WGCOMEDA 2017 REPORT

STEERING GROUP ON INTEGRATED ECOSYSTEM ASSESSMENTS

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REF ACOM AND SCICOM

Interim Report of the Working Group on Comparative Analyses between European Atlantic and Mediterranean marine ecosystems to move towards an Ecosystem-based Approach to Fisheries

24-27 April 2017

Lisbon, Portugal

ICES
International Council for the Exploration of the Sea

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Executive summary

The ICES Working Group on comparative analyses between European Atlantic and Mediterranean Ecosystems to move towards an Ecosystem-based Approach to Fisheries (WGCOMEDA) has **consolidated** a **collaborative platform** of research with scientists form the Atlantic and Mediterranean working at different levels from population, through community to ecosystem level. Proof of that is that this year 2017 starts a new three-year cycle. WGCOMEDA was established in 2014 and works in cooperation with other groups within the ICES SCICOM Steering Group on the Regional Seas Programme (SSGRSP). The group (chaired by Manuel Hidalgo, Hilmar Hinz and Marta Coll, Spain, and Christian Möllmann from Germany) met for the fourth time (the first one of this second cycle) in Lisbon, Portugal, on 24–27 April 2017. A total of 20 scientists from European Atlantic and Mediterranean countries attended the meeting (Norway, Denmark, France, Greece, Spain, Sweden, UK, and Portugal).

The objectives in the meeting were: i) to consolidate and to further develop the lines of research initiated between 2014 and 2016 in WGCOMEDA, ii) to establish new lines that allow developing comparative studies between Atlantic and the Mediterranean ecosystems, and iii) to develop Integrated Ecosystems Assessment tools and studies that can be applied in parallel in Atlantic and Mediterranean ecosystems. To do that, the group focused in the following topics, which combined activities initiated during last years with new studies and tasks.

1. **Understanding of the structural and functional role of ecological stability across different types of ecosystems.** The discussion of the group was based on recent results that illustrate a cross-systems comparison of fish community stability. The group also discussed new avenues of research on this topic: i) linking spatial and temporal stability, and ii) methods to investigate the potential influence of functional diversity and fish size on communities' stability.
2. **Using of functional traits information to assess the structure and functioning of demersal and benthic communities across Mediterranean and Atlantic systems – assessing vulnerability to fishing disturbance.** The group looked at the use of functional traits as an approach to investigate and compare the structure of benthic and demersal communities between Atlantic and the Mediterranean. Two studies were presented, one investigating the traits composition of exploited demersal communities in the Mediterranean, the other investigating the link between the vulnerability of benthos to physical disturbance (trawling) and specific ecosystem functions.
3. **Identifying products to support the implementation of IEA in regional ecosystems.** The group discussed about data and protocols to develop common IEA analyses to several areas in the Atlantic and the Mediterranean. The discussions focused in deciding which techniques could be applied and common data used across ecosystems with the aim of filtering information that is not available in all the ecosystems (e.g. zooplankton time-series). For next year, state-of-the-art IEA tools will be applied to a reduced list of systems to clarify the final set of data as well as the analytical protocol

The group decided to meet early May next 2018 in Montpellier/Sète (south France, final hosting location pending of confirmation).

1 Administrative details

Working Group name

WGCOMEDA - Working Group on Comparative Analyses between European Atlantic and Mediterranean marine ecosystems to move towards an Ecosystem-based Approach to Fisheries

Year of Appointment

2016

Reporting year within current cycle (1, 2 or 3)

1

Chair(s)

Manuel Hidalgo, Spain

Hilmar Hinz, Spain

Christian Möllmann, Germany

Marta Coll, Spain

Meeting venue

Portuguese Institute for the Sea and the Atmosphere (IPMA), Lisbon, Portugal

Meeting dates

24–27 April 2017

Participants group photo of the back-to-back meeting in Lisbon (IPMA). Members of WGCOMEDA, WGIAB and WGEAWESS appear in the photo.

2 Terms of Reference a) – d)

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
	This should capture the objectives of the ToR	Provide very brief justification, e.g. advisory need, links to Science Plan and other WGs	Use codes	1, 2 or 3 years	Specify what is to be provided, when and to whom
a	Provide a more complete understanding of the structural and functional role of **ecological stability** across different types of ecosystems.	a) The scientific and applied development of this ToR is sustained by the all the outcomes obtained in the previous 3-years of WG, that evidence which are the strategic and needed lines to follow up the research on this topic, and combining information from both seas (Atlantic and Mediterranean). b) The ecological and applied importance of understanding the mechanisms affecting the stability of natural systems for IAF justifies the work and research to be developed in this ToR. c) The ToR will benefit from the attendance of scientists from other WGs from SSGIEA such as WGIAB or WGEAWESS, and the designed back-to-back meetings with	1 and 3	3	Scientific collaborative papers for several **scientific questions**: **1.** The relative influence **drivers and structural properties** of communities for different type of ecosystems both in both seas (Atlantic and Mediterranean). **2.** The relative **contribution of different functional groups** to the stability of different systems. **3.** Mechanisms affecting the **non-stationary pattern on stability**. **4.** Relationship between **temporal and spatial** stability. **5.** Mechanisms affecting ecological **stability in the pelagic realm**.

		WGIAB and WGEAWESS. This guarantees a good coordination with other WGs of SSGIEA.			
b	Use of **functional traits information to assess the structure and functioning** of demersal and benthic communities across Mediterranean and Atlantic systems; and to predict their vulnerability to fishing disturbance.	a) This topic is directley addressing two main themes of ICES Strategic Science plan i.e. EFD Ecosystem Process and Dynamics and EPI Ecosystem pressures and Impacts. The TOR will provide further insights into the development of indicator that may help with the management of ecosystem goods and services and help to devise management strategies that may help to mitigate human impacts on these. b) The TOR is direcly related to outcomes obtained in the previous 3-years of WG, where the genearl ideas and work flows have been developed. Based on these previous outcomes the current TOR aims to complete a cross Mediterranean Atlantic comparison	1 and 3	3	**1. Database** on demersal fish and benthic invertebrate traits for species used within the analyses including where possible real data from a regional scale data e.g. median size, maturity etc. **2.** Methodology to assess the **resistance/resilience** of demersal and benthic communities with respect to their trait composition to fishing. **3.** Collaborative scientific papers **comparing functional properties of demersal and benthic communities** across regional seas and their vulnerability to fishing disturbance.
c	Further develop the analysis of the link between **ecological stability** across different	a) The scientific development of this ToR is sustained by the outcomes from the previous 3-years	1 and 3	3	**1. Database** on ecosystem properties of Mediterranean and Atlantic marine ecosystems **2**. **Methodology** to

	ecosystems types **and ecosystem properties** (structure and functioning)	of WG with the aim to follow up in the research on this topic. It will combine information from both seas (Atlantic and Mediterranean). a) This topic is addressing several main themes of ICES Strategic Science plan i.e. EFD Ecosystem Process and Dynamics and EPI Ecosystem pressures and Impacts. The TOR will provide insights into the knowledge needed to understand ecosystem dynamics that could help with guidelines needed for the management of marine resources.	assess the links between ecological stability and ecosystem properties. **3.** Collaborative scientific papers comparing **ecosystem stability and ecosystem properties** across regional seas and their vulnerability to fishing disturbance and environmental factors.

