Mediterranean Marine Protected Areas: Integrated Management as a Response to Ecosystem Threats

MMMPA/ CIESM International Joint Conference Report

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Contents

Foreword

Over the past decades, human development has steadily advanced hand in hand with technological progress. While usually equated to improved wellbeing, this has eventually proven to be a double-edged sword. The exploitation of natural resources, be they terrestrial or marine, has proceeded at a clearly unsustainable pace with consequences ranging far beyond solely environmental ones.

Building on concepts such as the Ecosystem Services framework, we are now starting to understand how the loss of biodiversity actually translates into socio-economic issues affecting entire communities and beyond, nations and entire world regions.

As anthropogenic pressures keep increasing on land like on the sea, environmental sciences have more and more clearly recognized the crucial need to take into account human-nature relationships to better inform and guide conservation and development. We are addressing social-ecological systems within which humans' fitness is grounded on our ability on one hand to develop and integrate different kinds of knowledge as well as technology-based solutions and, on the other hand, to develop appropriate forms of governance, characterized by trust and collaboration between local community, stakeholders and decision makers. Consequently, there is a growing interest from researchers and the public at large to understand social-ecological systems dynamics and the sustainability of human-nature interactions in a continuum linking the land and the sea. Such an approach is multidisciplinary by nature, informing the Ecosystem-Based Management (EBM) approach which aims for sustainable delivery of ecosystem services and benefits to human communities while simultaneously maintaining healthy and productive ecosystems.

Typically, EBM attempts to regulate human activities and reach conservation objectives through the establishment of Marine Protected Areas (MPAs). MPAs and other similar approaches (Aichi Target 11) are "the" places where conflicting demands need to be tackled via multidisciplinary and cross-sectorial approaches. In this regard, MPAs offer opportunities for endless "lesson learning" in conservation science, including generating further knowledge, using such knowledge to empower stakeholders and eventually address conflicts among them. However, to achieve and maintain these goals through constant feedback and adaptive management, appropriate comprehensive, integrative monitoring is essential.

The "Monitoring Mediterranean Marine Protected Areas project" (MMMPA) was funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under the Initial Training Network (ITN) Marie Sklodowska-Curie Actions. Launched in January 2012, the project ended in December 2015. The scope of the network has been to shape the profile of the next generation of MPA managers. Considering the key role of MPAs in achieving biodiversity conservation targets set at the international level, and the high discrepancy in the actual management between the existing Mediterranean MPAs, it is pivotal to reinforce these with concrete measures of management and governance capacity.

To do this, the MMMPA project has been structured in five scientific Work Packages (WPs), consisting of 10 inter-related sub-programmes where 'usual' scientific techniques in the field of marine monitoring (e.g., visual census, video/photosampling, genetic tools, assessment of trophic

status) were complemented by emerging supra-disciplinary fields such as underwater 3D biocartography merged with webGIS methodologies and holistic socio-economic approaches. Most monitoring applications attempted to provide high accuracy in monitoring incorporating low cost approaches, taking into account the budgetary constraints that MPAs currently encounter. Other WPs were dedicated to joint training activities, dissemination and outreach of results, and management and coordination activities.

Since linking science and policy, knowledge and governance of coastal social-ecological systems is a subject of particular interest for the CIESM Scientific Committee on Coastal Systems and Marine Policy (Committee 6), it was agreed to jointly hold the MMMPA conference and the CIESM Committee workshop to sustain the network activities and ensure results develop and are implemented beyond the lifespan of the project.

This report presents the contributions and outputs made by the MMMPA network members as well as from a diversified range of external contributors with the goal of not only communicating some of the most significant findings from the MMMPA project, but also stimulating discussion and new research directions in marine conservation and more particularly MPAs multiple impacts through comprehensive monitoring.

Carlo Cerrano

MMMPA Coordinator

Yves Henocque

Chair, CIESM Committee on Coastal Systems and Marine Policy

Take-Home Messages

1) Marine Protected Areas (MPAs) are first of all "Marine Managed Areas".

2) As such, they are managed following the 12 principles of the Ecosystem-Based Management (EBM) approach defined in the Convention on Biodiversity.

3) In a nutshell, EBM holds that natural resource management is about managing people's behaviour in ecosystems, rather than the ecosystems themselves.

4) Thus effective conservation management requires considering traditional cultural heritage and marine tenure systems within the contemporary structures of governance.

5) On a broader perspective, they have to be considered within the entire spectrum of Agenda 21, Chapter 17, encompassing both the land and the sea, and including:

   a. marine environmental protection;

   b. integrated management and sustainable development of coastal and marine areas within Exclusive Economic Zones (EEZs) and beyond (high seas);

   c. addressing critical uncertainties for the management of the marine environment and climate change;

   d. strengthening international, including regional, cooperation and coordination;

   e. and sustainable development of small islands.

6) While local development may be considered as "promoting the people, while trying to preserve the place", biodiversity conservation is about "preserving the place, while engaging the people". Far from opposing the two, coastal practitioners must reconcile them and ensure that local communities learn about and understand the term biodiversity in an inclusive and positive manner, and as an integral component of both environmental and human health, thus generating trust and conviction of the benefits they can get out of MPAs.

7) Therefore, MPAs, though focusing on protection, require a multi-use approach. As they are concerned with the organization and coordination of institutional and human resources for the purpose of attaining long-term strategic objectives; are part of a social-ecological system making it necessary to consider decision-making processes, planning and available knowledge; and their role and function must be planned in respect to available finances both present and future, technologies available and , the financial constraints, and local capacity to operate them.

Consequently, what follows, touching upon knowledge, tools, methods, and forms of governance to the benefit of MPA management, might be as well worth considering for any other coastal and marine management initiative in a well-defined area.

A glimpse of Tavolara - Punta Coda Cavallo MPA, Italy (Courtesy of Massimo Ponti).

Highlights from Conference Sessions

Keynote

Progressive-Change BACIPS: a flexible approach for environmental impact assessment by Joachim Claudet

Highlights:

- Traditional Before-After Control-Impact Paired Series (BACIPS) sampling designs are conceived to estimate ecological impacts that appear after a particular perturbation (as step changes) but they tend to underestimate those effects occurring gradually over time.

- Progressive-Change BACIPS is a novel approach to provide more reliable information on the magnitude of the impacts and the response of ecosystems to different types of perturbations.

- Application of Progressive-Change BACIPS reveal step and linear models are more reliable when fitted to the corresponding patterns of change.

- This novel approach is a powerful and easy to implement statistical method, general enough to deal with any human and natural impacts in an ecosystem.

Session 1: Protected Habitats and Ecosystem Functioning

Facilitated by Artemis Nicolidou and Luisa Mangialajo

Guest Speaker: Laura Airoldi
Presenters: Fabrizio Gianni, Paula Zapata Ramirez, David Cabana Permuy, Elizabeth Arévalo Carillo

Overview: An enlightening first session focused on monitoring programs and protocols for MPAs, providing current best practice guidance for surveying and mapping different marine ecosystems (e.g. marine forests of large brown seaweeds, coastal lagoons and coralligenous habitats) and their ecosystem function.

Highlights:

- Anthropogenic stressors are estimated to have caused a 60% loss in native coastal habitats worldwide throughout history. Revitalisation of altered marine environments through ecological restoration and reduction of local stressors should be incorporated in planning, policy and design of marine urban areas and waterfronts.

- Mediterranean marine forests of the genus *Cystoseira* are among the most threatened habitats, but at the same time they are important for marine life, supporting several ecosystem functions and services.

- Ecological restoration using transplants is a helpful tool for improving *Cystoseira* recovery on natural rocky-shores, including depleted MPAs, but also for "gardening" coastal defence structures, thus enhancing their ecological value.

- Manipulative experiments revealed that herbivorous fish, namely the salema *Sarpa salpa*, have a much greater role in structuring marine forests than previously thought, and their impacts should be evaluated and weighed as other local stressors especially when a restoration of lost/ damaged forests is planned.

- With new advances in technology, Habitat Mapping procedures based on remote sensing techniques are now a fundamental tool for monitoring benthic habitats and managing marine ecosystems, especially for complex coralligenous habitats.

- The Multibeam Echosounder Systems (MBES) forward-looking to the wall rather than the normal downward-looking, with the aid of remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), allow more accurate coralligenous mapping on vertical seawalls, caves and overhangs, providing more reliable information upon which to base management decisions.

- Comparison of Distribution Modelling techniques showed they all provide reliable information on spatial distribution of coralligenous habitats, however, the spatial predictions did vary due to the different weight assigned to the environmental variables within each model. These differences, although not substantial, emphasize the important role of critical expert evaluation before spatial predictions can be used for monitoring purposes or to inform decision-making.

- Benthic macro invertebrates are proved to be good indicators of natural and anthropogenic driven variation in coastal ecosystems. These organisms play a critical role in the balance and natural flow of energy and nutrients in lagoon ecosystems. Particular benthic habitats with different degree of structural complexity appear to directly affect their abundance and diversity, thus Ecological Quality Status assessments by means of macro invertebrate organisms need to consider the habitat structure and follow a habitat approach.

Session 2: Shifting Baselines, Monitoring and Assessment

Facilitated by Massimo Ponti and Sofia Reizopoulou

Guest Speaker: Ernesto Azzurro

Presenters: Daniel Mateos Molina, Serena Lucrezi, Eleni Kytinou, Alessandro Marroni, Eva Turicchia

Overview: A dynamic session focusing on information needs within MPAs. The diverse talks in this session focused on: exploring the role of local ecological knowledge and citizen science, the need for understanding shifting baselines and continual monitoring, assessment and evaluation of MPAs and the wider environment, the necessity of a wider spatial vision of human impact from the point of view of land cover changes which cause sediment delivery changes at the outflows in coastal MPAs and/or surrounding areas.

Highlights:

- Local ecological knowledge (LEK) of fishermen' communities offers a real possibility to reconstruct historical trends in the diversity and abundance of fish at large geographic scale providing valuable information that would otherwise be lost.

- Genuine participatory research increases the legitimacy of the data collected, builds trust and raises awareness, enhancing social capacity and our ability to respond to environmental issues.

- Thinking beyond the MPA to assess the consequences of land cover changes on sediment delivery to coastal waters allows better coastal-land management decisions for managing and restoring coastal marine ecosystems.

- Citizen science offers an additional and reliable tool to monitor environmental status of MPAs when reliable indicators and ad-hoc protocols have been designed and citizens well trained.

- Volunteers from diving clubs involved in visual surveys of selected bio-indicators of the ecological status of marine habitats provided valuable information; a closer collaboration between diving clubs, MPA managers and researchers could thus enhance the monitoring capacity within the MPA, normally restrained due to limited human and financial resources.

- Collaboration with non-research based initiatives such as the open access international database "Diver Safety Guardian" could contribute to MPA monitoring by providing environmental (e.g. temperature) or simple biological data.

Ghost crabs represent a so far unexploited but easy to monitor indicator species within the Mediterranean, which could offer insight into environmental stressors and predator prey dynamics.

