S.It.E. - Società Italiana di Ecologia

Capitale Naturale: la Gestione per la Conservazione

XXIX Congresso Nazionale S.It.E

(Società Italiana di Ecologia)

Ferrara, 10-12 Settembre 2019

SItE FERRARA 2019

Università degli Studi di Ferrara

Patrocinato da:

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Non solo il nostro benessere ma anche la nostra sopravvivenza dipendono dal mantenimento del Capitale Naturale e dei Servizi Ecosistemici a questo connessi. Dopo circa mezzo secolo di impegno per la Conservazione Ambientale, i risultati ottenuti in termini di mantenimento di Capitale Naturale non sono certo lusinghieri e la perdita di diversità biologica continua a tutti i livelli, con modalità che sembrano inarrestabili e con tempi sempre più rapidi.

Per questo, con sempre maggiore forza, si pone la necessità di un cambiamento nel paradigma della Conservazione della Natura: da facoltativa a necessaria, da "freno dello sviluppo" a valore aggiunto nelle dinamiche gestionali, nuovo baricentro di una più realistica definizione di sostenibilità.

Spetta agli Ecologi il recupero e la creazione di modelli culturali e operativi ampiamente condivisi, in cui la Gestione degli ecosistemi sia essa stessa la garanzia della Conservazione del Capitale Naturale.

Poiché il Capitale Naturale è inteso come la componente strutturale biotica ed abiotica e funzionale degli ecosistemi, abbiamo voluto declinare la sua importanza proprio a livello ecosistemico, pertanto le sessioni proposte mirano a far emergere le peculiarità degli ecosistemi e delle metodologie gestionali e conservative da applicare in essi per mantenerli in buona qualità ecologica.

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Un ringraziamento speciale va alla sig.na Oana Stepan, al dott. Mattia Lanzoni e al dott. Marco Milardi per la parte grafica e al sig. Massimo Sandri per il supporto informatico.

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Sessione 1:
Capitale Naturale, Well-being e Stress Ecology

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Capitale Naturale e Benessere

Partendo dal concetto di Benessere Equo e Sostenibile (BES) nel DEF (Secondo rapporto sullo stato del capitale naturale in Italia - 2018) e dagli indicatori BES/ISTAT lì legificati, si ragionerà sul concetto di Benessere tanto nelle sue accezioni correnti che in quella OMS di “stato di completo benessere fisico, psichico e sociale e non semplice assenza di malattia”. Si eviteranno le visioni dominanti di riduzionismo medico, che non di rado propone la condizione di malattia come esclusivamente causata da agenti patogeni o disfunzioni organiche, separando la salute individuale dal contesto ambientale locale, tenendo perciò conto della permeabilità dell’esistenza umana.
In particolare, si guarderà al benessere come prodotto di una storia naturale darwiniana, modellato da fattori tanto fisici quanto sociali, passando in rassegna le principali teorie (SRT, ART, mediazione delle opinioni). Fenomeni di accentuata fragilità psicofisica, mancato o ridotto coping allo stress, ansia, depressione, ecc… saranno letti in funzione di una insufficiente e poco interattiva gestione individuale degli stimoli prodotti dal contesto ambientale naturale, passando in rassegna alcuni degli studi e delle metanalisi più convincenti nel settore della Sanità Pubblica e della salute ambientale. In generale si toccheranno spunti sull’associazione dello spazio verde urbano sulla salute mentale e la salute generale sia in adulti sia in bambini, anche quelli affetti da sofferenza psichica da lieve a severa, iperattività, problemi emotivi, di condotta e di alterato comportamento prosociale.

