EURO-BASIN
BASIN SCALE ANALYSIS, SYNTHESIS AND INTEGRATION

SEVENTH FRAMEWORK PROGRAMME THEME 6 Environment

Collaborative project (Large-scale Integrating Project)

Project no: 246 933

Project Acronym: EURO-BASIN

Project title: European Basin-scale Analysis, Synthesis and Integration

Deliverable 8.1
Report specifying regions, taxa representation, data needs & sources for linear food-web analysis

Due date of deliverable: June 2011
Actual submission date: Dec 2011
Organisation name of the lead contractor of this deliverable: Un. Hamburg

Start date of project: 31.12.2010 Duration: 48 months
Project Coordinator: Michael St John, DTU Aqua

Project co-funded by the European Commission within the Seventh Framework Programme, Theme 6 Environment

Dissemination Level

PU	Public	X
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group specified by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

Deliverable 8.1 Report specifying regions, taxa representation, data needs & sources for linear food-web analysis (Responsible: UHAM, Delivery Date June 2011)

is a contribution to

Task 8.2: Comparative analysis of North Atlantic marine food web structure and function. This Task will focus first, on performing comparative food web analyses, for a set of North Atlantic regions. Then, the Task will conduct scenario analyses of the effects of changing fishing and environmental conditions in each region.

The aim of the food web analyses will be to distil out of historic data via retrospective analyses , metrics to describe food web structure and function such as are required for the EU-MSFD indicators of good ecological status. The approach will be to harvest the new information on diet and abundance coming from the other WP's in EURO-BASIN, and merge this with existing data sets. These data will form the basis for estimating the steady state annual flux of biomass in feeding networks representative of each of the study regions. The analysis will allow assessment of the role of key species in each region, ratios of production by integrated functional groups, and a variety of network metrics. For example, ratios of benthic/pelagic production and benthic invertebrate/demersal fish production which have been found to be diagnostic of ecosystem status in a variety of regions. . However they do not allow scenario testing to determine, for example, the ecosystem consequences of changes in fishing patterns or environmental conditions. For this, a dynamic simulation system is required. Here,, we have developed a simulation system incorporating explicit representations of low-trophic level and nutrient processes drawing on output from models developed in WP5 and WP6. Finally, scenario analyses will be used to investigate interacting effects of climate change and fishing on food web structure and functioning, including the examination of indicators representing good ecological status within the MSFD.

Responsible: USTRATH; Participants: ALL
Start month 1, end month 48

Executive Summary:
The main product of the deliverable is a summary of the biological data requirements and availability for the purpose of linear food-web analysis performed as part of Task 8.2. The report identifies geographic regions within the North Atlantic basin and distinguishes between data-rich regions as well as those that demand further inquiries about key trophic level species data from potential North American collaborators. Finally, the deliverable lists the available key trophic level species data in a given region per WP that provided the data, thus indicating the strong links between WP8 and the many ongoing activities within all other WPs.

Relevance to the project & potential policy impact:
The deliverable does not have a direct policy impact itself, but the data mapping and gap identification offers a firm base for building demonstration cases and proof of concept for a framework of end-to-end modeling, which can potentially be used to inform policy formulation, as stated in Deliverable 8.3.

Report:
In order to facilitate the comparative food web analyses, based on the principles of Ecopath, as well as the integrative analysis of past and future ecosystem change we have in a first step conducted a literature review on structural changes in marine ecosystems of the whole northern hemisphere (Möllmann & Diekmann 2012). We found abrupt and rapid shifts in food-web and community structure, commonly termed regime shifts. We found that rapid ecosystem changes occurred in synchrony during the late 1980s/ early 1990s suggesting a common climate driver. Trophic cascades triggered by overfishing are regularly involved indicating the interaction of multiple drivers. Multiple drivers potentially interact in a way that one undermines resilience (overfishing) and another (climate change) gives the final impulse for an abrupt change. Our review further shows that ecosystem regime shifts can be difficult to reverse when alternative stable states are involved. For EURO-BASIN this underlined the importance of understanding the drivers and mechanisms leading to regime shifts for developing ecosystem-based management strategies to achieve a sustainable exploitation of ecosystem services.

In a next step we made an inquiry within the marine research community on data availability that allows quantitative analysis and modelling of ecosystem structural changes. By this we assembled multi-trophic level meta-data for a large variety of northern hemisphere marine ecosystems, specifically for the Western North Atlantic (i.e. Scotian Shelf, the Gulf of Maine, Georges Bank the Southern New England area), the Eastern Atlantic Shelf Seas (i.e. Central Cantabrian Sea and the Bay of Biscay), the North-East Atlantic ecosystems (i.e. Barents Sea and the North Sea, the latter split into the Wadden Sea, the German Bight and an open sea area) and the semi-enclosed seas (i.e. Black Sea, the Mediterranean Sea and the Baltic Sea; the latter two split into sub-ecosystems in the Kattegat, the Sound, the Central Baltic Sea, the Gulfs of Riga and Finland as well as the Bothnian Sea and Bay and three coastal sites). In total time-series hold by colleagues internal and external of EURO-BASIN for 24 marine ecoregions.

