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M.T. Spedicato

COISPA Tecnologia & Ricerca, Stazione Sperimentale per lo Studio delle Risorse del Mare,
Via dei trulli, 18 - 70126 Bari, Italia.
spedicato@coispa.it

CRITICAL AND PROTECTED HABITATS OF THE MEDITERRANEAN SEA: KNOWLEDGE FROM THE MAREA PROJECT AND INSIGHTS FOR THE MARITIME SPATIAL PLANNING

HABITAT CRITICI E AREE PROTETTE DEL MEDITERRANEO: CONTRIBUTO DEL PROGETTO MAREA E IMPLICAZIONI PER LA PIANIFICAZIONE DELLO SPAZIO MARITTIMO

Abstract - *The outcomes achieved in the MAREA Framework project (MARE/2009/05 _ Lot1), related to the mapping and modelling spatial distribution of seagrass meadows, bioconstructions, nursery and spawning grounds of demersal and small pelagic species, fishing grounds, MPAs and FRAs, as well as stock units identification are outlined evidencing their relevance for the Integrated Maritime Policy and the ecosystem approach to fisheries management.*

Key-words: *seagrass meadows, bioconstructions, nursery areas, fishing grounds, ecosystem approach.*

Introduction - The wide and diversified demand for maritime space for different purposes (energy production and exploitation, maritime traffic, fishing activities, biodiversity conservation, tourism, aquaculture, etc.) has motivated the development of the Integrated Maritime Policy (EU Directive 2014/89) based upon an integrated maritime spatial planning and management approach for governance (i.e. Blue Growth). The strategy for marine and maritime research is an essential pillar of the European Maritime Policy as it is pivotal to allocate the full potential of sea-based activities in an environmentally sustainable manner. For the European Member States, obligations arising from the Habitats Directive (e.g. for the protection of regional priority habitats) and the Marine Strategy Framework Directive (EC Directive 2008/56) are further important drives for mapping the conditions, as well as the pressure components acting on predominant and sensitive habitats. The broad scope of the Common Fisheries Policy (CFP) aims for a sustainable exploitation of living aquatic resources in economic, social and environmental terms, thus it is intrinsically linked to both the Marine Strategy Directive and the Integrated Maritime Policy. The framework project MAREA (MARE/2009/05_Lot1) was launched by the European Commission (DGMARE) in 2009 to provide scientific advice and other services for the implementation of the Common Fisheries Policy (CFP) in the Mediterranean. One of the pillar of the MAREA project was the ecosystem knowledge and its integration into fisheries management. Along 4-years life of MAREA (http://mareaproject.net/), 11 specific projects were funded by DGMARE. Thus MAREA was a first-time occasion to expand knowledge of the Mediterranean seascapes for an impressively wide range of sensitive, critical and protected habitats. It has been an extraordinary challenge that has allowed to collate and review existing occurrence data and historical information as well as modelling spatial and temporal distributions. This was mostly achieved by the specific project MEDISEH (Mediterranean Sensitive Habitats; Giannoulaki *et al*., 2013a), while the specific project STOCKMED (Stock Units in the Mediterranean; Fiorentino *et al*., 2015) developed a methodological

framework and identified, using a holistic approach, stock units and their boundaries for a remarkable number of commercially relevant species. Interestingly this project also provided, for the first time, a paramount view on the main fishing grounds for several geographical sub-areas in the European Mediterranean, where spatial control is the one of the key pillars of an effort-based management system. Both projects shed light on main knowledge gaps. Globally around 100 researchers from several scientific Institutions of the Mediterranean contributed to these projects. All the maps from modelling are available in the MEDISEH and STOCKMED GIS viewer (http://mareaproject.net/medviewer/) a tool developed for the dissemination of the results from the two projects.