S1.1 Impact of nanoplastics on marine diatom *Skeletonema marinoi*: particles adhesion, ROS production and reduction of colonies length

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Marine diatoms are among the most abundant taxa of microorganisms associated to plastic fragments found in the marine environment. However, few information is current available concerning the impact of smallest plastic fragments, named nanoplastics, at both single cell and assemblage level. The aim of the present study was to investigate the impact of 70 nm polystyrene nanoparticles (PS NPs) functionalized with carboxylated groups (–COOH) to the marine diatom *Skeletonema marinoi*. PS NPs behaviour and surface charge in exposure conditions were characterized by dynamic light scattering (DLS), while impact on growth was investigated through a 15-days toxicity test, as well as the induction of reactive oxygen species (ROS). The interaction between microalgal cells and PS NPs was assessed by environmental scanning electron microscopy (ESEM), transmission electron microscopy (TEM), and interference contrast microscopy, using different sample preparation procedures. Furthermore, an analysis of *S. marinoi* colonies length upon PS NPs exposure was performed. Results showed no inhibition of growth under all tested PS NP concentrations (1, 10, 50 μg/mL) but a significant increase of both extracellular and intracellular ROS was observed. TEM images revealed PS NPs adhesion to diatoms external surface, mainly localized at fultoportula process (FPP), the structure responsible for linking cells to one another to form colonies. *S. marinoi* colonies length resulted significantly reduced upon PS NPs exposure probably as a consequence of PS NPs adhesion. The comparison of different imaging techniques to observe diatoms-NPs interaction highlighted how current methods might alter the interaction occurring in natural conditions between PS NPs and biota. PS NPs-diatoms adhesion could have serious implication at assemblage level by impairing diatom's buoyancy as well as at community level due to their trophic transfer up to the food chain.

S1.2 Nanoplastics impair Antarctic krill physiology with potential consequences on the biological carbon pump in the Southern Ocean

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Under current climate change scenarios, Antarctic organisms are facing multiple stressors that affect their survival, abundance and distribution as well as alter biological processes at the community and ecosystem level. Plastic debris has been recently identified as a potential threat to this remote region, being reported in Antarctic surface waters and sediments. However, studies showing the impacts of plastics ingested by Antarctic organisms are still limited. Antarctic krill (*Euphausia superba*) is a keystone species of Southern Ocean pelagic ecosystems, which dominates Antarctic food webs and, through the sinking of faecal pellets (FPs), contributes to the carbon flux to the deep ocean. Antarctic krill has been shown to ingest microplastics with limited acute toxicity, but digestive fragmentation into nanoplastics (< 1 µm) has been observed. In this study we investigated the effects of polystyrene nanoparticles (PS NPs) having different surface charge on Antarctic krill juveniles through short-term exposure (48 h). The suspensions of anionic (60 nm PS-COOH) and cationic (50 nm PS-NH_2) NPs in Antarctic sea water (SW, 34‰, 2°C) were analysed by Dynamic Light Scattering: PS-COOH formed nanoscale aggregates (average size of 862 nm) in SW, while PS-NH_2 maintained their nominal size. No significant mortality was observed after 48 h, although krill exposed to PS-NH_2 showed lower motility than individuals exposed to PS-COOH and were characterised by significant up-regulation of *cb6* gene involved in new cuticle formation. Similar findings reported for other microcrustaceans have been associated with mortality over long-term exposure. Both PS NPs were also present in krill FPs, characterised by lower density and sinking rate compared to control. Our findings demonstrate that PS NPs lead to significant physiological alterations in Antarctic krill, with potential large-scale detrimental effects on Antarctic food webs and biological carbon pump in the Southern Ocean.

S1.3 Micro - and nanoplastics in freshwaters: new emerging contaminants?

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Plastics are now one of the main challenges in the environmental management since the solution or more probably mitigation of the problem affects the lifestyle and habits of each of us. When in the environment, the macroplastics items were fragmented into smaller plastic particles by mechanical abrasion, photodegradation, oxidation, hydrolytic degradation. The fragmentation creates micro- (MPs) and then nanoplastics (NPs), which are recently redefined in two size categories: MPs with a size range 1<1000 μm and NPs between 1 nm and <1000 nm. There are several gaps of knowledge about the characterization of MPs and NPs in aquatic ecosystems, but mainly to evaluate the potential (eco)toxicological risk associated to them. Indeed, toxicological effects are linked both to their intrinsic toxicity, but also to the effects of additives, such as plasticizers, and the plethora of chemical pollutants adsorbed on their surface during their stay in the environment.

