GLOBEC INTERNATIONAL

NEWSLETTER

A Core Project of the
International Geosphere-Biosphere Programme

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Vol.9, No.2 | GLOBAL OCEAN ECOSYSTEM DYNAMICS | OCTOBER 2003

Editorial

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Many of you attended the highly successful 2nd GLOBEC Open Science Meeting in Qingdao, China, October 2002. The Proceedings of the meeting are ready for publication as a special issue of Fisheries Oceanography (FO 12 (4/5): 304 pp). They include 27 selected papers, peer-reviewed by scientists from our community. I use this opportunity to thank all the authors and reviewers for their hard work and for sticking to the deadlines! Attendants will receive their volumes shortly after publication, and extra copies can be purchased through the IPO at cost. The OSM marked a transition for GLOBEC, from a programme in implementation phase to a mature programme ready for integration and synthesis. Several GLOBEC activities at national and regional level are in synthesis, a process that will gather speed throughout the GLOBEC family as we approach our deadline of 2009. There is still a lot of science to implement in the process, and indeed new activities continue to be approved. For example read about the new Norwegian contribution to GLOBEC in this issue. Many of you would also be aware that new regional activities on Ecosystem Studies of Sub-Arctic Seas (ESSAS) and on Climate Impacts on Oceanic Top Predators (CLIOTOP) are in planning (see www.globec.org for more information). However, the emphasis on integration and synthesis of GLOBEC will increase in coming years. The Scientific Steering Committee is busy developing a strategy to facilitate this process. This integration will also occur in coordination with developments at the International Geosphere-Biosphere Programme (IGBP) and at the Scientific Committee for Oceanic Research (SCOR). In particular GLOBEC looks forward to co-operating with the new IGBP-SCOR initiative IMBER (Integrated Marine Biogeochemistry and Ecosystem Research, previously known as OCEANS), which is currently in planning. In future issues we hope to open our doors to IMBER and its research, to build and develop this broad and complex concept of 'Ecosystem Research'. IMBER will take over the space left by JGOFS, an incredibly successful programme that has just completed its work. JGOFS achievements are an inspiration and a lesson to GLOBEC. Goodbye JGOFS and welcome IMBER.

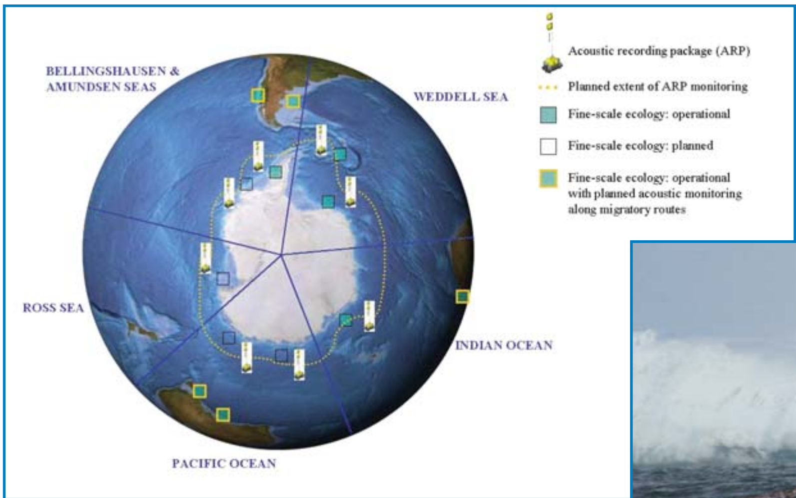


Figure 2. (Thiele, p. 9-11). Left- Map of existing and planned deployments of acoustic recording packages (ARP) for whale research around Antarctica. Right- Humpback whale lunge feeding.

A CORE PROJECT OF THE GLOBAL CHANGE IGBP

INTERNATIONAL GEOSPHERE-BIOSPHERE PROGRAMME
Co-Sponsored by: The Scientific Committee for Oceanic Research (SCOR)
and The Intergovernmental Oceanographic Commission of UNESCO (IOC)

Meeting announcement

The Small Pelagic Fish and Climate Change Programme (SPACC) is a regional programme of the Global Ocean Ecosystem Dynamics (GLOBEC) Project, and aims to understand and ultimately predict climate-induced changes in the productivity of small pelagic fish populations. SPACC announces two meetings in Chile, January 2004, on Spawning Habitat Dynamics of pelagic Fish.