Session 3: Resource and Biodiversity Threats

Facilitated by Jose Garcia Charton and Marco Abbiati

Guest Speakers: Christophe Lett and Kerstin Johannesson

Presenters: Antonio Calò, Daniel Mateos Molina, Patricia Marti-Puig, Adriana Villamor, Vasiliki Markantonatou, Giulia Prato

Overview: A noteworthy session which focused on the importance of ecological and genetic connectivity within and between MPAs for conservation and management measures, the use of novel molecular and biochemical techniques to assess connectivity and larval dispersal, and the integration of this information into marine spatial planning, and the creation of MPA networks.

Highlights:

- Monitoring sound production in grouper species can be used to identify spawning events. This knowledge can be fed directly into MPA regulations to ensure increased protection of these species during these events.

- The collection of spatially geo-referenced information related to fisheries, in terms of effort and catch, provides a wide range of opportunities to explore the impacts of this activity on benthic habitats, fish populations and trophic food webs.

- Risk assessments are complementary tools that assist managers in taking effective decisions in a holistic and clear approach.

- In order to ensure useful and reliable data, managers and researchers must find positive ways to collaborate with resource users to share information and build relationships based on trust, openness and honesty.

- Food-web modelling offers a potential tool for MPA managers to monitor ecosystem function and ecosystem impacts caused by interacting fisheries.

Session 4: Socio-Ecosystem Co-Evolution, Policies and Management

Facilitated by María Semitiel García and Pedro Noguera Méndez

Guest Speaker: José Pascual Fernández

Presenters: Katie Hogg, Sarah Young, Giampaolo Rampini, Yves Henocque

Overview: A thought-provoking session focusing on the governance of MPAs, exploring the need for greater participation of civil society in decision-making and the relevance for understanding the wider benefits and costs associated with MPAs.

Highlights:

- Fairness in attributing use restrictions for MPA users (e.g. diving clubs *vs*. fishermen) can have important consequences for users' satisfaction with management.

- Social network analysis was illustrated as a novel and informative method for analysing the relative participation of stakeholders in MPA management and decision-making processes.

- Participatory processes can be time consuming and costly, yet the outcomes of such processes are highly rewarding.

- Fishers' participation in decision-making processes at the local level still remains low despite the EU directives and literature which strongly encourage their increased participation.

- Fishers knowledge is a useful biological monitoring tool but also essential for building more constructive dialogue between scientists and fishermen. Greater effort must be put into genuine participatory research.

- To improve marine governance regional alliances must be forged and a balance must be found between the common heritage principle and the open access regime.

- The evaluation of MPA management effectiveness is a periodic cyclic process that improves understanding on the present MPA status, and guides future targets and addressing issues linked directly to clear management targets and actions.

Session 5: MPA Networks and committees

Facilitated by Yves Henocque

Presenters: Yves Henocque, Giuseppe Di Carlo, Fabio Vallarola, Sofia Reizopoulou, Silvia Revenga Martínez de Pazos, Vasiliki Markantonatou

Overview: An informative session focusing on the past and present experiences of MPA success in the Mediterranean and how lessons learned can be utilised when moving Mediterranean MPAs towards the future.

Highlights:

- Many exciting resources and opportunities are available for sharing and publishing research conducted in the Mediterranean, namely the CIESM international Congress.

- Time and energy must be invested into finding long-term sustainable funding to support MPAs.

- Blue growth and the private sector could be a potential source to generate the necessary income to support MPAs and the livelihoods of local communities.

A glimpse of Tremiti Islands MPA, Italy (Courtesy of Massimo Ponti).

The MMMPA Experience and Network

Vasiliki Markantonatou, Carlo Cerrano and Martina Milanese

The aim of the Marie Curie Initial Training Network Monitoring of Mediterranean Marine Protected Areas (MMMPA ITN) was to train the next generation of MPA managers. The MMMPA ITN project was structured through 5 scientific work packages and 10 inter-related sub-programmes. MMMPA is a joint research endeavour between 5 work packages (WPs) (both social and natural sciences). The 10 projects within the WP's include research into ecological and social processes that affect the health of the marine environment and the creation of tools to aid practitioners, stakeholders and governments plan for more effective marine management.

MMMPA began with the following partners: 5 Universities, 1 Research Centre, 1 SME and 5 MPAs. Throughout the life of the project an additional 2 MPAs, 1 SMA and research centre joined sharing with the MMMPA network their expertise and practical experience in MPA management. A unique opportunity was offered to MMMPA fellows to visit as many of these project partners as desired. The aim of these 'secondments' was to provide them first-hand experience of the day-to-day management of MPAs, and helped develop a set of multidisciplinary skills.

The research fellows first met in 2012 when the project began. From the onset they have worked closely together finding ways to collaborate and integrate their research projects, and offering one another insight and lessons learned from their primary case study MPA. This combined with the secondments has offered the fellows the chance to gain an in depth understanding of MPAs role and function and allowed them to explore what aspects of management are working well and which could be strengthened. Collaborations and interaction also developed outside the borders of the project where fellows attended external courses and training events to develop their technical skills and expertise e.g. in the use of relevant tools and concepts that would support the prestige of their research projects. The aim of MMMPA has not been solely focused on scientific achievements but rather on ensuring that the research outputs are suitable for MPA managers and policy makers and as such can be readily utilised in decision-making. In addition fellows have focused their energy on disseminating their findings to the wider public, presenting their data at various International Conferences and public events, producing stakeholder feedback reports, holding stakeholder feedback meetings and through the media and production of outreach videos (Fig. 1).
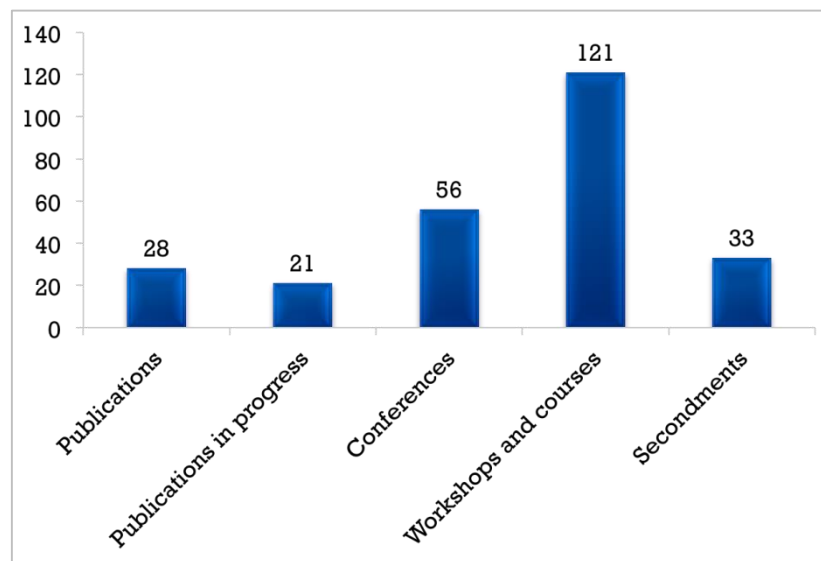
Figure 1. Total number of Conferences, trainings and publications accomplished by MMMPA Researchers (up to October 2015)

Social Network Analysis (SNA) offers a novel approach to illustrate the evolution of the MMMPA's social network. In so doing the fellows' development and collaboration throughout the project's life can be visualised and highlights how these connections have led to the success of the project and delivery of the final expected project outputs.

The analysis illustrates how a group of unconnected individuals and entities have forged relationships and formed a network over the last 3 years. Throughout the life of the project, the fellows have progressively established connections, encouraged by the annual training events, simultaneous secondments, and the necessity to complete shared deliverables (Fig. 2 and 3). The result of all these activities has been to create continuous interaction and communication between the fellows allowing experience and expertise to be shared efficiently within this cohesive scientific network. In addition the fellows' network has been significantly increased through their attendance to training events both internal and external to the project which were attended by other young researchers, offering the students the ability to create both personal and professional connections with a much wider net of individuals.

MMMPA has trained the next generation of MPA managers, equipping them with a flexible set of skills essential within a wide range of professional environments. The project was not only able to deliver tools for effective monitoring, assessment and management actions within the Mediterranean, but has invested in innovative outreach approaches that engage with a much larger public. A wide network of young scientists has been born out of MMMPA and it is expected to continue to grow from strength to strength as the fellows continue to collaborate and explore new career perspectives under a shared vision that has been developed for the future resource management in the Mediterranean Sea.
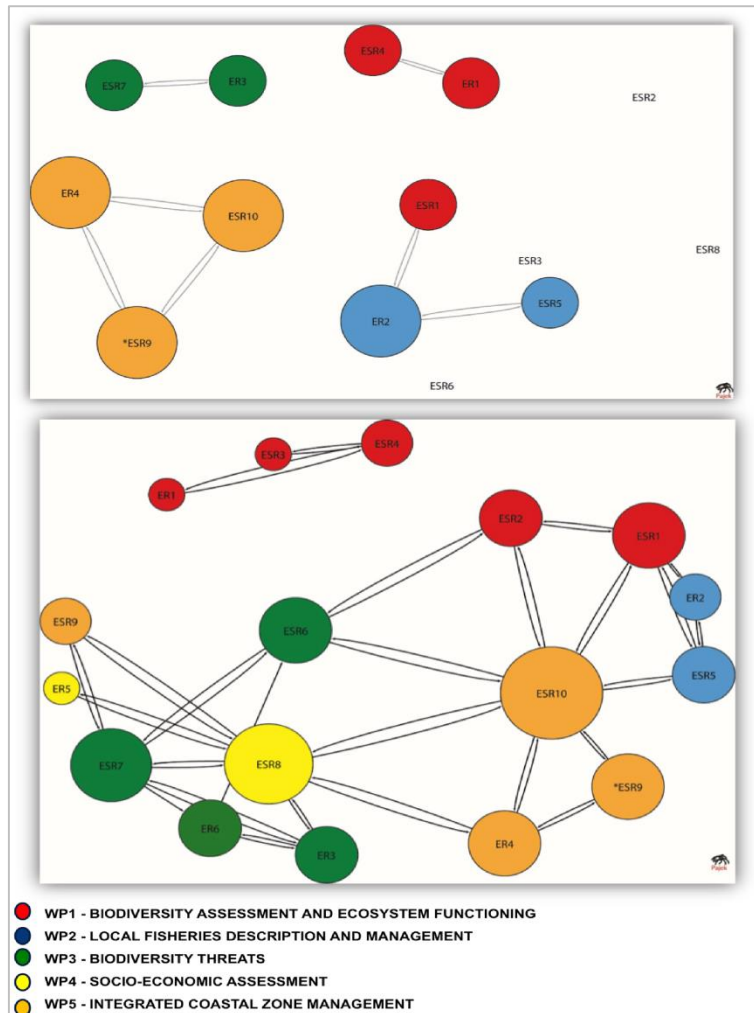
Figure 2. Evolution of MMMPA collaboration network during the project life. Colour of nodes indicates relevant WP in the project; size depicts the number of collaborations developed by every Researcher (degree centrality).
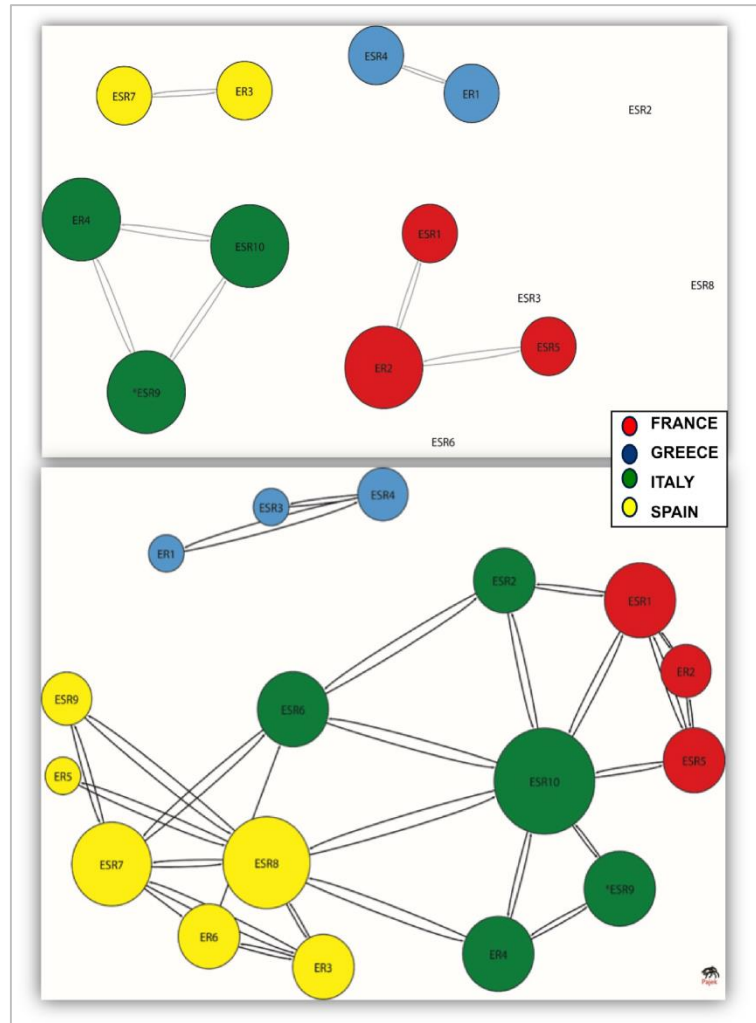
Figure 3. Evolution of MMMPA collaboration network during the project life. Colour of nodes indicates relevant hosting country; size depicts the number of collaborations developed by every Researcher (degree centrality).

