observing System
GOSLING	Global Opportunistic Sampling in GOOS
GSC	GOOS Steering Committee
HELCOM	Helsinki Commission
HOT	Hawaii Ocean Time Series
HOTO	Health of the Ocean (IOC)
HPLC	High Performance Liquid Chromatography

IATTC	Inter-American Tropical Tuna Commission
IBM	Individual-Based Models
IBTS	ICES International Bottom Trawl Survey
ICES	International Council for the Exploration of the Sea
ICSU	International Council for Science
IOS	Initial Operational System (GCOS)
INP	Instituto Nacional de la Pesca, México
INPESCA	Instituto de Investigaciones Pesca, Chile
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IOCARIBE GOOS	IOC Sub-commission for the Caribbean and Adjacent Regions GOOS
IOCCG	International Ocean Color Coordinating Group
I-OOS	ICES-Ocean Observing System
IOS	IGOSS Observing System
IUCN	International Union for the Conservation of Nature (and Natural Resources) [World Conservation Union]
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology (IOC-WMO)
JDIMP	Joint Data and Information Management Plan
JGOFS	Joint Global Ocean Flux Study
LMR	Living Marine Resources
MedGOOS	Mediterranean regional GOOS
MODIS	Moderate-Resolution Imaging Spectrometer
MPAs	Marine Protected Areas
NAFO	North Atlantic Fisheries Organization
NAO	North Atlantic Oscillation
NEAR-GOOS	North-East Asian Regional GOOS
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration, USA
OSPAR	Oslo- Paris Commission
PDO	Pacific Decadal Oscillation
PICES	North Pacific Marine Sciene Organization
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SCOR	Scientific Committee on Oceanic Research (ICSU)
SeaWiFs	Sea-Viewing Wide Field of View
SGMHM	ICES Study Group on Marine Habitat Mapping
SLH	Sea Level Height
SIO	Scripps Institution of Oceanography, USA
SOOP	Ship of Opportunity Programme
SST	Sea-Surface Temperature
TAO	Tropical Atmosphere-Ocean Array
UNAM	Universidad Nacional Autónoma de México, México
VPA	Virtual Population Analysis
WGEXT	ICES Working Group on the Effects of the Extraction of Sediments from the Marine Environment
WKCLAS	Workshop on Habitat Classification and Biogeographic Regions
WKGOOS	ICES Workshop on GOOS
WMO	World Meteorological Organization
XBTs	Expandable Bathythermographs

In this Series, entitled

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984 and which is published in English only, unless otherwise specified, the reports of the following meetings have already been issued:

1. Third Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
2. Fourth Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans S. Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Also printed in Spanish)***
4. First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
7. First Session of the Joint CCOP(SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
8. First Session of the IODE Group of Experts on Marine Information Management
9. Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Tectonics and Resources
10. Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
11. First Session of the IOC Consultative Group on Ocean Mapping ***(Also printed in French and Spanish)***
12. Joint 100-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
13. Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
14. Third Session of the Group of Experts on Format Development
15. Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
16. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica lnternacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica ***(Spanish only)***
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources ***(Also printed in French and Spanish)***
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities ***(Also printed in Spanish)***
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CCPS Working Group on the Investigations of 'El Niño' (***Also printed in Spanish)***
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN(OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the IOC-UNEP Group of Experts on Methods, Standards and lntercalibration
46. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
47. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
48. Twelfth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic ***(Also printed in French)***
54. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed in Spanish)***
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
56. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean

57. First Meeting of the IOC *ad hoc* Group of Experts on Ocean Mapping in the WESTPAC Area
58. Fourth Session of the IOC Consultative Group on Ocean Mapping
59. Second Session of the IOC-WMO/IGOSS Group of Experts on Operations and Technical Applications
60. Second Session of the IOC Group of Experts on the Global Sea-Level Observing System
61. UNEP-IOC-WMO Meeting of Experts on Long-Term Global Monitoring System of Coastal and Near-Shore Phenomena Related to Climate Change
62. Third Session of the IOC-FAO Group of Experts on the Programme of Ocean Science in Relation to Living Resources
63. Second Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
64. Joint Meeting of the Group of Experts on Pollutants and the Group of Experts on Methods, Standards and Intercalibration
65. First Meeting of the Working Group on Oceanographic Co-operation in the ROPME Sea Area
66. Fifth Session of the Editorial Board for the International Bathymetric and its Geological/Geophysical Series
67. Thirteenth Session of the IOC-IHO Joint Guiding Committee for the General Bathymetric Chart of the Oceans ***(Also printed in French)***
68. International Meeting of Scientific and Technical Experts on Climate Change and Oceans
69. UNEP-IOC-WMO-IUCN Meeting of Experts on a Long-Term Global Monitoring System
70. Fourth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
71. ROPME-IOC Meeting of the Steering Committee on Oceanographic Co-operation in the ROPME Sea Area
72. Seventh Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño' ***(Spanish only)***
73. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico ***(Also printed** in **Spanish)***
74. UNEP-IOC-ASPEI Global Task Team on the Implications of Climate Change on Coral Reefs
75. Third Session of the IODE Group of Experts on Marine Information Management
76. Fifth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
77. ROPME-IOC Meeting of the Steering Committee for the Integrated Project Plan for the Coastal and Marine Environment of the ROPME Sea Area
78. Third Session of the IOC Group of Experts on the Global Sea-level Observing System
79. Third Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
80. Fourteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
81. Fifth Joint IOG-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
82. Second Meeting of the UNEP-IOC-ASPEI Global Task Team on the Implications of climate Change on Coral Reefs
83. Seventh Session of the JSC Ocean Observing System Development Panel
84. Fourth Session of the IODE Group of Experts on Marine Information Management
85. Sixth Session of the IOC Editorial Board for the International Bathymetric chart of the Mediterranean and its Geological/Geophysical Series
86. Fourth Session of the Joint IOC-JGOFS Panel on Carbon Dioxide
87. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Pacific
88. Eighth Session of the JSC Ocean Observing System Development Panel
89. Ninth Session of the JSC Ocean Observing System Development Panel
90. Sixth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
91. First Session of the IOC-FAO Group of Experts on OSLR for the IOCINCWIO Region
92. Fifth Session of the Joint IOC-JGOFS CO, Advisory Panel Meeting
93. Tenth Session of the JSC Ocean Observing System Development Panel
94. First Session of the Joint CMM-IGOSS-IODE Sub-group on Ocean Satellites and Remote Sensing
95. Third Session of the IOC Editorial Board for the International Chart of the Western Indian Ocean
96. Fourth Session of the IOC Group of Experts on the Global Sea Level Observing System
97. Joint Meeting of GEMSI and GEEP Core Groups
98. First Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
99. Second International Meeting of Scientific and Technical Experts on Climate Change and the Oceans
100. First Meeting of the Officers of the Editorial Board for the International Bathymetric Chart of the Western Pacific
101. Fifth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
102. Second Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
103. Fifteenth Session of the Joint IOC-IHO Committee for the General Bathymetric Chart of the Oceans
104. Fifth Session of the IOC Consultative Group on Ocean Mapping
105. Fifth Session of the IODE Group of Experts on Marine Information Management
106. IOC-NOAA *Ad hoc* Consultation on Marine Biodiversity
107. Sixth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
108. Third Session of the Health of the Oceans (HOTO) Panel of the Joint Scientific and Technical Committee for GLOSS
109. Second Session of the Strategy Subcommittee (SSC) of the IOC-WMO-UNEP Intergovernmental Committee for the Global Ocean Observing System
110. Third Session of the Joint Scientific and Technical Committee for Global Ocean Observing System
111. First Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate
112. Sixth Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting
113. First Meeting of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS)
114. Eighth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of "El Niño" ***(Spanish only)***
116. Second Session of the IOC Editorial Board of the International Bathymetric Chart of the Central Eastern Atlantic ***(Also printed** in **French)***
116. Tenth Session of the Off ices Committee for the Joint IOC-IHO General Bathymetric Chart of the Oceans (GEBCO), USA, 1996

117. IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Fifth Session, USA, 1997

118. Joint Scientific Technical Committee for Global Ocean Observing System (J-GOOS), Fourth Session, USA, 1997

199 First Session of the Joint 100-WMO IGOSS Ship-of-Opportunity Programme Implementation Panel, South Africa, 1997

120. Report of Ocean Climate Time-Series Workshop, Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate, USA, 1997

121. IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional Global Ocean Observing System (NEAR-GOOS), Second Session, Thailand, 1997

122. First Session of the IOC-IUCN-NOAA *Ad hoc* Consultative Meeting on Large Marine Ecosystems (LME), France, 1997

123. Second Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), South Africa, 1997

124. Sixth Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico, Colombia, 1996 ***(also printed in Spanish)***

125. Seventh Session of the IODE Group of Experts on Technical Aspects of Data Exchange, Ireland, 1997

126. IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), First Session, France, 1997

127. Second Session of the IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LME), France, 1998

128. Sixth Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1997

129. Sixth Session of the Tropical Atmosphere - Ocean Array (TAO) Implementation Panel, United Kingdom, 1997

130. First Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), France, 1998

131. Fourth Session of the Health of the Oceans (HOTO) Panel of the Global Ocean Observing System (GOOS), Singapore, 1997

132. Sixteenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), United Kingdom, 1997

133. First Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1998

134. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean (IOC/EB-IBCWIO-IW3), South Africa, 1997

135. Third Session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), France, 1998

136. Seventh Session of the Joint IOC-JGOFS C02 Advisory Panel Meeting, Germany, 1997

137. Implementation of Global Ocean Observations for GOOS/GCOS, First Session, Australia, 1998

138. Implementation of Global Ocean Observations for GOOS/GCOS, Second Session, France, 1998

139. Second Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Brazil, 1998

140. Third Session of IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional - Global Ocean Observing System (NEAR-GOOS), China, 1998

141. Ninth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of 'El Niño', Ecuador, 1998 ***(Spanish only)***

142. Seventh Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Croatia, 1998

143. Seventh Session of the Tropical Atmosphere-Ocean Array (TAO) Implementation Panel, Abidjan, Côte d'Ivoire, 1998

144. Sixth Session of the IODE Group of Experts on Marine Information Management (GEMIM), USA, 1999

145. Second Session of the IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS), China, 1999

146. Third Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), Ghana, 1999

147. Fourth Session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC); Fourth Session of the WCRP CLIVAR Upper Ocean Panel (UOP); Special Joint Session of OOPC and UOP, USA, 1999

148. Second Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), France, 1999

149. Eighth Session of the Joint IOC-JGOFS CO2 Advisory Panel Meeting, Japan, 1999

150. Fourth Session of the IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional – Global Ocean Observing System (NEAR-GOOS), Japan, 1999

151. Seventh Session of the IOC Consultative Group on Ocean Mapping (CGOM), Monaco, 1999

152. Sixth Session of the IOC Group of Experts on the Global Sea level Observing System (GLOSS), France, 1999

153. Seventeenth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans (GEBCO), Canada, 1999

154. Comité Editorial de la COI para la Carta Batimétrica Internacional del Mar Caribe y el Golfo de Mexico (IBCCA), Septima Reunión, Mexico, 1998
IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico (IBCCA), Seventh Session, Mexico, 1998

155. Initial Global Ocean Observing System (GOOS) Commitments Meeting, IOC-WMO-UNEP-ICSU/Impl-III/3, France, 1999

156. First Session of the *ad hoc* Advisory Group for IOCARIBE-GOOS, Venezuela, 1999 ***(also printed in Spanish)***

157. Fourth Session of the IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS), China, 1999

158. Eighth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and its Geological/Geophysical Series, Russian Federation, 1999

159. Third Session of the IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS), Chile, 1999