3 Summary of Work plan

Year 1	WGCOMEDA work has been designed attending to the results achieved during its first 3 years to define which research topics will continue while reshaped in the new the ToRs A, B, and C. An important element in this new cycle is the work to be developed in the ToR D that will be done in close collaboration with members of WGIAB or WGEAWESS. It aims at identifying the main elements of the work developed in progress by WGCOMEDA that may have potential implementation in ICES IEA programme. The group will focus in identifying potential to use the scientific results of WGCOMEDA in the work of the regional IEA expert groups. This will be achieved by back-2-back meetings (with WGIAB and WGEAWESS) and direct communication with chairs.
Year 2	Develop the analyses and modelling defined for each tor The group will use the knowledge obtained in previous research, and the new scientific objectives agreed in the discussions of the first year to develop the statistical analysis and ecological modelling required. This will be developed for each research topic agreed. During the second year the group will start developing products derived from the scientific results of WGCOMEA for regional IEA implementation.
Year 3	Final discussion and synthesis of all the research topics The group will discuss the final results and outcome for the different research topics along the ToR A, B, C and D. Implementation of the strategic knowledge gained in the WG into the ICES IEA programme The group will produce a document outlining the use of WGCOMEDA scientific results in the regional IEA contexts.

4 Supporting information

Priority	The priority of this working group (WG) will continue to be the integration of both **cross-systems** and **system-specific** key scientific questions to guide research and improve the ecosystem approach to management of living marine resources of the European Seas using existing data and analysis from regional systems at the East Atlantic Ocean and Mediterranean Sea. Particularly, the aim of this new cycle of the WG will be twofold. First, we will continue developing fundamental research required to sustain the implementation of Integrated Ecosystem Approach (IEA) in the European Seas. Second, the WG will specifically address the challenge of a potential implementation of the research outcomes into the ICES IEA program. The working procedures will be based on developing and strengthening the scientific basis for regional and integrated ecosystem approach of coastal and marine living resources through a comparative platform of research. During the first three years, the WGCOMEDA succeeded in the development of a network and platform of collaboration, and corroborated that a comparative approach of marine ecosystems is essential to learn on how Mediterranean and Atlantic ecosystems are structured, how they function, and which are the more sensitive species or ecological processes to be managed within the ecosystem dynamics. The close collaboration envisaged with other WG of the SCICOM/ACOM Steering Group on Integrated Ecosystem Assessments (SSGIEA) such as WGIAB or WGEAWESS will provide a solid basis to develop the new objective, research topics and ToR of this new WGCOMEDA cycle. During this new WGCOMEDA cycle we will invite colleagues working in the Pacific ecosystems to the meetings and/or activities evidencing the commitment of the group to develop research and applied activities at a comparative large-scale.
Resource requirements	Information from ICES and GFCM, and JRC databases were and will continue being the main input for this group. Outcomes from foodweb models from the Ecopath International Development and Research Consortium will be used, too. No additional resources are identified, although participation of some experts (especially young scientists) to working group meetings depends on funding availability. The participation of young scientists is capital for a development of activities of the WG, and will highly benefit by the back-to-back meetings with members of WGIAB or WGEAWESS.

5 List of Outcomes and Achievements of the WG in this delivery period

- During de last year and as a part of the work developed under the umbrella of WGCOMEDA, a first cross Atlantic-Mediterranean study that summarizes the fish community composition attending to life-history strategies and traits was provided. This study was published in Global Ecology and Biogeography (Pecuchet *et al.* ,2017 *From traits to life-history strategies: deconstructing fish community composition in European Seas.* Glob. Ecol. Biogeog. DOI: 10.1111/geb.12587. This work is part of the PhD Thesis of the first authors, Lauréne Pecuchet, defended in 2017 in the Copenhagen University. (http://www.dtu.dk/english/research/research-at-dtu/research-news/nyhed?id=6F513B95-BFBD-4629-A583-72DAD5CA2DCC).
- Final results of the first cross Atlantic-Mediterranean comparison of fish community stability as well as its main structural components and affecting drivers (Hidalgo *et al.*, In prep.) Additional research on the relative contribution functional and structural stability is in preparation (Frelat *et al.*, In prep).
- The basis for a common IEA exercise with different Atlantic and Mediterranean ecosystems has been established this year, and it will be developed in close collaboration with IEA regional ICES WGs and MARCONS Cost Action initiative.
- First results of investigating the link between benthic resistance and recovery potential and ecosystem functions using a trait based approach. In preparation are a method paper and a comparative analysis across regional seas (Hinz *et al., I*n prep).

6 Progress report on ToRs and workplan

The WG has successfully advanced in all the ToRs, with the exception of ToR C because the leader (and WGCOMEDA chair, Marta Coll is currently on maternity leave). In the 2017 meeting, each ToR corresponded to a specific topic here below expanded. Along the week, several addition talks were presented and framed with each topic, in addition to various talks presented in the plenary session and the group-integration time, and a series of final additional talks presented as potential lines of research for WGCOMEDA.

We expand hereafter all this information in two blocks: **I)** WGCOMEDA specific activities and **II)** activities associated to the back-to-back meeting with WGIAB and WGEAWESS.

6.1 WGCOMEDA specific activities

6.1.1 TOPIC 1: Structural and functional role of ecological stability across different types of eco-systems - ToR A (Lead: M. Hidalgo).

Understanding the stability of marine ecosystems has been one of the main topics of research from the beginning of WGCOMEDA. As a first approach and during the first WGCOMEDA cycle, we investigated the main structural properties and drivers affecting emergent properties (e.g. properties of groups that cannot be entirely explained by their individual components) such as the stability of fish communities. To do that, we applied the portfolio analytical framework to compare five types of systems across Mediterranean and Atlantic demersal communities: Arctic, Upwelling, Mediterranean, East, and West Atlantic. The Portfolio Effect (PE) is a measure of the stabilizing effect of the diversity that can be also affected by other external (anthropogenic and environmental) drivers. PE estimates were estimated in close relation with community synchrony estimates, and both related to external drivers. Our results show that synchrony is affected negatively by the heterogeneity of Primary Production and a Global Indicator of Anthropogenic Impact (Figure 6.1.1), while the PE effect is positively affected by the mean value of Primary Production and negatively affected by the seasonal range of the bottom temperature (Figure 6.1.1). In addition, we investigated the partitioning of these effects for different groups of the ecosystems attending to mean life-history traits: somatic growth rate, length at maturity and trophic level.

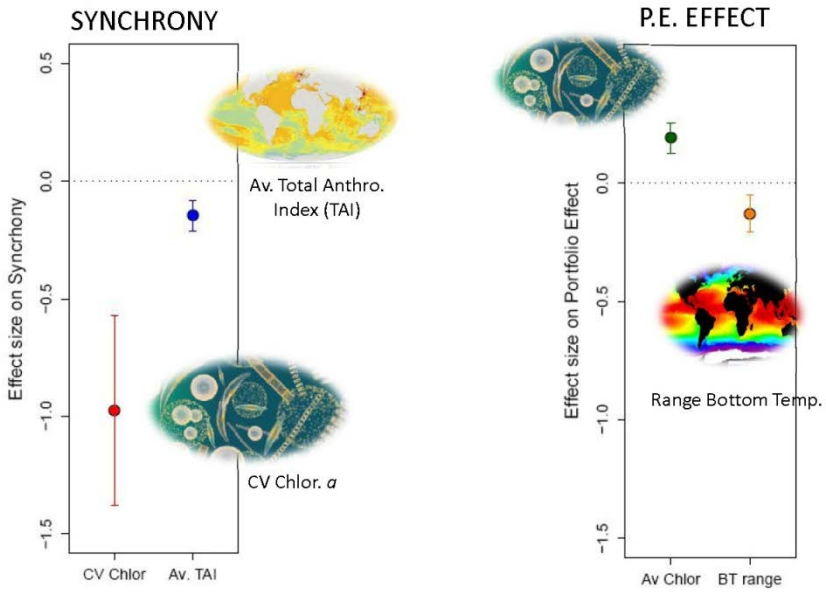

Figure 6.1.1. Relative global effects of synchrony (left) and communities' stability (PE effect, right).