Short films made by the MMMPA Early Researchers to inform and raise conservation awareness within the MPA stakeholders

Marine Protected Areas: Working for a resilient marine environment

Marine Protected Areas in Motion

Protect and connect the oceans - Don't leave MPAs alone!

Zoe and her adventures in the Mediterranean Sea

Together we can create a sustainable future

[Win-Win: The Marine Protected Area Story](#)

Only with a common effort can we save the Mediterranean Sea- for us and future generations
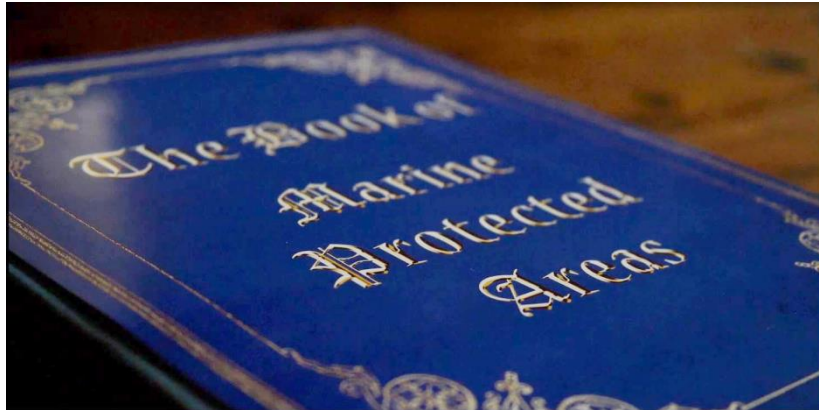
[The Book of Marine Protected Areas](#)

THANK YOU FOR JOINING US,

and for all the interest and input throughout the MMMPA and CIESM conference. If you have any queries relating to the event, contact Carlo Cerrano (c.cerrano@univpm.it) or Yves Henocque (Yves.Henocque@ifremer.fr).

MMMPA Early Stage Researchers

Annex 1 – Conference Abstracts

An example of effective awareness raising on Ustica Island, Italy (Courtesy of Katie Hogg).

Opening lecture

Opening lecture: Progressive-Change BACIPS: a flexible approach for environmental impact assessment

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[2] School of Life and Environmental Sciences, Deakin University, Burwood, Victoria, Australia.

[3] University of Georgia, USA.

[4] Laboratoire d'Excellence CORAIL, France.

1. Before-After Control-Impact Paired Series (BACIPS) sampling designs are powerful tools to derive inferences about ecological impacts because they enable to separate natural spatial and temporal variation from variation induced by a particular perturbation or intervention. However, BACIPS designs are generally constrained to the detection of step-changes of the system.

2. We propose a novel approach, the Progressive-Change BACIPS, which expands and generalizes the scope of BACIPS analysis to the study of effects that arise gradually over time. We first test the ability of this method to effectively describe a change induced by an impact using simulated data generated under different sets of conditions (initial density, effect magnitude, number of replicates, number of sampling dates after the impact and pattern of change) using step, linear, asymptotic and logistic models. We then apply the method to data from three published BACIPS studies.

3. We highlight that the classical BACIPS approach (step-change) is not always reliable because it could misestimate the magnitude of the effect and provide less information on how the system responds to the perturbation, legitimizing the use of diverse models in BACIPS analysis. Application of the Progressive-Change BACIPS method shows that step and linear model are the more reliable models when fitted on their corresponding patterns of change. Asymptotic and logistic models also well depict the effect simulated but require extensive data (i.e. many sampling dates and replicates per date). Under poor data context, however, step and linear models appears as good substitutes of the asymptotic and logistic models, respectively.

4. This novel approach is a powerful and easy to implement statistical method that is general enough to deal with any human and natural impacts in any ecosystem. Guidelines for the appropriate use of the Progressive-Change BACIPS method in ecological impact assessment are provided.

1 Protected Habitats and Ecosystem Functioning

Chairpersons:

A. Nicolaidou & L. Mangialajo

Subjects:
- Habitat fragmentation
- Habitat mapping
- Ecological functioning
- Biodiversity studies
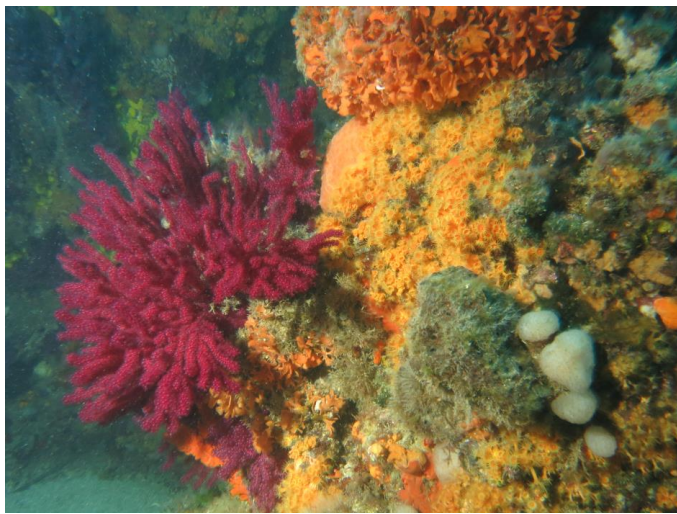
Croatian coralligenous habitat (Courtesy of Massimo Ponti).

1.1 Oral presentations

Topic presentation: Conservation and revitalisation of marine ecosystems in human-dominated seascapes

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Recent estimates suggest that > 60% of native habitats may have been lost throughout history in many coastal areas of the planet. Losses have resulted from multiple co-occurring global and local anthropogenic stressors in increasingly urbanized coastal regions, driving marine systems through thresholds of degradation. Losses are on-going at accelerating rates, and the overall benefits of current protection measures are low. I present results from experimental work aiming at understanding the drivers of loss and recovery pathways of degraded marine systems, following experimental manipulations mimicking management actions geared towards recovery. I focus on fucoid, canopy-forming algae along Mediterranean coasts, in light of their ecological relevance, their sensitivity to a variety of human impacts, and their declared conservation priority. This habitat is retracting particularly in urban areas, and is being replaced by turf-forming algae and invasive species, with major consequences for associated communities. I will describe habitat loss of these systems, identify potential underlying drivers, and discuss recovery and restoration potential in these systems, and the role of marine protected areas. I will also show that the reduction in the levels of local stressors (sediment loads and nutrient

concentrations) can be used as an effective intervention to increase resilience of canopy algae to projected global climate stressors (high wave exposure and increasing sea surface temperatures). I will conclude by discussing the need to incorporate conservation and revitalisation of marine environments in modern planning, policy and design of marine urban areas and waterfronts, where people would directly benefit from the ecological services provided by healthy marine ecosystems.

Conservation and restoration of Mediterranean marine forests: the role of herbivorous fish

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Mediterranean marine forests formed by *Cystoseira* species are key-habitats on rocky shores supporting several ecosystem functions and services. However, they have already suffered widespread and apparently irreversible loss, much of which may have gone unnoticed. Ecological restoration has been proposed as a helpful tool for improving *Cystoseira* recovery, even if the success of the first endeavours was extremely variable. In the framework of a European Programme (ITN-MMMPA), different experiments were carried out in order to improve marine forests conservation and restoration, highlighting the potential role of marine protected areas (MPAs) in this process. Firstly, we evaluated the relative role of herbivores on *Cystoseira* forests in the infralittoral fringe, by transplanting primary branches on artificial structures, where grazing pressure is particularly high, and by performing experiments in tanks. Results showed that fish, likely *Sarpa salpa*, can be the most effective grazers of intertidal *Cystoseira* belts, contrarily to what generally assumed, due to the very high position of these belts on the shore. Further experiments showed that *S. salpa* is able to strongly affect also growth and reproductive potential of natural *Cystoseira* forests. Our studies highlighted that the role of the herbivorous fish in structuring macroalgal communities has probably been underestimated in the Mediterranean Sea until present. The establishment of MPAs to protect healthy marine forests should be considered and reforestation may be performed in case of lost/damaged forests, always taking into account the rational procedures lying behind these actions, such as: i) remove the cause that started forests regression; ii) use non-destructive restoration methods; iii) control herbivores at least in the first stages of restoration and iv) set up a monitoring protocol.

The application of Habitat Mapping and Distribution Modelling techniques for the detection and management of coralligenous environments in Marine Protected Areas

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One of the critical steps for marine spatial planning (MSP) involves habitat mapping (HM) and distribution modelling (DM) techniques that can be a cost-effective and productive endeavour. The specific aims of this study were three-fold: i) test the potential of the HM and DM techniques to detect the importance of the environmental variables that define coralligenous environments (CE), based on geophysical substrate properties gathered through multi-beam bathymetry echo-sounder systems (MBES) in combination with optical data, collected during the ground truthing sampling, ii) evaluate the effectiveness and the performance of four well known DM modelling techniques for predicting the spatial distribution patterns of CE and iii) assess the resulting maps as a potential tool in management strategies. Here the case study of Portofino Marine Protected Area (MPA) is reported. Our results demonstrate that the produced maps provide information about where the habitats could be present and how they are related to the geomorphological context. Even though the models applied could describe the data equally well, the findings shows that there were differences in the way the models weighted the environmental variables and consequently the spatial predictions differ somewhat. These differences emphasizes the role of critical expert evaluation of spatial predictions before they are used to guide policy. We conclude that HM and DM could be important tools for understanding the distribution of species–habitat associations and to help resources managers make informed and ecologically

relevant decisions. Furthermore, their outputs are valuable inputs to design monitoring programs that support the management of the resources.

