Book of abstracts

XXXIII Congresso S.It.E.

Roma 23-26 settembre 2024

S.It.E. - Società Italiana di Ecologia

Misurare e prevedere il cambiamento per una gestione sostenibile degli ecosistemi

congresso.ecologia.it

Comitato organizzatore:

Maria Letizia Costantini, Edoardo Calizza, Giulio Careddu, Edoardo Casoli, Anna Fano, Fausto Manes, Valentina Mastrantonio, Daniele Porretta, Loreto Rossi, Simona Sporta Caputi, Daniele Ventura, Marcello Vitale

Comitato scientifico:

Antonio Pusceddu (Presidente), Flora Angela Rutigliano (Vice-Presidente), Elisa Anna Fano (Presidente uscente), Andrea Binelli, Edoardo Calizza, Pier Paolo Franzese, Danilo Russo, Gianluca Sarà, Salvatrice Vizzini,
Maria Cristina Mangano (Segretario Amministrativo)

Segreteria Organizzativa

symposia®

XXXIII Congresso S.It.E.

Roma 23-26 settembre 2024

Misurare e prevedere il cambiamento per una gestione sostenibile degli ecosistemi

S.It.E. - Società Italiana di Ecologia

Book of abstracts

XXXIII Congresso della Società Italiana di Ecologia – Roma
"Misurare e prevedere il cambiamento per una gestione sostenibile degli ecosistemi"

Pubblicato da:

Società Italiana di Ecologia

Editato da
Symposia S.r.l. S.U.

Logo del convegno a cura del Comitato Organizzatore, prodotto da Federico Palumbo e Alessandra Spanò

Grafica della copertina: Symposia S.r.l. S.U.

Grafiche di introduzione alle sessioni tematiche generate tramite intelligenza artificiale, a cura di Edoardo Calizza

Anno di pubblicazione: 2024

Misurare e prevedere il cambiamento per una gestione sostenibile degli ecosistemi

S.It.E. - Società Italiana di Ecologia

Indice

Effetti del disturbo su specie, habitat ed ecosistemi

Chairs

Massimiliano Scalici, Anna Barra Caracciolo, Daniele Ventura, Arnold Rakaj

Presentazioni Orali

Effects of small scale fishery on fish communities of the mpa "Parco Sommerso di Gaiola".

Luca Appolloni[1,2], Domenico Ciorciaro[2,3], Alberto Pagliarani[1], Adele Cocozza di Montanara[1,2], Gianmarco Di Pace[4], Maurizio Simeone[4], Giovanni Russo[1,2]

[1]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa); [2]Università degli studi di Napoli Parthenope; [3]Istituto di studi su impatti antropici e sostenibilità ambientale in ambiente marino (IAS), Consiglio Nazionale delle Ricerche (CNR); [4]Area Marina Protetta Parco Sommerso di Gaiola; luca.appolloni@uniparthenope.it

Marine Protected Areas (MPAs) effectiveness can be measured as capacity to conserve and, at meantime, provide natural resources to local populations. The effects of the disturbance produced by Small Scale Fishery (SSF) on fish community of MPA "Parco Sommerso di Gaiola" (Gulf of Naples, South Tyrrhenian Sea) were investigated.

The fishing grounds were divided in three areas: inside or close the MPA, at the West and at the East outside the MPA. In each area, population structures of species from SSF catches and from visual census surveys were compared. Statistical analyses were carried out on percentages of small, medium and large individuals to test for differences in population structures among areas; in addition, "capturability" analyses (sensu: Hawkins et al. 2007) was estimated for each species to assess the susceptibility of a species to be caught.

SSF catches were characterized by the dominance of medium and large individuals, while a meaningful part of small individuals, mainly outside the MPA, characterized visual census surveys. Statistical analyses showed that population structures from SSF catches were not different in the three areas, while significant differences were detected among visual census surveys. "Capturability" analyses show that conger, sea bass, breams, mullets and amberjack are the commercial species more likely to be caught.

Results suggest how SSF activities affect fish community structures. The exploitation of the commercial fishes, mainly selecting medium and large specimens, determines differences among population structures. In fact, from visual census observations it was evident that big sized specimens of commercial species were present inside the MPA and almost absent outside. These observations lead to conclude that MPA "Parco Sommerso di Gaiola" is effective in conserving well-structured fish populations despite its location in a strongly anthropized area.

Anthropogenic constraints on vegetation seasonal dynamics in urban ecosystems

Vincenzo Baldi[1,2], Alessandro Bellino[1], Mattia Napoletano[1], Daniela Baldantoni[1,2]

[1]Dipartimento di Chimica e Biologia "Adolfo Zambelli", Università degli Studi di Salerno, Fisciano (SA), 84084, Italia; [2]National Biodiversity Future Center (NBFC), 90133, Palermo, Italia; vbaldi@unisa.it

The present study, carried out within the framework of the project code CN_00000033, Concession Decree No. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, CUP, H43C22000530001377 Project title “National Biodiversity Future Center - NBFC”, aims to evaluate the anthropogenic constraints on the seasonal dynamics of vegetation biodiversity in urban ecosystems. The adopted approach focused on analysing, using seasonal phytosociological relevées from October 2023 to July 2024, the structural and functional diversity of the herbaceous communities colonizing two urban areas in southern Italy, subjected to different levels of management but similar climate. Taxa were identified at the species level, estimating their abundance through measures of number of individuals, dry mass and Braun-Blanquet cover, while Raunkiaer biological forms, chorology and Ellenberg indices were adopted to evaluate vegetation functional diversity.

Results show clear seasonal dynamics in vegetation composition and structure where subjected only to occasional mowing, with dominance-diversity relationships cycling through pre-emption models in winter to lognormal distributions in spring and autumn, passing through Mandelbrot models in summer. This sequence highlights the seasonal evolution of constraints due to endogenous processes (e.g. competition) and external pressures (e.g. summer drought), and is coherent with clear shifts in community composition. Where regular mowing, irrigation and fertilization occur, the seasonal signature on vegetation dynamics fades and the dominance-diversity community structure follows similar pre-emption models throughout the year, with limited variations in species richness and evenness. The relative seasonal variations in different diversity indices between the study areas further support the effects of anthropogenic constraints on vegetation seasonal dynamics.

Findings shed light on the temporal evolution of vegetation communities in complex urban ecosystems, with clear interpretations in terms of diverse anthropogenic constraints.

Exploring distribution and connectivity patterns of the dusky grouper Epinephelus marginatus in Sicilian coastal waters

Silvia Maria Bellù[1], Antonio Di Franco[2], Ilenia Epifani[3], Antonio Calò[4], Manfredi Di Lorenzo[2], Sylvaine Giakoumi[2], Giacomo Milisenda[2], Carlo Cattano[2], Marco Milazzo[4], Giulio Franzitta[2], Paco Melià[1]

[1]Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Via Ponzio 34/5, 20133 Milano, Italia; [2]Dipartimento di Ecologia Marina Integrata, Sicily Marine Centre, Stazione Zoologica Anton Dohrn, Lungomare Cristoforo Colombo, 90149 Palermo, Italia; [3]Dipartimento di Matematica, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milano, Italia; [4]Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Via Archirafi 20, 90123 Palermo, Italia; silviamaria.bellu@polimi.it

Connectivity within networks of marine protected areas (MPAs) is key to support the resilience of fish communities in the long run and scale up the benefits provided by single MPAs. Therefore, connectivity assessments are crucial for designing effective conservation strategies for fish populations. In the context of the Italian national research project “Reconnect”, we analyse connectivity among existing and candidate MPAs in Sicilian coastal waters using the dusky grouper *Epinephelus marginatus* as a model species, in view of (i) its key ecological role in Mediterranean rocky reef ecosystems, (ii) its vulnerability to intensive fishing and (iii) the concurrent knowledge gap on its population structure and dispersal features. We study connectivity using an individual-based bio-physical model and simulate larval dispersal with a Lagrangian approach. Species distribution models – providing predicted biomass of *E. marginatus* in space – are used as initial conditions of the simulations and are generated based on field data gathered either via underwater visual censuses (UVCs) or baited underwater videos (BUVs), depending on bathymetric conditions. To harmonise the data from these two census methodologies, their statistical relationship was explored on a pre-existing dataset by fitting various statistical regression models (*e.g.,* generalised linear models, two-parts models). This analytical framework allows for the elaboration of a set of connectivity metrics to (i) assess the performance of the existing MPAs network in the study area and (ii) identify potential connectivity hotspots where to funnel future conservation effort and reduce anthropogenic disturbance, ultimately contributing to science-informed MPAs spatial planning.

Impact of microplastics on aquatic species: a functional trait-based meta-analysis

Manuel Berlino[1,3], Gianluca Sarà[2,3], Maria Cristina Mangano[1,3]

[1]Stazione Zoologica Anton Dohrn, Department of Integrative Marine Ecology (EMI), Sicily Marine Centre, Lungomare Cristoforo Colombo (complesso Roosevelt), 90149, Palermo, Italy; [2]Dipartimento di Scienze della Terra e del Mare, DiSTeM, Università degli Studi di Palermo Ed. 16, 90128, Palermo, Italy; [3]NBFC, National Biodiversity Future Center, Palermo Viale delle Scienze Ed. 16, 90128, Palermo, Italy; manuel.berlino@szn.it

Microplastics represent a significant and pervasive threat to aquatic organisms. Due to the various ways microplastics can enter aquatic ecosystems, researchers focused on studying their ingestion and impact on aquatic organisms. However, there is a significant lack of research into how microplastics influence ecological responses across various levels of the ecological hierarchy, accompanied by considerable fragmentation of data in the existing literature. Functional traits, having indirect effects on individual fitness represent the main door through which anthropogenic disturbance can impact community structure, composition and ultimately aquatic ecosystems. This meta-analysis synthesizes data from 82 scientific papers encompassing studies on both benthic organisms and fish. The findings reveal that microplastics significantly impair functional traits across different habitats, life stages and trophic levels. Specifically, microplastics affect metabolism, growth and reproduction in benthic organisms, while significantly altering behavior in fish. These disruptions in functional traits may have cascading effects on energy transfer and trophic interactions within ecosystems. The study also highlights the critical role of experimental design (e.g. microplastic size, shape, type) in influencing observed outcomes. Integrating trait-based indicators with standardized protocols for analysing the impact of microplastics on aquatic organisms and ecosystems could represent a crucial step. This integration could provide guidelines for policymakers to develop adequate management and mitigation plans aimed at safeguarding ecosystems and the valuable goods and services they provide.

Eradication of brown trout from a karstic stream in Northestern Italy: effects on crayfish and Italian minnow populations

Marco Bertoli[1], Davide Lesa[2], Elena Bandi[3], Marino Prearo[4], Paolo Pastorino[4], Elisabetta Pizzul[1]

[1]Department of Life Sciences, University of Trieste, Via L. Giorgieri 10, 34127, Trieste, Italy; [2]Regional Authorithy for the Safeguard of Fish Resources, Via Colugna 3, 33100 Udine, Italy; [3]Natural Regional Reserve of the Rosandra-Glinščica Valley, Dolina 270, 34018 San Dorligo della Valle, Trieste, Italy; [4]The Veterinary Medical Research Institute for Piemonte, Liguria and Valle D'Aosta, Via Bologna 148, 10154, Torino, Italy; marbertoli@units.it

Brown trout *Salmo trutta* is listed among the 100 World's Worst Invasive alien species and one of the world's top 30 worst aquatic invasive organisms. Due to its adaptation capacity, brown trout can colonize different environments, even those which significantly differ from its typical habitat, negatively impacting native populations (fishes, crustaceans, amphibians) and ecosystems through predation and competition (both for habitats and trophic resources), but also as vector of exotic parasites. However, the brown trout was widely introduced, due to its importance as a major target species for recreational fishing. Due to these reasons, extirpation activities have been performed in many countries, using different methods to face brown trout impacts. In the present work, we analyzed the effects of a seven-years long eradication project (2018 - 2024) in a karstic stream placed in Northeastern Italy (Friuli Venezia Giulia Region): the Rosandra Stream is the only surficial watercourse in the Italian portion of the classic Karst, flowing within the Natural Regional Reserve of the Rosandra-Glinščica Valley. The eradication project, funded by the Reserve Authority, allowed to collect 948 brown trout specimens through the years mainly collected via electrofishing sampling campaigns, implementing the use of fishing rods for specific situations, in collaborations with the Regional Authorithy for the Safeguard of Fish Resources. After few years, the eradication project showed positive effects on native *Austropotamobius pallipes* and *Phoxinus lumaireul* populations, which showed a significant increase in their abundances since the beginning of the eradication campaigns. These effects are particularly evident for freshwater crayfish populations, and obtained data are of pivotal importance in a conservation perspective, as *A. pallipes* is listed as an endangered species in the IUCN Redlist and is reported in the Annexes II and V of the Habitat Directive 92/43/EEC.

Trait-based vulnerability index: assessing the impact of climate-driven predation on the Mediterranean coral Astroides calycularis

Mar Bosch-Belmar[1,2], Mario Francesco Tantillo[1], Gianluca Sarà[1,2]

[1]Laboratory of Ecology, Department of Earth and Marine Science (DiSTeM), University of Palermo, Palermo, Italy.; [2]NBFC, National Biodiversity Future Center, Palermo, Italy.; mariadelmar.boschbelmar@unipa.it

Biotic interactions are crucial processes that shape ecosystem structure and functioning. Climate change significantly alters the nature and strength of species interactions by influencing species responses, tolerance thresholds, and distributions, thereby defining "winners" and "losers" under changing environmental conditions. Here, we outline the trend of a recently intensified interaction between an endemic Mediterranean structuring species (the coral *Astroides calycularis*) and a range-expanding predator (the fireworm *Hermodice carunculata*) under warming conditions. The thermal performance curves of both species were experimentally defined, identifying their thermal optimum temperatures and tolerance thresholds. Additionally, the feeding response of the polychaete on the coral was studied and modeled. Trait-based maps showed that current warm temperatures and forecasted climatic conditions pose a significant risk to the shallow coral, with environmental temperatures exceeding its upper thermal threshold; while benefiting the fireworm by enhancing its spread and maximizing its metabolic and feeding performance at high temperatures. The interacting species' responses to temperature and the feeding performance of the predator were integrated to create a vulnerability index to predict the risk to which the habitat-forming species may be exposed. Investigated interacting stressors may synergistically jeopardize the integrity of this biodiversity hotspot habitat, reducing its complexity and leading to biodiversity loss.

A synergistic approach for evaluating freshwater ecosystem health and ecosystem services

Isabella Calattini[1,2], Tommaso Campani[1], Federico Pulselli[1], Dario Giani[1], Maria Cristina Fossi[1], Pietro Centorrino[2], Tiberio Fiaschi[3], Claudia Angiolini[3], Luisa Patrolecco[4], Paola Grenni[5], Silvia Casini[1]

[1]Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, Università di Siena, Italia; [2]Associazione LaGorà, Colle di Val d'Elsa (SI), Italia; [3]Dipartimento di Scienze della Vita, Università di Siena, Italia; [4]Istituto di Scienze Polari, Consiglio Nazionale delle Ricerche (ISP-CNR), Montelibretti, Roma, Italia; [5]Istituto di Ricerca sulle Acque, Consiglio Nazionale delle Ricerche (IRSA-CNR), Montelibretti, Roma, Italia; isabella.calattini@student.unisi.it

Human activities have increased pressures on rivers, causing a decline in freshwater quality and making them among the most threatened ecosystems worldwide, mainly due to climate change and mismanagement of land and water resources. For these reasons, this study aimed to propose an integrated monitoring methodology based on a holistic approach. The river health status will be assessed through the chemical-physical analyses of the environmental matrices, the study of the toxicological effects on organisms and four ecological indices. The ecosystem services (ES) provided by the river in different stretches will also be defined, with the aim of seeing how they influence, or are influenced by, the state of health of the river. The Elsa River, a tributary of the Arno River in Tuscany (Italy), was chosen as a case study because of the presence of a river park, agricultural and industrial activities and towns. Some chemical parameters of the water were tested with a citizen science project. Ecological indices based on benthic macroinvertebrates (STAR-ICMi), macrophytes (IBMR), diatoms (ICMi) and river functionality (FFI) were measured. *Squalius squalus* was used as a fish bioindicator for ecotoxicological analyses, including biomarkers, contaminant concentration and microplastic ingestion. Microplastics were analysed in water, pharmaceutical residues were measured in water, sediments and organisms, and microbiological characterisations of water and sediments was done. The ES will be evaluated in different sections. Preliminary results show a negative trend from upstream to downstream from a chemical and ecological point of view. The ecotoxicological analyses on fish underline the presence of neurotoxicity and genotoxicity effects in downstream sites. This holistic approach provides a comprehensive view of the state of health of the river. Comparing it with the ES provided by the river in its different sections will allow us to develop different management scenarios and identify the most sustainable one.

Investigating the toxicological effects of an oil spill off the Cap Corse (France) on Puffinus yelkouan

Ilaria Caliani[1], Carlo Amico[1], Laura Giovanetti[1], Silvia Casini[1], Antonella D'Agostino[1], Francesca Giannini[2], Giovanna Spano[3], Nicola Baccetti[4], Letizia Marsili[1]

[1]Università di Siena, Italia; [2]Parco Nazionale Arcipelago Toscano; [3]Tavolara A.M.P, Punta Coda Cavallo; [4]ISPRA-Istituto Superiore per la Ricerca e la Protezione Ambientale; caliani4@unisi.it

On October 7th 2018, approximately 15 miles north of Capo Corso (Corsica), a major oil spill occurred as a result of the collision of a Tunisian ferry with a stationary cargo ship and six hundred cubic meters of oil were dispersed into the sea. At that time, part of the *Puffinus yelkouan* population had already returned to breeding areas comprising a large fraction of the global population. We evaluated the potential toxicological effects of oil spill contamination in yelkouan shearwater individuals from Italian breeding areas after the oil spill accident. Different nesting areas were sampled in the breeding season: Montecristo was close to the oil spill area, Tavolara and Molara islands host over the 50% of the global population and Capo Carbonara MPA (Villasimius, southern Sardinia) was chosen as a control area, being far from the oil spill area. Polycyclic aromatic hydrocarbons (PAHs) accumulation, genotoxic and immune system markers were assessed in blood samples collected from 33 breeding adults. In addition, porphyrin levels were measured in feacal samples. Similar and quite high levels of low molecular weight hydrocarbons (naphthalene, acenaphthene, fluorene, and phenanthrene) were found in the three areas. We didn't find immune system alterations, while individuals from Tavolara island showed the highest nuclear abnormalities values, both Tavolara and Villasimius specimens showed statistically significant higher ENA values with respect to Montecristo. These results could indicate that the presence of genotoxic effects is not linked to the collision but caused by other sources of contamination. Furthermore, the highest porphyrin levels were found in specimens from Villasimius area. This study underlines the importance of ecotoxicological studies on endangered seabirds to be able to plan management measures for the conservation of the species.

Changes and temporal trends of demersal communities in the North-Western Ionian Sea

Angela Carluccio[1,2], Francesca Capezzuto[1,2], Giovanni Chimienti[1,2], Porzia Maiorano[1,2], Letizia Sion[1,2], Gianfranco D'Onghia[1,2]

[1]Università degli Studi di Bari Aldo Moro, Italia; [2]CoNISMa; angela.carluccio@uniba.it

Mediterranean marine biodiversity is impacted by several anthropogenic threats such as overfishing, pollution, habitat loss and degradation, non-indigenous species and climate change. Human impacts on marine ecosystems are expected to increase in the future, especially those related to climate change and its synergistic effects with other threats. In fact, the combination of increase of the water temperature and fishing pressures can lead to shifts in the size, spatial range and abundance of marine species. In this fast-changing scenario, assessing the distribution and abundance of species allows detect temporal trends in biodiversity and ecosystem structure. In the North-Western Ionian Sea, standardized data on the demersal species assemblages are collected in the framework of the MEDITS EU program since 1994. The temporal trends of distribution and abundance over a period of 29 years (1994–2023) were analysed. Cephalopods, chondrichthyes and osteichthyes showed an overall increase in the abundance, most probably due to the reduction of fishing effort. Significant increases in abundances of *Aristaeomorpha foliacea, Parapenaeus longirostris* and *Mullus barbatus* have been observed, probably due both to the reduction in fishing effort and the increase in the water temperature since they are known as thermophilic species. The increase in the bottom water temperature can also explain the significant decrease in abundance of *Nephrops norvegicus* and the shifting of the *Galeus melastomus* population towards deeper and colder waters. The significant increase in biomass observed for *Scyliorhinus canicula* could be explained by the presence of different refuge areas, both natural, such as canyons and irregular seabed where trawling cannot be carried out, and related to conservation initiatives, such as marine protected areas. Finally, the number of non-indigenous species increased significantly in the study area during the investigated period, but the effects on the biodiversity of faunal assemblages are not yet known.

A new multi-faceted approach to assess the sustainability of recreational diving activities and support management strategies for the sustainable use of marine resources

Letizia Ottone, Edoardo Casoli
Sapienza Università di Roma, Italia; ottone.1851296@studenti.uniroma1.it

Marine Protected Areas (MPAs) are crucial tool for conserving biodiversity and ensuring the sustainable use of marine resources. It is well known that MPAs host most of diving destinations due to their rich biodiversity and an increasing number of studies show that diving activities can have damaging effects on marine life, especially on sessile benthic organisms.

The present study aimed to evaluate the pressure of recreational diving activities within the MPA "Secche di Tor Paterno" through a multi-faceted approach. The first component of the study focused on analyzing the abundance and behaviour of the divers. This step allowed for the identification of the factors that most influenced the frequency of disturbance, *i.e.* diver contacts with the benthic organisms in the MPA. Additionally, the data collected during dives enabled the identification of seabed points most subject to physical disturbance through small-scale spatial analysis. Finally, the activities allowed for a detailed analysis of the potential impacts of scuba diving tourism on the composition and structure of the benthic communities in the MPA, using bioindicators recognized as sensitive to such disturbances.

Results indicated diving experience and use of camera as the most significant factors that influenced the impact on the benthos. Indeed, hotspots frequently disturbed by diving activities coincided with areas attractive to underwater photographers. Despite various contacts with the benthos, no significant changes in bioindicator species diversity were observed due to diving activities. Instead, depth appeared to explain variations in benthic community diversity among dive sites.

This study suggests that scuba diving activities in the MPA “Secche di Tor Paterno” do not significantly alter the benthic community structure, highlighting the sustainability of the diving tourism in the area. Furthrmore, it provides further indication to increase the effectiveness of the MPA management.

Microplastics and stableisotopes: assessing ingestion and biomagnification in invasive species within coastal wetland ecosystems

Cristina Coccia[1,2], Cristina Andolina[2,3], Salvatrice Vizzini[3,4,5], Luca Gallitelli[1], Federica Spani[6], Davide Taurozzi[1], Alessandra Cera[7], Armida Sodo[1], Michael Di Gioacchino[1], Andy Green[8], Massimiliano Scalici[1,2]

[1]Department of Sciences, University of Rome Tre, Viale Guglielmo Marconi 446, 00146 Rome, Italy; [2]2National Biodiversity Future Center (NBFC), Università di Palermo, Piazza Marina 61, 90133 Palermo, Italy; [3]Department of Earth and Marine Sciences (DiSTeM), University of Palermo, Via Archirafi 18, 90123 Palermo, Italy; [4]Centro di Sostenibilità e Transizione Ecologica (CSTE), Università degli Studi di Palermo, Piazza Marina 61, 90133 Palermo, Italy; [5]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Piazzale Flaminio 9, 00196 Rome, Italy; [6]Department of Science and technology for Sustainable Development and One Health, University Campo Bio Medico, Rome; [7]Institute of Freshwater Biology, Nagano University, 1088 Komaki, Ueda, Nagano 386-0031, Japan; [8]Department of Conservation Biology and Global Change, Estación Biológica de Doñana (EBD), CSIC, C/ Américo Vespucio 26, 41092 Sevilla, Spain; cristina.coccia@uniroma3.it

Coastal wetlands are socio-ecological systems of immense value, supporting high biodiversity and a wide range of human activities, including aquaculture, agriculture, fisheries, and tourism. Despite their importance, coastal wetlands face various anthropogenic pressures. Among these, invasive species pose a leading threat to biodiversity in these environments, representing a significant portion of their biota in many areas. Additionally, plastic contamination has emerged as a pervasive problem in these systems in recent years, further altering their biota and ecosystem functioning.

The red swamp crayfish (*Procambarus clarkii*) and the eastern mosquitofish (*Gambusia holbrooki*), originally from North America, are now distributed in temperate aquatic environment worldwide. Both species are generalist feeders and often coexist, utilizing different habitats—benthic for crayfish and pelagic for mosquitofish. Several studies have shown microplastic (MP) uptake in these species. Since *Procambarus* and *Gambusia* are significant prey for terrestrial and aquatic organisms, they can serve as potential vectors for transporting contaminants between land and water environments.

Stable isotopes of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) have been widely used to assess trophic relationships, determining long-term assimilation of food by consumers, and identifying nutritional deficiencies in predators. They have proven effective in detecting biomagnification processes, and recently, these isotopes have also been applied in MP studies.

In this study, we utilized stable isotope analysis alongside microplastic (MP) examination to assess MP contamination levels and estimate the trophic position of two co-invading invasive species, *Procambarus clarkii* and *Gambusia holbrooki*, across different zones within the Torre Flavia wetland in the Lazio region. Additionally, we investigated variations in carbon (C) and nitrogen (N) in relation to MP accumulation and explored potential biomagnification processes.

Assessment of the decline of Fucus virsoides: a habitat-forming macroalga on the brink of extinction

Emmanuelle Descourvières[1,2], Vinko Bandelj[2,3], Damiano Baldan[2], Cosimo Solidoro[2,3], Annalisa Falace[1,2]

[1]Department Life Sciences, University of Trieste, Trieste, Italy; [2]National Institute of Oceanography and Applied Geophysics - OGS, Trieste, Italy; [3]National Biodiversity Future Center - NBFC, Palermo, Italy; emmanuelle.descourvieres@phd.units.it

On temperate and cold rocky coast, intertidal canopy-forming *Fucus* species (Fucales, Phaeophyceae) structure complex habitats providing numerous essential ecosystem services. *Fucus virsoides* is a glacial relict endemic to the Adriatic and the only representative of the genus in the Mediterranean. In the past, it was considered widespread from northwestern Italy to southern Albania, but in recent decades its populations have declined drastically. In this study, we examine the long-term changes in *F. virsoides* and analyse the likely factors that have led to its decline.

To reconstruct the historical distribution of *F. virsoides* throughout its geographic range, historical records since the 19th century were collected and compared with the current distribution thanks to a cross-border collaboration. Mapping the patterns of change in its occurrence revealed a continuous decline that has left about twenty fragmented populations. We then investigated the connection between the occurrence of the species and both environmental and anthropogenic stress factors. Time series of potential marine and atmospheric factors affecting the spatio-temporal distribution of the species as well as land cover products were collected and analysed.

This study provides a comprehensive assessment of the status of *F. virsoides* and the factors leading to its decline, highlighting the importance of implementing immediate conservation measures to prevent the extinction of the species.

Applying a quantitative mechanistic framework to depict the trawling effects on benthic status

Gabriele Di Bona[1], Jan Geert Hiddink[2], Marina Penna[3], Marina Pulcini[3], Sasa Raicevich[3], Nunziacarla Spanò[4], Gianluca Sarà[1,5], Maria Cristina Mangano[5,6]

[1]Laboratory of Ecology, Department of Earth and Marine Science (DiSTeM), University of Palermo, Palermo, Italy; [2]School of Ocean Sciences, Bangor University, Anglesey LL59 5AB, United Kingdom; [3]ISPRA, Italian Institute for Environmental Protection and Research, Rome, Italy; [4]Department of Animal Biology and Marine Ecology, University of Messina, Salita Sperone 31, 98166 Messina, Italy; [5]NBFC, National Biodiversity Future Center, Piazza Marina 61, 90133 Palermo, Italy; [6]Stazione Zoologica Anton Dohrn, Dipartimento Ecologia Marina Integrata, Sicily Marine Center, Lungomare Cristoforo Colombo (complesso Roosevelt), 90142 Palermo, Italy; gabriele.di.bona16@gmail.com

The Marine Strategy Framework Directive aims to protect EU marine waters by achieving good environmental status. Descriptor 6 focuses on seafloor integrity, threatened by activities like bottom trawling. Bottom trawling disturbs the seafloor, alters marine diversity, and impacts habitat functions. This study assesses the impact of trawling on the benthic community of the Sicilian continental shelf, examining its longevity composition while considering the spatial scale, historical pattern, and intensity of trawling. Impact was assessed using three indicators, providing a continuous pressure-response curve at a 1 km² resolution: L1 - proportion of the community with life spans exceeding trawling intervals;, L2, median longevity decrease; and population dynamics PD - relative biomass decrease to carrying capacity. Fishing intensity data were used with varying temporal and spatial resolutions to identify optimal modelling conditions for accuracy. Median longevity, influenced by depth and fishing intensity, remains 8-9 years across models. Selected models suggest that in middle-outer shelf areas, increased fishing intensity shifts the community towards species with shorter lifespans, while in shallower areas, the opposite occurs. The L1 approach shows low spatial variation due to high SAR values and high median longevity but still indicates notable impact. The L2 approach reveals a 20% decrease in median longevity on the eastern Adventure Bank and south of Capo Passero, critical trawling areas. The PD approach is the clearest, detecting impact hotspots corresponding to trawling intensity peaks. In these critical areas, the PD method indicates that the benthic community is diminished by nearly 100% of its relative carrying capacity, highlighting significant impact. The findings of this study provide a method to map these impacts and assist policymakers in identifying sensitive areas and managing spatial planning effectively. The significant negative impacts near the eastern Adventure Bank and northwestern Malta Bank, crucial nursery grounds for commercial species, are particularly emphasized.

Investigating population dynamics and ecotoxicological effects in two apiaries under different levels of human-induced stress

Agata Di Noi[1,2], Ilaria Caliani[2], Niccolò Franci[2], Laura Giovanetti[2], Silvia Casini[2], Tommaso Campani[2]

[1]Università di Siena, Italia - Santa Chiara Lab, via Valdimontone 1, 53100, Siena; [2]Università di Siena, Italia - Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, via Mattioli 4, 53100, Siena; agata.dinoi2@unisi.it

The health of bees and other pollinating insects is increasingly threatened by human activities, which include factors like climate change, habitat destruction, parasitic infections, diseases, and notably, environmental pollution and pesticide use in agriculture. Population dynamics, the presence of *Varroa destructor* mites, and ecotoxicological impacts were examined in two apiaries subjected to varying levels of anthropogenic pressure. Biomarkers of neurotoxicity (acetylcholinesterase (AChE) and carboxylesterase (CaE)), metabolism (alkaline phosphatase (ALP)), biotransformation (glutathione S-transferase (GST)), and immune system (lysozyme (LYS), phenoloxidase (POx), and prophenoloxidase (proPOx)) were analyzed in different worker sub-castes of *Apis mellifera*. Specifically, we assessed biomarker responses based on sub-caste (newly formed, adult builders, and foragers), season (spring, summer, and autumn), and potential sources of contamination. The findings revealed a physiological oscillatory pattern in population dynamics and varroa levels, attributed to control treatments for parasitosis. Enzymatic activity values varied among worker sub-castes across the three seasons, with AChE activity being lower in newly formed bees and builders compared to foragers, while GST activity was higher in newly formed bees. The application of synthetic pesticides against varroa likely resulted in toxicological effects on bees treated for parasitosis. This study enhanced our understanding of the physiological activities of the investigated enzymes in different castes, providing deeper insight into the sub-lethal effects of pesticides and environmental contaminants, and how climate change and other stressors influence the population dynamics of these insects.

Soil microbial community and multifunctionality in natural and managed terrestrial ecosystems

Alessia Esposito, Enrica Picariello, Veronica Vitagliano, Flavia De Nicola

Dipartimento di Scienze e Tecnologie, Università del Sannio, via de Sanctis, 82100 Benevento, Italia;
a.esposito37@studenti.unisannio.it

Soils simultaneously perform multiple ecological functions. Disturbances related to land use can lead to a decrease in biodiversity of soil microbiome and, consequently, due to its crucial role in regulating nutrient stocks and transformations, a depletion of soil ecological functions. The current study aims to assess the effects of different land uses on functions performed by soil microbial community in order to define good drivers of multifunctionality. In the Matese National Park, adjacent areas under different land uses (forest F, meadow M and, pasture P) were selected, and the soils sampled at three times (June T1, July T2 and, December 2023 T3) relating to specific management practices in M and P areas: sowing (T1), harvest (T2) and, five months after harvest (T3) in M; at the beginning (T1), after one month of grazing (T2) and, after the end of the grazing (T3) in P. Water content, pH, organic matter content, labile, recalcitrant and stable organic carbon fraction and enzymatic activities (hydrolase - FDA, β-glucosidase - BG, phosphatase - PHOS, β-glucosaminidase - NAG, arylsulfatase - ARS, laccase - ABTS) were used for the calculation of ecological indices: metabolic activity index (MAI) and soil multifunctionality index (SMF). The enzymatic activities showed, on average, the highest values in F (except for BG and PHOS), although with seasonal variations. In P almost all enzymatic activities increased in T3. In M, ARS and PHOS increased over time , while BG and FDA after a decreased in T2 reached again the initial values in T3. The high MAI values found in P and M highlighted the sustainability of the management practices implemented. In P the grazing affected SMF index, being SMF value higher after the end of grazing period (T3).

Spatiotemporal variations in deer population density drive browsing impact on Mediterranean forest vegetation

Niccolò Fattorini[1,2], Gianmaria Bonari[1,2], Giovanni Fini[1,2], Claudia Angiolini[1,2], Francesco Ferretti[1,2]

[1]Università degli Studi di Siena, Italia; [2]National Biodiversity Future Center, Palermo; niccolo.fattorini@unisi.it

Herbivory shapes the structure and functioning of forest ecosystems worldwide. However, little is known about its potential environmental drivers such as water availability and multi-scale effects of herbivore population density in Mediterranean forests, where water availability is becoming scarcer and further predicted to drop over the next decades. During 4 years (2019-2023), we investigated the factors affecting browsing pressure by wild deer (roe deer *Capreolus capreolus* and fallow deer *Dama dama*) on the woody vegetation belonging to the Natura 2000 EU Habitat 9340 '*Quercus ilex* and *Q. rotundifolia* forests', within a Mediterranean protected area (central Italy). Browsing impact increased with increasing fallow deer densities at multiple scales, but was not affected by roe deer densities. This occurred at the whole habitat patch scale and separately for both the most dominant typical species/genera of Habitat 9340 in our study area (*Quercus ilex*; *Phillyrea* spp.). Greater population density, larger body size, more generalist diet, and higher gregariousness likely underpin the major impact of fallow deer. During our study, the ~25% decline in fallow deer density matched the increased numbers of wolves, whose diet included fallow deer (~25%). This result may support consumptive effects of predation leading to the top-down control of deer impact on vegetation. Herbaceous cover in forest patches diluted browsing pressure, indicating how the availability of alternative resources may mitigate deer impacts on woody vegetation. Contrary to expectations, higher rainfall increased browsing, suggesting resprouting of woody plants with enhanced palatability/nutrient content, increasing attractiveness to deer. This finding implies that browsing impact on Mediterranean forests would occur even when water availability increases, if herbivore density remains high. Our work emphasises the critical roles of spatiotemporal variations in population densities of wild herbivores in driving their browsing impact on natural habitats, offering valuable insights into the conservation of Mediterranean forests.

Insect conservation on Mediterranean small islands

Simone Fattorini

Department of Life, Health & Environmental Sciences, University of L'Aquila, Via Vetoio, Coppito, 67100, L'Aquila, Italy;
simone.fattorini@univaq.it

Intense human impacts, susceptibility to species invasion, small sizes of native populations, and high levels of endemism make extinction rates on islands much higher than those observed on mainlands. Mediterranean small islands are threatened by many factors, including overexploitation, landscape degradation, tourist pressures, and climate change. These islands host unique assortments of insect species, including several endemic taxa. A review of available information on the conservation status of various insect groups on Mediterranean small islands highlights some major areas of concern: (1) Island insects are mainly threatened by habitat loss due to clearance of natural vegetation for settlement (urbanization) and agriculture; (2) Invasive plants and animals (especially other insects) may represent an important, yet overlooked, source of threats; (3) Climate change has not been directly implicated in island insect decline to date, but it will be increasingly important in the near future due to the reduction of island size from rising sea level and the direct and indirect impacts of increasing temperature on ecosystem functioning and insect biology. Preservation of areas in good conservation status (mainly through site protection), habitat management and restoration, invasive species control, and species conservation actions, are urgently needed to improve insect conservation on Mediterranean small islands.

Alteration of gregarious behavior in terrestrial isopod population induced by abiotic and biotic factors.

Lorenzo Federico[1], Sara Peixoto[2], Susana Loureiro[2], Sara Villa[1], Rui Morgado[2]

[1]Università degli Studi Milano Bicocca, Piazza della Scienza 1, Milano, Italy; [2]CESAM - Centro de Estudos do Ambiente e do Mar, 3810-193 Aveiro, Portogallo; lorenzo.federico@unimib.it

Changing of abiotic and biotic factors can induce regime shift conditions in soil ecosystems, or compete in synergy or antagonism with pollutants in the onset of significant effects on organisms. Therefore, the development of ecological quality tools is required to monitor and prioritize those soils under depletion. In that way, the alterations in behavior of edaphic organisms are considered as warning signal indicators of changing of soil conditions. Specifically, the use of terrestrial isopods is of great importance for detecting the effect of abiotic or biotic factors at population level. The aim of this work was to assess the effect of these factors on the aggregation behavior in *Porcellionides pruinosus* for understanding the impact of such stressors on the population density. The stress induced by abiotic factors (as temperature, humidity, salinity, and pH) and by biotic factors (as edaphic competitor presence, necromone response, and dilution-to-extinction of soil microbial community) were assessed by the disaggregation index (DI) and the disaggregation in group (DG) for detecting alteration in the gregariousness. Results showed that these factors modulated the aggregation behavior in *P. pruinosus*, but the greater impact on the aggregation was driven by temperature (30°C) and humidity (70 and 80 %), where more than 50% of the terrestrial isopods population were fragmented. Compared to the biotic factors, the sterilization of soil induced disaggregation in a dose-response function, while the effect of the necromone affected only at the highest concentration tested. The principal component analysis showed the highest contribution for temperature (26.66% of the variance), while the remaining factors explained only 17.58%. Due to the effect of Climate Change, these environmental stressors may represent a risk factor for the maintenance of the gregarious behavior of terrestrial isopods and contribute, together with other anthropogenic stressors such as pollution, to significant alterations at the population level.

Growth rate, metabolic responses, recruitment and shell microstructures of Ostrea edulis resident population from the Gulf of La Spezia

Erica Gabrielli[1,2], Sofia Lorenzini[1,2], Chiara Lombardi[1], Davide Seveso[2,3]

[1]Marine Environment Research Centre S. Teresa, ENEA; Via Santa Teresa, 19032 Pozzuolo di Lerici, La Spezia, Italy; [2]Department of Earth and Environmental Sciences DISAT; University of Milano Bicocca, Piazza della Scienza 1, 20126 Milano, Italy; [3]MaRHE Center (Marine Research and High Education Center), Magoodhoo Island, Faafu Atoll, Maldives; e.gabrielli1@campus.unimib.it

The European oyster, *Ostrea edulis* (Linnaeus 1758), commonly known as the flat oyster, is a calcifying habitat-builder that provides ecosystem services such as climate regulation, biodiversity support, and enhancement of habitat complexity. As a key-stone species targeted as 'vulnerable and declining' under the OSPAR Convention, *O. edulis* beds have undergone various restoration projects across Europe. In the Gulf of La Spezia (Italy), the flat oyster has been present since the late 1800s, but the anthropogenic impacts have led to the near functional extinction of its habitat (i.e., oyster beds). Within the PNRR project RAISE, whose activities aim also to regenerate port areas using Nature-Based Solutions, a restoration initiative targeting *O. edulis* natural beds in the Gulf of La Spezia has been proposed. The PhD project will contribute to the knowledge on the resident population through the following objectives: **Ob1**: Monitoring the growth rate (length, width, thickness, and weight) and metabolic responses (respiration and calcification) in adult individuals collected within the harbor area and maintained in oyster cages. **Ob2**: Assessing the recruitment rate and settlement preferences of the population in three sites within the harbor area, using natural substrates and 'Chinese hats' commonly used as larvae catchers in oyster farming. **Ob3**: Investigating, in collaboration with the CNRS in Dijon (France), the functions and expressions of shell matrix components in oyster biomineralization. **Ob4**: Evaluating, in collaboration with the International Marine Centre in Sardinia (Italy), the impact of heat waves on the metabolism of *O. edulis*. In addition to biological data, physico-chemical parameters (temperature, oxygen, pH, pCO_2, salinity, chlorophyll-a) are recorded through weekly or monthly campaigns as well as thorough high resolution underwater observatory. The present project contributes to the knowledge of *O. edulis* populations and in understanding long-term resilience of flat oyster in the Mediterranean sea threaten by climate change.

Alien species as plastic trappers: the new ecosystem service of alien vegetation to trap riverine macrolitter

Luca Gallitelli[1], Massimiliano Scalici[1,2]

[1]Laboratory of Ecology – Department of Sciences, University of Roma Tre, Rome, Italy; [2]National Biodiversity Future Center (NBFC), Università di Palermo, Piazza Marina 61, 90133 Palermo, Italy; luca.gallitelli@uniroma3.it

Invasive alien plant species (IAPS) provide ecological threats due to their adverse effects on native biodiversity and ecosystem functioning. However, recent observations suggest that some IAPS may provide an unexpected ecosystem service by trapping riverine macrolitter, particularly macroplastics. This study aimed to quantify the role and capacity of aquatic and riparian IAPS to trap riverine macrolitter in central Italy rivers. To assess the impact of alien species that occurred in some rivers, we calculated an alloctony degree in a plot as the number of alien species on the total species. We investigated how vegetation structure (i.e., roots, branches, leaves) and community/diversity structure (i.e., number of species, type of vegetation) play a key role in plastic entrapment. Our results indicate that most of the alien riparian species occurred in the Tiber River's middle and lower courses, while alien aquatic species in smaller watercourses or lower courses. Among all the species occurring in the plots, although few were alien species, they entrapped a part of total macrolitter. Among the riparian species, *Amorpha fruticosa* and *Acer negundo* mainly blocked plastic packaging and plastic pieces, while *Vitis riparia* blocked most hygienic/sanitary towels and pieces, *Ficus carica* mainly bandages, and *Datura stramonium* entrapped clothes, aluminium cane, and plastic cups. Regarding aquatic species, *Eichhornia crassipes* and *Arundo donax* trap mostly packaging and plastic bottles. The plastic entrapment has been compared among the native and alien species. Among the species, we found that the higher the community structure and alloctony degree in a plot (number of alien species on the total species), the higher the plastic entrapment by vegetation. Here, we introduced the concept of "plastics vs alien plants", highlighting this new ecosystem service carried by vegetation. Given that IAPS significantly contribute to trapping macrolitter, these alien plants may potentially mitigate plastic pollution in aquatic systems.

A multi-biomarker approach uncovers varying physiological responses of common kestrels affected by human environmental impacts

Laura Giovanetti[1], Ilaria Caliani[1], Gianluca Damiani[2,3], Giacomo Dell'Omo[2], David Costantini[3,4], Silvia Casini[1]

[1]Università di Siena, Italia; [2]Ornis Italica, Piazza Crati 15, 00199, Rome, Italy; [3]Department of Ecological and Biological Sciences, University of Tuscia, Largo Dell'Università s.n.c., 01100, Viterbo, Italy; [4]Unité Physiologie Moléculaire et Adaptation, UMR7221 CNRS-Muséum National d'Histoire Naturelle, 75005, Paris, France.; laura.giovanetti@unisi.it

Human activities, especially agriculture and urbanisation, are causing a significant modification of natural environments. Consequently, animals adapt their physiology to these new environments to exploit them for foraging and breeding. This study aimed to compare the physiological status of nestling common kestrels (*Falco tinnunculus*) sampled from nest boxes installed in natural, rural, and urban areas around Rome, Italy. A multi-biomarker approach was applied to evaluate physiological responses at multiple levels, including antioxidant concentrations, immune functions, genotoxicity, and neurotoxicity. We found lower concentrations of glutathione and GSH:GSSG ratio values and a higher number of monocytes in urban kestrels than in other areas. Additionally, we observed higher DNA damage in rural kestrels compared to urban and natural ones, and inhibition of butyrylcholinesterase activity in urban and natural area birds compared to those from rural area. Similar values emerged among the study areas for respiratory burst, complement system activity, bactericidal capacity, and plasma non-enzymatic antioxidant capacity. These results show that urban environments do not necessarily cause physiological alterations in kestrels compared to those from other habitats, and due to the different environmental pressures across habitats, the specific organisms' responses can be detected through a multi-biomarker approach. Further studies are needed to identify which factors induce the physiological differences among natural, rural and urban. birds and to determine whether these differences are consistent over time and space.

Spatial disturbance of fishery on two dolphin species in the Northern Ionian Sea (Central-eastern Mediterranean Sea)

Maurizio Ingrosso[1], Pasquale Ricci[1], Carmelo Fanizza[2], Roberto Carlucci[1], Giulia Cipriano[1]

[1]Università degli Studi di Bari Aldo Moro, Italia; [2]Jonian Dolphin Conservation; maurizio.ingrosso@uniba.it

According to the EU Habitats Directive and the Maritime Spatial Planning Directive, assessing whether the fishery activities induce disturbances on cetaceans' occurrence and behavior is pivotal to identify appropriate conservation strategies and strengthen current policies regarding spatial management. In the Northern Ionian Sea (Central-eastern Mediterranean Sea), areas of overlap between commercial fisheries and the Area of Occupancy of *Stenella coeruleoalba* and *Tursiops truncatus* have been identified between 2012 and 2021.

Particularly, the spatial overlap with different fishing gears has been quantified characterizing the fishing effort intensity (FEI) of Trawlers, Purse seines, Longlines and Passive nets as low (<1h), medium (1-5h) and high (>5h) using AIS data available on Global Fishing Watch platform. The occurrence of dolphins and their feeding behaviour in each FEI level was analysed and differences in by FEI levels were tested using a non-parametric Chi square test, and a *post-hoc* multiple comparison test based on the Dunn's (z) test with Bonferroni correction. Analysis was carried out by *FSA* R package.

The spatial overlap covered 74% of the study area (934 on 1261 km^2 cetacean's Area of Occupancy). The occurrence of both species resulted to be significantly higher in areas with medium FEI levels rather than low or high values (p<0.001, z<0.001) with a sightings frequency of 49% and 53% for *S. coeruleoalba* and *T. truncatus*, respectively. Records of feeding behavior resulted significantly lower in areas with high FEI levels (p<0.001, z<0.001) for *S. coeruleoalba*. For *T. truncatus* this condition was confirmed only for medium FEI levels (p<0.001, z<0.001).

Results seem to show similar responses to fishing effort intensity for both species, however further assessments of disturbances should consider seasonal and yearly variation in fishing effort and the differences in single fishing gear displacement.

Some like it hot: tracking climate-driven range expansion of Trithemis annulata (Hexapoda: Odonata) in Italy

Gianandrea La Porta[1], Sönke Hardersen[2]

[1]Department of Chemistry, Biology and Biotechnology, University of Perugia (PG), 06123 Perugia, Italy; [2]Reparto Carabinieri Biodiversità di Verona, Centro Nazionale Carabinieri Biodiversità "Bosco Fontana", 46045 Marmirolo, Italy; gianandrea.laporta@unipg.it

Climate change is a key driver of global biodiversity loss, affecting wildlife through shifts in species phenology, physiology, behaviour, and distribution. These shifts can lead to habitat loss, local declines, and extinction cascades. Additionally, new species may compete with native ones, exacerbating conservation challenges. Traditionally, long-term distribution studies have focused on birds and mammals, but dragonflies, as bioindicator insects of ecological change, offer a valuable alternative. Easily identifiable by the public, dragonflies can be monitored through citizen science platforms, aiding in data collection even when institutional funding is scarce. One notable example is *Trithemis annulata*, a Libellulidae native to Afro-tropical regions, which has significantly expanded its range across southwestern Europe in recent decades, including Spain, France, and Italy. Historically confined to southern Italy for over 150 years, this species has spread northward into the Po Plains and several alpine valleys. To document and analyze the expansion of *Trithemis annulata* in Italy and determine the bioclimatic conditions for its current and future distribution, a dataset including 2,557 geographic distribution points from different online platforms from 1825 to 2023 was compiled. In the last 43 years, *Trithemis annulata* expanded northward at an average speed of 12 km/year, accelerating up to 34 km/year. Despite this rapid movement, the northward expansion of the species has not kept pace with rising temperatures, and the species has shown no significant upward shift. By 2040, Italy is projected to see a substantial increase in suitable areas for this Libellulidae, potentially expanding by up to 200%. This expansion, driven by climate warming, positions the species as a neo-native in recently invaded regions. Additionally, populations at the northernmost edge of its Italian range currently border the Alps, indicating a potential future expansion into central Europe.

Investigating fish assemblages to assess the conservation and functional values of the Po Delta wetlands

Mattia Lanzoni[1], M. Gaglio[1,2], A.C. Bonciu[2], G. Castaldelli[1]

[1]Università Studi di Ferrara, Italia; [2]Climate and Ecology Unit, Research and Museum Collections Office, MUSE-Museo delle Scienze; mattia.lanzoni@unife.it

Transitional environments in deltaic areas host a diverse range of aquatic ecosystems, each characterized by distinct living communities and ecological functions. Understanding these ecosystems is essential for their management and biological conservation. This study investigates the conservation value and ecosystem functioning of eight aquatic systems within the Po River Delta Park (Italy), one of Europe's most significant transitional areas, using fish communities as indicators based on presence/absence data.The analysis considered seasonal patterns in species occurrences and respective functional traits. Initially, multivariate analyses were performed to assess the impact of environmental characteristics on community composition. Subsequently, conservation values were measured through community composition, and the functional roles of wetlands were evaluated by examining fish traits related to habitat use and feeding mode. The contributions of different wetlands to alpha and beta diversity were also explored.The results indicated that water level patterns (artificial vs. tidal) and wetland surface area were the most influential factors in determining the species composition of fish communities in both taxonomic and functional terms. Coastal wetlands exhibited a higher number of species, including protected ones, indicating a greater conservation value. Functional beta diversity analysis revealed that migratory species significantly contribute to functional beta diversity, emphasizing the role of wetlands as nurseries and feeding grounds. During winter and autumn, detritivorous species primarily drive beta diversity, while planktivorous and piscivorous species are more influential in spring and summer, highlighting trophic seasonal variations.Overall, the findings demonstrate that fish communities are effective indicators for describing and monitoring ecosystem functioning in managed transitional waters, providing valuable insights for guiding the environmental management of these unique ecosystems.

Tursionet: Bottlenose dolphins' acoustic interactions with fishing gear in the Ligurian waters of the Pelagos Sanctuary

Davide Michel Lelong[1], Michele Manghi[2], Claudio Fossati[1,2], Gianni Pavan[1], Agnese Marchini[1], Guido Gnone[3], Fulvio Garibaldi[4], Eleonora Coppolella[4], Camilla Testori[5], Federica Giorda[5]

[1]University of Pavia, Italia; [2]Nauta Scientific rcs; [3]Fondazione Acquario di Genova ONLUS; [4]University of Genoa (DISTAV); [5]Istituto Zooprofilattico Sperimentale del Piemonte Liguria e Valle d'Aosta; davidlelong.blackfish@gmail.com

The interaction between small-scale fisheries and dolphins has always been contentious and often results in conflicts between fishermen and dolphins with important losses from both sides. These interactions could also often result in the entanglement of marine mammals in fishing gear, the major cause of mortality in marine mammals by human activities. The Tursionet project, funded by the Pelagos Initiative, aims to study the interactions and relationship between different types of fishing gear and the population of bottlenose dolphins that inhabit the coastal waters in the Pelagos Sanctuary, a Marine Protected Area for marine mammals located in the Northwestern Mediterranean between France, Italy, and Monaco. Several hydrophones have been deployed along the Ligurian coast near different types of fishing gear such as gillnets and pots in continuous recording to monitor the acoustic interactions of dolphins passing nearby. The frequency of encounters, the types of vocalizations, and the diel pattern are investigated to assess the intensity of these interactions and further explore the impacts they may have on the local population of dolphins. The different sites will also show if there are particular hotspots of activity where further monitoring may be needed. Finally, the results from this project will result in the development of automated systems that will be used in monitoring these interactions and ultimately develop mitigation strategies to reduce conflicts between the local fisheries and dolphins.

Engaging mollusks' farmers to increase the knowledge on distribution and impact of non-native species in aquaculture in the Adriatic Sea

Barbara Mikac[1,2], Lucia Palazzi Rossi[3], Federica Costantini[2,3,4,5], Marina Antonia Colangelo[2,3,4,5], Marco Abbiati[1,2,4,5], Eugenio Fossi[1]

[1]Dipartimento di Beni Culturali, Università di Bologna, Campus Ravenna, Via degli Ariani 1, 48121 Ravenna, Italia; [2]Centro Interdipartimentale di Ricerca Industriale Fonti Rinnovabili, Ambiente, Mare ed Energia – CIRI-FRAME, Università di Bologna, Campus Ravenna, Via Sant'Alberto 163, 48123 Ravenna, Italia; [3]Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna, Campus Ravenna, Via Sant'Alberto 163, 48123 Ravenna, Italia; [4]Centro Interdipartimentale di Ricerca per le Scienze Ambientali – CIRSA, Università di Bologna, Campus Ravenna, Via Sant'Alberto 163, 48123 Ravenna, Italia; [5]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Piazzale Flaminio 9, 00196 Roma, Italia; barbara.mikac@unibo.it

Aquaculture is one of the main vectors of non-native species (NNS) transport in the Mediterranean. We used farmers' local ecological knowledge as an information source to study the presence and effects of NNS in mollusks' farms in the Adriatic Sea. Study was conducted in 2023 through questionaries with representatives of 24 mussel and 10 oyster farms along Italian Adriatic coast. Most farmers (75% mussel and 90% oyster) knew what NNS are, however, they were aware only of the polychaete *Polydora*, the ascidian *Clavelina oblonga*, and the blue crab *Callinectes sapidus*, and could not indicate other NNS. Rather they could mention the higher taxonomic categories to which non-native organisms belong. The most quoted were ascidians, barnacles, and hydrozoans. From the beginning of their activity, farmers observed the appearance of new ascidians and hydrozoans and an increase in abundances of nemerteans, barnacles, ascidians and *Polydora*. They claim that these organisms eat or harm molluscs and reduce their marketability. Moreover, farmers were interviewed about the mollusks' translocation operations they perform. Besides locally producing their own seed, farmers acquire seeds from hatcheries in Italy, Greece, and France, and sell seed to other farms in Italy, Spain and France. Only two mussel farms buy adults for re-immersion and further growth, from Italy and France. Conversely, most mussel and few oyster farms sell their adult mollusks for re-immersion in other farms in Italy, Spain, and France. All these common farming operations might have been responsible for the import of new organisms and could contribute to their further spread in the Adriatic and the Mediterranean. Measures should be taken in collaboration among aquaculture industry, scientists and management bodies to train farmers in recognizing important non-native and pest species and develop procedures for their reporting and undertaking of management measures for the containment of their spread.

Patterns in osmolyte and secondary metabolite production in mangrove-associated algae across four Maldivian atolls

Rossella Nicolai[1], Ulf Karsten[2], Andreas Richter[2], Giuseppe C. Zuccarello[3], Yohan Didier Louis[1], Federico Cerri[1], Giulia Senna[1], Paolo Galli[1]

[1]Università degli Studi di Milano-Bicocca, Italia; [2]University of Rostock, Germany; [3]Victoria University of Wellington, New Zealand; r.nicolai1@campus.unimib.it

Mangrove habitats are known to provide essential ecosystem services to tropical countries around the world. These habitats are considered extreme for the organisms living within them, because they are subject to high temperatures, and substantial fluctuations in salinity levels and ultraviolet radiation. Among these organisms are the algae, a group of primary producers often found in association with mangrove prop roots and pneumatophores. To cope with the extreme conditions, algae are known to produce interesting osmolytes and secondary metabolites. In the Republic of the Maldives, mangrove-associated algae are extremely understudied. After carefully preparing an updated checklist of algae reported in the country, we found that only six benthic algal species haveb been reported in association with mangroves, and no information about their chemical composition is currently available. We conducted a field survey of algal diversity in the Maldivian mangroves from two central and two northern atolls and analyzed their chemical profile by GC and HPLC, with particular regards to low molecular weight carbohydrates and the UV-absorbing molecules mycosporine-like amino acids. The predominant taxa observed were members of the families Rhodomelaceae (Rhodophyta) and Cladophoraceae (Chlorophyta), which showed significant qualitative and quantitative differences in chemical composition across sites. Additionally, we discovered the presence of an algal taxon commonly observed in association with mangroves around the world, but previously unreported from the Maldivian mangroves. The explored habitats showed diverse geomorphological and environmental characteristics across sites, thus providing an interesting ground to study patterns in algal osmolyte and secondary metabolite production. Understanding the diversity and chemical composition of Maldivian mangrove-associated algae will help us understand the contributions of these important organisms to these essential ecosystems.

First assessment of the biophonies in the underwater soundscape of the Marine Protected Area “Secche di Tor Paterno” (Mediterranean Sea)

Daniela Silvia Pace[1,2], Zenab Irshaid[1], Giulia Pedrazzi[1], Elena Papale[2], Giuseppa Buscaino[2], Maria Ceraulo[2,3]

[1]Department of Environmental Biology, Sapienza University of Rome, Italy; [2]Institute of Anthropic Impact and Sustainability in the Marine Environment (IAS), National Research Council (CNR), UOS Torretta Granitola (TP) Campobello di Mazara, Trapani, Italy; [3]NBFC, National Biodiversity Future Center, Piazza Marina 61, Palermo, Italy; danielasilvia.pace@uniroma1.it

The soundscape is the acoustic environment resulting from natural and human sounds present within an ecosystem or an area. It acoustically profiles the location as a whole, comprising the fingerprint of the soniferous species using the area (biophonies), the noisy human activities (anthropophonies) and the physical phenomena (geophonies). As such, the study of the acoustic patterns and the spectral characteristics of the different components of the soundscape can be viewed as an ecological metric of the status, dynamics and health of an ecosystem, and an indicator of environmental changes.

This study aims to provide baseline information on the biophonic component of the underwater soundscape of the Marine Protected Area "Secche di Tor Paterno" (Mediterranean Sea), investigating site-specific diversity and temporal patterns in sounds’ production. Using autonomous recorders released/recovered in the MPA, 24-days acoustic data were collected in the summer 2020, 2022 and 2023. A total of 6.741 files corresponding to 113 hours of recordings was analysed using Raven Pro, Rx and Avisoft Pro software.

Biophonies were detected at all times. At least 8 categories of fish sounds were recognized, indicating the positive acoustic presence of *Scorpaena spp*., *Sciaena umbra* and the cryptic *Ophidion spp*. Bray-call series emitted by bottlenose dolphins (*Tursiops truncatus*) and impulsive sounds produced by *Alpheidae* species (i.e. snapping shrimps) were discriminated as well. The monthly/daily patterns revealed that fishes were acoustically active during the night, while crustaceans all-day-long, with two significant activity peaks (sunrise and sunset). The intense, concomitant nocturnal sound production by different fish species – mainly related to reproduction – was affected by the noise generated by vessels crossing the MPA, with a reduction of the emission rates.

These early findings emphasize the importance of soundscape studies to understand the acoustic community of a site, detect its changes/alterations, and improve MPA conservation effectiveness.

Feeding preferences of the invasive allochthonous Blue Crab (Callinectes sapidus Rathbun, 1896) in mesocosm and possible implications for mollusk fisheries

Francesco Palmas[1], Pierantonio Addis[1], Sonia Cheratzu[1], Viviana Pasquini[1], Antonio Pusceddu[1], Paolo Solari[2], Serenella Cabiddu[1]

[1]Università degli Studi di Cagliari, Italia. Dipartimento di Scienze della Vita e dell'Ambiente; [2]Università degli Studi di Cagliari, Italia. Dipartimento di Scienze Biomediche; fpalmas@unica.it

To identify which prey are at risk due to the invasion of blue crab (*Callinectes sapidus*) in the Mediterranean Sea, we investigated its feeding behavior and preference for different native Mediterranean bivalve species in a mesocosm experiment conducted withing the project eINS - Ecosystem of Innovation for Next Generation Sardinia (CUP F53C22000430001- MUR Grant Assignment Decree No. 1056).

No-choice prey size and video-recorded prey choice experiments were designed to test the following null hypotheses: i) prey mortality rates do not vary when prey species are provided singularly nor with prey size; ii) the predator does not have preferences when prey are provided singularly; iii) prey consumption rates do not vary among species; iv) manipulating, consuming and handling times do not vary among prey species.

Our results indicate that adult male *C. sapidus* exhibit a cyclic feeding/resting behavior and show a preference for the commercially exploited native clam, *Ruditapes decussatus*, followed by *Mytilus galloprovincialis* and *Cerastoderma glaucum*, either when provided alone or in combination with other prey. We also estimated that an adult male crab could consume up to 2.6 kg of clams per month during the spring and summer. We also anticipate that the preference of C. sapidus for *R. decussatus*, a vital commercial species in lagoons along the Italian coastline, will have severe consequences for the lagoons' trophic webs and the local economy.

