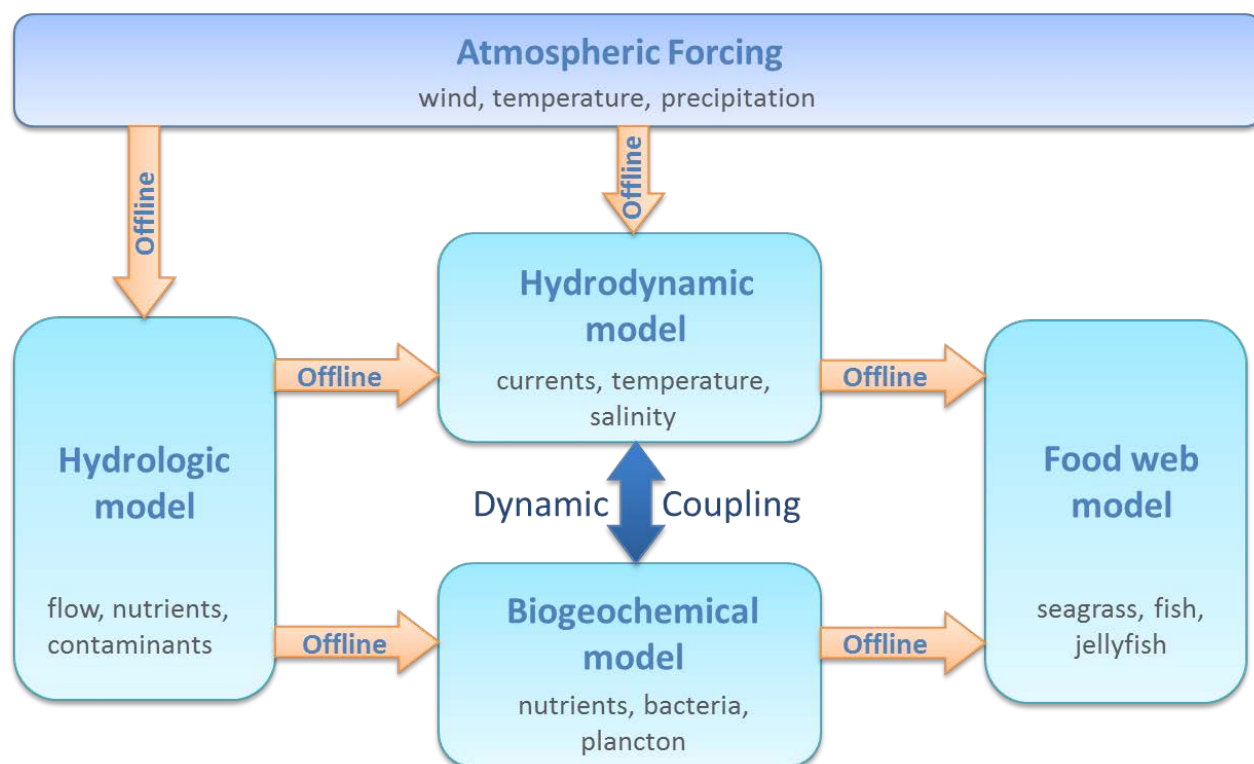European Commission

JRC TECHNICAL REPORTS

Report on the second workshop of the Network of Experts for ReDeveloping Models of the European Marine Environment

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Foreword

The second workshop of the 'Network of Experts for ReDeveloping Models of the European Marine Environment' was held on 22-23 March 2017 in Brussels, Belgium, jointly organized by DG Environment and DG JRC (Water and Marine Resources Unit) within the framework of the Administrative Arrangement (N110661/ENV.C.2/2016/733192) and the Marine Strategy Framework Directive (MFSD). The aim of this workshop was to continue the information exchange between the Commission and marine modelling experts. Another important objective of this initiative is to narrow the gap between modellers and decision makers in order to better exploit the full utility of models. In this context, the workshop consisted of 17 presentations covering the wide use of marine ecosystem models to address several indicators of the MFSD in coastal zones and European regional seas, including assessment, indicator development and scenario building. The presentations dealt with (1) General lectures, (2) Eutrophication, (3) Hydrography, (4) Higher Trophic Levels and (5) Fish. The participants were invited to join the network informal 'Network of experts on the Modelling of the European Marine Environment (MEME)'. DG Environment and DG JRC emphasized the added value of a joint effort to further develop modelling capabilities with the objective of providing useful advice for policy makers. This report summarizes the workshop and provides further detail on the presentations, discussion and conclusions.

1. Introduction

While the implementation of the Marine Strategy Framework Directive (MFSD) is progressing in the Member States (MS), the European Commission is building up its own analytical capacity in order to improve the understanding of the marine environment from an EU perspective. The progress achieved during the last 30 years in marine modelling now allows a more realistic simulation of many aspects of the marine environment. As already pointed out in previous meetings, the use of marine modelling can support the assessment process of the marine environment as foreseen in the MFSD by defining baselines, addressing data gaps and allowing for scenario simulations. To fully exploit this potential, the Commission is developing a modelling framework for the marine environment including all aspects necessary to create a Regional Earth System Modelling tool (*i.e.,* the atmosphere, the hydrology and the ocean components). This will be done in a transparent way, pursuing outside communication and consultation along two axes.

The first axis is vis-à-vis the Member States (MS) since it is vital to ensure consistency and mutual awareness between MS and the EU-level activities. This is true especially when assumptions and scenarios are being built up and when results are discussed. In order to achieve this, the Commission will ensure appropriate communication with the working groups under the Common Implementation Strategy of the MSFD.

The second axis is concerned with technical expertise. In this context the Commission has established an informal advisory network of marine modelling experts. The purpose of this network will be to ensure that the most pertinent and state-of-the-art technical knowledge is available in the development of the modelling framework. Participants in the network will be kept informed about progress in building up the modelling framework, and they will from time to time be asked for their opinions, advice or feedback.

This second workshop of the modelling experts group will serve to continue and improve the collaboration and awareness within the network. This workshop was jointly organized by DG ENV and DG JRC within the framework of the Administrative Arrangement NoENV. N110661/ENV.C.2/2016/733192 and was thematically focused as described below.

The marine environment is a very wide field of study, so a targeted step-by-step approach will be pursued in building up the modelling framework, both in terms of environmental issues and geographical coverage. Holistic Ecosystem Assessment is required by the MSFD in order to assess the achievement of Good Environmental Status (GES). Ecological modelling could play a key role within the implementation of the MSFD by supporting the assessment of the ecological state and to evaluate different management strategies.

Contributions to this second workshop were received addressing innovative modelling approaches in coastal zones and European regional seas using ecosystem modelling for assessment, indicator development and scenario building in support of MSFD implementation. One aim was to learn about existing work and to draw lessons for the build-up of the European modelling effort. Another important objective of this initiative was

to narrow the gap between modellers and decision makers in order to better exploit the full utility of models.

