Report: ECODRIVE Meeting
IMR Bergen 12th – 13th January

1. Project Management

Future ECODRIVE Meetings - It was agreed that planned sub-group meetings can/will occur and these will be organized, when needed, at the annual group meeting. For the next project meeting, several options were discussed, including Hamburg (Monday 27th September 2010) or some place in conjunction with the annual MarinEra Project meeting. To save one night, the meeting would start mid-day (Monday) and end late afternoon (Wednesday allowing a 2.5-d meeting (2 night stay). A MarinEra flier was handed to participants.

Project Acknowledgement - In the acknowledge section of papers it is important to mention ECODRIVE funding. Some statement should be written: "The present study was funded by ECODRIVE (Ecosystem Change in the North Sea: Processes, Drivers, Future Scenarios), a MarinERA project. " Also, oral presentations should show the new ECODRIVE logo.

Upcoming Meetings - There are two upcoming climate meetings that Jürgen mentioned (one ICES and one PICES). Potential keynote speakers should be recommended to Jürgen. We should also have participation upcoming workshop WKANSARNS (focusing on small pelagics in North Sea) to be held in July 6-9 in Nantes.
.
Website - The website is up and running. The website address is www.io-warnemuende.de/ecodrive.

Johannes recommended that the literature list should be updated with the basic references explaining the field. Subsections will be created. Myron suggested using WPs as first sub-sections and having additional sub-sections when needed:
WP1.1 References = long-term analyses of marine plankton and fish and climate-driven changes
WP1.2 References = marine ecophysiology, tolerance, bioenergetics
WP1.3 References = marine trophodynamics /foodwebs
WP2.1 Reference = Hydrodynamic modeling
WP2.2 References = NPZD and lower trophic level models
WP2.3 References = Multi-species analyses, etc.
WP3 References = Integrated assessments of marine systems (Baltic and North Sea)
WP4 References = Global Climate Models, Dynamic Downscaling, Climate Projections

Deliverables – No deliverable reports are necessary for German and Norwegian funding agencies. This was discussed. It was highly recommended to maintain the timeline of project milestones. Deliverable reports could be comprised of a series of manuscripts (with limited, over-arching text). A very preliminary list of manuscripts appears below (but must be updated).

2. Short summaries of research presentations

Maarten's Presentation (WP1)

A summary was provided of the Helgolands Roads Dataset. Temporal trends since the 1960s Phytoplankton: 20 species usable without restriction (phytoplankton). *Guinardia delicatula* dominated in the summer, *Thalasioneam* and *Odontella* are pushed to later in autumn or earlier in spring. Mean diatom day has shifted from 54 to 70 days. Herbivores are coming earlier. Zooplankton responses are also evident. Nutrient stoichiometry was discussed as a possible mechanism behind changes in the data series. An important limitation to using the zooplankton datasets could be cross-checking for systematic errors (e.g., due to purchasing a new microscope or having different researchers working on samples). Unlike the phytoplankton data set, Maarten had good confidence in the zooplankton dataset. Samples since 2005 reside on Helgoland. Earlier samples need to be obtained from another storage facility (Greve). Possibility of re-analysis of some samples (via zooscan) was discussed.

Carola's Presentation (WP1)
Comparison of CPR to Helgoland data (regional) and comparisons of long-term rends in the North Sea. Only three species *Temora longicornis*, *Euterpina acutifrons* and *Penilia avirostris*. Mean seasonality and long-term trends. *Temora* abundance was provided as an example. The seasonality compares quite well between the two data sets. The abundance of cyclopoid copepods has increased over time at Helgoland Roads, but has decreased in the CPR. Separating the North Sea into biophysical zones was considered to be a good idea for time series and/or spatial analyses of ecosystem changes. The zones could initially be based upon the original ICES sub-divisions (based upon hydrographical and topographical features / characteristics). Clarification of time series analysis activities (who is doing what) will be obtained at a future meeting in Hamburg.