1 – SPACC workshop on Characterizing and Comparing the Spawning Habitats of Small Pelagic Fish. Concepción, Chile, 12-13 January 2004.

The objectives of the workshop are:

1. To characterize in terms of environmental parameters the spawning habitats of small pelagic fish from a variety of ecosystems, including the Benguela, California, Canary, Humboldt and Kuroshio Current systems, the Bay of Biscay and the Iberian Peninsula, and southern Australia, using a variety of methods;
2. To use the results of the above analyses to conduct inter-ecosystem comparisons of anchovy and sardine spawning habitats;
3. To infer from the comparative analyses the likely responses of anchovy and sardine to changes in ocean climate and population size.

Convenors: C. van der Lingen (Marine and Coastal Management, S Africa), L. Castro (Universidad de Concepción, Chile), D. Checkley Jr. (Scripps Institution of Oceanography, USA), L. Drapeau (Institut de Recherche pour le Developpement, France).

Further information: Enquiries should be directed to Carl van der Lingen at vdlingen@mcm.wcape.gov.za. Visit the GLOBEC website for updated information.

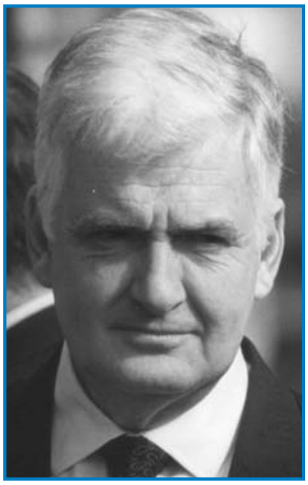
2- SPACC meeting on Small Pelagic Fish Spawning Habitat Dynamics and the Daily Egg Production Method, Concepción, Chile, 14-16 January 2004. The goal of this meeting is to analyze and compare the biological and oceanographic information obtained in DEPM studies around the world to assess the effect of environmental variability across spawning habitats on small pelagic fish populations. More specifically, the meeting will be organized around three major topics:

1. The relationship between the early life history of small pelagic fishes and their spawning habitat quality and dynamics;
2. The reproductive biology of small pelagic fishes and their spawning habitat;
3. New methodological approaches and spatial analyses in relation with the use of DEPM.

Convenors: L. Castro (Universidad de Concepcion, Chile), P. Freon (IRD, France), C. Van der Lingen (M&CM, South Africa).

Information: Questions regarding the Meeting should be directed to: Leonardo Castro: lecastro@udec.cl. Visit the GLOBEC website for updated information.

GLOBEC says goodbye to Jean-Paul Troadec



Jean-Paul Troadec, one of France's pioneers in multidisciplinary fisheries science, died of cancer on August 30th, 2003.

Dr Troadec was a retired senior scientist from IRD-France (formerly ORSTOM). He joined ORSTOM in the 1960's and soon became one of the leaders in the field of fisheries science in France. After spending several years in Ivory Coast at the Oceanographic Research Centre in Abidjan, he joined the Food and Agriculture Organisation (FAO, Rome) where he played a major role in its fisheries department. In the early 1980's, he became Director of the French Fisheries Research Institute known as ISTPM and initiated the merging with CNEXO that lead to the inception of IFREMER. Jean Paul Troadec was a brilliant scientist and a visionary. He had a major impact in fisheries science by initiating multidisciplinary GLOBEC-type research projects such as the French PNDR (Programme National sur le Déterminisme du Recrutement) in the mid-1980's. He was also one of the first fisheries scientists to highlight the importance of economic factors in controlling over-fishing and to emphasize the importance of access rights. Dr Troadec was a well respected fisheries expert at national and international level. The GLOBEC community wishes to express its condolences to his family and to the French scientific community.