On the contrary as in previous workshops where presentations were organized around geographic areas (Macias et al., 2016), in this occasion different general topics were selected and the sessions organized around them. In the first block of talks, a general overview of big modelling initiatives at European levels were presented such as the Marine Modelling Framework of DG JRC, the BLUE2 project coordinated by DG ENV or the Copernicus Marine Environmental Monitoring Service of MERCATOR Ocean. The second session was devoted (as the first MEME workshop) to eutrophication issues (D5 of the MSFD) as this remains one of the major water quality problems in lakes, reservoirs, coastal zones and the marine environment in many parts of the world. The following session was centered on 'hydrographic changes' (D11 of the MSFD) as one of the least studied and evaluated descriptors of the Good Environmental Status (GES) and being an example of how hydrodynamic models could be extremely useful tools. The fourth session was dedicated to the modeling of higher trophic levels with biodiversity indicators (DX) as the main MFSD-related targets. On the following sessions, a more concentrated approach to fish-stock modelling was presented emphasizing the links between environmental drivers and fish population dynamics, i.e., following the 'ecosystem based fisheries management' as encouraged not only by the MFSD but also by the Common Fisheries Policy as a method to foster the 'blue growth'. The final session of the workshop was a round table discussion about lesson learned by the EU marine modelling community in the past years and possible paths to move forward. Further down, individual sections of the present report summarize the different presentations within each section and the main key messages and discussion points raised within the attendants.

This report also includes three Annexes with (I) the list of participants and the title of the corresponding presentations, (II) the Abstracts, and (III) the Workshop Agenda.

2. General session. Big marine modelling initiatives at EU level

Three presentations were made within this session by G. Hoermandinger (DG ENV) and by C. Perruche (MERCATOR) about two of the big EU-wide initiatives on marine modelling.

On the first talk, G. Hoermandinger welcomed the group to this second workshop stressing the growing importance of modelling as a policy support tool. Such tools are very useful, for example, to evaluate the cost/benefit of policy options and to perform impact assessment studies. He mentioned that the inspiration to create the Marine Modeling Framework (MMF) within the EU-Commission came from the air-quality field were numerical models to evaluate the impact of policy options on air quality have been in use since decades. He stressed that in order for the MMF be an acceptable policy-support tool, transparency in its building and design should be applied, and that it needed to be ensured that the most adequate, state-of-the-art approaches are applied in agreement with the scientific community. In 2019 the Commission will have to produce a report about the MSFD

implementation in the different member states in accordance with Article 20(3) of the MSFD, and the MMF should be ready and operative for that deadline as far as possible.

The second talk, also delivered by G. Hoermandinger, was devoted to present the BLUE2 initiative to the attendants. This is a project launched by DG ENV through a call for tender aiming at bridging the gap between modelling tools and actual policy support. At the center of this initiative, the MMF models are located to which a set of pressures (and alternative scenarios) are provided. The different results provided by the marine models are then analyzed in socio-economic terms in order to evaluate the benefits of each management option evaluated. As the cost of each scenario is known, it is possible to perform a cost/benefit analysis of each option, effectively linking the scientific information provided by the MMF models to the policy-making cycle. To ensure the maximum transparency in creating the tools, the involvement of scientific experts (both in marine and freshwater environments), of the Member States, socio-economic experts and interested stake-holders is being sought. The list of pressures included in the initial design of the BLUE2 are: eutrophication, selected chemical contaminants, plastic litter, fisheries and water abstraction.

The third presentation of this session was delivered by C. Perruche (MERCATOR Ocean) to present the biogeochemical modelling initiatives within the Copernicus Marine Environmental Monitoring Service (CMEMS). The main aim of this service is to turn satellite and modelling data into information that is useful for end users within or outside the scientific community. The CMEMS is composed by a network of EU-producers with provides the data to a central information system where this data is adequately transformed and put at the service of downstream applications. They are also compiling a global network of biogeochemical observations in order to assess model performance (validation) and also to 'feed' those models through data-assimilation methodologies. The system has a hierarchy of biogeochemical models ranging from the global ocean to different regional implementations such as the 'Artic', the 'Baltic', the 'North Western Sea', the 'IBI' (Iberian-Biscay-Irish), the 'Mediterranean', and the 'Black Sea'. For each region the hydrodynamic and biogeochemical models are different and tailored to represent the particularities of each area. In all interested areas data assimilation is performed in order to improve the 'now-cast' capabilities of the model (operational models). They have also implemented different standardized routines to validate and quality assess all different models. There were some questions about how 'comparable' are simulations performed with very different biogeochemical models and the answer was that there is not a single biogeochemical model able to represent the very different characteristics of the diverse areas. The limitations of the 'operational' approach in doing scenarios were also discussed and the possibility of cooperation between CMEMS and the MMF team at JRC was mentioned.

3. Eutrophication (D5)

R. Friedland presented some results on the use of models to assess waters under the regulation of the WFD and the MSFD in the Baltic Sea. First of all, he showed a new method to establish chlorophyll-a limits considering historic values (simulated with pre-industrial

nutrients loads) and present values (including both, observations and simulations considering actual nutrients concentrations). This methodology allows to determine limits on a spatially-explicit frame that can help with management options for the different areas. He also showed that the selected hydrodynamic model could have a profound impact on the biogeochemical simulations. This is something typically neglected as it is assumed that any hydrological model could do a fair work. His research demonstrated the need of performing multimodel ensemble simulations. The second part of his talk was devoted to the more local effects of freshwater fertilization on small-scale coastal lagoons. He showed that only reducing nutrient loads (even below current targets) will not be enough to reach the GES in the lagoons so additional measures should be contemplated. Care must be used, though, when evaluating multiple management options (he presented the case of stablishing a mussel's farm) as the direct and indirect effects of such multiple approach can have opposite consequences for the GES (*e.g.,* increasing Secchi depth but creating more anoxic areas in the bottom waters).

The second presentation, provided by F. Grosse dealt with the links between nutrient loads from rivers and GES in the North Sea. In this basin, eutrophication is evaluated through different variables, including winter dissolved inorganic nitrogen (DIN) and phosphorus (DIP) concentrations, summer chlorophyll and summer oxygen levels. From this evaluation it appears that the entire south-eastern part of the basin is a 'problematic' area. The work here presented intended to use a biogeochemical model to identify the main sources of nitrogen to the basin in order to prioritize management options. They applied the 'Trans-boundary nutrient transport' concept which allows to trace different nutrients from their source (in this case different rivers, the atmosphere and adjacent seas) to the marine food webs. This way the causes of the observed eutrophication patterns could be traced back to their sources. They apply this methodology to the actual nitrogen loads and computed the relative contribution of each riverine country to the simulated levels of total nitrogen in the German Exclusive Economic Zone in the North Sea. Then they evaluated the impact of different nitrogen reduction measures (i.e., controlling the riverine input of DIN, organic nitrogen and both together), compliant with the EU Water Framework Directive (WFD), in the different countries. Results show that controlling both types of nitrogen inputs provides a stronger effect on winter DIN and summer chlorophyll in the marine environment. Finally they looked at the consequences of such measures on the bottom oxygen levels (presence of low-oxygen zones in the region being a nuisance since several decades). They found that oxygen consumption in the region of lowest bottom oxygen concentrations is strongly affected by nitrogen originating from the Northeast Atlantic, but also from the riverine sources, especially the German Dutch and British rivers. Thus, well-defined nitrogen reductions in these rivers will likely have a beneficial effect on bottom oxygen. However, current WFD reduction targets consider very low or none nitrogen reductions in the Dutch and British rivers, respectively. This implies these targets require revision. The results further show that stratification controlling the vertical mixing is of great importance for oxygen levels in the bottom layers. Therefore, the effect of nutrient reduction measures needs to be assessed in combination with climate change effects in order to allow for realistic estimates of the future oxygen conditions.

