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The introduction of marine Biometeorology will improve the specificity of the environmental change indication. I suggest inclusions into the suggested document as given in blue with some omittable figures for clarification.

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Literature:

Lange, U. & Greve, W. 1997: Does temperature influence the spawning time, recruitment and distribution of flatfish via ist influence on the rate of gonadal maturation? Deutsche Hydrographische Zeitschrift 49 (2/3), 251-263

Heyen, H., Fock, H. & Greve, W. 1998: Detecting relationships between the interannual variability in ecological time series and climate using a multivariate statistical approach- a case study on Helgoland Roads zooplankton. Climate Res. 10: 179-191

Greve, W. and U. Lange 1999: Plankton Prognosis in the North Sea. Deutsche Hydrogr.Z., Suppl. 10: 155-160

Greve Wulf, Uwe Lange, Frank Reiners and Jutta Nast 2001: Predicting the Seasonality of North Sea Zooplankton In: KRÖNCKE, I. & TÜRKAY, M. & SÜNDERMANN, J. (eds), Burning issues of North Sea ecology, Proceedings of the 14th international Senckenberg Conference North Sea 2000, Senckenbergiana marit. 32, in press

Working Group 1 (WG1): Indicators of environmental changes

(Moderator: Sabine Cochrane, Rapporteur: Chris Emblow)

Discussion items *and results*:

- Give general indicators for the impact of environment changes

General indicators (surrogates) are (indicating system (dis)equilibrium):

- *Taxonomic distinctness*
- *Structuring taxa*
- *Single taxa*
- *Functional groups*
- *Population dynamics*
- *Shifting taxa (temporal and spatial range change; exotics)*
- *Top predators*

- Give indicators for specific impacts (climatic changes, toxicants, etc.). ?

Previous list is applicable

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- *Top predators*

Take care that indicators are valid for long-term research and large scale (networking, uniform methods).

European marine biometeorological monitoring

- Do indicators (taxa/groups) exist which by their geographic and bathymetric distribution could be used?

As suitable geographic & bathymetric indicators were mentioned: Mytilus, Calanus, limpets, barnacles, chaetognaths (Sagitta spp)

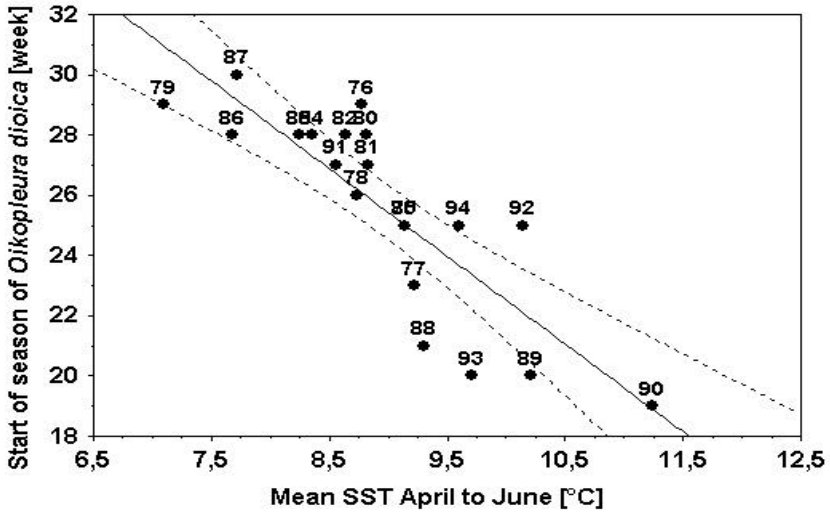
- Do indicators of early signs of biodiversity change/disturbance exist?

Early warning indicators are: taxon proportion (e.g. dominance of polychaetes), higher taxa diversity, seasonality, and selected single taxa.

functional biodiversity defines the species-specific functional relationship of any population to environmental forcing

seasonality changes indicate global warming effects

e.g. appendicularia (*Oikopleura dioica*), ctenophora (*Pleurobrachia pileus*) and many other



- What is the usefulness of biomarkers?