CONTENTS

Climatic warming impacting pelagic fish stocks in the Black Sea due to an ecological regime shift during mid-1990s

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The Black Sea may be considered one of the best marine examples for the present Anthropocene era because of the complex human-induced effects on its ecosystem superimposed on climate-driven changes. Since the 1970's, it has been drawn into a highly unstable mode through a series of perturbations, mainly imposed by manipulation of river discharges, high input of nutrients and organic loads, invasion of the gelatinous carnivore species *Mnemiopsis leidyi*, and excessive fishing. The most serious deterioration of the Black Sea ecosystem was recorded towards the end of the 1980's when it was dominated entirely by the top predator jellyfish *Mnemiopsis* (Fig. 1).

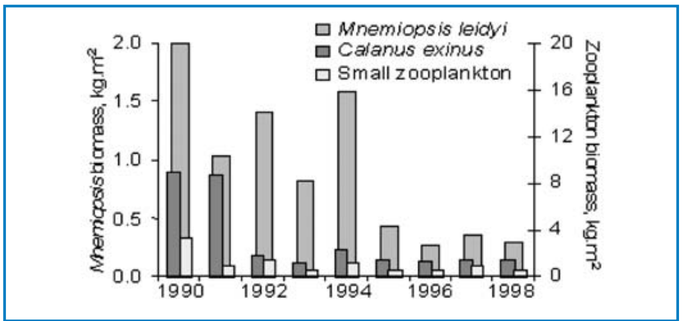

Figure 1. Autumn biomass distributions (kg m^{-2}) of Mnemiopsis, Calanus exinus and small mesozooplankton in offshore waters of the Black Sea (after Anninsky et al. 1998).

Adverse effects of human-induced perturbations have continued controlling the ecosystem during the last decade as well, even though some signs of recovery were noted (Kideys, 2002). The recovery of the ecosystem, suggested by the gradual decrease of the *Mnemiopsis* biomass (Fig. 1) and increase in the anchovy catch during the first half of the 1990's, was attributed to some measures for controlling eutrophication as well as a weaker top-down grazing control of *Mnemiopsis* on mesozooplankton community. On the other hand, abrupt decreases of both *Mnemiopsis* biomass and anchovy catch during the second half of 1990's together with low microzooplankton and mesozooplankton biomass levels comparable to those before 1995 indicate a different structure of the Black Sea ecosystem.This was caused by variations in its physical climate introduced by intensive warming of its surface waters (Oguz *et al*., 2003). The climatic signal coincided with 4 cm yr^{-1} net sea level rise in the basin, and a substantial change in the net annual mean fresh water flux from 150 km^3 yr^{-1} in 1993 to 420 km^3 yr^{-1} in 1997. These occurred as a consequence of the decadal scale climatic oscillations over the North Atlantic (Stanev and Peneva, 2002).

Sea surface temperature (SST) data provide a clear indication of warming of surface waters in the Black Sea during the 1990's. The basin-averaged winter (December-March)-mean and annual-mean SST variations during 1985-2001 period (Fig. 2) reveal an intense cooling period in the early 1990's followed by an equally strong winter warming phase during 1994-1996. The winter warming phase is maintained for the rest of the 1990's by a more gradual temperature variation. The basin-averaged winter SSTs retained at least their 1997 level of warming, and

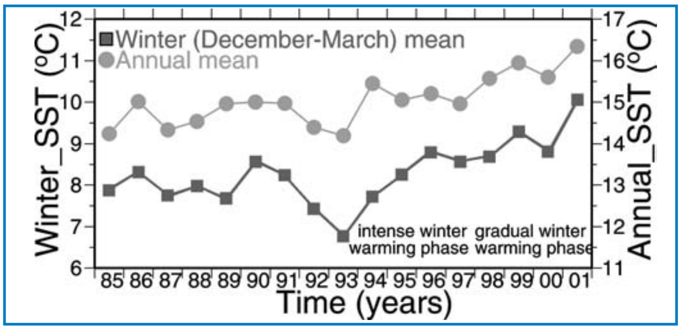

Figure 2. Basin-averaged, winter (December-March)–mean (squares) and annual-mean (dots) AVHRR sea surface temperature distributions in the Black Sea from 1985 to 2001. They are obtained from 9 km monthly-mean, gridded NOASS/NASA AVHRR Oceans Pathfinder data set. The averaging excludes the shelf areas shallower than 200 m. The temperature scale for the winter-mean data is given on the left, and for the annual-mean data on the right (after Oguz et al., 2003).

may be as high as ~10°C in 2001. These warmer winter SSTs were found to be correlated with milder winters characterized by relatively higher air temperatures (Krivosheya *et al.*, 2002), weaker heat loss to the atmosphere and weaker wind stress forcing exerted on the sea surface (Nezlin, 2001). The warming trend is also well-pronounced in the annual-mean data in the form of linear SST rise by about 2°C from 1993 to 2001 (Fig. 2).