Final results of this study were presented and the group discussed future lines of collaborative research. Two specific topics will be followed: *i*) understanding the taxonomic, functional and structural influence on stability (lead by Romain Frelat in close collaboration with C. Möllmann and M. Hidalgo) and *ii*) understating the relationship between spatial and temporal stability (lead by M. Hidalgo in close collaboration with Jaime Otero, Rita Vasconcellos, Sofia Henriques).

6.1.2 TOPIC 2: Use of functional traits information to assess the structure and functioning of demersal and benthic communities across Mediterranean and Atlantic systems; and to predict their vulnerability to fishing disturbance. - ToR B (Lead: H. Hinz)

While species compositions of communities may differ considerable between geographical regions, their functional structure may be quite similar. To compare communities across regional seas and thus to gain a more in depth understanding of the drivers shaping community function, species level information needs to be translated into a common language. One approach is to use functional traits information, whereby the species are defined by their functional traits rather than by their taxonomy. The resulting data matrix of functional traits can then be used as a basis of a comparative analysis. The aim of this topic is to adopt traits based approaches to investigate the potential vulnerability as well as the resistance and recovery potential of demersal and benthic communities to fishing induced changes. Comparing these community parameters across regional sea levels should provide new insights with respect to the functioning of communities in both the Atlantic and the Mediterranean ecosystems and thus may provide new options for regional management strategies. Under Topic 2, two studies are currently being developed: A) the use of traits based information to investigate the traits based composition of commercially exploited species lead by Vangelis Tzanatos. Here the analysis of life-history traits of species captured by Mediterranean fisheries is being explored. From this analysis the vulnerability of commercial species from a life-history perspective to exploitation pressures can be assessed. B) The analysis of benthic resistance and recovery potential from a

traits based perspective and its relationship with ecosystem functions. The aim of this study is to develop indicators to assess the vulnerability of benthic communities to fishing disturbance and to simulate the effect of different pressure gradients on ecosystem functions. The principle output is a tool to be able to assess the current state of any benthic communities given that the relevant trait information is available and that should be able to predict the consequences of increasing fishing effort on ecosystem functions i.e. inform about vulnerably or the resistance and recovery potential of ecosystem functions. The work is led by Hilmar Hinz, Anna Törnroos, and Silvia de Joan.

The study presented by Vangelis Tzanatos Topic 2 on fish communities thus far concentrated on Greek waters but can be expanded to other Mediterranean and Atlantic ecosystems:

Vangelis Tzanatos - " *Biological traits analysis of fisheries resources: From populations to the Ecosystem Approach to Fisheries Management*".

The project "Biological traits analysis of fisheries resources: From populations to the Ecosystem Approach to Fisheries Management" (BATFISH) is a research project that uses Biological Traits Analysis in order to comprehend the ecology of fish and other fisheries resources and improve the management of the marine ecosystem. Its aims are organized on three levels and comprise the following: (1) In the scale of populations: The study of the relationships among the biological characteristics of Mediterranean fisheries resources and the identification of life strategies, (2) In the scale of ecosystems: The study of the distribution of biological traits in different habitats and the shaping of niches in marine ecosystems, (3) In the scale of landscape: The identification of relationships and patterns between anthropogenic effects (e.g. fisheries, climate change) and biological traits. The rationale, research questions and content of BATFISH can be useful to move towards an Ecosystem-based Approach to Fisheries and were presented in the context of comparative analyses between European Atlantic and Mediterranean marine ecosystems as framed within the WGCOMEDA.

Preliminary results of the benthic traits analysis were presented by **Hilmar Hinz** "*The effect of benthic resistance and recovery potential on ecosystem functions: An ecological trait based approach*".

Preliminary results for the Irish Sea were presented but data for the Baltic and Catalan Sea are currently in perpetration. The study demonstrated the use of a new index termed **RRI** index = **R**esistance and **R**ecovery Potential **I**ndex. The index is the result of combining two separate indices a) a **R**esistance **I**ndex related to morphological and behavioural traits that increase resistance and b) a **R**ecovery **P**otential **I**ndex that included traits related to life-history traits on reproductive potentials and growth that may enhance recovery of populations. The new index can be used to assess the status of benthic communities with respect to their overall vulnerability and highlight key species that may be vulnerable or resistant to trawling impacts. The RRI index can subsequently be linked to functional indices such as the bioturbation index developed by Queiros *et al.* (2013) via simulations (Figure 6.1.2). Simulations can be run as complete removals or as reduction in abundance or biomass using the RRI to direct the simulated changes.

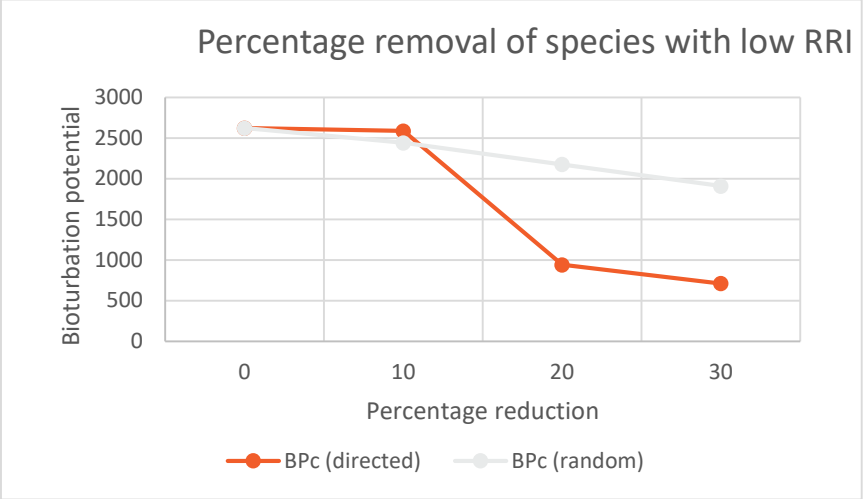

Figure 6.1.2. Removal of species with a low and high RRI from a low impact community in the Irish Sea. The removal of the 20% of the most vulnerable and most resistant species had contrasting effects on ecosystem functions. The analysis showed that the bioturbation was mainly carried out by vulnerable species that are likely to be affected by trawling.

The RRI groupings into Low Mod and High were cross-validated with data from a fishing ground for which the effort gradient was known. RRI groups appear to follow the expected changes with the highly resistant group (high RRI) not showing an effect to trawling, while Moderate and Low RRI species did show clear reductions in abundance in relations to increases in fishing intensities (Figure 6.1.3).

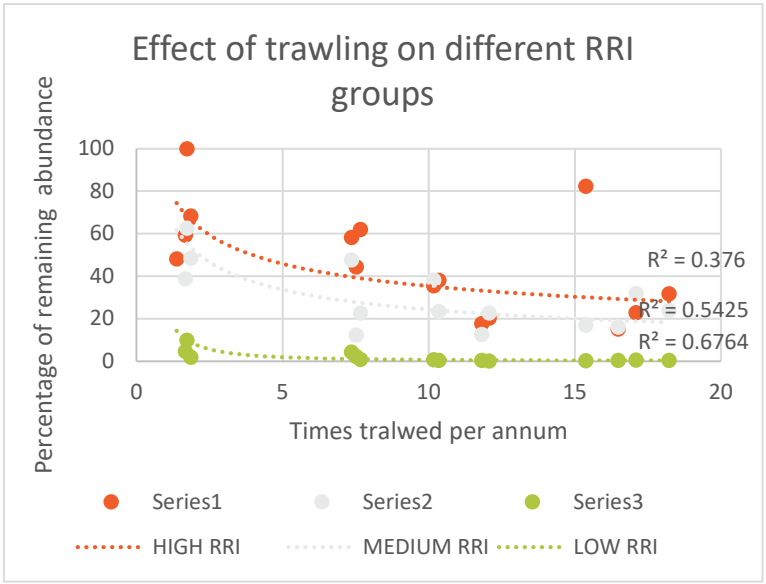

Figure 6.1.3. Changes in abundances of RRI groups (Low, Moderate and High) with increased in trawling intensity (Irish Sea data, Hinz *et al.*, 2009).

