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Elenco pubblicazioni e relativo abstract

- 1) *Bonifacio strait natural reserve (BSNR): Investigating ecosystem functioning through comparative modelling of marine protected areas. Ocean & Coastal Management, 256, p.107263 (Vanalderweireldt, L., Albouy, C., Le Loc'h, F., Libralato, S., Millot, R., Garcia, J., Santoni, M.C., Culioli, J.M., de Bettignies, T. and Durieux, É.D., 2024)*

Abstract: The Bonifacio Straits Natural Reserve (BSNR) is a Mediterranean Marine Protected Area (MPA) located in Corsica, characterized by rocky coasts, steep bathymetry, and regulated exploitation of marine resources. In this study, we updated the BSNR Ecopath model from 2010, providing a re-evaluation of the MPA's impact 13 years after the reserve's establishment and incorporating improved catch estimates, particularly for recreational fisheries. The model encompassed four primary producer groups, fourteen invertebrate groups, two Chondrichthyes groups, sixteen teleost groups, one seabird group, and one cetacean group. The BSNR model depicted a Mediterranean ecosystem where piscivorous fishes and cephalopods link primary producers to top predators (Tursiops truncatus, Dentex dentex and Epinephelus marginatus), emphasizing complex trophic relationships. Although the ecosystem faced moderate fishing pressure, the model revealed uneven pressure among groups, with rays, for example, being particularly vulnerable to fishing nets. Additionally, a mixed trophic impact analysis revealed an absence of competition among fishing fleets for resources, suggesting that, overall, recreational and artisanal fisheries do not impact each other. By comparing MPA models across the Mediterranean Sea, our research suggests that MPA establishment might enhance the overall biomass of ecosystems within their boundaries. This abundance can spill over into adjacent areas, thereby increasing biomass and diversity in those regions. In more exploited MPAs, higher values for the Finn cycling index and the consumption to total system throughput ratio indicated that fishing activities increased pressure on prey resources by diminishing the system's energy, pushing the ecosystem to optimize recycling.

- 2) *Shedding light on trawl fishing activity in the Mediterranean Sea with remote sensing data. ICES Journal of Marine Science, p.fsae153 (Marsaglia, L., Parisi, A., Libralato, S., Miller, N.A., Davis, P., Paolo, F.S., Fiorentino, F., Garofalo, G., Costantini, M. and Russo, T., 2024)*

Abstract: This study uses Synthetic Aperture Radar (SAR) vessel detections and Automatic Identification System (AIS) to predict trawl fishing intensity and distribution of fishing activity in areas where public AIS data are not available. By processing SAR data, considering spatial and temporal autocorrelation, and building a General Additive Model, a statistical relationship between SAR vessel detections and AIS fishing activity was established. The study provides spatially

explicit estimates of trawler fishing activity, compared with official fleet records published by the General Fisheries Commission of the Mediterranean, revealing the distribution and intensity of trawl fishing activity not previously publicly tracked. Fishing grounds in the Strait of Sicily along the coast of Tunisia and North of Egypt showed an intensity of trawl fishing activity similar to the Adriatic Sea. This area is historically known to be subject to the highest trawling pressure in the Mediterranean, and also as one of the most heavily trawled regions in the world. The study shows that the integration of remote sensing data, such as SAR, offers a promising avenue to overcome data gaps and improve fisheries management in the Mediterranean where only a portion of the fishing fleet is publicly tracked.

- 3) *Routes to Ocean Sustainability and Blue Prosperity in a Changing World: Guiding Principles and Open Challenges. In Quantitative Sustainability: Interdisciplinary Research for Sustainable Development Goals (pp. 29-47). Cham: Springer International Publishing (Solidoro, C., Libralato, S. and Canu, D.M., 2024)*
- 4) *Exploring circular shipbuilding: A systematic review on circular economy business models and supporting technologies (Sara Scipioni, Gianluca Dini, Federico Niccolini)*