Although the plastic items from terrestrial sources contribute to 80% of the total plastic debris that reach marine ecosystems, only few studies were conducted in freshwaters. Thus, we showed an overview of our studies carried out both at laboratory and in field to evaluate the fate, behavior and toxicological effects made by MPs and NPs. In details, we performed several experiments to investigate the capability of these emerging contaminants to be ingested and to infiltrate in the tissues of an invertebrate (*D. polymorpha*) and vertebrate (*D. rerio*) by using a biomarkers' suite and advanced microscopy. Moving to field studies, we investigated the presence of MPs through one of the bigger Italian wastewater treatment plants and we performed the ecotoxicological evaluation of MPs sampled in the four great Italian subalpine lakes.

The entire dataset obtained from these studies represents a starting point to answer the question about the hazard associated to MPs and NPs.

S1.4 Evaluation of the ecotoxicological stress induced by anthropogenic contaminants in *Apis mellifera*

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A rapid decline of *Apis mellifera,* a keystone pollinator of wild plant species and agricultural crops, was recorded worldwide in recent years. The massive use of pesticides in agriculture associated with pollution generated by other human activities and presence of parasites, can cause toxicological effects in bees including a decrease of the immune defenses, leading to collapse of the colonies. In order to adequately monitor these pollinating organisms, it is necessary to develop and apply highly sensitive and integrated ecotoxicological investigation methods. The aim of this study was to develop and apply a set of ecotoxicological biomarkers to study the effects of environmental contaminants on bees. In a first phase we investigated in the laboratory the effects of EMS, cadmium and a commercial fungicide (Amistar®xtra) in adult honey bees, evaluating eventual variation in glutathione S-transferase (GST) and acetylcholinesterase (AChE) activities, erythrocyte nuclear abnormalities (ENA) assay and differential haemocytes count (DHC). Genotoxic effects as well alteration of the immune system were found in bees treated with EMS, cadmium or the fungicide. Cadmium and Amistar®xtra also inhibited AChE activity, GST was induced by the fungicide and by EMS. In a second phase adult honey bees were collected from apiaries located in four environments characterized by different chemical input: a wooded environment (low input), an urban site, an orchard and a cultivated countryside site. ENA assay showed that bees taken from the countryside and the orchard had a greater number of abnormalities compared to the forest, confirming the presence of genotoxic substances in agricultural environments compared to control environments. GST was induced in bees from the urban environment, AChE was found to be inhibited in the countryside compared to the forest, suggesting the presence of substances with neurotoxic effect in this environment.

S1.5 Tracking responses to environmental stressors with video analysis: examples from planktonic organisms

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Nowadays, several ecosystems experience an unprecedented crisis because of multiple stressors affecting their functionality. Extreme hydroperiod fluctuations, increase in pollutants and temperature are just a few examples of the stressors affecting freshwater ecosystems on a global scale. Understanding how communities respond to environmental stress is crucial to the management of disturbed ecosystems. The behaviour of an organism is a functional trait that often changes as response to a changing environment, and thus can be used as an early warning signal. Behaviour is easy to observe and record on video, and its basic movement parameters can be quantified with great detail. In this context, video analysis represents a modern tool for the study of stress ecology. Nevertheless, the study of behaviour is often neglected in microscopic organisms such as algae, rotifers, or microcrustaceans. This contribution introduces the analysis of behaviour from videos by bringing examples from different freshwater phyto and zooplankton species.

S1.6 Selecting indicator species for ecological risk assessment of nanoplastics in the marine environment

