

The ICES/PICES/GLOBEC-SPACC Workshop on:

Changes in distribution and abundance of clupeiform small pelagic fish in relation to climate variability and global change [WKSPCLIM]

Chairs: J. Alheit (Germany), Jin Yeong Kim (Korea), R. Voss (Germany)
Kiel, Germany, 3-7 November 2008

Background and Goal

Background

Small pelagic fishes such as sardine, anchovy, herring and others represent about 20 – 25 % of the total annual world fisheries catch. They are widespread and occur in all oceans. They support important fisheries all over the world and the economies of many countries depend on those fisheries. They do respond dramatically and quickly to changes in ocean climate. Most are highly mobile; have short, plankton-based food chains and some even feed directly on phytoplankton. They are short-lived (3-7 years), highly fecund and some can spawn all year-round. These biological characteristics make them highly sensitive to environmental forcing and extremely variable in their abundance. Thousandfold changes in abundance over a few decades are characteristic for small pelagics and well-known examples include the Japanese sardine, sardines in the California Current, anchovies in the Humboldt Current, sardines in the Benguela Current or herring in European waters. Their drastic stock fluctuations often caused dramatic consequences for fishing communities, entire regions and even whole countries. Their dynamics have important economic consequences as well as ecological ones. They are the forage for larger fish, seabirds and marine mammals. The collapse of small pelagic fish populations is often accompanied by sharp declines in marine bird and mammal populations that depend on them for food. Major changes in abundance of small pelagic fishes may be accompanied by marked changes in ecosystem structure. The great plasticity in the growth, survival and other life-history characteristics of small pelagic fishes is the key to their dynamics and makes them ideal targets for testing the impact of climate variability on marine ecosystems and fish populations (Hunter and Alheit 1995).

Over the last 20 years, numerous accounts of recent changes in abundance and distribution of small pelagic fish such as anchovy, sardine, herring, sprat and sardinella have been given in peer-reviewed publications, technical and cruise reports, newspaper articles and personal communications of fishermen. Some examples are:

Changes in abundance

- Japanese sardine collapsed (Yatsu et al. 2008)
- Japanese anchovy recovered (Zenitani and Kimura 1997)
- Humboldt Current sardine collapsed (Alheit and Niquen 2004)
- Humboldt Current anchovy recovered (Alheit and Niquen 2004)
- Bay of Biscay anchovy collapsed
- Baltic sprat increased (Alheit et al. 2005)
- Sardinella in eastern Mediterranean (Tsikliras et al. 2007)
- Sardinella in western Mediterranean (Sabatés et al. 2006)

Changes in distribution

- European anchovy invaded North, Irish and Baltic Sea (Beare et al. 2004, Draganik and Wyszinski 2004)

- European sardine invaded North Sea (Beare et al. 2004)
- Eastwards shift of South African anchovy (Roy et al. 2007)
- Chilean anchovy moved south (Cubillos, pers. comm.)
- California sardine moved to British Columbia (McFarlane et al. 2005)

In most cases, the causes of these changes are not clear. It has been assumed that they might be related to climate variability or recent climate change or a combination of both of them, and they have been associated and correlated with respective climate indices such as NAO, AO, AMO, PDO, MOI or SOI. Most of these small pelagic stocks are of considerable economic importance and fishermen and fisheries managers are highly interested in finding out why the resources have could rely on for decades have all of a sudden diminished or almost disappeared. They are also interested in knowing whether small pelagic species, which were usually found only occasionally in their ecosystems, at once developed into fishable resources. Consequently, there is a need to know what caused these changes and how will these resources develop over the next years.

In order to respond to these demands and come up with reasonable predictions, scientists have to understand what are the causal relationships between the climate signals and the reactions of fish populations. So far, our respective knowledge is rather limited. One way to improve this understanding is the comparative method. By retrospectively comparing dynamics of small pelagics **in different ecosystems** and studying the impact of atmospheric and hydrodynamic forcing and the trophodynamic interactions we will improve our understanding of climate impact on small pelagics. Needless to say that this must be an interdisciplinary undertaking involving experts in climatology, oceanography, planktology and fish population dynamics.