The last presentation of this session (presented by D. Macias) dealt with the use of marine models to understand the causes of observed production hotspot in coastal environments

of the northern Mediterranean Sea. The models of the Marine Modelling Framework are here used to compare the pelagic productivity patterns and bottom oxygen levels (two indicators of eutrophication) in two twin simulations; one performed with nutrients coming from the EU rivers and the second assuming zero concentration of nutrients in the freshwater flow. The effect of rivers' fertilization on the marine ecosystems was found to be much larger in the Aegean and Adriatic Seas than in the Gulf of Lion region. Further, the temporal dynamics of hypoxic areas in the Aegean seems to be related with the nitrate concentration in the rivers while for the Adriatic the phosphate concentration seems to be the most important factor. For the Gulf of Lion the amount of freshwater flow and the induced stratification in the coastal region seems to be most relevant forcing of the hypoxic conditions development. These findings have consequences for rivers' management options in the different regions if eutrophication-related issues are to be avoided in the ecosystems downstream.

4. Hydrography (D11)

Hydrographic changes is one of the most difficult descriptors of the GES defined by the MSFD to measure due to the lack of harmonizing methodologies and control variables. However, 3D hydrodynamic models could provide an integrated view of the hydrological properties of marine environments with a high confidence degree. In this context, G. Saninno presented a lecture on the use of high-resolution models for simulating hydrological properties of the Southern European Seas (Mediterranean and Black Seas). He showed the need of correctly representing in the model the different straits connecting the diverse basins (Gibraltar and Turkish Straits mainly) and the potential effects that tides (normally not considered in SES models) could have on some key features as coastal currents development and deep water creation. He also show application of this type of advance models for blue growth applications such as energy extraction from the wave's movements.

The second talk on this section, presented by A. Gallego, continued on the evaluation of energy extraction from the marine environment but in this case using the water currents in a narrow coastal strait. In this area (Pentland Firth, North Scotland) tidal-generated water movements create intense currents that could be used to generate electricity by applying turbines (similar to the wind-farms). He showed how using models could help evaluate the potential effect of energy extraction from the currents for the surrounding marine environments. For this, he evaluated two different scenarios considering two levels of energy extraction and two different configuration of the turbines within the strait. Model results indicated that by excessive energy extraction, water elevation in the Firth could be affected, increasing the potential for coastal flooding in some specific regions. Also currents configurations within the strait could be changed, with a reduction on water flowing speed in the central channel and an increase along the coastal areas. Potential effects for the far-field where less critical but model results showed impacts (although not very important) along most of the eastern UK coast. Their team is still working on evaluating the (potential) impacts on the marine biogeochemistry of the region.

J. Jackari presented their work on using hydrodynamic models to assess the potential risk of chemical contamination derived from the leakage of weapons deposited at the bottom of the Baltic Sea after the Second World War. They have computed the 'risk' zones around the dump sites using a passive tracer method, these probability maps could be multiplied by the actual concentration found at specific sites to create distributions of 'estimated' present contamination levels. They also work on developing another method for assessing of the contamination – Lagrangian tracking with random disturbance. They are still working on this project trying to implement higher resolution hydrodynamic models based on NEMO.

In the following talk of this session, U. Raudsepp presented an application of high resolution hydrodynamic models to study the dispersion of chemical contaminants from ships (e.g., derived from painting surfaces, ballast waters, open-loop scrubbers, etc..). This work is part of a BONUS project (SHEBA) which aims to analyze the current situation plus a number of scenarios concerning air pollution, water pollution and noise in the Baltic Sea. They have identified more than 600 contaminants from ship but will concentrate in five (cooper, zinc, naphthalene, pyrene and dibromochloromethane). On top of this, they will try to simulate the dispersion paths of potentially invasive species being carried by the ballast waters of the ships. GETM and the dispersion model included in FABM are the tools currently being used in this work.

5. High Trophic Levels (HTL)

In the first talk of this session, J. Steenbeek spoke about the new features recently included in Ecospace (the spatial module of Ecopath). These include: a habitat capacity model, a dynamic spatial-temporal niche model driven by climatological variability;; a spatial temporal data framework, which links spatially-explicit data forcing to ecospace; advection, computed by a simple model (embedded in ecospace) or by providing hydrological data provided by another model; a contaminant tracer model, which simulates the transport of contaminants through the food web and ecology indicators, which are extensible (for example to include those contemplated by the MSFD). He also stressed that Ecopath core programming is not dependent on any operating system and that Ecopath with Ecosim have already been online coupled with GETM in a single Fortran code.

The second lecture was provided by J. Bruggeman presenting the latest developed models within FABM (Framework for Aquatic Biogeochemical Models) to represent higher trophic levels such as fish and shellfish. At Plymouth Marine Laboratory work has been recently done to couple an hydrodynamic-biogeochemical model (NEMO-ERSEM) of the North Sea and Iberian regions with a HTL model. This first attempt is a one-way (bottom-up) coupling in which the environmental information from the hydrodynamic-biogeochemical model is used to compute pelagic fish habitats (also in the face of climatic changes) and to feed a fish-size spectrum model (where fisheries is explicitly included). A similar approach is being tested in different areas such as the southern India region. They are now working towards a fully coupled ERSEM-HTL model where fish are to be treated as another state variable of the model. In this case a deep-integrated approach is to be followed (at least in the first stages). At the same time, another 'building blocks' for ERSEM are being developed to represent shellfish and macroalgae.

The [final presentation](#) of this block was provided by [J. VanDerMolen](#) and it dealt with the recent development and application of a HTL model at CEFAS. As the use of models is foreseen as a key element in the MSFD evaluation cycle, at CEFAS statistical models (General Additive Models, GAMs) are being used to evaluate key pathways for pressures within the marine food webs. Both bottom-up pressures (from climate to LTL) and top-down elements (from fisheries) are being evaluated. They have found small propagation of both type of pressures within the food web of the North Sea, so that the observed 'regime shifts' in the LTL of the region did not strongly influence the fish stock dynamics. They are also working on understanding how different fisheries management options in the future could influence the GES at the North Sea and how to deal with uncertainty in such simulations for the future.