Svein's Presentation (WP1)
"Hydrodynamic influences of *Calanus* Dynamics and Atlantic cod Recruitment". The deepwater volume inflow appears to dictate *Cal fin* abundance in the North Sea. When there is high influx into Norwegian coastal areas, this also occurs in the North Sea. Weak Atlantic inflow is wide and shallow and a small door opens for the Norwegian Sea intermediate water. This door is blocked by Strong Atlantic inflow - this explains the differences between deep and shallow volume fluxes. This challenges the great salinity anomalies which appears to be more associated with fluxes of water into and out of the Arctic (happening simultaneously) and not merely due to a great slug of water that is propagating around the system with 14 year period. Five-year time lag between SSB of cod and *Calanus*. $R^2 = 0.56$. NAO transport of + Atlantic inflow, - inflow of *Cal fin* NSIW, - transport of *Cal fin*., - Local spring production of *Cal fin*, lower cod spawning stock biomass 5 years later. The AMO, changes ocean climate *Cal fin*. moves north, + Ocean climate in Norwegian Trench, Beneficial conditions of overwinter of *Cal fin* in NT, negative for *Cal fin* in North Sea. Temperature is proxy for advections of *Cal fin*, Atlantic inflow is not source, it is *Cal fin* leak from NSIW, advection of *Cal fin* can support increase production of North Sea cod.

Mark's Presentation (WP1)
Anchovy in the North Sea, time series show marked abundance in 1995 with a peak in 2004 – the abundance is now going down again to relatively low levels (but still present). Stomach sampling has been undertaken on adult anchovy captured in the southwestern Baltic, German Bight, central North Sea and 55°N and 0°E. Tactic was to sample as many sites as possible and to do 5 fish per station. Omnivory was apparent. Fish larvae (clupeids and other species), but no fish eggs (so no cannibalistic tendency as found in other – upwelling systems. Sprat and herring have 95% in first diet categories of anchovy (mostly copepods) – only 90% of the diet of anchovy. German Bight

had a lot of chaetognaths. The diets are similar in southern areas of Europe. Anchovy tend to feed on larger prey items compared to sardine. One paper has been submitted to ICES J Mar Sci. "Effects of climate and food on anchovy distribution and abundance in the North Sea" by Raab, Licandro, Llope, et al. Other papers in Raab's PhD were also listed.

Jürgen's Presentation (WP1)
Three short period of abrupt changes in North Sea 1987-88, mid-1995, around 2000. The mid-1995, lots of documented changes in copepods and fish (adult clupeids) and other species. Poleward movements of small pelagic fish was discussed. Anchovy eggs found in Helgoland Roads time series in mid-1990s (timing agrees with work in the Irish Sea on adult anchovy). Norwegian spring-spawning herring also responded (increased), starting earlier (AMO) – 1983 a bit earlier. *Cal fin* versus *Cal Helg* changes (late 1990ies?). *Oithona similis* (German, Wadden Sea) has also increased, a species that is typically a coastal species in the Norwegian Seas. Contraction of the Subpolar Gyre may be connected to AMO – allows water to fill in around the British Isles. Both the AMO and the Volume index had simultaneous changes in their time series in 1995 (ICES working group). Main question in the mid-1990ies: what changed? Another basic question is, what are the mechanisms behind synchronous changes in Northwest European marine systems? Water transport signals happen three to four years after the NAO signal. Mid-1980s shift could be due to the minimum temperatures in the winter that shifted at that time. Threshold temperatures should be examined (e.g., sea lice in Norwegian salmon is correlated to winter temperatures).

Myron's Presentation (WP1, 4)
WP1.2 Work targeting ecophysiology of early life stages of fish and copepods was briefly discussed. Examples were provided of ecophysiologically-based maps that can be created for potential habitats of North Sea cod, sprat and herring based upon egg temperature tolerance and temperature x prey requirements for survival of young larvae. These maps are planned using projected changes in hydrography in the North Sea (WP4). Generic larval fish IBMs and temperature tolerance were discussed. An important point regarding the use of NPZD estimates is that size spectra need to be thoroughly examined. Recent studies suggest slopes are more negative in shallower waters and seasonal variation exists (slopes related to level of secondary production). Spatial changes in the North Sea must be examined and potential spatial differences in the slope (and therefore the production of different prey size classes) may need to be incorporated. Recommended to talk with Henk van der Veer regarding size spectra data available for North Sea (also discuss this with Xabier Irigoen).