There are direct & indirect links of biomarkers with biodiversity and environmental health. These links have to be explored further. Four types of biomarkers exist: reproduction, genotoxicity, immuno-depression,- pollution exposure: and seasonal timing?

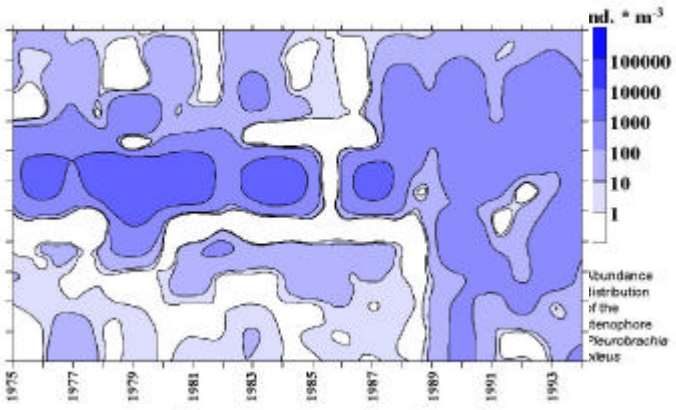
Remaining questions:

- *What is the link with biodiversity?*

species specific information

- *What is the relation with environmental health?*

Ecosystem stability changes can be caused by changes in the seasonality of top predators like ctenophores in this example:



equilibrium modifications: the shift of the *Pleurobrachia pileus* population dynamics from a two-peaked to a quasi-continuous annual distribution (Greve 2001)

- How to distinguish anthropogenic and natural impacts? *The distinction between anthropogenic and natural induced changes requires a good selection of a network of stations enabling inter-comparisons of sites to establish causes. The network should be selected at an appropriate scale (e.g. climate vs local impacts)*

Biometeorology: phenology responds to long-term (months) temperature impacts which in principal are climatic; exceptions as cooling water runoff are traceable and useful as specific effect indicators

- Indicate the major methods for the priority indicators?

phenological chequelists are recorded at a high frequency (weeks and days) by trained observers which need not be professional biologists (environmentalists, fishermen, divers, national park rangers and other)

- What indicators to use to predict a change in diversity (modelling)?

It is possible to predict changes in biodiversity for end users but it is important to carefully define boundary conditions and to be honest (with respect to both the input and the output). The input consists of combinations of assessment tools and the output could be models (GIS).

The prediction of the seasonality of species/populations according to preceding temperatures is possible for many zooplankton species of the North Sea. Other areas have to be investigated accordingly.

It is important to consider cascade effects: e.g. fisheries and natural changes result in changes of biodiversity (e.g. disappearance of 1 species) which on their turn will yield changes in other species and subsequently will have an impact on the food web and on habitats. For the end users it is important that the cause of these changes will be identified.

The seasonal reproduction timing and the following trophodynamic controls (match/mismatch Cushing) determine the year class success of holoplankton, benthos and fish.

- New question: The biological effects of which precise environmental changes do we want to measure (temperature changes, changes in seasonal patterns, interaction of climate changes with other environmental changes)? Why and what to monitor (which target?)

Any further biodiversity-changing impact has to be weighed against these changes.

- New question: Which taxa are appropriate to survey on long term at global scale and with which method:

Changes in biodiversity. Which habitats have to be covered? Spatial and temporal scale of the survey?

LME -wide and globally distributed (planktonic) species (*e.g. Oikopleura dioica*)

Key species population dynamics (possibly keystone, long-lived and sensible taxa)

Species at their limit of distribution (bathymetric and geographic)

latitudinal distribution limits (lateral displacements) provide biodiversity change indicators

Changes in the seasonal distribution (migration)

changes in the seasonal ontogenetic timing (phenology) are sensitive indicators

The effect on the physiology, reproduction, life cycles

seasonality is based on these temperature-dependent processes which could be studied by in vitro investigations