Presently an inquiry is made to the various colleagues and institutions for making the original data available for a common meta-analysis of ecosystem structural changes based on published methodology of ecosystem trend and status assessment (Hare & Mantua 2000, Link et al. 2002, Choi et al. 2005, Möllmann et al. 2009). The analysis will include

Principal Component Analysis (PCA) to identify main trends in the multivariate matrices of time-series as well as multivariate (Constrained/chronological Clustering – CC) and a univariate (Sequential Regime Shift Detection Method – STARS; Rodionov 2004) technique for identifying discontinuities in time-series. A description of the methods and the necessary code to conduct the analysis in R (www.r-project.org) is given in Diekmann et al. (2012).

In order to cover the EURO-BASIN areas we presently have assembled multi-trophic level data for the North Sea, the Barents Sea and the above mentioned North-American systems (see Table 1). We presently seek and compile data on more sub-areas such as the Norwegian Sea.

References:

Choi, J., Frank, K., Petrie, B. and Leggett, W. (2005). Integrated assessment of a large marine ecosystem: A case study of the devolution of the eastern Scotian Shelf, Canada. Oceanogr. Mar. Biol. 43, 67-93.

Diekmann, R., Otto, S., and Möllmann, C. 2012. Towards Integrated Ecosystem Assessments (IEAs) of the Baltic Sea – Investigating ecosystem state and historical development. In: Climate Impacts on the Baltic Sea: From Science to Policy. Reckermann, M., Brander, K., MacKenzie, B.R., Omstedt, A. (eds). Springer, 1st Edition, 2012, 260 p. Hare, S.R. and Mantua, N.J. (2000). Empirical evidence for North Pacific regime shifts in 1977 and 1989. Prog. Oceanogr. 47, 103–145.

Link, J., Brodziak, J., Edwards, S., Overholtz, W., Mountain, D., Jossi, J., Smith, T. and Fogarty, M. (2002). Marine ecosystem assessment in a fisheries management context. Can. J. Fish. Aquat. Sci. 59, 1429-1440.

Möllmann C., and Diekmann, R. (2012) Marine ecosystem regime shifts induced by climate and overfishing – a review for the Northern hemisphere. Advances in Ecological Research, in press.

Möllmann, C., Diekmann, R., Müller-Karulis, B., Kornilovs, G., Plikshs, M. and Axe, P. (2009). Reorganization of a large marine ecosystem due to atmospheric and anthropogenic pressure: A discontinuous regime shift in the central Baltic Sea. Global Change Biol. 15, 1377-1393.

Table 1. Regions, data availability needs & sources for linear food-web and structural ecosystem analysis.

Area	Trophic level	Available	Needed	Sources	WP links
North Sea	Phytoplankton	+		SAHFOS	WP2,3
	Zooplankton	+		SAHFOS	WP3
	Pelagic fish	+		UHAM/DTU	WP5
	Demersal fish	+		UHAM/DTU	
	Mammals		+		
	Birds		+		
Barents Sea	Phytoplankton		+		
	Zooplankton	+		IMR	WP3
	Pelagic fish	+		IMR	WP5
	Demersal fish	+		IMR	
	Mammals	+		IMR	
	Birds	+		IMR	
Norwegian Sea	Phytoplankton		+		
	Zooplankton		+	IMR?	WP3
	Pelagic fish		+	IMR?	WP5
	Demersal fish		+	IMR?	WP5
	Mammals		+		
	Birds		+		
*Georges Bank**	Phytoplankton		+		
	Zooplankton	+		NOAA	
	Pelagic fish	+		NOAA	
	Demersal fish	+		NOAA	
	Mammals		+		
	Birds		+		
*Gulf of Maine**	Phytoplankton		+		
	Zooplankton	+		NOAA	
	Pelagic fish	+		NOAA	
	Demersal fish	+		NOAA	
	Mammals		+		
	Birds		+		
*Southern New England**	Phytoplankton		+		

	Zooplankton	+		NOAA
	Pelagic fish	+		NOAA
	Demersal fish	+		NOAA
	Mammals		+	
	Birds		+	
*Scotian Shelf**	Phytoplankton	+		Bedford Institute of Oceanography, Dartmouth
	Zooplankton	+		
	Pelagic fish	+		
	Demersal fish	+		
	Mammals	+		
	Birds		+	

** Data not hold by EURO-BASIN, but in the process of approaching data holders as potential North American partners to the programme. Deliverables 8.2 and 8.3 will use data-reach regions as demonstration of concept using data held by the consortium.*