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The use of indicator species has become a standard monitoring approach in environmental risk assessment of legacy and emerging pollutants, however whether their selection is explicit about their ability to assess environmental impacts at the ecosystem level is still challenging. Since nanoplastics have been documented in the colloidal fraction of seawater in the North Atlantic subtropical gyre, an evaluation of their potential adverse effects on marine ecosystems is urgently needed. Owning such a small size (<1µm), nanoplastics end up to be buoyant and easily taken up by planktonic species, which could be directly impaired through cellular uptake or in turn could transfer them to predators through gut retention and/or body adhesion. In the present study, we present an overview of our major findings on nanoplastic impact on marine species belonging to different trophic levels and having key ecological roles in Mediterranean marine ecosystems. Polystyrene, abundant in marine litter and used as a model nanoplastic, has been found to cause mild to severe toxicity at cellular, organism and population level, often correlated to nanoplastic surface properties and their transformations in seawater. Impairment of green algae growth and diatom assemblages, disruption of embryonic and larval development of zooplanktonic, benthic grazers and filter-feeders species, which will end up to lethality in long-term exposure scenarios have been documented. Nanoplastics transformation in seawater and interaction with marine biota have been recognized as a major driver affecting their behaviour, fate and ultimate toxicity. Our results represent a first attempt to assess ecological impact of nanoplastics in the Mediterranean Sea. Understanding how the interactions occurring at the nano-bio interface affect nanoplastic fate and toxicity will improve the selection of the most suitable indicator species for future monitoring, management and mitigation strategies of such emerging pollutants in the marine environment.

S1.7 A comparison of biochemical and behavioural effects induced by cocaine and methamphetamine exposure to *Daphnia magna*

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In recent years illicit drugs have been identified as emerging aquatic pollutants. After human use, illicit drugs are excreted as metabolites or in their native form and enter the aquatic ecosystems, where are commonly measured in concentrations that might represent a threat to the health status of non-target organisms. Among these molecules, cocaine (COC) and methamphetamine (METH) are stimulants of special concern: COC is one of the most used illicit drug in Europe, while METH shows a worrisome increasing use trend worldwide. Both these molecules are found in both sewage and surface waters up to concentrations in the ng/L range and, considering their high biological activity, they might induce toxic effects towards aquatic organisms. However, at present the information regarding the potential toxicity of COC and METH towards aquatic species is still scant. Thus, the present work aimed at investigating and comparing the toxicity induced by 21-days exposure to two concentrations (50 ng/L and 500 ng/L) of COC and METH on the cladoceran *Daphnia magna*. Toxicity was assessed at both biochemical and behavioral level. In detail, the effects at biochemical level were focused on the onset of an oxidative stress situation by measuring the level of reactive oxygen species (ROS), the activity of antioxidant (SOD, CAT and GPx) and detoxification (GST) enzymes, as well as the levels of lipid peroxidation (LPO). Changes in swimming activity, in terms of distance moved and swimming speed measured through a video-tracking analyses, and in reproductive effort (i.e. 21-days reproduction chronic toxicity test) were uses as behavioral endpoints. Our results showed different, often contrasting, responses of *D. magna* specimens for different endpoints, suggesting that at the same concentration, COC was more toxic than METH.

S1.8 Environmental biomolecules affect the fate and toxicity of Cerium oxide nanoparticles for aquatic biota

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The ongoing development of nanotechnology have raised several concerns regarding the potential risk of nanoparticles (NPs) for the environment, in particular the aquatic ecosystems. In the framework of a need to properly predict environmental implications of NPs, an emerging challenge is to address the complex dynamic of physicochemical and biological processes that drive NPs toxicity once they are released into natural matrices. Therefore, the objective of this study was to perform an ecotoxicological evaluation of CeO_2NPs with different surface modifications, representative of NPs bio-interaction with molecules naturally occurring in water environment, to identify the role of biomolecule coating on nanoceria toxicity for aquatic organisms. Ad hoc synthesis of CeO_2NPs with different coating agents such as Alginate and Chitosan was performed, and the NPs were fully characterized. The marine bacteria *Aliivibrio fischeri*, the freshwater crustacean *Daphnia magna* and the freshwater bivalve *Dreissena polymorpha* were used as biological models to test the different ecotoxicity of the CeO_2NPs. Several endpoints were evaluated at different level of biological organization, from the molecular to the entire organism. Overall results show that the different coating affects the hydrodynamic behavior of CeO_2NPs in exposure media. The different coating influenced also significantly the toxic effects of CeO_2NPs in species-specific way. Specifically, in *D. magna* none of the CeO_2NPs triggered a significant oxidative stress, but behavioral assay showed that CeO_2NPs coated with Chitosan determined hyperactivity. In zebra mussel the CeO_2NPs coated with Alginate affected significantly the antioxidative stress machinery. Our findings emphasize the role of environmental modification in determining the NP effects on aquatic organisms.