Besides the bioturbation functional index, the study is developing three more functional indices: 1) Biotic habitat structure provision Index, 2) Energy processing potential (Feeding types) and 3) Higher trophic transfer potential (benthic prey prevalence). The relationship of these indices to the RRI will be explored for the regional seas data collated in future.

The study currently is still in a preliminary stage with respect to a regional comparison, however the method part will be published in due course.

6.1.3 TOPIC 3: Identify ways and products to support the implementation of IEA in regional ecosystems - ToR C (Lead: C. Möllmann).

The topic aims at develop a cross system analytical IEA comparative exercise including data from Atlantic and from the Mediterranean. To do that, the group first need to decide which data to compile and analytical tool to be used. The group agreed to use state-of-the-art multivariate techniques combined with a traffic light representation of the results. Regarding data, they agreed that some time-series regularly used in IEAs in the North Atlantic, such as zooplankton time-series, will not be able to be used in a common basis for all the systems. By contrast, the group also agreed to include several indicators on functional traits of fish at different ecosystems.

For next year, the group agreed in developing some preliminary analyses on a reduced number of systems to be discussed in the next meeting, where a final protocol for the analyses will be developed and distributed to scientists' representative of different systems.

An additional talk presented under this Topic 3 by Thorsten Blencker summarized the methods used and the main results obtained in the development of the Baltic Health Index (http://www.stockholmresilience.org/research/research-themes/marine/baltic-health-index.html), which is a regional study under the global Ocean Health Index framework. The objective of this regional study is to initiate the development of a tool that can be used by managers and decision-makers to guide management of the Baltic Sea region towards increased sustainability of the ecosystem.

6.1.4 Additional research topics presented

Three additional talks not framed in the previous topics were presented as potential future lines of research before the final discussion and wrapping up.

Florian Caillon - "Morphometrics based on Elliptical Fourier Analysis." [trait scheme].

The shape of fish is the result of evolution and adaptations to the species' environment and behaviours. A great diversity of shapes is found among marine fish species; however, the quantitative and objective description of this morphological diversity is complex. Outline analysis (also called Fourier Elliptical Transforms, EFT) could cope with these challenges by describing an outline into quantitative variables, called harmonic coefficients (Figure 6.1.4).

We applied EFT to describe the fish outline shapes of 99 fish species from 41 fish families of the North Sea. Then, the spatial distribution of morphological diversity was studied and compared with the functional diversity pattern. Finally, we explored the environmental drivers that could explain the observed morphological diversity.

By turning shape into quantitative variables, EFT reveals synthetic indicators that can be used to summarize the sampled morphological diversity. The main morphological diversity was linked to the elongation and the shape of dorsal, anal and caudal fins. Morphological diversity appears to have a strong latitudinal gradient along the North Sea, that was linked with differences in depth, primary production, and temperature.

Hopefully, these first promising results will path the way for larger studies on the ocean life, e.g. integrating behavioural, phylogenical and biomechanical data.

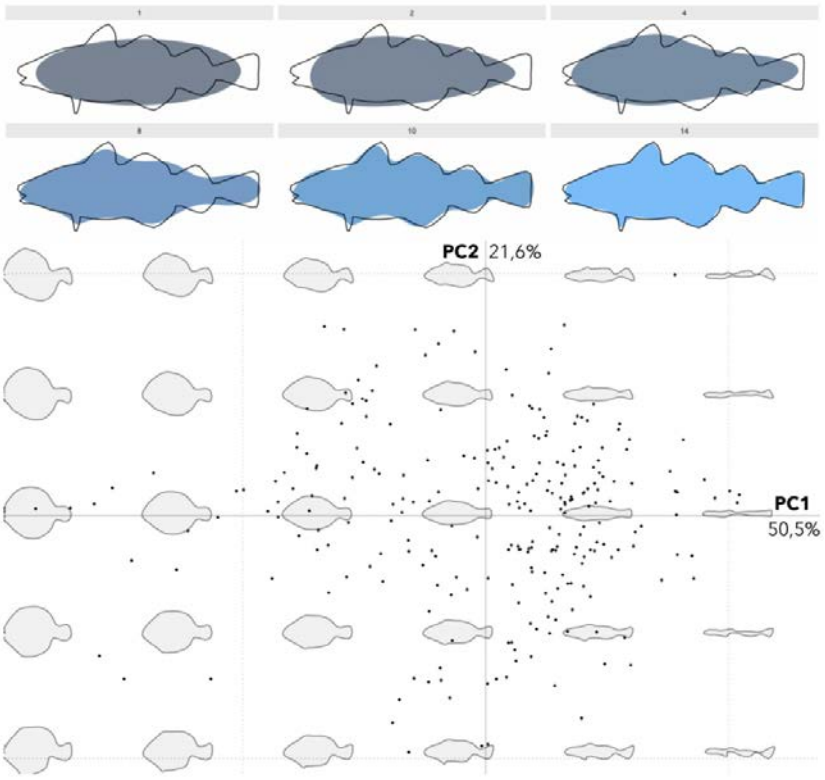

Figure 6.1.4. Representation of an outline analytical framework that combines Fourier Elliptical Transforms (EFT) with multivariate analyses.

Florian Caillon, Romain Frelat, Christian Möllmann, Vincent Bonhomme. *Describing fish morphological diversity with modern morphometrics*. Manuscript in preparation.

Jaime Otero - " Small-scale fisheries off the Galician coast: trying to see the wood for the trees"].

Small-scale fishing (SSF) is a large contributor to worldwide fish catches and food supplies and security. It, globally, provides employment to the largest number of fishers, as compared to industrial fisheries, and contributes to the development, growth and wellbeing of local economies, societies and cultures. However, despite its importance, SSFs have been traditionally under-attended and marginalized in national and international policies including the European Union where more than 80% of the fishing fleet is considered as small-scale and coastal fisheries. In general, this poor attention has been largely the case because most of the SSFs worldwide are not formally assessed, and this is of particular concern given that these poorly understood fisheries seem to be in substantially worse shape than the relatively well-studied ones. The lack of effective management in thousands of fisheries around the globe are mainly due to a lack of appropriate data which prevents the evaluation of the status and productivity of those fish stocks mostly in developing countries but also in industrialized ones.

Galicia (NW Iberian waters, Figure 6.1.5) is one of the main fishing regions in Spain and Europe counting a large fleet of around 4000 small-scale fishing boats which represent ~90% of the total number of registered vessels in the area. Despite these figures, the dynamics of this multi-gear artisanal fleet and the composition and status of the targeted species are poorly known. This is in part due to the lack and paucity of appropriate information that prevent the assessment and management of key species.

To ameliorate this situation, the regional government established an on board monitoring system in 1999 (Figure 6.1.5). Through this program, catch and operational data are regularly collected by observers enrolled in the artisanal fleet. In 2014, the ICES Science Fund provided initial support to the project "Catch rate standardization of finfish targeted by the Galician (NE Atlantic) small-scale fishery (CASGASS)". This one-year research initiative aimed at standardizing catch and effort data for a small number of relevant commercial species. A follow-up project funded by a contract agreement between the Galician government and IIM-CSIC will continue the work over the period 2016–2018. This new project has more ambitious objectives including: standardizing catch and effort data for 20 species including finfish, elasmobranchs, cephalopods and crustaceans; evaluate changes in size indicators; and compile life-history traits.