Effect of land use, vegetation type and season on shaping soil microbial community in Mediterranean ecosystems

Enrica Picariello, Alessia Esposito, Veronica Vitagliano, Flavia De Nicola
Dipartimento di Scienze e Tecnologie, Università degli Studi del Sannio, Benevento, 82100, Italia; erpicariello@unisannio.it

Soil provides multiple ecosystem services, producing food, playing a role in carbon sequestration and providing a reservoir for biodiversity. However, soils are subject to several disturbances (i.e. management practices in forests, tillage in agriculture fields, grazing in pastures). These disturbances can change soil properties and microbial community biodiversity, and seasonality also plays an important role in shaping the microbial community composition. Studies on the interactive effect of season and land use and their relative importance in driving change in soil microbial community are limited in the Mediterranean area.
Here, we aimed to answer how dominant vegetation, land use, and season affect the microbial community in different soil ecosystems. At this aim, for one year, the function (enzyme activities) and structure (DNA analysis) of the microbial communities were monitored in soils under different vegetation covers (turkey oak and beech) and land use (meadow and pasture); all the variables were analysed by variation partitioning analysis and the driving factors of the partitioning were determined (using permutational ANOVA). We also calculated the resilience of soil microbial community (by Metabolic Activity Index, MAI), deepening its response to different disturbances (forest management practices, tillage and grazing).
Dominant vegetation type and land use affected the soil microbial community more than the season in these Mediterranean ecosystems. MAI values higher in managed forests suggested a resilience response of the microbial communities and their recovery after about 15 years from cutting. Pasture and meadow management appeared not to affect soil microbial community functions, with MAI values higher in meadow respect to pasture.
This study provides novel insights into the factors that affect the composition of soil microbial communities, and related ecosystem functions, useful in implementing soil sustainable management practices.

Inventory and meta-analysis of demersal fishing impacts on oceans sedimentary biogeochemistry

Antonio Pusceddu[1], Justin Tiano[2], Emil De Borger[3,4], Sarah Paradis[5], Clare Bradshaw[6], Claudia Morys[6], Claudia Ennas[1], Karline Soetaert[3], Pere Puig[7], Pere Masqué[8,9], Marija Sciberras[10]

[1]Department of Life and Environmental Sciences, University of Cagliari, Via T. Fiorelli, 1, 09126 Cagliari, Italy; [2]Wageningen Marine Research, Wageningen University and Research, PO box 68, 1970 AB, IJmuiden, the Netherlands; [3]Royal Netherlands Institute for Sea Research (NIOZ), Department of Estuarine and Delta Systems, Korringaweg 7 PO box 140, 4401 NT, Yerseke, the Netherlands; [4]Ghent University, Department of Biology, Marine Biology Research group, Krijgslaan 281/S8, 9000 Ghent, Belgium; [5]Geological Institute, ETH Zürich, Zürich, Switzerland; [6]Department of Environment, Ecology and Plant Sciences, Stockholm University, Stockholm, Sweden; [7]Marine Sciences Institute, Consejo Superior de Investigaciones Científicas (ICM-CSIC), Barcelona, Spain; [8]International Atomic Energy Agency, Monaco; [9]Centre for Marine Ecosystems Research, School of Science, Edith Cowan University, Joondalup, WA, Australia; [10]The Lyell Centre, Heriot-Watt University, Edinburgh, EH14 4AP, UK; apusceddu@unica.it

Marine soft sediments contribute to the edification of continental margins, which represent one of the largest ecosystems on Earth and a hot spot of ecosystem services. Their integrity, however, is increasingly put at risk by anthropogenic disturbance, most notably by demersal fisheries. The need for global action to minimize the impacts of destructive fishing techniques on marine soft sediments is an urgent need. The assessment of the consequences of such impacts, however, has been limited, as global predictions are challenging, and because poor validations and oversimplified assumptions have led to large uncertainties. By exploring the scientific literature dealing with trawling impacts on marine sediments, we mapped out where, what and when such a disturbance has been studied and measured so far. We built up an open-access data repository about sedimentary and biogeochemical properties of trawled sediments. Then, using such a repository, we carried out a global meta-analysis to quantify the effects of demersal fishing on specific properties.

Studies examining the direct (control vs. impact) effects of bottom fishing revealed significant reductions in chlorophyll-a (-17%), phaeopigments (-24%) and proteins (-32%), with the largest impact detected on the top surficial sediment, where reductions in total organic carbon (-12%) were also detected. Conversely, fishing intensity gradient studies showed an increase in TOC in chronically fished areas. Recovery once fishing ceased was observed for the most labile organic matter components (e.g., phytopigments, total nitrogen, and proteins). We noticed also that natural factors such as bottom current velocity and surface primary productivity can influence both the direction and magnitude of the fishing effects.

We highlight knowledge gaps that might create bias in regional and global models that require empirical data for validation, emphasizing the implications of methodological biases as a result of inappropriate sampling in trawling impact studies and the importance of context-dependent effect size.

Threatening coastal aquatic habitats at crayfish stepping

Massimiliano Scalici[1,2], Luca Gallitelli[1]

[1]Department of Sciences, University Roma Tre, viale Guglielmo Marconi 446, 00146 Rome (IT); [2]National Biodiversity Future Center, Univeristà di Palermo, Paizza Marina 61, 90133 Palermo (IT); massimiliano.scalici@uniroma3.it

The infraorder Astacoidea is one of the most particular taxa from a conservation viewpoint, including some threatened species while others have negative impacts on habitats where they are introduced, establishing self-sustaining populations with possibilities to spread widely. Although the ancestor of Astacoidea colonised inland waters in the Triassic Period some living species inhabiting freshwaters have retained the ability to tolerate high salinity levels as well, and the brackish habitat colonization seems to be quite evident in some introduced crayfish. This *phenomenon* needs further investigations to understand whether crayfish can adapt to transitional waters, using them either as new elective habitats or as biological corridors. This possibility raises concern for conservation biology and no native species management, with specific regard to: 1) crayfish's transport and introduction; 2) the increasingly frequent records in transitional waters; and 3) alien threats' control and management in coastal habitats. Furthermore, here we present for the first time a record of *Procambarus clarkii* in marine ecosystems for the central Italy coast. Even if the impact on the newly colonised transitional habitats (such as river mouth and temporary wetlands) is not evident yet, the possibility of consequences on these fragile ecosystems seems certain, since they are strategic areas for (i) limicolous birds and endemic fish, and (ii) areas with important economic activities such as fisheries and aquaculture.

Movement responses of Italian riffle dace (Telestes muticellus) to extreme flow events in a Mediterranean mountain stream

Alfredo Schiavon[1,2], Daniel Nyqvist[2], Alessandro Candiotto[3], Michele Spairani[4], Franz Hölker[1,5], Johan Watz[6], Claudio Comoglio[2]

[1]Department of Biology, Chemistry, and Pharmacy, Free University of Berlin, Germany; [2]Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, Italy.; [3]Ittiologo libero professionista, Predosa, Italy.; [4]FLUME S.R.L, Loc. Alpe Ronc 1, 11010, Gignod (Aosta), Italy.; [5]Department of Community and Ecosystem Ecology, Leibniz Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany.; [6]Department of Environmental and Life Sciences, Karlstad University, Sweden.;
alfredo.schiavon10@gmail.com

Freshwater biodiversity is declining worldwide. Understanding fish behaviour is essential for mitigating this decline and ensuring the survival of fish populations. The increased occurrence and intensity of extreme hydrological events, closely linked to climate change, represents a potential threat to freshwater ecosystems. The Mediterranean ecoregion, in particular, is expected to face more frequent drought and flood events. Despite its ecological and management importance, comprehensive knowledge about the effects of such events on fish movement patterns remains largely unexplored, particularly for small, endemic species. Our research investigates the movement behaviour of the endemic Italian riffle dace, *Telestes muticellus*, within a small unregulated stream in the northern Apennines. We used PIT (passive integrated transponder) telemetry to track individual fish movements over droughts that caused intermittent flows and flood events. We compared the movement patterns during extreme events with those observed during periods without such flow disturbances. During drying and flood events, the fish expanded their linear ranges, showing the capability to adjust. High-flow conditions notably facilitated both downstream and upstream dispersal of *T. muticellus*. Under intermittent flow conditions occurring during drought events, the fish directed their movements towards aquatic refuges, demonstrating their resilience to drying riverbeds. These findings are particularly noteworthy given the strong site fidelity and confined home ranges observed during normal conditions throughout the study. The fish movement responses were possible due to the absence of anthropogenic barriers, underscoring the importance of preserving longitudinal river connectivity for mitigating the detrimental effects of increasingly frequent extreme flow conditions.

Current status of Pinna nobilis in the Lagoon of Venice and surrounding waters in the wake of mass mortality events: population trends, spatial patterns and environmental drivers

Marco Sigovini[1], Fabrizio Bernardi Aubry[1], Francesca Carella[2], Marta Cosma[3], Daniele Curiel[4], Sandra Donnici[3], Erika Drogo[5], Irene Guarneri[1], Elisabetta Manea[1,6], Tihana Marčeta[1], Giuseppe Pessa[7], Andrea Sabino[1], Gian Marco Scarpa[1], Luigi Tosi[3], Matteo Zucchetta[8], Alessandro Bergamasco[1]

[1]CNR-ISMAR, Consiglio Nazionale delle Ricerche - Istituto di Scienze Marine, Arsenale Tesa 104, Castello 2737F, Venezia; [2]Università di Napoli Federico II, Dipartimento di Biologia, Napoli; [3]CNR-IGG, Consiglio Nazionale delle Ricerche - Istituto di Geoscienze e Georisorse, Area territoriale di Ricerca di Padova, Corso Stati Uniti 4, Padova; [4]SELC soc. coop., Via dell'Elettricità 3/D, Marghera, Venezia; [5]Università di Pavia, Dipartimento di Biologia e Biotecnologie "L. Spallanzani", Pavia; [6]Laboratoire d'Ecogeochimie des Environnements Benthiques, LECOB, Observatoire Océanologique de Banyuls sur Mer Centre National de la Recherche Scientifique (CNRS) - Sorbonne Université, Banyuls sur Mer, France; [7]Gruppo Sommozzatori Caorle, Via Sansonessa 83, Caorle; [8]Istituto di Scienze Polari, Consiglio Nazionale delle Ricerche (CNR-ISP), Via Torino 155, Mestre, Venezia; marco.sigovini@ve.ismar.cnr.it

The Mediterranean fan mussel *Pinna nobilis* (L. 1758) has been experiencing since 2016 significant Mass Mortality Events (MMEs), associated with the protozoan *Haplosporidium pinnae*, which has caused a drastic decline of the species. Between 2019 and 2020 the epidemic reached the northern Adriatic and, subsequently, the Venice Lagoon, where *Pinna nobilis* was characterized by wide distribution and high densities. Despite the observed MMEs, the Venice Lagoon, one of the largest Mediterranean coastal transitional ecosystems (CTEs, still hosts a large residual population. Comparable situations of higher survival rate are also known for other CTEs, which seems to act as refugia for the species. The distribution and structure of *Pinna nobilis* remnant populations in the Venice Lagoon and surrounding waters have been investigated since 2021 through multiple approaches across different scales. A site close to Ottagono Alberoni, near Malamocco inlet, has been monitored monthly from October 2020. Video transects were collected in 2021 across the central Lagoon. During 2023, larval collectors were placed at 5 sites along the Veneto coastline in the framework of Life PINNARCA and Interreg IT-SI TRECap projects. In 2024, quantitative surveys over 50 sampling stations have been performed in collaboration with Regione Veneto in the context of Interreg IT-SI POSEIDONE. Overall, the investigations allowed assessing the status of the species, epidemic and population trends as well as spatial patterns. The Venice Lagoon still possibly hosts one of the largest extant population of the species, acting likely as a source of propagules for surrounding marine waters. Both *Pinna nobilis* distribution and mortality rates appear related to main environmental gradients, such as water exchange and salinity, providing insights into the underlying epidemic dynamics and ecological processes. Present results and main research perspectives will be discussed also in the context of management policies and conservation strategies for the species.

Effects of small-scale fishery on habitats: the case studies of Torre Guaceto and Porto Cesareo MPAs

Chiara Silvestrini[1], Alessandro Ciccolella[2], Paolo D'Ambrosio[3], Francesco de Franco[2], Luciana Muscogiuri[4], Simonetta Fraschetti[1]

[1]Università degli Studi di Napoli Federico II, Italia; [2]Consorzio di Gestione di Torre Guaceto, Carovigno (BR), Italia; [3]Dipartimento Infrastrutture di ricerca per le risorse biologiche marine, Infrastrutture ricerca a mare, Stazione Zoologica Anton Dohrn, Amendolara (CS), Italia; [4]Consorzio di Gestione Area Marina Protetta Porto Cesareo, Lecce, Italia; chiara.silvestrini@unina.it

Fishery is considered one of the human activities most responsible for marine habitat fragmentation and loss. However, while the impacts of large-scale fisheries have been largely studied, the potential impact of small-scale fisheries (SSF) on benthic habitats is more often presumed than assessed, with quantitative information still largely lacking. To contribute to fill this knowledge gap, we carried out a fine-scale assessment with the collaborative involvement of local artisanal fishers operating within the Marine Protected Areas of Torre Guaceto and Porto Cesareo, in the Southern Italy. Through *in situ* landing photo-sampling, we characterized both the sessile benthic bycatch and the commercial catch components of 146 fishing operations, thus comparing the results across the different habitats (e.g. seagrasses and coralligenous) representing the fishing grounds. Our findings show that the benthic bycatch is, on average, the 39% of the total catch (in terms of abundance), representing a concerning and non-negligible fraction.

To shed new light on the role of the SSF in the loss of habitat, we combined data on the bycatch of two habitat-forming species (*Axinella cannabina* and *Posidonia oceanica*) with those on the fishing effort, to quantitatively assess habitat loss driven by SSF. Knowledge on fishing effort is fundamental to develop *ad hoc* regional management strategies to promote eco-sustainable local fisheries. The achievement of the 30% target of the EU's Biodiversity Strategy will not be reached in absence of careful monitoring and assessment of SSF.

Impact of extreme climatic events on early life stage of a Mediterranean coral habitat-structuring species

Mario Francesco Tantillo[1], Gianluca Sarà[1,2], Mar Bosch-Belmar[1,2]

[1]Dipartimento di Scienze della Terra e del Mare Università degli studi di Palermo (UNIPA), Italy; [2]National Biodiversity Future Center (NBFC), Palermo, Italy; mariofrancesco.tantillo@unipa.it

Marine ecosystems are currently experiencing rapid changes, characterized by rising temperatures and more frequent extreme climatic events, which are having profound impacts across all levels of the ecological hierarchy. Marine heat waves (MHWs) and subsequent extreme storms pose significant threats to marine communities, causing alterations in their structure and composition. Understanding how key benthic structuring species respond to these environmental changes has become crucial, as local biodiversity relies heavily on their conservation status. The larval stage plays a particularly pivotal role in the life cycle of sessile organisms, facilitating the maintenance of local populations and the dispersal of species. Despite its critical importance, there remains limited understanding of how larval stages respond to environmental changes across many taxa. This study specifically investigates the response of the larval stage of a significant Mediterranean endemic habitat-former, the orange coral *Astroides calycularis* (Pallas 1766), under realistic single and multiple stressor conditions using manipulative mesocosm experiments. Our experiments exposed coral larvae to heat-temperature spikes, MHWs, and combined MHWs with dropping salinity treatments. We examined metabolic performance responses of the early-life stage, as well as larval survival and settlement abilities. Results indicated that rising temperatures and decreasing salinity significantly impair the species' performance, resulting in accelerated metabolism, faster settlement rates, and increased mortality. These findings are essential for comprehending and predicting species distribution and population dynamics under current and future environmental change scenarios. They also shed light on the fate of biodiversity associated with this habitat-forming species in the Mediterranean.

Competition for trophic resources between Apis mellifera L. and wild Apoidea: ecological and ethological approaches on a small island in the Tuscan Archipelago

Giorgio Vicari[1], Lorenzo Pasquali[2], Claudia Bruschini[2], Leonardo Dapporto[2], Alessandro Cini[1]
[1]Università di Pisa, Italia; [2]Università degli studi di Firenze, Italia; g.vicari5@studenti.unipi.it

Honeybees (*Apis mellifera* L.) provide an essential ecosystem service as pollinators. However, given their characteristics -big colonial size, generalist diet, wide foraging ranges- and their management, honeybees are capable of monopolising trophic resources (pollen and nectar), potentially impairing the survival of other species of wild bees. Competition can be especially harsh in small and homogeneous ecosystems, such as small islands. We investigated such potential competition on Giannutri, a small island within the Tuscan Archipelago National Park, in which 18 hives of managed honeybees are seasonally introduced since 2018. Spatial and flower-visits overlap between honeybees and wild bees suggests potential exploitative competition. Our experimental approach was to manipulate honeybees' abundance by closing and opening the beehives, to obtain 2 experimental conditions in which we assessed: a) the abundance of different species of Apoidea, through transect walks; b) trophic resources availability, through quantification of nectar volume (on *Teucrium fruticans* L. and *Salvia rosmarinus* Spenn.) and presence/absence of pollen (on *T. fruticans*); c) foraging pattern behaviours of target wild bees (*Anthophora dispar* Lepeletier and *Bombus terrestris* L.), through focal behavioural sampling and observation plots. We documented: a) a decline in the number of individuals of the target species over 4 years; b) a lower availability of trophic resources in days with presence of honeybees; c) changes in foraging behaviour patterns in target wild bees (e.g. less time spent in nectar suction on individual flowers by wild bees in presence of honeybees). Our results suggest that honeybees can have a detrimental effect on wild bees. Giannutri, therefore, represents not only a study area in which we want to safeguard wild bees' populations, but also a model system of a small Mediterranean landscape. In view of this, our findings can drive the draw up of new guidelines towards a more aware and sustainable beekeeping practice.

Posters

Macrobenthic communities along the rocky Cilento coast (southern Italy) characterized by different anthropogenic pressures

Daniela Baldantoni[1], Maria Antonietta Nitopi[1], Luigia Donnarumma[2], Floriana Di Stefano[3]

[1]Dipartimento di Chimica e Biologia "Adolfo Zambelli", Università degli Studi di Salerno, Italia; [2]Dipartimento di Scienze e Tecnologie, Università di Napoli "Parthenope", Italia; [3]Istituto Superiore per la Protezione e Ricerca Ambientale, Italia; dbaldantoni@unisa.it

Coastal rocky marine ecosystems are biodiversity hotspots threatened by anthropogenic pressure [1]. Benthic communities inhabiting shallow coasts can act as bioindicators of environmental disturbances. Their ability to structure themselves under a long-term anthropogenic disturbance, such as in the case of anthropized coasts, allows them to provide information not only about past conditions but also about the current state of the marine environment [2, 3].

In order to evaluate the relationships between the macrobenthic community biodiversity and the anthropogenic pressure, macroalgae and the associated macroinvertebrates (> 0.5 mm) from the upper infralittoral zone of the rocky Cilento coast (southern Italy), were collected. Samplings were carried out in July and December 2023, in 6 sites differing in the anthropogenic pressure (from harbors to protected areas), by sampling squares of 30x30 cm (5 replicates per site). Whole macroalgae biomass was determined as dry weight (75 °C until constant weight).

Among macroinvertebrates, a total of 6386 individuals in July and 4153 individuals in December were collected, belonging to Mollusca, Polychaeta, Crustacea, Echinodermata, Sipuncula and Nemertea. Positive correlations between macroalgae biomass and total number of macroinvertebrates ($r=0.56$; $p<0.01$), and in particular of Crustacea ($r=0.66$; $p<0.001$) and Sipuncula ($r=0.63$; $p=0.001$), were found. The values of the Shannon index were 1.64±0.24 in July and 1.60±0.29 in December with an Evenness of 0.72±0.06 in July and 0.71±0.08 in December. These values did not differ neither between the two seasons, nor among sites, highlighting that macrozoobenthic community in the studied area is only marginally affected by seasonality and anthropogenic pressure.

[1] Bianchi & Morri (2000). *Marine Pollution Bulletin 40*(5), 367-376

[2] Borowitzka (1972). *Marine and Freshwater Research 23*(2), 73-84

[3] Pinedo et al. (2007). *Marine Pollution Bulletin 55*(1-6), 126-135

Complexity-dependent responses in ecosystem processes to low-frequency electromagnetic disturbance

Alessandro Bellino, Daniela Baldantoni

Department of Chemistry and Biology "Adolfo Zambelli", University of Salerno, Via Giovanni Paolo II 132 - 84084 Fisciano (SA), Italy; abellino@unisa.it

Through an experimental approach aimed at evaluating the propagation of disturbance across a hierarchical progression of ecological systems, we demonstrated the coupling between low frequency electromagnetic fields (1st mode of Schumann resonances) and system functioning at different levels of complexity. The alterations of ecological dynamics elicited by interfering anthropogenic electromagnetic fields were demonstrated to depend on system complexity, with increasingly clearer responses in moving from organisms to ecosystems.

Here, focusing at the ecosystem level, we aimed at evaluating how the complexity of functionally coupled processes may modulate the responses to electromagnetic disturbances. To this end, we studied the effects on litter decomposition of Schumann resonances variably interfered by 7.83 Hz – 15 ± 2 μT artificial fields. To highlight potentially small effects, the study was carried out under controlled conditions for up to 216 days, by exposing litter bags with holm oak leaves in mesocosms for different times (0, 15', 30'), using a coil purposefully developed via finite element modelling. Decomposition was investigated in terms of rates of mass loss and of involved processes, i.e. microbial activity by means of CO_2 evolution and enzyme activities, estimating the effects through Bayesian multilevel modelling.

Results highlight that disturbance to Schumann resonances differentially affects enzyme activities and microbial respiration, with the type and amplitude of responses dependent upon process complexity. The interaction among these processes, each with specific dynamics, elicits non-linear, hormetic responses in litter decomposition that are buffered, in terms of amplitude, in respect to the underlying processes.

On the one hand, our research confirms the coupling between low frequency electromagnetic fields and the functioning of ecological systems. On the other hand, it sheds light on the role of complexity in modulating the propagation of disturbances among interacting processes and in buffering the effects they may elicit on ecosystem processes.

Effects of turbidity and salinity anomalies on predation rates of native and alien crabs from a temperate coastal lagoon: a mesocosm experiment

Sonia Cheratzu, Pierantonio Addis, Francesco Palmas, Viviana Pasquini, Antonio Pusceddu, Serenella Cabiddu
University of Cagliari, Department of Life and Environmental Sciences, Via T. Fiorelli 1, 09126 Cagliari, Italy; sonia.cheratzu@unica.it

The intensification of extreme weather events, such as heavy rainfall is among the most critical manifestations of climate change. Coastal lagoons, due to their shallow depths and the direct influence of freshwaters, can be considered as ecological sentinels of convective rainfall events. Indeed, convective rainfalls can cause sudden and extreme changes in lagoon waters and sediments which, in turn, can influence physiology and behavior of organisms. This could have cascading consequences on inter-specific interactions, possibly favoring allochthonous species invasion and stabilization. In the framework the project eINS - Ecosystem of Innovation for Next Generation Sardinia (CUP F53C22000430001- MUR Grant Assignment Decree No. 1056, we investigated whether salinity and turbidity anomalies caused by a major rainfall episodic event may influence allochthonous and native crabs in a coastal lagoon. To do this, we investigated the predation rates of the native *Carcinus aestuarii* and the allochthonous invasive *Dyspanopeus sayi* on the native bivalve *Mytilus galloprovincialis*, after exposure to different salinity and turbidity conditions, including values typically observed after a heavy rainfall. We report here that the native crab *C. aestuarii* showed a wider range of salinity values (10-35), within which it can feed, generally preferring smaller prey (valve length 10.1 -15.0 mm) and that it was severely disturbed under medium-high values of turbidity (100 and 300 NTU). In contrast, the alien crab *D. sayi* was able to feed within a narrower salinity range (25-35) and exploited prey of all sizes (valve length 10.1 -25.0 mm), discarding the larger ones only when subjected to the highest turbidity values (100 and 300 NTU). Our results suggest that, during sudden salinity anomalies, like those considered in our experiment, the native species, being apparently more adapt to tolerate better freshwater inflows, could overcome the allochthonous one, that, in turn, appears more tolerant to high turbidity levels.

Habitat suitability and sensitivity area for offshore wind farm siting around Pantelleria Island.

Laura Ciriminna[1,2], Giovanna Cilluffo[1,2], Geraldina Signa[1,2], Agostino Tomasello[1,2], Salvatrice Vizzini[1,2,3]

[1]Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università degli Studi di Palermo, Palermo, Italia; [2]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Roma, Italia; [3]Centro di Sostenibilità e Transizione Ecologica (CSTE), Università degli Studi di Palermo, Palermo, Italia; laura.ciriminna@unipa.it

Wind power is one of the fastest growing renewable energy technologies and there is a growing interest in the great potential of offshore wind energy, as offshore wind farms (OWFs) might overcome the main limitations of onshore wind parks (land availability, habitat modification and social acceptance). However, the expansion of OWFs has also boosted the interest on the related impacts on the marine environment and biodiversity. In this context, one of the objectives of the Wind In My Backyard project is to assess whether areas around the Island of Pantelleria, a small island with high potential for renewable energy production due to its location in one of the windiest areas in Italy, are also suitable for species of interest, which may experience negative impacts from the wind farm infrastructures. Ecological Niche Models, estimated using four different algorithms (generalized linear model, random forest, max entropy and supporting vector machine) were applied to predict and map habitat suitability to different species (six bony fish, one shark, three rays, one sea turtle and two dolphin). Combining outputs of habitat suitability, a sensitivity map to assess potential areas of higher sensitivity, due to the presence of multiple species, was created, highlighting a potential sensitive area extending along the northwest-southeast axis in the southern part of Pantelleria Island. Our study may be useful for the identification of potential sensitive areas, drive selection of suitable sites for wind farm installation and improving citizens' understanding of the complex processes involved in marine spatial planning.

Evidence of chronic trawling disturbance on bentho-demersal communities: insights from taxonomic and functional diversity

Gabriele Di Bona[1], Manuel Berlino[2,3], Gianluca Sarà[1,2], Maria Cristina Mangano[2,3]

[1]Laboratory of Ecology, Department of Earth and Marine Science (DiSTeM), University of Palermo, Palermo, Italy; [2]NBFC, National Biodiversity Future Center, Piazza Marina 61, 90133 Palermo, Italy; [3]Stazione Zoologica Anton Dohrn, Dipartimento Ecologia Marina Integrata, Sicily Marine Center, Lungomare Cristoforo Colombo (complesso Roosevelt), 90142 Palermo, Italy; gabriele.dibona@unipa.it

Trawling on continental shelves disrupts benthic communities by altering sediments and increasing species mortality, favoring opportunistic over ecologically crucial long-lived species. An ecosystem-based approach, particularly trait-based analysis, is essential for understanding trawling's broader impacts on community functioning, especially in areas like the Mediterranean's Strait of Sicily, where extensive trawling necessitates multi-year management plans to prevent overexploitation. The study focused on an area between Malta and Sicily, known for significant trawling on sand and muddy sediments. Fishing intensity, assessed using satellite data, showed a gradient from coastline to offshore, peaking along the eastern continental shelf margin. Swept area ratio values ranged from 0.36 to 37.37, indicating substantial trawling pressure. Depth increased while fishing intensity decreased towards lower latitudes. During experimental trawl surveys, 8,191 individuals from 103 species were collected, with demersal species comprising 70%. Multivariate analysis assessed the impact of fishing intensity and environmental predictors on species and trait composition, revealing demersal species densities negatively affected by fishing intensity but positively correlated with bottom temperature. Benthic species densities showed weak negative impacts from fishing intensity but positive associations with temperature and chlorophyll concentration. Taxonomic diversity remained unaffected by fishing intensity, though chlorophyll concentration negatively affected demersal indices while enhancing benthic richness and diversity. Functional diversity indices showed no significant variation due to fishing intensity. Multivariate analysis indicated that spatial coordinates and studied variables explained only a small portion of taxonomic and functional composition variance. The study found minimal differences in bento-demersal assemblage composition along the observed fishing intensity gradient across the eastern Strait of Sicily's continental shelf. The assemblage composition appears influenced by chronic bottom trawling and bathymetric factors. These findings underscore the complexity of managing trawling impacts in ecologically sensitive marine environments.

The PhytoPlastic project: exploring the plastisphere community in European lentic systems

Flavia Dory[1], Veronica Nava[1], Mona Abbasi[2], Oloyede Adekolurejo[3,4], Patrick Aurich[5], Nans Barthélémy[6], Berenike Bick[2], Bryan Burri[7], Marco J. Cabrerizo[8], Geoffrey Cairola[9], Teofana Chonova[10], Mathilde Cour[11], Vanessa De Santis[12], Annemieke M. Drost[13,14], Baptiste Fatras[9], Lena Fehlinger[15], Aida Figler[16], Dariusz Halabowski[17], Daniel Harvey[18], Ellinor Jakobsson[2], Benjamin Misteli[19], Laureen Mori-Bazzano[7], Valentin Moser[20,21], Julia Pasqualini[5], Federica Rotta[22,23], Bianca Schmid-Paech[24], Camille Touchet[6], Konstantinos Vaziourakis[2], Víctor Manzanares-Vázquez[25], Dar Jaffer Yousuf[26], Julia Gostyńska[27]

[1]University of Milano-Bicocca, Piazza della Scienza 1, 20126 Milano (MI), Italy; [2]Department of Ecology and Genetics/Limnology, Uppsala University, Uppsala, Sweden; [3]School of Biology, University of Leeds, Leeds, United Kingdom; [4]Department of Biology, Adeyemi Federal University of Education, Ondo, Nigeria; [5]Helmholtz-Centre for Environmental Research, UFZ, 39114 Magdeburg, Germany; [6]Université Claude Bernard Lyon 1, LEHNA UMR 5023, CNRS, ENTPE, F-69622, Villeurbanne, France; [7]Université de Genève, Département Forel, Geneva, Switzerland; [8]University of Granada, Campus Fuentenueva s/n, 18071, Granada, Spain; [9]ENSEGID engineering school, 33600, Pessac, France; [10]Department Environmental Chemistry, Eawag: Swiss Federal Institute of Aquatic Science and Technology, Zurich, Switzerland; [11]Independent researcher; [12]Water Research Institute - National Research Council of Italy, Verbania, Italy; [13]NIOO-KNAW, Wageningen, the Netherlands; [14]Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, the Netherlands; [15]University of Vic UVic-UCC, Department of Biosciences, GEA Research Group, Carrer de la Laura 13, 08500 Vic, Spain; [16]Semmelweis University, Department of Bioinformatics, Budapest, Hungary; [17]University of Lodz, Faculty of Biology and Environmental Protection, Department of Ecology and Vertebrate Zoology, Lodz,Poland; [18]UK Centre of Ecology & Hydrology, Lancaster University, Lancaster/Newcastle, United Kingdom; [19]WasserCluster Lunz, Lunz, Austria; [20]Community Ecology, Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland; [21]Department of Aquatic Ecology, Swiss Federal Institute of Aquatic Science and Technology Eawag, Dübendorf, Switzerland,Zurich, Switzerland; [22]University of Applied Sciences and Arts of Southern Switzerland, Via Flora Ruchat-Roncati 15, CH-6850, Mendrisio,Switzerland; [23]University of Pavia, Via Ferrata 1, 27100, Pavia, Italy; [24]Weihenstephan-Triesdorf University of Applied Science, Germany; [25]Department of Research and Development, Coccosphere Environmental Analysis, Málaga, Spain; [26]Leibniz-Institute of Freshwater Ecology and Inland Fisheries, IGB Berlin; [27]Adam Mickiewicz University in Poznan, Institute of Environmental Biology, Department of Hydrobiology, Poznan, Poland; flavia.dory@unimib.it

Among the various stresses that affect aquatic ecosystems, plastic pollution is considered a serious, ubiquitous, and widespread environmental hazard. A growing body of works recognizes that plastics can act as a substrate for the development of the biofilm, hence promoting the colonization of various species. In this context, the term “plastisphere” has been created to define the diverse community growing on the surface of plastic debris. Microalgae are a significant part of this community, but not much research has been done on the photoautotrophic portion of the plastisphere. Here, we present the preliminary results of the 4th Collaborative European Freshwater Sciences Project for Early Career Freshwater Researchers (“FreshProject”), the "PhytoPlastic" project. The project aims to investigate the temporal colonization of microalgae on different plastic polymers in lakes across a wide geographical scale. Two plastic polymers (low-density polyethylene and polyethylene terephthalate) and a glass substrate (as a control) were incubated for 30 days in 14 lakes across Europe. To assess the temporal and seasonal development of microalgae, samples were collected in each season after 3, 7, 15, and 30 days. Photoautotrophic biomass was quantified for each substrate by the estimation of chlorophyll a and ash-free dry mass. This project represents the first coordinated experiment conducted on a large spatial scale to investigate the interaction between microalgae and plastic. Beyond its scientific contributions, the project fosters collaboration among early-career researchers in freshwater sciences and lays the groundwork for future partnerships.

The role of bacterial coats in defining the health status of the macroalgae of the Cystoseira genus

Lorenzo Federico[1], Sarah Caronni[1], Pieraugusto Panzalis[2], Sara Villa[1], Sandra Citterio[1]

[1]Università degli Studi Milano Bicocca, Piazza della Scienza 1, Milano, Italia; [2]Area Marina Protetta Tavolara Punta Coda di Cavallo, Via Dante 1, Olbia, Italia; lorenzo.federico@unimib.it

The community of *Cystoseira* sl. (Phaeophyceae) represent one most productive biocoenosis of Mediterranean intertidal coastal bedrocks, and among the best indicators of the health status of such ecosystems. They host an abundant and rich endophytic and epiphytic bacterial, that seem to contribute significantly in guaranteeing important physiological processes. However, it is still not clear their role in the survival of such macroalgae in case of anthropogenic stress and Climate Change. The aim of our work was to investigate the role of the epiphytic bacterial community associated to the most abundant *Cystoseira* species in determining its health status in different conditions of stress. The epiphytic bacterial community associated with *Cystoseira* sl. was characterized in three different zones of the Tavolara Punta Coda Cavallo Marine Protected Area (Sardinia, Italy), with different level of protection (A, B, and C). The distribution and the abundance of the species was evaluated, and the CARtography LITtoral communities index' (CARLIT index) was applied for understanding the health condition. Secondly, some blades samples were collected along each transect and the quantitative and qualitative characterization of their associated epiphytic bacteria was conducted in the lab. Analyzing the results, no differences in the abundance and distribution of *Cystoseira* sl. were observed between differently protected zones. However some significant differences in both the abundance and composition of epiphytic communities associated to the blades of *Cystoseira* sl. were recorded, in relation to the levels of protection. Specifically, in the C zones, where disturbances are expected to be higher, an increase in the abundance of the bacterial community was observed and some of such bacteria appeared to be involved in seaweeds adaptation to stress, suggesting that the bacterial coat of the macroalgae of the *Cystoseira* genus can effectively play a key role in defining their health status in stressed conditions.

Prioritising riparian ecotones to sustain and connect multiple biodiversity and functional components in river networks

Luca Gallitelli[1], Maria Cristina Bruno[2], Jose Barquin[3], Laura Concostrina Zubiri[3], Micael Jonsson[4], Morgan Hughes[4], Stefano Larsen[2], Monika Laux[5], Giorgio Pace[6], Massimiliano Scalici[1,7], Ralf Schulz[5]

[1]Laboratory of Ecology – Department of Sciences, University of Roma Tre, Rome, Italy; [2]Research and Innovation Centre, Fondazione Edmund Mach, Via Mach 1, 38098 S. Michele all'Adige, Italy; [3]Freshwater Ecosystems Research Group, Environmental Hydraulics Institute of Cantabria Foundation, Santander, Spain; [4]Department of Ecology and Environmental Science, Umeå University, Umeå, Sweden; [5]Institute for Environmental Sciences, RPTU – University of Kaiserslautern-Landau, Landau, Germany; [6]CBMA Centre of Molecular and Environmental Biology, Minho, Braga, Portugal; [7]National Biodiversity Future Center (NBFC), Università di Palermo, Piazza Marina 61, 90133 Palermo, Italy; luca.gallitelli@uniroma3.it

The Biodiversa+ RIPARIANET project aims to optimize the spatial biodiversity conservation of natural stream-riparian networks in order to provide practitioners with evidence-based guidance and approaches to conservation by mainly exploiting the increasing resolution of remote sensing information. The main purpose of the project is to assess riparian integrity and connectivity along the watercourse. To reach this goal, we investigate riparian networks within six river basins in Europe, along a geographical and climatic gradient to assess multiple biodiversity and stressors at the local scale, and scale-up this information to the network scale using geostatistical tools and advanced modelling. The conservation status and threats on riparian habitats will be evaluated along the Sävar River basin (Sweden), Queich River basin (Germany), Noce Stream and Tiber River basins (Northern and Southern Italy), Saja River basin (Spain), and Cávado River basin (Portugal). Particularly, data on river functionality (i.e., hydrology, decomposition, biofilm biomass accrual, and metabolism), diversity (i.e., microbes and fungi, macroinvertebrates, bats, and riparian vegetation) and stressors (i.e., pesticides, microplastics, and macroplastics) will be evaluated in different abiotic and biotic matrices. We expect to (i) identify protection gaps and ecological hotspots along riparian networks, based on multiple biodiversity, functional and connectivity criteria, and (ii) provide decision-support tools for decision-makers at local and EU levels.

Thermal performance approach improves the accurate prediction of species distribution in nature: the case of the Mediterranean mussel Mytilus galloprovicincialis (Lamarck, 1819)

Antonio Giacoletti[1,3], Mar Bosch-Belmar[1,3], Nicoletta Marsiglia[1], Mario Francesco Tantillo[1], Maryna Pishchalkovska[2,3], Matteo Battiata[2,3], Donatella Termini[3,4], Gianluca Sarà[1,3]

[1]Dipartimento di Scienze della Terra e del Mare, Università degli Studi di Palermo, viale delle Scienze ed. 16, 90128 Palermo, Italia; [2]Dipartimento di Scienze della Terra e del Mare, Università degli Studi di Palermo, Via Archirafi 20, 90123 Palermo, Italia; [3]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italia; [4]Dipartimento di Ingegneria, Università degli Studi di Palermo, viale delle Scienze ed. 8, 90128 Palermo, Italia; antonio.giacoletti@unipa.it

Biodiversity is widely acknowledged as a fundamental provider of ecosystem services, influencing productivity, nutrient cycling, resilience and resistance to disturbances. Conversely, climate change has emerged as a significant force shaping biodiversity by affecting individual life histories. The impacts of climate change, such as rising temperatures, acidification, and sea level rise, drive physiological, demographic, and community-scale processes by causing shifts in the distribution and functioning of key species. During the Mediterranean hot seasons, intertidal organisms living on the edge between high and low tidal marks, are often subjected to significant environmental fluctuations. These fluctuations affect individual body temperatures, leading to short term (acclimation, phenotypic plasticity) or long term (adaptation, selection, changes in distribution) responses. The Mediterranean mussel, *Mytilus galloprovincialis* (Lamarck, 1819), represents a key and valuable species in marine ecosystems and an important bioindicator for environmental changes. These mussels have been extensively used as model organisms for physiological, genetic and ecological studies. They are included in the European Marine Strategy Framework Directive (MSFD, Descriptor 9, EU 2008), and are recognised as useful site-specific bio-indicators to meet the EU Good Environmental Status (GES). In this study, individual performances were investigated in terms of specific thermal tolerance to frame the effect of temperature on metabolic machinery functioning. Once sampled, *M. galloprovincialis* specimens were subjected to 14 different temperatures, ranging from 8°C to 34°C, with respiration rates measured as a proxy for metabolism. The results revealed a left-skewed curve, with a T_{opt} at 26.7 °C, classifying *M. galloprovincialis* as a thermo-tolerant species well-adapted to warmer waters. This may explain its global expanding range in response to rising temperatures. Understanding the thermal tolerance mechanisms of this species is essential for predicting the impact of climate change on marine biodiversity and for developing conservation strategies.

Impact of invasive alien plant species on ecosystems and society. Some evidences from Central Italy.

Duilio Iamonico, Eva Del Vico, Alessandro Montaldi, Simone Valeri, Giulia Capotorti

Department of Environmental Biology, Sapienza University of Rome, P.le Aldo Moro 5, 00185, Rome, Italy;
duilio.iamonico@uniroma1.it

Biodiversity, ecosystems and human well-being are strictly joined under a *One Health* perspective, which represents a cost-effective, sustainable, transdisciplinary, and practical strategy for attaining optimal health for people, animals and the environment.

Worldwide, ecological perturbations caused by biotic invasions have been identified as a growing threat to all these sectors, with invasive alien plants causing important biodiversity loss, and altering environmental quality, ecosystem services and socio-economic conditions.

In Europe, a very high number of established alien species was recorded, with temperate and Mediterranean regions generally more invaded than those occurring in arid and warm ones. In this context, and with a special focus on urban areas (often considered “hotspots of plant invasion”), peninsular Italy represents a model-territory to investigate aliens and their effects on both the environment and human societies.

As part of ongoing studies on flora and vegetation of the Lazio region (central Italy), we had the opportunity to verify the incipient or current invasion of several *taxa* and their negative effects on the environment and human well-being. Some examples are presented, including alien plant taxa negatively affecting 1) floristic richness and composition of vegetation communities in freshwater and terrestrial ecosystems, 2) priority habitats, 3) trophic networks, 4) traditional agriculture, 5) human health, and 6) landscape identity.

In accordance with national and European regulations on the conservation of nature (e.g. EU Regulation 1143/2014, which sets out rules to prevent and mitigate the impact of alien species on biodiversity), and the *One Health* approach (recognizing the biodiversity role for mitigating heat, noise, and air pollution), a sound and detailed knowledge of floras, with a special focus on aliens, their distribution, ecological preferences, and threats caused to native taxa, represents a fundamental base to manage landscape, carrying out actions for control/reduction and, when possible, complete eradication of most damaging populations.

Medium-term fire effects on soil properties in a United Kingdom peatland

Luigi Marfella[1], Rossana Marzaioli[2], Flora A. Rutigliano[2], Helen C. Glanville[1]

[1]Department of Geography and Environment, Loughborough University, LE11 3TU Loughborough, UK; [2]Department of Environmental Biological and Pharmaceutical Sciences and Technologies, University of Campania "Luigi Vanvitelli", Via Vivaldi 43, 81100 Caserta, Italy; l.marfella@lboro.ac.uk

Wetlands are considered environments of pivotal importance due to the multiple ecosystem services provision. Notwithstanding covering only ~3% of the Earth's surface, peatlands are a precious component of natural capital by constituting the largest terrestrial carbon sink (~30% of the global soil carbon) and an essential freshwater source. However, the effects of climate change coupled with direct human impacts have induced peat degradation further exposing this ecosystem to a high fire risk. Nowadays peatlands, including those in the boreal, tropical, and temperate biomes, are experiencing this ecological upheaval.

In the past five years in the UK, the number of fires has increased by ~60% compared to 2015-2019, largely affecting raised and blanket bogs. This research aimed to investigate the medium-term (~5 years) effects of the 2018 fire in a peatland within The Roaches Nature Reserve (southeastern sector of the Peak District National Park and Special Area of Conservation-UK0030280). Specifically, the study evaluated the soil recovery status by comparing several peat characteristics at increasing distances (80 m, 160 m; 240 and 320 m) from the control unburnt area and toward the fire ignition point.

Here, remote sensing analysis was employed to assess fire severity, revealing high-severity fire that predicted alterations in soil characteristics. Indeed, soil analysis results highlighted deacidification, reduced water content and decreased organic carbon content in the burned peat long-lasting five years post-fire. Consequently, microbial biomass was also affected as showed by the alterations found in microbial carbon and nitrogen, which have not yet recovered the values observed in the control.

Considering that peatland conservation is critical to addressing climate change, this research demonstrated the necessity of developing specific management strategies to effectively support postfire recovery such as preventive measures, rewetting and replanting.

Global biotic interactions of seagrasses: a systematic review of epibiont and epiphyte relationships

Nicoletta Marsiglia[1], Mar Bosch-Belmar[1,2], Francesco Paolo Mancuso[1,2], Gianluca Sarà[1,2]

[1]Dipartimento di Scienze della Terra e del Mare,Università degli Studi di Palermo, viale delle Scienze ed. 16, 90128 Palermo, Italia.;
[2]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italy.; nicoletta.marsiglia@unipa.it

Biological interactions are one of the main factors influencing the distribution and abundance of species worldwide. Seagrasses represent important shallow-water habitats all around the world and provide crucial ecosystem goods and services to humans. Thanks to their structural complexity, they support heterogeneous populations and interact with associated benthic invertebrates (e.g., sea anemones, isopods, gastropods) and fish populations, with which they establish complex relationships that influence the performance and fitness of the involved organisms. Here, a systematic review was performed to investigate the existing potential biotic interactions between seagrasses and epibionts-epiphytes on a global scale. A complex search string was created and ran in the online databases Scopus and WoS, yielding a total of 43 final outcomes in a temporal range between 1987 and 2024. Results showed pro and cons of different types of biotic interactions (mainly symbiosis, including mutualism and commensalism) among these habitat formers and the associated epibionts and epiphytes. The review revealed that the most studied interactions referred to *Posidonia oceanica* (Delile) L. and *Zostera marina* L. providing refuge and habitat to different epiphytes and epibionts. Reviewed studies also highlighted the importance of epiphytes, their potential role in the growth, nutrient dynamics and their implications in the light absorption for seagrasses. Also, epibionts such as sea anemones may chemically defended seagrasses from predation, therefore their mucous can coat seagrass leaves and obstruct sunlight absorption. Understanding the various types of biotic interactions and studying how they can influence the performance of the species involved is of vital importance in the current and future context of climate change.

Do wildfires occurring in Mediterranean mountain beech forest influence soil microbial community and other soil properties?

Rossana Marzaioli, Teresa Di Santo, Stinca Adriano, Esposito Assunta, Rutigliano Flora Angela
Università degli Studi della Campania "Luigi Vanvitelli", Italia; rossana.marzaioli@unicampania.it

Mediterranean wildfires have increased significantly in recent decades due to climate change. Recently, fires also have negatively impacted historically scarcely affected forests dominated by species that lack specific fire-adaptive traits, such as Mediterranean mountain beech forests. In this case, the resilience of the whole ecosystem to fire could be low with consequent long-term effects also on soil microbial community. This plays a key role in providing essential ecosystem services, such as the regulation of nutrient cycling, and is particularly sensitive to changes in soil physical and chemical properties induced by wildfire. This study aims to evaluate the effects of 2017 wildfire on soil microbial community in a burned beech forest included in Site of Community Importance “Dorsale dei Monti Lattari” IT8030008 (HD 92/43/EEC). Changes between burned and unburned plots, two, four, and six years after fire, were analyzed for total microbial biomass and fungal mycelium, fungal percentage of microbial biomass, microbial activities (soil respiration, N mineralization, nitrification), and some chemical properties (pH, electrical conductivity, cation exchange capacity, total N, total organic C, extractable and mineralizable C). Neither microbial properties nor total organic C appeared affected by fire during the study period. The decrease in cation exchange capacity, N and extractable C found two years after wildfire was not recorded again four and six years later. Over the years, only an increase in pH and decrease in electrical conductivity were observed in burned than in unburned soil. Our findings indicate that fire did not affect main soil functions on the medium-term probably because of the fast regrowth of plants (at first, mainly annual herbaceous plants, then partially replaced by perennials and *Fagus sylvatica* seedling) that protected soil immediately after fire. Therefore, in absence of further disturbances, a recovery of beech forest, across a long time of ecological succession, may be expected.

Plastic ingestion in flatfishes from a partially protected area in the southern Tyrrhenian Sea

Chiara Molino[1], Cristina Pedà[2], Francesco Longo[3], Danilo Malara[2], Chiara Bacchiani[2], Pietro Battaglia[2], Maria Cristina Mangano[4], Silvestro Greco[1,5,6], Teresa Romeo[7,8]

[1]Stazione Zoologica Anton Dohrn - CRIMAC, Calabria Marine Centre, Department of Integrative Marine Ecology (EMI), C.da Torre Spaccata, 87071 Amendolara (CS), Italy; [2]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department of Integrative Marine Ecology (EMI), Villa Pace - Contrada Porticatello 29, 98167 Messina, Italy; [3]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department of Integrative Marine Ecology (EMI), CRIMAC, Villa Pace - Contrada Porticatello 29, 98167 Messina, Italy; [4]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department of Integrative Marine Ecology (EMI), Lungomare Cristoforo Colombo (complesso Roosevelt), Palermo, Italy; [5]Stazione Zoologica Anton Dohrn Department of Integrative Marine Ecology (EMI), Via Gregorio Allegri 1, 00198 Rome, Italy; [6]University of Gastronomic Sciences, Piazza Vittorio Emanuele, 9 Pollenzo, 12060 Bra, CN, Italy; [7]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department of Biology and Evolution of Marine Organisms (BEOM), Via dei Mille 46, 98057 Milazzo (ME), Italy; [8]Institute for Environmental Protection and Research, ISPRA, Via dei Mille 46, 98057 Milazzo (ME), Italy; chiara.molino@szn.it

In this study we considered five Pleuronectiformes flatfishes as bioindicators against the presence of microplastics in the marine environment. Given their ecology and behaviour, these species are strictly related to the seafloor, the last sink for anthropogenic litter. Flatfishes were caught during an experimental fishing survey in the Gulf of Patti, a partially protected area (no-take zone for trawl fishery since 1990) off the Southern Tyrrhenian Sea. Overall, we examined 13 *Arnoglossus laterna* (mean TL 11.8 ± 0.9 cm), 5 *Arnoglossus rueppelii* (mean TL 9.6 ± 1.2 cm), 10 *Lepidorhombus boscii* (mean TL 20.3 ± 5.7 cm), 13 *Lepidorhombus whiffiagonis* (mean TL 24.2 ± 7.6 cm), and 24 *Citharus linguatula* (mean TL 17.6 ± 4.1 cm). Stomachs were subjected to chemical digestion to isolate plastic particles. Once isolated, particles were counted and categorized by shape, colour, size, and their polymeric nature was identified through FT-IR spectroscopy technique. Overall, 37 plastics particles were found in 28 flatfishes (%O = 43.1%). More than 97% belonged to microplastic category (<5 mm) and only one mesoplastic was found in the stomach of *L. whiffiagonis*. In details, microplastics were recorded in 5 *A. laterna* (%O = 38.5), 1 *A. rueppelii* (%O = 20), 1 *L. boscii* (%O = 10), 9 *L. whiffiagonis* (%O = 69.2), and 12 *C. linguatula* (%O = 50). Grey (21.6%) and transparent (16.2%) particles had the highest frequency of ingestion. Fibers were the most common microplastics in all the investigated species (70%), followed by fragments (22%). The main identified polymer was polyethylene (17.6%), followed by rubber and polyester (all having 5.9%). To the best of our knowledge, this is the first evidence of microplastic ingestion in four of our selected target species in Mediterranean waters. Our insights call for further investigations to better understand the threat of plastics on demersal habitats.

Environmental drivers affecting fattening and calcification process of wild and farmed mussels in the Adriatic Sea

Antonella Penna[1,6], Alessandra Campanelli[2], Federica Grilli[2], Mauro Marini[2,6], Alessandra Spagnolo[2], Carola Mazzoli[1], Samuela Capellacci[1], Silvia Casabianca[1,6], Giorgio Famiglini[3], Giuseppe Prioli[4], Chiara Cassarino[5,6], Erik Caroselli[5,6], Arianna Mancuso[5,6], Stefano Goffredo[5,6]

[1]Dep. of Biomolecular Sciences, Campus Enrico Mattei, University of Urbino, 61029, Urbino; [2]National Research Council, Institute of Marine Biological Resources and Biotechnologies (CNR IRBIM), 60125, Ancona; [3]Dep. of Pure and Applied Sciences, University of Urbino, 61029, Urbino; [4]M.A.R.E. S.c. a r.l., Via E. Toti, 2, 47841 Cattolica; [5]Dep. of Biological, Geological and Environmental Sciences, University of Bologna, 40126 Bologna; [6]Fano Marine Center, The Inter-Institute Center for Research on Marine Biodiversity, Resources and Biotechnologies, 61032 Fano; antonella.penna@uniurb.it

Mussels (*Mytilus galloprovincialis*) represent the most important species for the Italian shellfish production. Production comes mainly from sea-farms and from wild populations in the northern western Adriatic Sea. In the recent years, both farmed and wild mussels showed problems with meat loss and increased shell fragility, which negatively affect their quality and market value. Since farming techniques have remained unchanged and wild populations are similarly affected, environmental factors may be the cause of these effects. The main goals of this study, under the PRIN-PNRR Project ENDRIMUS, are to identify the main environmental and biological factors affecting the quality of farmed and wild mussels along a latitudinal gradient on the Adriatic coast, and to provide farmers with information for the future development of mussel farms. Among the environmental factors, salinity, total alkalinity and DIC (dissolved inorganic carbon) varied among sites, with lower values towards South. The nutrient concentrations also highlighted a decreasing gradient from North to South (nitrates from 12.4±5.1 to 4.4±0.01 µM) in winter when the influence of northern river flows was more significant. In spring, the concentrations appeared more homogeneous across all investigated areas. A decreasing trend of chlorophyll *a* (from 6.4±1.1 to 0.9±0.1 mg/L) towards South was found. Target phytoplankton group, as *Skeletonema* spp., *Pseudo-nitzschia* spp. and *Scrippsiella* spp., abundances in mussel tissues estimate by molecular qPCR showed values of 820±138, 180±54 and 47±7 cells/g of tissue, respectively, reflecting taxa retrieved in phytoplankton assemblages. All the mussel samples showed seed presence, likely settled in winter with the settlement season extending until spring when specimens of 2-4 mm TL were found without differences due to the latitudinal gradient or between farmed and wild mussels. These are preliminary results obtained by the two seasonal campaigns in the NW Adriatic Sea helping the interpretation of this complex phenomenon affecting Adriatic mussels.

What are the effects of forest management on soil microbial community? A study in turkey oak and beech forests of Matese mountain

Enrica Picariello, Veronica Vitagliano, Aessia Esposito, Flavia De Nicola
Dipartimento di Scienze e Tecnologie, Università degli Studi del Sannio, Benevento, 82100, Italia; erpicariello@unisannio.it

Forest management practices focused mainly on increasing forest productivity and growing biomass stock but not preserving soil. These practices can influence both soil chemical-physical properties and microbial communities, which play an important role in ecosystem functioning through the decomposition of organic matter, and carbon and nutrient cycling. Consequently, disturbance affecting soil microbial community may impact forest ecosystem and provided services.
The study aimed to assess if forest management preserves soil microbial community, both in terms of functions and metabolic potential. At this aim, two forest systems (beech and turkey oak) under different managements (coppice and high forest) were selected in the protected natural area of Matese Mountain (Southern Italy), and the soil microbial community was monitored along one year (summer, autumn, winter and spring). The soil microbial community was investigated for six enzymatic activities (arylsulfatase, phosphatase, laccase, glucosidase, glucosaminidase, FDA activities) and for metabolic fingerprint by Biolog EcoPlates™ method (average well color development, AWCD) based on the ability of microbial community to degrade a wide range of carbon substrates.
In soil under turkey oak, the results showed significant differences between forest managements only in arylsulfatase activity in summer, with values higher in high forest respect to coppice. In soil under beech, significant differences between forest managements, with higher value in coppice, were found for: FDA and glucosidase activities in summer and spring; laccase and phosphatase activities in summer; glucosaminidase and arylsulfatase activities in spring and autumn, respectively.
AWCD showed higher values under coppice with respect to the high forest, in both forest systems in summer. Higher AWCD values under high forest were found in soil under turkey oak, in winter and spring.
The results will suggest what forms of forest management to use whose impacts on soils are low enough to be considered sustainable.

Differential effects of bottom trawling intensities on sediment biogeochemistry in the Bornholm Basin (Baltic Sea)

Antonio Pusceddu[1], Clare Bradshaw[2], Claudia Ennas[1]

[1]University of Cagliari, Dept. of Life and Environmental Sciences, Cagliari, Italy; [2]Stockholm University, Dept. of Systems Ecology, Stockholm, Sweden; apusceddu@unica.it

Bottom trawling is among the most severe and concerning anthropic activities altering benthic marine ecosystems worldwide. Nonetheless, the most often absence of control (untrawled) conditions has led to conflicting outcomes of trawling impacts studies.

To provide insights on trawling impacts, we tested the null hypothesis by which quantity, biochemical composition, nutritional quality, extracellular enzymatic activities, degradation rates and turnover time of organic matter (OM) in coastal marine sediments do not vary across a bottom trawling intensity (BTI) gradient, as determined by Swept Area Ratio (SAR) data. Sediments were collected in October 2023 from seven sites characterized by low (SAR <2 y^{-1}), intermediate (2 ≤ SAR ≤4 y^{-1}), high (SAR >6) BTI. At each site 3 independent corers were collected by means of a multiple corer and the top 1st cm analyzed for protein, carbohydrate, lipid and phytopigment contents as well as for aminopeptidase and b-glucosidase activities.

Contents of all organic compounds, but proteins, varied among the three BTI conditions, with values in sites with intermediate and high BTI unexpectedly higher than those in low BTI conditions. The algal fraction of biopolymeric C (a proxy of OM nutritional quality) and the protein turnover time did not vary across the BTI gradient, while both enzymatic activities and the cumulative C degradation rates were higher in the most disturbed sites.

Our results, confirming previous findings in shallow coastal ecosystems, suggest that intermediate and high BTI could cause a local increase in sedimentary organic loads, though with limited variations in OM biochemical composition and nutritional quality for benthic consumers. Apparently, the mechanical disturbance in sediments exposed to most intense trawling activities stimulates OM degradation, which is, however counterbalanced by the increased OM contents, likely due to re-depositional patterns of resuspended material.

Extensive coastal monitoring of chemical and biological parameters along Calabrian coasts

Valerio Sabellico[1], Rosario Calogero[1,2], Erika Arcadi[1], Francesco Fabiano[3,4,5], Carmen Rizzo[5,6], Christian Galasso[7], Chiara Giommi[8], Claudio Berti[9], Teresa Romeo[10,11], Silvestro Greco[12,13]

[1]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Contrada Porticatello, 29 – 98167 Messina, Italy; [2]Stazione Zoologica Anton Dohrn, CRIMAC, Contrada Torre Spaccata – 87071 Amendolara (CS); [3]Department of Earth and Marine Sciences, University of Palermo, via Archirafi 22, Italy; [4]NBFC, National Biodiversity Future Centre, Piazza Marina 61, Palermo, Italy; [5]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department Ecosustainable Marine Biotechnology, Contrada Porticatello, 29, 98167 Messina, Italy; [6]Institute of Polar Sciences, National Research Council (CNR-ISP), Spianata S. Raineri 86, 98122 Messina, Italy; [7]Stazione Zoologica Anton Dohrn, CRIMAC, Department Ecosustainable Marine Biotechnology, Contrada Torre Spaccata - 87071 Amendolara (CS); [8]Department of Integrative Marine Ecology (EMI), Stazione Zoologica Anton Dohrn, National Institute of Biology, Contrada Torre Spaccata, 87071 Amendolara (CS); [9]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department of Research marine Infrastructures, Contrada Porticatello, 29, 98167 Messina, Italy; [10]Stazione Zoologica Anton Dohrn, Sicily Marine Centre, Department of Biology and Evolution of Marine Organisms, Via dei Mille 46, 98057 Milazzo, Italy; [11]National Institute for Environmental Protection and Research, Via dei Mille 46, 98057 Milazzo, Italy; [12]Department of Integrative Marine Ecology (EMI), Stazione Zoologica Anton Dohrn, National Institute of Biology, Ecology and Marine Biotechnology, Rome, Italy; [13]University of Gastronomic Sciences, Piazza Vittorio Emanuele, 9, Pollenzo, 12060 Bra, CN, Italy; valerio.sabellico@edu.unifi.it

The Calabrian coasts are internationally renowned as a place with a high degree of biodiversity, hosting a diverse range of marine and terrestrial ecosystems that need to be preserved and maintained as much as possible. Despite the absence of large industrial activities or large metropolies the anthropogenic impact represents a threat for this fragile oasis of life. Among several forms of pollution, also the biological one, even under the strong pressure induced by the pandemic period, began to be perceived as a very serious threat to man and the environment, together with the chemical contamination. To date, researchers are interested in deepen their occurrence, the biodegradation routes, bioaccumulation processes, and the short-term and long-term effects in the marine environment. Unfortunately, coastal zone monitoring programs are not always well implemented and this leads to poor environmental quality control. For these reasons, biological and chemical contamination represent a theme of overwhelming concern, as it is a potential threat to all marine species and a serious danger for human health. The present massive monitoring study was aimed at investigating the presence of biological and chemical contaminants in the marine environment of the Calabrian coasts. To pursue this objective, a sampling plane of water and sediments from different sites of the Calabrian area was employed to detect critical issues of the wastewater purifying system on the territory regional. In parallel, next generation sequencing approach was applied on selected samples of water and sediment to characterize the taxonomic compositions of microbial communities. The results detected several criticities among the sampling sites, due to obvious contamination of biological and industrial origin. The presence of *Vibrio* spp. and *E. coli* was evidenced in several samples, suggesting the need for more attention to monitoring to protect the environment.

Alien plants do not exert univocal responses on soil microarthropod community

Lucia Santorufo[1,2], Monica Zizolfi[1], Giorgia Santini[1], Valeria Memoli[1], Rossella Barile[3], Giulia Maisto[1,2]

[1]Department of Biology, University of Naples Federico II, 80126 Naples, Italy; [2]BAT Center—Interuniversity Center for Studies on Bioinspired Agro-Environmental Technology, University of Naples Federico II, 80126 Naples, Italy; [3]Vesuvius National Park, Via Palazzo del Principe c/o Castello Mediceo, 80044 Ottaviano, Italy; lucia.santorufo@unina.it

Alien plant species invasions are among the top five causes of biodiversity loss, significantly reducing the abundance, diversity, and fitness of native ones. Alien plants alter native community composition through competition and allelopathy and through changes in soil properties by releasing root exudates and organic matter, impacting soil biota. While the effects on soil microbial communities are well-documented, impacts on soil microarthropods remain controversial and context-dependent. This research aimed to fill this gap by evaluating the impact of two alien species, *Robinia pseudoacacia* L. and *Ailanthus altissima* Mill., on soil microarthropod communities. Additionally, microarthropod communities under these alien species were compared to those under two native plant covers belonging to mature (*Quercus ilex*) and early (shrubs) stages. In autumn 2023, twelve sites within Vesuvius National Park (three for each plant cover) were selected to sample and extract microarthropods. Microarthropods were assessed for density, richness, diversity, and the soil biological quality (QBS-ar) index. Collembola were identified at the species level, assessed for density, richness, and diversity, and categorized into ecological forms (euedaphic, hemiedaphic, and epiedaphic). The preliminary results reveal that the two alien species exert contrasting impacts on soil microarthropod communities. Specifically, *A. altissima* enhanced the density, richness, and diversity of both microarthropods and Collembola, as well as the QBS-ar index, showing a community to those found under *Q. ilex*. In contrast, under *R. pseudoacacia*, microarthropod biodiversity was significantly lower compared to *A. altissima*, showing a community similar to that found under shrubs. Furthermore, under *A. altissima* and *Q. ilex*, Collembola were evenly distributed across the investigated eco-morphological categories. Conversely, under *R. pseudoacacia*, euedaphic Collembola dominated (60%) the community. In conclusion, *A. altissima* showed a microarthropod community similar to a native mature stage, whereas *R. pseudoacacia* showed a community similar to early native stage, exhibiting contrasting results.