Habitat complexity by means of fractal dimension: A body length and community structure modulator for benthic macroinvertebrate communities in a lagoonal ecosystem

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In lagoonal ecosystems habitat type, among other factors, has been shown to play a key role in structuring macroinvertebrate communities. Investigating the role of habitat complexity, may provide an understanding of how different habitats modulate macroinvertebrate communities. Relevant information acquired from this approach, could support decision making processes in the design of management plans, and marine protected areas.

Here we have examined several hypotheses: Firstly, whether the fractal dimensions, at a scale of a phytal individual, differs in relation to the surface area and perimeter, at the studied scales. Secondly, whether a reliable proxy for sample complexity, can be estimated by weighting the fractal dimension of phytal individuals within a sample. And finally, whether sample complexity correlates with species richness, abundance, and diversity, and macroinvertebrate body lengths.

The fractal dimension of the phytal individuals, in relation to both the surface area and the perimeter showed significant differences. Furthermore the different magnification scales, one macro and three micro, show significant differences at the level of a phytal individual. In regards to determining sample complexity, the fractal dimension weighting method shows a significant difference, and may play an important role in modifying the complexity value of a sample. The results indicate, sample complexity correlates with body length distribution, and that habitat appears to be a body length modulator. We found a weak correlation of sample complexity, with the minimum body length, percentile 10 body length, and percentile 90 body length. Furthermore community structure in terms of species richness, abundance, and diversity, highly correlates with sample complexity.

Metabolic processes in lagoon sediments and benthic communities

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The main metabolic processes were studied in a marine protected area. Macrofauna, porewater chemistry and sediment characteristics were measured in Mesolonghi coastal lagoon in each season during a year and comparing different habitats within the lagoon. The trophic state of the system based on protein carbohydrate ratio told us that the system goes from unproductive in the area of the WWTP to productive in the station with seagrass. Also, the nutrient concentration decrease from the WWTP to the seagrass station in the mouth of the lagoon. About macrofauna, the abundance and the number of species also growth from the WWTP to the mouth of the lagoon where the seagrass habitat is, although the maximum was found in the station with algae.

Comparing bare sediment habitat of this lagoon and San Teodoro coastal lagoon similarities were found in the overlying water nutrient concentration, finding a decrease of nutrient concentration from the WWTP to the mouth of the lagoon but differences were found according to the sediment trophic status, in the Italian lagoon the areas near the WWTP are productive according to the proteins carbohydrates ratio, and macrofauna abundance and number of species was bigger in the stations near the WWTP.

Therefore, in Messolonghi lagoon is clear the importance of seagrass habitat. In the comparison of the different lagoon, a most efficient WWTP help to keep a good health in the coastal lagoons.

1.2   Poster presentations

Marine Protected Area of Capo Rizzuto: new instruments for the monitoring of the priority habitat *Posidonia oceanica* (L.) Delile

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The Marine Protected Area Capo Rizzuto has invested significantly in research and innovation in order to improve the process of monitoring, control and protection of *Posidonia oceanica* meadows. In fact, within the Svi.Stri.In project "Development of Innovative Instruments", funded by the Italian Ministry for the Environment Land and Sea, a prototype of a towing vehicle platform was developed, that can accommodate the GoPro digital cameras for filming the seabed in vertical prospecting (face down). The vehicle can shoot continuously for long distances and, by using special photogrammetric software, it is possible to create geo-referenced photo mosaics and 2D /3D modelling. Within the Svi.Str.In project, technical checks were carried out on the Astameter tool, which has been patented at the Italian Patent Office, Ministry of Economic Development. The Astameter is a multi-factorial tool useful for monitoring the *P. oceanica* meadows and capable of measuring, through probes and data logger, physical, environmental and hydrological factors such as sedimentation rate, growth rate of the matte, burial rate of rhizomes, light intensity and water temperature, dissolved oxygen, salinity and conductivity, CO_2. The innovative tools, object of the research project Svi.Str.In., prove to be very effective, especially if used in the monitoring of MPAs, in the assessment of coastal impacts due to the construction of maritime works, in the monitoring of the quality and conservation status. In this work, we present the preliminary results of the project Svi.Str.In. at the Marine Protected Area of Capo Rizzuto (KR, Calabria Region- Italy).

2   Shifting Baselines, Monitoring & Assessment

Chairpersons:
M. Ponti & S. Reizopoulou

Subjects:
- Human and natural impacts
- Citizen science
- Biological indicators
- Environmental education
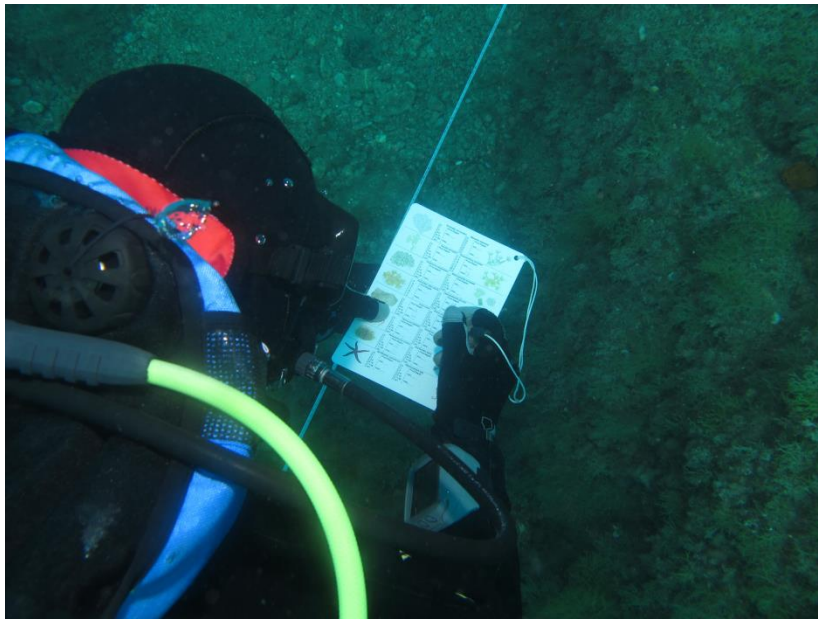
Underwater survey in a Mediterranean MPA (Courtesy Eva Turicchia).

2.1   Oral presentations

Topic presentation: Monitoring emerging changes in Mediterranean fish biodiversity: new opportunities arise from Local Ecological Knowledge

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Marine scientists and managers of today are both facing the great challenge of dealing with large-scale changes in the natural environments. The increasing pressure of human activities, climate change and invasive species are indeed causing rapid alterations on species distributions and assemblages but our responses are often inadequate to research and effective management. Here we illustrate an alternative approach that has recently emerged from the context of Mediterranean fish invasion: the 'Local Ecological Knowledge' (LEK). LEK can be simply defined as the information that a group of people have about local ecosystems. This knowledge,

acquired every day during a lifetime, is increasingly explored and scientifically analysed to track the distribution and the abundance of marine species at a large geographic scale yet with very limited research costs. A number of case studies, mainly related to the bio-invasion field, will be presented, illustrating aims and methods of this participatory research tool. When population densities are low and traditional sampling approaches are expensive or ineffective, LEK may represent the sole possibility to reconstruct historical trends and a realistic opportunity to develop early detection systems. At the same time our experience suggests that the proper use of LEK may contribute to the process of trust-building and awareness rising, ultimately enhancing the social capacity to respond to the current environmental issues, something that is really needed in a desirable 'social-ecological system' as well as in every Marine Protected Area.

Assessing consequences of land cover changes on sediment deliveries to coastal waters at regional level over the last two decades in the north-western Mediterranean Sea

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Human-induced changes to land cover and associated strong influence such changes have on sediment delivery to coastal waters are a well-recognized threat to nearshore marine habitats worldwide. Land cover has been commonly used as a proxy to document human alterations on sediment discharges. In the present study, changes in sediment delivery to coastal waters along the coastline of the Ligurian Sea (north-western Mediterranean Sea) were estimated on the basis of land cover data. This area includes benthic habitats- areas that are very sensitive to water turbidity and sedimentation increase -and warrant protection demonstrated by the establishment of five marine Sites of Community Importance and a Marine Protected Area (Portofino MPA). The principal objectives of the study were to identify changes in soil erosion in multiple basins and estimate the strength of the change over a defined period in sediment delivery at the outflow. A combination of Revised Universal Soil Loss Equation (RUSLE) model and sediment delivery ratio (SDR) was applied. The strongest changes happened individually in two different basins in the periods 1990-2000 and 2006-2012 meanwhile the period 2000-2006 showed several changes in several basins with less estimated change. This assessment can help to make better coastal-land management decisions for managing or restoring coastal marine ecosystems.

Ghost crabs as a monitoring tool for sandy beaches of the Mediterranean: Is it just a 'ghost story'?

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Ghost crabs (Genus *Ocypode* and *Hoplocypode*) inhabit sandy beaches of tropical to warm-temperate areas worldwide. *Ocypode cursor* is the only species found in the Mediterranean, ranging from Southern Turkey to Tunisia, including also Southern Italy and Greece. Outside of the Mediterranean, the species is distributed along the Atlantic coast of Africa. Given their key role as top invertebrate predators, scavengers, and prey to higher order species, ghost crabs are increasingly being employed in monitoring studies assessing the state of sandy beaches worldwide. There has been a particular increase in such studies in South America, Australia, The USA, and some African countries on the Atlantic and Indian Oceans. In the Mediterranean, *Ocypode cursor* is an important predator of vulnerable species such as loggerhead and green turtles, and a scavenger of cast up wrack. Studies have investigated the impact of this species on the population structure of turtles, discussing the resulting conservation and management implications. However, the role of *Ocypode cursor* as prey remains

largely unexplored. In addition, the potential of ghost crabs as ecological indicators of stressors on sandy beaches of the Mediterranean still needs to be fully tapped in. This discussion addresses the research gaps that should be filled concerning these issues. While taking note of the current challenges involved, the discussion also gives hope to the concept of turning the use of ghost crabs as an ecological indicator from a 'ghost story' to a 'ghost crab telling us a story' about Mediterranean sandy beaches.