Apart from the objectives outlined above, the data could be analysed in a number of other ways matching the research lines of WGCOMEDA. For instance, community and biodiversity analyses could be easily implemented; fleet dynamics and fishers' decisions would be also desirable to be evaluated; comparison to other SSFs such as the Greek fleet could be doable, etc. Last but not least, we would like to ultimately explore the application of data limited methods for assessment and management of the key species.

In order to tackle these, or other, topics, James Otero's research team is seeking for students and post-docs willing to join our group. Nowadays, regional funding opportunities (pre- and post-doc Galician government fellowships), or international programs (e.g. Marie Curie fellowships) are opened, and his team would be happy to develop projects based on our data in order to apply to one of those calls.

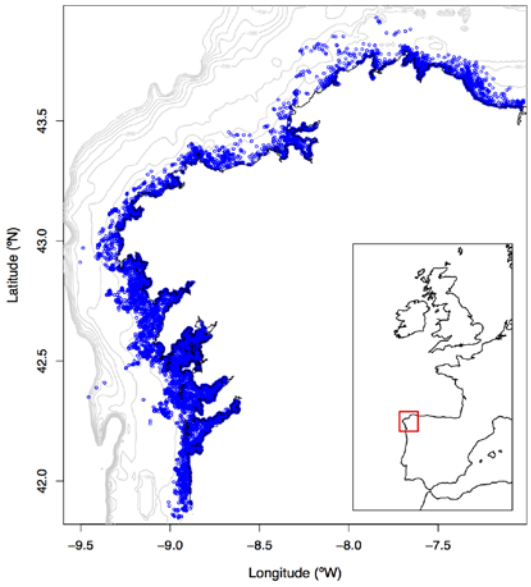

Figure 6.1.5. Map of the Galician coast and location of the ~50.000 sampled hauls over the period 1999 to 2016.

Jeremiah Plass-Johnson - "The effect of Mediterranean Marine Protected Areas on Functional diversity of fish communities".

In response to the loss and destruction of marine communities, marine protected areas (MPAs) have become a common tool to restore, protect or conserve aspects of these communities. Generally, it is known that fisheries-targeted species respond to

protection; however, given that these species are often large bodied, higher order predator species, their re-establishment can play a significant role in structuring communities because of competitive and predatory interactions. Thus, the effects of protection on species composition can be opposing or uncorrelated when differing sets of species simultaneously increase and decline. The slow response of species within MPAs to protection, or their opposing responses, may result in no net change in species diversity. Alternatively, metrics that account for traits that react to changes in the functioning of the assemblage give a more detailed overview in the redistribution of functional characteristics. This study evaluates the effects of protection on the functional diversity and the functional identity of fish assemblages from 13 Mediterranean MPAs. Results show that there was little effect of protection on community-wide functional indices, but rather average community-weighted (fish biomass) trait values display a compositional response to protection. Four traits and ten levels within traits showed an increase in MPA no-take zones while three traits with seven levels increased in fished areas. Through this meta-analytical approach, scientists learned that although traditional (species diversity, abundances) or community (functional richness or functional evenness) indices of fish assemblages of Mediterranean MPAs may not display a response, these communities indeed display a structural change.

6.2 Back-to-back activities with WGIAB and WGEAWESS.

Plenary presentations and integration time for discussion of the three groups were divided in 3 research schemes:

- Group 1: Trait-Based Integrated Trend Analysis - a continuation and spatial expansion [trait scheme].
- Group 2: Expansion of IEA methods to analyse spatio-temporal dynamics and developing trait-based indicators [method scheme].
- Group 3: Exploring the social-ecological system [SES scheme].

6.2.1 Plenary presentations

Six plenary talks were given in addition of three presentations of one of the chair of each group presenting 'the history' of each WG (see WG agenda). Here below a summary of these six talks:

Rita Vasconcelos - "Current limitations of global conservation to protect higher vulnerability and lower resilience fish species" [trait scheme].

Estuaries and coastal areas are threatened by intense and continuously increasing human activities. Here we estimated the sensitivity of fish assemblages in a set of 378 estuaries distributed worldwide (based on species vulnerability and resilience), and the exposure to cumulative stressors and coverage by protected areas in and around those estuaries (from marine, estuarine and freshwater ecosystems, due to their connectivity). Vulnerability and resilience of estuarine fish assemblages were not evenly distributed globally and were driven by environmental features. Exposure to pressures and extent of protection were also not evenly distributed worldwide. Assemblages with more vulnerable and less resilient species were associated with estuaries in higher latitudes (in particular Europe), and with higher connectivity with the marine ecosystem, moreover such estuaries were generally under high intensity of pressures but with no concomitant increase in protection. Current conservation schemes pay little attention to species traits, despite their role in maintaining ecosystem functioning and stability. Results emphasize that conservation is weakly related with the global distribution of sensitive fish species in sampled estuaries, and this shortcom-

ing is aggravated by their association with highly pressured locations, which appeals for changes in the global conservation strategy (namely towards estuaries in temperate regions and highly connected with marine ecosystems) (Figure 6.2.1).

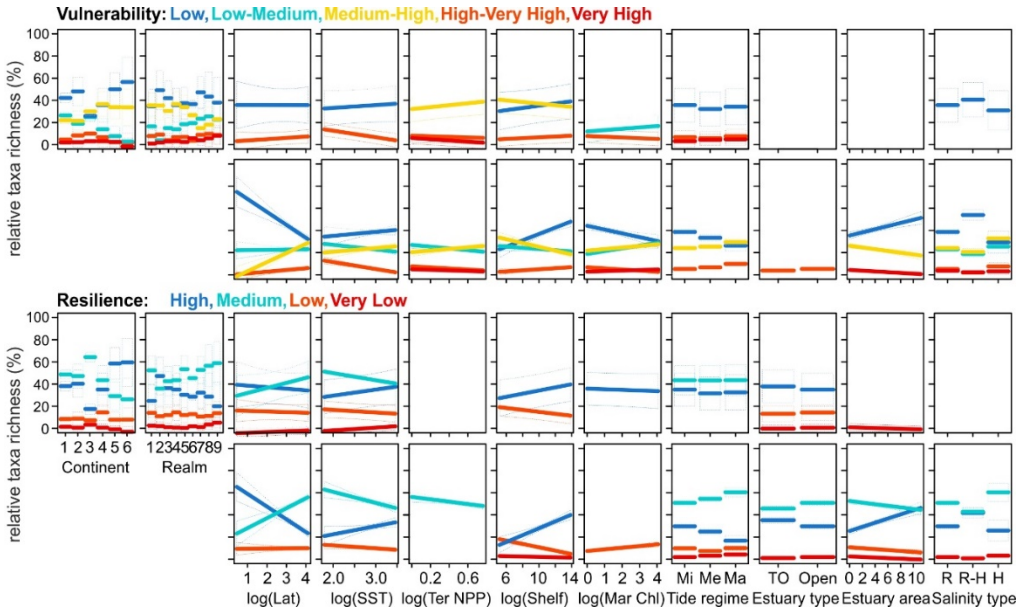

Figure 6.2.1. Relationships between fish traits (i.e. relative taxa richness of trait categories) of fish assemblages in sampled estuaries distributed worldwide and ecosystem features, according to fitted linear models. Traits considered are vulnerability, i.e. species intrinsic extinction vulnerability to fishing (Low, Low-Medium, Medium-High, High-Very High, Very High) and resilience, i.e. species productivity or resilience to fishing (High, Medium, Low, Very Low). Ecosystem features represented are: continent (1- North America, 2- South America, 3- Europe, 4- Africa, 5- Asia, 6- Oceania), marine biogeographical realm (1- Temperate Northern Pacific, 2- Tropical Eastern Pacific, 3- Temperate South America, 4- Temperate northern Atlantic, 5- Tropical Atlantic, 6- Temperate Southern Africa, 7- Western Indo-Pacific, 8- Central Indo-Pacific, 9- Temperate Australasia) , latitude (for representation purposes only), sea surface temperature (SST), terrestrial net primary productivity (Ter NPP), marine chlorophyll a (Mar Chl), continental shelf width (Shelf), tidal regime (Mi-microtidal, Me-mesotidal, MA-macrotidal), estuary type (TO-temporarily open, O-open) and salinity type (R-regular, R-H-regular to hyperhaline, H-hyperhaline). Only predictors with relative importance above 0.5 in linear models are represented.