Underwater photogrammetry as a novel approach to characterize and monitor Northern Adriatic biogenic outcrops: first results and perspectives

Marco Sigovini[1], Alessandro Bergamasco[1], Fabrizio Bernardi Aubry[1], Marta Cosma[2], Sandra Donnici[2], Irene Guarneri[1], Giuseppe Pessa[3], Luigi Tosi[2], Andrea Sabino[1]

[1]CNR-ISMAR, Consiglio Nazionale delle Ricerche - Istituto di Scienze Marine, Arsenale Tesa 104, Castello 2737F, Venezia; [2]CNR-IGG, Consiglio Nazionale delle Ricerche - Istituto di Geoscienze e Georisorse, Area territoriale di Ricerca di Padova, Corso Stati Uniti 4, Padova; [3]Gruppo Sommozzatori Caorle, Via Sansonessa 83, Caorle; marco.sigovini@ve.ismar.cnr.it

Over the last decade, the Structure from Motion (SfM) photogrammetric approach widely increased its applications. Currently it represents a valuable, cost-effective and innovative tool also for the investigation of underwater environments. Underwater photogrammetry allows non-destructive sampling and repeatable measurements, digitally recreating the geometry of marine sceneries from sets of overlapping photographs taken from different points of view. Main outcomes of this method are digital products such as 3D models, Digital Elevation Models (DEMs) and orthomosaics, bearing both morphometric as well as ecological information and allowing to obtain high-resolution and lasting records of habitat and communities' characteristics over ecologically relevant spatial scales. The SfM approach has been tested over the bio-geogenic outcrops scattered throughout the Northern Adriatic Sea seabed, locally known as "tegnùe" or "trezze". In this coastal region, very high turbidity is generally found; hence, this work highlights the potential of underwater SfM even in limited visibility conditions. Photogrammetric surveys were performed since 2022, in part within the framework of Interreg IT-SI TRETAMARA and TRECap projects, over test areas located in *Tegnùe di Porto Falconera* SAC, near Caorle (Venice). Surveyed areas span between 100-1000 m^2, with depth ranging from 6 to 10 m. Specific protocols for low visibility had to be developed. Very high-resolution (below cm) DEMs and orthomosaics were produced. Preliminary analyses were performed on these datasets to characterize landforms as well as epibenthic communities, allowing an explorative assessment of distribution, abundance and diversity of epibenthic organisms in relationship to main habitat features. Moreover, initial tests were conducted to assess changes between subsequent surveys over time on selected sub-areas. In perspective, the approach is effective in assessing the fine effects of anthropogenic and natural disturbance on species and habitats throughout time at very high spatial resolution, even in high-turbidity coastal waters.

Plasticising aquatic ecosystems: plastic pollution from inland to marine waters

Davide Taurozzi[1], Alessandra Cera[2], Alessandro Acierno[1], Giulia Cesarini[1,3], Cristina Coccia[1,4], Luca Gallitelli[1], Silvia Secco[1], Massimiliano Scalici[1,4]

[1]Department of Sciences, University of Rome Tre, Viale Guglielmo Marconi 446, 00146 Rome, Italy; [2]Institute of Freshwater Biology, Nagano University, 1088 Komaki, Ueda, Nagano 386-0031, Japan; [3]National Research Council - Water Research Institute (CNR-IRSA), Corso Tonolli 50, 28922 Verbania Pallanza, Italy; [4]National Biodiversity Future Center (NBFC), Università di Palermo, Piazza Marina 61, 90133 Palermo, Italy; davide.taurozzi@uniroma3.it

"Plastics" are a multifaceted group of emergent contaminants in aquatic systems whose effects can be detrimental at cellular, individual and ecosystem levels. Their ubiquity and persistence in the environment need research to further our understanding on their path and to establish risk thresholds. This work overviews our scientific contributions investigating macroplastics (plastics > 5 mm; MAPs), microplastics (between 5 mm and 0.001 mm; MPs), and nanoplastics (< 0.001 mm; NPs) in aquatic ecosystems (freshwater, transitional and marine) over the past 5 years. In detail, plastic occurrence, spatial-temporal distribution patterns and effects on micro and macro-organisms (plants and animals) were evaluated using field or laboratory studies. We found that hydrometeorological conditions regulated the input and mobilization of MAPs in rivers, modulating their discharge into the sea. While drifting downstream, some MAPs stayed entrapped in aquatic and riparian vegetation; depending on plant species, habits, life-forms, community diversity and structure. We observed that drifting MAPs were vectoring macroinvertebrates, vegetal organisms and MPs, facilitating their dispersal. In this sense, MAPs can also host diatom community: a one-year experiment on virgin MAPs placed in a wetland highlighted the effects on productivity and diversity. Regarding MPs in wetlands, we detected MPs in native invertebrates and invasive species, initiating investigations using stable isotopes. We investigated MPs ingestion by fish (occurring especially during feeding) and filtration by bivalves in both fresh and marine ecosystems; the latter were evaluated as good biomonitoring sentinels. Finally, our laboratory experiments showed that under exposure conditions, MPs and NPs cause sub-individual detrimental effects that vary according to the sensitivity of the organism considered (bivalves, hydroid polyps, planarians and diatoms). Similarities and dissimilarities detected between freshwater, transitional, marine ecosystems on responses to plastic exposure and spatial-temporal patterns will be discussed to contribute sparkling debate on sustainable management of aquatic ecosystems.

The comparison of structural and functional ecological traits in green, brown, and red macroalgae reveal a different resource trade-off among species living in the coastal zone of Campi Flegrei volcano.

Ermenegilda Vitale[1,2], Rosa Donadio[1,2], Giovanni Libralato[1,2], Simonetta Fraschetti[1,2,3], Carmen Arena[1,2]

[1]Department of Biology, University of Naples Federico II, Naples, 80126, Italy; [2]NBFC-National Biodiversity Future Center, Palermo, 90133, Italy; [3]CONISMA-Consorzio Nazionale Interuniversitario Per Le Scienze Del Mare, Rome, 00196, Italy;
ermenegilda.vitale@unina.it

This study aims to investigate how brown (*Dictyota dichotoma var. intricata (C. Agardh)*), green (*Cladophora rupestris (Linnaeus) Kützing*), and red (*Jania rubens (Linnaeus) JV Lamouroux*) macroalgae species living in a coastal zone of Campi Flegrei caldera (Pozzuoli Gulf, Italy) coordinate structural and functional traits for taking advantage of the habitat's environmental resources in spring and summer. This research may be of potential interest in providing baseline data for these algae and understanding the capability of different species to cope with the sudden environmental changes observed in the last decades. Using a field and laboratory approach, we monitored physico-chemical variables at the investigated site (water quality, temperature, pH, salinity, and irradiance), functional (photosynthetic efficiency, chlorophyll content, and antioxidant properties) and structural features (carbohydrate, area and dry matter content) of thalli. The results evidenced that during spring and summer, *Cladophora* and *Dictyota* exhibited better photosynthetic efficiency and higher values of pigments, carbohydrates, polyphenols and flavonoids than *Jania*, indicating a better light harvesting and utilization in carbon assimilation, as well as greater investment in antioxidant defenses. *Cladophora* and *Jania* showed a higher thallus dry matter content, which indicates a higher partitioning of carbon into structural biomass, favouring the resistance to mechanical and biotic stresses in these species. Conversely, *Dictyota* presented the highest specific thallus area and tannin concentration, suggesting a greater carbon allocation to photosynthetically active tissues and chemical defences than structural components. The overall data indicate that the different macroalgae species adopt distinct strategies to optimize the "trade-off" between the physiological cost of photosynthesis and the allocation of resources to protection/defence mechanisms. The ongoing investigations during the next seasons will provide further insight into adaptations and ecological dynamics of macroalgae in this coastal habitat.

Ecologia evolutiva e adattamento

Chairs

Daniele Porretta, Andrea Chiocchio

Presentazioni Orali

Designing the blueprint of Disease X: a prototypical modelling review of emerging zoonotic diseases spreading along different ecological pathways.

Davide Bogani, Lorenzo Mari, Renato Casagrandi
Politecnico di Milano, Italia; davide.bogani@polimi.it

Preparedness to fight an averted, yet possible next "Disease X" pandemics would require many actions along different dimensions. The WHO One Health framework has strongly highlighted the major threat posed by zoonotic infectious diseases - transmitted from animal to human hosts - and the necessity to reduce their risk of disease spillover and spread. An integrated framework that envisions all the ecological actors involved in the transmission cycle can inform policies to efficiently act well before the next “Disease X” pandemic event. Here, we target a set of zoonotic viruses brought to attention by the WHO, with critical epidemic potential and lacking effective countermeasures. Based on a performed review of almost 500 papers, we identify a taxonomy of prototypical models describing the local-scale spatiotemporal transmission of the target pathogens. The comprehensive approach of the analysis can provide relevant insights into the yet-unknown identity of Disease X: one of the target viruses, a related virus emerging from one of the target viral families, or - more generally - one of these viruses that evolves the ability to transmit in a new way or in an alternative host in unaffected and unprepared locations. We show the substantial differences that exist among diseases with distinct epidemiological characteristics and highlight the relative importance of the wildlife compartment for both human infection and viral maintenance. Specifically, we distinguish between viruses that can sporadically spill from animal hosts but then mainly circulate in humans (e.g. SARS-CoV1), viruses that efficiently co-circulate in humans and animals (e.g. LASV), and viruses for which humans are merely the dead-end host of a predominantly animal chain (e.g. RVF). This review serves a twofold objective: it represents an essential component for further modelling developments and provides a clear overview of the intrinsic benefits of simultaneously safeguarding human and environmental health.

Biogeographic history shapes spatial pattern of intraspecific variation in personality, performance and morphology

Andrea Chiocchio, Roberta Bisconti, David Costantini, Claudio Carere, Daniele Canestrelli
Università degli Studi della Tuscia, Italia; a.chiocchio@unitus.it

Addressing how individual variation within populations drives the evolution of biodiversity patterns is a major challenge in ecology and evolutionary biology. Historical biogeographic processes have had dramatic consequences on the structure of biodiversity. However, while the interplay between historical processes and genotypic variation within populations has been widely investigated, the effects of such processes on phenotypic variation remain poorly explored. Here, we investigate whether dispersal-driven processes of historical biogeographic relevance, such as late Pleistocene range dynamics, have contributed to shape the geographic patterns of phenotypic trait variation. We focus on dispersal-related personality, morphological and performance traits in the Tyrrhenian tree frog, *Hyla sarda*, which underwent a northward range expansion from the Sardinia island to the Corsica island during the last Glacial Maximum, when a temporary land-bridge connected these islands. We collected tree frogs from four geographic areas along the past expansion route, controlling for altitude, local habitat effects, demographic factors, and bioclimatic differences between geographic areas. Then, we scored intraspecific variation in two personality traits, two performance traits, along with morphological traits likely involved in the dispersal process. Tree frogs from Corsica were more prudent in a novel environment, they had significantly larger body size, longer limbs, wider heads, and displayed stronger take-off and adhesion performances compared to individuals from the source area in Sardinia. Overall, these results may suggest a non-random spatial sorting of the intraspecific variation in multiple phenotypic traits during the range expansion phase. In turn, they also suggest that population differentiation in phenotypic traits associations might be a legacy of past biogeographic dynamics, identifying an overlooked driver of current patterns of intraspecific variation in phenotypic integration and opening intriguing evolutionary scenarios on the processes shaping the phenotypic architecture of animal populations.

Multilocus Intron Polymorphisms (MIPs) as suitable tool for the analyses of interspecific hybridization

Leonardo Congiu, Boscari Elisa, Annalisa Scapolatiello, Chiara Samassa, Ilaria Marino, Francesco Martino, Lorenzo Zane
Università di Padova, Italia; leonardo.congiu@unipd.it

Interspecific hybridization is an evolutionary process that plays a crucial role in shaping the spatial and temporal patterns of biodiversity. Studying these processes necessitates specialized molecular techniques for recognizing and monitoring genetic introgression. In this methodological presentation, we introduce a new class of markers currently being developed at the University of Padua.

Our approach employs intron-targeted amplicon sequencing to genotype Multi-locus Intron Polymorphisms (MIPs) and evaluate genetic diversity. These highly variable intron regions, thanks to the high transferability between species provided by the highly conserved flanking exon regions, constitute powerful multi-SNP markers (microhaplotypes), suitable for various applications, including species and hybrid identification and population comparisons, even without prior knowledge of the species. We present the first highly transferable panel of MIPs across fish genomes, seeking to examine the advantages and limitations of these markers and evaluating their characteristics in relation to other available markers. Additionally, the potential of this method, developed here on teleosts, to be applied to other taxa is anticipated by various preliminary results.

Dissecting the structural and regulatory genomic basis of hypertrophied lip adaptations in Neotropical cichlid fishes

Paolo Franchini[1], Ming Li[2], Bai Wei Lo[3], C. Darrin Hulsey[4], Axel Meyer[2]

[1]Department of Ecological and Biological Sciences, University of Tuscia, Viterbo, Italy; [2]Department of Biology, University of Konstanz, Konstanz, Germany; [3]Max Planck Institute for Molecular Genetics, Berlin, Germany; [4]School of Biology and Environmental Science, University College Dublin, Dublin, Ireland; paolo.franchini@unitus.it

Cichlids are a species-rich family of teleost fishes renowned for their explosive phenotypic diversification, rapid adaptative radiation, and sympatric speciation. This makes them an ideal system to investigate the intricate interplay between ecological divergence and trait evolution, and to elucidate the genomic basis of adaptation. Hypertrophied lips, a trait associated with feeding variation, have convergently arisen in several cichlid adaptive radiations, including the Neotropical Midas cichlid species complex (*Amphilophus spp.)*. These thick lip phenotypes play significant ecological roles, enhancing feeding efficiency and specialized foraging strategies, thereby promoting niche differentiation and resource exploitation. A functional trade-off in feeding behavior between thick- and normal-lipped ecotypes likely fuels divergence through disruptive selection.

By integrating analyses of quantitative trait loci (QTL), genome-wide association studies (GWAS), pangenomics, transcriptomics, and topological associating domain (TAD) detection, we aimed to characterize the molecular genetic bases of the hypertrophied lip phenotype in Midas cichlids. Unlike previous studies, our findings reveal that multiple loci contribute to variation in this trophic trait, including two loci with large effect sizes. We then identified several differentially expressed (DE) genes between fishes with thick and thin lips. Notably, several of these DE genes were regulated by microRNAs also found to be DE in the same comparison. Moreover, pangenome reconstructions based on 32 chromosome-level haplotype-resolved assemblies for 16 phenotypically and genetically diverse Midas cichlid individuals resolved several ecomorph-specific structural variants that co-localize with lip GWAS and QTL intervals. Lastly, we identified altered TADs in genomic regions harboring coincident structural variants, GWAS, and QTL.

Overall, our results suggest that variation in lip size – a possible driver of sympatric speciation – is due to a complex interplay of multiple genomic factors. By elucidating the genetic architecture behind this ecologically significant trait, our study provides new insights into the molecular mechanisms driving ecologically based adaptive divergence.

Genomics of Lessepsian fish invaders: investigating the evolutionary dynamics behind the successful colonisation of the Mediterranean Sea

Francesco Giannelli[1], Samuele Broccardo[1], Ernesto Azzurro[2], Antonis Petrou[3], Marina Chiappi[3], Grigorios Skouradakis[4], Josephine Paris[1], Flávia A. Nitta Fernandes[1,5], Lorena Ancona[1], Tilman Alpermann[6], Mark Dimech[7], Emanuela Fanelli[1], Emiliano Trucchi[1]

[1]Università Politecnica delle Marche, Italia; [2]CNR - IRBIM, Ancona Italy; [3]Enalia Physis Environmental Research Centre; [4]HCMR Hellenic Centre for Marine Research; [5]University of Helsinki; [6]Senckenberg Research Institute, King Abdullah University of Science and Technology,; [7]King Abdullah University of Science and Technology,; Francescog900@gmail.com

The exponential increase in biological invasions worldwide, driven by globalisation and climate change is listed among the five biggest threats to the Earth's biodiversity. This trend poses a significant threat to the conservation of endangered species and ecosystems worldwide. The Mediterranean Sea emerges as notably affected by this phenomenon. Since the opening of the Suez Canal, a considerable amount of alien species have been entering the Mediterranean from the Red Sea, and their spread has been favoured by the consequences of climate change. Focusing on two successful Lessepsian fish invaders: Siganus rivulatus, a long-standing invader and Pterois miles a newly established invader, we aim to investigate the trends of different types of genetic diversity during the colonisation of the Mediterranean Sea. Our first objective is to investigate how the different timing and speed of invasion have shaped genetic diversity distribution and genetic load accumulation in these two invasive species. We also know that these species are adapting to significantly lower temperature and salinity levels than those in which they usually thrive. Our goal is to understand whether these two species are using the same gene combinations to adapt to the new environmental conditions. Lastly, considering different possible climate change scenarios, we aim to develop reliable predictive models to infer the possible future trajectories of these invasions, taking into account how non-neutral diversity may influence the invasive potential of these species. Preliminary results reveal a dramatic decline in genetic diversity moving from the source population to the northern bound of the invasive range with the Mediterranean population representing just a small portion of the total diversity present in the Red Sea suggesting that the colonisation of the Mediterranean is attributable to a single and rapid invasive event.

Infer the past to understand the future: Demographic history and environmental niche modelling in tortoises and terrapins

Alessio Iannucci[1], Marcella Sozzoni[1], Giulio Formenti[2], Massimo Bellavita[3], Sara Fratini[1], Guido Chelazzi[1], Erich Jarvis[2], Chiara Natali[1], Vladimir Trifonov[4], Anna Brüniche-Olsen[5], Claudio Ciofi[1]

[1]Dipartimento di Biologia, Università degli Studi di Firenze, Sesto Fiorentino (FI), Italia; [2]Vertebrate Genome Laboratory, The Rockefeller University, New York; [3]Riserva Naturale Regionale Selva del Lamone, Località Pontino, Farnese (VT), Italia; [4]Institute of Molecular and Cellular Biology SB RAS, Novosibirsk, Russia; [5]University of Copenhagen, Center for Macroecology, Evolution and Climate, Copenhagen, Denmark; alessio.iannucci@unifi.it

The recurrent climatic fluctuations of the Quaternary resulted in subsequent glacial and interglacial periods characterized by repeated changes in environmental conditions and resource availability. Several biotopes disappeared entirely or changed considerably leading to either extinction, survival in glacial refugia or adaptation to new habitats. Those environmental and distribution shifts likely had genetic consequences, with rapid demographic changes causing loss in genetic diversity. Patterns of demographic variation are reflected in the genome of a species which can be studied to estimate fluctuations in effective population size (N_e) using Pairwise Sequentially Markovian Coalescent (PSMC). The combination of PSMC and environmental niche modelling (ENM), which reconstruct changes in a species' distribution using paleoclimatic data, can provide insights into the effects of environmental variations on the life history of a species and eventually help understand its vulnerability to climate changes. Among vertebrates, turtles are one of the most endangered group due to illegal trade, habitat loss, pollution, and climatic alterations, which are already affecting several of their physiological and phenological characteristics. We used whole-genome sequencing data from 22 species of turtles to infer variation in effective population size through time and checked for correlation between N_e, heterozigosity, IUCN category and habitat availability during the Marine Isotope Stage 19, the last interglacial period, the last glacial maximum and the early Holocene. All species experienced a drastic decrease in *Ne* at the start of the last glacial period, which was correlated to a decrease in temperature. On the other hand, no correlation was found between extent of habitat availability, effective population size, extinction risk as defined by IUCN categories and heterozygosity.

Low levels of ecological adaptation among subspecies of the leopard (Panthera pardus)

Michela Leonardi[1,2], Sidney Leedham[1], Johanna L. A. Paijmans[1], Andrea Manica[1]

[1]Evolutionary Ecology Group, Department of Zoology, University of Cambridge; [2]Current address: Natural History Museum, London (UK). Department of Zoology, University of Cambridge (UK), Regno Unito; Gran Bretagna; michela.leonardi@nhm.ac.uk

The leopard (*Panthera pardus spp*.) is a generalist species that originated in Africa and dispersed into Eurasia between 400 and 600 thousand years ago. It is commonly subdivided into one African and eight Asian subspecies, roughly corresponding to the geographic areas each of them inhabits.

It is still unclear if such categorisation also reflects an ecological differentiation of leopards across different parts of their range. Here, we use species distribution modelling/habitat suitability modelling to compare the niches of leopard subspecies. Our aim is to investigate how the species' niche varies across its entire range and provide insight into the role of local adaptation and niche shift in its range expansion.

Our results support a general lack of niche separation between all subspecies. Most Asian subspecies have overlapping niches and occupy subsets of the African leopard's niche. Nevertheless, we found the Persian leopard, Panthera pardus saxicolor, to have the most distinct niche, giving some evidence for niche expansion in more Northern Asian subspecies.

We suggest little ecological differentiation among leopard subspecies and a lack of adaptation to novel climates after dispersal from Africa. This finding complements recent genetic studies in implying that the taxonomy of Asian leopards may not reflect biological differentiation, an important issue to resolve due to its relevance for the conservation of the species.

Same question, different answers: how resource availability shapes pace of life

Ludovico Lezzi[1], Milad Shokri[1,2], Alberto Basset[1,2,3]

[1]Università del Salento, Italia; [2]Natural Biodiversity Future Centre; [3]CNR-IRET; ludovico.lezzi@unisalento.it

According to evolutionary theories, each species adapts different strategies and makes trade-offs to maximize fitness. Even within the same species, individuals may follow diverse strategies, some bolder and more demanding than others. However, defining the driving forces that enhance this diversity still requires investigations.

This study aimed to examine the interplay between extrinsic environmental factors and individual pace of life using Gammarus insensibilis as the study organism, a detritivorous species in Italian lagoons. To this aim, cohorts with initial different densities were maintained for 45 days in laboratory experimental trials characterized by a constant resource supply, i.e. 20g of 15-day microbially conditioned Phragmites australis leaves. The population densities varied, corresponding to the individual-to-resource ratio, from 0.75 to 12.5 individuals per gram of resource. Resources were changed, and individuals were counted every 15 days. After 45 days, individual standard metabolic rates, recorded body mass, and maturity stage were measured.

Results showed an inverse relationship between cohort density and individuals' pace of life. Individuals reared in the lowest cohort density, compared to those in higher densities, had a greater average body mass, reached maturity faster, and had a higher baseline standard metabolic rate. Significant inter-individual variation in growth and metabolic rates was observed within each cohort, with the biggest individual ~10 times bigger than the smallest. Conclusively, this study revealed that the pace of life is modulated continuously across a spectrum of resource availability, with an increased resource-to-individual ratio resulting in a faster pace of life suggesting a wider range of individual personality outcomes. Our findings contribute to understanding the adaptive potential of population-level energy budgets influenced by the relative abundance of individuals with diverse energetic and life history outcomes.

On the origin of adaptations to novel conditions: insights from insecticide resistance

Valentina Mastrantonio, Valentina Lucchesi, Daniele Porretta

Dipartimento Biologia Ambientale, Sapienza Università di Roma, Italia; valentina.mastrantonio@uniroma1.it

Theory and empirical evidence support the idea that species adaptation to new environmental conditions may occur by two main routes: standing variation or *de novo* mutations. In origin from standing variation, adaptive polymorphisms are already present in the population before the selective pressure, and they will increase under positive selection. On the contrary, an adaptation from *de novo* mutations involves polymorphisms that originate in the populations once an environmental change has occurred. To date, a heated debate about the relative role of these two alternative routes is still occurring, mainly because we rarely can study populations before selection takes place.

Here, we exploited the information frozen in the genome of historical samples to disentangle between the two scenarios, putting them in the case of the diflubenzuron resistance in the mosquito *Culex pipiens*. Diflubenzuron is a chitin-synthesis inhibitor intensively used in northern Italy against mosquito vectors since 2007. In 2015, target-site resistance to this compound was detected in *Cx. pipiens* populations for the first time. By analysing current and historical samples, we showed that target-site resistance was already present in the populations of *Cx. pipiens* in the 1980s, thus pre-dating the use of diflubenzuron against this species. Concurrently by characterizing the morphology and behaviour of susceptible and resistant phenotypes in absence of insecticides, we revealed potentially advantageous traits associated with resistance. Taken together, our results support the importance of standing variation in adaptation and suggest that multiple selective pressures beyond insecticides may have favoured resistant individuals within populations.

Evolutionary distinct lineages of a migratory bird of prey show contrasting responses to climate change

Diego Rubolini, Joan Ferrer Obiol
Università degli Studi di Milano, Italia; diego.rubolini@unimi.it

Predicting species' responses to climate change is a pressing need hampered by our limited knowledge of spatiotemporal ecological and evolutionary dynamics. We combine landscape genomics, demographic reconstructions, and species distribution models to assess the ecological responses to past climate fluctuations and to future climate in an Afro-Palearctic migratory raptor, the lesser kestrel (*Falco naumanni*). We uncover two evolutionary and ecologically distinct lineages (European and Asian), whose demographic history, evolutionary divergence, and historical distribution range were profoundly shaped by past climatic fluctuations. Using future climate projections, we find that the Asian lineage is at higher risk of maladaptation, range contraction, increased migration distance, and consequently greater extinction risk than the European lineage. Our results emphasise the importance of providing historical context as a baseline for understanding species' responses to contemporary climate change, and demonstrate that incorporating intraspecific genetic variation improves the ecological realism of climate change vulnerability assessments.

Fishery genomics of the European hake. Evidence for subtle geographic differentiation and locally adaptive variation within the Mediterranean Sea

Lorenzo Zane[1,2], Rita Cannas[2,3], Costas Tsigenopoulos[4], Maria Teresa Spedicato[5], MED_UNITs Genetics Team[1,2,3,4]
[1]Università di Padova, Italia; [2]Consorzio Nazionale Interuniversitario per le Scienze del Mare, Italia; [3]Università di Cagliari, Italia; [4]Hellenic Centre of Marine Research, Greece; [5]COISPA Tecnologia & Ricerca, Italia; lorenzo.zane@unipd.it

Understanding population structure, genetic diversity, and adaptation in fish species is pivotal for fisheries genomics. This knowledge is crucial for effective fisheries management, conservation efforts, and to understand environmental impacts on fish populations.

This study employed ddRAD sequencing to identify and genotype single nucleotide polymorphism markers (SNPs) in European hake (Merluccius merluccius) population samples obtained during MED_UNITs project. Over 1,700 specimens from 41 sampling locations were analyzed, including extensive coverage of the Mediterranean Sea and one Atlantic location. Following reference-based assembly and quality filtering, we identified about 1,000 high-quality SNPs for downstream differentiation analyses. A comparison of the samples, based on all the SNPs, revealed significant genetic differentiation not only between the Atlantic and the Mediterranean Sea samples, but also within the Mediterranean. We observed significant differences between the Western, Central, and Eastern Mediterranean populations, as well as between the Levantine and Aegean Sea samples. Admixture analysis identified four genetic clusters, exhibiting varying frequencies in a west-to-east pattern within the Mediterranean. By employing the Population Branch Statistic, we identified SNPs putatively under selection in the admixed populations using an outgroup-case-control approach. The availability of individual phenotypic and environmental data allowed investigation of their correlation with SNPs. Notably, several putatively selected SNPs exhibited correlations with different individual parameters in independent comparisons supporting the possibility that these genetic variants lie in genomic regions with functional relevance, and they might be involved in response to the environment.

Our study offers new insights by revealing a significant degree of genetic structure within the Mediterranean region that extends previous results, which had only identified these differences through the analysis of outlier genetic loci. Additionally, the study highlights the adaptive genomic variation that underlies the observed population structure, thus providing valuable insights for the formulation of sound conservation strategies and development of sustainable fisheries practices.

Posters

Adaptation to hypersaline environments in sea rock-pool mosquitoes: Phenotypic plasticity meets and molds carry-over effects

Giulia Cordeschi[1], Roberta Bisconti[2], Valentina Mastrantonio[1], Daniele Canestrelli[2], Daniele Porretta[1]

[1]Sapienza Università di Roma, Italia; [2]Università degli Studi della Tuscia, Italia; giulia.cordeschi@uniroma1.it

In organisms living in highly variable environments, a strong phenotypic variability within populations is expected due to plastic responses to natural environmental variation. However, this is not commonly observed in nature. Here, we focused on the potential compensatory effects which might arise from the interaction between behavioural and morphological trait plasticity. These traits are remarkably sensitive to environmental conditions, and compelling studies showed that behavioural plasticity can influence individual life history traits such as body size or shape. In microcosm experiments, we manipulated saline concentration and analysed plastic responses in body size, pupal behaviour and carry-over effect across developmental stages in the sea rock-pool mosquito *Aedes mariae*. Analysing morphological traits, we found that larvae developed under increasing salinity conditions were smaller than larvae developed under constant conditions. Smaller body size at the pupal stage was also observed, testifying the occurrence of carry-over effects from larval to pupal stages. On the contrary, no differences were observed between adult sizes developed under the two salinity conditions. Analysing behavioural traits, we found that higher salinity promoted plastic changes in pupal diving behaviour. Under increased salinity pupae spent 20.6% less time underwater and performed fewer abdominal contractions than pupae under constant conditions. Because pupal energy expenditure is proportional to the time spent underwater, we suggest that the plastic pupal behaviour promoted compensatory growth, breaking down the carry-over effect from the pupal to the adult stage. This study highlights that plasticity at multiple traits in immature stages can affect carry-over and, ultimately, lead to the convergence of the adults' phenotypes.

Ecological and evolutionary perspectives on cancer cell population research: an initial review of current knowledge

Alessandro Fiore, Grazia Bramato, Giulia Girolimetti, Cecilia Bucci, Alberto Basset
Università del Salento, Italia; alessandro.fiore1@unisalento.it

Human tumor cell populations are comparable to communities of individuals within an ecological system, allowing for the application of ecological theories in cancer research. The exploration of group phenotypic composition in cancer - hallmarks of cancers - has highlighted the impact of individual cell traits on the fitness of both the cell and the population, to understand new perspectives on tumor progression and metastasis. Here, we want to illustrate how certain ecological theories can be applied to study some characteristics of tumor cell populations, in particular metabolism and the tumor microenvironment (TME).

Landscape genomic tools in area-based conservation planning: Insights from the Italian stream frog in the Aspromonte National Park

Giulia Gentile[1], Paolo Franchini[1], Giuseppe Martino[1], Roberta Bisconti[1], Antonino Siclari[2,3], Andrea Chiocchio[1], Daniele Canestrelli[1]

[1]Università degli Studi della Tuscia, Italia; [2]Aspromonte National Park, Santo Stefano in Aspromonte, Italy; [3]Città Metropolitana di Reggio Calabria, Piazza Italia, 89100 Reggio Calabria, Italy; giulia.gentile@unitus.it

From a conservation perspective, landscape genomic approaches have been mostly limited to assessing how structural landscape features influence functional connectivity within populations. Here, we explore the potential of landscape genomic data in the context of area-based conservation. Area-based conservation is by far the most successful strategy in addressing the ongoing global biodiversity loss. A key step in this approach is the designation of optimal zoning schemes that effectively integrate biodiversity protection with societal needs. Using restriction site-associated DNA (RAD) sequencing, we investigated the landscape genomic structure of the Italian stream frog *Rana italica* in the Aspromonte National Park. Population structure analyses revealed a substructure among the southern, central and northern areas of the park. Furthermore, by applying a moving-window approach, we generated maps of genetic diversity that showed higher diversity in the northernmost part of the national park. Surprisingly we found a counterintuitive pattern of lower levels of diversity within strictly than within mildly protected areas of the park. The ongoing study of functional connectivity within the park and its surrounding areas will allow us to understand how natural or artificial landscape elements influence intraspecific biodiversity patterns within and between the zones of the park and to provide fundamental knowledge to improve current zonation scheme.

Preliminary inference of patterns of loggerhead sea turtle colonization of the Tyrrhenian coastline using mitochondrial genome analysis

Alessio Iannucci[1], Livia Tolve[1], Luisa Garofalo[2], Federica Bellagamba[3], Cristiano Cocumelli[2], Cecilia Mancusi[4,5], Letizia Marsili[4], Giuliana Terracciano[3], Marco Alberto Luca Zuffi[6], Claudio Ciofi[1]

[1]Dipartimento di Biologia, Università degli Studi di Firenze, Italia; [2]Istituto Zooprofilattico Sperimentale del Lazio e della Toscana "M. Aleandri", RM, Italia; [3]Istituto Zooprofilattico Sperimentale del Lazio e della Toscana "M. Aleandri", PI, Italia; [4]Dipartimento di Scienze Fisiche, della Terra e dell'Ambiente, Università di Siena, Italia; [5]Agenzia Regionale per la Protezione Ambientale Toscana (ARPAT), Italia; [6]Museo di Storia Naturale, Università di Pisa, Italia; alessio.iannucci@unifi.it

The loggerhead sea turtle (Caretta caretta) is a globally distributed species and commonly found in the Mediterranean Sea. The main nesting beaches have been described in the Levantine basin, northern Africa and Ionian Sea, however, in the last decade, an increasing number of nesting turtles of unknown origin have been recorded along the coast of the Tyrrhenian Sea. In this study, we used mitochondrial DNA (mtDNA) analysis of samples from dead embryos collected in C. caretta different nests and from stranded individuals in Tuscany and Latium to provide a preliminary description of the ongoing colonization of the Tyrrhenian coast. Whole DNA was extracted from samples collected between 2012 and 2023. We sequenced the mtDNA control region of 64 individuals. Of these, a subset of 12 turtles had the whole mitochondrial genome sequenced and assembled. Previously published mitogenomes from our research group were included in the analysis. Haplotypes and haplogroups were assigned based on networks reconstruction and published literature. Mitogenomic haplotypic diversity was higher than control region haplotypic diversity and a single widespread mtDNA control region haplotype was split in five mitogenomic variants. All the haplotypes recorded in nesting sites belonged to the haplogroup already known in literature as the only one represented in Mediterranean rookeries, while half of the haplotypes recorded in stranded animals belonged to the Atlantic haplogroup. Our results indicate that attempts to colonize Tuscany and Latium seashores are most probably made by turtles from the Mediterranean, while Atlantic juveniles reach the Mediterranean to forage and for development but not for reproduction. Whole mitogenome sequence analysis also revealed a higher number of maternal lineages in the Tyrrhenian Sea with respect to single genetic markers, advocating the potential of mitogenomic analysis in population ecology studies.

Divulgazione dell'ecologia ed educazione ambientale

Chairs

Giuseppe Barbiero, Alice Stocco

Presentazioni Orali

Biophilic design reframed. The theoretical basis for experimental research

Giuseppe Barbiero
GREEN LEAF - Laboratorio di Ecologia Affettiva, Università della Valle d'Aosta, Italia; g.barbiero@univda.it

Biophilic Design is a design system based on Stephen Kellert and E.O. Wilson's Biophilia Hypothesis. Biophilia is literally 'love for life' – a feeling distinguished by the fascination evoked in human beings for Nature provoked by contact with Nature and by the affiliation that human beings establish with Nature. Biophilia is an evolutionary adaptation consisting of a set of innate learning rules that shape a spectrum of emotions, ranging from biophilia to biophobia. Two exaptations have been recognised in Biophilia, which occurred due to two moments of rupture of humankind from Nature: the first occurred in the Neolithic Age, the second with the Industrial Revolution which led to most humans becoming urbanized, disconnecting them from Nature. Designers following the principles of Biophilic Design seek to reconnect humans to Nature using our knowledge of biophilia as a guide for the design of artificial environments. Today, Biophilic Design is called to move away from empiricism, and instead implement the experimental tests of the Biophilia Hypothesis.

Plastic Crime Scene Investigation - PCSI communication plan: multifactorial societal participation for an inclusive territorial network framework

Raffaella Bullo[1,2,3], **Silvia Bianchelli**[1,4]

[1]Università Politecnica delle Marche, Italia; [2]Stazione Zoologica Anton Dohrn; [3]CIRCE srl; [4]National Biodiversity Future Center; r.bullo@pm.univpm.it

Citizen Science (CS) is more than just scientific research, it is about active civic participation. It is about going beyond reading news and watching documentaries, and actually getting involved in the scientific process. This deep and active involvement and the opportunity to collaboratively generate knowledge with others has significant impacts on society. This is particularly true in environmental science, where direct participation in scientific projects is closely linked to the opportunity to share knowledge and, in turn, make shared decisions on behaviors to change and practices to undertake. The democratization of the environment is a fairly recent idea that focuses on making environmental science more accessible to the wider community, with the aim of increasing scientists' awareness of local knowledge. CS initiatives serve as a foundational step in cultivating the necessary knowledge base, instigating behavioral shifts, and enhancing social capital through direct engagement with stakeholders and the wider community. Communication is a crucial part of CS activities, as without citizens there is no CS. It plays a vital role in recruiting, inviting, and maintaining participants' motivation. Communication involves a continuous effort to maintain transparency throughout every phase of the scientific process, from formulating the research question to publication, and requires attention in the development phase to include all the fundamental actors defined by Pietro Greco in 4 dimensions on a territory (institutional, business, scientific and citizenship dimensions). Here is presented the PCSI communication plan, a project dedicated to assessing a methodology for the quality-quantitative analysis of microplastics in seawater surfaces and beaches through a CS approach. The communication plan has structured the target of local actors on different levels: i. political structures, ii. law enforcement and related structures, iii. scientific institutions, iv. entrepreneurial structures, v. educational institutions, vi. artistic structures and cultural organizations and vii. social media.

RiVe methodology: a new Citizen Science tool for assessing riparian forest quality

Marco Cossu[1], Bruna Gumiero[1,2], Francesco Di Grazia[3], Cristian Di Stefano[1], Alessandra Casali[1]

[1]ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale; [2]Università di Bologna; [3]Università di Siena;
marco.cossu1994@gmail.com

Riparian zones are crucial for regulating geomorphological processes and supporting ecosystems, offering essential services like water quality improvement and biodiversity support. However, they are often overlooked in protocols assessing the ecological status of watercourses, as outlined by the Water Framework Directive. Many citizens view these areas as dangerous or unattractive, not understanding their importance. To address this, the "RiVe" methodology for Citizen Science activities was developed to assess the quality of riparian forests using accessible techniques. The RiVe methodology consists of three main phases: training, data collection, and analysis. Citizen scientists are initially trained through workshops and educational materials, equipping them with the skills to identify riparian plant species and use monitoring tools like the ODK Collect app or paper forms. During the data collection phase, participants monitor twelve target species, categorized into three ecological groups as indicators of habitat health, and record information about the river ecosystem. The data is analyzed to calculate the RiVe index, which assesses the quality of the riparian forest. This index ranges from 0 to 120, categorizing each survey into one of five quality classes, thus guiding management and conservation strategies. Effective management of riparian zones can restore ecological connectivity and integrate ecological corridors, especially in plains and agroecosystems, into a trans-European nature network, as supported by the recent Nature Restoration Law. A case study on the Idice stream shows that the RiVe protocol effectively identifies areas of significant degradation and assesses the local quality of riparian forests, while also increasing data collection and raising citizen awareness and interest in conserving local rivers.

Park, Science & Nature: the right mix for environmental education

Caterina Ferrari, Cristina Delcorso
PARCO NAZIONALE GRAN PARADISO, Italia; caterina.ferrari@pngp.it

"*What is a species? How can we understand its adaptation, its characteristics and how can we monitor it? And at the end..did I succeed in communicating all these topics*?"

This last question is the one we should ask ourself before and after planning an environmental education activity, to measure the effectiveness of our activity. A good tool to catch the interest of people of all ages but especially young, is by means of curiosity, raising interest and promoting new skills.

Raising interest and curiosity of people is easier when activities are proposed in a natural context, where different observations are largely possible, do not follow an established order and where questions are often generated spontaneously. Promoting new or unusual skills is favored when time is dedicated to observations and to specific questions in a relaxed environment.

In the Gran Paradiso National Park, most of environmental education pass trough scientific and practical activities organized directly in nature: for example by means of monitoring pollinators or with naturalist drawing based on observation. As a matter of fact, the Park is working intensively to promote different type of activities keeping the focus on the scientific approach so as on the ethical approach towards flora and fauna.

In this context we are having a positive feedback from the public of all ages, and even more important, people attending these event replicate what they have learn during successive context.

We thus are confident that proposing activities related with the observation directly in nature and with a quantitative and scientific approach may increase awareness among the public.

"Ecosystem services" in educational and training contexts

Caterina Lorenzi[1], Chiara Franzero[2]

[1]Università di Roma Tor Vergata, Italia; [2]Associazione G.Eco, Italia; caterinalorenzi.edu@gmail.com

The concept ecosystem services has over the past fifty years become a founding core of ecology, influencing its discourse and its ability to penetrate several civil society contexts.

There is a substantial literature devoted to the effectiveness of *ecosystem services* as a frame for promoting biodiversity conservation. For some authors, the concept has not been as successful as hoped as a vehicle for securing public interest and support for nature. Based on these arguments, we propose a reflection on the educational and didactic power of the concept in question, in view of the inevitable transformation process that scholarly knowledge must undergo in order to obtain effectively teachable knowledge.

I am Biodiversity: a transdisciplinary approach to improve ecoliteracy

Stefania Pinna[1], Sveva Lavecchia[2], Livia Taruffi[3], Cristina Del Corso[2]

[1]GREEN LEAF - Laboratorio di Ecologia Affettiva, Università della Valle d'Aosta – Université de la Vallée d'Aoste, Aosta, Italy; [2]Ufficio Comunicazione - Turismo e Promozione - Educazione Ambientale - PARCO NAZIONALE GRAN PARADISO; [3]Elementa Teatro - Compagnia di teatro di performance d'arte, Aosta; s.pinna1@univda.it

In 1997, the physicist, Fritjof Capra coined the term ecoliteracy, defined as an understanding of the principles of the organization of ecosystems and the application of those principles for creating sustainable human communities and societies. Frameworks for ecoliteracy include affective, knowledge, cognitive skills, and behavioral components. An ecoliterate person is prepared to be an effective member of sustainable society, with well-rounded abilities of head, heart, hands, and spirit, comprising an organic understanding of the world and participatory action within and with the environment.

The environmental education sector of Gran Paradiso National Park in collaboration with the Affective Ecology Laboratory developed the "I am Biodiversity" project involving students from the middle school in Cogne (Aosta Valley). Students, teachers, families, guides and experts in various fields were involved in a transdisciplinary approach to promote ecoliteracy.

The combination of scientific, educational and theatre languages made it possible to involve all components in a participatory approach during the school year and present to the community and families an eco-theatre performance entitled "Gaia's Revolution."

Activities were organized following six main elements: (1) ecological self—a sense of interconnectedness with the cycle of life; (2) sense of place and active citizenship—engagement in local culture, history, and organic community together with the ecosystem; (3) systems thinking and relationship—a sense of relationality, connectedness, and context; (4) the ecological paradigm—study of the whole, relationships, and networks; (5) pedagogy of education for sustainability—an experiential, participatory and multidisciplinary approach, focusing on the learning process; (6) reading the world of nature and culture by the art of theatre.

Pre- and post-experience questionnaires were collected to bring out how students' relationships with themselves, others and Nature changed.

A community along the river: participatory monitoring as a tool to encourage eco-literacy and sustainable policies

Marta Polizzi[1,2], Jessica Ferretti[3,4], Marta Del Giudice[2], Francesca Appolloni[2], Sara Vegni[4], Bruna Gumiero[5,6]

[1]Department of Biology and Biotechnology “Charles Darwin”, University of Rome “La Sapienza”, Piazzale Aldo Moro 5, 00185 - Rome, Italy; [2]Insieme per l'Aniene Association, via Vicovaro snc, 00155 - Rome, Italy; [3]Department of History, Cultural Heritage, Education and Society, University of Rome “Tor Vergata”, via Columbia 1, 00133 - Rome, Italia; [4]A Sud Association – Ecology e Cooperation OdV, Via Macerata 22/A, 00176 - Rome, Italy; [5]Department of Industrial Chemistry "Toso Montanari" - CHIMIND, University of Bologna, Viale del Risorgimento 4, 40100 - Bologna, Italy; [6]Department of Biotechnology, Chemistry and Pharmacy - DBCF, University of Siena, Via Aldo Moro 2, 53100 - Siena, Italy; polizzi_marta@peceasy.it

Citizen science has been widely used recently as a tool to disclose scientific knowledge and to collect more data about the environment. It is a form of social engagement and can potentially increase ecological awareness and consciousness. Practicing participatory monitoring in a big city such as Rome is fundamental to reconnect citizens with their natural heritage and to guide environmental policies. Rome is crossed by two big rivers, the Tiber and the Aniene affluent, the second being protected under the Valle dell’Aniene Nature Reserve and maintained in a semi-natural context. A Sud and Insieme per l’Aniene, supervised by experts in river ecology, wanted to address water quality in the most important rivers of the city, involving citizens in collecting data. In 2021 RomaUp investigated water quality in Tiber river while WalkUp Aniene engaged people in a preliminary exploration on the Aniene river banks; in 2022 RomaUp 2.0 was implemented adding sampling points on the Aniene river, and in 2023 Aniene WaterLab focused on the Aniene river only. Affordable and easy-to-use kits were chosen to collect eight physical-chemical and bacteriological parameters: pH, temperature (°C), turbidity, conductivity (µS/cm), nitrate (NO3-), phosphate (PO43-), ammonia (NH4+) and Escherichia coli (CFU). In 2023 dissolved oxygen was added as a parameter. Thanks to this monitoring activity, curiosity about the Aniene River has increased, leading to the extension of the investigated area and to the integration with further activities such as monitoring macroinvertebrates and riparian vegetation. In 3 years 1.965 observations were collected and 280 people were engaged. Results show that the Aniene river is critically more polluted than the Tiber, being water-treatment plants a big issue, together with agricultural practices and illicit waste treatment. Consequences for human health and ecosystem functionality could be severe and require a sudden intervention.

Ecology for territorial design and biomimetics

Silvia Pulina[1,2]

[1]Università degli Studi di Sassari, Italia; [2]NBFC - National Biodiversity Future Center; spulina@uniss.it

The functioning of natural systems is mandatory to be known when we want to design in the territory. This is important to understand the potential impacts and consequences of our actions on natural environment. In addition, studying the wide variability of shapes, sizes and structural details of natural world can help us to investigate the concept of structure in Nature, offering valuable information on the form-function relationship in the project and on the efficiency principles governing Nature. At the same time, the acquisition of awareness on natural environmental complexity raises the urgency to explore adaptation strategies in a changing environment.

In this contribution I report the study case of the Department of Architecture, Design and Urban Planning of the University of Sassari, where Ecology is tough to students of the degree courses of Architecture and Design. In Architecture, the functioning of natural systems is investigated to understand the urgent need to preserve them, also in light of the climatic crisis on-going. Selected ecosystems are analysed with the collection and interpretation of scientific data to recognize possible anthropic impacts and evaluate restoration and management activities.

In Design, starting from the analysis and interpretation of scientific data on phytoplankton ecology, students apply the acquired knowledge on natural principles to possible design applications with a biomimetic approach. Design solutions inspired by phytoplankton ecology are validated with the construction of experimental models and prototypes.

In both courses, Nature itself is considered as a model of environmental sustainability.

Beyond the guilt. Sensitive dance as a creative tool to stimulate connectedness to Nature in children.

Lontana Re[1], Jessica Ferretti[2], Giuseppe Barbiero[1], Stefania Pinna[1]

[1]GREEN LEAF - Laboratorio di Ecologia Affettiva, Università della Valle d'Aosta – Université de la Vallée d'Aoste, Aosta; [2]Università degli studi di Roma "Tor Vergata"; lontana.re@univda.it

Traditionally, public understanding of ecological issues relied on informative projects, leveraging data to engage people's rational side. Recent campaigns often utilize shocking imagery to evoke guilt, appealing to a specific emotion. However, this approach primarily targets cognitive and rational aspects, potentially triggering emotional denial. Emotional intelligence and empathy are crucial for motivation and awareness. Therefore, new tools are needed that deeply engage these aspects. This project focuses on improving biophilia, an innate but underdeveloped form of empathy towards Nature that can be nurtured through education and training. Sensitive dance can be a new tool to improve biophilia. Sensitive dance primarily engages the kinaesthetic intelligence, initially activating bodily and sensory aspects in participants. Furthermore, sensitive dance fosters social skills through contact and listening practices in pairs and small groups. This research investigates tools to enhance biophilia, starting from the hypothesis zero: "sensitive dance does not influence connectedness towards Nature". The experimental observations involve fifth-grade students. The treatment group will participate in five weekly, hour-long, age-adapted sensitive dance lessons. The control group will participate in physical education classes. Both groups will complete a test measuring connectedness with Nature before and after the five-week period. The project delves deeper into the concept of biophilia as an asymmetrical form of empathy, considering its development. Like empathy, does biophilia progress through stages of increasing complexity? What are the key factors involved in biophilia's development? Finally, how can we effectively cultivate biophilia?

One ecosystem: mapping for safe engagement with Nature

Alice Stocco[1], Fabio Pranovi[1], Giuseppe Barbiero[2], Stefania Pinna[2]

[1]Dipartimento di Scienze Ambientali, Informatica e Statistica, Università Ca' Foscari Venezia, Italia; [2]GREEN LEAF Laboratorio di Ecologia Affettiva, Università della Valle d'Aosta, Aosta, Italia; alice.stocco@unive.it

Recent transdisciplinary research demonstrates that interaction with Nature provides numerous benefits for human health and well-being. While this provides a valuable opportunity to reconnect people with Nature and offers healthcare professionals with a context to suggest “Green Prescriptions", which are recommendation to engage with natural environments, it also poses ecological risks. Engaging individuals in outdoor activities within environmentally sensitive areas can in fact disturb biodiversity and ecosystem functions, potentially triggering feedback that not only harm the resilience of the ecosystem itself but also reduce the effectiveness of these areas in providing restoration and supporting healing processes. To address these issues, we have developed “Gaia’s Maps”, a framework for mapping and evaluating natural areas to help people respect the environment and cooperate in taking care of ecosystem health as well as their own physical health, according to the Planetary Health perspective. The framework is based on an initial remote-sensing based identification of suitable locations for outdoor activities and Green Prescriptions, that is enriched with open-data and information collected in the field by visitors, who are encouraged to follow criteria suggested by a team of ecologists. An intuitive tool is then created, based on an index depicting the naturalness of the areas and their sensitivity to disturbance: this detects the areas that, although highly beneficial for human well-being, must be respected and protected to uncontrolled outdoor activities to avoid harm. This way, Gaia’s Maps framework promotes environmental education and enables informed and sustainable use of natural spaces. Additionally, it strengthens the relationship between healthcare professionals, who monitor and restore human health, and ecologists, who monitor and restore ecosystem health, underscoring the crucial importance of ecologists in ensuring that both people and ecosystems can thrive together.

Cs4rivers: citizens and scientists together to measure the habitat quality of riverine ecosystems

Chiara Vitillo, Alessio Polvani, Bruna Gumiero, Cristina Capineri, Fabrizio Monaci, Venere Stefania Sanna, Francesco Di Grazia, Luisa Galgani, Steven Loiselle, Stefano Loppi

Università di Siena - Siena - 53100, NBFC National Biodiversity Future Center - Palermo - 90133; vitillo2@student.unisi.it

Globally, biodiversity and ecosystems are experiencing irreversible losses caused by anthropogenic threats. Species are being lost at an unprecedented rate, causing degradation of ecosystem functioning and services. To address these questions, accurate and up-to-date data covering a wide geographical and temporal scale are needed. However, to support these efforts, there needs to be a concerted focus on education and outreach, to raise awareness for these issues, which in turn can increase bottom-up action and environmental stewardship, as well as democratise the fields of ecology and conservation. Citizen Science (CS) is a powerful approach for gathering the data required to address large-scale research questions and engaging the public in environmental issues. The development of citizen science initiatives and the use of citizen science data has increased in recent decades.

In this framework, a new CS project - CS4Rivers - has defined an innovative approach to measuring the Habitat Quality to facilitate the sustainable management of river ecosystems.

CS4Rivers guided by the University of Siena, within the NBFC with NRRP funds, is active in the Ombrone river basin (South Tuscany), throughout different monitoring activities: chemical water quality, macroinvertebrate community and riparian vegetation.

For macroinvertebrate and riparian vegetation monitoring, CS4Rivers employs a simplified protocol. The Data Quality is verified through comparisons with expert assessment data. Support materials and initial training have been developed for each activity. Preliminary results show the Habitat Quality value obtained by macroinvertebrate community analysis using the simplified and official protocol, and the Data Quality of coverage plant species percentages collected by citizens.

Within CS4Rivers, a pilot project in the Idice river basin (Emilia Romagna), involves 1 school and 3 groups of citizens who monitor the macroinvertebrate community in 7 stations and the riparian vegetation in 20.

Posters

Citizen Science for coastal biodiversity: monitoring exotic species on the central Adriatic coast with the Wild Coast Adriatic project

Federica Compagnone[1], Marco Varricchione[1,2], Angela Stanisci[1,2], Maria Laura Carranza[1,2]

[1]Department of Biosciences and Territory, University of Molise, Pesche (Is), Italy; [2]National Biodiversity Future Center (NBFC), Palermo (PA), Italy; f.compagnone@studenti.unimol.it

Coasts are hotspots of endangered Biodiversity in need of effective conservation and monitoring activities. We explored the potential of a *Citizen Science* (CS) generalist project called Wild Coast Adriatic (WCA) (https://sites.google.com/view/wild-coast-adriatic/attività-e-risultati?authuser=0) for a brief assessment of exotic species on the central Adriatic coast. WCA is a CS multi-taxa project supported by the iNaturalist platform that has been active since 2020 and includes the seashore of the Molise and Abruzzo regions embracing several sites of conservation interest (LTER: Long Term Ecological Research, N2K network, coastal protected areas).

We extracted from WCA the 139 records reporting aliens referable to 50 species. 94 records are of Invasive Alien Plants (IAP) of 15 taxonomic families (Asteraceae 28% and Fabaceae 10%) and 29 species coming from America (74%) and Africa (13%). 15 plant records are of two species of Union Concern (*Acacia saligna, Ailanthus altissima*). 45 reports are of alien fauna relative to 21 species coming from Asia (35%), North America (26%), and South America (18%). The most represented taxa are Insects (43%), Mollusks (24%), and Mammals (9%). 17 reports are of three aliens of Union Concern (*Myocastor coypus, Trachemys scripta, Gambusia holbrooki*).

From 2020 to 2023, the number of observations increased. Observations are evenly distributed across all seasons, with autumn recording the highest number of alien reports (43).

Alien species are heterogeneously distributed along the coast, with more records in southern Abruzzo. Most records (85) are outside protected areas. 54 records are inside N2K and LTER sites.

The considerable number of records of non-native species highlights the potential of CS to depict the distribution and spread of exotic species in coastal areas.

Challenge your knowledge on sandy beaches: the 2024 web platform-based competition for schools "EcoLogicaCup".

Lucia Fanini[1], Franca Sangiorgio[1,2], Alberto Basset[1,3]

[1]Department of Biological and Environmental Sciences and Technologies – University of Salento, Italia; [2]LifeWatch Italy; [3]LifeWatch ERIC; lucia.fanini@unisalento.it

Information technologies have reshaped teaching and learning in schools, and consequently, the ways we approach education. Nowadays, schools make significant use of instructional technologies as a support for inclusive learning. In Italy, ecology is not a study topic in itself but is embedded in civic educational curricula for both primary and secondary school cycles. In this context, the initiative "EcoLogicaCup" represents an opportunity based on a web platform, for schoolkids to participate to a non-formal learning path about ecological issues. It is a national online competition open to students from primary to high schools, aiming to stimulate the interest of youngest generations towards ecosystems and ecological sustainability. Every year different ecological topics are available on the LifeWatch platform for participants to study, exercise and finally challenge themselves to be the winners, answering questions organized around 5 difficulty levels. This implies that participants must learn about the topic and related key concepts. Schools have to officially join the competition, though single classrooms can be enrolled, depending on teachers' availability to engage. The topic proposed for 2024 edition was 'Sandy Beaches'. Sandy beaches are fascinating ecosystems connecting land and sea, providing several ecosystem services yet highly impacted by anthropogenic pressures. Given the large coastal extension of Italy (about 8,000km), sandy beaches are key ecosystems to be protected for both their ecological value and the economic resource they represent. EcoLogicaCup results pointed at a higher occurrence of incorrect answers in middle-schools compared to the high schools, though no incorrect answer was recorded for the "ecological value" set of questions. Primary schools' engagement also resulted lower than middle and high schools. Overall, this highlights the need to make ecological information less fragmented and more consistent along school levels, to accompany young citizens and provide them with knowledge and skills to care for the environment.

"Educating community enterprise," learning to design community socio-economic models with an adaptive and systemic approach starting from the enhancement of local ecological knowledge

Jessica Ferretti[1,2], Sara Vegni[2], Antonio Motisi[3], Tommaso La Mantia[3], Leonardo Scuderi[4], Alessandra Raichi[4], Gianpaolo Rampini[4]

[1]Dipartimento di Storia, Patrimonio culturale, Formazione e Società, Università degli studi di Roma Tor Vergata, Italia; [2]A Sud Association - Ecology and Cooperation OdV, Roma; [3]Dipartimento di Scienze Agrarie, Alimentari e Forestali (SAAF), Università degli Studi di Palermo; [4]Resilea A.P.S. (Social Promotion Association), Pantelleria; jessica.ferretti8@gmail.com

Pantelleria, a volcanic island located in the middle of the Mediterranean Sea, is part of one of the global biodiversity hotspots and since 2014 it has been recognized as a UNESCO World Heritage Site.
This island from a social point of view is at great risk of depopulation due to economic conditions and lacks educational and employment offers to the inhabitants. In 2023 the project "Educating Community Enterprise. Relationality and local ecological knowledge" responds to a social and environmental emergency. This project aims to enhance the local ecological knowledge that a community has of the ecological system of its territory, and to propose community enterprise as a participatory and community-based economic model to develop environmentally sustainable work alternatives.
Four educational courses with active methodologies were proposed for secondary and high school students. Excursions to learn about the island's biodiversity and build an 'ecological identity. Another path saw the young people accompanied by expert tutors together with the inhabitants holders of local ecological knowledge such as the Art of the Creeping Olive Tree, a unique olive-growing technique that makes it possible to counteract the island's aridity and strong winds. Another path was to create a Pantelleria nursery of native wild plants starting with seed collection to create gardens without introducing invasive alien species. Lastly, a course to develop interpersonal and communication skills and learn how to design a community enterprise. Currently the first year of this project has ended, in which the students have shown a high level of activation and participation. In May 2024 a Conference was organized by all partners togheter the students at the end of the 1st year of the project. We look forward to the second year of the project to present discussions and conclusions.

“Tracce nel Mare – Ecosistemi da Salvare” a science evidence-based game to boost ecological knowledge transfer on young citizens

Maria Cristina Mangano[1,2], **Gianluca Sarà**[2,3]

[1]Stazione Zoologica Anton Dohrn, Department of Integrative Marine Ecology (EMI), Sicily Marine Centre, Lungomare Cristoforo Colombo (complesso Roosevelt), 90149, Palermo, Italy; [2]NBFC, National Biodiversity Future Center, Piazza Marina 61, 90133, Palermo, Italy; [3]Dipartimento di Scienze della Terra e del Mare, DiSTeM, Università degli Studi di Palermo Ed. 16, 90128, Palermo, Italy; mariacristina.mangano@szn.it

Games, due to their inherent propensity, combine knowledge to discern patterns, making them extremely useful for science education. Ecology, the science of patterns’ recognition, has significant potential for gamification. Within this framework, we developed the game "Tracce nel Mare – Ecosistemi da Salvare" wherein ecological principles are translated into game mechanics. This approach aims to significantly enhance students' comprehension of marine ecological patterns. The primary ecological concepts incorporated into the game were: 1) habitat fragmentation, encompassing both the identification and understanding of the various factors driving fragmentation and its potential impacts on ecological patterns; 2) the relationship between biodiversity and ecosystem functioning; 3) the provision of ecosystem services linked to the functions of key habitat-forming species. The game begins with a "Puzzle Duel," designed to familiarize players with the target habitats: *Posidonia oceanica* meadows, vermetid reefs and coralline algae beds. Elements for success in ecology, such as exploration (i.e., monitoring) and information synthesis, have been integrated into the game's five challenges (i.e., boxes). These include: "Question Points", designed to stimulate the creation of a knowledge baseline on the target habitats; "Ecological Memory", aimed at memorizing habitat threats and the ecosystem services associated with healthy habitats; "Carbon Challenge", to facilitate learning about carbon cycling in coralline algae; "Vermetid Craft", to explore the functioning and services provided by reef-forming species. The game set contains a "master" box for teachers to guide the adventure, along with five challenge boxes. Each box is equipped with materials for two teams (2-10 players). The game has been donated to four Sicilian Marine Protected Areas (https://eeb.unipa.it/tracce-nel-mare/), to a local library/community centre and to the eco-museum in Palermo, and to an aquarium in Malta. The game was developed as a scale-up action of a capitalisation project Interreg VI-A Italy-Malta “CapSenHAR”, co-financed by the European Union's, Regional Development Fund.

Marine Environmental Threats: an Erasmus Blended Intensive Programme to inform about human impacts on the ocean environments

Agnese Marchini[1], Ana Cristina Costa[2], Maren Ortiz-Zarragoitia[3], Mar Santos-Simon[1,3]

[1]Università di Pavia, Italia; [2]University of Azores, Portugal; [3]University of the Basque Country, Spain; agnese.marchini@unipv.it

Designed as hybrid courses, Erasmus Blended Intensive Programmes (BIP) are based on innovative teaching, learning and training methodologies for students and teachers, combining virtual teaching and short periods of physical mobility. These programs involve a minimum of three international academic partners, fostering transnational and multidisciplinary curricula, while ensuring access to different teaching models and learning methodologies.