6. Fish modelling

This session started with a [presentation](#) by [J. Ruiz](#) on the link between environmental conditions and economic aspects in a small pelagic fisheries at southern Iberian. In the south-west region of the Iberian Peninsula the interplay between the Guadalquivir estuary and the shelf region of the Gulf of Cadiz creates a highly variable environment that controls the survivorship of the early stages of anchovy, a very valuable stock for the region. In this lecture a newly developed model for evaluating management options for this fisheries was presented. Such model consider the impact of environmental conditions for anchovy recruitment strength and the consequences of such variability for the fleet exploiting this resources. Contrary to current practices, it appears clear from this exercise that a variable TAC strategy provides much robust economic indicators for all actors involved. They have also developed an online tool which can be used by the different stakeholders to 'play' with different management strategies and experience by themselves the consequences of diverse scenarios. This integrated (environment-economy) evaluation tool is a step forward to more advanced management options although there is still room for improvement (such as considering multi-species models).

The [second lecture](#) of the session (given by [G. Triantafyllou](#)) presented a full life cycle model for small pelagic fish in the Aegean (and Mediterranean) Sea. At HCMR a complete end-to-end model for representing the major SPF in the region (anchovy and sardine) have been developed. This tool includes an hydrodynamic-biogeochemical model fully coupled to population models (super-individuals approach) of the selected fish species. The fish model include a bioenergetics component, a population model (following cohorts) and a movement module. Data assimilation is used to improve the hydrodynamic-biogeochemical simulations while the representation of the fish movement has been found to be a critical aspect for model performance. They are using different parameterization of this movement in relation with food availability (mesozooplankton gradients), density dependency, currents and a stochastic part. Also scenario runs for the whole Mediterranean Sea comparing SPF biomasses for the present-time with the period 2080-2100 have been performed. A decline in biomass between 3% and 33% is simulated due to a decrease in the available food (less productivity for the future) and an increase in the metabolic maintenance cost in a warmer ocean. In order to reduce simulation uncertainties (derived from the initial conditions and from unresolved processes) the use of ensemble runs is strongly advised.

J-N. Druon presented his work about a new index for potential fish production in EU waters based on remote sensing data and how this information could be feed into ecosystem models. The presence, size and duration of chlorophyll-a fronts in surface waters could be transformed into a 'zooplankton productivity index' that represents the fraction of the primary production potentially available for HTL. Such index seems to correlate quite well (both spatially and temporally) with fishing efforts and the origin of landings at EU level. This procedure can be applied to both satellite information and to simulate chlorophyll fields from biogeochemical models (thus allowing to make scenario evaluation) and is an important information for being linked with ecosystem models providing the bottom-up forcing sometimes missing (or roughly parameterized) in such tools.

The last presentation of this session was given by C. Piroddi on a recent work dealing with the time-evolution of ecosystem structure in the Mediterranean Sea during the last 60 years. The Mediterranean is a small sea (~2% of world's oceans) but presenting a much higher exploitation rate than any other EU regional seas. It has a low maturity in their food web (indication of a highly perturbed system) where the importance of the SPF is relatively large. In this work the time evolution of different key elements of the ecosystem are simulated along the last 60 years imposing a series of external forcings (temporally explicit) such as fishing effort and primary production rates (PPR). Two PPR time-series are used to drive the model: one coming from the own ecosystem model (computed internally as anomalies) and one from a proper hydrodynamic-biogeochemical coupled model (run independently from the ecosystem model). When the second option from PPR is used, the fit between model simulation and observation increased. Most of the functional groups show an increase in abundance up to a peak around 1985 and a later decline. The same is observed in the mean trophic level of the catches, which decreases in recent decades while the total catch (including all exploited species) have increased with time. The following steps with this model is to make the tool spatially explicit and to include more pressures such as aquaculture, invasive species, climate change and contaminants. This later version of the tool will be used to generate and evaluate scenarios (both in terms of the global change and regarding management options within the BLUE2 initiative).

7. Discussion session and Conclusions

At the end of the second day of the workshop there was a general session open for discussion with all attendants. However, and before the common session started, I. Makarenko presented the latest advances on the Black Sea Commission (BSC) regarding the implementation of the MSFD in such basin. For the Black Sea, MSFD is not compulsory as many of their bordering countries are not EU MS, however BSC is doing an effort to include indicators compatible with the MSFD in the new '*Black Sea Integrated Monitoring and Assessment Program*'. With this approach the GES definition for the Black Sea is expected to be compatible with the one proposed for the rest of EU regional seas.

Starting with the general discussion session, M. Maar proposed to show for the next MEME workshop some of the progress on the implementation and application of models for the Baltic and North Sea being developed at her home institution.

G. Hoermandinger insisted to the attendants that the tools and databases being created within the BLUE2 initiative will be publicly available for any interested party so a multimodel approach should be possible. Indeed from DG ENV such approach is much encouraged so consistent simulations (without model-specific bias) should be attained. G. Saninno indicates that for doing consistent multimodel runs a common dataset (initial, boundary and forcing) should be made available. It was agreed that also the definition of the scenarios (e.g., concerning freshwater management) should be available to all the community and open to questions/suggestions. B. Gustafsson indicated that it should be sensible to coordinate some sort of EU-wide multimodel comparison in order to detect especially vulnerable areas/basins. It is logical to expect that the same scenario (*e.g.* concerning freshwater management) could have very different impacts in diverse marine regions.

M. Gregorie asked whether the downscaled climatic forcing could be made public. It was indicated that this scenarios do not belong to the EU Commission but to different initiatives (e.g., CORDEX) and some data-restriction could be applied. In any case, more and more data is now freely available and within the BLUE2 initiative facilitation to the access of such data should be made. The same apply for the rivers' scenarios. In this case the data will be generated by DG JRC so, in principle, they should be publicly available.

Also, J. Ruiz asked how ones participation on this MEME group will be 'used' in case of a conflict between a MS and the Commission on any aspect of the future MSFD evaluation phase. The answer from DG ENV is that the participation on this expert group is based on 'personal' grounds and that no official responsibility could be derived for the participants. This is a group effort in order to ensure that the best science is applied, not a formal consulting group with legally-binding consequences.

On a more technical discussion, R. Friedland asked to the participants about their experience with two-way nesting modelling setups to improve resolution in certain regions. It was proposed that the most elegant and cost-efficient way in doing this is by using *'stretched'* coordinates grids in which resolution could be adjusted to ad-hoc objectives.

Another issue raised by A. Capet was about the different 'languages' and definitions used on the diverse pieces of legislation dealing with environmental issues in freshwater and marine regions (mainly WFD and MSFD). B. Gustafsson pointed out that, in general, there is around 1 mile (coastal zone) overlap on the regions covered by these two legal documents and that harmonization is fundamentally needed. DG ENV indicate that the contractor for the BLUE2 initiative will built the pressures inventory around the definition of the Programs Of Measures (POM) indicated in the different legislations aiming at bringing together the two '*sides*' of the problem (freshwater and marine).