Vasconcelos R.P., Batista M., Henriques S., Current limitations of global conservation to protect higher vulnerability and lower resilience fish species. Manuscript under review.

Romain Frelat - " Spatio-temporal dynamics of fish communities revealed by tensor decomposition" [method scheme].

Marine ecosystem-based fisheries management requires a holistic understanding of the dynamics of fish communities and their responses to external pressures such as fisheries exploitation and climate change. However, characterizing multispecies community dynamics in heavily exploited large marine ecosystems over time and space is difficult and requires specialized multivariate statistical approaches. We applied COSTATIS, a mathematical framework that allows the simultaneous analysis of a sequence of paired ecological tables (in our case species abundances and the environmental variables). We used this comprehensive approach to investigate link between the spatio-temporal dynamics of 31 fish species and 13 environmental variables, including hydro-climatic conditions (temperature, salinity, oxygen), biological

variables (primary production) and fishing pressure (Figure 6.2.2). The study was performed on the 7 subdivisions of the Baltic Sea on the recent decade: from 2003 to 2014. A strong gradient from the South-West to the North-East was found to shape the fish communities and most of the environmental variables, with higher salinity, temperature and oxygen content in the SW than in the NE. This spatial gradient was strong and stable across years. In contrast, the temporal dynamics of fish communities were more heterogeneous and not significantly linked with the temporal dynamics of the environmental variables. Finally, we identified 5 subcommunities of fish species, favoured by similar environmental conditions and sharing similar spatial distribution across the Baltic Sea. Using an innovative statistical approach, our study contributes to a better understanding of the patterns and drivers of the Baltic Sea fish communities, information that is key to inform a sustainable management of the ocean.

Romain Frelat, Saskia Otto, Camilla Sguotti and Christian Möllmann *Spatio-temporal dynamics of fish community and their relationship with environmental variables*. Manuscript in preparation.

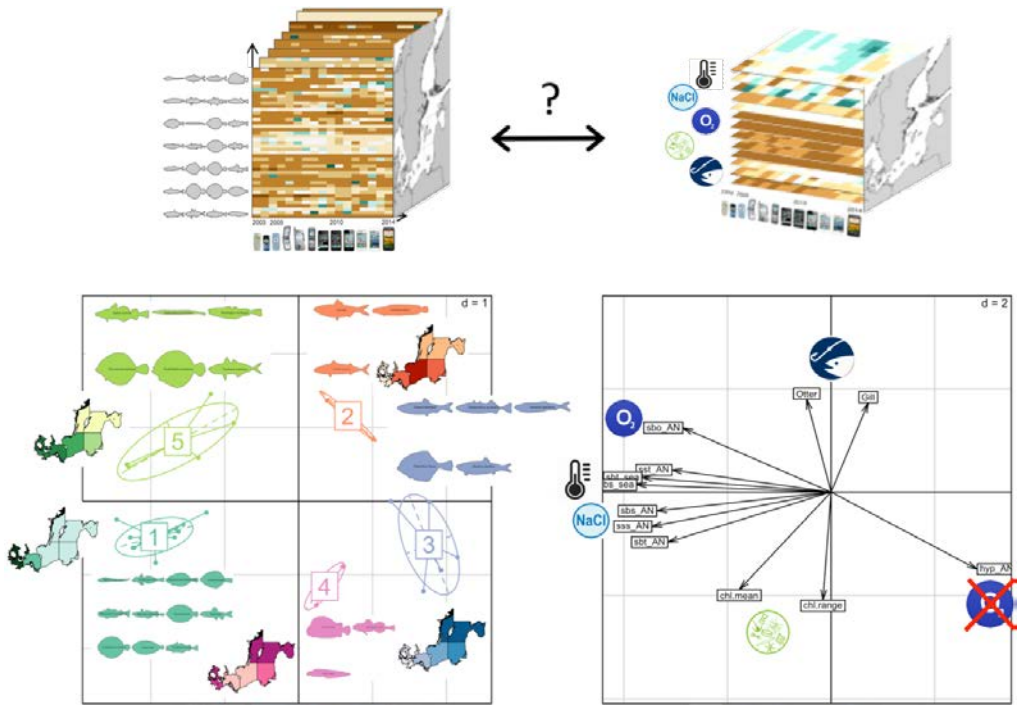

Figure 6.2.2. Summary of the mathematical framework (COSTATIS) applied to characterize multispecies community dynamics in heavily exploited large marine ecosystems over time and space, and applied over the Baltic Sea.

Paris Vasilakopoulos - "Resilience quantification framework that I had been working on, and applied it to Mediterranean fisheries resources to quantify resilience dynamics shaped by sea warming" [method scheme].

Complex systems, spanning from populations and ecosystems to societies and economies, often exhibit abrupt reorganizations in response to changing stressors, known as regime shifts or critical transitions. The theory of critical transitions suggests that such systems feature folded stability landscapes with fluctuating resilience, fold bifurcations, and alternate basins of attraction (Scheffer, 2009). However, the implementation of such features to elucidate response mechanisms in an empirical context is scarce, due to the lack of generic approaches to quantify resilience dynamics of individual systems. For this, we have introduced introduce an Integrated Resilience

Assessment (IRA) framework: a three-step analytical process to assess resilience dynamics and construct stability landscapes of empirical complex systems. The proposed framework involves a multivariate analysis to estimate holistic system indicator variables, non-additive modelling to estimate alternate attractors, and a quantitative resilience assessment to scale stability landscapes. The applicability of this framework is illustrated on empirical complex systems at different levels of biological organization, namely at the population and the community level. At the population level, an IRA was carried out for the Barents Sea cod population in 1949–2009 revealing a folded stability landscape with two basins of attraction shaped by the combined effects of fishing and climate change (Vasilakopoulos and Marshall, 2015; Figure 6.2.3). At the community level, IRAs were applied to the marine communities in the eastern and western Mediterranean Sea to reveal folded stability landscapes and multivariate shifts to regimes dominated by thermophilic species in response to sea warming during 1985–2013 (Vasilakopoulos *et al.*, in review). The approach exemplified for a fish population and two marine communities, revealing previously unknown resilience dynamics driven by anthropogenic and climate forcing, can be applied in other complex systems to elucidate discontinuous dynamics in a fast-changing world.

Reference: P. Vasilakopoulos, D. Raitsos, E. Tzanatos, C.D. Maravelias. *Resilience and regime shifts in a marine biodiversity hot spot*. Manuscript in preparation.