The BIP "Marine Environmental Threats" (MET) is a 6 ECTS course, coordinated by the University of Pavia (UNIPV; Italy), with the participation of the University of the Basque Country (UPV/EHU; Spain) and the University of Azores (UAç, Portugal). It is focused on the main issues jeopardizing the health of the marine ecosystems and addresses them from a transdisciplinary perspective, based on the UNESCO declaration of the Ocean Decade (2020-2030) and SDGs 4 (quality education) and 14 (life below water). In particular, MET includes an online virtual mobility component, which combines synchronous and asynchronous teaching taught by UPV/EHU and UAç (1 ECTS each), ensuring flexibility and accessibility to all course contents, with English as the main vehicular language. The virtual component evolves simultaneously to other curricular subjects and students develop digital competences, communication and time management skills, while working on subjects related to ecosystem health, marine pollution, biomonitoring, overfishing and fisheries management. Following the virtual phase, the students from all three universities attend a physical mobility week (4 ECTS) organized at UNIPV and consisting in multiple activities that include seminars, lab activities, field work and workshops. These activities address multiple subjects such as climate change, underwater sound pollution and bioinvasions. Throughout the duration of the course, participants are immersed in an interdisciplinary and multicultural atmosphere that promotes development of interpersonal skills, including active listening, multilingualism, and teamwork.

FAIR data for biodiversity and ecosystems conservation in a changing word

Alexandra Nicoleta Muresan[1], Cristina Di Muri[1], Davide Raho[1], Ilaria Rosati[1,2]

[1]Italian National Research Council (CNR), Research Institute on Terrestrial Ecosystems (IRET), Lecce, Italy; [2]LifeWatch Italy, Lecce, Italy; alexandranicoleta.muresan@cnr.it

The collaboration between different scientific communities within the cross-disciplinary field of environmental sciences is essential to exchange data, protocols, methods, etc. This collaboration is also crucial to integrate scientific knowledge in a clear and unambiguous manner. This is particularly important in a world undergoing significant environmental changes, where the impact of humans on all ecosystems is becoming increasingly evident. Conventional and technology-driven research activities produce a vast amount of data and other research products such as algorithms, software, models. However, these outputs often remain inaccessible and cannot be reutilised by other scientists. The adoption of FAIR principles (Findable, Accessible, Interoperable and Reusable) and Open Science practices can facilitate the endeavours in the conservation of ecosystems' functioning and services by promoting data sharing and reutilisation. From this perspective, e-Science tools are highly effective and useful for achieving the FAIR data principles, particularly in the context of interdisciplinary research. The ITINERIS project aims to provide a unique, integrated access point to FAIR products and services provided by the 22 participating Research Infrastructures (RIs) covering all four environmental domains. The ITINERIS Hub will integrate a terminology service to facilitate the search and discovery of Semantic Artefacts (SA) which can be also used to annotated data and/or metadata of research products, thereby strengthening semantic interoperability across RIs.

The Sunrise project and the public perception of the seagrass Posidonia oceanica

Stefania Pinna[1], Simona Bussotti[2,3], Marilù Cavallero[2], Paolo Guidetti[3]

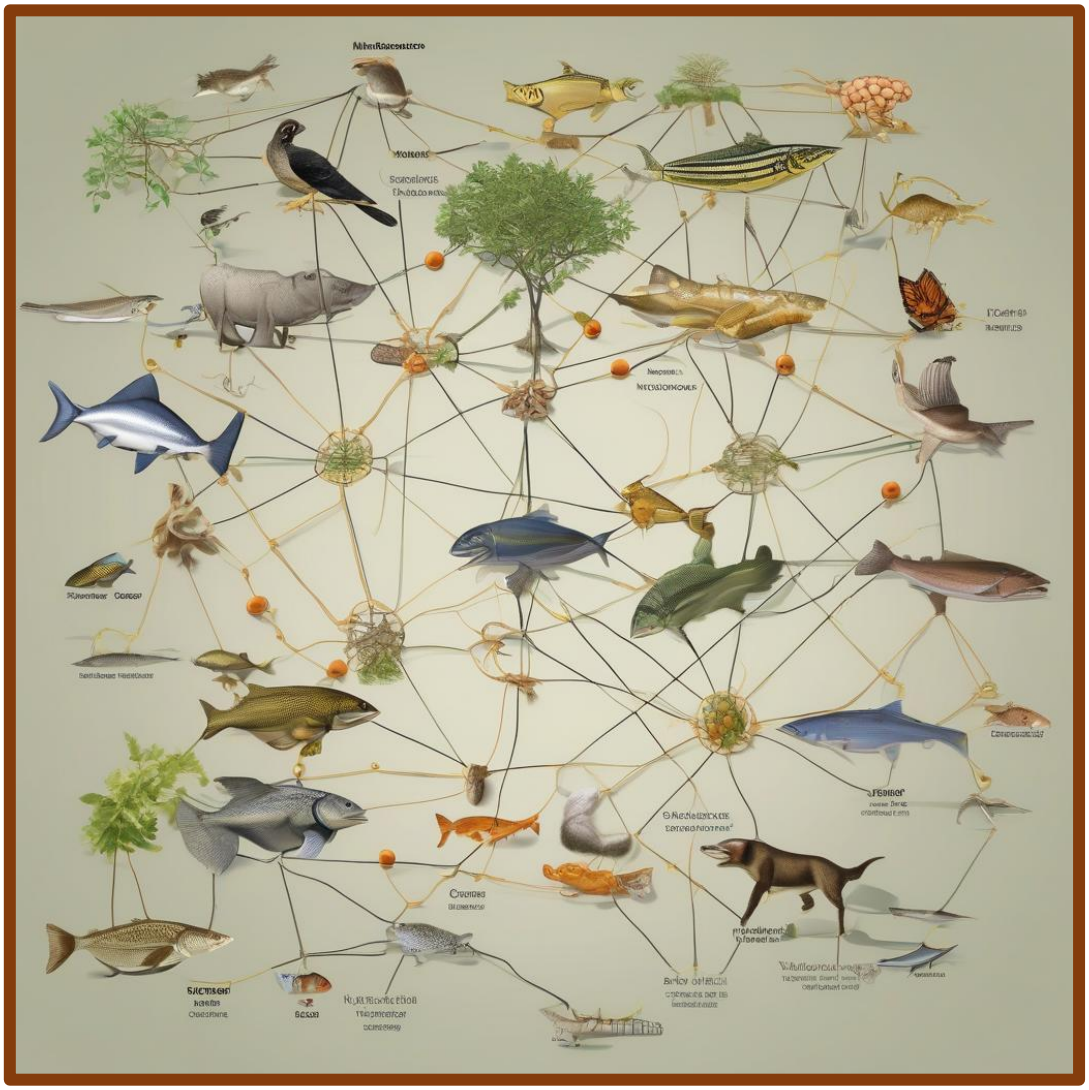
[1]GREEN LEAF - Laboratorio di Ecologia Affettiva, Università della Valle d'Aosta – Université de la Vallée d'Aoste, Aosta, Italy; [2]D.A.F.N.E. (Environmental Dissemination and Naturalistic-Ecological Training), Cooperative Enterprise, Genoa, Italy; [3]Department of Integrative Marine Ecology (EMI), Stazione Zoologica Anton Dohrn-National Institute of Marine Biology, Ecology and Biotechnology, Genoa Marine Centre, Genoa, Italy; s.pinna1@univda.it

Nature-based environmental education is crucial to improve the public awareness towards the benefits generated by protecting biodiversity locally. Seagrasses, from this perspective, support a rich biodiversity and deliver important ecosystem services, but widely remain poorly known.

In the frame of the "Sunrise" project, we assessed the public knowledge/perception about the seagrass *Posidonia oceanica* (L.) and its beach-cast accumulations (called "*banquettes*"), contributing to spread the notion about the importance of "marine naturalness, biodiversity and ecosystem services" in the context of Genoa City (Italy, NW Mediterranean). We administered a questionnaire to 250 pupils (aged 11-17) of 14 school classes then showing 'in the field' what discussed in classrooms. Elderly people, also, were involved to get info from their memories about *P. oceanica* and *banquettes* in the past.

Results show that only 14% of pupils recognizes *P. oceanica* as a "marine plant", while 68% perceives the presence of *banquettes* along the beaches as a "noise". Moreover, regarding their experience, about 60% answered rarely at the question if topics of Ocean Literacy and marine science issues were included in their school's curriculum.Elderly reported a vivid memory of the past presence of *P. oceanica* and *banquettes*, without any negative perception as it was 'natural'. Such evidences stress the urgent need i) to include (marine) ecological concepts in school programmes and ii) to promote inter-generational exchanges about environmental perceptions.

Further, according to the literature on emotional connections and cultural ecosystem services, we will investigate the affiliation of the pupils with coastal ecosystem, with the aim to bring out emotional affiliation, a factor on par with others traditionally recognized for behavior change, such as knowledge or interest.



Reti trofiche ed ecologia di comunità

Chairs

Loreto Rossi, Maria Letizia Costantini, Simona Sporta Caputi

Presentazioni Orali

Assessing the relationships between biodiversity loss/change on marine ecosystem functioning: Aquatic eddy covariance in the Mediterranean Sea

Ana Maria Botero Angel[1,2], Manuel Berlino[2,3], Maria Cristina Mangano[2,3], Peter Berg[4], Gianluca Sarà[1,2]

[1]Laboratorio di Ecologia, Università degli Studi di Palermo, Italia; [2]NBFC, National Biodiversity Future Center, Italy; [3]Stazione Zoologica Anton Dohrn, Italia; [4]Laboratory of Aquatic Eddy Covariance, University of Virginia, USA; anamaria.boteroangel@unipa.it

The ongoing and predicted loss of biodiversity due to anthropogenic stressors, including climate change, pose significant threats to ecosystem functioning, and ultimately to ecosystem services upon which humans depend. The potential ecosystem functions in natural systems are given by the biological diversity within it, since the functional traits and main ecological attributes of the species within it are responsible for most of the ecosystem processes. Particularly in marine environments, these impacts can be profound, altering from small scale biogeochemical cycles to the overall resilience of an ecosystem. This research will contribute to the understanding of the intricate relationships between biodiversity and ecosystem functioning, by studying the mechanisms linking biodiversity change/loss in marine environment multifunctionality. We employ the novel Aquatic Eddy Covariance (AEC) technique (Berg et al., 2003) to measure vertical turbulent fluxes of oxygen that are widely used proxy for benthic mineralization and primary production, and from which we can derive daily metabolic rates of respiration (R), gross primary production (GPP), and net ecosystem metabolism (NEM). AEC provides a *in situ* non-invasive approach, minimizing ecosystem disturbance while integrating the flux over a large benthic surface area with strong spatial heterogeneity. In this context, AEC can be used to measure ecosystem functioning related to primary production and carbon sequestration. These functions measured together with other such as those for nutrient cycling, can then be studied in relationship with the associated biodiversity (ideally across different trophic levels and in varying temporal and/or spatial scales). The relationships found between these two components of ecosystems, could provide a good picture of how the biodiversity present is contributing and shaping the functions independently, or together simultaneously (multifunctionality). Preliminary results are presented from a case study on Mediterranean seagrasses and mixed macroalgae communities in the Stagnone di Marsala coastal lagoon, in Western Sicily.

Effects of climate change on food webs and carbon sink capacity in Arctic lake ecosystems

Edoardo Calizza[1,2], Giulio Careddu[1,2], Davide Giannini[1], Simona Sporta Caputi[1], Matteo Ventura[1], Roberta Zitelli[1], Vittorio Pasquali[3], David Rossi[4], Maurizio Azzaro[5], Filippo Azzaro[5], Angelina Lo Giudice[5], Rosamaria Salvatori[6], Maria Letizia Costantini[1,2]

[1]Department of Environmental Biology, Sapienza University of Rome, Rome, Italy; [2]CoNISMa, Rome, Italy; [3]Department of Sciences and Environmental and Biological Technologies, University of Salento, Lecce, Italy; [4]CNR-IRSA, Montelibretti (Rome), Italy; [5]CNR-ISP, Messina, Italy; [6]CNR-ISP, Montelibretti (Rome); edoardo.calizza@uniroma1.it

Climate warming is expected to affect nutrient transfer in food webs, with pronounced effects in the Arctic due to warming amplification and nutrient-limited conditions. Arctic lake ecosystems represent biodiversity hotspots and carbon sinks of global value. Declining snow coverage is increasing primary productivity and herbivore abundance in lake catchment areas, which represent key drivers of nutrient input. However, predicting climate change effects on Arctic lake food webs remains challenging, hindering the conservation of these fragile ecosystems and their services.

This study examines the effect of snow coverage and consequent migratory bird density (*Branta leucopsis*) on lake food webs. We analyzed nine shallow lakes along a gradient from the coastline to glaciers on the Brøgger Peninsula, Svalbard. Using gas-flow measurements and C and N isotopic analysis, we assessed nutrient sources, CO_2 emissions, and trophic interactions. Bayesian mixing models were employed to investigate the diet of *Lepidurus arcticus*, a key omnivorous species in lake food webs.

Decreased snow coverage led to an increase in primary productivity and geese abundance around lakes. In turn, organic inputs from geese increased N concentration in sediments and improved the stoichiometric quality of aquatic vegetation. This led to two primary effects: (i) a fourfold increase in CO_2 emissions from sediments, and (ii) a dietary shift in *L. arcticus* towards greater consumption of sediments, which store long-term C, and aquatic vegetation, containing newly fixed C, thereby reducing its intake of animal prey. These changes resulted in a 12-17 gC m^{-2} $year^{-1}$ increase in C flow from basal resources to upper trophic levels, reducing potential long-term C accumulation.

By linking CO_2 emissions and C transfer in food webs to variations in snow coverage, vegetation, and geese abundance, this study advances our mechanistic understanding of the cascading effects of climate change on Tundra ecosystems and their capacity as carbon sinks.

Fishing pressure impairs the trophic ecology of benthic feeders: the case of red mullet (Mullus barbatus) in the central Adriatic investigated through a multidisciplinary approach

Luca Caracausi, Zaira Da Ros, Davide Silvestri, Alice Premici, Behixhe Ajdini, Cristina Truzzi, Emanuela Fanelli
Università Politecnica delle Marche, Italia; caracausi.luca@gmail.com

Bottom trawling is known to affect directly and indirectly the structure and functions of benthic ecosystems. Direct effects include the removal of benthic and benthopelagic species, whereas indirect effects include a wide range of impacts on the seabed and resident species. Among indirect effects, functional changes to benthic communities have also been reported, which in turn may affect the diet (i.e. food preferences and feeding habits) and the trophodynamics (i.e. trophic level in the food chain) of benthic-feeding fish. Here, we aimed to evaluate the impact of fishing pressure on the diet composition, trophic level and food source and lipid content of one of the most important commercial species of the Mediterranean Sea, the red mullet *Mullus barbatus* collected in three areas of the Central Adriatic Sea, characterized by different fishery pressure, according to Vessel Monitoring System data. Our results revealed significant differences in diet composition among areas, based on stomach contents analysis, suggesting that fishing activities influence the dietary preferences of red mullets, while $\delta^{13}C$ and $\delta^{15}N$ values did not reveal changes in carbon sources and trophic levels. Finally, significant differences were observed in the concentration of polyunsaturated fatty acids (PUFAs) and monounsaturated fatty acids (MUFAs) of specimen from the three areas and specifically areas with lower fishing pressure showed a higher concentration of healthy PUFAs, while areas with higher fishing pressure showed a higher concentration of MUFAs. The significant influence of this anthropogenic impact on the diet composition, stable isotopes contents and nutritional characteristics of *M. barbatus* underlines the importance of considering fishing pressure in fisheries management and also for maintaining a good nutritional quality of commercial marine species.

Functional traits assessment at the first level of the trophic web through the application of molecular ratios in coastal waters under environmental condition changes

Silvia Casabianca[1,2,3], Samuela Capellacci[1,2,3], Fabio Ricci[1,2,3], Giorgia Ravera[4], Geraldina Signa[2,5], Michele Scardi[2,6], Antonella Penna[1,2,3]

[1]Department of Biomolecular Sciences, University of Urbino, Urbino, Italy; [2]CoNISMa, National Inter-University Consortium for Marine Sciences, Rome, Italy; [3]Fano Marine Center, The Inter-Institute Center for Research on Marine Biodiversity Resources and Biotechnologies (FMC), Fano, Italy; [4]Department of Pure and Applied Sciences, University of Urbino, Urbino, Italy; [5]Department of Earth and Marine Sciences, University of Palermo, Palermo, Italy; [6]Department of Biology, University of Roma Tor Vergata, Rome, Italy; silvia.casabianca@uniurb.it

In marine phytoplankton ecology, biomass indices such as cell number or chlorophyll *a* determination may provide estimates of population abundances, but they do not account for the functional activity of species or groups. Conversely, molecular traits based on DNA and RNA, and ribosomal small subunit (18S rDNA) may be key for the metabolic dynamics in pelagic ecosystems. In this study, the metabolic activity has been assessed in two diatom species, *Chaetoceros socialis* and *Skeletonema marinoi*, typically occurring in the northwestern Adriatic Sea phytoplankton assemblages, by applying RNA/DNA and taxon-specific 18S rRNA/rDNA ratios. Significant correlations between abundance, chlorophyll *a*, carbon content and proteins were found (from rs=0.570 to rs =0.986, p<0.001). Biomass trend followed the logistic curve and during the initial stages of growth, the RNA/DNA and species-specific 18S rRNA/rDNA ratios of *C. socialis* and *S. marinoi* reached their maximum values (i.e., 23.2±1.5 and 15.3±0.8, and 16.2±1.6 and 30.1±5.4) after 2 and 6 days, respectively, in individual culture, with a subsequent sharp decreasing value for both species. In the co-cultured experiment, the maximum molecular ratio values were obtained after 4 days, in the exponential phase, showing values of 13.4±0.4 and 9.4±0.7 for total RNA/DNA and diatom 18S rRNA/rDNA ratios, respectively. Considering the molecular ratios for each target taxon, *C. socialis* and *S. marinoi* 18S rRNA/rDNA ratios showed maximum values of 24.4±2.0 and 8.2±0.7, for each species respectively, 4 days after the initial inoculum. These findings showed that changes in functional activity of primary producers may be associated with differences in RNA/DNA ratios, suggesting their potential as predictive tools for phytoplankton dynamics in coastal ecosystems that are subjected to pollution and climate pressures. Moreover, phytoplankton represents an important share of the first level of the trophic web and these ratios may be useful to evaluate coastal marine ecosystem productivity.

United in diversity: overlap and differences in the functional diversity of Mediterranean seagrass fish assemblages

Roberta Cimmaruta, Azzurra Lattanzi, Bruno Bellisario
Dip. di Scienze Ecologiche e Biologiche, Università degli Studi della Tuscia, Italia; cimmaruta@unitus.it

In the Mediterranean Sea, fish assemblages associated with seagrasses host a significant percentage of the total fish biodiversity and have been extensively studied. However, an overview of species richness and functional diversity at the Mediterranean scale was lacking, hindering the study of scale-dependent mechanisms related to fish habitat use and, ultimately, structuring ecological communities.

An exhaustive literature search was therefore implemented to build up a specific data base that includes the presence and the life stages of fish in the various seagrass habitats, along with specific functional traits known to be associated with fish habitat use and reproduction. The aim was to explore the extent to which fish species' traits drive the functional composition of fish assemblages associated with seagrass habitats and to determine if differences in seagrass structural complexity may influence the functional strategies of associated fauna.

The meta-analytic approach es applied revealed that the high species richness of fish in seagrass meadows is unevenly distributed among different habitats, showing a nested structure. Almost all the observed species present in *Posidonia oceanica*, with progressively smaller subsets found in *Cymodocea nodosa* and *Zostera* sp.

The characterization of the functional space and structure of fish assemblages across the various seagrass habitats showed that Mediterranean seagrasses host a vast array of functionally similar fish species characterized by r-like reproductive strategies and low-to-intermediate trophic levels, but differ for the traits exhibited by the associated predators.

Our findings reinforce the view that the predominant use of seagrass habitats by fish might be driven by the trade-off between different reproductive and feeding strategies.

Modelling community dynamics of mediterranean rocky reefs

Andrea Coppola, Paco Melià, Renato Casagrandi

Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano; andrea.coppola@polimi.it

Mediterranean infralittoral rocky reef ecosystems can undergo a distinctive regime shift, where the healthy state, characterized by macroalgal forests supporting rich and biodiverse communities that provide key ecosystem functions and services, are replaced by a degraded state, characterized by barrens formed by encrusting algae and showing low biodiversity. Sea urchins usually play a pivotal role in this process since, under certain conditions, they can significantly increase in number and favour, thanks to their grazing activity, this unwanted regime shift. We propose an ecological, process-based mathematical model that describes the processes influencing the spatio-temporal dynamics of the algal cover, focusing on the interactions between primary producers, sea urchins (whose grazing activity mediates the competition between the two algal groups) and sea urchin predators (such as sea breams, *Diplodus* spp.), and how these can drive the shift from a macroalgae-dominated forest to barren and vice versa. Our model allows us to describe population dynamics of the species involved and biomass flows across the different trophic levels. It makes also possible to explore how different levels of exploitation, on both sea urchins and their predators, can trigger a possible shift from forest to barren, thus driving a re-organization of the community. Although more robust calibration and validation is needed to make the model fully operational, this modelling approach has the potential to inform management policies and conservation strategies. Eventually, we aim at refining and expanding the model to include the effect of climate change and ocean connectivity, towards a basin-scale analysis at the meta-community level.

Ontogenetic and spatial variations in the trophic ecology of the blackspotted smooth-hound Mustelus punctulatus Risso, 1827 in the Adriatic Sea

Emanuela Fanelli, Luca Caracausi, Elora Chatain, Zaira Da Ros, Paula Masia-Lillo, Alice Premici
Polytechnic University of Marche, Italia; e.fanelli@univpm.it

Elasmobranchs face significant threats from intensive fishing and by-catch, particularly in the Mediterranean Sea, where 53% of sharks and rays are at risk of extinction. Understanding their biology and ecological roles is crucial to develop conservation strategies. In the current study the trophic ecology of the blackspotted smooth-hound *Mustelus punctulatus*, listed as vulnerable by the International Union for the Conservation of Nature, has been studied in three areas of the North-central Adriatic Sea, the Gulf of Trieste (named zone A), Venice Lagoon (zone B), and Emilia-Marche (zone C), by means of stomach content (SCA) and stable isotope analyses (SIA). SIA were carried out on both muscle and vertebrae. Our results showed that *Mustelus punctulatus* feed mostly on crustanceans and bony fishes, especially small pelagics, and to a lesser extent polychaetes and molluscs, with significant differences in diet composition among specimens collected in the zone A and those from zone C. Concerning SIA, while the $\delta^{13}C$ values in muscle tissue aligned with existing literature, a slight depletion in $\delta^{15}N$ was observed across all samples, which could be attributed to increased water intake from the Po River, exacerbated by the significant flood in May 2023, as fishing pressure in the area has decreased in the last years. Moreover, by comparing $\delta^{15}N$ values in the core and outer portions of vertebrae, corresponding to the mother's isotopic signature and prey assimilated within the last year, respectively, a clear ontogenetic shift in diet was observed. Remarkably, $\delta^{15}N$ values in the core varied significantly among samples from the three zones, suggesting the presence of at least two distinct nursery areas in the northern Adriatic Sea. These findings underscore the importance of considering regional variations and ontogenetic shifts in elasmobranch ecology for effective conservation and management strategies.

Seabed energy availability and sea duck's energy requirements for the prioritization of key feeding areas

Paola Forni[1], Julius Morkunas[2], Darius Daunys[2]

[1]CNR - Istituto di Geoscienze e Georisorse di Padova, Italia; [2]Klaipeda University, Lituania; paola.forni@igg.cnr.it

The Baltic Sea is a crucial wintering site for seabirds, particularly velvet scoters (*Melanitta fusca*). Velvet scoter is rapidly declining, despite being one of the most abundant wintering sea duck in the Baltic Sea. Protection measures should consider information such as diet, diving behaviour, time-budget and wintering energy requirements for the planning and zoning of marine protected area. Therefore, this work provides an integrated approach for the evaluation of the seabed energy and the energy demand of velvet scoter wintering in the Lithuanian coastal waters in the Baltic Sea. Diet analysis, using stomach content from bycaught individuals, were used to identify key prey species. The time-budget and diving behaviour were assessed via direct visual observations and transmitters deployment, respectively. The visual observations assessed the frequency of six behavioural categories during the day (resting, locomotion, feeding, comfort, alert and social interaction). Transmitters data provided information such as dive duration, descend, bottom and ascend duration, as well as the daily number of dives and the depth distribution. Literature data were used to recalculate the energy values associated with each behavioural category, providing insights into the estimation of daily energy expenditure. Benthic samples, collected between April 2020 and July 2021, were analysed to assess the distribution and biomass of prey in the environment. Benthic biomass was then modelled using Random Forest and converted into energy values to evaluate seabed energy availability. Information on the foraging ecology of velvet scoters and other energy costs (thermoregulation, basal metabolic rate, etc.) were combined to determine the sea duck's energy distribution. Ultimately, the integration of seabed energy availability and velvet scoter energy demands offers information for the zoning and prioritization of key feeding areas, which is essential for the conservation of this declining species in the Baltic Sea.

Paramuricea clavata forests support biodiversity and ecosystem functioning

Luca Licciardi[1,2], Alberto Colletti[1,2], Sara De Benedictis[1,2], Erika Fabbrizzi[1,2], Simone Maria Santo Musumeci[1,2], Chiara Silvestrini[1,2], Simonetta Fraschetti[1,2]

[1]Department of Biology, University of Naples Federico II, Naples, Italy; [2]National Biodiversity Future Center, Italy;
luca.licciardi2@unina.it

Coralligenous habitat is a biogenic temperate reef, representing one of the most important biodiversity hotspots in the Mediterranean Sea. The iconic species *Paramuricea clavata* is an ecosystem engineer which increases the spatial complexity of the habitat, developing animal forests that support the persistence of other species. In the last decade, *P. clavata* suffered the increase of multiple stressors which led to mass mortality events with substantially unknown consequences on associated benthic assemblages. We tested the hypothesis that *P. clavata* has the role of increasing local biodiversity. The study was carried out in the Gulf of Naples, where benthic communities inside vs outside the forests were compared in terms of β-diversity (partitioned in its two components nestedness and turnover) and functional richness. *P. clavata* forests are mainly represented by small size classes and show a wide range of both density (27 - 65 colonies/m^2) and biomass (100 - 505 g dry weight/m^2). The assessment of benthic assemblages reveals *P. clavata* forests support distinct communities, characterized by higher compositional and functional richness compared to the adjacent zones. The analysis of functional groups reveals that *P. clavata* prevents the spread of algal species, favouring the growth of sessile invertebrates. Comparing β-diversity, the turnover component is statistically significant at both taxonomical and functional level with higher values within the forest, highlighting the important role of *P. clavata* in modifying local environmental conditions and driving local species distribution. Our results provide new insights to the ecological relevance of this habitat and point out the importance of implementing its protection.

Preserving biodiversity and ecosystem services: which microhabitat must be prioritised in the lagoons of the Po Delta?

Alexandra Nicoleta Muresan[1], Mattias Gaglio[2], Michela Leonardi[3,4], Fabio Vincenzi[2], Elisa Anna Fano[5]

[1]Italian National Research Council (CNR), Research Institute on Terrestrial Ecosystems (IRET), Lecce, Italy; [2]Department of Environmental and Prevention Sciences, Unversity of Ferrara, Ferrara, Italy; [3]Natural History Museum, London; [4]Department of Zoology, University of Cambridge, UK; [5]Department of Life Sciences and Biotechnology, University of Ferrara, Ferrara, Italy; alexandranicoleta.muresan@cnr.it

Among coastal systems, river deltas are highly dynamic environments: they are hotspots of biodiversity, and they respond quickly to natural and human changes (Trincardi et al., 2023). In recent years, human impact on the Po River Delta (UNESCO heritage site and biodiversity hotspot) has significantly changed both the territory and the land use. Because of this, there have been major modifications in the type and amount of the ecosystem services that such area could offer to the local communities (Gaglio et al., 2017).

For five consecutive years (2015/2019) we sampled on a seasonal basis the macrozoobenthic community of the Po Delta (Emilia Romagna area) across all the microhabitats of the lagoons which responds optimally to natural and anthropogenic stressors (Mistri et al., 2000; Carvalho et al., 2011). We have demonstrated that the taxonomic and trophic-functional diversity of the same microhabitat (e.g., macroalgal beds, bare sediment, or *Phragmites* roots) is not comparable between different lagoons. Not only the macrozoobenthic communities are distinct, but the taxonomical and trophic biodiversity do not overlap either. The findings demonstrate the critical importance of conserving lagoon ecosystems in their microhabitat variability. Each lagoon system is unique, and preserving their distinct ecological characteristics is essential for maintaining their biodiversity and the ecosystem services they provide. Consequently, conservation strategies must prioritize the protection of these diverse microhabitats to ensure the long-term ecological integrity of the Po River Delta.

Patterns of occurrence, distribution and biometry of Faxonius limosus (Decapoda: Cambaridae) in two North-western Italian lakes

Marco Orlandi[1], Lyudmila Kamburska[1,2], Denise Schiavetta[3], Silvia Zaupa[4], Angela Boggero[1]

[1]National Research Council – Water Research Institute (CNR-IRSA), Corso Tonolli 50, 28922 Verbania; [2]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo; [3]Università del Piemonte Orientale -Department of Science, Technology and Innovation (DISIT) ,Viale Teresa Michel 11, 15121 Alessandria; [4]National Research Council – Water Research Institute (CNR-IRSA) Via Roma 3, 74123 Taranto; marco.orlandi@irsa.cnr.it

Biological invasions are constantly increasing globally, with freshwater ecosystems (rivers and lakes) among the most vulnerable. In these habitats invasive crayfish (Crustacea, Decapoda) have a significant ecological impact. The current study examined the population structure, as well as the spatial and temporal distribution of the invasive American crayfish *Faxonius limosus* in two subalpine lakes in northwestern Piedmont (Lake Orta and Lake Mergozzo) where its occurrence is well established. Littoral sampling covering a 1-year project (2021-2022) allowed us to measure, weigh and sex determine all collected individuals. Subsequently, the population structure was investigated to confirm whether 1) the invasive species' abundance (Hypothesis1- Hp1), 2) and its growth differ between the two lakes (Hp2);3) the potential use of invasive species to produce biofilm for sustainable food packaging as containment strategies (Hp3). This study found that total number of individuals caught were higher in Lake Orta (86) than in Lake Mergozzo (57) with a sex ratio M/F of 1.39 *vs* 3.07, respectively. However, its average Catches Per Unit Effort (CPUE) abundance in the two lakes was similar (Hp1). Individual growth was higher in Lake Mergozzo than in Lake Orta (Hp2). Producing crayfish-based biofilm from chitosan extracted from *F. limosus* exoskeleton may be a viable strategy for the species' containment (Hp3) at least in those countries where laws do not prevent their use and where reducing waste needs to become a pivotal practice. Our study is a valuable contribution to the deepening of knowledge on the ecology of *F. limosus* in the lakes of the Verbano area.

Understanding the distribution and habitat preferences of the Italian Spring Goby (Orsinigobius punctatissimus) in the springs of Lombardy

Adriano Palazzi, Beatrice De Felice, Simona Mondellini, Marco Parolini

Department of Environmental Science and Policy, University of Milan, Via Celoria 26, I-20133 Milan, Italy; adriano.palazzi@unimi.it

The Italian Spring Goby (*Orsinigobius punctatissimus)* is an endemic freshwater fish species considered Critically Endangered by the Italian IUCN committee. This species is closely associated with highly specific and isolated habitats, such as springs and oxbow lakes in the River Po plain, where Lombardy constitutes half of the species' range. Because of spring droughts, pollution, habitat loss and fragmentation, the species distribution in the freshwater ecosystems of Lombardy has been estimated being decreased by 70% in recent decades. However, information on the presence and ecology of this species is very limited because of the scarcity of monitoring activities in suitable habitats. For instance, the current knowledge about the habitat preferences of the species is outdated and based on past qualitative observations. Therefore, the aim of this study is to enlarge the knowledge on the ecology and distribution of the Italian Spring Goby in spring ecosystems of the Lombardy region. In spring-summer 2023 and 2024, we surveyed more than 130 springs spanned over a longitudinal gradient, collecting data on the presence of the species and fish community, as well as biotic and abiotic features of the spring. We found the species in 25 springs, corresponding to the 19% of the sampled sites. Results showed that the main predictive variables for the presence and abundance are morphological features such as substrate type, average depth, illumination, and retention of organic debris. This study provides novel insights into the habitat preferences of the Italian Spring Goby and its regional distribution.

Contribution of demersal and benthopelagic species to Benthic-Pelagic Coupling in two Mediterranean marine food webs

Pasquale Ricci[1], Roberto Carlucci[1], Giulia Cipriano[1], Ioannis Keramidas[2], Simone Libralato[3]
[1]Università di Bari, Italia; [2]Università di Salonicco, Grecia; [3]Istituto Nazionale di Oceanografia e Geofisica Applicata (OGS), Italia;
psqlricci@gmail.com

Energy exchanges between benthic and pelagic domains are regulated by physical processes and trophic interactions among species, which support the Benthic-Pelagic coupling (BPC). Identifying the species or groups of species that most contribute to BPC and act as key couplers is of interest for understanding this important ecosystem process. This analysis explores the species contribution to the BPC within the Northern Ionian Sea (NIS) and Aegean Sea (AS) food webs modelled through the Ecopath mass-balance modelled approach. Two original NIS and AS models composed by 51 and 44 functional groups (FGs) of species, respectively, were reorganized in a standard food-web model structure of 25 FGs for each one, to compare the results. Starting from consumption flows matrices of each standard model, the contribution of FGs to BPC was calculated through a Benthic-Pelagic Coupling Index (BPCI). BPCI summarized pelagic and benthic flows (downward, dQf) and those between benthic and pelagic domains (upward, uQf) based on consumption flows (t km^{-2} y^{-1}) estimated for each FG, considered as both predators and prey (excluding non-living detritus groups), through the pelagic, benthopelagic, demersal, and benthic domains. In addition, FGs were classified as direct, mediating or partial couplers according to their domains of membership and completeness in coupling between the benthic and pelagic domains.
In both food webs, zooplankton and suprabenthic crustaceans were the main direct couplers. In the NIS, the main mediating couplers contributing to uQf were benthopelagic decapod crustaceans (35% of the total uQf), demersal non-piscivorous fishes (21%) and benthopelagic fishes (19%). In the AS, demersal non-piscivorous fishes (mediating couplers) showed the highest contribution to uQf (45%), while benthopelagic cephalopods contributed to 31% of the total dQf.
Results stress the importance of demersal and benthopelagic FGs in BPC mechanisms, supporting the energy and matter recycling in the ecosystem, and thus its productivity.

Spatial predictions of invertebrate metabolic rates to climate change

Milad Shokri[1,2], **Alberto Basset**[1,2]

[1]Università del Salento, Italia; [2]National Biodiversity Future Center; milad.shokri@unisalento.it

Climate change is inducing profound alterations at all levels of biological organization, from individual organisms to entire ecosystems. These shifts are expected to continue in response to ongoing climate warming, which is largely mediated by metabolic rate. As metabolic rate is one of the first traits of organisms to respond to climate change, forecasting the extent of this change by the end of the century would lay the groundwork for disentangling higher ecological impacts and informing conservation decisions for potential mitigation. Here, we aimed to predict the metabolic rate response of invertebrates, which serve as primary consumers in the trophic web, under the CMIP5 climate change scenarios. Our predictions showed that metabolic rates could increase substantially, with more pronounced increases in species living at high latitudes under the modest climate change scenario.

Soil microarthropod community structure and trophic dynamics in forest ecosystems

Monica Zizolfi[1], Lucia Santorufo[1,2], Valeria Memoli[1], Giorgia Santini[1], Rossella Barile[3], Giulia Maisto[1,2]

[1]Department of Biology, University of Naples Federico II, Via Cinthia, 80126 Napoli, Italy; [2]BAT Center - Interuniversity Center for Studies on Bioinspired Agro-Environmental Technology, University of Naples Federico II, 80055 Portici, Italy; [3]Vesuvius National Park, Via Palazzo del Principe c/o Castello Mediceo, 80044 Ottaviano, NA, Italy; monica.zizolfi@unina.it

Forest litter is a critical component of soil ecosystem, providing habitats and food for a variety of organisms. Reducing erosion, conserving moisture and moderating temperature fluctuations, it acts as a protective layer for soils. Contextually, litter is a fundamental resource for soil microarthropods that, through feeding and shredding activity, contribute to litter breakdown and facilitate the nutrient access to plants and microorganisms. Despite their key role, researches regarding their community dynamics are still scarce. Therefore, the present research aimed to investigate changes in soil microarthropod community composition and trophy distribution under the main plant cover of the Mediterranean area such as pine (Pinus spp.), holm oak (*Quercus ilex* L.) and chestnut (Castanea spp.). Litter samples were collected and microarthropods were extracted and identified. Then, the relative abundance of microarthropods according to their trophy (detritivores, predators, omnivores and herbivores) was determined. The data revealed that: pine litter supported a community mainly composed by Prostigmata (38 %) and Oribatida (37 %) with higher percentage of detritivores (58 %); holm oak litter supported a community mainly composed by Prostigmata (42 %) and Oribatida (40 %) with similar partition between detritivores (49 %) and predators (49 %); chestnut litter hosted greater diversity in terms of species richness with higher percentage of detritivores (66 %). It can be supposed that litter quality and shape drive the composition of the soil microarthropod in terms of abundance of specific taxa and trophic role. In conclusion, soil microarthropod composition and functionality is strictly dependent on plant biodiversity exerting, in turns, effects on organic matter turnover.

Posters

Relationship between the associated biodiversity and ecosystem functioning in Cymodocea nodosa seagrass in a costal lagoon system (Stagnone di Marsala, Western Sicily)

Ana Maria Botero Angel[1,2], Manuel Berlino[2,3], Maria Cristina Mangano[2,3], Gianluca Sarà[1,2]

[1]Università degli Studi di Palermo, Italia; [2]NBFC, National Biodiversity Future Center, Italy; [3]Stazione Zoologica Anton Dohrn, Italia; anamaria.boteroangel@unipa.it

Biodiversity plays a crucial role in maintaining ecosystem functioning and ensuring the provision of ecosystem services that support human well-being, since the potential ecosystem functions in an ecosystem are a function of the diversity within it. In the marine environment, diverse species in different measure contribute to essential processes such as primary production, nutrient cycling, carbon sequestration and others, due their traits and main ecological attributes. However, biodiversity is increasingly threatened by anthropogenic stressors and climate change, leading to significant alterations in species composition and ecosystem dynamics. Seagrass meadows play a crucial role in coastal ecosystems, they enhance biodiversity in the areas where they are present by influencing the productivity, carbon cycling, filtration, food webs and other functions that make them great source of ecosystem services. The capacity of the seagrass to provide shelter and food is related to its architecture, which apart from being a direct measure of the state of the meadow, drives the secondary production, affecting the consumption and predation of organisms associated and, therefore, shaping its associated biodiversity. Seagrass structural complexity is then strictly connected with most of the ecological interactions, the structure of the community and the number of functions expressed by the underlying community. Here we present the results of our research where biodiversity is studied in a gradient of habitat structural complexity (shoot density; based on the hypothesis in which: higher complexity = higher biodiversity) to investigate its relationship to some indicators of ecosystem functions such as habitat provision, sediment stabilization and carbon sequestration. These results represent an important step in understanding the underlying mechanisms that drive ecosystem functioning, which then can be used to inform decisionmakers about the relevance of biodiversity when prioritizing conservation actions.

Catch'em'all! A semi-automated, threshold-based filtering pipeline to retrieve seagrass fish data from decades of literature

Azzurra Lattanzi, Bruno Bellisario, Roberta Cimmaruta
Dipartimento di Scienze Ecologiche e Biologiche, Università degli Studi della Tuscia, Italia; azzurra.lattanzi@unitus.it

Besides providing important ecosystem functions, seagrasses are highly productive habitat-forming species essential in supporting fish diversity. In the Mediterranean Sea, seagrasses represent the main component of the sublittoral marine environment hosting a huge number of fish species that use this habitat for reproduction, foraging and/or refuge from predation. Despite these key roles, a complete synthesis of fish species observed in different seagrass habitats at Mediterranean basin scale is still lacking, potentially limiting the understanding of the main mechanisms involved in determining fish diversity patterns.

We performed a systematic review by implementing a semi-automated, threshold-based filtering pipeline that allowed building up one of the most up-to-date databases covering all fish species reported in native Mediterranean seagrasses, including specific functional traits known to be involved with the potential use of seagrasses by fish. From a total of 62,881 papers covering decades of literature, the filtering pipeline allowed selecting 165 papers reporting original and unduplicated data about the presence of fish species on seagrasses, alongside spatial information, sampling methods, habitat composition, substrates and the life stage at which species have been reported. The database is composed of more than 9,000 records, for a total number of 248 species belonging to 75 families recorded from 101 localities and 10 different habitats.

Multivariate analysis allowed illustrating the potential of the database, providing support to several assumptions repeatedly stated in literature but so far sustained mainly by local and fragmented data, ultimately suggesting the onset of a general pattern in the occurrence of species, mostly based on life history and driven by body size and feeding habits. Although we evidenced unexpected knowledge gaps, our dataset could provide a sound basis for scientists and managers across many fields, from fisheries to biodiversity assessment and conservation.

Testing the mid-domain effect hypothesis and Rapoport's rule: the ants of Santa Catalina Mountains (Arizona, USA)

Simone Fattorini[1], Davide Bergamaschi[2], Kimberly Franklin[3], Wendy Moore[2]

[1]Department of Life, Health and Environmental Sciences, University of L'Aquila, Via Vetoio, 67100, L'Aquila, Italy; [2]Department of Entomology, University of Arizona, Forbes 410, PO Box 210036, Tucson, AZ 85721-0036, Arizona, United States of America; [3]Arizona-Sonora Desert Museum, 2021 N. Kinney Rd., Tucson, AZ 85743, Arizona, United States of America; simone.fattorini@univaq.it

Understanding the determinants of range extent and distribution of species is an important goal in community ecology. Based on the mid-domain effect (MDE) hypothesis, species range extent and their distribution are random within the limits of a spatial domain (e.g., an elevational or latitudinal gradient). On the other hand, Rapoport's rule postulates that species range extent and distribution vary according to the climatic fluctuations experienced along a climatic variability gradient. As climatic variability usually increases with elevation, species are expected to sort based on their climatic niche. Climatic specialists should only occur in climatically stable regions and therefore should present narrow range extents. Climatic generalists, conversely, are expected to inhabit both climatically stable and unstable areas and therefore present wide range extents. As a result, average range extents should increase from lower to higher elevations. We explored whether the hyperdiverse myrmecofauna of the Santa Catalina Mountains in the Madrean Sky Island Region conforms to the MDE hypothesis or Rapoport's rule. Ants were collected using pitfall traps. Elevational range extent was calculated for each species. Then, we divided the elevational range into bands of 50 m (from 1000 to 2800 m) and calculated for each band the mean species range extent. Finally, we regressed mean range extents against elevation. Since, according to Rapoport's rule, the variability of range extent should decline with increasing elevation (i.e., climatic variability), we also regressed the coefficient of variation of range extent against elevation. Mean range extent weakly increased with increasing elevation, while the coefficient of variation did not decline with increasing elevation. These findings suggest that, in general, the ants of the study area do not follow Rapoport's rule but conform to the MDE hypothesis.

An insight into the role of anaerobic fungi in the trophic web of anaerobic digestion aimed at methane production

Valentina Mazzurco Miritana, Stefano Ferri, Antonio Bozzelli, Lorenzo Panunzio, Giulia Massini

Department of Energy Technologies and Renewable Sources (TERIN) Laboratory for Hydrogen and new Energy Vectors (H2V) ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development Casaccia Research Centre - Via Anguillarese 301 – 00123, Rome (Italy); valentina.mazzurco@enea.it

Anaerobic fungi (AF) thrive in the rumen ecosystem, where they are recognised as the microbial component with the greatest capacity to hydrolyse plant biomass. Due to their ability to also degrade lignin and the strictly anaerobic conditions of the rumen, AFs have recently been taken into consideration for promising biotechnological applications. These include the energy valorization of waste biomass and in particular anaerobic digestion (AD) applied for the production of methane-rich biogas. However, the incomplete knowledge about AFs role in the AD trophic chain as well as the difficulty in detecting fungal structures metabolically active during the process limit the studies of their application at industrial scale. To gain new insights into the ecological role of AFs during AD, a bioaugmentation experiment was conducted in batch configuration using wheat straw as substrate and digestate from an industrial AD plant as inoculum. Moreover, a protocol was defined for the detection of metabolically active fungal structures. The results suggest that the role of AFs in the AD trophic web is at least twofold. They are both at its base, before the hydrolytic bacteria with which they cooperate, and at its apex, directly related with methanogenic Archaea. The latter connection seems to prevail in case of AD metabolic imbalance, in response to the need to consolidate the trophic web. In terms of bioprocess, bioaugmentation made AD more efficient, with an increase in CH_4 production of up to 80% when using AF and up to 120% in case of combined bioaugmentation with a pool of fermenting bacteria. These findings are of particular interest for future applications of AF aimed at producing sustainable and renewable energy also contributing to ecological waste disposal.

Distribution patterns of moth assemblages (Lepidoptera Geometridae) of sandy coasts in the Italian Central Adriatic

Micaela del Valle Rasino[1], Simone Fattorini[2], Andrea Sciarretta[3], Angela Stanisci[1,4], Maria Laura Carranza[1,4]

[1]Envix-Lab, Department of Biosciences and Territory, University of Molise, Via Duca degli Abruzzi, 86039 Termoli, and Contrada Fonte Lappone snc, 86090 Pesche, Italy.; [2]Department of Life, Health and Environmental Sciences, University of L'Aquila, Via Vetoio, 67100, L'Aquila, Italy.; [3]Department of Agricultural, Environmental and Food Sciences, University of Molise, Via De Sanctis, 86100, Campobasso, Italy.; [4]National Biodiversity Future Center (NBFC), Palermo, 90133, Italy.; m.rasino@studenti.unimol.it

The geometrid moths (Lepidoptera Geometridae), whose larvae have a quite restricted food niche and establish strong links with their host plants and habitats, are good candidates as bio-indicators of environmental quality. We analyzed the diversity pattern of geometrid moths and plant communities on dune landscapes in the Central Adriatic coast in a N2K site (SIC IT7228221 Foce Trigno - Marina di Petacciato), included in the LTER Network LTER_EU_IT_081). Moth and plant communities were sampled along three strips perpendicularly to the seashore. Within each strip, we sampled vegetation and moths on two dune sectors: (a) shifting dunes (EU Habitats 2120 and 2230), and (b) fixed dunes (EU Habitat 2260). Moths were collected using light traps with UV LEDs every 15 days for one year (December 2021 - November 2022). Vegetation was sampled by randomly placing 5 (4 m × 4 m) plots per sector in each strip (30 plots). For both moths and vascular plants, we compared the community structure of shifting dunes and fixed dunes. We also used multivariate analyses to explore the relation between moths and vegetation. We recorded 37 moth and 71 plant species. Moth alpha-diversity showed similar values in shifting and fixed dunes, while species composition varied substantially (high beta-diversity) between the two zones. Fixed dunes hosted a greater number of moth species with larvae feeding on woody plants. Shifting dunes were home to generalist moths associated with herbaceous vegetation. The most abundant species on the fixed dunes were *Cyclophora puppillaria* and *Peribatodes rhomboidaria* (both associated with woody species - phanerophytes and chamaephytes). The most abundant species on the shifting dunes was *Eucrostes indigenata* (associated with *Euphorbia paralias)*. Geometrid communities are tightly associated with the different zones of the dune vegetation and preserving dunes requires attention to both habitat types and their moths.

A systematic approach towards the identification of protected sessile benthic species in the Mediterranean Sea

Lucia Rizzo[1,2,3], Tomas Vega Fernández[2], Francesca Necci[2,4], Michael Grelaud[5], Patrizia Ziveri[5,6], Sergio Rossi[3,4]

[1]Consiglio Nazionale delle Ricerche, Italy; [2]Stazione Zoologica Anton Dohrn, Italy; [3]Consorzio Nazionale Interuniversitario per le Scienze del Mare, Italy; [4]Università del Salento, Italy; [5]Universitat Autònoma de Barcelona, Spain; [6]Institució Catalana de Recerca i Estudis Avancats, Spain; lucia.rizzo@cnr.it

Marine Animal Forests (MAFs) encompass a set of the most important marine benthic habitats into which diversified sessile suspension feeders like anthozoans, sponges, bryozoans, corals, sea pens, ascidians, tube worms, and bivalves occur. Such a mix of sessile species raises unique structures and supports important ecosystem functions, providing three-dimensional environments suitable for a number of additional associated species, and ultimately resulting in biodiversity hotspots. In the last decades, some MAFs have been the object of international conventions, EU directives, and national policies to address human-induced disturbances. Effective conservation, monitoring, and restoration actions require summarizing the available information to include MAFs in conservation plans. In the present research, the main international policies for the protection of coastal and marine fauna were screened in order to provide a list of protected species occurring in the Mediterranean basin. These international normative documents include the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of European Wildlife and Habitats (Bern Convention), the European Habitat Directive, and the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) of the Barcelona Convention. A wider view such as the one proposed by the International Union for Conservation of Nature (IUCN) is accompanying effective conservation measures. The obtained findings revealed that several MAF species are protected by some normative tools, nevertheless only a few species are reported by the EU Habitat Directive, which is the main legal instrument in the European nature conservation policy. This database represents a starting point to handle the dramatic loss of MAF biomass and biodiversity in the Mediterranean Sea, supporting the effective implementation of appropriate conservation and management measures in the Mediterranean basin.

Decoding phytoplankton coexistence mechanisms through a meta-analysis across 24 transitional water ecosystems

Angela Maria Scardia Scardia[1,2,3], Jessica Titocci[4], Lorenzo Liberatore[4], Alberto Basset[2,3,4]

[1]Department of Earth and Marine Sciences (DiSTeM), University of Palermo, Via Archirafi 20, 90123 Palermo, Italy; [2]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italy; [3]University of Salento, Department of Biological and Environmental Sciences and Technologies (DiSTeBA), Lecce,Italy; [4]Italian National Research Council (CNR), Institute for Research on Terrestrial Ecosystems (IRET), Lecce, Italy; angelamaria.scardiascardia@unipa.it

Investigating the mechanisms underlying the organization and maintenance of phytoplankton communities is crucial, particularly in the context of climate change. Since Hutchinson's plankton paradox in 1961, numerous theories have explored phytoplankton species coexistence mechanisms in highly diverse local guilds, linking individual-based processes to broader ecosystem and global dynamics. However, despite significant advancements, these mechanisms remain not fully understood. Here, we present a conceptual niche-based approach to decode the mechanisms organizing phytoplankton biodiversity using phytoplankton occurrence and abundance data. The study is based on an integrated dataset of 127311 individual phytoplankton records, belonging to 306 taxa, collected across 24 transitional water ecosystems distributed among five biogeographical regions: the Northern Atlantic Ocean, South-Western Atlantic Ocean, South-Western Pacific Ocean, Indo-Pacific Ocean and the Mediterranean Sea. We investigated size-abundance and species-area relationships and biodiversity patterns in terms of richness, diversity and similarity at different levels of data aggregation and scale. Our findings revealed a high taxonomic diversity both at regional and intra-regional level, with the Northern Atlantic Ocean area showing the highest taxonomic diversity and the Indo Pacific Ocean area showing the highest morpho-functional diversity. Negative trends in species-area relationships have been observed in all ecoregions except for South-Western Atlantic Ocean. Overall, tropical ecoregions (South-Western Atlantic Ocean, South-Western Pacific Ocean, Indo-Pacific Ocean) exhibited high intraregional similarity (between 42 and 70%) while, mid-latitude regions (Northern Atlantic Ocean and Mediterranean Sea) showed low intraregional similarity (less than 20%). The achieved results suggest neutral and lottery competition theories as the most likely to explain biodiversity organizations in the phytoplankton guilts of the studied biogeographical areas. These results seem to indicate the potential use of commonly collected data on phytoplankton community to address the community organization when integrated with the proposed conceptual niche-based approach.

Intra- and inter-specific trophic niche partitioning in Antarctic fish populations of the Ross Sea in the presence of sea ice

Roberta Zitelli[1], Giulio Careddu[1,2], Simona Sporta Caputi[1,2], Matteo Ventura[1], Davide Giannini[1], Edoardo Calizza[1,2], Loreto Rossi[1,2], Maria Letizia Costantini[1,2]

[1]Università di Roma "La Sapienza", Italia; [2]CoNISMa-Consorzio Nazionale Interuniversitario per le Scienze del Mare;
zitelli.1845500@studenti.uniroma1.it

The Antarctic marine food web supports high biodiversity and ecosystem services, including carbon sequestration, fisheries and tourism. Climate change is altering sea ice dynamics, modifying resource availability with cascading effects throughout the food web. Fish fauna, a dominant component of Antarctic marine communities, reach high biomass densities even with limited resources. However, mechanisms underlying Antarctic fish coexistence are poorly understood. Understanding trophic niche partitioning among fish populations and their dependence on sea-ice resources is thus essential for predicting climate change effects on food webs and associated services.

This study investigated the trophic niche of six Antarctic fish species in Terra Nova Bay (Ross Sea) under conditions of low (winter) and high (late spring) resource availability to evaluate coexistence mechanisms. It is hypothesized that strong trophic niche partitioning occurs both within and between species, particularly during the less productive season. Individual stable isotope analysis of carbon and nitrogen was performed on muscles and livers, which provided information on the winter and the late spring diet, respectively. ITUs (Isotopic Trophic Units, Rossi et al., 2019) were used to quantify trophic-functional redundancy (as the number of species per ITU) and potential vulnerability to species invasion (as proportion of empy ITUs in total). In winter, species had narrow niches with differences between populations yet a very low differentiation in resource use among conspecifics. In late spring, trophic niches were broader, with conspecifics specialising on different resources while maintaining a low overlap with other species. While supporting coexistence, such marked trophic niche differentiations produced a low functional redundancy among the studied populations and hence a high potential vulnerability to species invasion. Our results highlight the importance of resource diversity, including sea-ice resources, for fish coexistence in Antarctic ecosystems. Consequently, changes in resource availability due to variations in sea ice coverage could impact biodiversity persistence.

Ecotossicologia dei contaminanti emergenti

Chairs

Francesco Dondero, Cristina Fossi, Cristina Panti, Antonio Calisi

Presentazioni Orali

Microplastic pollution in a Mediterranean semi-enclosed coastal basin: insights from a multi-target approach

Cristina Andolina[1,2], Laura Caviglia[1], Giovanna Cilluffo[1,2], Cecilia Doriana Tramati[1,3], Maria Cristina Fossi[2,3,5], Matteo Baini[2,3,5], Margherita Concato[2,5], Salvatrice Vizzini[1,2,3,4]

[1]Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università degli Studi di Palermo, via Archirafi 18, 90123 Palermo, Italia; [2]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italia; [3]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Piazzale Flaminio 9, 00196 Roma, Italia; [4]4Centro di Sostenibilità e Transizione Ecologica (CSTE), Università degli Studi di Palermo, Piazza Marina 61, 90133 Palermo, Italia; [5]Dipartimento di Scienze fisiche, della Terra e dell'ambiente, Università di Siena, via P.A. Mattioli 4, 53100 Siena, Italia; cristina.andolina01@unipa.it

Transitional environments, such as coastal lagoons, can act as coastal filters by retaining pollutants originating from human activities occurring on the mainland. Among the sources of pollution reaching the lagoonal environment, microplastics (MPs) are considered one of the emerging contaminants whose distribution in the abiotic compartment and subsequent transfer to the biotic compartment need to be addressed. Here we assessed the distribution, abundance and composition of MPs in sediment, water and fish community of a semi-enclosed Mediterranean basin (the Stagnone di Marsala, Italy) with the aim to investigate: i) how the environmental factors characterizing the area (hydrodynamics and exposure to the open sea) influence MPs distribution and abundance in the abiotic compartment; ii) how fish trophic niche features (isotopic niche width) influence MP ingestion. MPs were found in all the compartments examined, with concentrations in the sediment being two orders of magnitude higher than in the water column, while MPs were found in 19% of the 106 fish of the five species analysed (three estuarine resident species: *Aphanius fasciatus*, *Atherina boyeri* and *Syngnathus abaster*, and two transient fish species: *Diplodus annularis* and *D. vulgaris*). The most abundant polymer analysed by μ-FTIR in fish was rayon (48%), followed by Polypropylen (14%) and acrylic (14%). Pearson correlation analysis revealed a significant positive correlation between the abundance of MPs in the water column and the abundance of MPs ingested by resident fish species, and a negative correlation between hydrodynamics and the MPs ingested by fish. No significant relationship, instead, emerged between fish trophic features and MPs ingestion. These results suggest that environmental condition influence the uptake of MPs by fish communities and highlights the importance of using a multi-target approach to disentangle the effects of MPs pollution in coastal lagoons.

Freshwater exposure to polypropylene micro- and nanoplastics affects proper wound healing and tissue regeneration in the leech model Hirudo verbana

Nicolò Baranzini[1,2], Camilla Bon[1], Laura Pulze[1,2], Maretti Alice[1], Nicolò Paris[1], Lorella Izzo[1], Francesco Acquati[1,2], Annalisa Grimaldi[1,2]

[1]Università degli Studi dell'Insubria di Varese, Italia; [2]Italian Leech Farm (ILFARM) Srl, Varese, Italia; nicolo.baranzini@uninsubria.it

Given the unique physical and chemical properties, plastic materials have brought important benefits to our society, becoming essentials in many applicative fields. Among the different plastics types, polypropylene (PP) is one of the most widespread, whose production increased in the last years due to the huge consumption of surgical masks and single-use packaging. However, its global diffusion led to an unchecked build-up and to an indiscriminate environmental dispersion of derived waste. Due to the low degradability, PP could be affected by biotic and abiotic agents, which lead to its fragmentation into micro- and nano-particles (MPs and NPs respectively). These adversely affect both aquatic and terrestrial organisms, in which bioaccumulate inside tissues, thus impairing their physiological responses. In this context, although numerous studies already demonstrated the potential MPs and NPs side effects on several biological processes, the putative impact of PP particles on wound healing and tissue regeneration has never been examined. To shed light on these aspects, the ability of PP-MPs and NPs to interfere with correct wound healing has been assessed in the consolidated freshwater invertebrate model *Hirudo verbana*. By means of morphological, immunofluorescence, histoenzymatic, and molecular analyses, in the current work it has been demonstrated how PP-MPs and NPs were able to induce fibrotic events, by a stronger activation of the inflammatory response and an abundant production of extracellular matrix components, which in turn inhibits the correct formation of blood vessels and the recruitment of muscle cells precursors.

The chronic exposure to pharmaceuticals and phtalates results in sub-lethal effects in the zooxanthellate coral Balanophyllia europaea

Arianna Bellingeri[1,2], Erik Caroselli[3,4], Stefano Goffredo[3,4], Ilaria Corsi[1,2]

[1]Department of Physica,l Earth and Environmental Sciences, University of Siena, Siena, Italy; [2]National Biodiversity Future Center, NBFC; [3]Marine Science Group, Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna, Italy; [4]Fano Marine Center, FMC; arianna.bellingeri2@unisi.it

Corals are fundamental elements of rocky shore ecosystems, which are threathened by wastewater and river discharges, tourism and climate change. Among many threats, that posed by emerging contaminants still needs to be throughly investigated. The aim of this study was to test wether a prolonged exposure to low concentrations of pharmaceuticals and bisphenol A (BPA) might affect the common and widespread shallow water zooxanthellate coral *Balanophyllia europaea. B. europaea* polyps were collected at 6 m depth in Calafuria (LI, Italy) in May 2023 and 2024, soon before the brooding period. *B. europaea larvae* were exposed to Carbamazepine (CB), Ibuprofen (IB) and Valsartan (VS) at 1-10 µg/L and to BPA at 10-100 µg/L, both separately and as mixtures (MIX_L: 1 µg/L CB, IB, VS + 10 µg/L BPA; MIX_H: 10 µg/L CB, IB, VS + 100 µg/L BPA), for 4 weeks. Toxicity endpoints were: mortality, metamorphosis and the average amount of chlorophyll (Chl) *a*-c_2/larva. Adults of *B. europaea* were exposed to MIX_L and MIX_H for 4 weeks, and toxicity endpoints were: Chl*a*-c_2/zooxanthellae, Chl*a*-c_2/coral surface, zooxanthellae/coral surface and the predation ability. Results showed no significant mortality for the larvae but an alteration in their ability to metamorphosize, which was reduced for larvae exposed to single pharmaceuticals but was enhanced for those exposed to BPA. In the adults, the ratio Chl*a*-c_2/zooxanthellae was significantly reduced upon exposure to both MIX_L and MIX_H, as well as the ratio Chl*a*-c_2/coral surface, while the ratio zooxanthellae/coral surface showed a slight increase. The predation ability resulted reduced in specimens exposed to both mixtures. The overall results showed that the prolonged exposure to low concentrations of pharmaceuticals and BPA might impact both larvae and adults of *B. europaea* and that the chlorophyll content, the metamorphosis and the predation ability might represent sensitive endpoints for the impact of such compounds.