The subsurface signature of the warming can be traced from the structure of the Cold Intermediate Layer (CIL), characterized traditionally by temperatures colder than 8°C. This cold water mass, convectively generated every winter within the upper 50-75m of the water column, preserves its identity between the seasonal and permanent thermoclines during rest of the year. As shown in Fig. 3 the average winter CIL temperature shows a linear trend of increase from its minimum value of 6.2°C in 1993 to around 7.7°C during the winters of 2000 and 2001. This trend follows quite closely the air temperature variations at the same site. Moreover, approximately 5-10 m rise of the anoxic interface level during the second half of 1990's (Yakushev *et al.*, 2001) might reflect destabilization of the permanent pycnocline as a consequence of warming of the surface waters.

The warming period may well be teleconnected to changes in

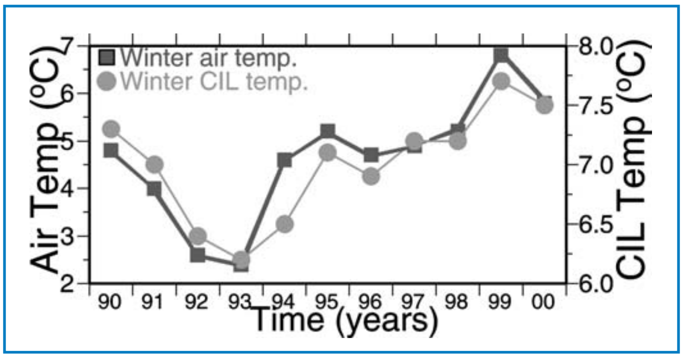

Figure 3. Winter (December-March)–mean air temperature (dots) and average CIL temperature (squares) distributions at a specific site along the northeastern coast of the Black Sea, off Gelendzhik from 1990 to 2000. The data are taken from Krivosheya et al. (2002).

the North Atlantic Oscillation (NAO) cycle, and the climatic warming trend of the Northern Hemisphere. Stanev and Peneva (2002) pointed out that the constant sea level rise of ~12cm in the Black Sea from 1993 to 1996 was correlated with the increased net fresh water flux into the basin which in turn is correlated with the dramatic decrease of the NAO index (from +2 to -2) during the same period. These changes in the physical climate of the sea imply a disintegration of the prevailing basinwide cyclonic circulation cell (Korotaev *et al.*, 2003), and weakening of the associated upward motion within the interior part of the basin after 1995.

In the Black Sea, different sets of biological time series data collected systematically at several coastal locations are available and show consistently similar features which might be correlated with local changes in the physical characteristics of the water column.

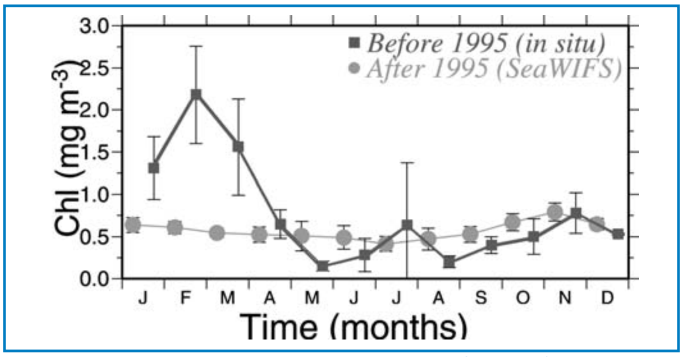

Figure 4. Monthly mean surface chlorophyll (mg m-3) distributions obtained by averaging all the monthly mean surface chlorophyll concentrations composed from different measurements carried out in deep parts of the sea prior to mid-1990's (squares) and from 9 km gridded SeaWIFS data for 1997-2002 and Ocean Color and Temperature Scanner (OCTS) data during November 1996-June 1997 (dots). The basin-averaging excludes the coastal regions shallower than 200 m (after Oguz et al., 2003).