Moving back to the BLUE2 initiative and regarding the economic evaluation of the different scenarios M. Gregorie indicated that cost/benefit analysis is not a simple task to be done. It is sometimes very difficult to quantify some of the ecosystems services (e.g., what is the value of seagrass?). G. Hoermandinger agreed on the difficulty of this task and indicated that the previous experience for example on air quality is not directly applicable to the marine environment (air quality issues have a direct impact on human heath) so a more

'imaginative' approach should be sought. J. Ruiz also indicated that socio-economic specialists and marine modelers should be brought closer to each other so the potential and limitations of the used tools and approaches are better understood by each community. This is not an easy task but it has been done in the past.

As final remarks, M. Gregorie asked how the progress being made by the BLUE2 are going to be made public. DG ENV proposed to create a *'link'* between the contractors and the MEME expert modelling group. The exact shape of this link is to be decided yet but it'll be communicated to the group in due time.

Annex I: List of participants and title of presentations

Authors/<u>Presenter</u>	Contact	Title
M. Aissi	mehdi.aissi@rac-spa.org	
J. Bruggeman	jbr@pml.ac.uk	Developing and applying models of fish and shell fish within FABM to support online coupling to e.g. ERSEM
A. Capet	acapet@ulg.ac.be	
C. Donati	cecilia.donati@mercator-ocean.fr	
J.N. Druon	Jean-noel.druon@ec.europa.eu	A monitoring tool for potential fish productivity at the EU scale
R. Friedland	rene.friedland@io-warnemuende.de	Integrated modelling of eutrophication parameters along WFD and MSFD waters in the south-western Baltic Sea
A. Gallego	a.gallego@marlab.ac.uk	Modelling pressures on the marine environment: tidal stream Marine Renewable Energy extraction and climate change
E. Garcia-Gorriz	elisa.garcia-gorriz@jrc.ec.europa.eu	
G. Giorgi	giordano.giorgi@isprambiente.it	3D hydrodynamic/water quality modelling for MSFD D7 indicator
M. Grégoire	mgregoire@ulg.ac.be	
F. Grosse	fabian.grosse@dal.ca	WFD-compilant nitrogen reductions within the OSPAR framework: a source-oriented approach for the North Sea
B. Gustaffson	bo.gustafsson@su.se	
G. Hoermandinger	guenter.hoermandinger@ec.europa.eu	Integrated policy assessment linked to models of the freshwater and marine environment for assessing the economic benefits of EU water policy and the cost of its non-implementation (BLUE2)
J. Jakacki	jaromirjakacki@gmail.com	Estimation of contamination area during potential leakage of dumped chemical munitions in the Baltic Sea
P. Lazzari	plazzari@ogs.trieste.it	
C. Perruche	coralie.perruche@mercator-ocean.fr	Copernicus Marine Environment Monitoring Service, biogeochemical modelling activities

P.Y. Le Traon	pierre-yves.letraon@mercator-ocean.fr	
M. Maar	mam@bios.au.dk	
D. Macias	diego.macias-moy@jrc.ec.europa.eu	Disentangling the causes of coastal production in Mediterranean Sea ecosystems
I. Makarenko	iryna.makarenko79@gmail.com	
C. Piroddi	cpiroddi@hotmail.com	Historical changes of the Mediterranean Sea ecosystem: modelling the role and impact of primary productivity and fisheries changes over time
U. Raudsepp	urmas.raudsepp@msi.ttu.ee	Shipping borne contaminants dispersion in the Baltic Sea
J. Ruiz-Segura	javier.ruiz@csic.es	Biology and economy equilibria in the coastal zone: modelling and scenario analysis as a rationalization tool for small-pelagics
G. Sannino	gianmaria.sannino@enea.it	A very high-resolution integrated Mediterranean and Black Sea ocean circulation model
J. Steenbeck	jeroen.steenbeek@gmail.com	Ecospace extended: advancing spatial-temporal ecosystem modelling of marine ecosystems
A. Stips	adolf.stips@jrc.ec.europa.eu	
G. Triantafyllou	gt@hcmr.gr	A full life cycle model of small pelagic fish and the assessment of model predictability
J. van der Molen	johan.vandermolen@cefas.co.uk	Recent developments and first applications in higher trophic level modelling at CEFAS

Annex II: Abstracts

(1) Integrated policy assessment linked to models of the freshwater and marine environment for assessing the economic benefits of EU water policy and the cost of its non-implementation (BLUE2)

Guenter Hoermandinger, European Commission, DG Environment, C2

Not provided

(2) Copernicus Marine Environment Monitoring Service, biogeochemical modelling activities

Coralie Perruche. MERCATOR Ocean.

An overview of the Copernicus Marine Environment Monitoring Service (CMEMS) will be first given. The presentation will then be focused on biogeochemical observation (in-situ, satellite) and modelling products that CMEMS provides. Global and regional (European Seas) biogeochemical models and modelling products will be described as well as validation and quality assessment methodologies. Data assimilation issues will also be discussed. Perspectives for the evolution of CMEMS biogeochemical modeling activities will finally be given.

(3) Integrated modelling of eutrophication parameters along WFD and MSFD waters in the south-western Baltic Sea

Rene Friedland, G. Schernewski, IOW

Part 1: Combining ecosystem models
Ecosystem models – although widely used – cannot be more than a simplification of real ecosystems. When estimating the reference conditions for all German coastal waters in the south-western Baltic Sea (managed either under the umbrella of MSFD or WFD), we reduced the impact of the model bias on the target values by dividing the simulated pre-industrial state with the simulated present one to get a measure for the spatially explicit reaction of every water body to the changed nutrient loads. We then used this measure to transfer the present observed state of the eutrophication parameters Chlorophyll.a, Total Nitrogen & Phosphorus to the reference conditions according to MSFD and WFD. To get able to further reduce the impact of the model bias on the estimated reference state, we combine in a next step three ecosystem models to calculate for every model system the specific ratios between the simulated pre-industrial states and present ones to become a more comprehensive estimate of the reference state.

Part 2: Estimating the effect of measures like mussel farms
Coastal waters, like Oder Lagoon, are an important filter of nutrients and hazardous substances, what is reflected amongst others by the strong gradient in Chlorophyll.a towards the open sea. Until now for both – coastal waters and open sea – the only measure to achieve the Good Ecological State as claimed by MSFD and WFD is the reduction of nutrient inputs. But many coastal systems are no longer affected by nutrient loads, raising the question if additional measures within the coastal waters are necessary. E.g. mussel

farms can be an efficient and low-cost retention measure to reduce phytoplankton in coastal waters, but also open sea waters would profit. Here a model based example from the German part of Oder Lagoon will be shown.