Assessing the effectiveness of mitigation measures on pollinator decline: an integrated multi-biomarker approach (ÆM-POLLY project)

Silvia Casini[1], Tommaso Campani[1], Ilaria Caliani[1], Ginevra Manieri[1], Andrea Franchi[1], Agata Di Noi[1,2], Laura Giovanetti[1], Mariana Mazzei[3], Lisa Cabiddu[3], Lucia Lenzi[3], Francesco Lami[3], Roberto Costantino[3], Fabio Sgolastra[3]

[1]Università di Siena, Dipartimento di Scienze Fisiche della Terra e dell'Ambiente, Siena, Italia; [2]Università di Siena, Santa Chiara Lab, Siena, Italia; [3]Università di Bologna, Dipartimento di Scienze e Tecnologie Agro-alimentari, Bologna, Italia; silvia.casini@unisi.it

The aim of the ÆM-POLLY PNRR PRIN project is to develop and validate an integrated protocol as a tool to verify if the mitigation measures foreseen by the EU Green Deal for agricultural practices, are effective in halting and reversing the decline of wild pollinator biodiversity. This monitoring protocol will integrate endpoints in terms of presence, abundance and diversity of wild pollinator species with endpoints able to assess the state of health at the sub-individual, individual and population level. These endpoints are selected and designed to diagnose biological alterations in wild pollinators due to different pressures: chemical stress from pesticides, stress linked to climate changes, food and water deficiencies, habitat loss and diseases. Such an integrated approach using a set of biomarkers has never applied before to wild pollinators. The monitoring protocol is applied in 4 orchards and 4 vineyards characterised by the presence or absence of mitigation measures, and in 4 adjacent natural areas. Surveys for assessing pollinator diversity are performed once in spring and once in late summer. During this activity individuals of the most abundant/representative species are sampled for chemical (pesticide levels), morphological (body size and fluctuating asymmetry variations) and biomarker analysis (immune, reproductive, and nervous systems, oxidative stress, metabolism, detoxification processes and genotoxicity, energy mobilisation and feeding performance). From our project we expect to: 1) obtain a dataset of baseline biomarker values related to the health status of representative pollinator species; 2) assess the effectiveness of the mitigation measures by comparing the pollinator diversity and the biomarkers related to their health in two types of crops; 3) define a final integrated monitoring protocol to assess the health status of wild pollinators and their biodiversity; 4) develop user-friendly guidelines to assess the effectiveness of the different mitigation measures in different agroecosystems, to guide decisions and inform policies.

Microplastics from textile sector: first results on polymer type and pathways towards surface water

Isabella Gambino[1], Giulia Pezzoli[1], Elisa Terzaghi[1], Enrica Baldini[2], Giovanni Bergna[3], Antonio Di Guardo[1]

[1]Università degli studi dell'Insubria, Italia; [2]Centro Tessile Serico Sostenibile (CTSS), Como, Italy; [3]Lariana Depur, Fino Mornasco (CO), Italy; isabella.gambino@uninsubria.it

Microplastics (MPs), deriving from the textile sector, are today receiving great attention. Mainly shaped as fibers, these tiny particles are intensely released during many processes, representing an important contributor to freshwater pollution, mainly through wastewater treatment plants (WWTPs). Although conventional WWTPs are not designed to remove MPs, enhanced technologies (e.g., tertiary and quaternary treatments) could remove more the 90% of MPs. However, not all WWPTs are equipped with these highly performing processes. Moreover, in WWTPs a large amount of MPs may end up in sludge, which could contribute to terrestrial and later aquatic ecosystem contamination. The aim of this study is to investigate the pathway of MPs released by the textile industry to surface water. An overview of different fabric treatments will be given to illustrate the processes responsible for MP release and discharge to textile wastewater. Preliminary data, obtained with a quantitative method (Pyrolysis-GC-MS), regarding the release of MPs in selected fabric production steps and in WWTPs will be illustrated to elucidate the range of concentrations and polymer types which can be found. These activities are part of the LIFE CASCADE project which aims at developing analytical procedures and wastewater treatment technologies meant to detect and remove micropollutants including MPs.

Upscaling of PFAS in the trophic chain: from molecular to ecosystem responses

Davide Gualandris[1], Maria Teresa Guerra[2], Davide Rotondo[1], Candida Lorusso[1], Antonio Calisi[1], Giorgio Mancinelli[2], Francesco Dondero[1]

[1]Università del Piemonte Orientale, Dipartimento di Scienze ed Innovazione Tecnolpogica, Italia; [2]Università del Salento, DIpartimento di Scienze e Tecnologie Biologiche ed Ambientali, Italia; davide.gualandris@uniupo.it

This study investigates the occurrence and effects of per- and polyfluoroalkyl substances (PFAS) across various environmental matrices, including water, soil, different plant parts (roots, leaves), arthropods, and annelids, at a contaminated firefighting training site in Trelleborg, Sweden. We gathered and assessed both aquatic and terrestrial ecosystems, successfully reconstructing the trophic web by means of Stable Isotopic Analysis (SIA).

The results offer significant insights into the bioaccumulation and biomagnification processes of PFAS. Our data showed that in the terrestrial ecosystem, BSAF values showed a consistent increase across the trophic levels with a trend consistently higher than 1 for short-chain PFAS such as PFHxA, PFHpA, and PFPeA. In contrast, long-chain PFAS such as PFOS, PFOA, and PFHxS were often below the threshold level indicating a low bioaccumulative potential. For the aquatic system, BCF values at the top of the trophic chain were significantly higher, ranging from 10^3 to 10^4 in top predators. While long-chain PFAS exhibited a staple increase across the trophic levels, congeners such as PFHxA, PFHpA, and PFPeA showed non-linear trends.

A key component of this research involved also a 30-day long-term experiment using the OECD species Eisenia fetida (Oligochaeta) exposed in the Trelleborg's soils across a PFAS contamination gradient. Our multi-tiered analysis encompassed molecular, enzymatic, behavioural, and high order level effects such as survival and reproduction, highlighting the impairment of lower and apical biological functions.

This study underscores the intricate interactions and potential ecological risks associated with legacy PFAS contamination. The findings are critical for enhancing our understanding of the long-term environmental consequences of PFAS exposure and for developing informed risk assessment and management strategies.

Plastics and plastisphere affects ecosystem processes of large rivers

Barbara Leoni[1], Sudeep Chandra[2], Monica M. Arienzo[3], Zeb S. Hogan[2], Isabella Gandolfi[1], Valeria Tatangelo[1], Emily Carlson[2], Seila Chea[4], Savoeurn Soum[5], Rachel Kozloski[2], Veronica Nava[1]

[1]Università Milano Bicocca, Italia; [2]Global Water Center and Biology Department, University of Nevada, 1664 N. Virginia, Reno, NV 89557-0314, United States; [3]Desert Research Institute, 2215 Raggio Pkwy, Reno, NV 89512, United States; [4]4Institute of Technology of Cambodia, PO Box 86, Russian Conf. Blvd. Phnom Penh, Cambodia; [5]Royal University of Phnom Penh, Russian Federation Blvd (110), Phnom Penh, Cambodia; barbara.leoni@unimib.it

The 'plastisphere is a new ecosystem developping on plastic surfaces that rapidly undergo biofouling in aquatic ecosystems. While numerous studies have investigated the biodiversity of the plastisphere, few have ventured into understanding the impact of these communities on the functionality and metabolism of aquatic ecosystems. We present an experimental study aiming to address this gap by quantifying the broader effects of plastic debris on epiplastic biofilm community development and by assessing the resulting consequences on ecosystem metabolic traits (i.e., net ecosystem production, gross primary production, respiration, and community dark metabolism from 3 rivers, of the Lower Mekong Basin, with contrasting trophic state and water clarity. Over a 30-day period, we incubated four different plastic polymers (polyethylene (PE_30d); polypropylene (PP_30d); polystyrene (PS_30d); polyamide (PA_30d)) and collected additional macroplastics of an unknown submergence time (PE_unk), characterizing the algal biomass, bacterial and algal biodiversity(16S and 18S rRNA), and metabolic traits of the community growing on their surface. Our findings showed limited microalgal biomass and bacterial dominance, with potential pathogens present. The location significantly influenced community composition, highlighting the role of environmental conditions in shaping community development. When assessing the effects on ecosystem productivity, our experiments showed that biofouled plastics led to a significant drop in oxygen concentration within river water, leading to hypoxic/anoxic conditions with subsequent profound impacts on system metabolism and the capability of influencing biogeochemical cycles. Scaling our findings revealed that plastic pollution may exert a more substantial and ecosystem-altering impact than initially assumed, particularly in areas with poorly managed plastic waste. These results highlighted that the plastisphere functions as a habitat for biologically active organisms which play a pivotal role in essential ecosystem processes.

Molecular effects of emerging contaminants in Caretta caretta through skin biopsies and blood ex-vivo exposure

Giacomo Limonta[1,2], Matteo Baini[1,2], Ilaria Caliani[1], Maria Cristina Fossi[1,2], Giovanni Furii[3], Eleonora Matrone[1], Chiara Sablone[1], Cristina Panti[1,2]

[1]Department of Physical Sciences, Earth and Environment, University of Siena, 53100, Siena, Italy; [2]National Biodiversity Future Center, 90133, Palermo, Italy; [3]Sea Turtle Rescue Centre Legambiente, Molo di Ponente, 71043, Manfredonia, Italy.; giacomo.limonta@unisi.it

Contaminants of emerging concern (CECs) include a variety of compounds increasingly detected in the marine environment that could represent a threat to the ecosystem health, while being still insufficiently regulated. The loggerhead sea turtle (*Caretta caretta*) is worldwide employed as bio-indicator of the marine environment status and may represent a promising bio-indicator of CECs impact as well.

In the framework of the PNRR spoke 2 zero pollution project, this research focuses on two important classes of CECs: a representative mix of pharmaceuticals compounds (ibuprofen, valsartan, carbamazepine) and plasticizers (bisphenol A and phthalates), selected based on environmental contaminants data available in the literature.

To explore whether the selected CECs could elicit biological responses in *Caretta caretta*, we employed an ex-vivo approach. Skin biopsies and blood were collected from hospitalized sea turtles and immediately treated with environmentally realistic concentrations of CECs (1-10-100 ug/L) for 12h (Blood) and 24h (biopsies). The biological response was measured through gene expression analysis of specific target genes. Expression of genes involved in inflammation and innate immunity (PTGS2, LYZ), endocrine receptors (THRα, RXRα, Erα, PRα), energy and lipid metabolism (ACADL, PPARα, FASN), detoxification (GST) and oncosuppression (TP53) were quantified through droplet digital PCR.

Plasticizers (phthalates and bisphenol A) caused a stronger gene expression dysregulation than pharmaceuticals, mainly due to their interaction with endocrine nuclear receptors such as progesteron (PRα) and estrogen (ERα) receptors. The selected pharmaceuticals show limited effect on gene expression although some specific target genes, such as prostaglandin-endoperoxide synthase 2 (PTGS2) may still represent promising markers of exposure. The results of this study contribute to develop ex-vivo experimentation methodologies in *C. caretta* and furnish preliminary data on the biological effects of CECs in this species, aiming to develop potential new molecular monitoring tools.

Ecological fitness impairments induced by chronic exposure to polyvinyl chloride nanospheres in Daphnia magna

Andrea Masseroni, Sara Villa
Università degli Studi di Milano Bicocca, Italia; a.masseroni2@campus.unimib.it

The aim of this study was to evaluate the effects of chronic exposure (21 days) to an environmentally relevant concentration (10 µg/L) of two different nanoplastic (NP) polymers on the aquatic model organism *Daphnia magna*. This study examined the impact of exposure to 200 nm polystyrene nanoplastics (PS-NPs) and polyvinyl chloride nanoplastics (PVC-NPs), which had an average size similar to that of PS-NPs (ranging from 50 nm to 350 nm). The effects of polymer exposure on morphometric parameters, number of molts, swimming behaviour, and reproductive outcomes were evaluated. The findings indicate that both polymers resulted in an increase in molting behaviour. Moreover, exposure to PVC-NPs had a negative impact on the reproduction of *D. magna*, as evidenced by a delay in the day of the first brood, a reduction in the total number of offspring produced, and, consequently, a slower population growth rate. This study identified the fitness impairments caused by exposure to PVC-NPs, which can lead to relevant ecological consequences. Although the influence of particle size cannot be ruled out, it can be inferred that polymer properties may have played a role in the observed effects. We hypothesised a correlation between the hormonal functionality of ecdysone and the impairment of reproduction. Further investigation of the impact of this plastic polymer at lower levels of biological organisation is recommended to gain a better understanding of the potential mechanisms involved in the effects of this plastic polymer on wild organisms.

Assessing the impact of Gadolinium contamination on marine bivalve Donax trunculus: implications for environmental and human health

Silvia Secco[1], Marta Cunha[2], Giovanni Libralato[3], Marco Trifuoggi[3], Antonella Giarra[3], Rosa Freitas[2], Massimiliano Scalici[1]
[1]Departement of Sciences, University of Roma Tre, Viale Guglielmo Marconi, 446, 00146 Rome, Italy; [2]Departement of Biology & CESAM, University of Aveiro, 3810-193 Aveiro, Portugal; [3]Departament of Biology, University of Naples Federico II, Complesso Universitario of Monte Sant'Angelo, Via Vicinale Cupa Cintia 26, 80126, Napoli, Italy; silvia.secco@uniroma3.it

Gadolinium (Gd), a rare earth element, has many technological and medical applications. Used in magnetic garnets, computer memories, and Magnetic Resonance Imaging (MRI), its safety has been questioned due to associations of the appearance of nephrogenic systemic fibrosis and calcium homeostasis disruption observed in the patients submitted to MRI. Studies also reveal its persistence in the body post-MRI and accumulation in the brain, bones, kidneys, and skin. Environmental concerns arise from its release into water bodies via hospital effluents and inefficient removal by wastewater treatment plants, reaching alarming levels in coastal and marine environments worldwide. Based on these assumptions this study aims to investigate the contamination of this emerging contaminant in 7 Italian areas along the Tyrrhenian, Ionian and Adriatic Seas. The bivalve Donax trunculus was selected and sampled as early warning sentinel, as well as sediment and water matrices. Lesina (Puglia) and Sibari (Calabria) were significantly the most contaminated sites in both sediment and D. trunculus matrices, confirming that the bivalves reflect environmental contamination. In addition, a 14-day indoor experiment with increasing Gd concentrations in D. trunculus was carried out to study the toxic effect of Gd and the oxidative stress caused by the contaminant. The results revealed that the detected concentrations of Gd induced oxidative stress in D. trunculus, affecting its metabolic capacity, antioxidant enzyme response, biotransformation mechanism, and lipid peroxidation. D. trunculus proved to be a suitable sentinel species for Gd analysis, showing a proportional accumulation of contaminants in its tissues. These findings highlight the risk of oxidative stress even at lower Gd concentrations, which are common in nature. As the use of Gd increases, environmental concentrations may rise, posing health risks to aquatic organisms and humans through biomagnification.

Investigating bioaccumulation of legacy and emerging chemicals in plant foliar biomass: a comparative analysis of current approaches

Elisa Terzaghi, Martina Calì, Antonio Di Guardo
Università degli Studi dell'Insubria, Italia; elisa.terzaghi@uninsubria.it

In 2013 the scientific opinion “Addressing the New Challenges for Risk Assessment” published by three scientific committees of the European Commission, DG SANCO (SCHER, SCHENIR, SCCS) identified the need for improving the ecological realism in both exposure and effect assessment. For example, it highlighted the necessity to further define bioaccumulation behavior and mechanisms for the variety of plant species, considering also emerging contaminants. Plants can accumulate organic contaminants from air and soil through leaves and roots thanks to several processes, and this represents the first step for the entrance of these compounds in the food webs from herbivore and detritivore organisms. To describe chemical concentration ratios between the plant compartment of interest (e.g., leaves) and the exposure medium (e.g., air), bioconcentration factors (BCF) also known as leaf-air partition coefficient (K_{LA}) are used. Several authors tried to review and compare some of the available K_{LA} measured and predicted data in order to assess the comparability of the approaches and suggest preliminary guidance for planning future bioaccumulation studies. However, only a few works were considered, and K_{LA} source of variability was not fully investigated. Moreover, the suitability of the existing approaches (mainly developed for legacy compounds) for the prediction of leaf uptake of emerging contaminants was not verified. In the current work all the available approaches (i.e., more than K_{LA} 80 equations) were compared and used to predict emerging contaminant bioaccumulation in plants. The results showed that the equations developed for traditional chemicals (e.g., PAHs, PCBs, DDT, etc.) overestimate the bioaccumulation of emerging contaminants (e.g., phthalates, organophosphate ester flame retardants, etc.) in leaves of several orders of magnitude. Therefore, further studies are necessary to better understand the factors that can influence the accumulation of emerging contaminants in leaves of several species and develop new K_{LA} equations for these types of compounds.

Disaggregation behaviour in the terrestrial isopod Porcellionides pruinosus as a new endpoint for soil quality assessment

Sara Villa[1], Lorenzo Federico[1], Gianna Monti[2], Susana Lourero[3]

[1]Università di Milano Bicocca, Dip. Scienze Ambiente e della Terra, Italia; [2]Università di Milano Bicocca, Dip di Economia, Metodi Quantitativi e Strategie di Impresa, Italia; [3]University of Aveiro, Centre for Environmental and Marine Studies, Portugal;
sara.villa@unimib.it

Among rapid ecotoxicological bioassays for screening soil quality, avoidance behaviour tests on gregarious edaphic species such as *Porcellionides pruinosus* are widely used. However, the effect of soil contamination on adaptive aggregation ability has not been investigated. The aim of this study was to develop a new ecotoxicological endpoint related to the disaggregation effect under infochemical disruption at the population level during an avoidance behaviour test. This new endpoint was evaluated using tire particles (TPs) and benzothiazole (BT) as preliminary physical and chemical substances. The disaggregation index (DI) and disaggregation groups (DG) are presented as measures of fragmentation of the population to quantify the effect of contaminants on aggregation behaviour. Aggregation disruption in a group of ten individuals is assessed alongside the sub-lethal avoidance test after a 48 hour exposure. The degree of disaggregation is measured by the number of subgroups formed. The DI and DG indices range from 0 to 1, representing the highest degree of aggregation and disaggregation, respectively, achieved at the end of the test. Our results show that all woodlice exposed to TPs and BT successfully passed the validation of the avoidance test, but failed to show gregarious behaviour in control soil, indicating fragmentation within the population, even if in uncontaminated soil. The disaggregation effects in woodlice occurred at higher concentrations than the avoidance ones, suggesting a possible effect on the adaptive capabilities of the population even in the control soil. These results suggest a combination of avoidance behaviour and disaggregation in individuals of *P. pruinosus*. Consideration of both aspects may provide more ecological, accurate and robust results for the evaluation of the stress induced by contaminant on natural population.

Posters

Natural and synthetic pigments: behavior and impact on aquatic and terrestrial ecosystems.

Serena Anselmi[1,2], Tecla Bentivoglio[1], Francesca Provenza[1], Stefania Trevisan[1], Monia Renzi[2,3]

[1]Bioscience Research Center, Italia; [2]Consorzio nazionale interuniversitario per le scienze del mare, Italia; [3]Dipartimento di Scienze della Vita, Università di Trieste, Italia; sere.anse@hotmail.it

Pigments used in various industries such as the production of paints, dyes and cosmetics are heterogeneous materials sized between 0.2-0.3 micrometers and can be classified as emerging pollutants. Unlike dyes, they do not penetrate the material but form a colored layer on the surface of the objects from which they are easily released and dispersed in the environment. Pigments are divided into four main categories: natural inorganic substances (from metals or rare earths extracted from mineral deposits), synthetic inorganic substances (industrially produced from raw minerals), natural organic substances (from plant or animal sources), and synthetic organic substances (from petroleum derivatives).

Their dispersion in the environment poses a significant threat to terrestrial and aquatic ecosystems, as they cause pollution both through the release of the chemical substances that compose them and through their nanometric nature, which has the property of interacting with organisms, thus threatened the conservation of the ecosystem biodiversity.

In this study, six pigments (three synthetic and three natural, similar colors) with the widest range of commodity applications were selected. Size, morphological properties, chemical composition (metals, metalloids, rare earths), and behavior in the aquatic environment, both freshwater and marine were determined. In addition, their ecotoxicity was assessed using two target species: the bacterium *Aliivibrio fischeri* (aquatic environment) and the monocotyledonous plant *Lepidium sativum* (terrestrial environment). In addition, in plants, the absorption of pigments at the root level was also evaluated. The results show a significant difference of behavior of the pigments in aquatic environments depending on the salinity of the matrix; content of metals, metalloids and rare earths also depending on their color; a significant absorption at the root system level by plants. Our results suggest that further research is needed to evaluate the risk for the environment related to the massive use and dispersion of pigments.

Impact of Rare Earth Element on aquatic ecosystems: a case of study on Gadolinium

Paolo Pastorino[3], Eleonora Grazioli[1], Irene Biagiotti[1], Lorenzo Donnini[1], Stefania Trevisan[1], Francesca Provenza[1], Serena Anselmi[1,2], Giuseppe Esposito[3], Alesandra Maganza[3], Camilla Mossotto[3], Marino Prearo[3], Monia Renzi[2,4]

[1]Bioscience Research Center, Italia; [2]Consorzio nazionale interuniversitario per le scienze del mare, Italia; [3]Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta; [4]Dipartimento di Scienze della Vita, Università di Trieste; eleonora.grazioli@bsrc.it

This study aims to enhance our understanding of emerging pollutants and their effects on energy transfer within trophic networks. The main goal is to investigate how exposure to substances can impact the ecological mechanisms regulating biomass distribution across trophic levels, to predict their effects and manage their thresholds. Specifically, the study concentrates on the impact of Gadolinium (Gd) on autotrophic and heterotrophic organisms.

The selected taxa as models for both marine (*Aliivibrio fischeri, Phaeodactylum tricornutum, Paracentrotus lividus*) and freshwater ecosystems (*Aliivibrio fischeri, Raphidocelis subcapitata, Daphia magna*) represent the foundational elements of total productivity, reflecting the carbon content within the natural capital. Gadolinium is an external element primarily used in medical settings as a contrast agent for enhancing magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) efficacy. However, the increased Gd content in recent years, exacerbated by the Covid-19 pandemic, has prompted a need for further investigation.

This research aims to perform reliable predictions applicable to empirical models and meeting legal requirements for Gd distribution and permissible levels in marine and freshwater environments. Through assessing ecotoxicological responses and essential biometric characteristics under relevant environmental concentrations, organisms in mesocosms were exposed to known pollutant levels (ranging from 0.1 to 100 µg/L). Significant ecotoxicological effects were recorded at 100 µg/L, prompting additional concentration tests at higher levels (250-500-800 µg/L). Trophodynamic analysis revealed shifts in carbon content per unit and their implications for overall productivity. The outcomes of this study provide insights into how Gd influences biomass loss, subsequently impacting energy transfer between trophic levels.

Per- and polyfluoroalkyl substances (PFAS) differently modulate the innate immune response in the medicinal leech Hirudo verbana

Nicolò Baranzini[1,2], Gaia Marcolli[1], Camilla Bon[1], Laura Pulze[1,2], Francesco Acquati[1,2], Davide Rotondo[3], Davide Gualandris[3], Antonio Calisi[3], Francesco Dondero[3], Annalisa Grimaldi[1,2]

[1]Università degli Studi dell'Insubria di Varese, Italia; [2]Italian Leech Farm (ILFARM) Srl, Varese, Italia; [3]Dipartimento di Scienza e Innovazione Tecnologica, Università del Piemonte Orientale, Alessandria, Italia; nicolo.baranzini@uninsubria.it

Per- and polyfluoroalkyl (PFAS) compounds constitute a class of chemicals that possess unique water and oil-repellent properties. For this reason, these synthetically produced fluorinated compounds are implicated in various applicative fields and are used to produce many items, such as food packaging, non-stick cookware and cosmetics. In this context, although PFAS improved many aspects of the everyday life, on the other hand their global distribution led to an abundant release in the environment, with an elevated consequent risk of bioaccumulation in the living organisms as already observed for other pollutants. Indeed, given their properties, PFAS resist to any kind of degrading process and this property, combined with a massive use and release of PFAS-containing products, make their waste a crucial environmental worldwide problem. In this context, while numerous data are available regarding the toxicity of the first generation "legacy" PFAS, scant information exists on newly synthesized emerging molecules, with limited details on the cellular-level effects. Given these premises, the medicinal leech *Hirudo verbana* has been proposed in the current study to assess the possible side effects of four different fluorinated PFAS compounds (HFPO-DA, PFMoBa, PFOA and PFMOPrA) during freshwater dispersion. In particular, two concentrations (0.6 and 229 µM) have been tested, evaluating PFAS ability to induce leech inflammatory response and oxidative stress. Results have been analyzed by means of morphological, immunohistochemical and molecular assays, revealing how these molecules were differently able to modulate both the cellular and the molecular response. As recently demonstrated for plastics particles, this work can lead new information also about PFAS, deepening the current knowledge on their potential harmful effects, deriving also from a possible accumulation in living organisms.

Assessing the ecological impact of PFAS-contaminated soils on earthworms: apical toxicity and sublethal responses

Antonio Calisi, Davide Gualandris, Davide Rotondo, Candida Lorusso, Marcello Manfredi, Francesco Dondero
Università del Piemonte Orientale, Italia; antonio.calisi@uniupo.it

Fire training sites and airports are major PFAS contamination sources due to the widespread use of Aqueous Film-Forming Foam (AFFF). Although recent policies restrict PFAS congeners higher than C8, legacy contaminants such as PFOS and PFOA persist, impacting ecosystems. Modern AFFF formulations still include short-chain PFAS and their oxidizable precursors. In terrestrial ecosystems, earthworms play a key role in soil processes. This study assesses the impact of PFAS-contaminated soil on earthworms, highlighting ecological consequences and the need for sustainable policies. Using a multi-tier approach, the study investigated apical toxicity and sublethal responses of earthworms across a PFAS contamination gradient at a drill site in Trelleborg, Sweden. PFAS contamination was confirmed with 22 compounds measured, mainly PFOS, PFHxS, PFOSA, 6:2 FTS, PFHpS, PFOA, and PFPeA, ranging from 960 ppb to 8.7 ppb. OECD No. 207 (acute toxicity) and No. 222 (reproduction) tests, plus 30-day sublethal assessments, were conducted. Biomarkers included mRNA relative abundances of immune-related genes (lysenin and ccf-1) and oxidative burst in hemocytes; enzymatic responses in tissues, including catalase, phenol oxidase, and acetylcholinesterase. A behavioral test based on escape time was administered to each earthworm after 30-day exposure. Pristine soil with similar granulometric size and organic matter served as an external reference control. Acute toxicity (mortality) at 14 days was below the threshold of OECD test No. 207, but reproduction was impacted at all sites except B7 according to OECD No. 222. In general, sublethal responses across the PFAS gradient showed a significant impact compared to the reference control, but a linear response was barely observed with the PFAS concentration found in soil. Acetylcholinesterase activity and escape time showed interesting correlations, warranting further investigation of critical neurotransmitters for locomotion using LC-MS metabolomics. These findings contribute to understanding PFAS-contaminated site ecology and aid in constructing an environmental database for risk assessment.

Bioactive contaminants in the Mediterranean Sea and their bioaccumulation in Posidonia oceanica seagrass: two case studies from the central Tyrrhenian Sea

Jasmin Rauseo[2,3], Francesca Spataro[2,3], Luisa Patrolecco[2,3], Daniele Ventura[1], Anna Barra Caracciolo[4], Tanita Pescatore[2], Sara Ardenti[1], Edoardo Casoli[1,2]

[1]Sapienza Università di Roma; [2]Istituto Scienze Polari (CNR-ISP); [3]National Biodiversity Future Center (NBFC); [4]Istituto di Ricerca Sulle Acque (CNR-IRSA); jasmin.rauseo@cnr.it

The Mediterranean Sea is facing rising anthropogenic impacts. In addition to marine traffic, tourism, and industrial activities, the basin is also subject to significant riverine runoff that transports contaminants from cities and rural areas. The combination of these pressures and the basin's unique characteristics makes the Mediterranean an accumulation sink for numerous pollutants, including the new generation of compounds and molecules classified as emerging contaminants.

Among these, pharmaceutical and personal care products (PPCPs) and phenolic endocrine-disrupting compounds (PEDCs) have gained attention for their designed bioactivity, and mutagenic and/or carcinogenic properties for organisms, posing a risk to marine ecosystems and human health. Despite this, studies reporting the occurrence and concentration of these pollutants in the Mediterranean marine environment are still lacking.

This study aimed to evaluate the presence of selected PPCPs and PEDCs in two Italian coastal areas with different anthropogenic pressures and exposure to pollutant sources: the Marine Protected Area of Rome Municipality 'Secche di Tor Paterno', located in the Central Tyrrhenian Sea, few miles southern from the River Tiber mouth, and the popular summer tourist destination of Giglio Island (Tuscany Archipelago). The Mediterranean endemic seagrass *Posidonia oceanica* meadows develop on seabed shallower than 40 m in both areas. Surface seawater, sediment, and *P. oceanica* (rhizomes and leaves) were collected to investigate the occurrence of pollutants and evaluate the seagrass's potential application as a bioindicator of PEDCs and PPCPs contamination. Additionally, an ecological risk evaluation was performed based on the measured concentrations of these bioactive pollutants in the seawater. Results showed that PPCPs were present at higher concentrations than PEDCs in the study areas and bioaccumulated in *P. oceanica*, suggesting that this seagrass can be a suitable bioindicator of organic contamination. The risk analysis performed also indicated that the selected contaminants may pose a high risk to the marine ecosystem.

Antioxidant cellular response of the soft coral Pinnigorgia flava after exposition to polypropylene nanofibers and polypropylene nanofibers leachate

Eleonora Concari[1], Enrico Montalbetti[1,2], Valerio Isa[1,2], Andrea Madaschi[1], Federico Cerri[1,2], Simone Montano[1], Paolo Galli[1,2], Davide Seveso[1,2]

[1]Dipartimento di Scienze dell'Ambiente e della Terra, Università degli Studi Milano - Bicocca, Italia; [2]MaRHE Centre (Marine Research and High Education Center), Magoodhoo Island, Faafu Atoll 12030, Maldives; e.concari@campus.unimib.it

After the spreading of COVID-19, the amount of plastics in the ocean was severely enhanced due to the increased production of PPE, in particular surgical masks. Once entered into the environment, these disposable items can both release potential toxic additives and undergo fragmentation leading to the formation of microplastics and nanoplastics. Moreover, microplastics and nanoplastics are considered the most harmful for corals and marine organisms since can easily be ingested. Current information regarding the effects of micro and nanoplastics on coral reefs is limited; especially the toxicity of nanoplastics and nanoplastics leachate from fibers degradation of synthetic fabrics. The alcyonacean *Pinnigorgia flava* was exposed for 72 h to different concentrations of polypropylene nanofibers (0.1 and 1 mg/L) and nanofibers leachate (0.1 and 1 mg/L) under controlled aquaria conditions. The cellular response was assessed through antioxidant enzymatic assays, namely Superoxide Dismutase (SOD), Catalase (CAT), Glutathione Reductase (GR), and Glutathione-S-Transferase (GST). Results showed that for all treatments, oxidative stress was experienced in all samples. However, different patterns of enzymatic activity were observed between nanofibers and leachates, with a general higher toxicity generated by leachates exposition that produced an inhibition and/or impairment of the antioxidant defense mechanisms at cellular level. This study represents a new area of investigation and is one of the first to focus on such stressors on soft coral species. In addition, the results highlight that nanofibers and leachates are indeed a major threat for coral reefs, which are already exposed to multiple climate change stressors and relentless anthropogenic pressures.

Exploring the potential of reduced Graphene Oxide (rGO) to mitigate copper and nickel stress in Lemna minor plants

Marco D'Eugenio[1,2,3], Maria Adelaide Iannelli[3], Barbara Casentini[2]

[1]Department of Environmental Biology, Sapienza Università di Roma, Rome, Italy; [2]Water Research Institute, National Research Council (IRSA-CNR), Montelibretti (Rome), Italy; [3]Institute of Agricultural Biology and Biotechnology, National Research Council (IBBA-CNR), Montelibretti, Rome; marco.deugenio@uniroma1.it

This study explores the potential of reduced graphene oxide (rGO) to mitigate metal stress in *Lemna minor* 5500 through its adsorption capacity. We investigated the co-exposure effects of nickel (Ni) and copper (Cu) on the duckweed plant.

Experimental set-up included different treatments (in triplicate): control plants (CP) in mineral water, plants with rGO (1 mg/L) (PG), plants exposed to either Cu (1 mg/L) or Ni (1.3 mg/L) (PM) and plants exposed to a combination of rGO (1 mg/L) and either Cu (1 mg/L) or Ni (1.3 mg/L) (PGM).

Cu exposure significantly reduced biomass (20%) by T14 in PM compared to CP. This effect was not statistically significant at T7, although a similar trend of RGR was observed. Interestingly, rGO treatment appeared to mitigate Cu stress. After 14 days, PGM plants showed a statistically significant increase in carotenoid content (43%) compared to PM, while total chlorophyll content also increased by 65% (though not statistically significant). These findings suggest rGO may alleviate Cu-induced stress on *L. minor*, potentially through enhanced chlorophyll and carotenoid production.

Copper accumulation in the PGM treatment was 25% lower than in the PM treatment after only seven days, suggesting its greater effectiveness in reducing copper accumulation. Our findings from the Cu co-exposure experiment support the hypothesis that GBMs can reduce metal bioavailability for plants. Ni uptake wasn't affected by rGO, suggesting a need for further study on this metal-rGO interaction. These results suggest a possible relationship between the observed effects and the different affinities that Cu and Ni may have for rGO and, consequently, their relative bioavailability for L. minor. The different physiological performances of the two treatments seem to confirm these hypotheses. Further investigations will be necessary to verify their applicability in the field of phytoremediation, such as large-scale experiments with different GBM and selected Lemna clones.

Phytotoxicity effects of tetracycline and sulfonamide mixture in the presence of copper on Lemna x mediterranea plants

Chiara De Carolis[1,2,3], Marco Fabriani[1], Giovanna Frugis[1], Valentina Iori[1], Barbara Casentini[3], Fabrizio Pietrini[4], Maria Letizia Costantini[2], Maria Adelaide Iannelli[1]

[1]Institute of Agricultural Biology and Biotechnology, National Research Council (CNR-IBBA), Montelibretti, Rome, Italy; [2]Dipartiment of Environmental Biology, "Sapienza" University of Rome, Rome, Italy; [3]Water Research Institute, National Research Council (CNR-IRSA), Montelibretti, Rome, Italy; [4]Research Institute on Terrestrial Ecosystems, National Research Council (CNR-IRET), Montelibretti, Rome, Italy; chiara.decarolis@uniroma1.it

Antibiotic (ABs) use is surging globally, particularly in intensive livestock production. ABs are often incompletely metabolized by animals, leading to significant excretion through feces and urine. Consequently, aquatic environments are becoming major repositories of ABs, with significant negative impacts on ecosystems, as these emerging pollutants also affect non-target organisms. This study examines the effects of a mixture of sulfamethoxazole (SMX) and chlorotetracycline (CTC), along with their potential interaction with copper sulphate ($CuSO_4$ $5H_2O$, Cu), released in aquatic environment from anthropogenic sources, on the aquatic plant *Lemna* sp., a common aquatic plant worldwide distributed and used as a model organism in ecotoxicology tests due to its rapid growth and sensitivity to environmental pollutants. Initially, following OECD guidelines[1], the toxicity Cu, SMX and CTC was investigated on *Lemna mediterranea* 9425a plants. The concentration-response relationship was used to estimate EC_{50} values: Cu, EC_{50}= 7.27 mg/L; SMX, EC_{50}= 173.00 mg/L and CTC, EC_{50}= 6.99 mg/L.

To simulate environmental conditions, *L. mediterranea* was exposed to SMX (2.5 mg/L) and CTC (0.1 mg/L) mixture alone and in combination with different concentrations of copper sulphate, 1.5 mg/L and 4 mg/L, for 14 days. The inhibitory effects induced by contaminants on duckweed plant growth and physiology have been evaluated by measuring fronds biomass, relative growth rate (RGR), pigment content, chlorophyll fluorescence, tolerance index and bioconcentration of Cu. Interestingly, the presence of the antibiotic mixture in combination with Cu appeared to mitigate the harmful effects of copper alone respect to duckweed's biomass and chlorophyll content. This was observed at both exposure times (7 and 14 days). Antibiotics seemed to lessen how much copper the plants absorbed at the highest copper dose, but the plants still accumulated copper over time, just more slowly.

[1]OECD. *Lemna* sp. growth inhibition test. Guideline 221. Organization for Economic Co-operation and Development: Paris, France 2006.

Integrated models for the development and assessment of high impact chemicals and materials: the INSIGHT project

Francesco Dondero[1], Iseult Lynch[2], Antreas Afantitis[3], Willie Peijnenburg[4], Martin Paparella[5], Lisa Bregoli[6], Jaakko Siltaloppi[7], Angela Serra[7], Dario Greco[7], Insight Consortium[8]

[1]University of Eastern Piedmont, Italy; [2]University of Birmingham, UK; [3]Novamechanics LTD, Cyprus; [4]Leiden University, the Netherlands; [5]Medical University of Innsbruck, Austria; [6]Warrant Group SPA, Italy; [7]Tampere University, Finland; [8]The INSIGHT Consortium (https://insight-project.org/); francesco.dondero@uniupo.it

The INSIGHT project (https://insight-project.org/) showcases four case studies integrating ecotoxicology and chemo-nano informatics models, demonstrating the intersection of ecotoxicology, chemical and material science safety, sustainability, and advanced in silico approaches. These integrated models, both data-driven and physics-based, provide comprehensive assessments of material safety, sustainability, and functionality, forming a Knowledge Graph that offers new insights and linkages between disparate concepts. The case studies encompass different chemicals or materials, industrial applications, model sets, regulatory landscapes, and scientific questions. They highlight the innovative integration of models and the resultant technical and societal insights.

The case studies focus on the following 4 topics. Graphene Oxide (GO) for Batteries and Construction: GO enhances battery performance and durability of cement. Challenges include scalable production and toxicity assessment. The study addresses GO's impact on material durability and recyclability within regulatory frameworks like REACH and RoHS. Per and Poly Fluoroalkylated Substances (PFAS) for the aerospace industry: PFAS are valued for thermal stability and low friction but pose environmental and health risks. The study explores PFAS replacements and models regulatory compliance, focusing on REACH and the Water Framework Directive. Bio-based Synthetic Amorphous Silica (SAS) for Tyres: Derived from renewable resources, bio-based SAS offers a sustainable alternative to conventional silica. The study evaluates life-cycle and social impacts, aligning with regulations like the EU's End-of-Life Vehicle Directive. Antimicrobial Coatings: Used in healthcare, food packaging, and consumer products, these coatings face challenges like microbial resistance and environmental impact. The study compares nano-enabled coatings with conventional disinfectants, under the EU Biocidal Products Regulation.

The informatics-driven approach integrates diverse modelling methodologies, including social life cycle assessment, to provide a holistic view of material functionality, safety, and sustainability. Each case study is documented through nanopublications, forming a Knowledge Graph consistent with the INSIGHT Data Management Plan and demonstrating leadership in model FAIRification.

ID: 161 / **POSTER-SP5.ECOTOX: 8**
Ecotossicologia dei contaminanti emergenti
Poster
Argomenti: Non voglio partecipare ad alcun premio

Preliminary assessment of microplastic pollution in aquatic ecosystems of Tuscany: distribution in abiotic and biotic compartments

Alice Gabetti[1,2], Annamaria Nocita[3], Camilla Mossotto[1,2], Alessandra Maganza[1,2], Giuseppe Esposito[1,2], Elena Bozzetta[1,2], Monia Renzi[4], Serena Anselmi[5], Tecla Bentivoglio[5], Marino Prearo[1,2], Paolo Pastorino[1,2]

[1]Istituto Zooprofilattico del Piemonte, Liguria e Valle d'Aosta, Via Bologna 148, Torino (TO).; [2]Centro di Referenza Regionale per la Biodiversità degli Ambienti Acquatici, Via Lino Maritano 22, Avigliana (TO).; [3]Sistema Museale di Ateneo, Università degli Studi di Firenze, Via La Pira 4, Firenze (FI).; [4]Dipartimento di Scienze della Vita, Università degli Studi di Trieste, Via L. Giorgieri 10, Trieste (TS).; [5]Bioscience Research Center, Via Giovanni Velasco 14, Orbetello (GR).; alice.gabetti@izsto.it

Microplastic (MP) pollution is a major environmental concern and a significant threat to aquatic life. This study presents a preliminary assessment of MP pollution in abiotic (water and sediment) and biotic (macrophyton, periphyton, the edible part of the gastropod *Sinotaia quadrata*, the bivalve *Corbicula fluminea*, and the crustacean *Atyaephyra desmarestii*) compartments along different rivers in the Tuscany region. Five sampling sites were identified along the Arno, Bisenzio, and Ombrone rivers, which are known to be exposed to anthropogenic pressures (e.g., presence of a textile factories, effluents from various urban centers). *S. quadrata* (N=325) was found at all five sampling sites, while *C. fluminea* (N=19) was only found at site five and *A. desmarestii* (N=50) at site two. Samples were sorted by stereomicroscopy at 10-80X, and potential targets were then chemically analyzed using microscopy coupled with Fourier transform infrared spectroscopy (μFT-IR). The analysis led to the identification of 101 items. The main MP colors were blue, white, and black, and the primary chemical types identified were polypropylene, polyethylene terephthalate, and polyethylene. A total of 56 MP items were found in *S. quadrata*, with a statistically significant difference in the average size of microplastics across different size classes. For *C. fluminea* and A. *desmarestii*, 9 and 5 MP items were found, respectively. Regarding the abiotic compartments and macrophyton, 31 MPs were identified with a mean size of 318.55 μm for water, 235.70 μm for sediment, and 291.77 μm for macrophyton samples. No MPs were found in periphyton. This study underscores the pervasive presence of microplastics in both abiotic and biotic components of river ecosystems in Tuscany, highlighting the need for further research and mitigation strategies to address this environmental threat.

Effects of micro and nano fibres derived from surgical face masks in Danio rerio

Andrea Masseroni[1], Marta Ribeiero[2], Alessandro Becchi[1], Francesco Saliu[1], Carlos Granadeiro[2], Chiara Urani[1], Sara Villa[1], Miguel Santos[2,3]

[1]Università degli Studi di Milano Bicocca, Italia; [2]University of Porto, Portugal; [3]Interdisciplinary Centre of Marine and Environmental Research, Matosinhos, Portugal; a.masseroni2@campus.unimib.it

The environmental challenge of plastic waste has been compounded by the global COVID-19 pandemic. During this period, countries have introduced the obligation to wear surgical face masks in public places to control the spread of the virus.

Since face masks are predominantly made of polystyrene (PP) and tend to release micro/nano fibres (MNFs), they pose a potential hazard to ecosystems.

The present study provides new information regarding the impacts of MNFs in aquatic organisms by evaluating the effects of secondary PP-MNFs derived from the non-woven PP fabrics of surgical face masks on *D. rerio* individuals.

The impact of MNFs on embryonic and larval zebrafish developmental stages has been evaluated by respectively short-term (up to 6 days) and median-term (up to 15 days) bioassays. The effects of low (0.2 mg/L), medium (1 mg/L), and high (5 mg/L) environmental-relevant contamination levels of MNFs were evaluated. Alterations in several apical endpoints (embryonic development, survival, growth, morphology, behaviour) and transcriptomic analysis were investigated.

After six days of exposure, a significant reduction in the eye area was observed in both the 0.2 mg/L and 5 mg/L treatments. It is noteworthy that the upregulation of genes related to the negative regulation of developmental processes could explain the observed morphological alterations. Moreover, the downregulation of genes involved in energy-related metabolic processes suggests an impairment in the correct development of organisms exposed to PP-MNFs. Furthermore, an increased mortality in MNF treatments occurred between 9 and 12 days, period when larval fish make the transition from endogenous feeding to exogenous feeding. This suggests an impairment in foraging behaviour occurred due the exposure to secondary PP-MNFs.

The findings of this study demonstrate that environmental levels of PP-MNFs may pose a hazard to aquatic organisms, suggesting the potential for an ecotoxicological risk associated with the improper disposal of surgical face masks.

Microplastics and invasive crayfish species: preliminary observations from Lake Maggiore (NW Italy)

Marco Orlandi[1], Giulia Cesarini[1], Riccardo Sbarberi[2], Denise Schiavetta[3], Lyudmila Kamburska[2,4], Stefano Magni[2], Andrea Binelli[2], Mirko Zanini[5], Nicole Santi[5], Angela Boggero[1]

[1]National Research Council – Water Research Institute (CNR-IRSA), Corso Tonolli 50, 28922 Verbania; [2]Department of Biosciences, University of Milan, Via Celoria 26, 20133 Milan; [3]Università del Piemonte Orientale -Department of Science, Technology and Innovation (DISIT) ,Viale Teresa Michel 11, 15121 Alessandria; [4]National Biodiversity Future Center (NBFC), 90133 Palermo, Italy; [5]Maddalena & associati Sagl, Via Ai Rïégn, 6672 Gordevio, Switzerland; giulia.cesarini@irsa.cnr.it

Microplastics (MPs) and invasive species pose significant threats to aquatic conservation, representing critical global eco-environmental challenges. MPs affect aquatic habitats, including physical and ecotoxicological effects on biota, whereas invading species are a key cause of global biodiversity decrease. In Europe, crayfish are among the most common freshwater invaders, leading to local ecological and economic impacts. Lake Maggiore, characterized by growing urbanization, industrial and touristic activities is an important survey area for evaluating the combined effects of these environmental pressures due to its vast hydrographic basin, able of conveying large quantities of MPs towards the lake. This study aimed to assess the presence of invasive crayfish in Lake Maggiore, their biometry and their MPs degree of bioaccumulation. Three invasive crayfish species (*Faxonius limosus*, *Pacifastacus leniusculus*, and *Procambarus clarkii*) were captured in the Swiss sector of the lake along the littoral of Locarno area through baited traps. They were divided by sex, weighed and sized and their belonging to the species were also confirmed through molecular approach. A pool of 30 individuals per species and sex divided into small, medium and large sizes was considered for the analyzes of the presence of MPs in the intestine. The results revealed MPs accumulation of 0.07 ± 0.06 items/specimen in *P. clarkii*, 0.20 ± 0.10 items/specimen in *P. leniusculus*, and 0.37 ± 0.31 items/specimen in *F. limosus*, the latter showing higher concentrations. Polyester and polyacrylate were the most common MPs in the three species. Thus, intestinal content may reflect the bioavailability of MPs in Lake Maggiore, giving an alternative to monitoring abiotic matrices while additionally supporting invasive species containment. More research is needed to discover the best crayfish species for detecting MPs pollution and to assess how much MPs move from the intestine to other organs, particularly muscle edible tissues used in the food market.

The Scopoli's shearwater (Calonectris diomedea) as a sentinel for biomonitoring emerging contaminants in Mediterranean marine ecosystems

Marco Parolini[1], Federico De Pascalis[2], Federico Tossani[2], Jacopo G. Cecere[2], Diego Rubolini[1]

[1]Università degli Studi di Milano; [2]Istituto Superiore per la Protezione e la Ricerca Ambientale - ISPRA; marco.parolini@unimi.it

Contaminants of emerging concern (CECs) include a vast array of currently unregulated xenobiotics, including chemicals, their by-products. These contaminants are not necessarily newly synthetized, but their presence in natural ecosystems has only recently started to be investigated. Some CECs are currently under scrutiny for regulation because they have potential adverse effects on wild organisms and human health, including pharmaceuticals and personal care products (PPCPs), flame retardants (FRs), certain pesticides, plastic additives, per- and polyfluoroalkyl substances (PFASs), nanoparticles, and micro and nanoplastics. During the last years, the occurrence and distribution of certain CECs have been detected in the Mediterranean basin, one of most polluted marine regions, and their bioaccumulation and biomagnification have been documented. However, the studies on the trophic transfer of CECs in marine ecosystems have mainly focused on species belonging to low trophic levels. We propose the Scopoli's shearwaters (*Calonectris diomedea*), a top-predator in the Mediterranean marine trophic chain, as an excellent sentinel organism for biomonitoring spatial and temporal pattern of CECs in this area. We will focus on obtaining biological samples from shearwaters breeding at several colonies across most of the Mediterranean Sea, from Greece to Spain. The accumulation of different CECs, including PPCPs, FRs, plastic additives and PFASs will be assessed in the blood from fledglings exposed to local levels of contamination. These analyses will shed light on the spatial distribution of CECs and will act as a baseline for biomonitoring the fate of CECs in Mediterranean ecosystems.

Towards One-Health approach to neurotoxicity assessment of PFAS

Davide Rotondo[1], Laura Lagostena[2], Konstantinos Papavasileiou[3], Valeria Magnelli[1], Davide Gaualandris[1], Candida Lorusso[1], Antonio Calisi[1], Iseult Lynch[4], Antreas Afantitis[3], Francesco Dondero[1]

[1]Università del Piemonte Orientale, Italia; [2]Istituto di Biofisica, CNR, Italia; [3]Novamechanics LTD, Cyprus; [4]Università di Birmingham, UK; davide.rotondo@uniupo.it

Worm movement depends on alternating waves of inhibitory and excitatory neurotransmitters, namely GABA and acetylcholine, at the neuromuscular junction. We have previously shown that short-term exposure to per- and polyfluoroalkyl substances, such as PFOA and the short chain perfluoropropylene oxide dimer acid (HFPO-DA), also known as GenX, can affect neurotransmitter levels and impair locomotion in the red worm *E. fetida*. In this work, we performed molecular docking analysis of a battery of 34 different PFAS congeners with the 3D structure of the human GABA-a receptor, showing that several structurally different PFAS have varying affinities for different binding sites and that the majority of PFAS congeners prefer the more spacious flumazenil site, while at the intracellular side, all molecules showed affinity towards the picrotoxin site. We selected a subset of mostly potentially active compounds and assessed their toxicological properties in terms of survival and GABA chloride channel modulation in a modified neuronal-like neuroblastoma cell line. Despite no acute toxicity and hormetic effects, several PFAS compounds could affect GABA chloride currents. PFOS was the most effective in reversibly suppressing GABA current, followed by PFMOBA, PFOA, CH3-PFO3-3-6-9-TriDoA, branched ADONA, and PFMOPrA. These findings highlight the complex interactions and potential neurotoxicity of various PFAS compounds, emphasizing the need for comprehensive risk assessment strategies. The One Health approach, considering the interconnected health of humans, animals, and ecosystems, is crucial for addressing the multifaceted impacts of PFAS contamination. Integrating environmental, biological, and chemical data is essential to develop effective policies and interventions to protect public health and the environment.

Capitale naturale, servizi ecosistemici e contabilità ambientale

Chairs

Pier Paolo Franzese, Fausto Manes

Presentazioni Orali

Urban Ecosystem Accounts for Italy: benchmarking Italian values against other European countries

Javier Babí Almenar[1,2], Renato Casagrandi[1,2]

[1]Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, 20133, Milano, Italia; [2]NBFC, National Biodiversity Future Center, Palermo 90133, Italia; javier.babialmenar@polimi.it

The recently approved Nature Restoration Law (NRL) sets targets for urban green space and tree cover. Concurrently, the proposal for an amendment to the EU Regulation on Environmental Accounts includes accounts for ecosystem extent, condition, and services for urban ecosystems, aligning with the UN Statistical Standard for Ecosystem Accounting (SEEA-EA). The NRL anticipates increased urban green space and tree cover in each Member State until satisfactory levels are achieved. However, it remains unclear what defines a satisfactory level and how it will be evaluated, though it is expected to relate to optimal or good ecosystem condition as outlined in SEEA-EA. Here, we benchmark Italian urban ecosystems in terms of extent, condition, and services against European counterparts. Hopefully, initiating a discussion to better understand potential satisfactory levels. We conduct an overall comparison and a closer look at countries with similar climates and population size. We develop thematic urban ecosystem accounts for the latest year available in Copernicus data (2018). Specifically, we create accounts for ecosystem extent, four condition variables (green space, tree cover, imperviousness, and particulate matter (PM) concentration), and air filtration as an ecosystem service. Results show that Italian urban ecosystems have slightly more artificialized areas and fewer (peri)urban forests than the EU average. In general, condition variables and air filtration efficiency in Italian urban ecosystems are similar to European averages. However, $PM_{2.5}$ and PM_{10} in Italian urban ecosystems exceed European averages by 3-7 µg/m³ (a 20% higher than the European average), varying seasonally. Italian medium-sized cities also show higher imperviousness per inhabitant and lower urban green per inhabitant than European counterparts, with regional variations within Italy. Overall, if satisfactory levels within NRL and related policies are defined as feasible general European values, Italy is unlikely to face major challenges, compared to most European counterparts, in meeting them.

The overlooked role of necromass in the carbon budget of Posidonia oceanica seagrass beds

Ludovica Capasso[1,2], Rendina Francesco[1,2], Buonocore Elvira[1,2], Franzese Pier Paolo[1,2], Russo Giovanni Fulvio[1,2]

[1]International PhD Programme/UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Italy; [2]CoNISMa, Piazzale Flaminio 9, (00197) Rome, Italy.;
ludovica.capasso001@studenti.uniparthenope.it

The endemic seagrass of the Mediterranean Sea Posidonia oceanica forms extensive beds, considered among the most complex and productive marine ecosystems. They are also defined as priority habitats by the European Community Directive 92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora.

The balance between primary production and remineralization governs the cycle of these ecosystems, especially considering that most of their production plays a role as necromass. The fate this necromass may endure is highly variable. Indeed, once being shed from the original bed, the destination of the dead biomass depends on the major driving forces acting on the bed (e.g., hydrodynamic characteristics and coastline conformation). Consequently, the necromass is exported towards other locations, leading to the formation of deposits both offshore (the neglected "maceration sites") and onshore (the so-called "banquettes"). They both constitute an important carbon stock and a source for detrital food webs, also providing valuable ecosystem services (e.g., sediment retention and protection from coastal erosion).

In this study, we investigated the fate of the primary production in a P. oceanica bed off the Ischia Island (Southern Italy). Three different compartments were considered: (i) the living bed, (ii) the maceration site, and (iii) the banquette.

The aim was firstly to assess and quantify the associated carbon pools (gC m-3). Furthermore, the purpose was also to investigate and possibly to determine their fluxes among the three different compartments using ecosystem accounting.

Beside the well-known importance of the living seagrass beds, results shed light on the key role of the overlooked necromass of Posidonia oceanica in the blue carbon cycle.

Mangroves of the Maldives: unveiling and studying these unique ecosystems

Federico Cerri[1,2], Yohan Didier Louis[1,2], Luca Fallati[1,2], Rossella Nicolai[1,2], Giulia Senna[1,2], Paolo Galli[1,2]

[1]Department of Earth and Environmental Sciences DISAT, University of Milano-Bicocca, Piazza della Scienza 1, Milano, Italy; [2]MaRHE Center (Marine Research and Higher Education Center), Magoodhoo Island, Faafu Atoll, Maldives; f.cerri@campus.unimib.it

Mangroves represent one of the most biologically and ecologically important ecosystems in the world, providing habitat and food for various terrestrial, estuarine, and marine species. Furthermore, they have an estimated economic value of at least $1.6 billion per year as they provide several ecosystem services, including fisheries enhancement, coastal protection, carbon storage and sequestration, and promotion of tourism and recreational activities. However, in the Maldives, knowledge about mangroves is scarce and their importance is still underestimated. The aim of our project is to study these ecosystems and conduct the first ever survey of all mangroves in the Maldives to improve the understanding of their unique ecosystems in order to take more action to protect them from human impact. In our recently published paper, we reviewed all information on mangroves in the Maldives and found that mangrove ecosystems have been documented on 108 islands (9% of all Maldivian islands) with 14 different mangrove species. However, the number of studies is limited and the number of islands with mangroves is potentially higher. In this context, in our last expedition, we explored the mangroves of Laamu and Thaa Atolls. We explored 9 mangrove areas and found two more islands with mangroves unreported in literature. For each mangrove habitat, the different macro-types of mangrove habitat, i.e. fringing, lake-based, embayment, and swamp-based, were documented, and water parameters, including temperature, pH, salinity, and dissolved oxygen level were assessed. Furthermore, mangrove species were visually identified, and leaves samples were collected for identification with DNA barcoding. As the Maldives are experiencing an increasing demand for areas for agricultural expansion and coastal urban development and has recently been classified as critically endangered by the global assessment of IUCN, this work can push the authorities to ensure an effort in the management, protection, conservation, and restoration of these ecosystems.

Wetland type matters: evaluating distinct sets of ecosystem services for reliable ecosystem accountings

Mattias Gaglio, Lanzoni Mattia, Vincenzi Fabio, Castaldelli Giuseppe

Università degli Studi di Ferrara, Italia; gglmts@unife.it

Following the launch of the System of Environmental-Economic Accounting - Ecosystem Accounting (SEEA-EA) by the United Nations in 2021, ecosystem accounting has become a prevalent means of incorporating natural capital value into policymaking processes. Nevertheless, the reliability of such a tool depends on the accuracy and reliability of data at the level of individual ecosystems. This aspect is of particular importance when applied to deltaic environments, where aquatic ecosystems provide different and distinct bundles of ecosystem services (ES).

The present study aims to evaluate the diverse sets of ES delivered by four transitional wetlands, representing the aquatic ecosystems of the Po delta (Italy), based on empirical data gathered from primary sources. The results demonstrate that wetlands exhibit considerable variation in their qualitative and quantitative values, contingent upon their specific uses, management practices, and ecological characteristics. Coastal, closed lagoons and saltworks are primarily utilized for provisioning and cultural ES with direct market value, while other ES are of lesser monetary significance. In contrast, the value of regulating ES (i.e. water regulation) is prevalent in the inner wetlands.

Although primarily utilized for productivity purposes, the wetlands of the Po Delta exhibit distinct sets of ES according their specific features and differ in total ES value. By providing a detailed understanding of the ES provided by different wetland types, this study highlights the importance of tailored management practices to maximize the ecological and economic benefits of these critical ecosystems. The findings indicate a clear need for ecosystem-level studies in deltaic environments as a foundation for the scaling up of ecosystem accounting at regional and national levels.

Assessing natural capital and ecosystem services in marine ecosystems: the case study of the Strait of Sicily (central Mediterranean)

Umberto Grande[1,2,4], Elvira Buonore[2], Pier Paolo Franzese[2], Fabio Fiorentino[1], Valentina Lauria[1], Evelina Sabatella[3], Danilo Scannella[1], Sergio Vitale[1], Germana Garofalo[1]

[1]National Research Council of Italy, IRBIM - Institute for Marine Biological Resources and Biotechnology, Mazara del Vallo, Italy; [2]International PhD Programme / UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Centro Direzionale Isola C4 (80143), Naples, Italy; [3]National Research Council of Italy, IRPPS - Institute for research on population and social policies, Fisciano, Italy.; [4]Department of Geobotany and Landscape Planning, Nicolaus Copernicus University in Torun, Torun, Poland.; umbertogrande@gmail.com

The Strait of Sicily (central Mediterranean Sea) is identified as a biodiversity hotspot able to provide multiple ecosystem services, supporting human life at different scales. However, the Strait of Sicily is one of the most threatened areas in the Mediterranean basin. Anthropogenic pressures are degrading its natural capital and the ability to provide ecosystem services, negatively affecting human well-being. In this context, the present study aimed to implement a multimethodological assessment framework to assess natural capital and ecosystem services in the Strait of Sicily, tracking changes over time. Combining Environmental and Ecosystems Accounting and conventional ecological indicators, the ecological and economic value of natural capital and ecosystem services was assessed.

The Eco-exergy method, coupled with the Shannon diversity index, was implemented to account for the complexity and organizational level of demersal natural capital stocks, monitoring changes in the last fifteen years. In addition, spatial and hotspot analyses were applied to identify areas exhibiting high natural capital and diversity values. Moreover, a set of environmental variables was investigated to link the decline of natural capital to environmental stressors.

The outcomes showed a decline in demersal natural capital stock and diversity, which is closely linked and discussed in relation to the observed trends of environmental variables in the investigated period. In addition, two ecological areas valuable for conservation purposes were identified.

Subsequently, the "System of Environmental-Economic Accounting Ecosystem Accounting" framework was applied to assess a set of ecosystem services provided by the Strait of Sicily, both in biophysical and monetary terms. Extent, condition and ecosystem services flow & use were assessed. Among ecosystem services, food provisioning, carbon sequestration, and nursery function were assessed. The method of willingness to pay for habitat conservation was also applied. Results will be useful to policymakers in charge of developing strategies to achieve impelling conservation actions and sustainability goals.

Spatio-temporal dynamics of Posidonia meadows functioning in the Mediterranean Sea: using benthic chambers for Blue Carbon prediction

Francesco Paolo Mancuso[1,2], Mar Bosch-Belmar[1,2], Mario Francesco Tantillo[1], Martina Russi[1,2], Viviana Piermattei[3], Marco Marcelli[4], Gianluca Sarà[1,2]

[1]Department of Earth and Marine Science (DiSTeM), University of Palermo, Palermo, Italy; [2]NBFC, National Biodiversity Future Center, Spoke 1, Palermo, Italy; [3]Ocean Predictions and Applications Division, Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy.; [4]Laboratory of Experimental Oceanology and Marine Ecology, Department of Ecological and Biological sciences DEB, University of Tuscia, Port of Civitavecchia, Civitavecchia (RM), Italy.; francesco.mancuso@unipa.it

This study investigates the spatio-temporal, trait-based distribution and functioning of *Posidonia oceanica* meadows in the Mediterranean Sea, utilizing benthic chambers to upscale ecosystem services predictions. *Posidonia* meadows are critical for marine biodiversity, nutrient cycling, and carbon sequestration. We conducted in-situ metabolic measurements of *Posidonia* meadows in the northern Tyrrhenian Sea, integrating these with remote sensing data to develop predictive models of key metabolic traits under current and future climate scenarios. The Net Community Production (NCP) was used to assess community metabolism, constructing Thermal Performance Curves (TPC) for *Posidonia* habitat. Results showed that *Posidonia* meadows exhibit autotrophic metabolism year-round, with optimal performance at 23°C and upper thermal limits at 35°C. Spatial predictions indicated seasonal variations in metabolic performance, with significant future changes due to rising temperatures. Our findings highlight the essential role of *Posidonia* meadows in providing ecosystem services, such as oxygen production, CO_2 absorption, and carbon fixation, which are projected to increase under moderate warming scenarios. However, the meadows may face performance declines during the warmest periods, particularly in the central-western Mediterranean, potentially impacting local fisheries and ecosystem stability. This study underscores the need for conservation efforts to preserve *Posidonia* habitats, integrating high-resolution data into ecosystem management strategies to mitigate climate change impacts. By providing a comprehensive understanding of the metabolic responses of *Posidonia* meadows to varying temperature regimes, this research contributes to the broader effort of forecasting the ecological consequences of global warming on marine ecosystems. It also emphasizes the importance of adaptive management strategies that can enhance the resilience of these vital habitats, ensuring the sustained provision of their ecosystem services in the face of environmental change.