Abstract: Nowadays sustainability is receiving increasing attention, and particularly circular economy (CE) principles' applications within industrial sectors. However, a comprehensive exploration of CE-oriented applications – i.e., circular business models (CBMs) and circular supply chains (CSCs), – in the shipbuilding sector is actually missing, differently from other engineering-to-order industries, such as constructions. Considering the relevance of the sector, this study proposes a first step in filling up this gap through the systematic analysis of recent engineering and management literature on CE strategies within shipbuilding. As main result, we present applicable CE-oriented strategies and related supporting technologies, mainly referable to circular design, end-of-life, operations and inventory management oriented to product-life extension through effective disassembling. In addition, sustainability-oriented resource management represent essential activities in supporting the transition by focusing on eco-materials and waste reduction. Lastly, we highlight that the CE application is facilitated by dedicated supporting technologies, underscoring the importance of sustainability-oriented digitalization for the creation of social, environmental, and economic value for this strategic sector. The proposed solutions might orient shipbuilding companies in activating the transition towards circularity, even though predominantly focused on economic and environmental sustainability/circularity than social aspects. The presence of limited examples of applied circular solutions reduce the exploration of all possible solutions related to shipbuilding, asking for more applied studies and on-field exploration of the topic.

- 5) *Le implicazioni organizzative di una strategia di cybersecurity (Martina Neri, Federico Niccolini, Gianluca Dini)*

Abstract: I più recenti ed autorevoli report in tema di cybersecurity sottolineano come gli attacchi informatici, se pur diretti a tutti i tipi di organizzazioni, sono

particolarmente indirizzati verso quelle piccole e molto piccole. Nonostante ciò, il livello di preparazione delle Piccole e Medie Imprese (PMI) Italiane in tema di cybersecurity è ad oggi poco investigato. Ciò assume una particolare rilevanza in relazione al ruolo che le PMI ricoprono nel tessuto economico-produttivo del nostro paese. Per navigare nel dominio cyber, è essenziale che le PMI affrontino le minacce provenienti dal mondo digitale in una prospettiva sistemica, non affidandosi solo a soluzioni tecnologiche. La tecnologia deve essere utilizzata complementariamente con altre variabili organizzative, quali conoscenza, la cultura, la resilienza e la consapevolezza. È solo in quest'ottica ad ampio spettro che si può parlare di cyber-preparedness. Il presente studio ha l'obiettivo di effettuare una valutazione del livello di preparazione cyber delle PMI Italiane. La ricerca si è composta di due fasi consecutive e ha coinvolto 165 PMI italiane. Nella prima fase, la valutazione è stata effettuata tramite un questionario a carattere tecnico organizzativo. Le implicazioni organizzative e i punti critici delle risposte emerse nella prima fase dello studio sono state analizzate quindi e approfondite in una seconda, attraverso delle interviste semi-strutturate. I risultati mostrano come, in generale, le PMI non abbiano ancora raggiunto un alto livello di cyber-preparedness. La consapevolezza su tali tematiche risulta poco presente; infatti, la cybersecurity e le sue implicazioni organizzative non sono ancora coerentemente inserite nella cultura organizzativa; inoltre, alcune delle più importanti caratteristiche della resilienza organizzativa sono ancora lontane dall'essere implementate. Dai risultati nascono riflessioni sulle implicazioni organizzative e manageriali della cybersecurity per le PMI.

- 6) *Mechanisms for Securing Autonomous Shipping Services and Machine Learning Algorithms for Misbehaviour Detection* (Haruna, M.; Gebremeskel, K.G.; Troscia, M.; Tardo, A.; Pagano, P)

Abstract: Technological developments within the maritime sector are resulting in rapid progress that will see the commercial use of autonomous vessels, known as Maritime Autonomous Surface Ships (MASSs). Such ships are equipped with a range of advanced technologies, such as IoT devices, artificial intelligence (AI) systems, machine learning (ML)-based algorithms, and augmented reality (AR) tools. Through such technologies, the autonomous vessels can be remotely controlled from Shore Control Centres (SCCs) by using real-time data to optimise their operations, enhance safety, and reduce the possibility of human error. Apart from the regulatory aspects, which are under definition by the International Maritime Organisation (IMO), cybersecurity vulnerabilities must be considered and properly addressed to prevent such complex systems from being tampered with. This paper proposes an approach that operates on two different levels to address cybersecurity. On one side, our solution is intended to secure communication channels between the SCCs and the vessels using Secure Exchange and COMmunication (SECOM) standard; on the other side, it aims to secure the underlying digital infrastructure in charge of data collection, storage and processing by relying on a set of machine learning (ML) algorithms for anomaly and intrusion detection. The proposed approach is validated against a real implementation of the SCC deployed in the Livorno seaport premises. Finally, the experimental results

and the performance evaluation are provided to assess its effectiveness accordingly.

