

## **ICES/PICES Workshop on the Reaction of Northern Hemisphere Ecosystems to Climate Events: a Comparison (WKNORCLIM)**

*Comparative analysis of northern hemisphere marine ecosystem reorganizations – a large-scale approach to develop the basis for an ecosystem-based management of marine resources*

The workshop intends to conduct retrospective studies that analyze, re-analyze or synthesize existing information using a comparative approach. Specifically, we will try a northern hemisphere comparison of the effects of climate variability and change and anthropogenic forcing on regime changes in marine ecosystems. By applying this comparative approach to a wide range of different marine systems the workshop will identify large-scale synchronies and regional expressions in regime shift patterns and their underlying causative agents and mechanisms.

We expect to have data sets from the several North Pacific and European systems.

The idea of the workshop is to conduct the same analysis on all data sets for the individual ecosystems, eventually allowing a comparison of regime shift timing, and to identify common and region-specific drivers.

To conduct an effective analysis during the short period of time, the following minimum set of analyses will be conducted:

1. Principal Component Analyses (PCAs) to derive the main trends in the ecosystems
2. „Regime Shift Analyses“ on (i) the multivariate data sets using Chronological Clustering, and (ii) the PCA-output using STARS

As a basis for the analyses for every ecosystem to be analysed, one biotic and one abiotic data matrix needs to be available. Hence, an extensive selection of time-series is necessary. A few guidelines need to be followed when compiling the matrices.

The „biotic matrix“ should (if possible)

- represent all trophic levels (i.e. phyto- and zooplankton, planktivorous and piscivorous fish as well as marine mammals)!
- single variable time-series need to be aggregated to annual values; however if seasonality is strong, e.g. seasonal (most likely spring and summer) time-series can be included (often necessary for plankton).
- variables should be representative for a respective ecosystem, i.e. should include dominant species, but should be as far as possible balanced between trophic levels (meaning avoiding e.g. 20 plankton but only 3 fish species).

The „abiotic matrix“ should (if possible)

- represent all potential abiotic drivers of the local ecosystem dynamics (e.g. fisheries, eutrophication, hydrography, climate, etc.), and
- include a global climate index (e.g. Arctic Oscillation, NAO, etc.) present in the data sets of all ecosystems (suggestions appreciated!).

Generally, a number of trade-offs are needed when selecting and compiling the variables. This should be conducted by the regional experts. Important decisions are usually necessary to assure a balanced representation of the trophic levels and to avoid strong co-linearity in the data sets.

Usually, in time series missing values are encountered. For PCAs and, consequently, for the analysis of sudden changes in multivariate data sets missing values need to be replaced and some variables need to be previously transformed. When performing a PCA, many statistical programmes exchange missing values with variable averages. However, if data show a long-term temporal trend, this might be obscured in the ordination plot. Generally, we recommend to exchange data gaps with the average of the four nearest data points. This might be not possible, if gaps exist at the beginning or the end of the time series, or consecutive observations are missing. We advise the regional experts to fill the gaps, considering their best knowledge about temporal trends and variability in the data.

It would be very helpful, if as many as possible datasets would be ready before the workshop. If you need help with this, please let us know!

Furthermore, we have developed within the “ICES/HELCOM Working Group on Integrated Assessment of the Baltic Sea – WGIAB” (Diekmann & Möllmann 2010) some standard procedures and a code in R ([www.r-project.org](http://www.r-project.org)). If some of you who have data ready want to do the calculations before and try the code, you will find it attached to this e-mail.

In general an important issue for those who haven't done the intended analyses for their systems yet ... **IF YOU NEED HELP, PLEASE LET US KNOW!**

Diekmann, R., & Möllmann, C. (Eds). 2010 Integrated ecosystem assessments of seven Baltic Sea areas covering the last three decades. ICES Cooperative Research Report No. 302. 90 pp. Download at <http://www.ices.dk/products/cooperative.asp>.

Christian Möllmann  
Rabea Diekmann