Visual surveys for monitoring megabenthic communities in a Marine Protected Area of Greece

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The aim of the present study was the qualitative and quantitative recording of the composition of benthic flora and fauna within and in the outer zone of Messolonghi lagoon, a marine Protected Area in Western Greece. The study was largely conducted by non-destructive visual surveys, through counts of benthic species along a reference line of 100 m, by SCUBA diving. The flora coverage in 52 × 52 cm quadrats was also examined in order to estimate the ecological quality of the area with the Ecological Quality Index (EEI). A total of 147 taxa were identified adding a great value to the existing information on the flora and fauna of the protected area. Data of the presence and abundance of protected, endemic and alien species were obtained. High densities of the protected bivalve *Pinna nobilis* (Linnaeus, 1758) and the alien nudibranch *Melibe viridis* (Kelaart, 1858) were detected. Significant differences in benthic communities were observed among the 15 sampling stations. The ecological status of the study area was proven to be high, according to the results of the EEI index.

The Diver Safety Guardian: a further supporting tool for MPA diving activity and safety

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DAN Europe has realized a new interactive electronic dive logbook database, allowing to collect Divers' and Dives' information and to upload it on an open-access internet-based international database: the "Diver Safety Guardian" (DSG). The objectives are dives data collection and analysis, their evaluation both providing real time feed-back and epidemiologically, their comparison with current decompression algorithms as well as the entirety of data uploaded from all DSG users. Each goal is set in order to estimate each dive's decompression risk level and to give immediate feedback to the diver.

DSG uses the widely adopted Buehlmann ZH-L16 model as its referral platform, as compared to the originally developed PMR model that DAN Europe developed since 1993 to evaluate and mitigate decompression risk. Every diver can also obtain additional information: detailed graphics of real diving profiles compared to the "ideal" theoretical ones, diver's error alert, dive risk evaluation, diver "behaviour" analysis as compared to the "ideal safe diver" or the "average diver", statistics on own dives and their geo-localization.

The information collected, after sensible data removal, feeds the International DAN Diving Safety Research Database, which already includes over half a million anonymous dive profiles. The DSG open-access platform allows Divers to access these data and compare their own "diving style" with the rest of the international diving community, making each dive and Diver part of a global program of Diving Safety Citizen Science.

Citizen science as a tool for the environmental quality assessment of Mediterranean Marine Protected Areas

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The growing need to assess the environmental status of Mediterranean habitats and the large availability of data collected by Reef Check Italia onlus (RCI) volunteers along subtidal rocky shores and in coralligenous habitats suggest the possibility to develop innovative and reliable indices that may support decision makers in applying conservation strategies, particularly important for Marine Protected Areas (MPAs). The reliability of data collected by RCI volunteers was tested and it resulted comparable to that of marine biologists. The biology and ecology of the taxa included in the RCI protocol have been deeply reviewed in order to define their sensitivities toward natural and anthropic disturbances and the aptitude as indicators of ecological status and environmental quality. Based on data collected by RCI volunteers, three main categories of indices were developed and proposed: indices based on species diversity, indices on the occurrence of single indicator taxa, including several protected species and three non-indigenous species (*Caulerpa cylindracea*, *Caulerpa taxifolia* and *Rapana venosa*), and indices on species sensitive toward different pressures and impacts, as expected by the European Marine Strategy Framework Directive. As case studies, indices were applied to some Italian Marine Protected Areas and compared with independent assessments. Although these indices still require fine-tuning, the preliminary results are very promising. Their application, however, requires greater collaboration between MPA managers and dive centers, which ultimately should share the same goal: a sustainable fruition of natural resources.

2.2 Poster presentations

A baseline for the coastal benthic assemblages of the Tremiti Islands MPA (Italy)

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Altogether, small environmental variations can lead to profound long term ecological changes, but are unlikely to be perceived by humans because too small and slow compared to their life. Measures of conservation need adequate "baselines" to track changes over time, whether they are of natural or anthropic origins. With this aim, benthic assemblages surrounding San Domino, Caprara, San Nicola and Cretaccio Islands were recorded along 42 benthic transects perpendicular to coasts, during summer 2013. Obtained data were graphically represented in vertical sections and mapped using graphical and statistical routines in R and Quantum Geographic Information System. The study was carried out thank to a collaboration between Tremiti Island MPA (Gargano National Park), local dive centres and master students selected after a competition. Results offered the possibility to create both an extended baseline for next monitoring programs and a book for dissemination purposes, where the description and the distribution of the most important species are available.

Guidelines for the conservation, monitoring and restoration of *Cystoseira* forests in the Mediterranean Sea

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In the Mediterranean Sea, large-brown seaweeds of the genus *Cystoseira* and *Sargassum* (order Fucales) dominate rocky bottom assemblages from the surface until several dozens of meters depth. They form dense forests, offering an habitat for a great variety of organisms. Unluckily, loss of marine forests has been observed in many coastal areas, mainly driven by water pollution, coastal urbanization and outbreak of herbivores, like sea urchins and herbivorous fish. In this context, marine protected areas (MPAs) represent preferential sites for *Cystoseira* forests conservation, as many human impacts are absent or reduced and management and monitoring actions are higher than in unprotected zones. Here we suggested an approach based on few simple steps allowing the implementation of marine forests conservation in Mediterranean MPAs. As a first step, it is necessary to create a georeferenced detailed cartography of *Cystoseira* canopies in the MPAs in order to integrate such key-species in the management plan and check their evolution over time. Successively, the conservation status of intertidal and sublittoral marine forests should be assessed, by mean of non-destructive quantification methods such as density and/or coverage evaluation. Then, such characteristics of the forests should be included in regular monitoring plans, in order to detect potential early signs of decline. In case *Cystoseira* forests are lost or in regression, the causes of such decline should be investigated and managed. If necessary, due to the low dispersal ability of most *Cystoseira* species, restoration actions may be considered.

Guidelines for monitoring coralligenous assemblages within a Management context

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Governmental bodies are increasingly obliged to manage the marine environment under a suite of legislative packages to ensure appropriate and sustainable management of marine ecosystems. In specific, the European Union Marine Strategy Framework Directive (MSFD) requires the Good Environmental Status of marine environments (GES) in Europe's regional seas. Spatially continuous and broad scale data on the distribution of both biological and physical resources and their interactions, are often required for decision making in marine spatial planning and ecosystem management approaches with which to achieve MSFD directives. In particular, maps have proved to be a useful method of summarising biological information concerning the seabed. Therefore, here we present a framework with simple steps that uses different data and models to map coralligenous environments as a tool to forecast future conditions and evaluate management actions of these habitats. Our aim is to offer an easy and understandable guideline to inform and provide recommendations to managers and policymakers about how to accurately locate and best protect coralligenous and its resources, how to evidence possible different sensitivities between habitats in relation to geomorphology, create or redefine different zones or levels of protections at Marine Protected Areas and how to forecast future changes due to global warming and/or anthropogenic activities. We believe that the application of this standardized methodological framework could strengthen management efficiency and will help to make the best decision at local scale that also take into consideration the broader regional contacts and in that way, help to achieve or maintain a GES for 2020.

Guidelines for monitoring land cover changes to assess potential impacts on water quality in coastal marine protected areas

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Changes in land cover can increase the runoff of sediments, pollutants and nutrients into coastal waters, having negative effects on benthic habitats due to increased water turbidity and siltation, and declines in water quality. The necessity of integrated approaches far beyond the MPA boundaries and better understanding of the potential impact of land cover changes in coastal ecosystems is critical to improve marine and coastal ecosystem-based management, and current management plans. The goal of this study is the establishment of the use of land cover changes as a proxy of potential sediment delivery changes at the outflows. The methodology combines a simplified Revised Universal Soil Loss Equation (RUSLE) model with sediment delivery ratio (SDR) methodology, and CORINE land cover to assess the potential change on basin's sediment delivery driven by the land cover changes. This approach was applied to the areas surrounding Portofino MPA as a study case. Our study area showed important changes in the potential sediment delivery yield of the outflows to coastal waters in the last two decades because of land cover changes. The strongest changes happened in the periods 1990-2000 and 2006-2012, and for this latest period the estimated sediment delivery of a basin increased 5 times over with the outflow located closer (less 150 m) to a wide posidonia seagrass meadow. This assessment can help to make better coastal-land management decisions, influence terrestrial policies and/or ask for compensatory actions for managing or restoring coastal marine ecosystems.

Guidelines for monitoring trophic relationships and ecosystem functioning in Mediterranean MPAs

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Stepwise guidelines to build a trophic ecosystem model with the Ecopath with Ecosim and Ecotroph software for a coastal Mediterranean MPA are provided. A standard list of functional groups developed from the simplification of a highly detailed model of the Port Cros MPA is presented, and can be adapted to each MPA depending on the ecosystem under study. Data requisites for model building are biomass, production to biomass and consumption to biomass rates, diet and fisheries catches for each functional group. Indications for the collection of vital rates and diet data from the literature and from empirical equations are provided. Data on biomass and fisheries catches should be local, thus a list of groups for which biomass data shall be collected in priority to obtain reliable model outputs is delivered. For these key groups, and in particular for high trophic level predators, suggestions for field monitoring techniques are also provided. To highlight the potential outcomes of such approach, a selection of model outputs for the Portofino MPA case study is presented, including the visual representation of the food web, the identification of keystone groups and the impact of fisheries on the trophic structure of the ecosystem.

Guidelines for the effective management of lagoons on the basis of obtained results

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A monitoring plan and a guideline to manage coastal lagoon is proposed after analyse the obtained results during an annual seasonal sampling made in Messolonghi coastal lagoon (South-West Greece). Basic and well known methods as measurement of main nutrients in the water and sediment analysis were proposed, but also, new methods as the analysis of the Chromophoric Dissolved Organic Matter and its importance was discussed in the poster. Also, the efficiency of filter feeders bivalves and the seagrass habitats were study.

Management guidelines for Mediterranean coastal lagoons: The use of benthic macroinvertebrate communities as biological quality indicators

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Mediterranean coastal lagoons are sheltered, shallow water bodies mostly characterized by their high productivity and varied biodiversity. These organically enriched ecosystems play a key role in buffering pollution loads that are transported by continental drainages into the sea. Human activities such as industry discharges, sewage treatment plants, fisheries, and tourism amongst other factors cause irreversible and long-term reversible damages to coastal lagoons.   One of the most important lagoon ecosystem components is benthic invertebrate fauna. Due to their sessile, sedentary, and the relatively long-lived life of macroinvertebrate species, they are considered sensitive indicators for natural and anthropogenic variations within the marine ecosystem. Macroinvertebrate species have also been proved to be good indicators of temporal and chronic disturbances.   To aid effective monitoring of benthic macroinvertebrate lagoon communities, a selection and standardization of optimal and cost-effective guidelines are provided. They consider factors such us: spatial and temporal coverage, targeted habitats, sampling effort, sample and mesh size will help on the optimization of the sampling and further assessment. Furthermore, we also recommend a pilot study to determine local conditions and improve the sampling grid design. For this, prior analysis of hydrological and ecological data (e.g. fresh water inflows, rivers, communication with the sea, depth, waterways and currents) is recommended. Finally, we point out the importance of habitat complexity on the structuring of macroinvertebrate benthic communities, and how this aspect might be helpful in revealing significant information that could assist decision making for the designing of management plans and marine protected areas. Thus, the use Geographic Information System (GIS) tools, to enable adequate substrate and habitat mapping is also recommended.