(4) WFD-compliant nitrogen reductions within the OSPAR framework: a source-oriented approach for the North Sea

Fabian Grosse and Hermann Lenhart, Hamburg University

The North Sea constitutes a marine ecosystem influenced strongly by anthropogenic nutrient (nitrogen and phosphorus) inputs from rivers and the atmosphere, especially, in coastal areas. These nutrients enhance biological activity and, thus, organic matter production, impacting on the oxygen conditions of the North Sea.

At present, OSPAR aims for the alignment of the demands of two EU regulations, the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD), with the already existing OSPAR Common Procedure. In practice, this implies to find rules for comparing the eutrophication status defined by OSPAR, resulting in a regional classification of problem and non-problem areas, with the definition of the 'good environmental status' (GES) under MSFD.

In this context, it is important to analyze the response of eutrophication-related criteria defined by OSPAR, e.g., winter inorganic nutrients, summer chlorophyll-a and oxygen, in relation to nutrient reduction scenarios. For this purpose, OSPAR achieved a definition of river nitrogen reductions for individual rivers with consent of the member states in relation to the WFD, which is currently in the implementation phase.

In the first part, we assess the impact of a WFD nutrient reduction scenario (reduction run) on the North Sea's German Exclusive Economic Zone (EEZ) compared to a reference run. In addition, we quantify the contributions of individual nitrogen sources (incl. rivers, adjacent seas and the atmosphere) on the nitrogen content in this region and highlight the differences between the two simulations. This is done by applying a nutrient tagging technique – often referred to as 'trans-boundary nutrient transports' (TBNT) – which underpins the "source-oriented approach" of national environmental protection agencies as well as OSPAR.

This analysis reveals that the coastal part of the German EEZ is dominated by nitrogen from the German rivers, while the Dutch and British rivers and the North Atlantic show significant contributions farther off-shore. In consequence, the strong nitrogen reductions in the German rivers result in a distinct decrease in marine nitrogen content in the coastal zone. In contrast, response in the off-shore areas is clearly less due to the very low and zero nitrogen reductions in the Dutch and British rivers, respectively. We furthermore show that the response in chlorophyll-a to riverine nitrogen reductions is rather limited in both coastal and off-shore areas.

In the second part, we focus on oxygen deficiency (oxygen concentration <6 mg L-1 according to OSPAR) which is most likely to occur in the off-shore regions of the southern and southeastern
North Sea. We expand the TBNT method by a direct link of the oxygen-affecting processes to nitrogen from individual sources.

The analyses of the reference and reductions runs with respect to oxygen reveals that the Dutch and British rivers as well as the atmosphere constitute the main anthropogenically affected contributors to nitrogen-related oxygen consumption in the region most susceptible to oxygen deficiency. Consequently, the WFD-compliant riverine nitrogen reductions applied for this study result only in a minor improvement of the oxygen conditions in this region.

(5) Disentangling the causes of coastal production in Mediterranean Sea ecosystems

D. Macias, A. Stips, E. Garcia-Gorriz. European Commission, Joint Research Centre, Institute for Environment and Sustainability, 21027, Ispra, ITALY

Field-based observations provide an accurate picture of the major conditions of marine ecosystems but fail to provide a conceptual mechanistic link between causes and consequences of the observed patterns. In the case at hand, the Mediterranean Sea, the general conception, based on field-measurements and remote sensing information, is that this is an oligotrophic basin with a few biological production hotspots related either with strong mesoscale variability (such as the Alboran Sea) or with the presence of important rivers (such as the north-western region, the northern Adriatic or the Aegean Sea). Some of the areas related with big rivers in the northern Mediterranean coasts, have been described to be suffering from eutrophication issues, and rivers-borne nutrients have been typically blamed for this problems.

However, a causal link between drivers (e.g., rivers' fertilization) and consequences (amount of coastal production) is still missing. Establishing such links is fundamental for implementing managing programs aiming to achieve the Good Environmental Status of the marine ecosystems as directed by the Marine Strategy Framework Directive.

Manipulating the quality of major rivers (fertilization sources) to study the consequences on the marine ecosystems downstream is not a feasible (or desirable) approach to stablish the causal relationships between them. However, we can do so by using numerical models as the ones included in the Marine Modelling Framework developed by JRC. Thus, here we compare two identical hindcast (covering the period 1960 – 2010) performed with and without nutrients in the rivers' waters.

Comparing these two model runs for three identified production 'hotspots' in the northern Mediterranean coast (North West Mediterranean, Adriatic and Aegean) we found that rivers fertilization is a very important source for pelagic primary production and plankton biomass in the two later areas. Also, in these two zones seasonal hypoxic benthic conditions were found to be linked to freshwater nutrients. On the contrary, for the NW Mediterranean region, the presence or absence of nutrients in the rivers' waters made very little difference

in terms of planktonic production while its impact on benthic hypoxic areas is slightly larger. It is shown that mesoscale processes and associated vertical transport of nutrients are the main processes responsible for the majority of the production in this NW Mediterranean region. We discuss, then, the consequences of these fundamental differences for freshwater management and ecosystems status evaluation in the light of different policy options and within the context of future climate change

(6) A very high-resolution integrated Mediterranean and Black Sea ocean circulation model

Sannino G., Bargagli A., Carillo A., Iacono R., Napolitano E., Pisacane G., Struglia M.V. Climate modelling and impacts laboratory. ENEA CR Casaccia. Rome, Italy

During the last decade, high-resolution models of the ocean circulation and wave dynamics, developed at the Climate Modelling Laboratory of ENEA, have been used to produce both short-range forecasts and long term climatologies. Since 2013, a wave forecast system is running operationally, which is composed of a suite of models at different resolutions encompassing the entire Mediterranean, with local zooms over sub-regions of interest.

The experience made in the last decade indicates that there are some key elements that need special attention. One is the highly variable two-way water exchange between the Mediterranean Sea and the Atlantic Ocean through the Strait of Gibraltar. The Strait is characterized by a complex bathymetry with a succession of contractions and sills, its interaction with tides determines the characteristic of the hydraulic control and makes it an active element of the Mediterranean thermohaline circulation. Similarly, the Turkish Straits System (TSS), composed of the Bosphorus and Dardanelles Straits and the Marmara Sea, has been found to be crucial in determining the interactions between the Mediterranean and the Black Sea. Different, very high-resolution configurations of the MITgcm have been developed to simulate the Gibraltar Strait and TSS dynamics, respectively, including the effect of tides. Moreover, an ad hoc configuration of the MITgcm has been used to investigate the effects of tides on the thermohaline circulation of the whole Mediterranean basin, accounting for both the internal equilibrium and the incoming lateral components and explicitly resolving the Gibraltar strait dynamics. Results indicate that including the representation of explicit tidal forcing in the simulation of Mediterranean circulation has non-negligible effects in the basin interior, in addition to the expected intensification of local mixing processes.