Gjert's Presentation (WP1, 2)
WP1.3 The importance of predator-prey overlap in predicting North Sea cod recovery was discussed based upon the results of a multi-species upper trophic level model. Spatial distributions of fish and overlaps among upper trophic level predators are highly variable (IBTS survey). Hindcast of the multi-species model with variable overlap is more similar to the single species hindcast than multi-species hindcast with constant overlap. Ricker SRR fitted for the period 1991 to 2007 for projections. SSB of single species is far too optimistic. Minimum overlap also is over-estimating SSB of North Sea cod. Spatial dynamics of predator-prey interactions is critical – results indicate that overlap varies with temperature.

Rabea's Presentation (WP3)
WP3 Multivariate statistics will be used in corroboration with WGHAME and Baltic Sea Integrated assessment. 1979 to 2004. Using fish data from the ICES assessment start in 1983 – extended those to 1979. This time series will be updated for ECODRIVE. Quintiles were used for 51 variables. No sub-regions were utilized. Trophic control patterns. Kenny et al. 2009 was discussed. Also discussed Baltic work. North Sea sub-sections can be analyzed. Common trends in variable groups - examining lag 1. Using (add) atmospheric proxies.

1) Different regions are required
2) Data set should be improved (lengthened, extended)
3) Northern areas (e.g., timing of spring bloom, Mum, David Mills)
4) Production by Mike Heath (look at the RECLAIM datasets)

Marc's Presentation (WP1, 2, 3)
Presentation about the herring modeling approach and the ability to create informed proxies (abiotic factors) impacting recruitment strength in that species. The biophysical modeling tool allowed metabolic requirements of young larvae to be calculated at different temperatures and body sizes based upon changes in foraging potential and other physiological attributes (e.g., assimilation efficiency). The work is being conducted in 3-D. Prey fields have yet to be incorporated into the approach. Availability of biomass estimates from the CPR survey may be helpful. Observed mean lengths of larvae captured in the MIK survey were greater prior to 1990 (or shortly thereafter). Morten commented that the variability in the values was higher starting a bit later. The modeled and observed lengths only agreed for the most recent years. Marc discussed three possible reasons for the discrepancy (changes in size-selective mortality, changes in the prey field available to fish prior to 1990 and/or changes in the relative condition and growth dynamics of the herring larvae).

Thomas' Presentation (WP2)
Hindcast simulations are available for at least 30 years but could be done for longer. A validation exercise will be done. There was a delay of three to four months because of the installation of a new mainframe system. The new machine (an IBM) requires a lot of time to adapt the code. A new North Sea model with 3 km resolution goes from 51 to 62°N, 4W to 13E. The resolution is much higher than previously (20 km). The temperature and salinity have been compared to BSH. The differences between observed and modeled salinities are <0.2 psu in most areas. The model estimates the hydrography in the southern North Sea quite well but the Baltic outflow is too deep within transects around 58 and 59°N. This is no longer apparent along a transect at 60°N. Temperatures compared well as usual. For the long-term run, an investigation for 60 year period (from NCEP/NCAR), reanalysis (6h) has already been performed on the old 20 km grid. A discussion about using climatological means for river data does not lead to a final conclusion. SST Helgoland 1973-2007 is biased by 0.6°K. Surface and bottom temperature plots were shown along with heat content. Bottom temperatures in the northern North Sea (150 m) were 4 to 6°C earlier in the time series but those low temperatures have disappeared in the last decade. The timing and intensity of thermocline parameters was variable and did not show a clear trend in time (due to opposing effects of physical forcings). Correlations between temperature in different times of the year and NAO was between 0.41 and 0.49. The model runs were from 1948 to 2007.

A discussion of comparison of long-term modeled data ensued. Prior to hard comparison, it is instructive to merely show the ensemble of data that we've modeled. Put results together and see how they compare. This could be followed by a more complex (hard) comparison.