Biotic and abiotic strategies to enhance energy valorization of organic fraction of municipal solid waste and sludge of wastewater treatment plants

Valentina Mazzurco Miritana[1], Roberto Ciccoli[1], Adolfo Le Pera[2], Lorenzo Panunzio[1], Stefano Ferri[1], Antonio Bozzelli[1], Emanuele Fanelli[1], Roberto Albergo[1], Giulia Massini[1]

[1]ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development. Department of Energy Technologies and Renewable Sources (TERIN) Via Anguillarese 301, 00123, Rome, Italy; [2]Calabra Maceri and Services Laboratory, Via Marco Polo Z.I. da Lecco - 87036 Rende (CS), Italy; valentina.mazzurco@enea.it

In recent decades, mesophilic anaerobic digestion (AD) has been widely applied on an industrial scale for the energy valorisation of organic waste according to a sustainable Waste-to-Energy approach. Despite the numerous advantages of AD treatment, mainly the disposal of organic waste and the production of CH_4, the performance of the bioprocess can still be improved by optimising biotic and abiotic process parameters. This study evaluated the AD treatment of a mixture of two problematic wastes of predominantly urban origin, namely the organic fraction of municipal solid waste (OFMSW) and sludge from wastewater treatment plants (70% and 30%, respectively). To improve CH_4 production and yield and make the AD process more sustainable, two different strategies were compared, based on a non-conventional operating temperature (42°C) and the bioaugmentation of the microbial community in mesophilic condition (37°C), respectively. Two batch-configured experiments were conducted on a bench scale with acclimatized microbial communities monitoring CH_4 production and yield, fibre composition and microbial community characteristics. The results showed that a 5°C increase in operating temperature increased cumulative CH_4 production by 43.9%. However, bioaugmentation provided the best yields in terms of mL CH_4 production compared to the added volatile solid (VS). Furthermore, as bioaugmentation was performed at day 12 with the aim of reactivating the CH_4 process, it increased production by a further 19.2% and almost doubled the yields compared to the unaugmented condition (611.3 ± 3.2 vs 373.7 ± 28.1 mL CH_4 gVS^{-1}, respectively). The latter result is of particular interest for future research developments aimed at identifying strategies for recovering and enhancing the AD process in real plants, which are often subject to episodes of critical process conditions and inhibitory effects.

Urban-rural continuum for the sustainable management of urban areas: the case study of the metropolitan city of Rome

Lorenza Nardella[1], Pier Paolo Franzese[2], Fausto Manes[3]

[1]Research Institute on Terrestrial Ecosystems (IRET), National Research Council (CNR), Viale G. Marconi 2, 05010 Porano, Italy; [2]International PhD Programme/UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Italy; [3]Department of Environmental Biology, Sapienza University of Rome, P.le Aldo Moro 5, 00185 Rome, Italy; lorenza.nardella@iret.cnr.it

Urbanization is a global mega-trend resulting from urban population growth, urban expansion and migration from rural to urban areas. Road and communication infrastructure have been improved across large parts of rural areas, and demographic projections show that upcoming urbanization will occur in peri-urban areas, as well as in small cities and interconnected towns. The distinction between rural and urban is becoming increasingly blurred; rather than two separate entities in their own right, rural and urban areas represent two ends of a spectrum, connected via numerous linkages across a rural–urban *continuum*. As urban forms expand into the rural realm, the extent and condition of natural and semi-natural ecosystems is increasingly threatened by human-induced pressures, while their capacity to maintain consistent supply of Ecosystem Services (ESs) is reduced, with cascading impacts on the quality of urban life. In this context, Green Infrastructures emerge as fundamental Nature-Based Solutions because they enable residents to experience multiple co-benefits through the ESs they provide, in line with a "One Health" vision.

We present a spatial analysis of ES provision and synergies/trade-offs along the urban–rural gradient for the metropolitan city of Rome. We focus our attention on two macro classes of human-induced environmental pressures that are particularly critical to the quality of life in urban contexts, namely air pollution and the Urban Heat Island effect. We found that all the selected ESs, besides a few exceptions, are provided as a bundle, which means they appear together repeatedly. On average, ES provision grows at comparable paces moving from the inner urban core towards peri-urban and rural areas. As a consequence, most densely urbanized areas were found to be ESs coldspots, that is low ES-supply areas, compared to peri-urban and rural areas. These findings may support the implementation of the recent European Nature Restoration Law in urban areas.

Evaluating Ecohydrological Models: A comparative analysis on quantifying the impacts of blue-green infrastructure

Margherita Nardi[1], Tams Laura[2], Pier Paolo Franzese[1], Eva Nora Paton[2]
[1]Università Parthenope, Napoli, Italia; [2]Institut für Ökologie, TU Berlin, Germany; margherita.nardi001@studenti.uniparthenope.it

Urban trees play a fundamental role in enhancing the liveability of our cities by providing several ecosystem services, including stormwater retention, air and water quality improvement, and heat island mitigation. However, the complex interplay between green systems and urban environments poses challenges in accurately quantifying their contributions. To estimate these interactions and forecast their effects, several highly specialized modelling tools are available. Indeed, the lack of a comprehensive and user-friendly tool that could fully characterize and describe the interactions has been noticed. This study aims to assess the performance of three models, the drainage model SWMM, the water-stress model URbanTRee and micro-meteorological model PALM, in reproducing green systems and urban environment interactions, particularly in terms of runoff, infiltration, evapotranspiration, soil moisture, and thermal conditions. We used a comparative analysis by parameterising the three models to the same case study, two well-monitored trees in TU-Campus, Berlin, with the same input data. The SWMM model, Storm Water Management Model, provided a high-resolution assessment of runoff and infiltration dynamics. The URbanTRee model focuses on runoff, infiltration, evapotranspiration and soil moisture dynamics. Finally, the PALM, an advanced model for atmospheric and oceanic boundary layer flow, stands out for simulating evapotranspiration, soil moisture and thermal conditions. The model intercomparison showed the difficulties that arise due to different model interoperabilities, such as different parameterisation required, the different data formats, and the different space and time resolutions used. However, once normalized, it was possible, to determine which model best described each aspect of rainfall separation and which information got lost while applying different model scales and structures. In conclusion, it was shown that comparative analyses among environmental models facilitate the choice, the implementation and thus the performance of these tools, resulting in a positive impact on urban planning, environmental management, and ecosystem service assessment.

A metadatabase of the natural capital of small and medium size islands: the SMILES approach

Emilio Padoa-Schioppa[1], Noemi Rota[1], Francesca Bretzel[8], Alessandro Chiarucci[3], Nazil Demirel[4], Nenad Jasprica[9], Dejan Mandžukovski[7], Francesco Santi[3], Daniela Smiraglia[5], Fotios Xystrakis[6], Savvas Zotos[2], Ioannis Vogiatzakis[2]

[1]Research Unit of Landscape Ecology, Department of Earth and Environmental Sciences, University of Milan-Bicocca, Italy; [2]TERRESTRIAL ECOSYSTEM MANAGEMENT LAB, FACULTY OF PURE AND APPLIED SCIENCES, OPEN UNIVERSITY OF CYPRUS; [3]Biome Lab, Department of Biological, Geological, and Environmental Sciences, University of Bologna, Bologna, Italy; [4]Institute of Marine Sciences and Management, Istanbul University, Istanbul, Turkiye; [5]Italian Institute for Environmental Protection and Research (ISPRA) - Italy; [6]Forest Research Institute, Hellenic Agricultural Organization DIMITRA, Greece; [7]Department for Forest Management Planning PE Nacionalni šumi, St.Kliment Ohridski no.68 blvd. Skopje North Macedonia; [8]Istituto per la Ricerca sugli Ecosistemi Terrestri (IRET), Consiglio Nazionale delle Ricerche, Italy; [9]University of Dubrovnik, Institute for Marine and Coastal Research, Dubrovnik, Croatia; emilio.padoaschioppa@unimib.it

European islands are hotspots of biological and cultural diversity. Compared to the mainland, they are more vulnerable to climate change, tourism development, uncontrolled land use changes and financial crises. Although ecosystem services assessments have been conducted worldwide in various geographical areas, islands -especially small and medium size ones- remain underrepresented.

SMILES (*Enhancing Small-Medium IsLands resilience by securing the sustainability of Ecosystem Services*) is a COST action that aims to provide a platform for coordinated interdisciplinary research on several aspects of mapping and assessing of ecosystems services in small/medium European Islands. The goal is to synthesize and strengthen the knowledge base for the conservation of island realms and contribute to their sustainable development. One of the expected output of SMILES is a comprehensive database of natural capital for all small and medium size islands.

The approach to achieve this result involved building a metadatabase that links islands to existing datasets of natural capital. First, we adopted a definition of natural capital to create a list of its components. Then, we compiled a list of islands (ranging from 1 km^2 to 10,000 km^2), which included about 6,000 islands, considering all overseas territories, the entire Mediterranean basin, and more than 3,000 islands belonging to three countries (Russia, Norway and Denmark).

A novel approach to this evaluation was the inclusion of marine natural capital associated with the islands. By combining ecological zones, geographical factors and political borders, we delineated a buffer area around each island that can be considered part of its marine natural capital.

The final result is a global metadabase, available on COST action website that allows user to identify biodiversity and natural capital hotspots, island with natural heritages sites, or protected areas that can be prioritized in future conservation efforts.

Rhodolith beds: overlooked biogenic habitats providing essential ecosystem services

Francesco Rendina[1], Umberto Grande[1,2,3], Pier Paolo Franzese[1,2], Elvira Buonocore[1,2], Giovanni Fulvio Russo[1,2]

[1]Department of Science and Technology, Parthenope University of Naples - ULR CoNISMa - Centro Direzionale Isola C4 (80143), Naples, Italy; [2]International PhD Programme / UNESCO Chair "Environment, Resources and Sustainable Development"; [3]Department of Geobotany and Landscape Planning, Nicolaus Copernicus University, ul. Lwowska 1, 87-100, Toruń, Poland.;
francesco.rendina@uniparthenope.it

The interactions between abiotic and biotic components within ecosystems generate functions that provide a wide range of ecosystem services vital for human well-being. The ecosystem services provided by coastal and marine ecosystems are increasingly recognized, especially for highly productive habitats such as mangrove forests and seagrass beds. However, some key vegetated ecosystems, like rhodolith beds, remain overlooked. Rhodolith beds are biogenic calcareous habitats formed by the aggregation of unattached, non-geniculate coralline algae. These beds are distributed worldwide and, due to their 3D structural complexity, host a high biodiversity of benthic microalgae, fleshy macroalgae, zoobenthos, and fishes, also of commercial interest. Rhodolith beds are also relevant in the blue carbon cycle through their role in carbon sequestration and carbonate production, even if their real contribution to climate regulation has still to be deeply understood. Indeed, although several studies address the functional role of rhodolith beds, there is an urgent need to link this knowledge to the supply of ecosystem services. This study aims to provide an overview of rhodolith bed ecosystem services according to the CICES classification (i.e., provisioning, regulation and maintenance, and cultural), also investigating supporting services (i.e., ecological functions) for their crucial role in generating all the other ecosystem services. Rhodolith beds are vulnerable to various anthropogenic threats on both global (e.g., climate change) and local (e.g., fishing) scale. Consequently, negative impacts on rhodolith beds may undermine their ability to provide these essential services. In this scenario, it is crucial to assess how the ecosystem services provided by rhodolith beds are changing in response to global environmental changes. This overview will offer useful insights for the management and conservation of these important yet vulnerable marine ecosystems.

Integrating information about status biomonitoring and ecosystem functioning through transdisciplinary methodology to communicate restoration success

Ilaria Rigo[1,2], Julia Pasqualini[4], Mario Brauns[4], Chiara Paoli[1,2,3], Paolo Vassallo[1,2,3]

[1]DISTAV, Dipartimento di Scienze dellaTerra dell'Ambiente e della Vita Università degli Studi di Genova, corso Europa 26, 16132, Genova, Italia; [2]CONISMA, Consorzio Nazionale Interuniversitario per le Scienze del Mare, Piazzale Flaminio, 9, 00196 Roma, Italia; [3]NBFC (National Biodiversity Future Center), Palermo, Italia; [4]Department of River Ecology, Helmholtz Centre for Environmental Research-UFZ, Bruckstr. 3a, 39114Magdeburg, Germany; ilaria.rigo@edu.unige.it

Rivers are dynamic systems which provide essential ecosystem functions (e.g., nutrients retention, climate regulation) and services (e.g., water supply, fish production) benefiting humans.

Many river ecosystems have been impacted by anthropogenic activities, for instance the construction of dams can degrade the hydromorphological conditions such as habitat loss and thus reduce biodiversity and alter ecosystem functioning.

As required by the EU Water Framework Directive, restoration river programs aim to reverse negative trends due to impacts, eliminate degradation causes and reinstate essential key processes.

In collaboration between UNIGE (Italy) and UFZ (Germany), a transdisciplinary methodology was developed and tested to assess the success of river restoration in terms of biodiversity and ecosystem functioning in the Ecker stream in Germany. This work was made possible by the Antonio Moroni award funded by SItE.

The analyses conducted within the European RESTOLINK project involved dividing the stream into three sections: a reference upstream reach (control), a middle section with an old weir (impacted), and a downstream site where an old weir has been replaced with a step-pool structure (restored). In each reach, classical methods to asses rivers status through biodiversity measurements are supplemented by biophysical quantification of the natural capital and ecosystem functions through emergy analysis. The latter is based on a donor-side perspective, able to value an ecosystem as production cost in terms of resources exploited to generate and maintain biomass and trophic network. Natural capital is then calculated in the three river sections to obtain a unique system measure to assess restoration efficacy and complement ecological status evaluations. Biophysical measures can be then converted into monetary terms in order to better communicate obtained results also to managers and integrating them into monitoring plans.

Exploring ecosystem services perceptions and plural values to enable transformative change in the Venice lagoon, Italy.

Silvia Rova[1], Maraja Riechers[2], Daniele Brombal[3], Lorenza Maistrello[4], Fabio Pranovi[1]

[1]Environmental Sciences, Informatics and Stetistics Dept., Ca' Foscari University of Venice, Italy; [2]Fisheries & Society Group, Thünen Institute of Baltic Sea Fisheries, Rostock, Germany; [3]Asian and North African Studies Dept., Ca' Foscari University of Venice, Italy; [4]IRCCS San Camillo Hospital, Venice, Italy; silvia.rova@unive.it

Climate change and biodiversity crises are rooted in the narrow set of utilitarian values that are prioritized in current policymaking processes. Therefore, recognizing the plurality of nature's values is a key step to enable a transformative change towards sustainability. In this work, we aim to explore the diversity of nature's values and ecosystem services (ES) perceptions expressed by the citizens of the Venice lagoon, Italy. The 965 complete responses obtained from our survey revealed a diversity of values, with almost half of the respondents mentioning a combination of two or more values of nature, including intrinsic, relational and instrumental ones. The perceptions expressed on ES allowed to divide the sample into four clusters, which recognize the importance of the lagoon's ES to different extents. Interestingly, these distinct ES perceptions are associated with different priorities in terms of nature's values, and can be positioned along a gradient ranging from high to low alignment with sustainability principles. These results convey two key messages. First, part of the local community already recognizes the high importance of the lagoon's ecological structures, processes and ES, and holds values aligned with sustainability principles. These perspectives and values should thus be recognized and embedded in the local decision making processes. Second, the citizens that currently fail to recognize the importance of ES are those to which the greatest efforts should be directed, to promote a shift towards sustainability-aligned values and behaviours. Understanding how ES are perceived complements existing ES assessments providing insights on which ES categories are poorly recognized, and can help to envisage new ways to convey their importance to the public and decision makers. From a leverage points perspective, working in these directions means to act upon crucial value-centred leverage points that can enable a transformative change towards a sustainable use of natural resources.

Diversity of Milan's trees: species, distribution, and characteristics to inform decisions

Davide Stucchi[1,2], Javier Babí Almenar[1,2], Renato Casagrandi[1,2]

[1]Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, 20133, Milano, Italia; [2]NBFC, National Biodiversity Future Center, 90133, Palermo, Italia; davide1.stucchi@polimi.it

Trees and green spaces are crucial elements for urban quality of life. Beyond their presence and abundance, species diversity and urban distribution of city trees are also important. These characteristics help to inform the status of urban ecosystems, ecosystems services supply, and management. They also serve as inputs in ecological models supporting decision-making on urban tree management and ecosystem services. Here, we aim to map and analyze tree species, age, morphological characteristics and diversity attributes in the municipality of Milan in relation to contextual factors, and to assess whether there are variations. We used a dataset of public trees provided by Milan municipality. Analyses were conducted city-wide and partitioning Milan into a uniform grid. Particular attention was paid to assess whether there were significant differences between trees within and outside parks. Among other aspects, we identified dominant species, calculated indices of species diversity and similarity and studied age and size trends by tree species. In terms of dominant species, differences emerged between trees within parks and outside parks. For example, *Quercus* trees are only predominant in parks, mainly in the form of young individuals; in contrast, *Platanus x acerifolia* is mainly found outside parks, and composed of most individuals that are over 30 years old. DBH versus age plots confirmed that there is a linear growth relationship for most species, indicating continuous growth. In contrast, crown diameter versus age plots show an unnatural saturation, especially clear in trees outside parks, which plausibly results from established management practices. These findings provide insights into the current distribution of public trees in Milan and provide *in situ* allometric relationships for several species' morphological attributes. This information could be useful to inform future planning and management actions, as well as ecological models supporting such actions aimed at enhancing urban ecosystem and biodiversity conditions.

Posters

Inventorying carbon stocks of protected European blue carbon ecosystems: first outcomes from a systematic review

Claudia Armenio[1], Cristina Andolina[2,3], Giovanna Cilluffo[2,3], Geraldina Signa[2,3], Antonio Mazzola[2], Salvatrice Vizzini[1,2,3,4]

[1]Centro di Sostenibilità e Transizione Ecologica (CSTE), Università degli Studi di Palermo, Piazza Marina 61, 90133 Palermo, Italia; [2]Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università degli Studi di Palermo, via Archirafi 18, 90123 Palermo, Italia; [3]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italia; [4]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Piazzale Flaminio 9, 00196 Roma, Italia; claudia.armenio@unipa.it

Among the several ecosystem services provided by seagrasses, saltmarshes and mangroves, carbon sequestration and long-term storage in sediments is receiving increasing attention as a possible nature-based solution contributing to climate change mitigation. Therefore, an inventory of available data on the carbon stocks of blue carbon (BC) ecosystems is of crucial importance to understand the extent of the contribution of such a nature-based solution and to guide management practices towards conservation and restoration strategies. In this study we reviewed the state of knowledge on carbon stocks of European BC systems in protected and unprotected sites, with the aim to emphasize their role as key ecosystem service providers that should be included in conservation priorities. A systematic review approach was used to assess the literature focusing on European seagrass and saltmarsh habitats. A total of 661 data were extracted from 47 papers out of 832 retrieved that were published between 1994 and 2023. Most of the sites of the 18 countries inventoried were protected under the Natura 2000 Habitats Directive (EU countries) or were Special Areas of Conservation (non-EU counties). The top meter soil Corg stocks (kg Corg m^{-2}) of seagrass habitats was significantly higher in protected sites than in unprotected sites, but not in saltmarsh habitats. The results of this study provided baseline information on BC systems at the European level and revealed a lack of data in most of the Mediterranean basin, suggesting the need to increase the spatial coverage of carbon stock studies, especially in Mediterranean Marine Protected Areas. In this context, protected areas can serve as valuable laboratories to test the effectiveness of protection on the potential of the BC systems and can help to provide a more comprehensive picture of their potential role in climate change mitigation.

Ecosystem Services in urban regeneration projects by NBS key

Emanuele Asnaghi, Claudia Canedoli, Noemi Rota, Marta Cotti Piccinelli, Chiara Baldacchini, Riccardo Castellanza, Emilio Padoa-Schioppa

Università degli Studi di Milano-Bicocca, Italia; e.asnaghi@campus.unimib.it

The objective of this project is to assess and quantify the ecosystem services (ES) provided by urban regeneration interventions through the application of Nature-Based Solutions (NBS) framework. This research will contribute to important issues such as sustainability, economic support, biodiversity protection and informed policy-making. The project started with an extensive review of contemporary literature to identify the optimal indicators for ES quantification in urban area like squares. However, the literature review revealed a very heterogeneous perspective on both the type and methodology of these indicators, thus making a selection based merely on literature unworkable.

Subsequently, we adopted a structured procedure designed for the monitoring of NBS. This procedure permit to visually representing the project context and the related Theory of change. This methodology maps and traces the observed and presumed causal relationships supposed to influence one or more project objectives, providing a solid basis for accurate planning, management, and monitoring of NBS effectiveness. By documenting the direct threats affecting the objectives and the factors that influence those direct threats, practitioners can identify key intervention points and how to quantify their variations over time.

The project is currently applying this methodology to the analysis of the NBS projects of Piazza della Scienza and the renovation of Piazzale Loreto (Milan) where to monitor some target such as: the concentration of CO2 and PM10, the abundance of invasive species, the thermal comfort, the percentage of impermeable surfaces and the economic budget required for maintenance. To enhance comparability with other case studies and achieve the uptake of current knowledge, the indicators will be based on the EU evaluation framework.

Eventualy we aim to conduct a multiscale and transdisciplinary qualitative-quantitative analysis, enabling a comprehensive evaluation of ecosystem services in their entirety-encompassing ecological, social, and economic dimensions—within diverse territorial and cultural contexts.

Distribution analysis of organic carbon and CO2 fluxes along soil profile to explore alternative methodologies for soil respiration measurements

Rosaria D'Ascoli[1], Christian Landi[1], Riccardo Valentini[2], Simona Castaldi[1]
[1]Università degli Studi della Campania "Luigi Vanvitelli", Italia; [2]Università degli Studi della Tuscia, Italia;
rosaria.dascoli@unicampania.it

This work is a part of PRIN project “New Digital Technologies for full carbon accounting of forests and woody crops” aiming to investigate technological innovations for real time monitoring the 3-D structure of trees, leaves developments, diameter growth and soil GHG exchanges, in order to develop a new Forest and Woody crops Digital Twins, which could become standards for carbon and GHG accounting. In this context, forest ecosystems and fruit tree orchards will be studied, that play a fundamental role as carbon sinks.

Understanding the carbon distribution and respiratory flows along profile is part of an overall carbon accounting picture that is currently fundamental to determine the contribution of terrestrial ecosystems to carbon sequestration, according with all the carbon farming measures and mitigation measures implemented in the *Farm to Fork* Strategy.

In this study, we defined the distribution of organic carbon and CO_2 fluxes along soil profile in an olive grove of Central Italy (VT), under organic farming for the last nine years (no irrigation, fertilization or soil tillage), in order to explore alternative methodologies of soil respiration measurements based on CO_2 gradient technology rather than closed accumulation chambers. Data from this study were preliminary to the phase of future insertion of CO_2 sensors along soil profile.

In the top soil layer, high values of respiration and microbial carbon were found, whereas the deep soil layers (10-40 cm) had a reduced microbial carbon and activity (about by 73% and 90%), and a lower organic C content (about by 80%), compared to top layer. The striking thing of these preliminary results is that, also in organically managed soil for several years, biological activity and organic C are relegated to the most superficial layer, and CO_2 fluxes from deep soil remains low even when stimulated by ideal conditions of humidity and temperature.

Ecological implications of Posidonia oceanica banquettes removal

Ilaria Dentamare[1,2], Ludovica Capasso[3], Elvira Buonocore[2,3], Pier Paolo Franzese[2,3], Giovanni Fulvio Russo[2,3]

[1]Consiglio Nazionale Delle Ricerche (CNR), Istituto di Ricerche sulla Popolazione e le Politiche Sociali (IRPPS), Corso S. Vincenzo Ferreri, 12 (84084), Salerno, Italy.; [2]CoNISMa, Piazzale Flaminio 9 (00197) Rome, Italy.; [3]International PhD Programme/UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, via F. Petrarca 80 (8013), Naples, Italy.; ilaria.dentamare001@studenti.uniparthenope.it

The endemic seagrass of the Mediterranean Sea, Posidonia oceanica, forms extensive meadows that deliver several ecosystem services both underwater and along the shoreline. Like terrestrial plants from which it originates, Posidonia oceanica consistently generates new leaves while discarding the older ones. Under various environmental conditions, substantial quantities of these dead leaves can accumulate on the shore, forming structures referred to as "banquettes". These deposits, often mixed with sediments, may vary from scattered layers to extensive piles with variable thicknesses from a few centimeters up to several meters. These formations act as natural barriers against coastal erosion since they prevent sand loss and dissipate wave energy. Moreover, the degradation of the washed-up leaves gives back large amounts of nutrients, relevant to the functioning of the coastal food web. In touristic regions, these banquettes are often perceived as a nuisance, prompting local authorities to mandate their removal, thus affecting coastal ecosystem dynamics.

This study proposes the assessment of P. oceanica banquettes along the coastline of the Campania Region (Southern Italy), estimating their biomass and the associated concentration of nutrients and other chemical elements. The main goal is to evaluate the potential loss of natural capital and ecosystem services associated with the removal of P. oceanica banquettes.

The findings revealed that approximately 40 tons of carbon per year are sequestered in the beached biomass along the Campania coastline, equivalent to the annual primary production of about 160.000 m^2 of meadows. The results of the statistical analysis showed that values of biomass and nutrients remain consistent across different sites, potentially reducing the extensive sampling effort required to collect field data, especially for large-scale investigations.

This study presents a multidisciplinary approach useful for the evaluation of different strategies for the sustainable management of Posidonia oceanica banquettes.

"Soil biodiversity and biological indicators of soil health and ecosystem services in a European context"

Carlo Febbi, Michael Bonkowski
University of Cologne, Germania; cfebbi@uni-koeln.de

This thesis aims to contribute to the knowledge of the intricate interaction between the services provided by soil ecosystems and the biodiversity within them. The main objective is to understand the relationships that exist between soil ecosystem services and its biodiversity. These relationships significantly influence the ecosystem, and understanding them is crucial for maintaining soil health and productivity.

The investigation uses a dual approach – "top/down" and "bottom/up" – to examine these relationships. The top/down approach involves examining satellite data and relating it through abiotic and biotic factors and ecosystem services. The bottom/up approach is used to link the soil community, biodiversity, and its functions to soil ecosystem services. Integrating these two perspectives allows us to obtain a more comprehensive understanding of soil ecosystems.

The research is conducted in the context of the Inden mining site, which offers a unique opportunity to study soil communities in a disturbed environment with the same soil properties and a unique chronological sequence of sites belonging to the area. The data collected from this site will be normalized and scaled, making it possible to extrapolate the results to a broader geographical area, particularly the North Rhine-Westphalia (NRW) region in Germany in collaboration with SOB4ES project.

The goal is to contribute to the scientific understanding of soil biodiversity and its role in ecosystem services. This knowledge is fundamental for developing effective strategies for soil conservation and sustainable land management. Ultimately, the aim is to ensure the long-term health and resilience of soil ecosystems, which are vital for human well-being and environmental sustainability.

Modelling Regulating Ecosystem Services in Mountain Environment: assessment of PM10 and O3 removal by alpine forests in the Province of Bolzano, Italy

Fabiana Figurati[1], Lorenza Nardella[2], Umberto Grande[1,3], Elvira Buonocore[1], Pier Paolo Franzese[1]

[1]International PhD Programme/UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Italy; [2]National Research Council of Italy, Research Institute on Terrestrial Ecosystems (IRET-CNR); [3]Department of Geobotany and Landscape Planning, Nicolaus Copernicus University, ul. Lwowska 1, 87-100, Toruń, Poland.; fabiana.figurati001@studenti.uniparthenope.it

Even if air pollution concentrations have declined over the last two decades, the amelioration of air quality remains one of the biggest challenges that Europe is facing nowadays. Atmospheric pollution is still a major cause of mortality and disease in Europe and remains the largest environmental health risk. Particulate Matter (PM) and Ozone (O_3) can be considered some of the most hazardous among the whole of air pollutants. The present study aims to assess how forests can have a pivotal role in the air quality amelioration throughout the Regulating Ecosystem Services (RES) of PM_{10} and O_3 removal. The case study investigates the role of the alpine forest of the Bolzano Province in providing these RES. Arboreal vegetation contributes to the abatement of PM_{10} concentrations via deposition mechanisms involving the leaf surface while the O_3 is removed from the atmosphere thanks to the stomata. Considering their morpho-functional traits, the vegetation was divided into two functional groups. A spatially explicit high-resolution modelling approach integrating green cover, remotely-sensed Leaf Area Index (LAI), and PM_{10}/O_3 concentrations data was used. The maps of mean seasonal removal efficiency (kg/ha) and total removal (Mg) were obtained elaborating the data in a GIS environment and performed on a seasonal basis. Finally, the monetary evaluation of both the RES of PM_{10} and O_3 removal was performed using the externality value provided by the European Environment Agency (EEA) for EU countries for these pollutants. The biophysical and economic assessment of these two RES could support forest managers and policy-makers committed to developing strategies for sustainable development and human well-being.

An Ecosystem Services Assessment towards the adoption of a Climate Change Adaptation Plan in the Province of Trento (Italy)

Mattias Gaglio[1,2], Andreea Cristina Bonciu[2], Elisa Anna Fano[3], Valeria Lencioni[2]

[1]Dipartimento di Scienze dell'Ambiente e della Prevenzione, Università degli Studi di Ferrara, Ferrara, Italia; [2]Unità di Ricerca Clima ed Ecologia, Ufficio ricerca e collezioni museali, Museo delle Scienze di Trento (MUSE), Trento, Italia; [3]Dipartimento di Scienze della Vita e Biotecnologie, Università degli Studi di Ferrara, Ferrara, Italia; gglmts@unife.it

The ongoing climate change requires the implementation of urgent adaptation measures in alpine areas in order to mitigate the detrimental effects on natural capital and associated Ecosystem Services (ES). Alpine regions, like Trento province in North Italy, are facing significant challenges, including shifts in temperature, altered precipitation patterns and increased frequency of extreme weather events. The objective of this study is to evaluate the most relevant ES in order to support the Climate Change Adaptation Plan (CCAP) for the Trento province, using the river Noce basin as a pilot area. The research began by identifying the most relevant ES provided in the area, including water provision, livestock, carbon sequestration, biodiversity support and cultural services. Effective indicators for each ES were then selected based on available data and suitable methodologies, ensuring that the assessment was comprehensive and context-specific.

The results highlight a heterogeneous distribution of ES within the basin, driven by varying environmental characteristics and landscape patterns. This spatial variability underscores the necessity for adaptive management practices that can address local needs and conditions. The study emphasizes the necessity of incorporating ES assessment in adaptation planning to ensure that alpine areas can effectively navigate the challenges posed by climate change while safeguarding their natural and socio-economic assets. The integration of ES assessment into CCAPs is of paramount importance for the sustainable management of alpine regions, as it provides a framework for the recognition and valuation of the multifaceted benefits that ecosystems offer.

Investigating regulating ecosystem services provided by green infrastructures: The case study of the Salerno province (southern Italy)

Bita Koushki[1], Simona Rusciano[1], Umberto Grande[1,2], Elvira Buonocore[1], Pier Paolo Franzese[1]

[1]International PhD Programme/UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Italy; [2]Nicolaus Copernicus University in Toruń Department of Geobotany and Landscape, Toruń, Poland; bita.koushki001@studenti.uniparthenope.it

The United Nations 2030 Agenda for Sustainable Development prioritizes the sustainability of cities and urban ecosystems, aiming at making cities and human settlements inclusive, safe, resilient, and sustainable environments. Nature-based solutions offer a long-term solution to urban environmental challenges by providing several ecosystem services. Green Infrastructures (GI) play an important role in enhancing human well-being by providing ecosystem services that improve air quality, reduce water runoff, reduce pollution from multiple sources, and mitigate urban heat island effects, all of which have significant benefits for human health and municipal budgets. Climate change is projected to raise the demand for these ecosystem services. Many cities are facing the task of ensuring that urban forests, an important component of the urban landscape, remain resilient and continue to offer critical ecosystem services under future climate regimes. In this study, the ecosystem services generated by GI in the Province of Salerno (Southern Italy) were assessed by using the i-Tree Canopy software, which provides a statistically reliable estimate of land cover types using aerial pictures as well as values for air pollution reduction, atmospheric carbon capture, and hydrological benefits. The results highlight the importance of GI in urban areas for improving ecosystem and human health. This study could support urban forest managers, municipal planners, and policymakers to make effective resource management decisions, formulate policies, and set priorities.

Natural capital in the energy transition: focus on offshore wind farms

Paola La Valle, Daniela Paganelli, Ornella Nonnis
ISPRA, via Vitaliano Brancati 48 - 00144 Roma Italia; paola.lavalle@isprambiente.it

The 5th Italian Report on the State of Natural Capital and its recommendations provides important elements to consider in the implementation of the Ecological Transition Plan (ETP), the National Biodiversity Strategy 2030, and the National Recovery and Resilience Plan (NRRP). The report recalls the need to act on the principle of "*Do No Significant Harm*" (DNSH) and maximize the adoption of Nature-Based Solutions (NBS). These recommendations should also be taken into account for the achievement of the national goals of energy efficiency by 2030, of renewable growth and CO_2 reduction, etc. as defined by the National integrated Energy and Climate Plan (NECP). In this context, offshore wind farms, which are expected to be developed along all Italian coasts, will play a crucial role in the national energy policy.

Considering that the Mediterranean Sea is characterized by high biodiversity, endemic species and protected habitats, the increase in offshore wind farms must include targeted actions to preserve natural capital and ensure adequate conservation of ecological resources. These infrastructures can cause environmental impacts depending on the type of installation and on the environmental characteristics of the area affected by wind farms. In this context, scientific literature reports effects on marine mammals and fish (noise and electromagnetic fields), marine avifauna and benthic habitats and communities (e.g. habitat loss and fragmentation, structural changes and reef effect). The development of offshore wind farms should therefore be driven by the protection of natural capital and associated ecosystem services in order to prevent significant effects on the marine ecosystem.

Capturing the real picture: a new approach to assessing food systems through an agroecological lens

Margherita Martinelli, Simona Castaldi
Università degli Studi della Campania "Luigi Vanvitelli", Italia; margherita.martinelli@unicampania.it

Food systems are currently unsustainable, crossing multiple planetary boundaries and causing significant environmental damage. Food production is considered one of the largest drivers of global environmental change by contributing to climate change, biodiversity loss, freshwater use, land-system change and interfering with the nitrogen and phosphorus cycles. Therefore a comprehensive and radical transformation is required (Willet et al., 2019).

In this context, the Horizon project SWITCH aims to foster a just transition towards healthier and more sustainable food systems. Investigating the barriers and opportunities for change, the project aim to develop practical solutions to support this transition.

One of the main challenges is represented by the assessment and representation of what is sustainable. Current tools like LCA offer standardized protocols for environmental impact assessment, but they focus solely on products and neglect the crucial ecosystem services provided by agricultural systems (Prost et al., 2023).

Agroecology has emerged as a promising approach for food system transformation (Ewert et al., 2023). It seeks to integrate ecological principles with agricultural practices and societal interests, proposing a more comprehensive solution to the challenges facing food systems (Wezel et al. 2020; Gliessman & de Wit Montenegro, 2021).

However, current available agroecology assessment tools such as TAPE (Tool for Agroecology Performance Evaluation) (FAO, 2019) lack of clear links between agroecological principles and their effects on ecosystem services (Schipanski et al., 2016; Mouratiadou et al. 2021).

This research will present the crucial steps towards developing a comprehensive, standardized, and evidence-based framework for assessing sustainability from an (agro)ecological perspective. The framework will then be tested within the SWITCH project to evaluate its effectiveness in capturing the true impact of agroecological practices and its applicability in real-world settings.

Tools to enhance citizens actionability towards more sustainable systems: the SWITCH food health and sustainability database

Cristina Masini[1], Margherita Martinelli[1], Luigi Alessandrino[1], Maria Palmieri[1], Emilia Longobardi[1], Micol Mastrocicco[1], Marilena Vitale[2], Marco Pizzuto[3], Virgilio Maretto[3], Maria Vincenza Chiriacò[4], Simona Castaldi[1]

[1]Università degli studi della Campania "Luigi Vanvitelli", Italia; [2]Dipartimento di Medicina Clinica e Chirurgia, Università "Federico II" di Napoli, Italia; [33] pOsti, Viale delle Province 155A, 00162 Roma, Italia; [4]Institute for Climate Resilience - Euro-Mediterranean Center on Climate Change; cristina.masini@unicampania.it

At a time when environmental awareness and public health are top priorities, assessing the environmental and nutritional impact of food is essential. To meet this need, we have developed a comprehensive food database within the framework of the European project SWITCH: Switching European food systems for a just, healthy, and sustainable dietary transition through knowledge and innovation. Accompanied by an online tool, this database presents both the environmental and nutritional values of a wide range of foods. This tool aims to help consumers, researchers, and policymakers make informed and sustainable food decisions.

Our database, an update of the SUEATABLE-LIFE database (Petersson et al., 2021), includes three main environmental indicators: carbon footprint, water footprint, and Fish Sustainability Index. The carbon footprint measures the total amount of greenhouse gas emissions produced throughout a food's life cycle, from production to consumption. This parameter is crucial for understanding the contribution of food production to climate change. The water footprint calculates the total amount of water polluted to produce a food, a particularly relevant indicator in times of increasing water scarcity. The Fish Sustainability Index assesses the sustainability of fishing and aquaculture practices related to seafood products.

In addition to environmental indicators, our database provides detailed analyses of nutritional values, including macro and micronutrients. These values were calculated as averages of data from all the European countries participating in the SWITCH project, providing a balanced overview of the nutritional quality of foods at a European level.

Our goal is to provide a practical and accessible tool for assessing the environmental and nutritional impacts of food and to promote more sustainable and healthy food choices. The online tool connected to the database is designed to be intuitive and user-friendly, allowing users to easily compare different food options and make decisions based on accurate and up-to-date data.

Linking air quality monitoring and ecosystem services assessment in urban areas: a case study in Campania region (Southern Italy)

Chiara Monteleone[1], Umberto Grande[1,2], Elvira Buonocore[1], Pier Paolo Franzese[1]

[1]UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Italy.; [2]Nicolaus Copernicus University in Toruń Department of Geobotany and Landscape, Toruń, Poland; chiara.monteleone001@studenti.uniparthenope.it

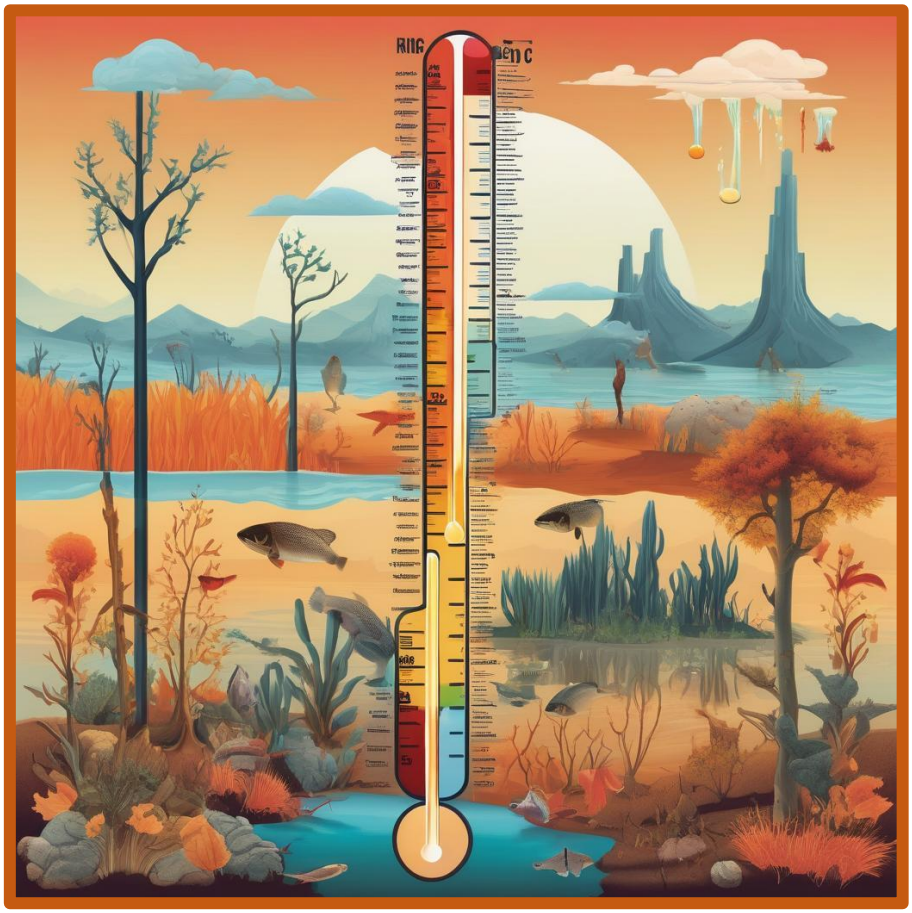
Urban air quality is becoming a serious concern at global scale. Emissions due to human activities are leading to profound changes in the atmosphere composition, also affecting ecological functions and processes, and consequently undermining human well-being. In this context, the 2030 United Nations Agenda and related Sustainable Development Goals (SDGs) highlight the need for addressing this global challenge. In particular, SDG 11 "Sustainable cities and communities" aims to make cities and human settlements inclusive, safe, resilient and sustainable, highlighting the need to implement Nature-Based Solutions useful for improving air quality. Among NBS, Green Infrastructures (GI) can play a crucial role being able to provide a wide range of Ecosystems Services, among which the regulating ecosystem services of Particulate Matter (PM) removal. The present study aims to develop an integrated multi-methodological approach linking air quality monitoring and ecosystem services assessment in urban areas, choosing the municipality of Nola, a highly urbanized area in the Province of Naples (Southern Italy), as a case study. The monitoring of air quality was performed by installing an air station sampler to detect and quantify air pollutants (CO, NO, NO_2, SO_2, H_2S, O_3, PM_{10}, and $PM_{2.5}$). Subsequently, the ability of urban vegetation in removing air pollutants was assessed using the i-Tree canopy software. Results show that GI in the Municipality of Nola are not capable of counteracting the high concentration of air pollutants. The results of this study will be useful to policymakers in charge of developing strategies to achieve ecosystems and human health in urban areas.

Potential loss of natural capital generated by fishing activities on the coralligenous habitat of Tremiti Islands Marine Protected Area

Serena Silva[1], Elvira Buonocore[1,2], Michele Guidato[3], Monica Contegiacomo[3], Pier Paolo Franzese[1,2]

[1]International PhD Programme / UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, Centro Direzionale, Isola C4, 80143, Naples, Italy.; [2]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Piazzale Flaminio, 9, 00196 Rome, Italy.; [3]Ente Parco Nazionale del Gargano, Riserva Naturale Marina "Isole Tremiti", Via Sant'Antonio Abate 121, 71037, Monte Sant'Angelo (FG).;
serena.silva001@studenti.uniparthenope.it

The coralligenous habitat represents one of the most important marine biodiversity hotspots, playing an important role in the carbon cycle. Coralligenous is a biogenic habitat of the circalittoral zone formed by calcareous structures built by crustose coralline algae and other assemblages of calcifying organisms. Due to its structural complexity, it is also considered one of the most vulnerable marine habitats, very sensitive to environmental changes and anthropogenic impacts, such as climate change and fishing activities. Trawling is the most harmful fishing method that is causing the degradation of large areas of coralligenous reef concretions. Small-scale and sport fishing can also cause damage to the most sensitive organisms of the coralligenous habitat that can be damaged or removed by fishing gear, both during the fishing activity and in the case of the involuntary abandonment of stranded or damaged fishing nets. In this study, the global scientific literature on coralligenous habitat and fishing activities was explored using the VOSviewer software. In addition, the loss of natural capital due to fishing impacts was assessed by implementing a biophysical and tropodynamic environmental accounting model. The investigated study area is the Tremiti Islands Marine Protected Area located in Southern Italy. The results highlight a research gap in the application of ecosystem accounting methods useful to quantify and value natural capital and ecosystem services associated to the coralligenous habitat, and their loss due to human impacts. The results also show a significant loss of natural capital value due to fishing activities in the study area. In conclusion, this study can support local managers and policy makers to achieve sustainable development and biodiversity conservation goals.



Effetti del cambiamento climatico sugli ecosistemi

Chairs

Marcello Vitale, Alessio Collalti, Edoardo Casoli

XXXIII Congresso S.It.E.

Roma 23-26 settembre 2024

Misurare e prevedere il cambiamento per una gestione sostenibile degli ecosistemi

S.It.E. - Società Italiana di Ecologia

Presentazioni Orali

Phenological and epidemiological impacts of climate change on peach production

Daniele Bevacqua[4], Chiara Vanalli[1], Andrea Radici[2], Renato Casagrandi[3], Marino Gatto[3]
[1]Pennsylvania State University, United States; [2]IRD, France; [3]Politecnico di Milano, Italy; [4]INRAE, UR1115, France.;
daniele.bevacqua@inrae.fr

Agricultural food security is threatened by climate change impacts, which can distress crop growth and favor the spread of infectious diseases. We examinethe synergism of two potential causes of future yield failure in peach production: the effects of global climate change on fruit tree blooming and on the spread of fungal diseases. The 'disease triangle', well-known concept in plant pathology that represents the interplay between the environment, plant hosts, and pathogens, was evaluated for brown rot in peach orchards in light of climate change. Coupling a climate-driven mechanistic phenological and epidemiological model across the French continental territory, we provided projections of yield losses for four peach cultivars (early, mid-early, mid-late, and late) in the XXI century under different climate change scenarios. We considered as adaptation strategy the possibility of shifting peach production sites to new suitable areas. Global warming is expected to impair fruit phenology with blooming failure events in the south-western part of the country that comprise the 31% of the French territory at the end of the XXI century. This will be less extreme under the more moderate greenhouse gas (GHG) emission scenario, even though sporadic blooming failures will still occur that will involve less than the 10% of the French territory. In contrast, future warmer and drier conditions will decrease brown rot-induced yield loss in the historicallocations devoted to peach cultivation. Thanks to the considered adaptation strategy, the peach national yield could still be fulfilled even under the most extreme GHG emission scenario. Comprehensive mathematical frameworks, that concomitantly consider the climatic effects on the plant hosts and on their pathogens, are required to provide reliable future predictions of crop yields and to inform control and adaptation strategies to guarantee food security under global warming.

Toward a global relationship between net primary production and biodiversity in marine ecosystems

Francesco De Leo[1], Gianmarco Ingrosso[1], Alberto Basset[1,2]

[1]National Research Council Research Institute on Terrestrial Ecosystems; [2]University of Salento,Italia; francesco.deleo@cnr.it

Oceans are critical for sustaining life on Earth, acting as carbon sinks, regulating climate, and providing essential ecosystem services for human wellbeing. Net Primary Production (NPP), defined as the rate at which phytoplankton convert inorganic carbon into organic matter via photosynthesis, represents the primary process sustaining the flow of energy into ecosystems. Consequently, from a theoretical point of view, NPP may also represent the most important driver influencing species richness and abundance. This study represents a proof of concept of the intricate relationship between NPP and biodiversity in marine ecosystems on a global scale, utilizing data from satellite observations and in-situ measurements. Results indicate a strong linear correlation between NPP and biodiversity, suggesting that higher productivity supports greater species richness and ecosystem resilience. Moreover, our findings highlight that diverse marine ecosystems tend to be more productive due to factors such as complementarity and functional redundancy among species. However, this relationship is complex, with some highly diverse ecosystems potentially experiencing reduced productivity due to competition for resources. Current trends in global environmental changes, including global warming and eutrophication, are likely to alter this balance. Warming sea temperatures, changes in ocean stratification and nutrient availability can impact NPP, which in turn affects marine biodiversity. This research underscores the importance of understanding NPP-biodiversity dynamics for developing effective conservation strategies. While the prevailing trend in marine ecosystems is a reduction in NPP in response to ongoing climate change, local trends may vary due to the influence of other environmental variables, resulting in a higher level of uncertainty. Using easily accessible satellite data, such as NPP, to inform biodiversity expectations could be a valuable tool for planning and managing conservation policies. Our study contributes to this understanding by integrating comprehensive data and emphasizing the need for adaptive approaches in marine conservation amidst changing global conditions.

Present and future impact of alien plants on biodiversity in Europe

Silvia Giulio[1], Cao Pinna Luigi[2], Alicia Teresa Rosario Acosta[1], Giuseppe Brundu[3], Laura Celesti-Grapow[4], Simona Ceschin[1], Sandra Citterio[5], Silvia Del Vecchio[6], Rodolfo Gentili[5], Chiara Montagnani[5], Jan Pergl[7], Lorenzo Pinzani[1], Petr Pyšek[7], Hana Skálová[7], Michaela Vítková[7], Flavio Marzialetti[3], Marta Carboni[1]

[1]Department of Sciences, Roma tre University, Italy; [2]School of Mathematics and Statistics, University of Glasgow; [3]Department of Agricultural Sciences, University of Sassari; [4]Department of Environmental Biology, La Sapienza University of Rome; [5]Department of Earth and Environmental Sciences, University of Milano-Bicocca; [6]Department of Biological, Geological and Environmental Sciences, University of Bologna; [7]Institute of Botany of the Czech Academy of Sciences; silvia.giulio@uniroma3.it

Biological invasions are one of the major drivers of biodiversity loss. Efficient conservation efforts require knowing where negative impacts on biodiversity are likely to occur in the future, taking climate change into account.

The environmental impact classification for alien taxa (EICAT) is a well-known standardized system adopted by IUCN to score and compare impacts of alien species to native biodiversity and can be potentially used to predict invasion threats to biodiversity in Europe. We selected 100 terrestrial alien plant species known for their high potential for impacts. For each of them, we (i) assessed the EICAT impact score, (ii) fitted ensemble species distribution models and (iii) matched impact scores and geographical distributions across alien plant species to map the risk of biodiversity loss due to plant invasion in Europe, in the present and in 2050 under different climate change scenarios.

Preliminary results showed that several species with major impacts, inducing local extinctions of native species, have the potential to spread widely throughout Europe. Coastal, mountain and northern regions showed higher potential increase in the intensity of impacts in future climatic scenarios. Competition with native species in invaded communities, chemical and structural impacts on ecosystems were the most common mechanisms though which these alien plants are likely to affect biodiversity in Europe.

Vulnerability of Mediterranean seagrasses to climate change: insights from species distribution modeling and climate-niche factor analysis

Bohao He, Lorenzo Mari
Dipartimento di Elettronica,Informazione e Bioingegneria, Politecnico di Milano; bohao.he@polimi.it

Seagrasses are essential to marine ecosystems, where they often play the role of foundation species and provide key ecosystem services, from habitat provision and coastal protection to water purification and carbon sequestration. We collated distribution data for >90% of Mediterranean seagrass species to analyze their vulnerability to climate change using species distribution modeling and climate-niche factor analysis. Our results show that seagrasses generally exhibit narrow ecological tolerances to variations in the environmental variables associated with their current distribution, indicating high sensitivity to climate change. Our study highlights the increasing vulnerability of seagrasses under progressively more severe climate change scenarios and, in particular, identifies significant risks under SSP 8.5. We also find that Posidoniaceae consistently show higher levels of vulnerability than Cymodoceaceae, and that the Adriatic Sea is a regional hotspot of vulnerability compared to other Mediterranean sub-basins. Our study thus highlights the need for targeted mitigation strategies to protect seagrass habitats from the impacts of climate change, and suggests ways to prioritize interventions based on the differential vulnerability projected for different taxonomic groups and/or geographic regions.

Harnessing Posidonia oceanica wrack to mitigate the effects of a reduced precipitation scenario on dune vegetation

Virginia Menicagli[1], Claudio Lardicci[2,3,4], Elena Balestri[1]

[1]Dipartimento di Biologia, Università di Pisa, via Derna 1, 56126 Pisa, Italia; [2]Centro per l'Integrazione della Strumentazione scientifica dell'Università di Pisa (CISUP), Università di Pisa, via S. Maria 53, Pisa, Italia; [3]Centro Interdipartimentale di Ricerca per lo Studio degli Effetti del Cambiamento Climatico (CIRSEC), Università di Pisa, Via Del Borghetto 80, Pisa, Italia; [4]Dipartimento di Scienze della Terra, Università di Pisa, via S. Maria 53, Pisa, Italia; virginia.menicagli@biologia.unipi.it

Coastal sand dunes are ecologically and economically important habitats but are threatened by multiple factors including climate changes. Climate scenarios predict the intensity and frequency of precipitations will decrease in coastal Mediterranean areas by the end of the century. Water shortage associated with reduced precipitations is a major factor limiting seedling survival in dunes. A greater precipitation reduction is expected in spring, a period favorable for dune plant recruitment. Depositions of *Posidonia oceanica* wrack can be also present along beaches and embryo dunes. This material can provide essential nutrients to dune plants, but whether it can affect the ability of seedlings to cope with abiotic stressors like water shortage is still largely unknown. Here, the individual and combined effects of precipitation amount (current *vs.* predicted reduced according to SSP2-4.5 stabilization scenario) and wrack deposition (no wrack *vs.*wrack alone *vs.* wrack plus sand) on seedling establishment and growth of three dune species, *Cakile maritima*, *Thinopyrum junceum*, and *Calamagrostis arenaria*, were investigated in mesocosm. Wrack water holding capacity and leachate chemical/physical properties were also evaluated. Neither precipitation nor wrack affected seed germination and seedling emergence success for all investigated species. Reduced precipitation decreased root development while wrack promoted seedling aboveground elongation, regardless of its composition. Reduced precipitation also reduced biomass production in *T. junceum* and *C. arenaria* but only in the absence of wrack. Wrack retained water up to five-fold its weight and increase water pH, conductivity, and nutrient content. Our findings indicate that expected reduced precipitations could make dune plant seedlings more vulnerable to additional stressors. But wrack could mitigate reduced precipitation effects in *T. junceum* and *C. arenaria* by retaining most available water. Thus, maintaining *P. oceanica*wrack on beaches could be a valuable, eco-sustainable strategy for supporting the resilience of dunes under ongoing climate change.

Modelling climate change effects on Mediterranean forest species aimed at restoration ecology activities

Kristina Micalizzi, Danilo Lombardi, Elisa Spennati, Marcello Vitale

Sapienza Università di Roma, Dipartimento di Biologia Ambientale, Italia; kristina.micalizzi@uniroma1.it

This study employs a modelling approach to assess the impact of climate change on four key species—*Quercus cerris*, *Fraxinus angustifolia* subsp. *oxycarpa*, *Phillyrea latifolia*, and *Pistacia lentiscus*—within a Mediterranean forest ecosystem. Field measurements, obtained using an infrared gas exchange analyser, inform the calibration and validation of a modified Farquhar and Caemmerer biochemical model of photosynthesis. This species-specific model simulates instantaneous net assimilation ($\mu molCO_2/m^2s$), stomatal conductance ($mmolH_2O/m^2s$), and transpiration rates ($mmolH_2O/m^2s$). To account for each species' unique water-use efficiency, we incorporate marginal carbon cost theory in transpiration estimation.

By integrating model results over time, we obtain gross and net primary productivity, and transpiration values for each species under current climate conditions (2022) and future climate change scenarios (Shared Socioeconomic Pathways (SSP) 2.6 and 8.5). Key findings include:

1. *P. latifolia* and *F. oxycarpa* exhibit reduced annual net primary productivity under the SSP 8.5 scenario (179 and 624 gC/m^2y) compared to 2022 levels (227 and 674 gC/m^2y).
2. Conversely, *P. lentiscus* and *Q. cerris* demonstrate increased annual primary productivity in the SSP 8.5 scenario (872 and 425 gC/m^2y *vs.* 828 and 392 gC/m^2y of 2022).
3. Annual transpiration values are expected to rise for *Q. cerris* and *P. lentiscus* (from 392 and 484 gH_2O/m^2y in 2022 to 444 and 532 gH_2O/m^2y in SSP-8.5), while decreasing significantly for *F. oxycarpa* (from 674 gH_2O/m^2y in 2022 to 227 gH_2O/m^2y in SSP-8.5) and marginally for *P. latifolia* (from 227 gH_2O/m^2y in 2022 to 206 gH_2O/m^2y in SSP-8.5).

The model provides insights into how different species respond to climate change, which can be useful in guiding conservation and management strategies in ecological restoration projects.

The future in the past? Nitrogen isotopes and applications of metabolic theory on fossil foraminifera for paleoenvironmental reconstructions during a rapid global warming event in Earth's history

Simone Moretti[1,2], Alexandra Auderset[1,3], Curtis Deutsch[4], Ronja Schmitz[1], Lukas Gerber[1], Ellen Thomas[5,6], Valeria Luciani[7], Maria Rose Petrizzo[8], Ralf Schiebel[1], Aradhna Tripati[9], Philip Sexton[10], Richard Norris[11], Roberta D'Onofrio[7], James Zachos[12], Daniel Sigman[4], Gerald Haug[1], Alfredo Martínez-García[1]

[1]Max Planck Institute for Chemistry, Germania; [2]Istituto di Scienze Polari, Consiglio Nazionale delle Ricerche, Bologna, Italy; [3]University of Southampton, Southampton, United Kingdom; [4]University of Princeton, Princeton, United States; [5]Yale University, New Haven, United States; [6]Wesleyan University, Middletown, United States; [7]Università di Ferrara, Ferrara, Italy; [8]Università Degli Studi di Milano, Milan, Italy; [9]University of California, Los Angeles, United States; [10]The Open University, Milton Keynes, United Kingdom; [11]Scripps Institute of Oceanography, University of California, San Diego, United States; [12]University of California, Santa Cruz, United States;
simone.moretti@mpic.de

Dissolved oxygen in water represents an essential substrate for most marine ecosystems. Its concentration is steadily decreasing in response to global warming. Alhough short-term impacts are well understood, the spatiotemporal paucity of instrumental records, coupled with numerical simulations with conflicting predictions about the future of oxygen deficient zones (ODZs) in the tropical Pacific, makes it difficult to make long-term predictions about the future of oxygen in the oceans and the resulting impact on marine ecosystems.

An alternative and complementary approach is given by the study of global warming events in the history of our planet that have left a tangible and measurable trace in the geological record. The use of geochemical and morphometric analyses on fossil organisms can provide important information on the long-term response of ocean habitability to temperature rise. We show here new evidence in favor of tropical subsurface oxygenation during the Paleocene-Eocene Thermal Maximum (PETM), a rapid global warming event that serves as a "geologic analogue" to ongoing warming.

The isotopes of organic nitrogen on fossil planktonic foraminifera shells indicate that the tropical Pacific ODZ contracted during the PETM, implying an increase in oxygen in the vicinity. The plication of the metabolic theory of aquatic ectotherms in the fossil record, shows that the increase in size of tropical planktonic foraminifera, despite warming, implies that oxygen availability increased in the tropical Pacific.

These changes are consistent with biogeochemical models for the SSP5-8.5 scenario for 2300, in which a decline in biological productivity and subsequent respiration rates allow tropical oxygen to increase, even as global ocean oxygen decreases. The upping tropical oxygen may have alleviated the physiological stress on planktonic organisms in areas of higher biodiversity, helping to avoid a mass extinction of planktonic organisms during the PETM, despite the largest benthic extinction in the Cenozoic.

Adaptability of crustose coralline algae recruits to different field temperature and light conditions

Alessandra Puccini[1], Viviana Peña[2], Giulia Ceccherelli[1]

[1]Università di Sassari, Italia; [2]Universidad De A Coruña, Spain; alessandra.puccini@hotmail.it

Crustose coralline algae (CCA) are among the major calcifying organisms in the Mediterranean Sea and are important foundation taxa in the photic zone. They enhance the structural complexity of marine ecosystems, promoting settlement and metamorphosis of various invertebrates. Due to multiple local factors and climate change effects, coralligenous reefs are in decline. Investigations on CCA, the foundation species, are therefore necessary to know their adaptability to different conditions and thus to evaluate the possibility of possible restoration actions based on CCA transplantation. To this end, a manipulative field experiment was conducted in Costa Paradiso (North Sardinia, Italy) where CCA recruited at 35 m of depth on artificial substrates (terracotta and ceramics 10x10 cm tiles) with varying initial coverage (high and low): to disentangle the effects of irradiance from those of the temperature, three treatments were used by fixing the tiles at 1) 15 m of depth where they were placed in a natural cavity so that the algae could experience the 35 m light irradiance but water temperature above the thermocline (LLHT), at 2) 15 m of depth outside the cavity (HLHT), and at 3) the same origin depth, 35 m, where irradiance was low and temperature below the thermocline (LLLT). The recruits exhibited greater growth when exposed to higher temperature compared to those in combined low light and low temperature conditions. A posteriori, molecular and morphological analyses were conducted to identify the CCA species which allowed estimating the species-specific growth rate at the studied conditions.

Understanding European hake dynamics in a changing Mediterranean Sea: a new modelling framework

Andrea Schiavo[1], Isabella Bitetto[2], Walter Zupa[2], Andrea Radici[3], Maria Teresa Spedicato[2], Paco Melià[1]

[1]Politecnico di Milano, Italia; [2]COISPA Tecnologia & Ricerca, Italia; [3]IRD, UMR Mivegec, Francia; andrea.schiavo@polimi.it

Managing marine aquatic resources is a complex challenge due to the intricated processes unfolding at sea. This challenge is amplified in the Mediterranean Sea, where pronounced seascape, climatic, and social variability critically affect the biodiversity of the basin across sub-regions. The traditional approach to fisheries management in this area has long relied on stock assessment with classical stock-recruitment models to reconstruct historical population dynamics and predict their response to different effort regulation measures. However, these methods lack robust predictive power due to their limited ability to incorporate changing environmental conditions and anthropogenic pressure. Our work proposes a spatially explicit metapopulation model of the European hake (*Merluccius merluccius*) within the area of the Adriatic and Ionian Seas. The model integrates the effect of environmental variables on life-history traits and larval connectivity. This approach, therefore, allows us to predict the response of the hake stock to different scenarios of climate change (RCPs) and fishing pressure, generating a realistic representation of the stock dynamics in the medium to long term and predicting the potential future spatial distribution of the stock. This tool enables the mapping of different performance indicators in space and time, informing the development of area- and effort-based management strategies that optimize resource conservation while identifying areas particularly sensitive to management interventions. This modelling framework provides a flexible and valuable tool for designing effective marine protected area networks and facilitating sustainable fisheries management practices.

