

# 4 Long-term Monitoring and Ecosystem Health

## 4.1 Summaries of presentations

### **Ecosystem health within the framework of operational oceanography, Or: GOOS, the Health of the Ocean (HOTO) and Living Marine Resources (LMR) Modules**

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In the description of the GOOS Design a discussion is held between balancing the user needs and the scientific and technical feasibility. Two modules have been defined with clear needs, which are relevant for this workshop: Health of the Ocean (HOTO) and Living Marine Resources (LMR). In this contribution the needs will be compared with what is actually possible and which kinds of information are already available or will become available in the near future. Because Ecosystem Health is not a well defined concept current literature on this item will be discussed and related to the needs compiled under both HOTO and LMR.

Discussions about ecosystem health are strongly linked to the human health concept on the one side and on reference norms on the other side. Both aspects will be reviewed briefly and the consequences for measuring parameters evaluated. Based on current knowledge the criteria and parameters so far used in descriptions of ecosystem health will be presented: forerunners in this field are groups around Costanza and Sherman.

Emphasis will be laid on the practical application of measured parameters for the purpose of the HOTO and LMR Modules.

### **The Continuous Plankton Recorder (CPR) survey and climate change issues**

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The CPR survey which is operated by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), in Plymouth, UK, is currently in its 68th year of existence. The survey and its products are unique as they comprise the only long-term and ocean basin wide operational survey of plankton in the world. The survey started in the North Sea in 1931 extending out into the Atlantic in 1939. Currently, the core area of the survey reaches from the east coast of the USA to the north west European shelf between approximately 37° and 64°N. In recent years CPRs were also deployed in the Baltic, Mediterranean, Gulf of Guinea and monthly tows will start in the Pacific in 2000. Voluntary merchant ships on their normal passage are used to tow CPRs; typically 22 routes are towed in the core region each month of the year. On average more than 80000 nautical miles are sampled each year and more than 4000 samples analysed when the phyto- and zooplankton are counted and identified into ~400 taxonomic categories. Since the survey started close to 4 million nautical miles of the oceans have been sampled and approximately 200,000 samples analysed. The survey has achieved its unique position by making few changes to the CPR and by strict adherence to sampling and analytical protocols with the maintenance of a skilled team of plankton analysts. The survey is supported by an international consortium of funders comprising in 1999 eight countries, the European Union, UNIDO and the IOC. SAHFOS is also involved in the design and testing of new technology as eventual replacements for the CPR.

There has been an increasing recognition of the uniqueness of the CPR time series as a 'barometer' against which to assess climate change and the effects of pollution on the natural variability of marine populations and as

environmental input to fisheries assessments. Evidence from CPR records suggests that the plankton integrates hydrometeorological signals and may be used as a possible index of climate change. Strong links have been demonstrated between the plankton and a major mode of atmospheric variability in the northern hemisphere, the North Atlantic Oscillation. There is evidence that some of the changes observed have also impacted fish stocks through changes in abundance, recruitment and distribution. Comparison between fishery statistics and CPR data for the North Sea suggests that the fishery may at times cause strong top down control on the plankton. Results from the survey are also being used to interpret eutrophication issues and assess planktonic biodiversity and its spatial and temporal variability. The baseline data available from the survey are also being used to assess the spread of introduced species and occurrence of algal blooms, of relevance to studies on ballast water exchange. The scale of the changes seen over five decades emphasises the importance of maintaining existing and establishing new, long term and wide scale monitoring programmes of the world's oceans under the flag of the LMR module of GOOS.

### **The diversity of harmful algal blooms: a challenge for operational monitoring**

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A broad spectrum of events comes under the category of harmful algal blooms (HABs), the common denominator being a negative impact on human activities. Harmful algal blooms involve a wide diversity of organisms, mechanisms of impact and bloom dynamics. Gaps in scientific knowledge and lack of adequate technology constitute a major hindrance to the improvement of observational capabilities and progress in predictive understanding of these phenomena. An effective HAB operational monitoring system should include a long-term, global, observing network for phytoplankton species composition and related physical, chemical and biological variables, coupled with an array of models and

statistical tools and sustained by an effective data management system. Expected products encompass different temporal scales of prediction and levels of benefit. Early warning of HAB events allows us to put in action specific contingency plans aimed at minimising damage to human health and economic losses. The next step is to forecast HABs with a lead time in the order of 1-7 days, which would allow for more effective management and mitigation procedures. Finally, it would be necessary to assess the risk for HAB events in the context of long-term variations of climate and anthropogenic impact, to assist managers and decision-makers in planning the use of coastal areas.

### **Eutrophication assessment based on probabilistic methods; the development of a simulated normal distribution derived for a data base of nitrate values**

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Eutrophication assessment is a complicated endeavour due to the number of interrelated parameters that have to be taken into account and the fact that there is overlapping between the frequency distributions of the concentrations values of the oligotrophic, mesotrophic and eutrophic water bodies. In addition, deviation from normality either results into data transformation, distorting the original information of the data, or eliminates considerably the number of statistical techniques used for data analysis. In the present work a probabilistic procedure is proposed for assessing eutrophication levels. Nitrate concentrations have been used from two data sets characterising oligotrophy and eutrophication respectively; a simulated normal distribution has been developed without data transformation or applying any drastic data manipulations. This procedure is described in a stepwise manner and as a method can be used to define eutrophication scales, assign critical values and test any nitrate concentration data for the evaluation of the trophic conditions of coastal areas.