S1.9 Predicting vertical movement of PCBs in contaminated soil: evaluation of bioavailability, leaching and bioremediation potential

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Among the national priority polluted sites, the SIN Brescia Caffaro is located in a mid size city Brescia, (200,000 inhabitants) in northern Italy. The site derived from the activity of the former Caffaro s.p.a., a chemical factory among the largest former polychlorinated biphenyls (PCBs) producer in Europe, which produced such chemicals for more than 50 years up to mid 80'. About 100 Ha of agricultural areas were contaminated by a mix of Persistent Organic Pollutants (POPs, mostly PCBs, dioxins, furans) and heavy metals (Hg, As) in variable concentrations, often exceeding the safety values. Contamination mostly resulted because of runoff irrigation with contaminated waters. PCBs were measured in three different agricultural areas and in three different points per area, in vertical cores up to 1 m depth. The resulting samples were representative of 0-10, 10-20, 20-30, 30-40, 40-60, 60-80, 80-100 cm. The results of concentration measurements with depth (for about 80 PCB congeners) confirmed a general tendency of PCBs to be confined to the upper 40-60 cm (depending on the congener). For example, in field A, PCB 28 ranged from 150 to 250 µg/kg in the top 30 cm to about 0.6 µg/kg at 1 m depth; PCB 209 (peculiar of Caffaro production) ranged from 15000 to 13000 µg/kg in the top 30 cm, descending to about 13 µg/kg at 1 m depth. These concentrations of PCBs were then compared to those obtained by a modified version of the the SoilPlusVeg model (a multilayered dynamic multimedia fugacity model) and used to predict discharge amounts and conditions regulating vertical movement. The objective was to reconstruct soil concentration profile during the historical contamination to predict discharged amount, potential for additional vertical movement, and conditions regulating chemical bioavailability for future PCB rhizoremediation.

S1.10 Polystyrene nanoparticles disrupt embryogenesis of ascidian *Ciona robusta*

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Ciona robusta is a solitary ascidian that inhabits shallow waters and marine coastal areas. This species has been recently adopted as valuable biological models for ecotoxicity studies, thanks to its rapid embryonic and larval development and resemblance to vertebrates.

In recent years, plastic pollution has been recognized as an emerging threat for marine environment and embryo and larval stages of marine invertebrates species might be a potential target of smallest particles as nanoplastics. The present study aims at investigating the effects of model nanoplastics, as polystyrene nanoparticles (PS NPs), on the embryogenesis of the tunicate *Ciona robusta*. PS NPs, owing negative and positive surface charges, respectively as carboxylated (PS-COOH) and amino-modified (PS-NH2), were tested for 22 h in the range of 0-100 µg/mL. Embryotoxicity was assessed as percentage of larvae developed and their morphology compared to controls (sea water). Furthermore, PS NPs behaviour in sea water media was characterized, in order to link the exposure to any potential effect. The results indicate that negative charged PS (-COOH), which form micro-aggregates once dispersed in sea waters, show no sign of embryotoxicity up to 100 µg/mL. Conversely, positively charged PS (-NH2), which result still in nanoscale dimension in sea water, significantly compromise hatching and larval development even at the lowest tested concentration (1 µg/mL). Our preliminary findings support the hypothesis that nanoplastic surface charges are drivers of toxicity in seawater and ascidian embryos could be a sensitive target of nanoplastic exposure. Disruption of cholinergic function and/or other pathways of embryonic development are currently investigated at physiological and gene expression levels, in order to identify the mechanisms of toxicity of nanoplastics in a chordate model system.