Posidonia oceanica bleaching: mensurative and manipulative experiments to investigate causes in a warm-edge location

Patrizia Stipcich[1,2], Carmen Arena[1,2], Giulia Ceccherelli[2,3], Rosa Donadio[1,2], Carlos Jimenez[4], Vasilis Resaikos[4], Ermenegilda Vitale[1,2], Simonetta Fraschetti[1,2]

[1]Università di Napoli Federico II, Italia; [2]National Biodiversity Future Centre, Palermo, Italy; [3]Università degl studi di Sassari, Italia; [4]Enalia Physis Environmental Research Centre, Nicosia, Cyprus; patrizia.stipcich@unina.it

In the Mediterranean Sea the temperature increase has accelerated over recent years, affecting at different levels key species like the endemic seagrass *Posidonia oceanica.* Recently, in warm-edged locations of Mediterranean basin, *P. oceanica* bleaching (i.e. discoloration of leaves still attached to the shoots) has been observed in late summer, but the factors that trigger the phenomenon remain unknown. This study aimed at i) estimating the spatio-temporal variability of *P. oceanica* leaf condition in Konnos Bay, Cyprus (mensurative experiment) and ii) investigating the role of light irradiation and temperature on leaf bleaching by a reciprocal transplant of plant cuttings from different depths under a light gradient obtained by using shading nets (manipulative experiment). To pursue our goals, morphological (*i.e.* leaf area, leaf necrosis, leaf bleaching) and eco-physiological (*i.e.* chlorophyll, carotenoids, anthocyanins) responses were considered. The hypothesis supported by the mensurative experiment is that interactive effects of irradiance and temperature (both continuously recorded by loggers) are responsible for the extent of bleaching and, as consequence, during summertime, shallow untouched *P. oceanica* plants are expected to bleach before the deep ones due to the exposure to higher temperature and irradiance conditions. The manipulative experiment could shed light on the effects of the variability of conditions influencing the seagrass leaf status of transplanted plants. More specifically, the occurrence of bleaching on deep cuttings transplanted at shallow depth without shading net, would support the hypothesis of the join temperature and light sudden variation in bleaching induction. Both approaches will allow to identify a potential modulation of light harvesting pigments found in the shoots at different depths as a plant defense strategy. Analyses are ongoing and both experiments will last until August 2024.

Predatory interactions in a warming world: Functional response of invasive and native freshwater fish species

Matteo Ventura[1], Vincenzo Pasquariello[1], Edoardo Calizza[1,2], Giulio Careddu[1,2], Simona Sporta Caputi[1,2], Davide Giannini[1], Loreto Rossi[2], Maria Letizia Costantini[1,2]

[1]Sapienza Università di Roma, Italia; [2]Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Italia;
matteo.ventura@uniroma1.it

Freshwater ecosystems play a crucial role in providing globally relevant ecosystem services. Yet, freshwater communities worldwide have experienced substantial declines due to human-driven changes, with non-native fishes and global warming identified as major threats. Although it is known that most fish are ectotherms, thus metabolically influenced by temperature, the effect of warming on fish impact has often been overlooked.

Among freshwater fishes, the eurythermal *Micropterus salmoides* is one of the most widely introduced and invasive species. Its predatory pressure has altered species composition and size structure of invaded communities, with *M. salmoides* often becoming the dominant predator. Although the species has been increasingly studied over the last few decades, the role of temperature in its predatory impact has only been marginally considered.

In this manipulative laboratory study, Functional Responses (FRs), describing the feeding rate as a function of prey density for *M. salmoides* and trophically analogous fish species (*Esox cisalpinus* and *Perca fluviatilis*), provided valuable insights into the effect of temperature (+3-6 °C increases) on predatory response and outcomes of competition between these predators. An increase in functional response (+418%) on prey populations with rising temperatures was recorded for the invasive species. Conversely, decreases in functional response and increases in mortality were recorded for the native ones. The differences in FRs were related to changing prey handling (which includes capture, consumption, and digestion of prey and defines the magnitude of the FR curve) with temperature.

The study highlights that the impact of *M. salmoides* on prey populations is expected to increase with warming, while native predators may experience a reduction in their competitive capacity, with implications for species coexistence and food web dynamics. Investigating the effects of biological invasions and climate change separately is therefore not sufficient for accurately measuring ongoing changes and appropriately managing ecosystems.

How climate change is shifting Earth’s ecosystems

Marcello Vitale[1], Alessio Collalti[2]

[1]Sapienza Università degli Studi di Roma, Italia; [2]Consiglio Nazionale delle Ricerche, Perugia, Italia; marcello.vitale@uniroma1.it

This speech serves as an introductory contribution to the discussions on the "Effects of Climate Change on Ecosystems" session. Ecosystems are communities of living things, including plants, animals, and microorganisms, interacting with each other and the physical world. People rely on ecosystems for many benefits, such as food, water, clean air, building materials, and recreation. Ecosystems can vary in size, from large ones (areas surrounding a national park) to as small as a single fallen tree. They can also overlap with one another or be part of larger ecosystems. These connections between ecosystems make them dependent on one another, and not dependent on the organisms within them. Climate change affects ecosystems in many ways. Climate controls how plants grow, how animals behave, which organisms thrive, and how they interact with the physical environment. The IPCC warns that if current warming trends continue, global temperatures could double by 2030-2052, causing devastating effects on ecosystems worldwide. The ocean, which absorbs over 80% of global warming, is particularly affected. Elevated sea-surface temperatures are damaging coral reefs, leading to bleaching and extinction. Ocean acidification, caused by higher CO2 levels, further threatens corals and shelled sea creatures. Sea levels are rising due to ocean water warming and the melting of land-based glaciers. Over the last century, the sea level has increased by an average of 20 centimeters. All regions at the global level are experiencing the impacts of climate change, but impacts vary by area and ecosystem. People are taking many actions to help ecosystems adapt to climate change impacts or minimize the effects. For example, environmental agencies that manage the nations' natural resources are now considering climate change in policies and planning. At the local level, many groups are preserving habitats and restoring ecosystems that have been damaged or disturbed in the past.

Posters

Enhancing ecosystem function assessment through cost-effective Tea Bag decomposition studies in marine habitats

Manuel Berlino[1,3], Ana Maria Botero Angel[2], Maria Cristina Mangano[1,3], Gianluca Sarà[2,3]

[1]Stazione Zoologica Anton Dohrn, Department of Integrative Marine Ecology (EMI), Sicily Marine Centre, Lungomare Cristoforo Colombo (complesso Roosevelt), 90149, Palermo, Italy; [2]Dipartimento di Scienze della Terra e del Mare, DiSTeM, Università degli Studi di Palermo Ed. 16, 90128, Palermo, Italy; [3]NBFC, National Biodiversity Future Center, Palermo Viale delle Scienze Ed. 16, 90128, Palermo, Italy; manuel.berlino@szn.it

Climate changes are increasingly affecting marine ecosystem having general negative effect on their functioning, stability and potentially their resilience against multiple stressors. In this context, analysing decomposition rate in different ecosystems represent an important step to be studied to assess changes in nutrient cycling and carbon dynamic that may play a crucial role on ecosystem multifunctionality i.e. referring to the ability of an ecosystem to sustain multiple function and services simultaneously. Despite the importance of decomposition rate, global climate predictions continue to be hindered by limited data due to the high costs and efforts associated with comparative litter decomposition studies. Here we took advantage of the tea bags decomposition index (TBI) to study pattern of decomposition rate in a lagoon of the Stagnone di Marsala, Western Sicily, by deploying tea bags following a density gradient of seagrass. A seagrass ecosystem has been selected as target testing marine ecosystem as pivotal in services such habitat forming or carbon sequestration and being of the ecosystems facing challenges from climate change and anthropogenic pressures. TBI represents an innovative and cost-effective techniques based on a well standardized curve of decomposition and stabilization rate of two commercially available teas. This represents a cost-effective method allowing for an increased replication in field experiments and, more importantly, the standardized nature of TBI facilitates comparable data collection across different ecosystems. Additionally, due to its high accessibility, the methodology is suitable for sharing with the public and for large-scale application also in citizen science context. Involving the public in this kind of experiments could lead to an increase in data across multiple ecosystems, allowing for more useful replications to enhance comparisons between different ecosystems and achieve more robust results. In this context, TBI represent a salient tool to strength the science-stakeholders interface and facilitate the translational ecology.

Effects of experimental heatwaves on plankton communities from different Mediterranean aquatic ecosystems

Marco Cherchi[1], Bachisio Mario Padedda[1,4], Andrea Di cesare[3], Francesca Allemanno[3], Paola Casiddu[1], Lyudmila Kamburska[3,4], Antonella Lugliè[1], Bastianina Manca[1], Roberta Piscia[3], Cristina Pittalis[1], Ilaria Rosati[2], Raffaella Sabatino[3,4], Cecilia Teodora Satta[5], Jessica Titocci[2], Silvia Pulina[1,4]

[1]Università degli studi di Sassari, Italia; [2]National Research Council - Research Institute on Terrestrial Ecosystems (CNR-IRET, Strada Prov.le Lecce-Monteroni, 73100, Lecce, Italy; [3]National Research Council - Water Research Institute (CNR-IRSA), Corso Tonolli 50, 28922, Verbania, Italy; [4]National Biodiversity Future Center, NBFC, Piazza Marina 61, 90133 Palermo, Italy; [5]AGRIS agenzia regionale per la ricerca in agricoltura in Sardegna; m.cherchi4@phd.uniss.it

Heatwaves are extended periods of abnormally warm temperatures that exceed typical conditions. This phenomenon is occurring with increasing frequency worldwide, particularly in the Mediterranean area. Global warming is linked to the rise of heatwaves, and projections suggest they will become even more severe in the future.

While a growing body of research explores how climate variability affects food web structure, trophic interactions, and potential changes in ecosystem functioning, less is known about the effects of extreme events like summer heatwaves on vulnerable environments. Such environments include Mediterranean coastal lagoons and artificial lakes, which deserve attention as they provide essential goods and ecosystem services.

In this scientific proposal we report the experimental set up and the preliminary results of laboratory experiments performed in summer 2024, with the aim ofstudying the experimental effects of a summer heatwave on two different natural plankton communities collected from an artificial lake (Bidighinzu Lake) and a coastal lagoon (Cabras Lagoon) located in Sardinia (West Mediterranean). The two natural plankton communities include different trophic levels (picoplankton, nanoplankton, microplankton, and mesoplankton) and are incubated separately in laboratory at an increased temperature treatment (+5 °C), in presence and in absence of mesozooplankton. Respectively, mesozooplankton (such as copepods/cladocera) or microzooplankton (namely ciliates) represent the plankton food web top consumers. Different analysis techniques are applied, such as microscopy, flow cytometry and Next-Generation Sequencing.

While most studies have monitored the effects of natural heatwaves on plankton communities, only a few experimental studies have been undertaken to simulate a heatwave in order to mimic a perturbation and to follow its effect on a natural community under controlled conditions in a reproducible manner. Our research aims to fill this gap.

Carbon flux dynamics in the Bosco della Mesola Po Delta park

Paola Forni[1], Ilaria Perissi[1], Mariasilvia Giamberini[1], Ilaria Baneschi[1], Elisa Anna Fano[2], Antonello Provenzale[1]

[1]CNR - Istituto di Geoscienze e Georisorse, Italia; [2]Dipartimento di Scienze della Vita e Biotecnologie, Università di Ferrara, Italia;
paola.forni@igg.cnr.it

Wetlands have a crucial role as carbon (C) pools. Current wetland degradation negatively impacts their capacity to store carbon and could transform them into strong carbon dioxide (CO_2) and methane (CH_4) sources. This could be the case of the Bosco della Mesola (Ferrara), a remnant floodplain forest in the Po Delta, where climate change is already inducing other degradation phenomena like saltwater intrusion and biodiversity loss. Assessing the vertical C fluxes at the water-atmosphere interface might help to understand and possibly reduce CO_2 and CH_4 release by appropriate restoration actions. The study aims to qualitatively determine the trends of the C fluxes and monitor the ecologic impact of climate change in this area. Using a floating flux chamber equipped with a LICOR IRGA, we investigated CO_2 and CH_4 fluxes in 4 different lentic sites, 2 ponds and 2 canals, with salinity gradient, presence/absence of macrophytes, and different bottom sediment organic matter. We will also explore the role of freshwater input in the two canals. The study also lays the basis for the future development of a simplified model that will support the analysis of wetlands carbon fluxes in future climate change scenarios and in response to restoration activities.

Climate change impacts and anthropogenic pressure: integrated research and approaches to protect and preserve coastal environment from fecal contamination

Angela Freddi[1,2], Manuela Coci[2], Grazia Marina Quero[2], Silvia Casabianca[2], Sarah Pizzini[2,3], Mauro Marini[2,3], Fabio Ricci[1,3], Antonella Penna[1,3], Elena Manini[2]

[1]Università di Urbino, Dipartimento di Scienze Pure ed Applicate (DISPEA), Urbino (PU); [2]Istituto per le Risorse Biologiche e le Biotecnologie Marine del Consiglio Nazionale delle Ricerche (CNR-IRBIM), Ancona (AN); [3]Fano Marine Center, Fano (PU);
a.freddi2@campus.uniurb.it

This research aims to define an innovative approach for a more efficient, reliable, and integrated study of the coastal marine environment, which can host numerous microorganisms, including enteric pathogens from human or animal feces. It focuses on chemical and microbiological pollutants from human activities and climate change, assessing fecal and pesticide contamination in river and coastal marine environments and evaluating biodiversity impacts by analyzing indicator species in sediments. The fecal bacteria will be characterized at the genetic level to identify their host or environment of origin, serving as indicators of contamination sources. To determine the source of the faecal contamination, water and sediment samples were collected from various locations along the Arzilla River (North Marche coast) and adjacent beach during periods of higher rainfall associated to dramatic drought. A new integrated methodological approach is performed for the determination of fecal indicator bacteria, divided into a traditional cultural method and a molecular diagnostic approach. The former involves isolating pure colonies of *Escherichia coli*, used to identify phylogroups originating from different animals, while the latter involves the extraction of genomic DNA from bacteria in water and sediment samples, and the q-PCR detection of species-specific Bacteroides associated with MST (Microbial Source Tracking) primers for human, domestic animals, livestock, birds. Preliminary results showed higher levels of faecal bacteria at sites upstream of the Arzilla River after intense rainfall events, suggesting that these areas have significant inputs, likely from point sources of faecal pollution, to Arzilla River, which receives faecally contaminated water. This information can be used to implement corrective actions to minimize risks to public health and the environment. The insights gained from this approach can also inform future research and policy to address the combined effects of climate change impacts.

Effects of bird-mediated nutrient inputs on basal food sources in Arctic lake food webs

Davide Giannini[1], Giulio Careddu[1,2], Simona Sporta Caputi[1,2], Matteo Ventura[1], Roberta Zitelli[1], Rosamaria Salvatori[3], Loreto Rossi[1,2], Maria Letizia Costantini[1,2], Edoardo Calizza[1,2]

[1]Università di Roma La Sapienza, Italia; [2]CoNISMa-Consorzio Nazionale Interuniversitario per le Scienze del Mare; [3]CNR-ISP, sede di Montelibretti, Roma; davide.giannini@uniroma1.it

Climate change is significantly impacting Arctic ecosystems, particularly through the 'Arctic greening'. This process, driven by increased temperatures and precipitation, enhances terrestrial productivity, herbivore density, and associated nutrient inputs. However, effects of increased inputs on Arctic lacustrine ecosystems, which are crucial carbon sinks and biodiversity hotspots despite being strongly N-limited, remain poorly understood.

This study investigates the impact of changes in terrestrial vegetation and organic inputs from migratory geese on the basal food sources supporting lake food webs. We analyzed nine shallow lakes along a gradient from the coastline to glaciers on the Brøgger Peninsula, Svalbard, using C and N isotopic analysis to assess nutrient sources in sediment and aquatic vegetation. Bayesian mixing models were employed to quantify the contributions of terrestrial and aquatic vegetation, geese, and aquatic animals to the organic matter (OM) in sediments.

Our findings indicate that nitrogen inputs from geese increased with terrestrial vegetation cover around lakes, directly correlating with N concentrations in aquatic vegetation and sediment. δ15N values in algae also increased with goose density, suggesting their potential as bioindicators of bird-mediated eutrophication in Arctic lakes. The contribution of goose droppings to sediment OM varied between 0 and 22%, increasing with terrestrial vegetation cover. Aquatic animal necromass was the main source of OM, contributing between 30-60% regardless of vegetation cover, highlighting a robust mechanism of internal nutrient recycling in these N-limited ecosystems, driven by the winter freezing of lakes.

Our space-for-time approach suggests that climate change-induced increases in goose density will enhance nutrient inputs in Arctic lakes, characterized by sophisticated internal recycling mechanisms. Increased nutrient concentrations in basal food sources are likely to have cascading effects on higher trophic level consumers. Further research is needed to understand how these changes will affect food web structures and associated ecosystem services under climate change scenarios.

The influence of the thermal environment and the role of Paramuricea clavata in coralligenous community structure

Gabriella La Manna[1,2], Alberto Colletti[2,4], Maria Del Mar Bosch-Belmar[3], Ylenia Fabietti[2,3], Simonetta Fraschetti[2,4], Luca Licciardi[2,4], Giuseppe Morello[2,3], Simone Musumeci[4], Arianna Pansini[1], Luigi Piazzi[1], Federico Pinna[5], Maryna Pishchalkovska[2,3], Alessandra Puccini[1], Gianluca Sarà[2,3], Patrizia Stipcich[2,4], Mario Francesco Tantillo[3], Giulia Ceccherelli[1,2]

[1]Università di Sassari, Dipartimento di Scienze Chimiche, Fisiche, Matematiche e Naturali, Sassari; [2]National Biodiversity Future Center, Palermo; [3]Università degli Studi di Palermo, Dipartimento di Scienze della Terra e del Mare, Palermo; [4]Università di Napoli Federico II, Dipartimento di Biologia, Napoli; [5]Department of Integrative Marine Ecology, Genoa Marine Centre, Stazione Zoologica Anton Dohrn, Genova; glamanna@uniss.it

Coralligenous reefs are biodiversity hotspots and crucial benthic ecosystems in the Mediterranean Sea due to the valuable ecological services they provide. However, they are highly vulnerable to human-induced stressors such as sediment re-suspension, eutrophication, and mechanical disturbances from fishing, anchoring and scuba diving. Additionally, warming events have significantly impacted these reefs, causing mortality among various species, including gorgonians. Among these, *Paramuricea clavata* is a key structuring species of the coralligenous, as it creates three-dimensional habitats that foster the development of ecological niches and increase assemblage complexity. Despite numerous studies documenting various aspects of these reefs, further research is needed to fully understand the ecological role of *P. clavata* on the structure of coralligenous benthic communities under different thermal conditions. To investigate the influence of *P. clavata* on species/taxa richness and composition of the associated benthic community, photographic sampling of coralligenous reefs was conducted during two periods in 2023 (early summer and early autumn) at several Mediterranean sites (Sardinia, Campania, and Sicily) and depths (from 20 to 40 meters) in areas characterized both by the presence and the absence of *P. clavata*. The thermal environment was continuously measured using temperature loggers throughout the whole study period. The presence of *P. clavata* was positively associated to taxa richness and the abundance of Alcyonacea, hydroids, encrusting sponges, ramified bryozoans and serpulids, and negatively to the abundance of turf, green and red algae, and massive sponges. Generalized linear latent variable model revealed the combined effects of period, heating event duration, and temperature on the community, also highlighting groups of species/taxa that exhibited similar responses. Identifying functional groups influenced by the presence of a habitat-forming species, alongside the influence of the thermal environment, can provide valuable insights for formulating recommendations for the effective conservation of this priority habitat, highly sensitive to climate change.

Bottom anoxia induced by climate change increases the release of ammonia from sediment in deep subalpine Italian lakes, thereby increasing the risk of eutrophication

Leonardo Morini[1], Ugo Marzocchi[2,3], Marta Lidia Sudo[2], Diana Arroyave Gomez[4], Sara Benelli[4], Monia Magri[4], Giuseppe Castaldelli[1], Marco Bartoli[4]

[1]Università di Ferrara, Dipartimento di Scienze dell'Ambiente e della Prevenzione, Italia; [2]Department of Biology, Center for Electromicrobiology, Aarhus University, Aarhus, Denmark; [3]Center for Water Technology (WATEC), Department of Biology, Aarhus University, Aarhus, Denmark; [4]Università di Parma, Dipartimento di Scienze Chimiche della Vita e della Sostenibilità Ambientale, Italia; mrnlrd@unife.it

The Italian subalpine lakes are some of the most impacted ecosystems by climate change, leading to increased water stratification. This reduces the amount of dissolved oxygen in the deepest part of the water column, leading to hypoxia and anoxia, which affect all the biologically relevant nutrient cycles. Deep anoxia could manifest effects in the whole lake leading to depleted fish stocks, the emergence of toxic algal blooms, and the decrease in the value of ecosystem services provided. To predict the effects of stratification on the nitrogen cycle, sediment cores from two different lakes (Iseo and Idro) that manifest deep anoxia were sampled and incubated ex-situ keeping temperature and dissolved oxygen concentration as close as possible to in-situ conditions. Cores from oxic and anoxic stations were compared after being analyzed for their physical-chemical properties, solutes and dissolved gas profiles along depth using rhizons and microsensors, quantification of net nutrient fluxes at the sediment-water interface, and the application of the isotope pairing technique to quantify rates of denitrification, dissimilative nitrate reduction to ammonium and anammox. Nitrification rates were quantified by the 15N dilution technique. The results evidenced how anoxic sediments lose the capacity to nitrify. Accordingly, the lack of nitrate significantly decreases denitrification compared to oxic sediments. The anoxic benthic system loses the capacity to release nitrogen as gaseous molecular nitrogen. Instead, the particulate organic nitrogen that settles on anoxic sediments is almost completely recycled and released as ammonia due to mineralization. The accumulation of ammonia in the deep hypolimnion at concentrations of almost ~150 µM poses a serious risk of eutrophication of the euphotic layer if partial or complete mixing of the water column were to happen.

The red & blue invasion: invasiveness levels of Callinectes sapidus and Procambarus clarkii in three Italian lagoons

Daniele Paganelli[1], Lucrezia Cilenti[2], Giorgio Mancinelli[3], Salvatrice Vizzini[4], Agnese Marchini[1]

[1]Department of Earth and Environmental Sciences, University of Pavia, Via Sant'Epifanio 14, 27100, Pavia; [2]Institute of Sciences of food Production (ISPA), Via Michele Protano, 71121 Foggia; [3]Department of Biological and Environmental Sciences and Technologies (DiSTeBA), University of Salento, Lecce, Italy S.P. 6, Lecce - Monteroni - LECCE (LE); [4]Department of Earth and Marine Sciences, University of Palermo, CoNISMa, Via Archirafi 18, 90123 Palermo, Italy; daniele.paganelli@unipv.it

The risk screening toolkit Aquatic Species Invasiveness Screening Kit (AS-ISK), integrated with local experts' ecological knowledge, was used to evaluate the level of invasiveness of two decapod species, namely *Callinectes sapidus* and *Procambarus clarkii* in three assessment areas in Southern Italy: Lesina lagoon, Acquatina lagoon (Apulia) and Stagnone di Marsala (Sicily). These target lagoons were identified in the PRIN - TROPHYC project as specific areas to investigate the biology, trophic ecology, invasion history and impacts of *C. sapidus* in the Mediterranean Sea.

The blue crab currently occurs in all the three areas, while the red swamp crayfish only in one of them (Lesina), but a future colonisation of the other two target areas cannot be totally excluded considered the high bio-ecological plasticity of the crayfish and the presence of suitable environmental conditions. For example, in the freshwater courses around Acquatina lagoon, *P. clarkii* is already quite abundant while, in Stagnone di Marsala, it is not reported yet. Thus, to quantify the level of invasiveness of these species in all the three areas, the same information on local ecological context was used, and both species were assessed according to their specific biological and ecological traits and classified by specific threshold values provided by AS-ISK.

Results indicate high level of invasiveness for both species, providing similar scores for the environmental impacts and species nuisance traits in all the three lagoons, with *C. sapidus* displaying higher scores than *P. clarkii*. The main difference between the two species is due to the impacts on the commercial sector, which is notably higher in *C. sapidus*, particularly in Lesina and Acquatina lagoons.

These results confirm that both decapods have the potential to be invasive, but their impacts are mainly related to the local environmental and socio-economic characteristics of the assessment areas.

Future sea warming impacts on habitat suitability for five marine species along the Sardinia coastline

Francesco Palmas[1], Francesca Cariccia[1], Abyaba Hiba[2], Mar Bosch-Belmar[3,4], Marchessaux Guillaume[3,4], Gianluca Sarà[3,4], Antonio Pusceddu[1]

[1]Università degli Studi di Cagliari, Department of Life and Environmental Sciences, Sardinia, Cagliari, Italy; [2]Scuola Universitaria Superiore IUSS Pavia, Pavia, 27100, Italy; [3]NBFC, National Biodiversity Future Center, Palermo, Italy; [4]Laboratory of Ecology, Department of Earth and Marine Sciences, University of Palermo, Palermo,Italy; fpalmas@unica.it

Sea warming is causing severe physical and chemical changes in marine ecosystems worldwide, which, in turn are affecting the biology and ecology of marine organisms.

To implement the Regional Strategy of Adaptation to Climate Change of the Sardinia Region, safeguarding commercial and/or protected marine species, habitat suitability maps along the Sardinian coastline were created for current and projected (2050) temperature ranges in different IPCC scenarios (RCP 4.5, RCP8.5). Based on different functional traits, thermal tolerance curves were reconstructed from the literature for a bivalve (*Mytilus galloprovincialis*), two echinoderms (the sea urchin *Paracentrotus lividus* and the sea cucumber *Holothuria tubulosa*), a seagrass (*Posidonia oceanica*), and a fish (*Mullus barbatus*).

For each species, potential variations in habitat suitability for the current period (1987-2010) and the above-mentioned IPCC scenarios (2021-2050) were estimated in terms of quality (from lethal to optimal) and quantity (percentage of change).

In both scenarios, we report a summer decrease in habitat suitability for *M. galloprovincialis*, with a more pronounced contraction under the warmest scenario. *P. lividus* could be exposed to a habitat improvement in May, but a decline in summer, more marked under the warmest scenario. In both scenarios *H. tubulosa* could face an anticipated good habitat condition for reproduction and, again, much worsened conditions in summer. *P. oceanica*, due to its considerable thermal tolerance, showed minimal habitat contractions (<20%) in August for both scenarios. In both scenarios, males of *M. barbatus* are expected to face a decreased habitat suitability from May to November and females from June to October, suggesting a considerable variation in the availability of optimal temperature conditions for their recruitment.

Our results, though missing weights for other potential covariates, suggest the need of urgent actions to put in place a strategy to manage exploitation and conservation of the investigated species in the warming future.

Energy security and environmental sustainability

Gianfranco Picone, Umberto Grande, Elvira Buonocore, Pier Paolo Franzese

International PhD Programme/UNESCO Chair "Environment, Resources and Sustainable Development", Department of Science and Technology, Parthenope University of Naples, via F. Petrarca 80 (8013), Naples, Italy; gianfranco.picone001@studenti.uniparthenope.it

In the past two centuries, fossil energy storages accumulated over millions of years have been exploited at an increasing rate to support human economy. Fossil fuels were formed over millions of years from the burial of photosynthetic organisms, including plants on land (mainly generating coal) and plankton in the oceans (mainly generating oil and natural gas). To grow these organisms carbon dioxide was removed from the atmosphere and the ocean, and their burial inhibited the movement of that carbon through the carbon cycle. Burning fossil fuels returns CO_2 back into the atmosphere at a rate that is hundreds to thousands of times faster than it took to be buried, and much faster than it can be removed by the carbon cycle. This affects the Earth system in a variety of ways and represents the primary cause of the current climate change due to the massive emission of greenhouse gases altering the Earth's dynamics at a global scale. Nearly two-thirds of carbon dioxide emissions, along with a significant amount of nitrous oxide and methane, derive from the burning of fossil fuels such as oil, natural gas, and coal. This scenario has a strong impact on both human and ecosystem health. In this paper, we review the global scientific literature on energy security with a special focus on biophysical limits, identifying main pathways and possible solutions to ensure long-term environmental sustainability.

Warming effects on plankton communities from Mediterranean freshwater and coastal lagoon ecosystems

Cristina Pittalis[1], Silvia Pulina[1,4], Andrea Di Cesare[3], Francesca Allemanno[3], Paola Casiddu[1], Marco Cherchi[1], Lyudmila Kamburska[3,4], Antonella Luglié[1], Bastianina Manca[1], Roberta Piscia[3], Ilaria Rosati[2], Raffaella Sabatino[3,4], Cecilia Teodora Satta[5], Jessica Titocci[2], Bachisio Mario Padedda[1,4]

[1]University of Sassari, Department of Architecture, Design and Urban Planning, via Piandanna 4, 07100 Sassari, Italy; [2]National Research Council - Research Institute on Terrestrial Ecosystems (CNR-IRET, Strada Prov.le Lecce-Monteroni, 73100, Lecce, Italy; [3]National Research Council - Water Research Institute (CNR-IRSA), Corso Tonolli 50, 28922, Verbania, Italy; [4]National Biodiversity Future Center, NBFC, Piazza Marina 61, 90133 Palermo, Italy; [5]AGRIS Agenzia Regionale per la Ricerca in Agricoltura in Sardegna; c.pittalis@studenti.uniss.it

Global warming is significantly altering the structure and functioning of aquatic ecosystems. The Mediterranean region is identified as one of the most vulnerable areas to global warming, with artificial lakes and coastal lagoons representing particularly susceptible environments that are crucial for the provision of essential ecosystem goods and services. Predictions indicate rising temperatures as cause of plankton biodiversity loss, favouring smaller species, with profound consequences for the structure and efficiency of the pelagic food web.

With the project "a warmer Future world: effects on plankton communities and pathogens in mediterranean vUlneRable ecosystems" (2022PRIN call - FUTURE), we are studying the effects of climate warming on natural plankton communities in the Mediterranean, including different trophic levels, from picoplankton to mesozooplankton, and applying a traditional approach, mainly optical microscopy and flow cytometry, together with a more advanced molecular basedapproach, mainly Next-Generation Sequencing. We are considering natural plankton communities from two different Mediterranean ecosystems: an artificial lake (Bidighinzu Lake) and a coastal lagoon (Cabras Lagoon) located in Sardinia (West Mediterranean) and part of the Italian Long-Term Ecological Research Network.

With this contribution, we present preliminary results on the seasonal dynamics of different plankton size classes in relation to seasonal variations of water temperature and algal nutrients during the first six months of field activity in the artificial lake and the costal lagoon. These data are essential for planning laboratory experiments to be performed in summer 2024 and aimed at investigating plankton responses to extreme climate events, such as heat waves.

The impact of thermal stress on coral pigment and non polar metabolites profile: a preliminary study

Matilda Porro[1], Francesco Saliu[1], Alessandro Becchi[1], Federico Cerri[1,2], Valerio Isa[1,2], Marina Lasagni[1], Yohan Didier Louis[1,2], Davide Seveso[1,2], Paolo Galli[1,2], Silvia Lavorano[3]

[1]Department of Earth and Environmental Sciences (DISAT), University of Milano - Bicocca, Piazza della Scienza 1, 20126 Milan, Italy; [2]MaRHE Center (Marine Research and Higher Education Center), Magoodhoo, Faafu Atoll, 12030, Maldives; [3]Costa Edutainment SpA, Acquario di Genova, Area Porto Antico, Ponte Spinola, 16128 Genoa, Italy; matilda.porro@campus.unimib.it

One of the major problems of our century is the rising of the ocean temperatures, causing several consequences on marine ecosystems. One of the most evident phenomena is the coral bleaching, which modify the symbiotic relationship between the polyp and unicellular algae, necessary for the energy balance and survival of the coral system. This project was focused on the development of an innovative experimental method, to be evaluated on a laboratory scale, to study the impact of rising temperatures on coral metabolism, specifically on the pigments in symbiotic algae and on non-polar metabolites. Extractions were performed on two coral species cultivated in the Aquarium of Genoa, Pocillopora damicornis and Stylophora pistillata, following indications from the literature. The pigment analysis was conducted using an HPLC-DAD instrument, detecting the continuous wavelengths in the visible spectrum in the 350 to 700nm window. For non-polar metabolites, an organic solvent extraction and purification procedure was carried out and then analyzed by gas chromatography coupled with mass spectrometry (GC MS) in non-target mode. The collected data were subjected to a statistical analysis and referring to the pigments analysis, significant differences in the medians of the distributions were searched for using the Mann-Whitney tests. For non-polar metabolites, a statistical analysis was carried out comparing the differences between stressed and non-stressed (control) samples and the metabolites identified were put under different classes. In conclusion, this work has shown that the expression of both photosynthetic pigments and non-polar metabolites undergoes significant variations when corals are subjected to temperature variations. Future studies could be conducted eventually, involving more species and more replicates could be tested to ensure statistical robustness and predictive adoption of the selected markers.

Ecological restoration: sfide della ricerca per invertire la perdita di biodiversità

Chairs

Silvia Bianchelli, Valentina Asnaghi

Presentazioni Orali

From heuristics to mechanistic understanding (and modelling) of ecological dynamics – a focus on the restoration of Posidonia oceanica meadows

Alessandro Bellino, Vincenzo Baldi, Alfonso Romano, Daniela Baldantoni
Department of Chemistry and Biology “Adolfo Zambelli”, University of Salerno, Via Giovanni Paolo II 132 – 84084 Fisciano (SA), Italy; abellino@unisa.it

A crucial challenge in ecosystem restoration, due to the ecological system complexities and the spatial and temporal scales involved, is the prediction of system evolution, the associated uncertainties and the final outcomes. A natural approach to this goal is the use of process-based models, but their requirements in terms of data and mechanistic understanding of system ecology still limit their adoption in the restoration of high complexity systems. Indeed, despite the large amount of data globally acquired, the lack of shared comprehensive strategies for *what* needs to be collected and *how*, promotes the adoption of heuristic approaches based on collections of failures and successes. A remarkable example in this context is provided by the restoration of *Posidonia oceanica* meadows, one of the most important Mediterranean marine coastal ecosystems in terms of productivity, biodiversity and control of local, regional and even global ecological dynamics. The limited resilience of these ecosystems, threatened by diverse anthropogenic pressures, forces the adoption of restoration approaches with variable and hardly predictable degree of effectiveness. With the aim to transitioning from heuristic to mechanistic restoration approaches, the research focused on creating an individual-based model of meadow evolution grounded in Dynamic Energy Budget theory, and a cured and harmonized information base on *P. oceanica* ecology, summarizing more than 6 decades of research in the form of an open geo-database. Results revealed striking imbalances in data type, quality and redundance, with surprising shortage of usable data for model development and parameterization. The coupling between the information base and the model, however, has the potential to form a feedback loop providing the much-needed strategy to move from heuristics to mechanistic approaches. Indeed, the model’s functional hypotheses can orient the collection of data embedded in clear theoretical processes, which in turn allow model development ensuring the effectiveness of restoration approaches.

Ecological restoration of vegetated habitats: a path towards the recovery of coastal biodiversity

Silvia Bianchelli[1,2], Cristina Gambi[1,2], Cinzia Corinaldesi[2,3], Roberto Danovaro[1,2]

[1]Università Politecnica delle Marche, Dipartimento di Scienze della Vita e dell'Ambiente, Ancona, Italy; [2]Università Politecnica delle Marche, Italia; [3]Università Politecnica delle Marche, Dipartimento di Scienze e Ingegneria della Materia, dell'Ambiente ed Urbanistica, Ancona, Italy; silvia.bianchelli@univpm.it

Seagrass meadows and macroalgal (Fucales) forests are hot spots of biodiversity in coastal areas and play a key role in the provisioning of ecosystem services. These habitats experienced regression in the Mediterranean basin in the last decades, due to a combination of multiple anthropogenic and climate-induced impacts. The ecological restoration of these habitat-forming species is a priority to reverse biodiversity loss and for the recovery of their ecosystem functions. We report here successful case studies of ecological restoration of seagrass (*Cymodocea nodosa*) and Fucales (*Gongolaria barbata*) along the coasts of the Marche region (NW Adriatic Sea). Benthic biodiversity (using meiofauna as a proxy) was analyzed in terms of abundance, richness of taxa and taxonomic/species (nematode) composition. Three interventions were carried out: 1) transplanting of the seagrass *Cymodocea nodosa* at Gabicce and the restoration of the brown alga *Gongolaria barbata* in the Conero Riviera and in Site of National Interest (*SNI)* of Falconara Marittima. At "Falconara" site we combined active and passive restoration interventions, as this site has been interdicted for years. All the applied approaches were successful in restoring the damaged habitats and recovering natural populations. Active and active/passive restoration interventions, however, 6/12 months after the interventions, showed both biodiversity and assemblage structure different from the controls when considering meiofaunal assemblages as proxy of biodiversity. Nematodes resulted useful indicators of restoration success. Macrophytes' restoration can be successful and has positive effects on benthic local biodiversity, however, is a relatively long process that can take years to reach a complete recovery. A multilevel approach and habitat inter-connected approach could be useful to increase restoration success and resilience of damaged vegetated habitats.

The role of beekeeping in fostering an integrated model of ecologically sustainable and multifunctional agriculture. The API project

Tommaso Campani[1], Ilaria Caliani[1], Agata Di Noi[1,3], Laura Giovanetti[1], Ginevra Manieri[1], Franchi Andrea[1], Fiaschi Tiberio[2], Angiolini Claudia[2], Romi Marco[2], Cai Giampiero[2], Casini Silvia[1]

[1]Università di Siena, Dipartimento di Scienze Fisiche della Terra e dell'Ambiente, Siena Italia; [2]Università di Siena, Dipartimento di Scienze della Vita, Siena Italia; [3]Università di Siena, Santa Chiara Lab Siena Italia; campani@unisi.it

Climate change, pollution, and environmental degradation pose significant threats to the stability of agricultural production and investment planning in this sector. This necessitates the diversification of the agricultural output alongside the creation of resilient and sustainable agro-ecosystems. Diversification can also occur outside traditional cropping systems through ecological infrastructures that create favourable habitats for beneficial insects, such as pollinators, and provide food sources for domesticated animals like honeybees. Recent FAO studies indicate that increasing the density and variety of pollinating insects directly impacts crop productivity and can help small farmers enhance their average yields. Furthermore, pollinating insects play a crucial role in ecosystem regulation, with the value of pollination services necessary for food production amounting to approximately 260 billion euros annually. Unfortunately, we are witnessing a constant increase in insect mortality, with a serious risk of extinction for wild pollinators and honeybees. The API project aimed to develop an integrated and multifunctional farm model that synergizes beekeepers and farmers, enhancing farm profitability through sustainable apiculture and also improving the environmental and economic sustainability of beekeeping by maintaining and increasing the survival and productivity of bees. A survey of botanical species was conducted on each farm and showed the presence of more than 300 species relevant to beekeeping. In areas where nectar-producing species were insufficient, multi-floral meadows were planted, tailored to the farms' specific soil, climate, and altitude characteristics. Additionally, we recorded the ecological infrastructures containing native botanical species beneficial for wild pollinators and implemented these in the marginal areas of the farms. The effectiveness of the implemented actions was monitored by evaluating the health status of both introduced and existing bee populations on the farms and checking contaminant levels in the samples collected by the colonies. Additionally, surveys were conducted at each site to assess pollinator diversity.

Are the targets of the Nature Restoration Law achievable at a regional scale? An analysis of Natura 2000 sites in the Sardinia region

Michele Defraia[1,2], Erika Bazzato[2,3], Michela Marignani[2,3]

[1]Institute for Advanced Studies, IUSS, Palazzo del Broletto Piazza della Vittoria, 15 27100, Pavia, Italy; [2]Department of Life and Environmental Sciences, University of Cagliari, Via Sant'Ignazio da Laconi, 13, 09123 Cagliari, Italy; [3]Project e.INS - Ecosystem of Innovation for Next Generation Sardinia; michele.defraia@iusspavia.it

Nature Restoration Law (NRL) aims to restore 20% of terrestrial and marine degraded ecosystems of the European territory by 2030. To achieve this goal, each Country must contribute at both national and regional scales.

One of the initial provisions states that by 2030, Member States should prioritize restoring natural ecosystems within Natura 2000 sites, making it urgent to focus on the conservation status of the habitats in these areas.

We chose Sardinia as a case study because Natura 2000 sites cover a similar percentage of its territory (18,87%) compared to the National (19,38%) and the European level (18,6%). Additionally, Sardinia's insularity, high biodiversity levels, and low population density make it an ideal model to test NRL feasibility.

We collected official Natura 2000 data from the Italian Ministry of the Environment (MASE). For each habitat within each site, we assessed the potential for restoration based on the value of the conservation status, i.e. the degree of conservation of the structure and functions of the natural habitat type concerned and restoration possibilities.

Results show that coastal ecosystems are the most endangered, with a few exceptions in habitats with limiting environmental characteristics, such as sea cliffs.

Despite the importance of restoring these environments in terms of biodiversity safeguards, their reduced distribution will have a limited impact on the NRL target, while forest and shrub habitats will potentially be the major contributors.

Relying solely on habitat restoration within Natura 2000 areas will not be sufficient to meet the NRL targets. This implies that interventions in natural areas outside Natura 2000 and agricultural territories will be necessary.

A qualitative analysis at the regional scale can provide insight into the feasibility of reaching the NRL targets and provides an example that can be adjusted and replicated at higher hierarchical levels across Europe.

Innovative management for the restoration of degraded soils to improve ecosystem functioning

Teresa Di Santo, Rossana Marzaioli, Lucio Zaccariello, Elio Coppola, Giovanna Battipaglia, Simona Castaldi, Maria Laura Mastellone, Flora Angela Rutigliano

Università degli Studi della Campania "Luigi Vanvitelli", Italia; teresa.disanto@unicampania.it

Restoring degraded agricultural soils is essential to ensure food security, protect biodiversity, and mitigate climate change. Indeed, soil provides key ecosystem services such as food provisioning, regulation of water and nutrient cycles, and climate regulation through C sequestration in organic matter. The use of slowly-decomposing organic improvers, such as biochar and hydrochar (derived from thermochemical conversion of organic waste) may promote carbon sequestration and favour the growth of soil microorganisms, which play a fundamental role in ecosystem functioning. However, to apply these improvers on a large scale, it is necessary to exclude any negative effects on the biotic community.

As part of the interdisciplinary project "CHIMERA", financed by University of Campania *L. Vanvitelli*, the effects of hydrochar addition to the microbial and chemical properties of degraded agricultural soil were evaluated through a pot experiment. Two types of hydrochar, derived from hydrothermal carbonization of two distinct sources (residues of thistle - *Cynara cardunculus* L. - and sewage sludge, respectively), were applied in two doses (3 kg m^{-2} and 6 kg m^{-2}). The experimental design included five treatments (four with hydrochar and one control without hydrochar), five replicates per treatment, and five exposure times (18, 72, 92, 146 and 517 days). After each period, soil samples were analyzed for microbial biomass and activity, indices of microbial metabolism (metabolic quotient and mineralizable quotient), bacterial genetic diversity (as richness) and some chemical properties (pH, total and extractable organic C, cation exchange capacity).

The results showed no toxic effects following the addition of hydrochar from sludge and thistle. An improvement in soil properties, particularly microbial biomass and activity, pH and total organic carbon content, was generally observed. However, further studies are needed to verify whether these positive effects persist in the long term and whether they are confirmed on other soil types and raw materials.

Mussel biofiltration of noxious metals in an experimental aquaculture system

Francesco Dondero[1], Federica Gulino[1], Maurizio Aceto[1], Valentina Gianotti[1], Davide Gualandris[1], Davide Rotondo[1], Antonio Calisi[1], Tiziano Verri[2], Candida Lorusso[1]

[1]Università del Piemonte Orientale, Italia; [2]Università del Salento, Italia; francesco.dondero@uniupo.it

Aquaculture is one of the most rapidly expanding sectors in global food production, contributing slightly over half of the world's fish for human consumption. However, concerns regarding the environmental impact of aquaculture operations and the potential for sustainability persist. Coastal areas designated for aquaculture often experience compromised water quality due to human activities, such as wastewater drainage and discharge of aquaculture residues, resulting in ecosystem damage. In light of these concerns, integrating effective remediation systems with aquaculture becomes imperative.

Previous studies have highlighted the role of mussels in reducing chlorophyll, phosphorus, and nitrogen levels in salmon farming. Recent research demonstrated their efficacy as biofilters for microplastics and metals. This study aims to further explore the potential of mussels as biofilters in fish farming systems.

Mussels were exposed in microcosms at a density of 1 individual per liter, either in the presence or absence of algae. Mussels demonstrated significant metal accumulation abilities over a 10-day exposure period. Statistical analysis using robust linear regression models indicated that external metal concentration significantly influenced internal metal concentration. Metals such as Ag, Cd, Co, Cr, and Pb showed high significance across all exposure levels, both in the presence and absence of algae. Other metals, including Cu, Fe, Ni, V, and Zn, showed partial significance, while Mn did not exhibit a significant effect.

We developed a mathematical model for heavy metal removal in aquaculture. This model incorporates the decay rate k for each metal species and includes parameters such as metal input, system volume, and the number of mussels to be deployed in the aquaculture farm. The numerical model effectively predicts the reduction of metal concentrations over-time, providing critical insights for designing mussel-based biofilters. These findings contribute to the broader goals of the Italian project Fish RISE (ARS01_01053), supporting sustainability and environmental protection in aquaculture practices

RENOVATE Project: a forward-thinking approach to marine conservation, emphasizing the need for comprehensive, ecosystem-based strategies

Viviana Piermattei[3], Marco Marcelli[1], Gianluca Sarà[2], Simone Bonamano[1], Elena Scagnoli[1], Maria Del Mar Bosch Belmar[2], Francesco Paolo Mancuso[2], Giovanni Coppini[3], Sergio Scanu[3], Daniele Piazzolla[3], Andrea de Lucia[9], Giorgio Fersini[10], Giulia Ceccherelli[4], Paola Del Negro[5], Annalisa Falace[6], Nadia Pinardi[7], Lorenzo Mentaschi[7], Jacopo Alessandri[7], Alessandra Savini[8], Ivan Federico[3], Salvatore Causio[3], Alice Madonia[3]

[1]Università della Tuscia, Italia; [2]Laboratory of Ecology (EEB) University of Palermo (Italy), Department of Earth and Marine Science, Viale delle Scienze, Ed. 16, I-90128 Palermo (Italy); [3]Global Coastal Ocean Division (GOCO), Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy.; [4]Dipartimento di Scienze della Natura e del Territorio (DIPNET), Università di Sassari, Via Piandanna, 4 – 07100 Sassari, Italy; [5]Oceanography Division, National Institute of Oceanography and Applied Geophysics (OGS), Trieste, Italy; [6]Department of Life Sciences, University of Trieste, Trieste, Italy,; [7]Alma Mater Studiorum University of Bologna, Department of Physics and Astronomy, Bologna, Italy; [8]Department of Physics and Astronomy Augusto Righi, University of Bologna, Bologna, Italy.; [9]Institute of Anthropic Impact and Sustainability in Marine Environment, CNR-IAS 09170, Loc. Sa Mardini, Torregrande, Oristano, Italy; [10]Port Authority System of the Central Northern Tyrrhenian Sea, 00053 Civitavecchia, Italy;; viviana.piermattei@cmcc.it

RENOVATE is an Italian applied research project whose main objective is to restore the functions and services of the marine ecosystem affected by the expansion of the Civitavecchia Port Hub. It includes restoration and mitigation measures for the priority Habitat 1120* (*Posidonia oceanica*) and some biocoenoses of Habitat 1170 (Reefs, such as Coralligenous, *Cystoseira* s.l.) and two species of high naturalistic and ecological importance: *Corallium rubrum* and *Pinna nobilis*.

RENOVATE is an ambitious Nature-Based Solutions (NBS) project based on innovative, holistic approaches aimed at achieving medium- to long-term goals to restore the functionality of habitats to the extent that they have been lost. The design phase, the experimental set-up and the duration of the project (10 years) ensure the success of the actions through rigorous planning, continuous monitoring, maintenance, review and adaptation of the experimental actions based on the results obtained.

To develop this approach, it is necessary to implement an integrated modelling and observing system and operational modelling at regional and coastal scales. This will contribute to the planning phase of restoration, development of an early warning system for extreme events, dredging and avoidance of potential impacts, implementation of ecological compensation measures to restore ecosystem services, siting and implementation of NBS and monitoring of recovery of ecosystem services over 10 years.

Preliminary results will be presented showing promising trends in the recovery of *Cystoseira s.l.* and Coralligenous. Initial monitoring data indicate positive responses that emphasize the potential effectiveness of the implemented measures.

A comprehensive approach to macroalgal forest restoration planning in Tenerife

Margalida Monserrat[1], Jacopo Cimini[1,2], Annalisa Falace[1,3], Valentina Asnaghi[1,2,4], Paolo Vassallo[1,2], Mariachiara Chiantore[1,2,4]

[1]CoNISMa, Piazzale Flaminio 9, Roma Italy; [2]DiSTAV, Università di Genova, C. so Europa 26, 16132 Genoa, Italy; [3]Department of Life Sciences, University of Trieste – Trieste, Italy.; [4]National Biodiversity Future Center, 90133 Palermo, Italy;
margalida.monserratbarcelo@ext.unige.it

In alignment with the UN Decade of Ecosystem Restoration and the UNESCO Agenda for Sustainable Development, significant efforts are underway to protect and restore marine ecosystems such as the newly approved EU Nature Restoration Law. Within this framework, the Ocean Citizen EU project (HORIZON-MISS-2021-OCEAN-02) aims to develop replicable marine restoration protocols that integrate habitat restoration, carbon immobilization, and biodiversity regeneration with social and economic benefits for local communities. Pilot sites have been selected to experimentally test and develop sustainable restoration actions for various shallow and deeper marine forests.

The present study focuses on restoring intertidal macroalgal forests of brown canopy-forming macroalgae in one pilot site, Tenerife (Canary Islands, Spain). Macroalgal forests are among the Earth's most productive and biodiversity-rich ecosystems, supporting fisheries and enhancing ecosystem resilience. Despite their ecological importance, they are in regression worldwide, including the study site where declines of 90% of the extension of some *Cystoseira sensu lato* species have been reported in the last decades, mainly attributed to ocean warming and habitat degradation These declines are calling the need for urgent actions to prevent further losses and restore areas unable to recover naturally.

To enhance restoration efficiency, several preparatory steps are undertaken. First, we are characterizing the macroalgal communities in the restoration site, establishing a critical baseline for evaluating restoration success and community evolution. We are also assessing habitat suitability following identification of potential stressors. Additionally, we are evaluating potential *Cystoseira s.l.* species for restoration, donor sites, and *ex-situ* out-planting techniques. Finally, we are developing a long-term monitoring protocol to assess restoration evolution.

This research provides crucial knowledge for restoring marine biodiversity and sustaining the ecosystem services provided by macroalgal forests. Outcomes will support marine conservation efforts, ensuring the long-term viability and the myriad benefits these ecosystems offer to marine life and coastal communities.

Ecological restoration for the conservation of certain coleopteran and lepidopteran species of community importance in Umbria

Matteo Pallottini, Gianandrea La Porta, Silvana Piersanti, Manuela Rebora, Antonia Concetta Elia, Enzo Goretti
Dipartimento di Chimica, Biologia e Biotecnologie - Università degli Studi di Perugia, Italia; matteo.pallottini@collaboratori.unipg.it

Life Imagine Umbria (LIFE19 IPE/IT/000015, 2020-2027) project supports the development of a management strategy for the Natura 2000 network in the Umbria region (Italy). Its main objective is to maintain and improve the conservation status of habitats and species under the Habitats and Birds Directives, in specific target Natura 2000 Sites. Effective ecological restoration projects focused on saproxylic Coleoptera and certain Lepidoptera species have been carried out to address this issue. Best practices for enhancing the habitats of *Rosalia alpina*, *Cerambyx cerdo*, and *Lucanus cervus* involve measures primarily aimed at increasing the presence of senescent trees (beeches and oaks) and associated forest necromass. Specifically, the project created artificial senescence microhabitats such as uprooted trees, broken trunks on the ground, and log piles. Other techniques included a general renaturalisation of the forests by a partial removal of artificial *Pinus* spp. plantations aimed at restoring the original forest habitat. Best practices for *Osmoderma eremita* consisted mainly in creating and installing artificial cavities (Wood Mould Boxes) for increasing the presence of microhabitats suitable for larval development. Additional measures for all the Coleoptera species included creating semi-open areas, such as clearings around habitat trees. The best practices to improve the habitat of the lepidopteran *Eriogaster catax* consisted of creating artificial ecotonal strips rich in shrubs, predominantly blackthorn (*Prunus spinosa*), and protecting existing shrub areas by preventing their transformation into forests, as well as removing alien and synanthropic vegetation. Finally, the best practices for *Euphydryas provincialis* and *Melanargia arge* concerned safeguarding the grasslands by limiting the settlement of shrubs, trees, and alien or synanthropic vegetation. The project aims at implementing demonstrative actions for ecological management and habitat restoration to counteract the decline of these species and improve their conservation status.

Best practices for Posidonia oceanica restoration: evidence from a meta-analytic synthesis

Arianna Pansini[1], Manuel Berlino[2,3], Marina Cristina Mangano[2,3], Gianluca Sarà[3,4], Giulia Ceccherelli[1,2]

[1]Università di Sassari, Italia; [2]National Biodiversity Future Center, Italia; [3]Stazione Zoologica Anton Dohrn, Italia; [4]Università di Palermo, Italia; apansini@uniss.it

Active restoration actions are considered reliable strategies for enhancing seagrass ecosystems within an acceptable time frame. Effective future seagrass restoration management requires valuable information on the effectiveness of past restoration actions. At this aim, we have quantitatively collated evidence of restoration actions for the slow-growing seagrass *Posidonia oceanica*, endemic to the Mediterranean Sea. A meta-analysis of the literature, consisting of 33 documents and 1223 case studies was conducted to provide evidence on any human mediated active restoration, transplanting or rehabilitation outcomes of *P. oceanica*. Results identified the geographical distribution of interventions across countries, their environmental conditions (such as the transplanting depth and type of substrate) as well as the procedural contexts of trials including surface, transplanted plant portion, anchoring technique and monitoring variables. The current study identified an overall lack of standardization in the practices and methodologies used, as well the monitoring variables that severely constrain the analysis of *P. oceanica* restoration outcomes. However, positive outcomes were observed when transplanting in matte substrate, using plagiotropic rhizomes and modular anchoring systems. Moreover, seagrass restoration success is related to shallow transplants, using deeper donor shoots, transplanting with low density and, not surprisingly, when monitoring more than 30 months. Overall, our outcomes clamours for increased funding for monitoring and reporting outcomes, and improved monitoring consistency, that could greatly enhance the understanding of *P. oceanica* restoration keeping it more effective.

Nature-based solutions using organic amendments for recycling alkaline spoil material and green recovering of a degraded area

Ludovica Rolando[1], Paola Grenni[1], Antonio Finizio[2], Rodolfo Gentili[2], Anna Barra Caracciolo[1]

[1]Consiglio Nazionale delle Ricerche-Istituto di Ricerca sulle Acque, Italia; [2]Università di Milano Bicocca-Dipartimento di Scienze dell'Ambiente e della Terra, Italia; ludovica.rolando@irsa.cnr.it

Several tunnelling projects have been implementing in Europe and worldwide for easily connecting people in areas with geographical constrains, such as the presence of mountains. For this purpose, tunnel industry produces millions of cubic meters of excavated soil (spoil material) which can be re-used for different purposes, in line with circular economy. Lime (1–6%) can be added for chemically stabilize excavated materials soils and makes it possible its handling. However, lime addition to SM leads to a significant increase in soil pH up to very high values (ca. 12), with possible deleterious effects if it will be in contact with soil biota or plants. In this work, a real case study, where a tunnel for the A1 highway has been implemented, for planning revegetation and reforestation of the degraded construction site area (Appennini Mountain, close to Florence, Italy) is reported. Microcosm experiments were set-up for 4 months with spoil material and surface soil mixed with different organic amendments (OAs) (compost, pomace or digestate) for evaluating *Medicago sativa* growth and soil quality improvements. Subsequently, at the construction site, a field experiment was set up using mesocosms with the same OAs and five tree/shrub species commonly present in this region: *Ostrya carpinifolia* (black hornbeam), *Quercus pubescens* (downy oak), *Fraxinus ornus* (ash), *Olea europaea* (olive) and *Corylus avellana* (hazel). The plant survival and development was evaluated as well as soil characteristics (e.g. pH, organic carbon) and microbial community structure and functioning in amended and un-amended mesocosms for 3 years. The soil quality increased significantly adding OAs, with the best results and plant growth in digestate or compost presence. These experiments are propaedeutic to the implementation of the new reforestation in the degraded area.

Reforestation facilitated by wood mulch enhances the soil microbiota

Giorgia Santini[1], Lucia Santorufo[1], Valeria Memoli[1], Monica Zizolfi[1], Gabriella Di Natale[2], Marco Trifuoggi[3], Giulia Maisto[4]

[1]Università degli studi di Napoli Federico II, Dipartimento di Biologia, Italia; [2]CeSMA-Centro Servizi Metrologici e Tecnologici Avanzati, Universit`a degli Studi di Napoli Federico II, Corso Nicolangelo Protopisani, 80146, San Giovanni a Teduccio, Italy; [3]Department of Chemical sciences, Università Federico II of Naples, via Cinthia, 80126, Napoli Italy; [4]Vesuvius National Park, Via Palazzo del Principe c/o Castello Mediceo, 80044, Ottaviano, Napoli, Italy; giorgia.santini@unina.it

Natural reforestation and reforestation facilitated by wood mulch represent two distinct approaches to recover degraded forests, each offering unique advantages and challenges. Differently from the natural reforestation, that facilitated by mulch involves the application of organic materials, such as wood chips, on the soil in order to enhance plant growth. Indeed, mulch preserves soil moisture, minimizes erosion, suppresses weeds, and enhances soil structure and fertility through the organic decomposition. The research aimed to evaluate whether natural reforestation (NR) and reforestation facilitated by wood mulch (MR) noticeably modified the soil properties. In order to achieve the aim, soils (depth: 0-10 cm) collected after two years of the reforestation process, performed within the Vesuvius National Park, were characterized for the main abiotic and biotic properties that were compared to those of un-reforested shrubs (N). Particularly, the soil samples were analyzed for pH, water content, organic and total C contents, and N, Al, Ca, Cu, Fe, K, Mg, Mn, Na, Ni, Pb and Zn concentrations. Moreover, DNA yield, microbial respiration and activities of hydrolase, dehydrogenase, b-glucosidase and urease were measured. In order to integrate some of the investigated soil properties, the Integrative Biological Responses (IBR) index was calculated to consider the biotic ones and the Pollution Load Index (PLI) was calculated to evaluate the degree of the soil metal contamination. The findings showed that the IBR was higher in MR (6.38) than in NR (6.09) and N (5.89) soils. Instead, the PLI did not statistically vary among MR (1.75), NR (1.90) and N (1.81) soils. In conclusion, only the reforestation facilitated by wood mulch would seem to enhance the biological response although further investigations need in order to monitor the trend over the time.

Assessing the functional and structural recovery time of a transplanted Posidonia oceanica meadow: lessons from the application of the SER Five-star System and the Recovery Wheel.

Geraldina Signa[1,2], Davide Bruno[3], Giovanna Cilluffo[1,2], Marta Greco[1], Lea Marta Castellini[1], Cecilia Doriana Tramati[1,2], Vincenzo Raimondi[4], Mauro Assenzo[4], Sebastiano Calvo[1,4], Antonio Mazzola[1,2], Agostino Tomasello[1,2], Salvatrice Vizzini[1,2,3]
[1]DiSTeM, Università di Palermo, Italia; [2]CoNISMa, Roma, Italy; [3]CSTE, Università di Palermo, Italia; [4]Biosurvey, Palermo, Italy;
geraldina.signa@unipa.it

An increasingly common approach to halting degradation and promoting the recovery of marine ecosystems and the provision of associated ecosystem services is the implementation of seagrass restoration projects. However, evaluation of the success of seagrass restoration is still based on long-term monitoring of structural indicators such as survival and density of transplanted plants. In contrast, functional indicators may be better suited to provide more rapid information on the recovery of ecosystem functions, which is usually considered to be the main objective of ecosystem restoration. In this study, the Five-star System and the Recovery Wheel monitoring framework, launched by the Society for Ecological Restoration in 2016, were applied to assess the overall progress one year after a restoration intervention in a degraded area (Gulf of Palermo, Sicily, Mediterranean) by transplanting *Posidonia oceanica*. Six ecosystem attributes covering functional and structural aspects: (i) physical conditions (sediment dynamics), (ii) species composition (fish composition and functional response), (iii) ecosystem function (habitat processes and interactions), (iv) absence of threats (chemical pollution), (v) structural diversity (fish biodiversity) and (vi) plant health (growth and physiology of *P. oceanica*) were selected and monitored at the restored site and at a reference site (i.e. the healthy nearby donor meadow). Functional attributes showed an overall improvement over the reference site one year after transplantation, while indicators of chemical pollution and fish diversity did not change over time, and *P. oceanica* health indicators actually deteriorated. Although a period of less than 10 years is usually considered too short to assess the success of ecosystem restoration interventions, here we have shown that the first signs of functional recovery are already detectable one year after seagrass transplantation. However, the structural response of associated fish, the reduction in pollution levels and, even more importantly, the improvement in plant health take longer to recover.