7) *Development of a Multi-Radio Device for Dry Container Monitoring and Tracking (Falcitelli, M.; Misal; Noto, S.; Pagano, P.)*

Abstract: Maritime shipping companies have identified continuous tracking of intermodal containers as a key tool for increasing shipment reliability and generating important economies of scale. Equipping all dry containers with an Internet-connected tracking device is a need in the global shipping market that is still waiting to be met. This paper presents the methods and tools to build and test a prototype of a Container Tracking Device (CTD) that integrates NB-IoT, BLE Mesh telecommunication and low-power consumption technologies for the massive deployment of the IoT. The work was carried out as part of a project to build the so-called "5G Global Tracking System", enabling several different logistic applications relying on massive IoT, M2M standard platforms, as well as satellite networks to collect data from dry containers when the vessel is in open sea. Starting from a preliminary phase, in which state-of-the-art technologies, research approaches, industrial initiatives and developing standards were investigated, a prototype version of the CTD has been designed, verified and developed as the first fundamental step for subsequent industrial engineering. The results of specific tests are shown: after verifying that the firmware is capable of handling the various functions of the device, a special focus is devoted to the power consumption measurements of the CTD to size the battery pack.

8) *Deficiencies in monitoring practices of marine protected areas in southern European seas (Sylvaine Giakoumi, Katie Hogg, Manfredi Di Lorenzo, Nicolas Compain, Claudia Scianna, Giacomo Milisenda, Joachim Claudet, Dimitrios Damalas, Pierluigi Carbonara, Francesco Colloca, Athanasios Evangelopoulos, Igor Isajlović, Dimitrios Karampetsis, Alessandro Ligas, Bojan Marčeta, Magda Nenciu, Victor Nita, Marina Panayotova, Rosaria Sabatella, Paolo Sartor, Antonio Di Franco)*

Abstract: Worldwide, states are gazetting new Marine Protected Areas (MPAs) to meet the international commitment of protecting 30% of the seas by 2030. Yet, protection benefits only come into effect when an MPA is implemented with activated regulations and actively managed through continuous monitoring and adaptive management. To assess if actively managed MPAs are the rule or the exception, we used the Mediterranean and Black Seas as a case study, and retrieved information on monitoring activities for 878 designated MPAs in ten European Union (EU) countries. We searched for scientific and grey literature that provides information on the following aspects of MPA assessment and monitoring: ecological (e.g., biomass of commercially exploited fish), social (e.g., perceptions of fishers in an MPA), economic (e.g., revenue of fishers) and governance (e.g., type of governance scheme). We also queried MPA authorities on their past and current monitoring activities using a web-based survey through which we collected 123 responses. Combining the literature review and survey results, we found that approximately 16% of the MPA designations (N = 878) have baseline and/or

monitoring studies. Most monitoring programs evaluated MPAs based solely on biological/ecological variables and fewer included social, economic and/or governance variables, failing to capture and assess the social-ecological dimension of marine conservation. To increase the capacity of MPAs to design and implement effective social-ecological monitoring programs, we recommend strategies revolving around three pillars: funding, collaboration, and technology. Following the actionable recommendations presented herein, MPA authorities and EU Member States could improve the low level of MPA monitoring to more effectively reach the 30% protection target delivering benefits for biodiversity conservation.