An example for the usefulness of the comparative approach is demonstrated by the present situation of small pelagic fishes in European waters. North Atlantic marine ecosystems are exposed to the forcing of several climatic phenomena, such as the North Atlantic Oscillation (NAO), the Atlantic Multidecadal Oscillation (AMO) and global warming. At present, a fascinating natural climate experiment involving small pelagic schooling fish with pelagic eggs such as sardines, sardinellas, anchovies and sprats, is going on in waters surrounding Europe, which has been largely ignored, in spite of its acute and future commercial importance for the European fishing industry. Numerous observations by European fishery scientists over the last 20 years demonstrate clearly that small pelagic fish populations in all shelf seas surrounding Europe from the North African upwelling and the Black Sea in the south up to the Baltic Sea and southern Norwegian coasts are shifting their distributional borders to the North with concomitant dramatic changes in abundance and recruitment. Spectacular examples are the invasion of the North Sea by anchovies and sardines since the 1990s which have established spawning populations in this northern shelf sea and the penetration of the western Baltic Sea by anchovies and sardines. Another example is the drastic increase of the Baltic sprat stock which was initiated in the late 1980s. Whereas Spanish and French fishermen are banned from catching anchovies in the Bay of Biscay because of the precarious state of the stock and the Spanish fish industry has to import anchovies from distant places, fishermen in the North and the Baltic seas do not know how to market the increasing amounts of anchovies found in their nets.

Assuming that global warming will continue, dynamics of small pelagics will have profound consequences for fisheries and their management in North and Baltic Seas. Sardines and, particularly anchovies, will increase their population abundances, maybe locally up to commercial sizes. Sprat will spawn earlier in the season and its population size will depend on

the match/mismatch situation with its food sources. In any case, drastic changes in the dynamics of small pelagics will occur with concomitant problems for fisheries management. As has been observed in the Baltic and other ecosystems, small pelagics are usually good indicators of changes of entire ecosystems. Needless to say that the changes described above for anchovies, sardines and sprat were paralleled by similarly dramatic changes in abundance, distribution and phenology of key plankton populations. Consequently, we have to tackle the problem from the ecosystem point of view.

Goal

The workshop will bring together experts from the fields of climatology, physical oceanography, plankton and fisheries from different ecosystems. Ideally, participants will prepare background papers about their respective ecosystems and small pelagic resources which will be distributed to all participants before the workshop. This will bring all participants on the same level of knowledge, decrease the time needed for presentations at the meeting and increase the time for analysis and discussion. The product of the workshop is at least one joint paper for submission to a peer-reviewed journal. Hopefully, several additional papers on more regional issues can be added.

The ICES/PICES/GLOBEC-SPACC Workshop on **Changes in distribution and abundance of clupeiform small pelagic fish in relation to climate variability and global change** [WKSPCLIM] (Chairs: J. Alheit, Germany; R. Voss, Germany; Jin Yeong Kim, Korea) will meet in Kiel, Germany, 3-7 November 2008 to:

- a) document changes in distribution, abundance, condition and phenology of clupeiform small pelagic fish;
- b) to interpret these changes in the ecosystem context with a particular view to dynamics of plankton communities
- c) to identify where these changes can be linked to hydrodynamic and climatic changes

WKCLIM will report by 31 December 2008 to the attention of the Living Resources Committee, the Oceanographic Committee and GLOBEC/SPACC.

Supporting Information

PRIORITY:	The work of the group is essential if ICES is to progress with the understanding of the mechanisms driving changes in pelagic fish populations by connecting fish population dynamics to the environment and the ecosystem
SCIENTIFIC JUSTIFICATION AND RELATION TO ACTION PLAN:	The WK addresses goal 1 Understand the physical, chemical, and biological functioning of marine ecosystems, in particular action numbers 1.2.2 Changes in spatio-temporal distributions in relation with environmental change, 1.6 assess and predict impact of climate variability, and 1.7 play an active role in collaborations between ICES and GLOBEC. This WK is also related to Goal 4 Advise on the sustainable use of living marine resources, in particular Action No. 4.11 Develop the scientific basis for an ecosystem approach to management. The WK will further allow ICES to answer the OSPAR request on the impact of climate change on fish population dynamics and distributions
RESOURCE REQUIREMENTS:	No specific resource requirements beyond the need for members to prepare for and participate in the meeting
PARTICIPANTS:	Participants will include scientists from WGs of LRC and OCC as well as from GLOBEC/SPACC and the PICES, Mediterranean and Canary Current regions
SECRETARIAT FACILITIES:	None
FINANCIAL:	None
LINKAGES TO ADVISORY COMMITTEES:	Link with ACE through particular ToRs related to the OSPAR request
LINKAGES TO OTHER COMMITTEES OR GROUPS:	Link with WGPBI and WGRP of the Oceanography Committee (Link fish populations to meso-scale physical structures, use of hydrodynamic models outputs). Link with groups dealing with environmental and fisheries survey data.
LINKAGES TO OTHER ORGANIZATIONS:	This workshop will be proposed for approval by the Executive Committee of GLOBEC and the Fishery Science Committee of PICES
SECRETARIAT MARGINAL COST SHARE:	