Guidelines on genetic connectivity as a tool for assessing the effectiveness of Marine Protected Areas

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The design and management of Marine Protected Areas (MPAs) and MPA networks should take into account the spatial distribution patterns and connectivity among populations of the target species, as a key element in biological conservation. Connectivity is the exchange of individuals among populations through the passive

transport and/or active movement of individuals at whatever life stage. Well-connected and highly diverse populations are more resilient to natural and anthropogenic environmental impacts. In the context of MPA monitoring, genetic analyses are considered a powerful tool for assessing population diversity and connectivity patterns at different temporal and spatial scales. In this poster presentation the guidelines to apply genetic analyses as a monitoring tool for MPAs are presented. Two case studies in which genetics tools were used to assess connectivity patterns between protected and unprotected areas in the Western Mediterranean Sea were provided. In these case studies, two widely distributed intertidal limpets, *Patella rustica* and *Patella caerulea*, and a commercially renowned coastal fish, the saddled sea bream *Oblada melanura*, were considered. The results of these studies provide MPA managers with good examples on how to apply these guidelines and obtain the information needed to address specific species conservation issues.

Guidelines for monitoring and mapping artisanal and recreational fishing activity on vulnerable habitats

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Small scale and recreational fisheries monitoring and management is one of the most important challenges that MPAs have to encounter, from a socio-economical, cultural and ecological point of view. The difficulty to monitor these activities is mainly due to the fact that from one hand, small-scale fishing shows strong heterogeneity combining different gears and targeting species throughout the year. From the other hand, there is a great number of recreational fishers with several access points by boat or by coast to fish, using a variety of tools that can be adjusted depending on the practice. Understanding the spatial and temporal patterns of fishing effort is fundamental for informing management decisions for sound conservation of benthic ecosystems.

The present study provides a step-by-step approach for monitoring and mapping spatial and temporal patterns of artisanal and recreational fishing activity. Simple spatial indicators and analysis are suggested in order to describe fishing pressure and identify areas that receive the greatest fishing effort, using as an example Portofino MPA (Ligurian sea, Italy). The approach integrates information originating from a range of monitoring strategies that may be adopted depending on the capacity of MPA management performance, and incorporates uncertainty regarding available information following the precautionary principle. In addition, prerequisite information such as bathymetry and habitats distribution, and combination of monitoring strategies is suggested for increasing the confidence on spatial allocation of fishing activity. Produced results may provide baseline information for the identification of metiérs, ecological modelling, stock assessments and conservation planning.

Set of guidelines for monitoring social satisfaction with MPA management

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An MPA is a socially constructed set of rules that govern human interactions within a specified area – who, may do what, where and when. MPA objectives ultimately stem from human needs and desires, whether to increase the number of fish, support traditional livelihoods or protect sensitive habitats. It is therefore important to systematically monitor social impacts of MPAs and evaluate the outcomes of management actions. 'Management effectiveness' and societal 'satisfaction' of MPA performance are primary indicators useful for reporting (i.e. accountability). In addition, the data collection process (surveys, interviews, meetings) has the potential to build relationships between administrators and users, generating social capital, which helps anticipate potential problems and reduce conflict. In this set of guidelines, we outline how to monitor this topic and provide reference to additional sources of information that would be beneficial to anyone wanting to conduct social research. MMMPA conducted a socio-economic assessment in Cabo de Palos, Spain.

We use this case as an example to illustrate what can be achieved using social research methodologies, giving consideration to costs/expenses. Using participatory techniques to monitor changes in satisfaction with MPA management provides useful evaluation data and at the same time opportunities for administrators and stakeholders to interact and build trust in the management process.

Ethical guidelines and good practice for social research

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As researchers, we have an obligation to apply high ethical standards, to act with integrity and to strive for consistency of thought and action. This is particularly true for social scientists, whose 'subjects' are people. With the increasing popularity of paradigms such as 'research in action' addressing issues of inequality, well-being, behaviour and decision-making we have to be cognisant of our potential impact on societal norms and culture. Ethics refers to the established standards that prescribe what humans ought to do, usually in terms of rights, obligations, and benefits to society, fairness, or specific virtues. Most research institutions, professional associations and government agencies have adopted specific codes, rules and policies relating to research ethics. These rules help protect both the organization and the researcher against potential legal implications of neglecting to address important ethical issues of participants. In these guidelines we outline best practice for conducting social research addressing concerns such as: informed consent, confidentiality, respondent burden and feedback.

Guidelines for monitoring management effectiveness in Mediterranean Marine Protected Areas

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Management effectiveness evaluation provides an organized and compacted way to integrate and synthesize information essential to MPA management, and enables managers to prioritize and address issues by setting new targets directly linked to management actions. We evaluated the management performance of five Mediterranean Marine Protected Areas: Portofino (IT), Tavolara-Punta Coda Cavallo (IT), Ustica (IT), Port Cros (FR), and Cabo de Palos (SP), based on the existing guide of Tempesta and Otero (2013), which was updated during the process. Information was collected through a synthesis and integration of different approaches (semi-structured interviews with MPA Management Boards, staff and stakeholders, literature review, personal experience) during the period 2013-2014. Case studies were initially assessed separately on the basis of 21 indicators in the form of simple questions, that described the general categories of (i) management and legislation; (ii) conservation features; (iii) pressures; (iv) communication and outreach. Finally the MPAs were compared in order to identify common challenges and good examples in MPA management. We highly recommend that the evaluation should be a cyclic process conducted by a neutral practitioner, and results should be disseminated in order to exchange knowledge, reach the adoption of common monitoring frameworks and increase MPA management effectiveness.

3   Resource and Biodiversity Threats

Chairpersons:

M. Abbiati & J.A. García-Charton

Subjects:

- •   Reduced demography
- •   Genetic connectivity
- •   Conservation of marine biodiversity
- •   Variations in the trophic nets
- •   Overfishing

Pelagic fishes at Cabo de Palos MPA, southern Spain (Courtesy of Massimo Ponti).

3.1   Oral presentations

Topic presentation: Multiple approaches for assessing larval connectivity in the south lagoon of New Caledonia

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Three approaches for assessing larval connectivity have independently made recent significant advances: genetics (parentage analysis of recruits); otolith microchemistry (artificial marking of embryos); and biophysical modelling of larval dispersal. In the COMPO project (http://www.compo.ird.fr/) we have integrated these three approaches into a single analysis of marine connectivity patterns for two species with contrasting ecology in the South lagoon of New-Caledonia: a fish (humbug damselfish, *Dascyllus aruanus*) and a bivalve (giant clam, *Tridacna maxima*). Self-recruitment, i.e. recruitment of individuals on their natal reef, was assessed empirically on a reef of the lagoon, as well as connectivity between this focal reef and 10 surrounding reefs. A model was also developed to simulate larval trajectories during their dispersal phase within the lagoon, allowing to assess self-recruitment and larval connectivity numerically. We found that self-recruitment on the focal reef and connectivity with the surrounding reefs is possible but generally very low. At the scale of the studied reefs and for both species, we can therefore conclude that most recruits were not produced locally.

Propagule dispersal and larval patch cohesiveness in a Mediterranean coastal fish

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The assessment of fish dispersal has a fundamental importance for both conservation and management of fisheries resources as it can provide crucial information for the establishment of effective marine protected areas (MPAs) and networks of MPAs. In this study we investigated otolith elemental composition in early life stages of the saddled sea bream *Obalda melanura* (Linnaeus, 1758) (Perciformes: Sparidae) in order to obtain information on its propagule (egg - larva) dispersal in the south-western Mediterranean Sea. Specifically, considering late stage larvae and early post-settlers, we investigated: (1) number of potential natal sources; (2) propagule dispersal distances and (3) larval patch cohesiveness during the last phase of the larval life. Seven natal sources were found to replenish, with different proportions, almost all the sampling sites along a stretch of coastline of ~180 km. This outcome suggests that propagules dispersal can take place at least up to ~90 km. We show also that different larval patches can merge in the pelagic environment after having travelled separately for some days. This information can provide important insights for the understanding of fish dispersal process and supporting the correct establishment of spatially explicit conservation strategies such as

Sound production as an indicator of *Epinephelus marginatus* and *Mycteroperca rubra* spawning aggregations in a Mediterranean MPA

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Grouper species are seriously threatened by overfishing in the Mediterranean Sea. Two of these species, the dusky grouper *Epinephelus marginatus* and mottled grouper *Mycteroperca rubra*, have distinct reproductive behaviours, which require study in order to understand critical information regarding their population dynamics, particularly in marine protected areas (MPAs) where some fishing is allowed. The aim of the present study is to collect preliminary information on the temporal dynamics of reproductive behaviour in *E. marginatus* and *M. rubra* in a Mediterranean MPA (Cabo de Palos - Islas Hormigas marine reserve, Murcia, SE Spain), by using passive acoustic monitoring (PAM) and underwater visual census (UVC) techniques. Two digital spectrogram long-term acoustic recorders (DSG; Loggerhead Instruments) were deployed on the suspected spawning aggregation site in July 2015 and were programmed to record 20 s of sound every 5 min over four months. Visual censuses were conducted weekly during the same period. The occurrence of daily and seasonal changes in sound production that may be associated with changes in colour patterns and behaviours, as well as the correlation between abundance and sound production will be analysed. Monitoring this event will help improve knowledge on reproductive behaviours of threatened species, which is essential for designing management and evaluating the effectiveness of MPAs, hence providing important information to support the design and implementation of fisheries management and conservation strategies.

Topic presentation: Genetic diversity, population structure and connectivity in a marine ecosystem under multiple threats - the Baltic Sea

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The Baltic Sea is a postglacial environment characterized by a strong and permanent salinity gradient. Over the past 6000-8000 years, the (rather few) marine species that have successfully established populations in the sea have in many cases become extremely numerous and act as key components of the Baltic Sea ecosystem. Genetic studies have recently revealed that many of these are locally adapted to the low salinity of the area and genetically isolated ("isolation by adaptation") from populations outside the sea. Mapping of population genetic structures, connectivity and unique genetic elements show complex, and mostly species-specific patterns that make management a challenge. Furthermore, predictions of how the physical environment will change, as a consequence of climate change over the coming 50-100 years, suggest dramatic perturbations of temperature and salinity. A careful management of unique genetic elements important in local adaptation of Baltic Sea populations seems the only way forward. This requires, however, much more comprehensive genetic data for most species, and clear strategies for protection of genetic biodiversity using MPAs and other approaches. This, in turn, demands strong collaborations among scientists, authorities and other stakeholders, and not least, an increased understanding for the role of biodiversity within species.

Population connectivity within and among Mediterranean MPAs: a case study using two closely related intertidal species

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Marine Protected Areas (MPAs) networks should be designed to protect species diversity and ensure long-term persistence of species. For achieving this purpose, MPAs should be efficient in terms of maintaining genetic diversity and connectivity at different spatio-temporal scales. Here, the efficiency of four western Mediterranean MPAs (Cabo de Palos, Port-Cros, Tavolara and Portofino) was assessed comparing the genetic variability of two widely distributed congeneric species of limpets (*Patella caerulea* and *Patella rustica*) in protected and nearby non-protected sites. Mitochondrial cytochrome oxidase c subunit 1 region was used for evaluating the connectivity among MPAs whereas the more variable microsatellite markers were used for evaluating connectivity patterns within and around each MPA. Genetic diversity differed among protected and non-protected sites for both species, with higher extent for *P. caerulea*. However, this "MPA effect" was not consistent in all locations. At geographic level, both species showed high genetic connectivity between Port-Cros, Tavolara and Portofino locations (including MPA and surrounding sites) with slight significant genetic differentiation with the most south-western location (Cabo de Palos). At local MPA level, no protection effect was observed in genetic diversity. Moreover within each MPA, different patterns of genetic structure and connectivity were observed depending on species and local environmental features. The results of this study suggest that multi-species and multi-scale management approaches are needed to evaluate the efficiency of MPAs.