- 9) *Factors affecting the variability of discards in Mediterranean bottom trawl fisheries (Konstantinos Tsagarakis, Walter Zupa, Alessandro Ligas, Claudia Musumeci, George Tserpes, Maria Teresa Spedicato)*

Abstract: The current study examined the effect of environmental, operational, temporal and catch-related variables on the discard quantities of four species subject to the EU landing obligation (*Merluccius merluccius*, European hake, HKE; *Parapenaeus longirostris*, deep-water rose shrimp, DPS; *Mullus barbatus*, red mullet, MUT; *Trachurus trachurus*, horse mackerel, HOM) caught in Italian and Greek bottom trawl fisheries. Generalized Additive Models were applied to discards per unit of effort of each species in seven study areas distributed over different subdivisions of the Mediterranean Sea (Western Mediterranean: (i) Ligurian Sea and Northern Tyrrhenian Sea, (ii) Southern and Central Tyrrhenian Sea; Central Mediterranean: (iii) Southern Adriatic Sea, (iv) Western Ionian Sea; Eastern Mediterranean: (v) Eastern Ionian Sea, (vi) Central and South Aegean Sea, (vii) Crete) and were able to explain 21–96% of the deviance. Geographic coordinates and depth were included as significant covariates in the majority of the final models, showing that discards are affected by bathymetric preferences of the species and sizes, local patterns in productivity and/or possible existence of nursery grounds. Discard rates were higher at the shelf break for HKE and DPS, slightly shallower for HOM, while MUT discards occurred mainly in waters <100 m depth. Positive relationships between discards and volume of catches and negative ones between discards and the mean length (especially for HKE) highlighted the effect of the catch characteristics as well as fishers' discarding behaviour. Interannual effects seemed to be related to trends in species abundance and recruitment success, while seasonal patterns were usually linked to the recruitment period and/or seasonal fishing intensity. The length of the vessel, vessel age and haul duration were significant in few cases, but there were no common patterns across all regions/species. Overall, the results showed that discarding in Mediterranean bottom trawl fisheries is affected by a large number of variables that should be taken into account for a more effective mitigation of unwanted catches.

- 10) *Seabed intervention with an underwater legged robot (Giacomo Piccardi, Anna Astolfi, Marcello Calisti)*

Abstract: Efficiently performing intervention tasks underwater is crucial in various commercial and scientific sectors; however, propeller-driven vehicles face limitations due to their floating nature. In Remotely Operated Vehicles (ROVs)

operations, this can be compensated by the ability of the operator, but they come with high operational costs. Instead, Autonomous Underwater Vehicles (AUVs) have shown promise, but demonstrated intervention tasks are limited to controlled environments or docked. To address these limitations, we focused on the use of Underwater Legged Robots (ULRs), which offer greater stability and agile seabed mobility thanks to their legged propulsion system. This paper presents the field demonstration of teleoperated pick-and-place tasks using the ULR SILVER2 for which a novel stance control, Graphic User Interface (GUI), and tendon-driven gripper have been developed based on the lessons learned through several hours of field use. The methodology is validated through four field trials, including missions in both shallow water and open sea environments. The trials involve picking and placing various objects, such as plastic bottles, bags, and cans. The results demonstrate successful teleoperated object grasping and manipulation in real-world conditions, with collection times ranging from a few minutes to around ten minutes. Overall, this research contributes to advancing the capabilities of ULRs and lays the foundation for future underwater intervention missions in various scientific and industrial applications, aligning with the goals of the Decade of Ocean Science for Sustainable Development.

- 11) *New Technologies for Monitoring and Upscaling Marine Ecosystem Restoration in Deep-Sea Environments (Jacopo Aguzzi, Laurenz Thomsen, Sascha Flögel, Nathan J. Robinson, Giacomo Picardi, Damianos Chatzievangelou, Nixon Bahamon, Sergio Stefanni, Jordi Grinyó, Emanuela Fanelli, Cinzia Corinaldesi, Joaquin Del Rio Fernandez, Marcello Calisti, Furu Mienis, Elias Chatzidouros, Corrado Costa, Simona Violino, Michael Tangherlini, Roberto Danovaro)*