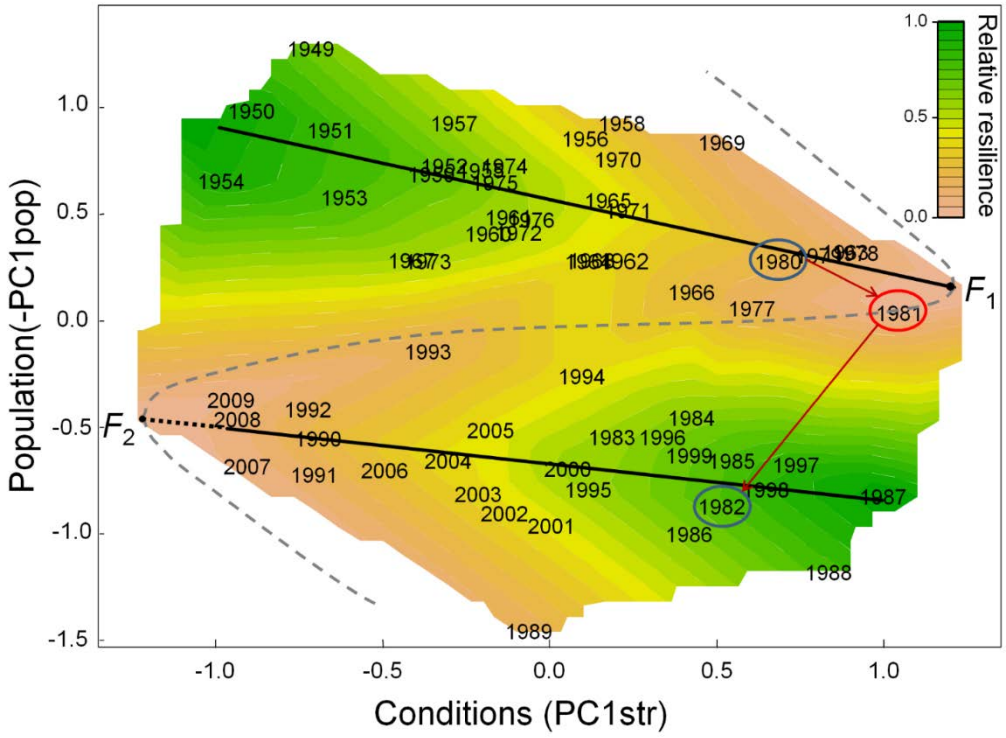

Figure 6.2.3. The folded stability landscape of Barents Sea cod during 1949–2009. The x-axis is the first PC of a PCA carried out on 5 stressor variables (PC1str) and the y-axis is the first PC of a PCA carried out on 13 population variables (PC1pop). Continuous black lines indicate the linear attractors, dotted black line indicates the possible extension of the lower branch, dashed grey lines indicate the approximate position of the basin's borders and F_1, F_2 indicate the tipping points. Colours represent the relative resilience contour interpolated from the relative resilience of each year. Circles and arrows indicate the 1981 regime shift. From Vasilakopoulos and Marshall, 2015.

Additional talks presented in the plenary time were:

- Martin Lindegren - "A trait-based assessment towards understanding long-term changes in ecosystem functioning: the Central Baltic Sea as a case study" [trait scheme].
- Tessa Francis - "A multi-model approach to incorporating traditional ecological knowledge and human dimensions into Pacific herring management: an Ocean Modeling Forum case study" [SES scheme].
- Margarita Rincon - "Testing environmental, economic and social criteria in a co-creation process with stakeholders: An example model for European anchovy using shiny R package" [SES scheme].

6.2.2 Integration time

The integration time was framed under the same research scheme aforementioned, and consisted in several fast (5 min) talks plus discussions. Here below a summary of the talks presented.

Esther Beukhof - "A trait-based approach to understand fish species distributions through trait-environment relationships" [trait scheme].

In this study, a trait-based approach was used to understand fish species distributions across European shelf seas. When focusing on taxonomy only one may miss the mechanistic understanding of what underlies these distributions. Trait-based ecologists argue that traits are useful in explaining where species occur, since it is the traits that determine how species respond to the environment. We used a unique dataset containing the spatial occurrence of over 250 marine fish species across Europe's continental shelf seas – ranging from Iceland and southern Greenland to Portugal with a high spatial resolution of ¼ degree. The main aims were to identify key traits for marine fish that explain fish species distributions and to identify the most important relationships between marine fish traits and the environment. Three-matrix approaches (RLQ and fourth-corner analysis) were used to investigate the relationships between species traits and environmental variables through the information on species occurrences. We demonstrated that marine fish species can be characterized according to their traits along a fast-slow continuum mainly characterized by age at maturity, lifespan and growth. This is continuum is then determined by a coastal to offshore gradient, implying that depth, temperature, productivity and seasonality are important factors for structuring marine fish communities.

Additional talks presented in the plenary time were:

- Manuel Hidalgo - "A trait-based approach to understand fish species distributions through trait-environment relationships" [methods scheme].
- A summary of the material presented in the Topic 1 in WGCOMEDA. See section 7.1.
- David Reid - " Generating knowledge to support EBFM: WKIRISH/ FishKOSM – Progress and future direction".
- Saskia Otto - "Lessons learned - SWOT analysis on IEA methods ".
- Anna Törnroos - "General introduction to trait-based approaches." [trait scheme].
- Lauréne Pécuchet - "From traits to life-history strategies" [trait scheme].

6.3 Cooperation with other

The meeting developed this year in a back-to-back framework is an evidence of the active collaboration of WGCOMEDA with other ICES WGs. This combined meeting will be likely to be repeated given the important feedback and stimulating activities developed across groups. However, it is more likely that it will occur every two-three years to let each group work more in depth in their independent commitments. Indeed, the Topic 3 lead by C. Möllmann is a research activity specifically designed to embrace effort and activities between WGCOMEDA, WGIAB and WGEAWESS.

6.4 Cooperation with Advisory structures

The WG has secured the official support from the General Fisheries Commission for the Mediterranean (GFCM). Furthermore, GFCM sees the WGCOMEDA group as a possible vehicle to ask specific scientific questions with respect to the overarching theme of the WG. Following the memorandum of understanding that exist between the two organizations, the WG can develop as an important vehicle in perusing this collaboration between both ICES and GFCM by both organizations. As a part of the activities planned for 2018, one of the chairs, Manuel Hidalgo, will attend to the annual MEDITS coordination meeting to transmit to a broad Mediterranean community the activities that will be developed under this second 3-year cycle of WGCOMEDA.

7 Revisions to the work plan and justification+

Not applicable.

8 Next meeting

The next meeting will take place in May 2018 in Montpellier or Sète, France

References

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Scheffer, M. Critical Transitions in Nature and Society (Princeton University Press, New Jersey, 2009).

Vasilakopoulos, P. Marshall, C. T. 2015. Resilience and tipping points of an exploited fish population over six decades. Glob. Change Biol. 21, 1834-1847 (2015).

Vasilakopoulos, P. Raitsos, D. Tzanatos, E. Maravelias C.D. (in review) Resilience and regime shifts in a marine biodiversity hot spot.

Annex 1: List of participants

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Annex 2: Recommendations

Recommendation	Adressed to
Using traits data for both fish and benthic species to conduct regional and cross regional studies have been highlighted by studies and scientists of WGCOMEDA, WGIAB, and WGEAWESS. The lack of a common, standardized and quality controlled database was a clear concern voiced at the meeting. The working group members emphasized that the traits based approach is and will be an important tool to be able to work on multispecies levels and over large spatial scales in future. An urgent need was identified to manage and store trait data that are currently collated and held by individual researchers. The creation of a common trait database was proposed that could be managed by or with the help of the ICES Data Centre.	BEWG, WGMHM, all EGs of SSGRSP, ICES Data Centre
2. All WGCOMEDA members agree that ICES may take the initiative to strengthen the MoU between ICES and GFCM towards a more cooperative study to facilitate a collaborative exploitation and open access of survey data (both demersal and pelagic information).	ACOM or SCICOM

Annex 3: Agenda

BACK-2-BACK MEETING

ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea [**WGIAB**]

ICES Working Group on Comparative Analyses between European Atlantic and Mediterranean marine ecosystems to move towards an Ecosystem-based Approach to Fisheries [**WGCOMEDA**]

ICES Working Group on Ecosystem Assessment of Western European Shelf Seas [**WGEAWESS**]

– SPECIFIC AGENDA FOR WGCOMEDA–

Lisbon, Portugal, 24–27 April 2017

IPMA

Monday 24/04/17

12.30-13-30. Arrival of participants

13.30 – 14.00. Welcome by Fátima Borges (IPMA) and Marián Torres (CCMAR)

14.00– 15.00. Practical information, goals and setup of the WGIAB/WGEAWESS/WGCOMEDA back-2-back meeting.