Seagrass medows - In the framework of MEDISEH, a dataset of distribution of seagrasses across the Mediterranean was derived from the compilation of published and unpublished information from several areas. Distribution maps were drawn based on the revised information of phanerogams (i.e., *Posidonia oceanica*, *Cymodocea nodosa*, *Zostera marina*, *Zostera noltii*, *Halophila stipulacea*, *Ruppia maritima*). Results showed that the known *P. oceanica* meadows cover 11687 km² in the Mediterranean basin but information on regression signs/health status of meadows is very limited. *P. oceanica* modelling was carried out accounting for both presence and absence records using Random Forests models. A fine-scale assessment of the current and historical known distribution of *P. oceanica* has been provided evaluations of the total area of meadows and the magnitude of regressive phenomena in the last decades (Telesca *et al*., 2015).

Bioconstructions - A thorough review of existing spatial datasets showing the distribution of coralligenous and *maërl* habitats across the Mediterranean Sea was undertaken, highlighting current gaps in knowledge. Predictive modelling was then carried out, based on environmental predictors to produce the first continuous maps of these two habitats across the entire Mediterranean basin (Martin *et al*., 2014).

Habitats of small pelagic species - Historic survey data (i.e. acoustic, ichthyoplankton, bottom trawl surveys) from five different areas along with satellite environmental and bathymetry data were compiled. Generalized additive models were applied in a presence absence approach, using the available datasets along with satellite environmental (e.g. Sea Surface Temperature, Chlorophyll, Sea Level Anomaly) and bathymetry data. Annual habitat suitability maps over the period 2000-2010 and addressing different life stages (i.e. adults, juveniles and eggs) of the target species were obtained. Based on these annual maps, habitat persistency maps were produced using GIS techniques, where persistent and occasional locations suitable for nurseries and spawning grounds were identified (Giannoulaki *et al*., 2013b).

Nursery areas of demersal species - The analysis of the time series of MEDITS bottom trawl survey data was carried out in the European Mediterranean waters to estimate the distribution of nursery areas and spawning grounds of 12 key demersal fish and shellfish species. Spatial analysis techniques were applied per species, area and life stages using different modelling approaches (GLM, GAMs, GAMMs, ZiGams, geostastics) depending on data peculiarities. Annual density/probability were obtained and hot spots, i.e. persistent nursery and spawning areas of most species,

identified. Using MEDISEH results Colloca *et al.* (2015) focused on the nursery of 11 demersal fish and shellfish commercial species analysed in the European Union Mediterranean waters. The Authors evidenced a high interspecific spatial overlap between nursery areas mainly along the shelf break of many different sectors of the northern Mediterranean, indicating a high potential for the implementation of conservation measures.

Marine Protected Areas (MPA) and Fishery Restricted Areas (FRA) - In MEDISEH project to answer the question: up to what degree the identified critical and sensitive habitats are currently protected, MPAs (part of the NATURA 2000 Network, parks, reserves, other designated types etc.) and FRAs were identified at the level of GSA along with information on the fishing restrictions applied in each area. This revision work revealed the occurrence of 148 MPAs, 336 proposed MPAs and SPAMIs (Specially Protected Areas of Mediterranean Importance under the SPA/BD Protocol of Barcelona Convention). FRAs included EU and national gear specific closures (e.g. for trawl, purse seines) and measures with a spatio-temporal dimension aiming to protect marine species and habitats from fishing activities in the Mediterranean basin. MEDISEH review highlighted the considerably larger extent of FRAs that mainly protect very deep grounds from trawling.

Fishing grounds - In STOCKMED project geo-referred information and data on the spatial and temporal distribution of fishing effort/grounds in relation to the target species were collated and reviewed, producing maps of effort distribution of the main fishing gears, though sometime not strictly related to the target species. VMS data were also used to assess the spatial distribution of fishing effort and the identification of the fishing grounds. In addition, a new approach has been developed, providing an estimate of the potential fishing areas of the vessels registered in the EU ports according to the Fleet Register of the European Union.