The intimate relationship between climatic warming and the annual phytoplankton production can be inferred by comparing the multi-year average and basin-average monthly chlorophyll distributions for the periods before and after 1995 (Fig. 4). The Black Sea ecosystem up to mid-90's has been characterized by two distinct chlorophyll peaks (Yunev *et al.*, 2001). The major peak occurred either during February or March with a secondary peak in October or November. The surface mixed layer is characterized by much lower chlorophyll concentrations during the warm part of the year, from May to September, due to limited nutrient supply into the mixed layer. On the contrary, the composite ocean color data set representing the monthly mean chlorophyll concentrations since 1996 onwards (shown by dots in Fig. 4) indicates steady winter values of about 0.5 mg m^{-3} in contrast to a well-pronounced peak of ~2.0 mg m^{-3} in the data set prior to the mid-90's. Weaker turbulent mixing and stronger stratification during mild winters of all these years should be responsible for more limited nutrient supply from the nutricline, and consequently erosion of the late winter-early spring peak of the annual surface chlorophyll distribution by more than half after the mid-90's. Such a poor new production-based biological activity in February-March is followed by equally poor regenerated production during rest of the spring season. The annual structure acquires only a weak autumn peak of about 0.75 mg m^{-3} comparable to its counterpart in the former data set.

The measurements near Gelendzhik along the northeastern coast of the Black Sea also reveal two different forms of the annual mesozooplankton biomass distributions before and after

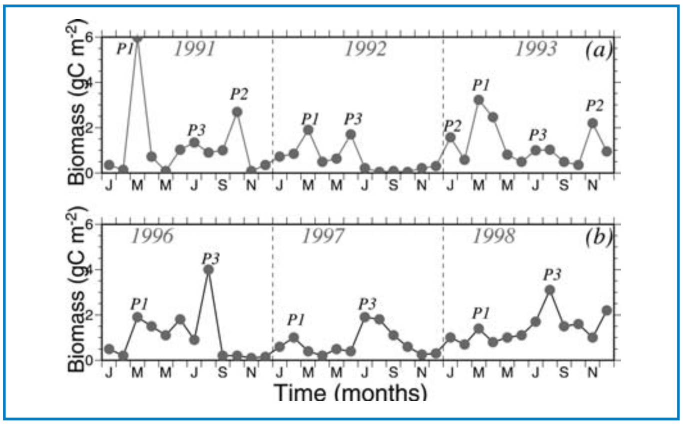

Figure 5. Distributions of mesozooplankton biomass (gC m^{-2}) near Gelendzhik along the northeastern Black Sea. Measurements are carried out during (a) 1991-1993 period, (b) 1996-1998 period (after Oguz et al., 2003).

1995 (Fig. 5). Their distributions for the 1991-1993 period possess two distinct maxima with the primary one in March, and the secondary one in October-November. They, denoted in Fig. 5a by P1 and P2, respectively, thus follow the spring and autumn phytoplankton blooms. These two peaks are connected with the relatively weaker summer mesozooplankton activity (given by the peak P3). The intensity of the latter peak is controlled by two contrasting processes; the subsurface phytoplankton production, and the feeding pressure of anchovy larvae which imposes its strongest control during the summer. This structure slightly differs during 1992 by weaker spring peak P1, and shift of the autumn peak P2 towards the following early winter season.

Similar measurements carried out at the same site during the 1996-1998 period, i.e. in warming phase of the Black Sea, show a systematically different annual pattern. The early-spring mesozooplankton bloom (i.e. the peak P1 in Fig. 5b) is no longer a dominant feature of their annual structure due to the bottom-up resource limitations in the spring primary production. The autumn mesozooplankton biomass distributions after the mid-1990's (i.e. the peaks P2 in Fig. 5b) are also somewhat lower than those of the early 1990's displayed in Fig. 5a. On the contrary, the summer peak P3 emerges as the most dominant feature of the annual mesozooplankton structure after mid-90's. It possibly arises due to a relatively weaker top-down grazing pressure introduced by reduced anchovy population. Somewhat similar annual structure is also observed within the Sevastopol Bay from September 1999 to November 2001 (Finenko *et al.*, 2003; see Fig. 12 in Oguz *et al.*, 2003). Once again, the mesozooplankton biomass is highest during summer months, even though the summer peak is shifted towards the autumn during the year 2000.