The natural development of such studies was the realization of a new integrated model of the Mediterranean and Black Sea system, in which the high-resolution non-uniform curvilinear orthogonal grid was extended to encompass the whole domain. The grid has an overall regular horizontal resolution of 1/48°, locally enhanced in the Straits in order to satisfy the minimum requirements dictated by findings of the high resolution dedicated experiments. The new model is operationally run at ENEA, and is expected to expand the experience gained at ENEA in the field of operational oceanography, so far applied to the development of a high-resolution operational model of the Tyrrhenian Sea. The latter has been running since 2009, leading to significant improvements in the understanding of the Tyrrhenian Sea circulation and of its variability.

(7) Modelling pressures on the marine environment: tidal stream Marine Renewable Energy extraction and climate change

Alejandro Gallego (Marine Scotland Science) presenting work by colleagues in Marine Scotland Science (Rory O'Hara Murray), the National Oceanography Centre – Liverpool (Michela de Dominici) and others.

Marine Renewable Energy (MRE) has the potential to become an important source of electricity generation in European waters. In Scotland, in addition to offshore wind, there is considerable resource potential for tidal stream and waves MRE developments (in descending order of technology readiness). As part of collaborative research projects, we explore modelling methodologies and investigate the potential effects of large scale tidal stream MRE extraction in the area where such developments are more likely in the short- to middle-term, the Pentland Firth and Orkney waters, in the north of Scotland, and further afield. We also investigate the potential effects of climate change on the physical environment by mid-21st century and how the farfield effects of climate change and MRE extraction may interact with each other.

(8) 3D hydrodynamic/water quality modelling for MSFD D7 indicator

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Both Marine Strategy Framework Directive and EcAp program for Barcelona Convection for the protection of the Mediterranean Sea (by Descriptor 7 (D7) and Ecological Objective 7.2 respectively), request an assessment of permanent alterations of the hydrographical conditions on marine ecosystems due to new constructions on the coast and marine installations and seafloor anchored structures starting from 2012. Changes in the tidal regime, sediment transport, current or wave action, can lead to modifications of the physical and chemicals characteristics of coastal environment which in turn implies an impact on marine ecosystem.

Environmental Impact Assessment procedure in place take into account the overall impact of infrastructures on ecosystem but a specific focus on a quantitative and sound linkage between alterations of the hydrographical conditions and coastal or marine environment conditions is still lacking. In this study, we have implemented a 3D Hydrodynamics model (TELEMAC-3D) for the area of Port of Monfalcone in North Adriatic – Italy, where works for deepening of the access channel and basin evolution of the port and a small LNG storage, regasification and distribution terminal are planned and submitted to EIA. In order to estimate the impact on coastal ecosystems, 3D Hydrodynamics model has been coupled with DELWAQ and a specific monitoring programs to collect in-situ parameters has been developed to calibrate/validate the model.

(9) Estimation of contamination area during potential leakage of dumped chemical munitions in the Baltic Sea

Jaromir Jakacki[1], Anna Przyborska[1], Jacek Bełdowski[1], Maria Golenko[2], Victor Zhurbas[2]
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After World War II approximately 60 thousand tons (the exact amount is not known and some sources estimate it as more than 200000 tons) of chemical munitions were dumped in the Baltic Sea. The precise dumping areas are not known either, but based on the past investigations and information it is possible to select some main regions of dumping: Skagerrak, Bornholm Deep, Gdansk Bay and Gotland Basin (see figure). Dumped munitions can be dangerous in the event corrosion and potential leakage. Since there is no tool for estimating the influence of the leakage of dangerous material on the benthos and the bottom areas, two methods was implemented for assessment of contamination of potential leakage. The first one is analysis of spreading of passive tracer implemented in the hydrodynamic model of the Baltic Sea. The second one is based on Lagrangian tracking with random disturbance, also adapted in Baltic Sea model. Based on performed simulations spatial and temporal scales of the pollution has been estimated.

(10) Shipping borne contaminants dispersion in the Baltic Sea

Urmas Raudsepp and Ilja Maljutenko, Department of Marine Systems, Tallinn University of Technology

Most of the antifouling-paints coatings used on the hulls of ships contain biocides to suppress biofouling. After banning TBT by IMO in 2008 Cu-based antifouling has become main alternatives for TBT (Tornero & Hanke 2016). One of the aim of the ongoing BONUS project Sustainable Shipping and Environment in the Baltic Sea region (SHEBA) is to assess impact of shipping borne pollutants to the water quality indicators of MSFD. The resulting distribution of antifouling contaminants can support monitoring activities of MSFD D8 (contaminants). AIS based gridded shipping activity (underwater area of hull) in the Baltic Sea is related with leaching rates of Cu2O antifouling agents. Dispersion of antifouling contaminants from shipping lanes is simulated as passive tracers using 3D hydrodynamic model for the year 2012. As results, we present the spatial distributions of shipping related contaminants in the water column for a year 2012. Simulated dispersion of grey and black water discharged outside territorial waters can be considered as a proxy for additional nutrients affecting eutrophication.

(11) Ecospace extended: advancing spatial-temporal ecosystem modelling of marine ecosystems.

Jeroen Steenbeek [1,2], Marta Coll [1,2], Villy Christensen [1,3]
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Spatial-temporal modelling capabilities of ecological models have significantly improved in recent years[1]. This is also the case of Ecospace, the spatial-temporal module of the Ecopath with Ecosim (EwE) approach, which has received several major improvements such as the new Habitat Foraging Capacity model (HFC)[2]. The HFC offers the ability to spatially drive the foraging capacity of species from the cumulative effects of multiple physical, oceanographic,

and environmental and topographic conditions (such as temperature, salinity, oxygen concentrations, primary production, substrate, depth, etc.). The HFC runs in conjunction with the EwE food web and fisheries dynamics, and, in combination with the spatial-temporal data framework (DF)[3], bridges the gap between niche models and classic food web models. The HFC and the DF provide a range of coupling capabilities between EwE and other models, including lower trophic level models (such as ROMS). Other major improvements of Ecospace include the re-designed Ecotracer, which tracks pollutants in marine food webs over time and space, and the updated Advection model. These tools have been applied at very different spatial scales (from a global to local perspectives)[4-7] and can be used to derive informative ecological indicators with a meaningful spatial-temporal resolution to inform current management processes (such as MSFD, MSPD and CFP in European Seas).