Three areas that are important in Svein's opinion would be:

1) Tidal front in the southern North Sea must be well represented
2) Structure of Jutland Current (Nutrient-driven advection) and
3) Volume fluxes across different areas

Such comparisons (of physical modeled data) are planned by Thomas (2nd ECODRIVE PhD student). Myron suggested that a comparison of long-term NPZD models would be beneficial (particularly with regard to overwinter values of secondary production). Morten made the point that physical models must be compared first and that NPZD (or NPD) outputs from long-term runs are offline. Running that NPD model within another physical model possible.

Ute's Presentation (Uni-Bergen) (WP2)

Ute gave a presentation on the background of the Uni Bergen model system. Physical model runs available for 1958 to 2004, coupled bio-physical runs for 1980s to 2004. Improvement of boundary conditions, blue-greens and oxygen, improved for Baltic Sea. Long-term runs planned for 1948-2009. Specifically, more tidal constituents, atmospheric nutrient deposition and other factors are being updated. The inclusion of tides has a large impact on phytoplankton production (50 to 60%). The timing of blooms is also influenced by interacting tidal constituents. Ongoing collaborations with Volker Mathias (GKSS Geesthacht) for atmospheric nutrient deposition (NH4 and NO3). Runs with and without atmospheric nutrient deposition were compiled. Also sediment fluxes are now included. The long-term hindcast simulations from 1958 will be compiled with different atmospheric forcing data (NCEP/NCAR, ECMWF era-40). Parallel model version is available (35 minutes per year), which allows for model runs with increased spatial resolution. There was a delay in Uni Bergen due to the hiring project personnel.

Morten's presentation (WP2)

Morten showed heat content for the North Sea indicating similar years where changes occurred that were previously discussed in biological presentations. Also, more recent years show cooling. 1955-2008. Meso and microzooplankton have been added and they are stabilized after four to five years. Offline model is available to WP4 (same model used in hindcast and future projections. The results agreed with a comment made by Svein who made the point that the warmest temperatures on record were made in 2006 and now the waters are somewhat cooler (below are close to average). Svein also suggested that we update our time series so as not be misleading (or ignorant of) recent trends. There is a large thermal gradient along the Norwegian coast during the last few years.

Moritz's Presentation (WP2)

Moritz Mathis gave a presentation on his work in Thomas' group. Projection of hydrodynamic condition in the North Sea for the 21 century. Using HAMSOM. (3km, mesoscale resolution). The lateral boundaries were A1B for MPI-OM – monthly mean values – temperature, salinity and surface elevation. The model REMO provided hourly values – got 6 values: air temperature, surface pressure, winds (magnitude and direction) and cloud cover. Efforts to prepare for the water and atmospheric data were discussed (ways to correct values for differences to make data fit with HAMSOM utilization). Hindcast predictions are also going to be done.

Johannes' Presentation (WP2)

ECOHAM4.2 1970 to 2006 simulations have been made. The model is not really an NPZD model due to the addition of other state variables (including those in the sediment, bacteria, two

fractions of detritus, etc.). Annual atmospheric nitrogen deposition is 30% of that entering via rivers. Primary production is decoupled (carbon is still fixed at various nutrient concentrations). The agreement between the North Sea inflow and NAO could be seen only for the years around 1989. Acidification can be seen in the northern North Sea (0.09 pH units from 1970 to 2006). River DIC loads more heavily influence pH values in the southern North Sea. The North Sea may be more influenced by acidification than the open ocean, therefore the values may be expected (values shown were similar to those occurring since the industrial revolution in world's oceans). Diatoms highest in 1980s and decreasing later. Non-diatoms also highest in 1980s. Redfield production – ammonium uptake by flagellates (non-diatoms) causes the highest variability, particularly by that occurring in the southern North Sea. 0.73 correlation between river discharge and precipitation but this was not correlated well to the NAO due to the rivers flowing through areas that are impacted in different ways by the NAO.

Björn's Presentation (WP4)
The first point were activities within WP4, Future scenarios – using hydrodynamic and NPZD models (eutrophication scenarios). Regional hydrodynamic projections, eutrophication, higher trophic levels and exploitation, scenario forecasts of North Sea ecosystem. IPCC downscaling. An application using ROMs was provided in the previous meeting. Basic message was, that added value is obtained from downscaling but that major problems with the GCM will not be fixed by downscaling. Atmospheric forcing more important than regional boundaries. Will do 20 to 30 year control, 2*20 year scenario with A1B (HAMSOM) and cooperative analysis of results. Eutrophication could be tackled, if NORWECOM was run offline (Jason Holt has done some simulations for MEECE that could be interesting). The last task within 4.5 is very close to a synthesis activity.