Genetic structuring across marine biogeographic boundaries in rocky shore invertebrates

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Biogeography investigates spatial patterns of species distribution. Discontinuities in species distribution are identified as boundaries between biogeographic areas. Do these boundaries affect genetic connectivity? To address this question, a multifactorial hierarchical sampling design, across three of the major marine biogeographic boundaries in the central Mediterranean Sea (Ligurian-Tyrrhenian, Tyrrhenian-Ionian and Ionian-Adriatic) was carried out. Mitochondrial COI sequence polymorphism of seven species of Mediterranean benthic invertebrates was analysed. Two species showed significant genetic structure across the Tyrrhenian-Ionian boundary, as well as two other species across the Ionian Sea, a previously unknown phylogeographic barrier. The hypothesized barrier in the Ligurian-Tyrrhenian cannot be detected in the genetic structure of the investigated species. Connectivity patterns across species at distances up to 800 km apart confirmed that estimates of pelagic larval dispersal were poor predictors of the genetic structure. The detected genetic discontinuities seem more related to the effect of past historical events, though maintained by present day oceanographic processes. Multivariate statistical tools were used to test the consistency of the patterns across species, providing a conceptual framework for across-species barrier locations and strengths. Additional sequences retrieved from public databases supported our findings. Heterogeneity of phylogeographic patterns shown by the 7 investigated species is relevant to the understanding of the genetic diversity, and carries implications for conservation biology.

Risk assessment of fishing footprint on coralligenous habitats

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Coralligenous are considered both vulnerable and essential fish habitats, yet little is known regarding their response to human pressures. Although trawling is considered the most important threat, recreational and artisanal fishing may also cause severe damage to their long-lived, key structural species. Characterizing fishing activity in the Mediterranean requires complicated approaches due to the increased heterogeneity and combination of gears, the variation of target species and the poor data availability. Monitoring and mapping of fishing pressure is just the first step to allocate fishing impacts on vulnerable habitats and seafloor integrity. More integrated approaches are necessary in order to understand the risks of fishing activity on conservation targets and efficiently inform management response.

The present study identifies the potential risk of coralligenous degradation or loss in Portofino MPA (Italy) by integrating fishing pressure and habitat vulnerability assessments through a standardized protocol. The approach considers the cumulative impacts caused by different fishing practices such as (i) direct mechanical damage; (ii) abrasion from lost gear; (iii) input of non-synthetic compounds from fishing boats; (iv) suffocation from sediment re-suspension.

In comparison to other attempts towards this direction the suggested method takes into account the heterogeneity of techniques and captures the different scale of impacts on benthic habitats in a systematic way, providing a useful tool that integrates ecological, management and policy interventions. The risk assessment can be easily applied and communicated in a straightforward way by managers, and has the potential to be expanded for assessing threats of fishing activity at different ecological components.

Food-web modelling: A possible ecosystem management tool for Mediterranean MPAs?

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Mediterranean coastal ecosystems support a great diversity of habitats and species, being a major challenge for an ecosystem management approach. In particular, management of Marine Protected Areas should be informed about the possible effects of protection on often complex food-webs. The application of food-web modelling through the Ecopath with Ecosim software (EwE) may allow to unravel such a complexity and could thus help to better pursue the conservation and management objectives of Mediterranean MPAs. Unfortunately, whilst widely applied at larger ecosystem scales where the presence of industrial fisheries allows for large data availability, EwE has not yet gained full attention as a possible tool for the management of smaller coastal areas. Main drawbacks are the difficulty of obtaining local biomass data for all functional groups and the low availability of catch estimates from artisanal and recreational fisheries. Here we propose a standardized and simplified model structure developed for Port-Cros MPA (France) and present its application in two case-studies that well represent Mediterranean data availability: the Portofino MPA (Italy), where available local biomass data was used; the Cap Roux fishery reserve (France), where biomass data was collected in the field. Through extensive sensitivity analysis on catch estimates we account for the impact of data uncertainty on model outputs. We identify the possible management applications of such tool, as indices useful for monitoring ecosystem functioning and the assessment of the ecosystem impacts of interacting fisheries. We conclude that this standardized approach could provide a well-defined framework for integrating available (but dispersed) data on Mediterranean coastal ecosystems into a coherent picture of ecosystem functioning.

3.2   Poster presentations

Genetic divergence between two sympatric morphotypes of the Zoantharia *Parazoanthus axinellae* along the north-western Mediterranean Sea

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In order to protect marine biodiversity we first need to describe it. However, the definition of species is a largely debated issue and still nowadays many groups of organisms are lacking a proper taxonomical classification. Molecular tools are useful to delineate species boundaries and their evolution. Among others, Cnidaria, due to their high phenotypic plasticity and lack of diagnostic morphological characters, are one of the marine taxa with large species definition problems. *Parazoanthus axinellae* is the most common, abundant and widespread Zoantharia species of the Mediterranean Sea. In the north-western Mediterranean two sympatric morphotypes are commonly found (Gili et al. 1987): a thinner yellow form (*P. axinellae muelleri*), and a thicker orange form, only found in this area (*P. axinellae liguricus*). In the present study we will investigate the genetic structure of this two sympatric morphotypes in order to assess their genetic diversity and structure. Samples of both morphotypes were collected in four sites along the north-western Mediterranean. Two markers, the mitochondrial COI and the nuclear ITS, were sequenced, and their diversity and structure analysed according to morphotype and geographical origin. Results point out a sharp and consistent differentiation between morphotypes, with no clear geographical structure. The magnitude and meaning of this divergence is discussed through the analysis of phylogenetic relationships with other species of the same genera. A full revision of Zoantharia, taking into account several markers at the time, could provide a clearer picture on the speciation process in this understudied marine group.

4 Socio-Ecosystem Co-Evolution, Policies & Management

Chairpersons:

M. Semitiel-García & P. Noguera-Méndez

Subjects:

- Purpose and need for MPA
- ICZM, Planning of MPAs
- Fishery management
- Governance as a prerequisite
- Participative approach
- Stakeholders' perceptions and trajectories
- Alliances and Marine Peace Parks

MMMPA fellow conducting a socio-economic survey in Cabo de Palos, Spain (Courtesy of Katie Hogg).

4.1 Oral presentations

Topic presentation: The governance of marine protected areas: step zero and beyond

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The governance of Marine Protected Areas (MPAs) is frequently a critical factor for their success. This begins when thinking about the area to be protected. Taking into account only in the selection process the element of the natural environment is common problem. The social side of the environment is also important: the attitude of civil society constitute a critical factor. For instance, we can find how MPAs created at the same time, with the same legislation, with similar rules may succeed or fail because the attitude of the local population and local organizations. This is especially relevant in the inception process, what we call the step zero, a process where need to be placed a lot of efforts and time. The time factor is crucial, frequently people do not know exactly what can imply an MPA and it is necessary some time so that a common understanding of the advantages and potential risks can be taken into account by stakeholders, and decisions can be made. Not less important is the fact that the goals of the MPA need to be elucidated. Different actors may have different goals, even with the same MPA, and this needs to be streamlined in the inception process and later. Finally, we

need to take into account the synergies that can be developed between conservation, small-scale fisheries, and tourism, that can be enhanced with stakeholder involvement and planning.

Constraints, barriers and opportunities to increased participation of cofradías and fishers in a hierarchical governance structure: the case of Cabo de Palos, Spain

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The inadequacy of marine coastal management approaches based on top-down and centralised interventions are well recognised. In response, there has been increased demand for greater transparency and wider participation in fisheries management from- industry, stakeholders and policy-makers alike. In this article, we combine qualitative discourse with relational data to explore the images held by stakeholders regarding the role of fishers and fisher's organisations in Cabo de Palos-Islas Hormigas marine reserve (CPHMR) governance network, and the potential barriers and opportunities to participation. Extensive fieldwork was carried out during 2013-2015 in including key informant interviews, focus group meetings, individual surveys and participant observation. This research indicates that decentralisation does not necessarily mean more participation, and in fact illustrates the continued marginalisation of fishers and their organisations. In the context of decision-making processes there is disparity in the images held by fishers and other stakeholders regarding their role and participation, which is a significant barrier towards increasing participation. This research points to the importance of both increasing the fishers capacity to improve their connections within the governance network and capacity to participate, but also more importantly, highlights that more political will from the top is required to generate real sharing of power and genuine participation. The lessons learned and conclusions drawn are useful MPAs that are contextually similar.

Perceptions of Marine Protected Area winners and losers: A comparative regulatory burden approach

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Marine Protected Areas (MPAs) are often marketed on the basis of conservation and livelihood benefits i.e. protection of benthic biodiversity and enhanced fish stocks through spill over. MPA's by restricting activity through regulation (both legally and informally) transfer direct use benefits from consumptive resources users such as fishers to non-consumptive users such as dive operators and scientists. Issues such as distributional equity of benefits and costs are rarely discussed in the literature. We present results from a case study looking at perceived winners and losers of a 25 year old, 'successful' Fisheries Reserve in Cabo De Palos, Spain. The reserve, established in 1995 by the Spanish Government was designed 'to maintain sustainable fisheries, enabling artisanal fishermen to preserve their traditional way of life'. Despite increased fish size and abundance fishers are not perceived as the primary beneficiaries. Qualitative analysis of interview data from resource users expands on who and how the community identify impacts of the Fisheries Reserve and we discuss the basis for those mental constructs in terms of comparative regulatory burden.

Pantelleria Island: a testing ground for a participatory approach aimed at fostering the creation of an MPA proposed and developed by local inhabitants

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The future of MPAs should involve the active participation of local communities through the recovery and preservation of sustainable practices peculiar to local traditions. In the island of Pantelleria, an experimental participatory process, based on civil society, started in 2013. The first step was listening to the needs of the "stakeholders" of the sea - fishermen, diving centres, free divers, tourist operators and people of the island - who developed an idea of protection based on the needs of their own category. The second step was creating the "Tutela Pantelleria" Workgroup, including each category's representatives, which developed a common proposal of protection to be submitted to institutions.

Human aspects are important to form a group and avoid its disintegration. A process depends not only on its structure, but also on the ability of people to relate to each other and have a common perspective. That's why the model adopted for Pantelleria is mainly aimed at creating a community of interest around the protection of a common resource, which is the island's territory. At present, the group is focusing on traditions as a key element for an MPA that aims at safeguarding the environment and biodiversity. The work group now should become a link between civil society and institutions using the proposal as the starting point of an open participatory debate.

Participatory process is fundamental to rebuild local identities through the protection of traditions and environment, strengthen confidence with institutions and develop a sustainable local economy.

