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The Climate and Eastern Ocean Systems Project

Objectives of CEOS

The CEOS project is an international collaborative study of potential effects of global climate change on the living resources of the highly productive eastern ocean upwelling ecosystems and on the ecological and economic issues directly associated with such effects. A major focus of the study are the clupeoid fishes (anchovies, sardines, etc.) that are heavily exploited in these large marine ecosystems and which have recently been exhibiting episodes of collapse, rebound, or switches in dominance.

The major objectives of the CEOS project are thus to: 1) assemble, summarize, and analyze the data record of the past four decades regarding the four eastern ocean boundary upwelling ecosystems mentioned above along with data from other upwelling areas; 2) apply the comparative method to identify key physical processes and ecosystems responses; 3) resolve underlying global-scale trends in each individual regional system that may be obscured by local interyear and interdecadal variability; 4) investigate the relationship of these global trends to accumulating greenhouse effects; 5) construct scenarios for future consequences of global climate change on upwelling resources; and 6) analyze and project ecological and social impacts on associated human activities and values.

Eastern ocean upwelling ecosystems present certain

forcing that may be confined to a single region will also be analyzed. In this approach, greatly increased degrees of freedom for empirical model formulation and verification are obtained from the more numerous realizations of shorter period events in the data record and from the fact that the different regional sets of realizations may be independent from one another.

Some initial scenarios are already available. For example, Bakun (1990) has argued that one consequence of increased greenhouse effects that can be confidently expected is that temperature gradient between the ocean and the continents will increase during the spring-summer upwelling seasons in these systems. This would be reflected in increased alongshore wind and enhanced sea breeze circulation, which would impact recruitment (Mendelssohn and Mendo 1987). Evidence exists for an "optimal environmental window" with respect to wind effects (Fig. 2), such that changes in characteristic wind speed may disrupt finely tuned reproductive strategies of the small pelagic fishes which are essential trophic components of these ecosystems.

Another approach to identifying trends in ecosystem processes will be through the construction of sequences of trophic models of the ecosystems and by computing the values of indices expressing their emergent properties. Emphasis will be given to the theory of Ulanowicz (1986) and to the concepts of maturity, stability, and especially

change and of the mechanisms for change (or conversely, for homeostasis) will be attempted via detailed analysis of temporal changes in ascendancy and related indices. The analysis will include comparisons among upwelling systems and also comparisons with models of other

Linkages of the CEOS Project

The CEOS project addresses most of the strategic and integrating priorities listed in the U.S. "Global Research Program Priority Framework" especially the "Ecological

Several national research laboratories working on similar systems are associated with this project through a cooperative agreement with ORSTOM. This project presently includes: the Institut Scientifique des Pêches Maritimes, Morocco; the Centre de Recherches Océanographiques d' Abidjan, Côte d' Ivoire; the Fisheries Research Utilization Branch, Ghana; and the Centre de Recherches Océanographiques de Dakar-Thiaroye, Sénégal, which will focus on regional case studies of climatic variability, coastal ecosystem dynamic and associated human responses. The collaboration of scientists from these institutes with the CEOS project is funded by the Scientific Committee on Dynamics and Use of Renewable Resources (DURR) of ORSTOM. Other national institutions are linked directly with the project, and/or through their own linkages with ICLARM.

products, however, in which these insights will be presented. These will be:

- a multi-authored book, tentatively titled "Global versus Local Changes in Marine Pelagic Systems", which will contain most of the research results;
- one synopsis for each of the four anchovy species making up the bulk of the biomass in each of the abovementioned ecosystems (*Engraulis ringens*, *E. mordax*, *E. encrasicolus* and *E. capensis*);
- a report presenting ECOPATH II models of the four systems, and the data upon which they are based;
- various scientific papers in the primary literature.

41- The manuscript will appear in the next issue of *FIGURE*

The CEOS project, as one of its contributions, will make the Comprehensive Ocean-Atmosphere

Thus, the project will last until mid-1994 at least, and this offers numerous possibilities for interested colleagues in developing or developed countries to team up with us. If you are interested, please write to the CEOS project at

ARTICLES

- 4-5 A Momentous Year for Fisheries and ICLARM • *K.T. MacKay*
- 5-6 ICLARM's Strategy for International Fisheries Research: A Summary
- 7-9 Fish for the Future - A Synopsis of the Report of the Study on International Fisheries Research
- 10 UNCED and Fisheries
- 11-13 NGO Fisheries and Sustainable Agriculture Treaties
- 14-15 The Peruvian Anchoveta, Charles Darwin and Us • *D. Pauly*
- 16-17 Problems Ahead for Fisheries Information Databases • *J.L. Maclean*

AQUABYTE (AQUACULTURE) SECTION

- 18-20 A Standard Format for Design and Evaluation of Pond Experiments • *J.P. Szyper*
- 21-22 Feasibility of Adopting Aquaculture to Increase Resource Productivity in Existing Bangladesh Farming Systems • *M. Ahmed and M.A. Rab*
- 23 News Items
- 24 New NTAS Members
- 24 Members Write
- 25 Photosection

FISHBYTE (FISHERIES) SECTION

- 26-30 The Climate and Eastern Ocean Systems Project • *A. Bakun, V. Christensen, C. Curtis, P. Cury, M.H. Durand, D. Husby, R. Mendelsohn, J. Mendo, R. Parrish, D. Pauly and C. Roy*
- 28-29 Brainstorming Workshop on Simulation

- of Sardine Fisheries in Lake Kariba • *B.E. Marshall*
- 39-41 Growth, Mortality, Maturity and Length-Weight Parameters of Fishes in Lake Kariba, Africa • *J. Kolding, E.M. Tirasin and L. Karege*
- 42-43 Length-Weight Relationships of Lake Kariba Fishes • *F.S.B. Torres, Jr.*
- 44-45 Tatang Sudjastani, 1940-1992
- 45-46 News Items

AFSSRNEWS SECTION

- 47-49 Regulations, Enforcement and Fisheries Resource Management • *K.K. Viswanathan*
- 49-50 News Items
- 50-51 Project Updates
- 51 Newsbits
- 51 In the Pipeline...

REGULAR FEATURES

- 52 International News
- 53 Asian Fisheries Society News
- 54-55 Book Review
- 56 Readership Survey, Part II
- 57-67 Information Department
- 68-71 Index to Articles, p. 57-65
- 71 Lore of the Sea
- 72 Advertisement