The effect of bottom-up limited unfavorable phytoplankton growth and subsequently reduced mesozooplankton stocks associated with climatic warming emerge at higher trophic levels in the form of decreasing trends in both the gelatinous carnivore biomass and the anchovy catch data during the second half of the 1990's (Fig. 1). Evidently, mesozooplankton stocks can no more meet the annual food demand of the pelagic fish community at a steady level. As warming prevails longer, both mesozooplankton and pelagic fish stocks are expected to decline further due to stronger bottom-up limitation associated with continual loss of nutrients from the euphotic zone against their more limited supply from subsurface levels. From the fishery perspective, a closer look at future evolution of the plankton community structure is therefore of critical economical importance.

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ICES/GLOBEC Cod and Climate Change Programme – results and achievements

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Cod stocks have generally declined over the past twenty years and landings fell from about 1.6 million tons in 1980 to just over half that in 2000. Climate change probably played a part in this decline for some stocks, but the overwhelming cause was excessive levels of fishing. Productivity and distribution of cod has been affected by environmental variability, with major consequences for recovery rates of depleted stocks.

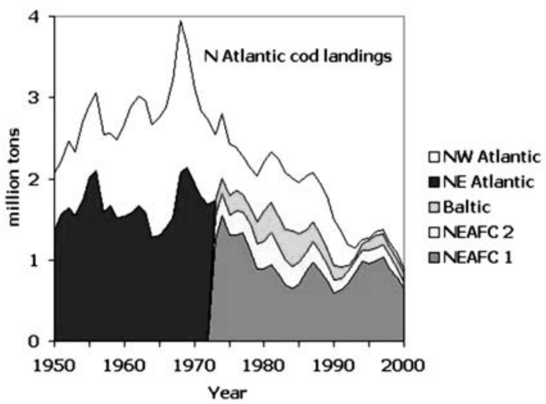

Figure 1. Catches of cod in the North Atlantic, by region (1950-2000)

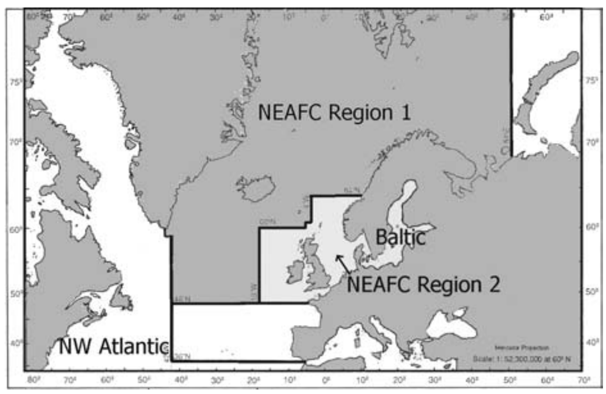

Figure 2. Main North Atlantic fishing regions, as reported in Fig. 1

The decline in cod stocks was steepest in the NW Atlantic, where landings in 2000 were 10% of their 1980 level and most fisheries remain closed. In many of these stocks individual growth rates declined from the early 1980's onward and condition of individual fish was also poor, so that mean weights at age fell by 50% or more. Poor condition contributed to lowering of recruitment rates, while natural mortality increased. The consequence of these changes, which are due in part to environmental variability and climate change, is that the productivity of some stocks has declined to the point where they are unlikely to recover even if the ban on fishing continues.

In the NE Atlantic the changes are less adverse. From 1980 to 2000 landings dropped by 50%, but in NEAFC Region 1 the decline was only 28%. Recruitment rates have fallen at the warm end of the species range, around the British Isles, but growth rates remain high and there is no evidence to date of increased natural mortality, such as has been observed in the NW Atlantic.

Information about the effects of climate on the processes which govern production (growth, maturation, egg production, transport during early life, survival and natural mortality) can be used in appraising the management options for sustainable fisheries. The development of methods for doing so has been