Abstract: The United Nations (UN)’s call for a decade of “ecosystem restoration” was prompted by the need to address the extensive impact of anthropogenic activities on natural ecosystems. Marine ecosystem restoration is increasingly necessary due to increasing habitat degradation in deep waters (>200 m depth). At these depths, which are far beyond those accessible by divers, only established and emerging robotic platforms such as remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), landers, and crawlers can operate through manipulators and multiparametric sensor arrays (e.g., optoacoustic imaging, omics, and environmental probes). The use of advanced technologies for deep-sea ecosystem restoration can provide: high-resolution three-dimensional (3D) imaging and acoustic mapping of substrates and key taxa, physical manipulation of substrates and key taxa, real-time supervision of remote operations and long-term ecological monitoring, and the potential to work autonomously. Here, we describe how robotic platforms with in situ manipulation capabilities and payloads of innovative sensors could autonomously conduct active restoration and monitoring across large spatial scales. We expect that these devices will be particularly useful in deep-sea habitats, such as reef-building cold-water corals, soft-bottom bamboo corals, and soft-bottom fishery resources that have already been damaged by offshore industries (i.e., fishing and oil/gas).

- 12) *A New Approach towards a User-Driven Coastal Climate Service to Enhance Climate Resilience in European Cities* (Roberta Paranunzio, Iulia Anton, Elisa Adirosi, Tasneem Ahmed, Luca Baldini, Carlo Brandini, Filippo Giannetti, Cécil Meulenberg, Alberto Ortolani, Francesco Pilla, Gregorio Iglesias, Salem Gharb)

Abstract: Coastal climate services play a crucial role in developing customised climate information for diverse end-users and stakeholders. To build climate-resilient societies, decision-makers should be empowered through easy access to powerful tools that enable timely adaptation to future and ongoing hazards. For this reason, fit-for-purpose climate services are needed to conduct accurate historical characterisation and projections for interpretative studies on climate- and water-related risks at the local coastal scale. The EU-funded SCORE project (Smart Control of Climate Resilience in European Coastal Cities) utilises climate and marine services for the development of smart technologies that support nature-based solutions to address specific concerns, including rising sea levels, coastal erosion, and coastal flooding due to extreme weather events. As part of the SCORE project, decision-makers will be able to address climate change-related coastal effects in their own cities through novel participatory approaches (Coastal City Living Labs—CCLLs). As part of this framework, this work (i) discusses the main requirements for the identification of fit-for-purpose coastal climate services for local-scale impact studies in European coastal cities based on CCLL requests and prior knowledge and (ii) provides relevant parameters and features that fulfil the users' needs.

- 13) *Evaluation of the exposure of the Mediterranean biodiversity to marine litter: the ASI – plastic busters MPAs projects connection* (Massimo Perna, Carlo Brandini, Michele Bondoni, Chiara Lapucci, Francois Galgani, Simone Panigada, Ana Canadas, Cristina Panti, Maria Cristina Fossi)

Abstract: A number of marine species in the Mediterranean are threatened by the presence of several pressure factors, which include climate change, collisions with vessels, entanglement and ingestion of marine litter, especially plastic. Risk reduction policies can only be conceived starting from an accurate analysis of the exposure to such pressure factors. To estimate spatial abundance of both marine species and plastic litter and to assess the exposure risk, a two-stage analysis approach was applied, using aerial survey data from the ACCOBAMS Survey Initiative (ASI), in synergy with the Plastic Busters MPAs (PB MPAs) project. First, a detection function was fitted to observation data to obtain detection probabilities for individuals, then a Generalized Additive Model (GAM) was employed to estimate the spatial distribution of relative abundance, based on survey observations. A bivariate Local Indicator of Spatial Association (LISA) was then applied to the maps of relative abundance to derive risk maps of exposure of marine species to marine litter. The maps, obtained with a spatial resolution of about 10 km, allow us to identify areas with the highest neighboring abundance of taxa and marine litter, in particular for the MPAs studied by the PB MPAs project, which include the North-Western Mediterranean (Pelagos Sanctuary and Tuscan Archipelago), the Ionian and Aegean Sea (Zakynthos), and the Strait of Sicily (Cabrera Archipelago).