Regional alliances and engagement of local governments and communities

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The sectorial and fragmented governance regime of marine areas do not serve the cause of the sea as a common heritage of human kind. If these regions are to be equitably and sustainably used, a balance needs to be found between the common heritage principle and the open access regime. Regional or transboundary initiatives are usually considered as a good way in attempting to combine conservation issues with resolving conflicting relationship between States. This presentation will review and evaluate a number of them around the world including so-called Alliances and Marine Peace Parks as trans-boundary cooperative environmental research functioning like an entry point for constructive discussions progressively building up trust between countries including local governments and communities that may be divided or simply ignore each other.

4.2   Poster presentations

Increasing information flow and stakeholder engagement in Marine Protected Areas

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Enhancing stakeholder engagement in order to holistically inform decisions and increase the efficiency of conservation management is essential. Stakeholder engagement may (i) promote cooperation and the

exploration of possible solutions; (ii) facilitate mitigation of conflicts due to various interests; (iii) enhance coordination and enforcement of common rules in a more transparent way. Stakeholder participation has been characterized as a long and difficult process that requires an in depth knowledge of the social-ecological systems' complexity, focusing on the factors that influence stakeholder engagement and the level of participation that is desired. In addition, integration of information and communication strategies that allow interaction and knowledge sharing between users should be considered as the means to achieve successful engagement. Stakeholder Analysis (SA) and Social Network Analysis (SNA) are complementary methodologies that provide compacted information and guidance for fostering communication, trust and collective learning in natural resource management. We have applied these methodologies in Portofino MPA to identify central stakeholders with the capacity to act as communication hubs in the social network, and explore the presence of a core-periphery network structure, which may boost information flow and increase social learning. Our findings offer insights regarding the role of social networks' structure in MPA management and highlight the importance of strengthening relationships between actors through web technology tools, which may augment plurality and new ideas into the engagement process. The present study provides guidance for increasing stakeholder engagement towards adaptive collaborative management of resources and effective governance performance.

Setting of the Governance for Management of Transboundary Fishery Restricted Area. Identification of the key element in case of the Central Adriatic Sea

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Aiming to maintain ecosystem health and to sustain ecosystem services that people relies on, the European Union has adopted the Ecosystem Based Management (EBM) of marine space. To ensure that the principles of EBM approach is adhered to, a transboundary Fishery Restricted Area (FRA) established in the Central Adriatic Sea is suggested as a tool to sustainably manage fishery activity and conserve marine resources of the area. Maritime Spatial Planning (MSP) is to be applied in the suggested area not only for the allocation and management of human activities but also for clarifying institutional roles, their responsibilities and interaction between actors that will ensure effective management. This study emphasizes on principle of setting the governance and stakeholder engagement as a key concept for establishing an effective management of shared marine resources. Stakeholders from fishery activity and environmental protection from Italy and Croatia, and their relationships were analysed. Through policy analysis, online survey and interviews, in total 35 Italian and Croatian stakeholders, their role in the planning process and the sector of interests were identified. In order to understand the governance setup and evaluate the communication in their social network, Social Network Analysis was conducted from which stakeholders that may promote the creation of the FRA and bridge stakeholders in the social network of C. Adriatic were determined.

The present study suggests that there is currently limited interaction between the two countries, and emphasizes the importance of international institutions for improving transboundary communication for supporting the establishment of the FRA.

5 MPA Networks and committees

Chairpersons:

Y. Henocque & F. Vallarola

Subjects:

• Networks and committees
• Projects presentations

Participative community meeting in Cabo de Palos MPA, Spain, to validate research findings (Courtesy of Katie Hogg).

5.1 Oral presentations

CIESM C6 - Coastal Systems & Marine Policies

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Through CIESM Congress sessions, CIESM Research Workshops and frequent electronic exchange, the Committees provide researchers with many opportunities to present, confront and publish their latest hypotheses, data and perspectives. CIESM workshops in particular aim to explore emerging themes of research at the Mediterranean level. They often initiate follow-up collaborative research activities with an interdisciplinary flavour. The main themes of C6 are: coastal processes; coastal erosion; land-sea interfaces (estuaries, lagoons, deltas); scientific aspects of ICZM; climate change impacts; coastal vulnerability; river fluxes to the coastal zone, natural and anthropogenic changes.

Making MPAs work in the Mediterranean Sea

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Although it represents less than 1% of the global ocean surface, the Mediterranean is one of the main reservoirs of marine and coastal biodiversity in the world. At present, MPAs cover a mere total surface area of the Mediterranean of almost 114 600 km^2, so about 4.56%; and 1.08% if we exclude the Pelagos Sanctuary (87

500 km^2). The 161 MPAs of national status cover a surface of 18 500 km^2 (0.73% of the Mediterranean); the 9 MPAs of international status represent 88 000 km^2 (3.5 % of the Mediterranean, 0.02% if we exclude the Pelagos Sanctuary). The 507 Natura 2000 at sea sites amount to 25 200 km^2 (1% of the Mediterranean). However, the majority of these MPAs are coastal, located in the northwester side of the region and often not well managed. WWF and MedPAN have worked with a number of partners to advance the Mediterranean MPA network towards the 10% protection and effectiveness target, set by the Convention of Biological Diversity. This entails working with practitioners at the regional level and in the field. Stakeholder engagement, participatory planning and management, conflict resolution and peer-to-peer dialogue have been successful recipes for resolving the many challenges that managers face daily. These approaches have proven successful and have created a new mind-set and culture that MPAs are effective tools to deliver ecological, social and economic benefits. As a result, the MedPAN network has significantly expanded and it is today an important life line for Mediterranean MPAs. We now look at the next challenges, ensuring the MPA can maintain a sustainable level of funding, engage with the private sector and develop blue growth solutions to generate income and support the livelihoods of local communities.

AdriaPAN: Adriatic Protected Areas Network

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AdriaPAN, the Adriatic Protected Areas Network, is a bottom-up initiative, started by two Italian marine protected areas, "Miramare" and "Torre del Cerrano". The aim of the network is to make contacts between Protected Areas in the Adriatic easier, to improve their partnership effectiveness. AdriaPAN is a growing network with a great potential for joining efforts in environmental protection, sustainable development. 10 Italian Protected Areas, both marine and coastal, initially signed the Cerrano Charter, the founding act of AdriaPAN, in 2008. Now the number has increased to 43 members from all countries bordering the Adriatic Sea, and more than 50 associated organizations (institutions, NGOs, etc.) interested in collaborating on AdriaPAN initiatives. Joining the network is free and the only requirement is to officially subscribe the **Cerrano Charter**, to achieve the mission herein defined.

The AdriaPAN is conceived as an integral part of the existing network of MPAs managers in the Mediterranean (MedPAN): it aims at representing and promoting the ecological, cultural and economic specificities of the Adriatic sea and coasts. The first step of AdriaPAN was the public presentation on 2008 October the 6th, during the IUCN-WCC Conference in Barcelona –Spain.

In the *EU Strategy for the Adriatic and Ionian macro-region*, published in 2014, the network of protected areas AdriaPAN enters as one of indicative actions to the extent directed to the protection of the Environment and Biodiversity[1].

EMODnet Mediterranean Checkpoint: An approach for the assessment of observational data systems and targeted applications

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The concept of EMODnet Checkpoints was introduced within the framework of the EU's Marine Knowledge 2020 Strategy and has a regional scope (North Sea and Mediterranean checkpoints) envisaged to determine the gaps in data and observation systems and priorities for an observation system that supports the delivery of

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[1] See the **Action Plan** published in the "Official documents" released by the European Commission June 17, 2014 (AdriaPAN pp.42-43).

sustainable growth and innovation. As with other EMODnet Checkpoints, the EMODnet MedSea (http://www.emodnet-mediterranean.eu) assesses basin-monitoring systems on the basis of the data needs from end-user applications. These are of paramount importance for: (i) the blue economy sector (offshore industries, fisheries); (ii) marine environment variability and change (eutrophication, river inputs and ocean climate change impacts); (iii) emergency management (oil spills); and (iv) conservation of natural resources and biodiversity (Marine Protected Areas). The Challenge on Marine Protected Areas aims to analyse the existing Mediterranean network of Marine Protected Areas and determine whether the network constitutes a representative and coherent network as described in article 13 of the Marine Strategy Framework Directive (MSFD).

Spanish network of marine reserve: 30 years enhancing fisheries and protecting habitats

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The Spanish Marine Reserves Network accounts in 2015, 10 marine reserves, 100 000 ha protected (IUCN Category VI), 10 000 of which are no take zones (IUCN Category I), seven Mediterranean marines reserves and three in Canary Islands and they all have been put in force by the Spanish Secretary of Fisheries that manages them, sharing the expenses with regional fisheries agencies in 4 of them. Their aim is to foster and maintain fisheries since the first one, the marine reserve of the island of Tabarca born in 1986, they have been asked for by the fishermen. The basis to set a marine reserve has always been scientific information. Once they are put in force, the Spanish Secretary for Fisheries and regional fisheries agencies in the case they too have waters under their control, provide permanent tools, the main one being permanent surveillance with boats well equipped and crews while the research for follow up are too undertaken, most of them engaging the Spanish Institute for Oceanography. Awareness actions are too undertaken focusing local actors.

Follow up results show the work for rock fisheries and shellfish: spill-over effects have been calculated as well as proofs of healthier fisheries stocks with bigger sizes and a: grouper and spiny lobster are good examples of the "marine reserve" effects. The network is a tool to study anthropic effects such as invasive algae evolution and effects of the warming of superficial waters in the Mediterranean. Other trait in the network is that aiming the good environmental status of the habitats and waters, fisheries administration are trying to maintain natural conditions.

This network is a case study not only for ecosystem approach in fisheries but as a case of marine spatial planning in littoral zones where although the network does not mean very big areas, different littoral uses obliges the Spanish Secretary for Fisheries to look for a sound road map considering the importance to limit anthropic effects.

More information at: www.reservasmarinas.net

MMMPA: social network and collaboration

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The scope of the network drawn for the Marie Curie Initial Training Network Monitoring of Mediterranean Marine Protected Areas (MMMPA ITN) has been to shape the profile of the next generation of MPAs managers. Considering the key role of MPAs in achieving the biodiversity conservation targets fixed at international level, and the high discrepancy in the actual management between the existing Mediterranean MPAs, it is pivotal to reinforce these with concrete measures of management and governance capacity.

The MMMPA ITN is structured through 5 scientific work packages and 10 inter-related sub-programmes. Based on the proposal, deliverables were set accounting only for a theoretical degree of interaction among partners. However, during the project lifetime, some of the predefined deliverables changed both in relation to difficulties in obtaining data and to implement new opportunities.

Here we apply Social Network Analysis (SNA) techniques to describe the evolution of the MMMPA's social network, in order to document how the different Early Stage Researchers (ERSs) were connected throughout the project, and highlight how these interactions allowed the reaching of the final expected outcomes.

The analysis indicates that - although initially fragmented groups were formed in the network - ESRs progressively established connections across individual deliverables and built collaborations through a dynamic process of continuous interaction and communication, which resulted in a cohesive scientific network. It is expected that this network will continue to grow and strengthen as the ESRs will keep collaborating and explore new career perspectives under a shared vision that has been developed for the future resource management in the Mediterranean Sea.

Annex 2 - List of Participants

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