Discussion of the general agenda (Fátima Borges with chairs).

- Introduction of WGs:
- History and future of **WGIAB** (Lena Bergström)
- History and future of **WGEAWESS** (Steven Beggs).
- History and future of **WGCOMEDA** (Manuel Hidalgo)

15.00 – 15.15. Coffee break

15.15 – 15.45. '*Re-welcome*' to WGCOMEDA, discussion of the agenda, presentation of participants, objectives and structure (i.e. initial topics) of WGCOMEDA for the period 2017-2019:

- Topic 1: Traits-based approaches (TB): novel methodologies to develop comparative analyses, TB on benthic species, implementation of size information (Hilmar Hinz).
- Topic 2: Interplay between stability-diversity-resilience: embracing temporal and spatial scales (Manuel Hidalgo).
- Topic 3: Transferring and adapting methods and tools on Integrated Ecosystem Approaches (IEA): starting IEA exercises in regional systems of the Mediterranean Sea (Christian Möllmann).

15.45 – 16.00. Introduction to focused discussion on Topic 1 on traits-based approaches (Hilmar Hinz).

16.00 – 16.15. Topic 1: '*Biological traits analysis of fisheries resources: From populations to the Ecosystem Approach to Fisheries Management'* (Vangelis Tzanatos).

16.15 – 15.45. Discussions on the topic 1.

16.45 – 17.00. Coffee break

17.00 – 17.15. **Topic 1:** 'The effect of benthic resistance and resilience on ecosystem functions: An ecological traits based approach' **(Hilmar Hinz).**

17.15 – 18.00. **Discussions on the topic 1.**

20.00. Common dinner if wanted.

Tuesday 25/04/17

09.00 – 10.30. PLENARY presentations. Back-2-back. WGIAB/WGEAWESS/WGCOMEDA; 15min each**:**

- Martin Lindegren: "A trait-based assessment towards understanding long-term changes in ecosystem functioning: the Central Baltic Sea as a case study".
- Rita Vasconcelos: "Current limitations of global conservation to protect higher vulnerability and lower resilience fish species ".
- Tessa Francis: "A multi-model approach to incorporating traditional ecological knowledge and human dimensions into Pacific herring management: an Ocean Modeling Forum case study".

10.30 – 10.45. Coffee break

10.45 – 11.15. Synthesis discussion on the topic 1: summary of agreements, work to be developed, novel ideas and definition of tasks.

11.15 – 11.40. Introduction to focused discussion on Topic 2 on the interplay between stability-diversity-resilience (Manuel Hidalgo).

11.45 – 12.30. Discussions on the Topic 2.

12.30 – 13.30. Lunch break

13.30 – 13.45. Topic 2: Setting new activities on the topic. For instance: '*Comparative studies based on vulnerability metrics*' (Joachim Claudet).

13.45 – 14.45. Discussions on the topic 2.

14.45 – 15.15. Coffee break

15.15 – 16.00. Closing discussions on the topic 2: summary of agreements, work to be developed, novel ideas and definition of tasks.

16.15 – 16.45. Discussion oriented to prepare 'integration meetings between groups'.

16.45 – 17.00. Coffee break

17.00 – 18.00. GROUP INTEGRATION: session on trait-based approaches back-to-back with WGIAB/ WGEAWESS. 5 min speed talks and common discussion.

- Anna Törnroos/Martin Lindegren: General introduction to trait-based approaches.
- Lauréne Pécuchet: Life-history strategies of European Seas' fish communities
- Esther Beukhof: Exploring trait-environment relationships using Europe's marine fish communities.

20.00. Common dinner if wanted.

Wednesday 26/04/17

09.00 – 10.30. PLENARY presentations. Back-2-back. WGIAB/WGEAWESS/WGCOMEDA; 15 min each:

- Margarita Rincon: "Testing environmental, economic and social criteria in a co-creation process with stakeholders: An example model for European anchovy using shiny R package".
- Romain Frelat: "Spatio-temporal dynamics of fish communities revealed by tensor decomposition".
- Paris Vasilakopoulos: "An Integrated Resilience Assessment framework to quantify non-linear dynamics of complex natural systems".

10.30 – 10.45. Coffee break

10.45 – 11.00. Introduction to focused discussion on Topic 3 on transferring and adapting methods and tools on IEA (Christian Möllmann).

11.00 – 11.30. Discussions on the topic 3 – Limitations and adaptations when transferring IEA tools to the Mediterranean systems.

11.30 – 11.45. Topic 3: *'The Mediterranean Spanish coast as an example of regional case studies on IEAs'* (Manuel Hidalgo).

11.45 – 12.30. Discussions on the topic 3.

12.30 – 13.30. Lunch break

13.30 – 14.45. Discussions on the topic 3: defining steps to integrate IEA in Mediterranean systems, additional potential systems to perform the work in close collaboration.

14.45 – 15.15. Coffee break

15.15 – 15.30. Topic 3: *'Baltic Health Index – an integrative assessment'* (Thorsten Blenker)

15.30 – 16.00. Closing discussions on the topic 3: summary of agreements, work to be developed, novel ideas and definition of tasks.

16.15 – 16.45. Discussion oriented to prepare 'integration meetings between groups'.

16.45 – 17.00. Coffee break

17.00 – 18.00. GROUP INTEGRATION: Group integration (session on IEA methods back-to-back with WGCOMEDA/ WGEAWESS; 5min speed talks)

- Manuel Hidalgo: "Stability on demersal fish communities: embracing temporal and spatial scales"
- Dave Reid: "Generating knowledge to support EBFM: WKIRISH/ FishKOSM – Progress and future direction"
- Saskia Otto: "Lessons learned - SWOT analysis on IEA methods"

19.00 . **Common social event WBIAB/WGEAWESS/WGCOMEDA** - Dinner with live fado music, traditional Portuguese food. 28 €, not including drinks.

Thursday 27/04/17

09.00 – 9.45. Synthesis discussion: from WGCOMEDA work to WGIAB and WGAWESS, and back.

09.30 – 10.30. Future of WGCOMEDA group: defining the future roadmap in the next three years including potential new topics.

10.30 – 11.00. Coffee break

11.00 – 12.30. Presentations of WGCOMEDA members on **additional** and future topics:

- Florian Caillon: Morphometrics based on Elliptical Fourier Analysis.
- Jaime Otero: Complexity of artisanal fisheries along the Galician coast.
- Jeremiah Plass-Johnson: Effects of Mediterranean MPAs on the functional composition of fish assemblages.

(Potentially completed with 1-2 additional small talks).

12.30 – 13.30. Lunch

14.30 – 15.15. Final WGCOMEDA Session.

- Wrap-up of each topic.
- Discussion on venue for the next meeting
- Planning of the report
- Report writing

15.15 – 16.45. CLOSING PLENNARY: all groups

17.00. Meeting closure

18.00. TEJO RIVER TOUR (Price 20€).