[1]Coll, M. et al. Modelling dynamic ecosystems: venturing beyond boundaries with the Ecopath approach. Reviews in Fish Biology and Fisheries 25, 413-424 (2015).
[2]Christensen, V. et al. Representing variable habitat quality in a spatial food web model. Ecosystems 17, 1397-1412 (2014).
[3]Steenbeek, J. et al. Bridging the gap between ecosystem modeling tools and geographic information systems: Driving a food web model with external spatial–temporal data. Ecological Modelling 263, 139-151 (2013).
[4]de Mutsert, K. et al. Exploring effects of hypoxia on fish and fisheries in the northern Gulf of Mexico using a dynamic spatially explicit ecosystem model. Ecological Modelling 331, 142-150 (2016).
[5]Coll, M. & Steenbeek, J. Standardized ecological indicators to assess aquatic food webs: the ECOIND software plug-in for Ecopath with Ecosim models. Environmental Modelling and Software 89, 120-130 (2017).
[6]Coll, M., Steenbeek, J., Sole, J., Palomera , I. & Christensen, V. Modelling the cumulative spatial-temporal effects of environmental factors and fishing in a NW Mediterranean marine ecosystem. Ecological Modelling 331, 100-114 (2016).
[7]Christensen, V. et al. The global ocean is an ecosystem: Simulating marine life and fisheries. Global Ecology and Biogeography 24 507-517 (2015).

(11) Developing and applying models of fish and shell fish within FABM to support online coupling to e.g. ERSEM.

Jorn Bruggeman. Plymouth Marine Laboratory, Plymouth-UK.

Not provided

(12) Recent developments and first applications in higher trophic level modelling at CEFAS

Johan van der Molen, CEFAS

In Europe and around the world, the approach to management of the marine environment has developed from the management of single issues (e.g., species and/or pressures) toward holistic Ecosystem Based Management (EBM) that aims to maintain biological diversity and protect ecosystem functioning. Integrative studies using food web and ecosystem models are able to investigate changes in food web functioning and biodiversity in response to changes in the environment and human pressures. Modeling should be used to: support the development and selection of specific indicators; set reference points to assess state and the achievement of GES; inform adaptive monitoring programs and trial management scenarios (Hyder et al. 2015; Lynam et al 2016; Rossberg et al 2017). CEFAS have developed modelling capacity (process-based and statistical) to address the areas and

we demonstrate the use of integrative statistical models to investigate key signals in systems and process based models to suggest reference levels (Lynam et al 2017; Lynam and Mackinson, 2015; Thorpe et al 2015, 2016).

(13) Biology and economy equilibria in the coastal zone: Modelling and scenario analysis as a rationalization tool for small-pelagics

Javier Ruiz[1]*, Margarita María Rincón[1], David Castilla[2], Fernando Ramos[3], and Juan José García del Hoyo[2].

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(3) Instituto Español de Oceanografía. Centro Oceanográfico de Cádiz, Puerto pesquero, Muelle de Levante s/n, Apdo. 2609, 11006 Cádiz, Spain

A coupled population dynamics and economic model is applied to the purse seine anchovy-fishery in the Gulf of Cádiz. The model simulates the population dynamics, landings and profits on a probabilistic frame. These simulations are used to assess the biological and economic consequences of an individual quota management framework enveloped by a fixed Total Allowable Catch, the present strategy used to manage this stock in the Spanish fishery. Our results accurately indicate that this strategy magnifies the biological and economic vulnerabilities associated with the exploitation of the stock, thus jeopardizing sustainability in both realms. Alternative scenarios, such as flexible strategies based on adaptation to environmental forcing, are explored. The results indicate that even a basic implementation of an adaptive management is more favorable than the rigid strategies in the necessary equilibrium between profits and sustainability at the implementation of the MSFD and other EU policies.

(14) A full life cycle model of small pelagic fish and the assessment of model predictability

George Triantafyllou, HCMR

Not provided

(15) A monitoring tool for potential fish productivity at the EU scale

Jean Noel Druon, European Commission, Joint Research Centre

The JRC explores the potential of the Ocean Productivity Index for Fisheries (OPIF) to monitor the potential production of fish at the EU scale. This index uses the daily detection of productive oceanic features from ocean color satellite sensors as a proxy for food availability to fish populations. These productive features, such as eddies or gyres, were shown to attract fish and top predators (Druon et al. 2016, 2015, 2012) and are indeed active long enough (from weeks to months) to allow the continuous production of zooplankton. The monitoring of productive pelagic habitats supports the EU-MSFD as

changes in ecosystem productivity impact fisheries, eutrophication and biodiversity. The OPIF index showed substantial correlation with spatial fishing effort and landings of the North-East Atlantic Ocean (ICES 0.5 degree resolution). Potentially eutrophicated waters, which mostly correspond to disrupted food chains, are excluded by removing high levels of daily chlorophyll-a contents. This index, which takes the most out of Earth Observation data, is derived at suitable spatial (5 km) and temporal (daily) scales to be used as forcing data within both stock assessment models and full ecosystem models. Trend prediction of future potential marine resources under the effect of climate change is also possible provided a plankton model is available, as it is currently tested in the Mediterranean Sea.

(16) Historical changes of the Mediterranean Sea ecosystem: modeling the role and impact of primary productivity and fisheries changes over time.

Chiara Piroddi. University of Barcelona, SPAIN.

The Mediterranean Sea has been defined "under siege" because of intense pressures from multiple human activities; yet there is still insufficient information on the cumulative impact of these stressors on the ecosystem and its resources. This work evaluates how the historical (1950-2011) trends of various ecosystems groups/species have been impacted by changes in primary productivity (PP) combined with fishing pressure for the whole Mediterranean Sea using a food web modelling approach. Results indicate that both changes in PP and fishing pressure played an important role in driving species dynamics. Yet, PP was the strongest driver upon the Mediterranean Sea ecosystem. This highlights the importance of bottom-up processes in controlling the biological characteristics of the region. We observe a reduction in abundance of important fish species (~34%, including commercial and non-commercial) and top predators (~41%), and increases of the organisms at the bottom of the food web (~23%). Ecological indicators, such as community biomass, trophic levels, catch and diversity indicators, reflect such changes and show overall ecosystem degradation over time. Since climate change and fishing pressure are expected to intensify in the Mediterranean Sea this study constitutes a baseline reference for stepping forward in assessing the future management of the basin.

Annex III: Workshop Agenda

AGENDA

Day 1 –Wednesday 22 March	
10:00	Workshop opening and welcome address by COM
	Round table introductions ALL
	Background and review of scope and desired outcomes ENV
10:30	**Session I - General**
11:30	*Coffee Break*
11:45	**Session II - Eutrophication**
13:00	Lunch Break
14:00	**Session III – Hydrography**
15:30	Coffee break
16:00	**Session IV – Divers Approaches HTL**
17:30	Discussion day 1
18:00	***CLOSURE OF DAY 1***
19:30	Dinner
09:00	***Day 2 –Thursday 23 March***
09:00	**Session V - Fish**
10:30	Coffee break
11:00	***Round table: lessons for EU level modelling***
12:00	
12:00	***Conclusions and next steps***
13:00	
13:00	***END OF THE WORKSHOP***

References

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

List of abbreviations and definitions

DG ENV: Directorate General Environment

DG JRC: Directorate General Joint Research Centre

FABM: Framework for Aquatic Biogeochemical Models

GES: Good Environmental Status

MS: Member State

MSFD: Marine Strategy Framework Directive

SERS: Southern European Regional Seas

WFD: Water   Framework   Directive

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