Identification of Stock Units - Stock unit identification is the first step for defining shared stocks among countries and fisheries, thus being a crucial basic knowledge of any spatial analysis of fisheries and effort deployed at spatial scale. STOCKMED project allowed to identify stock units and their boundaries by an objective and replicable approach based on integration of multidimensional data set having space as unifying descriptor. These results represent the first identification of stock structure of the main target species in the Mediterranean according to an holistic approach. The project outcomes highlighted that the re-organization of stock units in larger areas will imply the necessity of using, developing or adapting stock assessment and forecast tools taking into account the different components of the pressure in terms of catches, fishing mortality and effort by fleet and gear on stock units spatial scale. This knowledge is essential for setting spatial based management measure, besides the conventional ones (e.g. technical, effort based).

Conservation priorities - MEDISEH project provided, in addition, the basic support to identify priority sites for conservation/management in the Mediterranean Sea. An exercise based on a conservation planning approach was carried out using the software MARXAN (Ball and Possingham, 2000; Game and Grantham, 2008) for prioritizing candidate sites, on the basis of quantitative data on the distribution of priority habitats, existing threats and existing conservation initiatives for spatial

optimization. Conservation targets were set in accordance to the EU Habitats Directive (92/43/EEC), the Marine Strategy Framework Directive, the Convention on Biological Diversity (http://www.cbd.int/convention/) and the commitments undertaken at the World Summit on Sustainable Development in the Convention on Biological Diversity, approved by Council Decision 93/626/EC. Results showed that the percentage of overlap between the current conservation measures and the MARXAN scenario is about 50% of the identified priority areas, and Adriatic Sea emerged as one of the most relevant priority area (De Leo *et al*., 2014). From MEDISEH outputs overlap of the nursery grounds with existing spatial fisheries management measures and trawl fisheries restricted areas was also investigated (Colloca *et al*., 2015). Spatial analyses showed considerable variation depending on species and associated habitat/depth preferences with increased protection seen in coastal nurseries and minimal protection seen for deeper nurseries (e.g. *Parapenaeus longirostris* 6%). This is partly attributed to existing environmental policy instruments (e.g. Habitats Directive and Mediterranean Regulation EC 1967/2006) aiming at minimising impacts on coastal priority habitats such as seagrass, coralligenous and *maërl* beds.

Conclusions - MAREA framework project provided an unprecedented opportunity for filling important gaps of knowledge on spatial localization and modelling of critical and protected habitats, as well as for the localization of fishing grounds, and for identification of stock units with their spatial boundaries. In addition, other key results, relevant for the management of fishery resources, were achieved. All these outcomes play a pivotal role for applying at Mediterranean scale the marine spatial planning and the Integrated Maritime Policy, but also for assisting the implementation of the ecosystem approach to fisheries management. Another important result of the MAREA framework project was represented by the identification of knowledge gaps in the different fields, thus providing the basis for future improvements. Outcomes of MEDISEH project provided relevant results useful to other European projects, such as CoCoNet (http://www.coconet-fp7.eu/) and ADRIPLAN.

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References

BALL I., POSSINGHAM H. (2000) - Marxan (v1.8.2): Marine Reserve Design using Spatially Explicit Annealing. Available at: http://www.marineplanning.org/pdf/marxan_manual_1_8_2.pdf

COLLOCA F., GAROFALO G., BITETTO I., FACCHINI M.T., GRATI F., MARTIRADONNA A., MASTRANTONIO G., NIKOLIOUDAKIS N., ORDINAS F., SCARCELLA G., TSERPES G., TUGORES M.P., VALAVANIS V., CARLUCCI R., FIORENTINO F., FOLLESA M.C., IGLESIAS M., KNITTWEIS L., LEFKADITOU E., LEMBO G., MANFREDI C., MASSUTÍ E., PACE M.L., PAPADOPOULOU N., SARTOR P., SMITH C.J., SPEDICATO M.T. (2015) - The seascape of demersal fish nursery areas in the North Mediterranean Sea, a first step towards the implementation of spatial planning for trawl fisheries. *PLoS ONE*, **10** (3), doi:10.1371/journal.pone.0119590.