Unravelling the physiological suitability of different tree species for restoration efforts in a Mediterranean protected area

Elisa Spennati, Kristina Micalizzi, Marcello Vitale
Università di Roma La Sapienza, Italia; elisa.spennati@uniroma1.it

Given the rising need for forest restoration, identifying resilient local biodiversity for present and novel climates is crucial. Current species selection for reforestation will have a persistent effect on forest resilience, however, a comprehensive framework for monitoring the success of these programs is still in its infancy. This study employs a functional trait-based approach to evaluate the suitability of the species: *Fraxinus ornus, Quercus cerris* and *Quercus pubescens* in the short term for reforestation within a Mediterranean protected area. We focused on traits associated with hydraulics, carbon utilization and storage (e.g., water use efficiency, net assimilation rate, non-structural carbohydrates), posited as crucial for species' growth and survival, particularly in environments facing prolonged hot-drought spells in summer. Our objectives include determining which traits contributed to different performances. They might suppose an advantage across species under short-term drought in a botanical garden experiment and post-planting in the reforestation site. Secondly, we explored whether the carbon storage may have played a role in the survival of the transplanted species in the reforestation site, after the summer period. Therefore, we compared the non-structural carbohydrate pool in both alive and dead seedlings in the study area and the nursery seedlings.

Use of compost for improving Technosol properties and plant-soil performance: a potential strategy for urban greening

Ermenegilda Vitale[1,2], Pasquale Napoletano[3], Carmen Arena[1,2,4], Anna De Marco[4,5]

[1]Department of Biology, University of Naples Federico II, Naples, 80126, Italy; [2]NBFC-National Biodiversity Future Center, Palermo 90133, Italy; [3]Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Florence, 50144, Italy; [4]BAT Center—Interuniversity Center for Studies on Bioinspired Agro-Environmental Technology, University of Naples Federico II, Portici, 80055, Italy; [5]Department of Pharmacy, University of Naples Federico II, Naples, 80131, Italy; ermenegilda.vitale@unina.it

Urban green spaces provide ecosystem services, including biodiversity conservation and human well-being. Requalifying abandoned lands or planning new green areas with native species offer environmental and cultural benefits. This study explored the sustainable and eco-friendly application of compost (2 kg m^{-2}) to Technosols, to improve soil quality and its suitability for plant growth. Soil quality was assessed before compost addition and for one year after plant establishment, while the effect on plants by monitoring structural and functional traits of the herbaceous spontaneous *Malva sylvestris* L. (Ms) and the transplanted Mediterranean sclerophyllous *Phillyrea angustifolia* L. (Pa) and *Quercus ilex* L. (Qi). Compost addition increased soil nutrient availability over time and favoured the physiological performance of Ms in long-lasting promoting high photosynthetic efficiency and carbon investment in photosynthetic tissues. Conversely, Pa and Qi maintained after 11 months higher leaf water content, despite limited soil water availability, suggesting a slower response to compost addition. The results indicate that compost can enhance Technosols quality, benefiting all species involved and potentially contributing positively to urban greening and ecosystem services.

Posters

Imta based system in offshore environment (Ligurian Sea): combining aquaculture and ecological restoration

Paolo Albicini[1], Valentina Asnaghi[1,2], Luca Fanciulli[3], Lorenzo Meroni[1,2], Jacopo Cimini[1], Claudia Pezzilli[1,2], Mariachiara Chiantore[1,2]

[1]DISTAV, Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Università degli studi di Genova, Corso Europa 26, 16132, Genova, Italia; [2]NBFC (National Biodiversity Future Center), Palermo, Italia; [3]AQUADEMA s.r.l., Via Porto Turistico, 16033 Lavagna, Genova, Italia; paolo.albicini@edu.unige.it

Aquaculture represents one of the most sustainable and efficient animal and vegetal production system. Integrated multi-trophic aquaculture systems may represent an even better solution; such systems, by combining the co-cultivation of fed aquaculture species (e.g., finfish), with inorganic extractive aquaculture species (e.g., seaweeds) and organic extractive species (e.g., suspension and deposit feeders), could improve economic, social and environmental benefits.

Within this context we should consider aquaculture and restoration combined when we envisage to implement one of the most sustainable approaches to restoration: reproduce to restore. In essence, only a few individuals of animal organisms need to be collected to be reproduced in captivity, enormously amplifying the number of individuals to be implanted, minimizing the number of individuals taken and, therefore, the negative impact on the donor site. In the case of seaweeds, the collection from the donor site may be limited to fertile portions, without any actual removal of whole specimens.

The University of Genoa, in collaboration with Aquadema s.r.l, in the context of the European project Novafoodies and of the National Biodiversity Future Centre, is about to run an experimental IMTA system in the Ligurian Sea (Lavagna, Genova).

The farm was already running as a monoculture farm of *Sparus aurata* and *Dicentrarchus labrax*. The add on species for the system are *Ostrea edulis* and *Ericaria amentacea*.

The cultivation of the brown canopy forming seaweed *Ericaria amentacea* in the aquaculture plant could represent a valuable approach for a larger scale production of juveniles of a valuable species for restoration action implementations.

This may represent a new and virtuous form of aquaculture with notable environmental benefits: implementing the culturing phase can become an economic and social opportunity, supporting the development of circular processes, and reducing the ecological impact of aquaculture plants by removing nutrients deriving from feeds and fish wastes.

Artificial floating island as an ecological restoration tool for Lake Trasimeno's biodiversity conservation

Barbara Caldaroni, Gianandrea La Porta, Sara Futia, Ambrosius Josef Martin Dörr, Antonia Concetta Elia

Dipartimento di Chimica, Biologia e Biotecnologie. Università degli Studi di Perugia, Italia; barbara.caldaroni@dottorandi.unipg.it

Lake Trasimeno in Umbria, Italy, is known for its shallow waters and significant natural importance as a Special Area of Conservation, Special Protection Area, and Ramsar site. The phenomena of 'reed-bed die-back' and fluctuations in water levels at Lake Trasimeno have been previously observed. Marsh habitats play a crucial role in preserving biodiversity by supporting the survival of wild flora and fauna of Community interest, as well as providing valuable ecosystem services.

To aid in the restoration of lake ecosystems with changing water levels, artificial floating islands (AFIs) have been introduced as soilless planting structures. These floating mats consist of aquatic and wetland plants, supporting a variety of ecological communities including algae and zooplankton.

Commonly planted vegetation on AFIs includes reeds, cattails, and irises, which help remove pollutants, enhance biofilms and act as filters for eutrophic waters to improve water quality and the overall ecosystem. Additionally, AFIs, reduce soil erosion processes, and offer protection against leaching phenomena and provide habitats for fish, birds, and insects.

The establishment of a reed bed and the creation of a buffer zone between the fields and the marsh vegetation are vital for the completion of the life cycle of odonates, and play a significant role for *Lindenia tetraphylla*, a dragonfly species of community interest.

The present study focuses on the development of AFIs, testing different materials to determine the best substrate for plant growth and island flotation. The installation of AFIs in Lake Trasimeno area may allow the restoration of the *Phragmites australis* community to improve the biological habitat of the species *Lindenia tetraphylla.*

Valorisation of marine necromass to improve soil biodiversity and restore coastal degraded areas: the PRIN 2022 PNRR EMBRACE Project

Flavia De Nicola[1], Mattia Napoletano[2], Giovanni De Feo[3], Alessandro Bellino[2], Marco De Sanctis[4], Alessio Langella[5], Mariano Mercurio[1], Enrica Picariello[1], Claudio Di Iaconi[4], Emanuela Luciani[4], Francesco Izzo[5], Ciro Romano[6], Stefania Oppido[6], Fulvio Trasacco[7], Francesco Giuliano[7], Daniela Baldantoni[2]

[1]Dipartimento di Scienze e Tecnologie, Università degli Studi del Sannio, Benevento, 82100, Italia; [2]Dipartimento di Chimica e Biologia "Adolfo Zambelli", Università degli Studi di Salerno, Fisciano (SA), 84084, Italia; [3]Dipartimento di Ingegneria Industriale, Università degli Studi di Salerno, Fisciano (SA), 84084, Italia; [4]Istituto di Ricerca Sulle Acque del Consiglio Nazionale delle Ricerche (CNR-IRSA), Bari, 70132, Italia; [5]Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse (DiSTAR), Università degli Studi di Napoli Federico II, Napoli, 80126, Italia; [6]Istituto di Ricerca su Innovazione e Servizi per lo Sviluppo del Consiglio Nazionale delle Ricerche (CNR-IRISS), Napoli, 80134, Italia; [7]BIOS MIMESIS SRL, Aversa (CE), 81031, Italia; fdenicol@unisannio.it

The EMBRACE Project (PRIN 2022 PNRR) aims to address the restoration of degraded Mediterranean soils and improve the structural and functional biodiversity of their communities by focusing on the valorisation and use of marine biowastes, through a circular economy perspective. Specifically, the approach relies on optimizing the production of energy and organic fertilizers from marine detritus (seagrass litter and fish wastes), reducing its disposal and obtaining organic resources that can foster the recovery of degraded soils. The feasibility of these resources, produced through a combination of anaerobic digestion and composting aided by quarry waste zeolites, will be evaluated in relation to their ability to improve soil natural revegetation and biodiversity, both above- and below-ground.

In terms of seagrass litter, the project focuses on *Posidonia oceanica* (L.) Delile, whose detached leaves accumulate in large amounts on the coasts and, notwithstanding their crucial ecological roles (protection from erosion, biodiversity hosting), are often removed and disposed of to favour tourism. At the same time, fishing activities produce large amounts of wastes that, coupled with seagrass litter, improve necromass C:N:P ratios. The choice of optimal waste proportions (1:3 fish:seagrass) and the addition of zeolites (working as ionic exchanger of NH_4^+ and Na^+), favour methanogenic microorganisms in spite of the high salinity. The sustainability of the entire process, from the acquisition of wastes to their processing and the recovery of degraded soils with the produced organic fertilizers is evaluated through Life Cycle Assessment approaches.

Integrating functional diversity and species distributions to inform ecological restoration in the western miombo woodlands

Michela Leonardi[1,2], Ana Claudia Araujo[1], Arianna Salili-James[1], Ben Scott[1], Neil Brummitt[1]
[1]Natural History Museum, London, United Kingdom; [2]Department of Zoology, University of Cambridge, United Kingdom;
michela.leonardi@nhm.ac.uk

The miombo woodlands are a dry forest/seasonal woodland ecosystem found in southern Tropical Africa. Their distribution covers from Angola to Tanzania, and they are characterised by the genera *Brachystegia*, *Julbernardia* and *Isoberlinia*. In this poster we present an innovative approach to inform the ecological restoration of functionally-deprived areas in the western miombo.

We firstly undertook a thorough study of historical and current literature to compile an extensive list of native species from the region. We then collected georeferenced observation data for each from online databases, and cleaned and thinned them to minimise biases. Through species distribution modelling for every taxon with more than 10 “clean” observations we were able to obtain estimates of species richness for each pixel.

The second stage is to collect trait information for each species from trait databases, floras and the analysis of herbarium specimens, and then estimate functional diversity across the area based on trait hypervolumes of the species observed or modelled as potentially present in each pixel.

The expected relationship between species richness and functional diversity under equilibrium conditions is known. Integrating these two lines of evidence will therefore identify regions with functionally-healthy and functionally-deprived ecosystems. By the comparison between these two, we will identify under-represented functions in the latter which will allow the best candidate species for restoration and replanting efforts to be defined.

Food by-products as sustainable ingredients in feed for sea urchin (Paracentrotus lividus) farming

Simone Maria Santo Musumeci[1], Antonio Luca Langellotti[2], Mariacristina D'Ascoli[1], Giovanni Luca Russo[2,3], Maria Toscanesi[4], Marco Trifuoggi[4], Alberto Colletti[1], Paolo Masi[2,3], Simonetta Fraschetti[1]

[1]Department of Biology, University of Naples Federico II; [2]Center for Innovation and Development in Food Industry, University of Naples Federico II; [3]Department of Agricultural Sciences, University of Naples Federico II; [4]Department of Chemical Sciences, University of Naples Federico II; simonemariasanto.musumeci@unina.it

Sea urchins play a crucial role as marine grazers but face severe threats from overexploitation, significantly affecting the decline of *Paracentrotus lividus*, an important Mediterranean species.
To face this issue, exploring sustainable strategies like aquaculture is considered profitable despite its slow growth rate posing a challenge. Developing a balanced diet is essential for their growth, and eco-friendly feeds from industrial waste offer a promising solution. This study investigates the feasibility of using sustainable feeds derived from anchovy processing by-products and industrial carrot waste for sea urchin aquaculture. For the first time, these alternative diets were tested on juvenile sea urchins of various sizes, enabling a comprehensive evaluation of growth performance over time. Experimental diets (D100 and D50) were compared with a commercial pellet control diet. Results indicate that alternative diets can sustain sea urchin growth, although performance varies significantly among diets and sizes. In particular, D50 and control diets exhibit a higher somatic growth rate (SGR) and food conversion ratio (FCR) than D100 diet which shows lower SGR, especially in larger size classes. Chemical analysis reveals significant differences in feed assimilation efficiency and impacts on nitrogen absorption across size classes and diets. Findings suggest that eco-friendly industrial waste feeds can be adopted for sea urchin aquaculture. However, further research is needed to optimize feeding protocols and understand mechanisms affecting growth performance and feed assimilation efficiency. Aligning with circular economy principles, utilizing food waste in aquaculture can aid in conserving overexploited sea urchin stocks and promoting sustainable marine resource management.

Artificial substrates as a tool for the conservation of the Italian Spring Goby (Orsinigobius punctatissimus)

Adriano Palazzi, Beatrice De Felice, Simona Mondellini, Diego Rubolini, Marco Parolini

Department of Environmental Science and Policy, University of Milan, Via Celoria 26, I-20133 Milan, Italy; adriano.palazzi@unimi.it

The Italian Spring Goby (*Orsinigobius punctatissimus*) is a critically endangered freshwater fish species native of the River Po plain. It thrives in habitats with spring water, including resurgences and oxbow lakes. Reproduction typically occurs in spring and summer, where suitable substrates such as stones, branches, and leaves are used for eggs laying. Male parental care extends from eggs fertilization until hatching. In the last decades, threats such as spring droughts, climate change, pollution and habitat loss have led to the 70% decline in the distribution of the species across Lombardy region, resulting in habitat fragmentation, decrease of suitable reproductive substrates, and consequently impairments of the reproduction and population decline. Thus, the improvement of reproductive substrate including artificial substrates emerged as a promising conservation strategy for this species. In this study, we tested the efficiency of the improvement of reproductive substrate including hollow bricks into 10 springs where populations of the Italian Spring goby were detected. Springs were visited every two weeks to check for the use and effectiveness of artificial substrates for the reproduction, as well as to measure environmental variables. We observed reproduction and eggs deposition 2 weeks after the substrates were positioned. Multiple depositions were observed in the same hollow brick, with a preference for the smaller holes. Although the holes were also used by the red swamp crayfish (*Procambarus clarkii*) it was possible to detect eggs of the Italian Spring Goby at different developmental stages. These findings indicate that artificial substrates can be used as a safe reproductive refuge and therefore representing a promising strategy for the conservation of Italian Spring Goby populations.

SeaForSoil: marine biopolymers to develop novel strategies to increase the water retention in soil for sustainable farming systems under water constraints

Flora Angela Rutigliano[1], Vincenzo Zammuto[2], Elio Coppola[1], Waqas Ali Akbar[1], Giorgia Santini[3], Rossana Marzaioli[1], Marina Morabito[2], Concetta Gugliandolo[2], Giulia Maisto[3]

[1]Università degli Studi della Campania "Luigi Vanvitelli", Italia; [2]Università degli Studi di Messina, Italia; [3]Università degli Studi Federico II di Napoli, Italia; floraa.rutigliano@unicampania.it

Climate change is affecting water availability, turning many countries into semi-arid or arid. The scarce quantity of water in many countries, as in Mediterranean areas, can form water-repellent barriers (''water repellency'') in the soil, limiting the rate and capacity of water absorption, with dramatic implication for functioning of both natural and agricultural ecosystems and, consequently, for the human well-being. According to UN Agenda 2030 for Sustainable Development, which aims to progressively improve land and soil quality, combat desertification, restore degraded land and soil, the PRIN PNRR SeaForSoil project intends to evaluate an innovative strategy in sustainable agriculture to increase water availability through incorporation of biopolymers derived from marine organisms into soils. Biopolymers could increase soil water content, reduce soil water repellency and improve overall soil quality and, as a consequence, plant growth. Biomasses of marine cyanobacteria and seaweeds, and polysaccharides produced by thermophilic bacteria were investigated for their wetting properties and ability to improve water retention in laboratory-scale soil model. Moreover, to exclude any toxic effects of selected biomasses and biopolymers, both bioluminescence inhibition, based on *Vibrio harveyi*, and phytotoxicological tests, with *Lepidium sativum* L. and *Sorghum saccarathum* L., were performed. The addition of either biomasses or biopolymers in the soil at different doses (0.05 and 0.1 % dry weight) generally slowed water loss compared to the control (without any biomass or biopolymer). The recorded effect depended on the type and dose of either biomass or biopolymer. Biomasses and biopolymers did not significantly affect the bioluminescence emitted by *V. harveyi,* and did not induce any phytotoxicity response in *L. sativum* and *S. saccharatum*, indicating that they were not toxic. These preliminary results allowed us to identify biomasses and biopolymers with optimal characteristics that will be further tested in pot experiments to evaluate their effect on soil quality and plant growth.

Coralligenous restoration in the coastal area of northern Latium (Italy): insights into the ongoing activities of the RENOVATE project

Elena Scagnoli[1], Daniele Piazzolla[2], Viviana Piermattei[2], Giorgio Fersini[3], Marco Marcelli[1]

[1]Laboratory of Experimental Oceanology and Marine Ecology, Department of Ecological and Biological sciences DEB, University of Tuscia, Port of Civitavecchia, Civitavecchia (RM), Italy; [2]Ocean Predictions and Applications Division, Centro Euro-Mediterraneo sui Cambiamenti Climatici, Italy; [3]Port Authority System of the Central Northern Tyrrhenian Sea, 00053 Civitavecchia, Italy; elena.scagnoli@unitus.it

Ecosystem restoration plays an important role in maintaining biodiversity and ensuring the resilience of ecosystems to face anthropic and climatic impacts such as heatwaves and extreme events.

To improve the changes of restoring success and to mitigate the biodiversity loss, it is fundamental to have conscience concerning the environmental factors surrounding the implanted organisms and the better experimental techniques and procedures.

The Coralligenous biocoenosis, one of the most important bioconstructions in the Mediterranean Sea, provides fundamental ecosystem services but is severely threatened by human activities and climate change.

Our work aims to develop a restoration protocol based on the recovery of bycatch organisms, testing various existing techniques.

We present first results of this activity, including census data, recovery operations, and the first pilot restoration activities for corals. This research is part of the RENOVATE project (Ecosystem Approach to the Evaluation and Experimentation of Compensation and Mitigation Actions in the Marine Environment: the case of the Civitavecchia Port Hub).

3D point clouds based on underwater photogrammetry for monitoring Posidonia transplantation areas

Daniele Ventura[1], Edoardo Casoli[2], Gianluca Mancini[3], Andrea Belluscio[4], Giandomenico Ardizzone[5]

[1]Università degli Studi di Roma La Sapienza, Dipartimento di Biologia Ambientale; [2]Università degli Studi di Roma La Sapienza, Dipartimento di Biologia Ambientale; [3]Università degli Studi di Roma La Sapienza, Dipartimento di Biologia Ambientale; [4]Università degli Studi di Roma La Sapienza, Dipartimento di Biologia Ambientale; [5]Università degli Studi di Roma La Sapienza, Dipartimento di Biologia Ambientale; daniele.ventura@uniroma1.it

Seagrasses are considered one of the most important shallow-marine ecosystems and ensure, at the global scale, a large plethora of goods and services for their ecological, physical, and economic values.Unfortunately, since the last century, seagrass meadows are rapidlydeclining due to both natural processes and human-mediated impacts. Continual loss of seagrasses coupled with the decline of coastal environmental quality has resulted in national and international legislation and policies for the protection and conservation of seagrass habitat. For this reason, several guidelines were developed focused on mitigation measures to prevent further losses and facilitate recovery through restoration actions. Although both seagrass experimental trials and large-scale transplanting operations have been carried out, little effort has yet been made to define new methods to remotely follow over time the survival and growth of the transplanted fragmentsHere we propose an SfM-based approach for mapping seagrass transplantation areas to produce ultra-high spatial resolution orthophoto mosaics and Digital Elevation Models (DEMs) based on the processing of underwater imagery to digitally create 3D surfaces of such key habits. We applied our approach on a Posidonia transplantation area located in Giglio Island near the site impacted by Costa Concordia shipwrecking. This method provides a valid alternative to traditional methods for creating centimetre-level accuracy cartographic products of living P. oceanica and could be applied to map other complex benthic habitats threatened by natural and anthropogenic factors.

Assessment of nitrogen removal efficiency and greenhouse gas emissions in constructed wetland systems

Fabio Vincenzi, Elisa Soana, Giuseppe Castaldelli

Università degli Studi di Ferrara, Italia; fabio.vincenzi@unife.it

The deterioration of aquatic ecosystems is giving rise to concerns about the quality of water resources and the emission of greenhouse gases. Nevertheless, the restoration of aquatic vegetation has the potential to play an important role in increasing denitrification processes and reducing emissions of nitrous oxide (N_2O) and methane (CH_4). The objective of the project is to evaluate the role of emergent aquatic vegetation in nitrogen removal processes. The project will investigate the equilibrium between dissimilatory and assimilative processes and the environmental factors influencing the emission of N_2O. Nutrient and gas fluxes will be quantified in mesocosms, employing a validated experimental approach. The use of mesocosms, which reproduce the environmental complexity of full-scale systems, will serve as models for the study of the underlying processes that determine the depuration performance of canals and wetlands. The standard biogeochemical methods for estimating the metabolism of aquatic environments will be employed in combination with the "N_2 open-channel" method for the direct measurement of nitrate removal via denitrification as N_2. This method entails the quantification of the N_2:Ar ratio in water samples through the use of MIMS (Membrane Inlet Mass Spectrometry, Bay Instruments). In addition to a comprehensive parameterization of nitrogen removal via denitrification, the primary objective of the study is the quantification of greenhouse gas emissions (N_2O, CH_4). Previous studies have indicated that greenhouse gas (GHG) emissions from vegetated canals within agricultural landscapes may not be a significant issue. However, our understanding of these processes remains incomplete. It is, therefore, essential to refine this approach and make it more accurate and widely applicable to facilitate its integration into nature-based solutions for water quality improvement in agricultural basins. This will contribute to the achievement of the Water Framework Directive goals without unexpected GHG emissions.

Ecologia del paesaggio e cambiamento globale

Chairs

Maria Laura Carranza, Irene Petrosillo,
Emilio Padoa-Schioppa

Presentazioni Orali

Filling the gap between conceptualizing and assessing individuals' home-ranges

Alberto Basset[1,2,3], Vanessa Marrocco[4], Marco Elia[1], Ludovico Lezzi[1], Lucia Fanini[1], Francesco Cozzoli[3], Flavio Monti[3], Milad Shokri[1,2]

[1]Università del Salento, Italia; [2]National Biodiversity Future Center, Italia; [3]CNR-IRET, Italia; [4]LifeWatch ERIC;
alberto.basset@unisalento.it

The interactions among individuals, either vertical and horizontal, occur in space, and the space units can be conceptually described by the individual home range. However, while the home range concept is clearly defined as the spatial area required by an individual to satisfy its overall needs over the life cycle, its operationality and comparability can be hindered due to the complexity of individual behavior, such as sociality, and life cycle, as well as the absence of a standardized individual tracking system for most, if not all, species. Thus, the concept of home range can only be fully operational and comparable when the temporal and spatial scales are appropriately defined, based on the specific scientific questions being addressed. Here, we present a few study cases, covering both terrestrial and aquatic species, at local and global scale, using field and laboratory data to analyze the actual concept consistent with the data used, which allows assessment of home-range size and gives insights into the underlying mechanisms. When the spatial area required by an individual to satisfy its overall needs is contextualized to the competitive interactions between individuals of the same or different species, a time frame and an individual tracking system can be adapted to describe and analyze the spatial extent where interactions occur as well as the resource-mediated interaction among individuals. As all interactions occur in space, a proper, modular, definition of home range seems suitable to assign a spatial extent to intra and interspecific interactions among competing individuals.

The influence of urban landscapes on ecological components contributing to plant pollination

Paolo Biella, Giulia Brambilla, Andrea Galassini, Valentina Verduci, Massimo Labra
Università degli studi di Milano-Bicocca, Italia; paolo.biella@unimib.it

In the last decades, a global decline in biodiversity has been taking place due to the strong impact of anthropogenic activities. However, in large cities, refuge for pollinators persist and, from a One-Health and urban sustainability perspective, it is pivotal to understand how to properly characterize those ecological components contributing to pollination services in relation to changing landscapes. These components are mainly constituted by species diversity, their interactions and their functional traits, leading to different pollination success according to how the landscape influence them. This contribution will, firstly, delve into these components and how they should relate to pollination. Secondly, examples from several monitoring campaigns will be shown in relation to landscape features (e.g. forest patches, green area size, green area fragmentation). Data from monitoring of bee diversity in six main Italian cities and their interactions will be presented, showing how these may ultimately relate to the pollination of plants. This took place within the Spoke 5 activities (Urban Biodiversity) of the PNRR and NBFC plan. This contribution sheds light on the complex relationship between the environment and the regulating ecosystem services, contributing to a better understanding of how landscapes influence pollination, for a more sustainable and healthful urban environment.

Assessing the ecological connectivity of the Marine Protected Areas of the Campania region (Southern Tyrrhenian Sea)

Erika Fabbrizzi[1,2], Francesco Colloca[3], Alberto Colletti[1,2], Sara De Benedictis[1,2], Chiara Silvestrini[1,2], Simone Musumeci[1], Stefano Moro[3], Francesca Acampa[3], Simonetta Fraschetti[1,2]

[1]Dipartimento di Biologia, University of Naples Federico II, Naples, Italy; [2]National Biodiversity Future Centre, Palermo, Italy; [3]Department of Integrative Marine Ecology, StazioneZoologica Anton Dohrn, 00198 Rome, Italy; erika.fabbrizzi@unina.it

Marine Protected Areas (MPAs) are essential tools for preserving marine biodiversity. Ensuring MPAs' ecological connectivity is one of the key criteria for establishing coherent reserve networks, promoting the resilience of marine communities to environmental perturbations. To this end, beta-diversity analyses, which measure dissimilarities/similarities among assemblages in terms of species composition, have proven to be effective for quantifying connectivity among MPAs across various spatial scales, from local to regional. The Campania region is represented by approximately 480 km of coasts and hosts four nationally designated MPAs, representing nearly 2% of the regional sea. To assess the ecological connectivity of the four MPAs, we investigated the taxonomic beta-diversity (expressed as pairwise Jaccard dissimilarity) of rocky benthic assemblages, including 36 protected sites plus 28 unprotected sites outside MPAs' borders. This analysis allowed us to explore potential connectivity patterns and how the actual conservation settings can benefit from the allocation of new protected areas. We considered the two components of beta-diversity, i.e., turnover and nestedness, to untangle the processes determining the dissimilarities observed. Preliminary results showed that species pools across MPAs are quite similar (average dissimilarity is 52%), with turnover being the dominant component of dissimilarity between MPAs in terms of species composition. This suggests MPAs, protecting distinct species assemblages, can contribute to protect representative portions of the regional biodiversity. Including unprotected locations in the analysis led to spatial scale-dependent increases in the nestedness component, suggesting the effects of human pressures as potential drivers of the observed patterns. However, the role of these locations in supporting the species dispersal and resilience within the network is also discussed. The integration of these results with particle dispersion models, showing marine currents flow and velocity, can be a profitable strategy for the identification of linked sites across the study area.

Eco-functional diversity in coastal dunes unveiled by high-resolution remote sensing and plant traits

Michele Innangi[1], Federica Pontieri[1], Mirko Di Febbraro[1], Marco Balsi[2], Ginevra Colonna[3], Maria Laura Carranza[1,4]

[1]EnviXLab, Dipartimento di Bioscienze e Territorio, Università del Molise, Contrada Fonte Lappone, 86090 Pesche (IS), Italy; [2]Dipartimento di Ingegneria dell'Informazione, Elettronica e Telecomunicazioni, Università di Roma La Sapienza, Via Eudossiana 18, 00184 Rome, Italy; [3]Dipartimento di Scienze della Terra e dell'Ambiente, Università di Pavia, Via Adolfo Ferrata 7, 27100 Pavia, Italy; [4]National Biodiversity Future Center, Piazza Marina 61, 90133 Palermo, Italy; michele.innangi@unimol.it

Human activities such as urbanization, tourism, and invasive species increasingly threaten coastal dune ecosystems, which provide essential ecosystem services. Effective conservation and management require understanding dune vegetation's structure and function, focusing on eco-functional characteristics. This study analyzes and maps eco-functional plant classes in Molise, southern Italy, using high-resolution remote sensing and plant functional traits. Forty-six taxa were identified, including diagnostic species for various EUNIS habitats, during vegetation sampling of 67 sites in the "Foce Trigno-Marina di Petacciato" LTER area. Ecological indicator values for soil moisture, nitrogen, reaction, light, and temperature were extracted, and traits such as life form, height, seed mass, and dispersal distance were analyzed. High-resolution remote sensing data was acquired using unmanned aerial vehicles with RGB, multispectral, and LiDAR sensors.

Model calibration involved evaluating multicollinearity and retaining critical vegetation and remote sensing variables. Vegetation clusters were identified using K-means clustering based on scaled vegetation variables. A model with four classes and five attributes (seed mass, dispersal distance class, ecological indicator value for temperature, Berger-Parker, and Simpson dominance index for life forms) was chosen from 2544 potential models for its ecological relevance. This model illustrated distinct eco-functional classes associated with specific dune habitats. Significant taxa for classification included *Eryngium maritimum* and *Thinopyrum junceum*, recognized for their ecological and diagnostic value.

The final eco-functional maps revealed heterogeneity in both dunes, with Class 1 prevalent near the coast and Class 4 more isolated. One dune exhibited distinct horizontal zonation with repeating bands, while the other showed a subtle mosaic pattern. This comprehensive approach, combining field sampling and advanced remote sensing, provides a robust framework for studying coastal dune vegetation. Insights into ecosystem resilience can guide strategies to mitigate environmental threats and enhance conservation efforts. Future research should refine these models and extend their applicability to other coastal regions.

Assessing ecophysiological patterns of Ailanthus altissima and differences with native vegetation classes using Copernicus satellite mission in a Mediterranean island

Flavio Marzialetti[1,7], Vanessa Lozano[1,7], André Große-Stoltenberg[2], Maria Laura Carranza[3,7], Michele Innangi[3,7], Greta La Bella[4], Simonetta Bagella[5,7], Giovanni Rivieccio[5,7], Gianluigi Bacchetta[6], Lina Podda[6]

[1]Department of Agricultural Sciences, University of Sassari, Viale Italia 39/a, 07100 Sassari, Italy; [2]Division of Landscape Ecology and Landscape Planning, IFZ Research Centre for Biosystems, Land Use and Nutrition, Institute of Landscape Ecology and Resource Management, Justus Liebig University Giessen; [3]EnvixLab, Department of Bioscience and Territory, University of Molise, C. da Fonte Lappone, 86090 Pesche, IS, Italy; [4]Department of Science,Roma Tre University, Roma, Italy; [5]Department of Chemistry, Physics, Mathematics and Natural Sciences, University of Sassari, Via Vienna 2, 07100 Sassari, Italy; [6]Centre for the Conservation of Biodiversity (CCB), Department of Life and Environmental Sciences, University of Cagliari, Viale S. Ignazio da Laconi 11-13, 09123 Cagliari, Italy; [7]National Biodiversity Future Center (NBFC), Palermo 90133, Italy; fmarzialetti@uniss.it

Invasive alien plants negatively affect biodiversity and ecosystem services. The EU Copernicus Mission delivers free remote sensing data, facilitating cost-effective and timely monitoring of invaded areas. This study deploys multispectral (Sentinel-2) and thermal (Sentinel-3) satellites to characterize ecophysiological traits of vegetation patches invaded by *Ailanthus altissima* in Sardinia, and analyzes seasonal ecophysiological changes between highly invaded and native vegetation classes. A total of 176 invaded patches and their non-invaded buffer areas were identified on aerial orthophotos, digitized and rasterized at the resolution of 20 m^2. These cells were classified to the second level of the regional vegetation map (Carta della Natura) in *A. altissima* and native vegetation classes. *A. altissima* dominance was found in six vegetation classes: Mediterranean maquis, Mediterranean sub-nitrophilous grassland, deciduous woody vegetation, evergreen woody vegetation, agricultural herbaceous areas, and agricultural woody areas. After, we calculated a set of spectral indices as proxies of leaf chlorophyll and carotenoid content (CVI, SIPI3), productivity and canopy biomass (EVI, LAI), leaf water content (NMDI, MSI), soil features (CI), and daily evapotranspiration. We analyzed the monthly trends of these indices in invaded patches and buffer areas and their seasonal differences between invaded and not invaded cells, using linear mixed models (LMMs), two-way ANOVA, and Estimated Marginal Means. Our results highlighted the potential of Copernicus mission in capturing the temporal trends of ecophysiological spectral traits in invaded areas, as the high conditional R^2 values of LMMs ranged from 0.522 of CVI to 0.776 of LAI. The greatest significant differences between invaded and not invaded cells were observed during summer, i.e. higher productivity and canopy biomass, greater leaf water content, lower leaf carotenoid content, and lower bare soil presence. These results confirmed that *A. altissima* might have a competitive advantage over native vegetation, especially during the summer drought period of the Mediterranean basin.

Seventy years of landscape change in the Central Adriatic coast: exploring the role of different dynamic processes on LTER sites

Federica Pontieri[1], Mirko Di Febbraro[1], Michele Innangi[1], Maria Laura Carranza[1,2]

[1]EnviXLab - Department of Biosciences and Territory DiBT, Molise University, Contrada Fonte Lappone, snc, 86090 Pesche, Italy;
[2]National Biodiversity Future Center (NBFC), Palermo, 90133, Italy; f.pontieri@studenti.unimol.it

Coastal areas, placed between land and sea, host a highly specialized biodiversity that is consistently impinged by human activities. Remote sensing (RS) offers sound support for describing and modelling landscape dynamics.

Based on multi-temporal landscape analysis we explored the main dynamic processes shaping landscape changes in the Central Adriatic coasts over the last 70 years. We specifically compared dynamic processes and landscape changes inside and outside coastal LTER (Long Term Ecological Research) sites, which offer a perfect playground for studying and modelling ecological processes.

We focused on a coastal tract (Molise region) that hosts two LTER sites (IT20-003-T: Foce Saccione-Bonifica Ramitelli and IT20-002-T: Foce Trigno–Marina di Petacciato) that are also included in the N2K network (IT7222217 and IT7228221).

Based on fine-scale (1:5000) multi-temporal land cover maps (1954, 1986, 2022), we calculated transition matrices and identified the main dynamic processes (e.g. urban expansion, seashore erosion, etc.) occurring on two-time steps (1954-1986; 1986-2022). We compared landscape processes inside and outside LTER sites implementing a Random Forest model (RF).

Major changes occurred in the first time step (1954-1986) with Agriculture expansion and forestation processes dominating inside LTER sites and urbanization outside. In the second time step (1986-2022) coastal landscape resulted more dynamic inside LTER sites with naturalization being the main process. This second period registered minor changes with curtailed expansion of agriculture and urban areas on both landscapes (inside and outside LTER sites) which do not align with the global trend of coastal urbanization.

The increased understanding of the main dynamic processes shaping coastal landscapes provides new elements and updated information useful for managing and conserving coastal areas.

ISOMED - A database of isotopic signatures of Mediterranean food web components

Salvatrice Vizzini[1,2], Emanuela Fanelli[3], Daniela Berto[4], Federico Rampazzo[4], Zaira Da Ros[3], Seta Noventa[4], Tomaso Fortibuoni[5], Camilla Antonini[4], Giovanna Cilluffo[1,2], Geraldina Signa[1,2], Alice Premici[3], Roberta Bardelli[1,2], Saša Raicevich[4]

[1]Dipartimento di Scienze della Terra e del Mare, Università degli Studi di Palermo, via Archirafi 18, 90123 Palermo, Italy; [2]Consorzio Nazionale Interuniversitario per le Scienze del Mare, Piazzale Flaminio 9, 00196 Roma, Italia; [3]Dipartimento Scienze della Vita e dell'Ambiente, Università Politecnica delle Marche, Via Brecce Bianche, Ancona, Italia; [4]Istituto Superiore per la Protezione e la Ricerca Ambientale, Loc. Brondolo 30035, Chioggia, Italia; [5]Istituto Superiore per la Protezione e la Ricerca Ambientale, Ozzano dell'Emilia, Italia; salvatrice.vizzini@unipa.it

The study of food webs represents a valuable tool for understanding the ecological dynamics that shape energy flows and predator-prey relationships. Because of their relative stability, food webs are also a good proxy for assessing anthropogenic impacts at the ecosystem level. On this basis, within the implementation of the Marine Strategy Framework Directive, Member States are required to assess the status of the marine food web in the context of Descriptor 4, specifically considering the diversity and productivity of trophic guilds. One of the most widely used approaches for assessing the structure and functioning of marine trophic networks is based on the use of stable isotopes of carbon and nitrogen (δ13C and δ15N), which are particularly useful for understanding the trophic ecology of a wide range of taxa whose diet composition may be impractical to assess through traditional approaches (e.g., stomacal content analysis). However, such data are scarce and have not been collected systematically, often making it difficult to assess the status of marine trophic webs. Here we present ISOMED, a georeferenced database of published isotopic values of δ13C and δ15N and elemental carbon and nitrogen composition of basal organic matter sources and consumers collected in the Mediterranean Sea. The reported information includes data for more than 5000 records at the species/taxa level. ISOMED provides a unique tool to study interactions and energy fluxes for components of the Mediterranean food web and contribute to the operationalization of ecosystem indicators for the assessment of Good Environmental Status.

Fire history and biotic legacies in a fire prone Mediterranean coastal pine forest landscape: The potential role of fire refugia in post-fire ecological succession

Maria Floriana Spatola[1], Paola Mairota[1], Emilio Padoa-Schioppa[2], Flora Angela Rutigliano[3]

[1]Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Università di Bari Aldo Moro, Piazza Umberto I, 70121 Bari, Italy;
[2]Dipartimento di Scienze dell'Ambiente e della Terra, Università di Milano Bicocca, Piazza dell'Ateneo Nuovo 1, 20126 Milano, Italy;
[3]Dipartimento di Scienze e Tecnologie Ambientali Biologiche e Farmaceutiche, Università della Campania "Luigi Vanvitelli" Via Vivaldi, 43, 81100 Caserta, Italy; maria.spatola@uniba.it

Improving forests health and resilience is one of the goals of the New EU 2030 Forest Strategy and of the EU 2030 Biodiversity Strategy because forests provide many ecosystem services. In Mediterranean areas, wildfires are recurrent anthropogenic disturbances causing forest ecosystems degradation. This is of particular concern in areas of conservation interest that are increasingly affected by wildfires. A transdisciplinary and multiscale approach is adopted in the PRIN Project 20222CT8J3 FLER_MeCoFor to evaluate wildfires legacies through specific structural and functional indicators, based on field, ancillary, and satellite data. The project aims to assess the effect of recurrent wildfires in the Natura 2000 (N2K) site IT9130006—Pinewoods of the Ionian Arch (Apulia region, Southern Italy) which hosts the Habitat of Priority Interest 2270* (Wooded dunes with Pinus pinea and/or Pinus pinaster). At the landscape level the role of fire refugia in post-fire ecological succession is being investigated at two spatial scales (N2K forest landscape and the 9 individual stands comprised). This is based on the reconstruction, presented here, of the 1980 to 2020 fire regime and fire refugia spatio-temporal pattern and recovery time, within burned forest patches. Over the 40 years interval 22 (frequency 0.55) wildfires were mapped and characterised in terms of fire severity using ancillary and LANDSAT imageries. More than half (55.66%) of the total landscape area (1893.60 ha) was disturbed (mean fire size 47.91±46.98 ha) and 7.26 % of the burned area was classified as fire refugia (mean size 3.48±4.19 ha). Individual stands exhibit different fire regimes and fire refugia (permanent *vs* non-permanent) recovery space-time pattern. This confirms fire regime scale-dependency and underlies differential resilience dynamics and pathways of fire refugia and their neighbouring areas. These aspects are being further investigated at the ecosystem level by considering the effects of different fire severities on vegetation and soil properties.

Analysis of biodiversity loss drivers: Murge and Tirso cases study

Donatella Valente[1,2], **Irene Petrosillo**[1,2]

[1]Landscape Ecology Laboratory, Department of Biological and Environmental Sciences and Technologies, Università del Salento, Lecce, Italia; [2]NBFC, National Biodiversity Future Center, Palermo, Italia; donatella.valente@unisalento.it

Biodiversity is the basis of life on Earth and global ecosystems can become unstable if biodiversity is destroyed. It provides essential biological resources and ecosystem services, for human society. However, the loss of biodiversity is severe and caused by several interacting drivers, accelerating the degradation of ecosystems. Climate change has multifaceted effects influencing biodiversity and ecosystem functions. Habitat fragmentation is also a major factor of biodiversity loss, as it degrades habitats and leads to a significant decrease in the living space available for various species. Within the context of the Broad Area Sites (BASs), called "Murge" and "Tirso", identified within Spoke 4 of the Future National Biodiversity Centre, the research objectives were: 1) the characterization of the biodiversity; and 2) the analysis of different drivers of biodiversity loss, such as land consumption and landscape fragmentation, analyzed through landscape metrics, as well as climate change. The most significant results revealed a high level of fragmentation both within and outside the protected areas characterizing both BASs, especially in priority habitats falling outside the protected areas. This is confirmed also by the dynamics of land consumption, mainly due to urban sprawl, which erodes important and fragile ecosystems, leading to a consequent loss of habitats and ecosystem services. In addition to this local driver, climate change could exacerbate the negative consequences of these changes according to the different capacity of habitats to adapt to extreme events. It is therefore crucial to compare and analyze areas within and outside protected areas to identify gaps in conservation management and strengthen biodiversity conservation priorities also in the context of climate change. These factors contribute to the loss of biodiversity, impacting local environments and global ecological balances and human well-being, highlighting the urgent need for sustainable land management practices that reconcile development goals with environmental conservation.

On the role of agricultural landscapes for the improvement of the Natura2000 network: a multi-level approach for informing local Green Infrastructure planning

Simone Valeri, Eva Del Vico, Duilio Iamonico, Alessandro Montaldi, Giulia Capotorti
Department of Environmental Biology, Sapienza University of Rome; simone.valeri@uniroma1.it

The European Biodiversity Strategy for 2030 is triggering significant investments in Green Infrastructure (GI) for enhancing ecological connectivity, especially between EU Natura2000 (N2K) sites scattered across highly anthropized landscapes. In agricultural matrices, although GI actions can improve the role of agroecosystems in supporting N2K functionality, priority deployment needs are still poorly investigated across Europe. Since well-planned networks of natural and semi-natural linear elements (LE) could enhance biodiversity and connectivity, these elements are among the landscape features to be increased in agricultural lands. At a finer detail of investigation, LE themselves can be considered ecosystem subtypes with varying conditions, but a comprehensive methodology is still needed to assess their capacity to support biodiversity.
This study aims to address these gaps by (i) categorizing NUTS3 in W-Mediterranean Europe based on N2K network features, landscape composition, and environmental heterogeneity, (ii) identifying N2K-related GI deployment needs with respect to nodes (protected areas) and links (residual woody elements in arable land), (iii) proposing an assessment method for LE conditions focused on biodiversity-support capacity and based on different structural, compositional and landscape indicators, (iv) exploring extrinsic factors that potentially affect LE conditions (contiguity to protected habitats and governance frameworks), and (v) identifying key LE features to be restored. This landscape ecology approach allows challenges posed by land-use and climatic changes to be effectively addressed under a multi-level perspective. On the one hand, four GI deployment needs were identified and spatialized: restoring connectivity, consolidating node and link conservation, creating new protected areas, and expanding N2K sites. On the other hand, the proposed LE condition assessment method was tested in eight NUTS3 in Italy and Spain, where structural continuity was found to be the most important feature to be restored. The two levels of analysis are both useful for informing subsequent local actions aimed at N2K network improvement.

Misurare e prevedere il cambiamento degli ecosistemi montani ed estremi

Chairs

Marco Parolini, Antonello Provenzale, Ramona Viterbi

XXXIII Congresso S.It.E.

Roma 23-26 settembre 2024

Misurare e prevedere il cambiamento per una gestione sostenibile degli ecosistemi

S.It.E. - Società Italiana di Ecologia

Presentazioni Orali

Preserving alpine high-mountain lakes: threats, strategies, and research priorities

Antonia Concetta Elia[1], Marino Prearo[2], Elisabetta Pizzul[3], Marco Bertoli[3], Monia Renzi[3], Barbara Caldaroni[1], Ambrosius Josef Martin Dörr[1], Sara Futia[1], Paolo Pastorino[2,4]

[1]Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Via Elce di Sotto, 8, Perugia, Italia; [2]Istituto Zooprofilattico del Piemonte, Liguria e Valle d'Aosta, Via Bologna 148, Torino, Italia; [3]Dipartimento di Scienze della Vita, Università degli Studi di Trieste, Via L. Giorgieri 10, Trieste, Italia; [4]Centro di Referenza Regionale per la Biodiversità degli Ambienti Acquatici, Via Lino Maritano 22, Avigliana (TO), Italia; antonia.elia@unipg.it

Alpine high-mountain lakes, often considered scenic marvels, play critical roles as indicators of global environmental change, repositories of geological history, and vital freshwater sources. Despite their pristine and remote locations, these lakes face significant threats that modify their ecological equilibrium. Climate change, primarily through glacier retreats, shifts in water temperatures, and heightened UV radiation levels, poses a substantial risk. Furthermore, pollutants transported over long distances, the introduction of invasive species, rising water demand from Alpine storage power stations, and expanding tourism and recreational activities further heighten vulnerability, exacerbating habitat disturbance and environmental degradation.

This study underscores the crucial importance of Alpine high-mountain lakes, emphasizing the urgent need to address both established and emerging threats. It outlines future research priorities focused on developing comprehensive monitoring programs and proactive conservation measures, highlighting the necessity of understanding the ecological health of these ecosystems, evaluating environmental impacts, and formulating effective strategies. Integrating interdisciplinary approaches is essential to deepen our understanding and mitigate threats to high-mountain lakes, ensuring the preservation of their ecological integrity and natural heritage for future generations. Engaging local communities and citizen scientists enhances data collection, promotes stewardship, enriches scientific knowledge, and fosters community involvement in environmental conservation.

Elevation-dependent change in ERA5 precipitation and its extremes

Olivia Ferguglia, Elisa Palazzi, Enrico Arnone
Università di Torino, Italia; olivia.ferguglia@unito.it

Mountain regions are recognised as climate change hotspots. Increasing evidence from observations and model studies indicates that warming rates depend on elevation and often intensify with elevation, causing high-altitude environments to experience more rapid temperature changes than lower elevations. This phenomenon, known as Elevation-Dependent Warming, has been extensively studied due to its potential to accelerate transformations in mountain ecosystems, cryospheric systems, hydrological regimes, and biodiversity. However, fewer studies have examined the elevation-dependent changes of other climate variables, such as precipitation and its extremes (Elevation-Dependent Precipitation Change), that are as important as the temperature for high-altitude environments and downstream. Precipitation is crucial for mountain hydrological resources as its study in the context of climate change. Elevation and complex terrain significantly influence precipitation formation, contributing to the increase of extreme precipitation events. In this contribution, we present an analysis of the changes in mean precipitation and its extremes in ERA5 global reanalysis data in key mountain areas of the globe, along with their elevational dependence, from 1951 to 2020. The areas include the Tibetan Plateau, the US Rocky Mountains, the Greater Alpine Region, and the Andes, as representative of different latitudes and climatic influences. Our analysis reveals common patterns of elevation-dependent change in precipitation and its extremes in most of the mountainous areas, which emerge beyond their geographical differences. A positive elevational gradient of extreme precipitation trends is found in the Tibetan Plateau, the Greater Alpine Region, and the subtropical Andes, highlighting a wetting effect (positive trends) at very high elevations. In contrast, the Rocky Mountains exhibit a negative elevational gradient, with a drying effect (negative trends) increasing with the elevation. Mean precipitation, heavy (≥10 mm/day) precipitation and the length of consecutive wet days show a consistent elevation-dependent stratification within each of the study areas, suggesting possible common driving mechanisms.

Macrobenthic assemblages and the influence of microhabitat in a high-mountain lake (Northwest Italy)

Alice Gabetti[1,2], Camilla Mossotto[1,2], Alessandra Maganza[1,2], Giuseppe Esposito[1,2], Marco Bertoli[3], Barbara Rizzioli[4], Elisabetta Pizzul[3], Elena Bozzetta[1,2], Antonia Concetta Elia[5], Marino Prearo[1,2], Paolo Pastorino[1,2]

[1]Istituto Zooprofilattico del Piemonte, Liguria e Valle d'Aosta, Via Bologna 148, Torino (TO).; [2]Centro di Referenza Regionale per la Biodiversità degli Ambienti Acquatici, Via Lino Maritano 22, Avigliana (TO).; [3]Dipartimento di Scienze della Vita, Università degli Studi di Trieste, Via L. Giorgieri 10, Trieste (TS).; [4]Ente di gestione delle aree protette delle Alpi Cozie, Via Fransuà Fontan, 1, Salbertrand (TO).; [5]Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Via dell'Elce di Sotto 8, Perugia (PG).; alice.gabetti@izsto.it

High-mountain lakes are remote freshwater ecosystems with limited accessibility. These lakes host simplified biotic communities, primarily benthic macroinvertebrates in the littoral zone, which serve as bioindicators of environmental pressures. To better understand the specific processes within these ecosystems, it is recommended to evaluate them on a fine spatial scale. A two-year monitoring study was conducted in July 2022 and July 2023 at Nero Lake (2020 m a.s.l., Cesana Torinese, Northwest Italy). The monitoring of the lake evaluated three main aspects: the composition of littoral benthic macroinvertebrate communities, the differences in these assemblages between the two years, and site-specific factors influencing the macroinvertebrate community. Five sites along the lakeshore were selected for measuring physicochemical water parameters and sampling macroinvertebrates. Data collected were analyzed to compare trends across years and within specific sites. The results revealed that Nero Lake exhibited consistent macrobenthic communities across the two years studied, but significant differences were observed in its microhabitats. This suggests that substrate type and physicochemical water parameters influence community composition. Chironomidae larvae and Mollusca were the dominant species, showing distinct associations with different substrates and environmental factors between years. The variability observed in microhabitats indicates that even small-scale environmental fluctuations can have significant impacts on community structure, stressing the need for continuous and precise environmental monitoring. The study's findings contribute to our understanding of the relationships between benthic macroinvertebrates and their environments, highlighting the necessity of detailed, small-scale assessments to comprehend ecosystem dynamics and develop effective conservation strategies.

Climate controls on carbon cycling in alpine ecosystems

Silvio Marta[1], Marta Magnani[1], Gianna Vivaldo[1], Ilaria Baneschi[1], Alice Baronetti[1], Simona Gennaro[1], Mariasilvia Giamberini[1], Michele Lonati[2], Simone Ravetto Enri[2], Antonello Provenzale[1]

[1]Institute of Geosciences and Earth Resources (CNR-IGG), Italian National Research Council, via Moruzzi 1, 56127 Pisa (PI), Italy;
[2]Department of Agricultural, Forest and Food Sciences, University of Torino, largo Braccini 2, 10095 Grugliasco (TO), Italy;
silvio.marta@igg.cnr.it

Climate change affects natural and semi-natural ecosystems worldwide, with mountains experiencing even more drastic impacts due to elevation-dependent warming. High-elevation grasslands and alpine tundra act as regulators of the hydrological cycle, stabilise slopes and have a paramount role in nitrogen and carbon cycling. Owing to the very short snow-free season and the consequent adaptation of alpine plant to fast growth, alpine ecosystems mainly act as carbon sinks, with primary production usually exceeding ecosystems respiration. Combining timeseries of field (CO_2 fluxes and environmental variables; 3,590 single measurements - 5 sites), weather (daily precipitation and temperature), vegetation (PFT classification - 653 images) and remotely sensed data (CLr, NDSI, DEM) in the Nivolet area (Gran Paradiso NP, Italy), we investigated the environmental and climate controls on ecosystem respiration and primary production using structural equation modelling. We found GDD_0 (growing degree days since snowmelt) exerting a strong control on both respiration and production. The effect of GDD_0 on production is both direct, possibly reflecting the importance of cumulated heat on vegetation height, and mediated by the seasonal trend in greening (proxied by CLr). While greening had no effect on respiration, GDD_0 had a direct effect, supporting the view that ecosystem respiration was mainly microbial-driven and temperature-related. Summer cumulative precipitation proved to promote both respiration and production, at least until the phenological peak. Surprisingly, winter cumulative precipitation had no effect on production, and a negative effect on soil respiration, suggesting a direct effect on the cycling of organic matter rather than a contribution to the spring/summer water balance. Other variables (i.e., radiation, air temperature, soil moisture, PFT, topography) all supported our a-priori expectations or had no significant effect. Our results contribute to identify the causal relationships between climate and carbon cycling, allowing for a deeper understanding of the effects of climate changes on alpine ecosystems.

Carbon stock and soil microbial diversity dynamics following afforestation in Northeast Italy

Speranza Claudia Panico[1,2], Giorgio Alberti[1,2], Antonio Tomao[1], Riccardo Spaccini[3], Guido Incerti[1,2]

[1]Università degli studi di Udine, Italia; [2]National Biodiversity Future Center, NBFC; [3]CERMANU, Department of Agricultural Sciences, University of Naples Federico II; speranza.panico@uniud.it

Spontaneous afforestation of formerly man-used land has increasingly been considered as a Nature-Based Solution to mitigate climate change. Besides obvious C sink above ground, afforestation leads to low soil pH, high C:N ratios and changes in litter and soil organic matter (SOM) quality with beneficial implications for soil carbon sequestration. However, less is known about the effects on soil microbial communities, which may play a crucial role as a controlling factor for nutrient cycling, SOM stabilization and soil fertility. The aim of this study, within the framework of Task 4.2.1 of Spoke 4 of the National Biodiversity Future Centre (NBFC), is to investigate the dynamics of carbon stocks and soil microbial diversity following afforestation in Julian Pre-Alps (Taipana, UD) using a space-for-time approach. Orthophotos were used to identify and date the successional stages spanning 70 years from grassland to forest.Organic C pools including soil, living trees, standing and lying dead wood and litter, as well as main physical-chemical properties including fine C molecular composition by 13C-CPMAS NMR, were measured, and fungi and bacteria community diversity was assessed by soil DNA metabarcoding.Aboveground C stock increased from 8.42 ± 0.91 tC ha^{-1} in grassland, to 158.98 ± 23.85 tC ha^{-1} in the oldest stands. Soil C stock, after initially decreasing from 63.62 ± 15.4 tC ha^{-1} in grasslands to 47.74 ± 3.34 tC ha^{-1} in shrubby sites, significantly increased along the successional process, reaching 78.44 ± 19.42 tC ha^{-1} in mature forest. Microbial α-diversity substantially differed between bacterial and fungal communities, with the formers progressively declining while fungi showed a bell-shaped response peaking at intermediate successional stage (34 years).These findings open interesting perspectives for the management of rewilding dynamics suggesting alternative scenarios targeting either climate change mitigation and/or ecosystem resilience, with the latter strictly associated to the functional redundancy of microbial diversity.

Chemical pollution in high-mountain Alpine lakes: sources, impacts, and research insights

Paolo Pastorino[1,2], Antonia Concetta Elia[3], Marco Bertoli[4], Elisabetta Pizzul[4], Monia Renzi[4], Elena Bozzetta[1,2], Marino Prearo[1,2]

[1]Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Italia; [2]Centro di Referenza Regionale per la Biodiversità degli Ambienti Acquatici, Via Lino Maritano 22, Avigliana (TO); [3]Dipartimento di Chimica, Biologia e Biotecnologie, Università degli Studi di Perugia, Via dell'Elce di Sotto 8, Perugia.; [4]Dipartimento di Scienze della Vita, Università degli Studi di Trieste, Via L. Giorgieri 10, Trieste.; paolo.pastorino@izsto.it

High-mountain lakes in the Alps, despite their remote locations, are vulnerable to chemical pollution. This presentation examines these lakes as repositories for Persistent Organic Pollutants (POPs) and Contaminants of Emerging Concern (CECs), highlighting their sources and impacts on both the environment and human health. Fourteen studies have explored POPs in these lakes, focusing on substances such as polychlorinated biphenyls, DDT, and its metabolites, polybrominated diphenyl ethers, and polycyclic aromatic hydrocarbons. Most research on POPs in high-altitude lakes is concentrated in the Italian Alps (63%), with further studies conducted in Switzerland (22%), Austria (12%), and France (3%). The primary focus is on sediments (65%), followed by fish (33%) and water (2%). In terms of CECs, six studies have investigated the presence of musks, perfluorinated compounds, and microplastics. These studies are mainly conducted in Switzerland (42%), France (33%), and Italy (25%), with fish samples (46%) being the primary focus, followed by sediment (17%) and water (17%). Other compartments like zooplankton, frogs/tadpoles, and snow are less frequently studied. This presentation also covers the pathways through which pollutants reach these remote lakes, including atmospheric transport, glacial meltwater, and human activities. Protecting these pristine environments requires continuous research, vigilant monitoring, and dedicated conservation initiatives.

Freshwater diatom diversity from Mediterranean and Alpine temporary ponds: status, trends, and new insights for conservation

Davide Taurozzi[1], Massimiliano Scalici[1,2]

[1]Department of Sciences, University of Rome Tre, Viale Guglielmo Marconi 446, 00146 Rome, Italy; [2]National Biodiversity Future Center (NBFC), Università di Palermo, Piazza Marina 61, 90133 Palermo, Italy; davide.taurozzi@uniroma3.it

Temporary Ponds (TP) represent critically endangered habitats, declining in number and hydroperiod length throughout the whole of their Italian range. Knowledge of diatom community structure, ecological preferences and distribution patterns help us to determine the conservation status and the influences of environmental variables on TP. Here, we link diatom community structures, environmental variables and geographical constraints to quantify the changing influence of hydroperiod length on diatom community structure of 6 ponds across an altitudinal gradient, from the Tyrrhenian coast to the Italian Apennines. Over twelve months of samplings, we found that alpine ponds hydroperiod is limited to five months (June – October). Based on a comprehensive data set of 72 samples from 6 TP, we showed that the factors best explaining benthic diatom community structures were electrical conductivity, pH and altitude. The results revealed how "motile" diatoms showed the best adaptations to the typical droughts of TPs. Moreover, low-altitude diatoms live in assemblages largely structured by interspecific competitive interactions, while alpine ponds are mainly structured by aggregation patterns. Of over 150 diatom species identified, approximately 15% are also included in the Red List of endangered species. Overall, alpine ponds show less species richness than Mediterranean ponds. Short hydroperiods can influence diatom communities. We hypothesize that the restricted dry phase typical of Alpine ponds didn't allow the community stabilization, favoring the settlement of first-stages pioneers species. Moreover, using diatom species ecological sensitivity values and a set of environmental factors combined in the EPI-D diatomic index, average good water quality was described for the ponds, highlighting better values for Mediterranean ponds.

This study contributes to increase awareness on conservation of this neglected habitats and will aim to inform future environmental legislation by understanding the hidden ecological importance of ponds and diatoms suitability for temporary freshwater biomonitoring.

Posters

Irrigation and drought stress effects on CO2 exchange in mountain ecosystems: the Levionaz (Gran Paradiso National Park) case study

Silvana Beatriz Goiran[1], Gianna Vivaldo[1,2], Alice Baronetti[1], Michal Krupiński[3], Edyta Woźniak[3], Ilaria Baneschi[1,2], Mariasilvia Giamberini[1], Brunella Braco[1], Michele Lonati[4], Antonello Provenzale[1,2]

[1]Institute of Geosciences and Earth Resources of the National Research Council (CNR-IGG), via G. Moruzzi 1, 56127 Pisa, Italy; [2]National Biodiversity Future Center (NBFC), Piazza Marina 61, 90133 Palermo, Italy; [3]Centrum Badań Kosmicznych PAN, ul. Bartycka 18a, 00-716 Warszawa, Poland; [4]Department of Agricultural, Forest and Food Sciences, University of Torino, largo Braccini 2, 10095 Grugliasco (TO), Italy; silvana.goiran@igg.cnr.it

In the context of climate change and sustainable development, under the crucial perspective of an increasing pressure from human impacts, long-term conservation of mountain areas is a key strategy to improve ecosystem resilience to global warming.

In the present study we evaluated the role of water availability on CO_2 fluxes exchange, net ecosystem exchange (NEE), ecosystem respiration (ER) and gross primary production (GPP) in the Levionaz Plain, a high mountain grassland located in the Gran Paradiso National Park (Italian Alps). CO_2 fluxes were measured by the accumulation chamber method, and soil volumetric water content (VWC) was used as proxy for water availability. Fluxes responses to different hydric regimes were established by comparing artificially irrigated (IN) and not irrigated (OUT) plots during two different years (2022, 2023), which showed different drought conditions. In particular, we detected that in 2022 was the most severe drought event recorded in the last 17 years.

Results revealed that under drought conditions, water availability plays a key role in the ecosystem exchange of CO_2. ER and GPP fluxes showed different responses in the two plots, with GPP most affected, and with significant differences detected in 2022, where higher values were measured in the IN plots for all fluxes. In 2023, only GPP and NEE showed significant differences between IN and OUT areas, while ER was not sensitive to irrigation. Generalized linear models highlighted that VWC was a dominating driver in the driest 2022 for both ER and GPP, but not in 2023. GPP demonstrated high sensitivity to VWC over the two evaluated years, being the response to water availability in the driest 2022 more pronounced than that of ER.

This study provides insights for managing alpine grassland, suggesting that strategic, low-level irrigation during droughts can sustain productivity, offering a conservation strategy to mitigate extreme drought impacts.