3. "Deliverable Papers"

The following list of papers was a starting point towards dealing with all deliverable reports. Note, these papers do not represent those planned for WP2.3, WP3 and WP4 activities – those still need to be added. This strategy was adopted since deliverable reports are not requested by national funding agencies). Everyone should be aware of the milestones (and their dates), so that the data flow within project is not interrupted.

"Deliverable Papers" (a rough view)

1) Comparison of long-term zooplankton time series from the North Sea: Apples and Oranges on the same tree
2) Environmental drivers of changes in lower trophic level productivity
3) Physiological-based modeling of early life stages of key North Sea fish species
4) Modeling top-down and bottom-up processes impacting herring (Axel, Marc, Mark)
4) Path analysis of food web changes in the North Sea (Marc)
5) Comparison and calibration of long-term physical models in the North Sea (Thomas)
6) Comparison of long-term runs of lower trophic level models in the North Sea (Morten)
7) Cod, climate and copepods in the northern North Sea
8) Comparing responses of plankton communities and atmosphere ocean coupling in the North Sea (literature study) (Sven, et al.), synthesis paper
9) North Sea Ecophysiology Paper - North Sea copepods and larval fish early life stages.

10) Projecting climate-driven changes in over-wintering
11) Workshop paper on sardine and anchovy: building hypotheses regarding likely causes of changes in productivity. (Jürgen and Mark Dickey-Collas)

4. Participants

Alheit, Jürgen
Boersma, Maarten
Daewel, Ute
Dickey-Collas, Mark
Diekmann, Rabea
Dingsør, Gjert
Hjøllo, Solfried
Hufnagl, Marc
Kong, Sopha-Mith
Mathis, Moritz
Pätsch, Johannes
Peck, Myron
Pohlmann, Thomas
Pushpadas, Dhanya
Skogen, Morten
Sundby, Svein
Svendsen, Sturla Winger
Wagner, Carola
Ådlansvik, Bjørn

5. Agenda

Tuesday

10.00 – 10.20 Final discussion and decision on agenda

10:20 – 10:35 Progress **WP 1** (Maarten and Svein)

10:35 – 10.50 Helgoland Roads data (Maarten)

10:50 – 11:05 Comparison CPR and HR data (Carola)

11:05 – 11:20 New data on anchovies in North Sea (Mark)

11:20 – 11:40 Coffee break

11:40 – 12:10 Climate analysis of long-term ecosystem changes (Svein)

12:10 – 12:40 Climate drivers of North Sea zooplankton and small pelagic fishes (Jürgen)

12:40 – 14:00 Lunch break

14:00 – 14:15 Data set describing ecophysiological tolerances and optima to abiotic factors for key species and assemblages (phyto, zoopl and fish) for ecosystem analyses in WP3 (Myron)

14:15 – 14:45 Progress **WP 3** (Gjert and Rabea)

14:45 – 15:00 Development of "informed proxies" from recent biophysical modeling work on marine fish early life stages (Marc)

15:00 – 16:00 Discussion in small groups (for example: one group on WP1, one group on WP3)

16:00 – 16.20 Coffee break

16:20 – 16:50 Progress **WP 2** (Thomas and Ute)

16:50 – 19:00 Presentations by Ute, Thomas, Morten, Johannes, Björn?

20:00 Joint dinner (where?)

Wednesday

09:00 – 09:30 Progress **WP 4** (Björn and Myron)

09:30 – 11:00 Group meetings of all 4 WPs (4 rooms required)

11:00 – 11:20 Coffee break

11:20 – 13:00 Group meetings ctd.

13:00 – 14:20 Lunch break

14:20 – 15:00 Project management **WP 5** (Jürgen and Morten)

15:00 – 16:30 Group meetings ctd.

16:00 – 17:30 Presentation of results of group meetings

17:30 – 18:00 Wrap up

19:00 Joint dinner