DE LEO F., BELLUSCIO A., COLLOCA F., D'AMBROSIO P., GIANNOULAKI M., MARTIN C.S., PAPADOPOULOU K.-N., SCARDI M., SPEDICATO M.T., FRASCHETTI S. (2014) - Setting conservation priorities for the conservation of critical habitats in the Mediterranean Sea using conservation planning tools. *Biol. Mar. Mediterr*., **21** (1): 159-162.

FIORENTINO F., MASSUTÌ E., TINTI F., SOMARAKIS S., GAROFALO G., RUSSO T., FACCHINI M.T., CARBONARA P., KAPIRIS K., TUGORES P., CANNAS R., TSIGENOPOULOS C., PATTI B., COLLOCA F., SBRANA M., MIFSUD R., VALAVANIS V., SPEDICATO M.T. (2015) - Stock units: Identification of distinct biological units (stock

units) for different fish and shellfish species and among different GFCM-GSA. STOCKMED Deliverable 03: Final Report. January 2015: 310 pp.

GAME E.T., GRANTHAM H.S. (2008) - Marxan User Manual: For Marxan version 1.8.10. University of Queensland, St. Lucia, Queensland, Australia, and Pacific Marine Analysis and Research Association, Vancouver, British Columbia, Canada. Available online at: http://www.uq.edu.au/marxan/docs/Marxan_User_Manual_2008.pdf

GIANNOULAKI M., BELLUSCIO A., COLLOCA F., FRASCHETTI S., SCARDI M., SMITH C., PANAYOTIDIS P., VALAVANIS V., SPEDICATO M.T. (EDS) (2013a) - Mediterranean Sensitive Habitats. Contract SI2.600741. Final Report: 557 pp.

GIANNOULAKI M., IGLESIAS M., TUGORES P., PYROUNAKI M.M., LEONORI I., CAMPANELLA F., BONANNO A., PATTI B., BIGOT J.L., SARAUX C., DE FELICE A., TIČINA V., BASILONE G., MACHIAS A., SOMARAKIS S., SCHISMENOU E., SIAPATIS A., TSERPES G., CUTTITTA A., VALAVANIS V., PAPADOPOULOU N., NIKOLOPOULOU M., GRISTINA M., MARTIN C., SPEDICATO M.T. (2013b) - Harmonising data from heterogeneous sources to characterise small pelagic fish habitat in the Mediterranean Sea. ICES CM2013/ G: 17.

MARTIN C.S., GIANNOULAKI M., DE LEO F., SCARDI M., SALOMIDI M., KNITWEISS L., PACE M.L., GAROFALO G., GRISTINA M., BALLESTEROS E., BAVESTRELLO G., BELLUSCIO A., CEBRIAN E., GERAKARIS V., PERGENT G., PERGENT-MARTINI C., SCHEMBRI P.J., TERRIBILE K., RIZZO L., BEN SOUISSI J., BONACORSI M., GUARNIERI G., KRZELJ M., MACIC V., PUNZO E., VALAVANIS V., FRASCHETTI S. (2014) - Coralligenous and *maërl* habitats: predictive modelling to identify their spatial distributions across the Mediterranean Sea. *Scientific Reports*, **4**, doi: 10.1038/srep05073.

TELESCA L., BELLUSCIO A., CRISCOLI A., ARDIZZONE G., APOSTOLAKI E.T., FRASCHETTI S., GRISTINA M., KNITTWEIS L., MARTIN C.S., PERGENT G., ALAGNA A., BADALAMENTI F., GAROFALO G., GERAKARIS V., PACE M.L., PERGENT-MARTINI C., SALOMIDI M. (2015) - Seagrass meadows (*Posidonia oceanica*) distribution and trajectories of change. *Scientific Reports*, **5**, doi:10.1038/srep12505.

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