S1.11 An integrated approach to assess the effects of particulate matter on functional traits of *Quercus ilex* L. in an urban area

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Fine and ultrafine particulate matter (PM) pollution have become one of the main environmental concerns in our cities, affecting human health and wellbeing. Recently, increasing attention has been given to the ameliorating role on air quality exerted by Green Infrastructures (GI), that can play a relevant role as Nature Based Solutions for PM removal. On the other hand, PM can affect the functionality of vegetation and, accordingly, its capacity to provide Ecosystem Services. This work proposes an integrated approach to evaluate how PM exposure can affect the functional traits of *Quercus ilex* L., selected as a target species for its widespread use in the urban green of Mediterranean regions. Leaves of *Q. ilex* were sampled in eight sites of the metropolitan area of Rome (Italy), selected as different GI elements and characterized by different levels of vehicular traffic, including peri-urban forests as control sites. Physiological traits derived from chlorophyll *a* fluorescence (ChlF) were assessed together with leaf magnetic properties, used to characterize the magnetic fraction, of anthropogenic origin, of the PM accumulated by leaves. Oxidative potential assays were also performed on aqueous extracts of the PM adsorbed. ChlF highlighted that photosynthetic functionality decreases with increasing of magnetic susceptibility in the sites with higher PM exposure. These were also the sites where the oxidative potential reached the highest values. Among the considered functional traits, the effective energy dissipation by active reaction centers of Photosysthem II, and the photosynthetic Performance Index (PI) could be used as a functional marker of oxidative pressure due to PM. Our results suggest that the functional impairments caused by PM on plants in urban areas, can affect the regulating Ecosystem Services provisioning.

S1.12 Nanoplastics and their ecological impact on marine biota: new biological identities acquired upon exposure to the sea urchin *Paracentrotus lividus* coelomic fluid

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Plastic pollution is a well-recognized threat to aquatic ecosystems health. There is substantial evidence that a wide range of biotic and abiotic processes taking place in fresh and marine environments break discharged plastic debris into micro- and nanosized fragments. Therefore, polystyrene nanoparticles (PS NPs) are considered an upcoming risk to marine ecosystems. When NPs encounter biological fluids, they are readily covered by a biomolecular coating formed by biomolecules in the surrounding milieu, named "protein corona", which critically drives NPs biological fate and toxicity. Hence, to get a comprehensive picture of PS NPs ecological impacts it is of primary importance to characterize protein corona on such NPs. Here we provide a first attempt to identify key components of protein corona of charged amino- and carboxyl-functionalized (PS-NH_2 and PS-COOH, respectively) PS NPs exposed to coelomic fluid (CF) of the Mediterranean Sea urchin *Paracentrotus lividus*. The formation of protein coronas conferred identical colloidal features to both positively and negatively charged PS NPs, which acquired a negative ζ potential and monodisperse size distribution in sea urchin CF. Proteomic analysis revealed striking functional analogies of proteins identified from NP-coronas, especially entailing the potential to promote cell association and internalization of both NP types, as mediated by adsorbed protein species. Such basal findings strengthen the importance of NPs biological identity in the evaluation of ecotoxicological potential of polymeric NPs, as a way to evaluate their ecological impacts in marine ecosystems.

S1.13 An ecologically-based approach using marine mussels for testing the efficacy of nanostructured cellulose sponges for Zinc removal from seawater

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Despite the growing interest in nanotechnologies for marine pollution remediation, potential impacts associated with the use of nanomaterials on marine ecosystem have been underestimated so far. To promote the applicability of ecofriendly and sustainable materials and avoid any unexpected toxic side effects for marine biota, an ecologically-based approach has been developed using marine mussels to test the eco-safety and efficacy of newly developed smart materials. A novel nanostructured cellulose-based sponge (CNS), developed within an eco-design study, has been tested for their ability to remove zinc from seawater. Mediterranean filter-feeder *Mytilus galloprovincialis,* well known for showing clear biological responses to heavy metals exposure has been selected. Specimens were *in vivo* exposed for 48h to Zn (10 mg/L), CNS alone and CNS-treated Zn contaminated seawaters (CNS t-Zn), while only seawater was used for controls. A highly significant removal of Zn was observed in CNS t-Zn with levels within an order of magnitude lower than those present in treatment waters. Lysosomal membrane stability and micronucleus frequencies resulted significantly affected by Zn exposure while no differences with controls were observed in haemocytes of mussels exposed to CNS t-Zn as well as CNS alone. Mantle of mussels exposed to Zn resulted clearly damaged with the edge almost lost and absent/wilted siphons. Upon exposure to CNS t-Zn waters, mantle of mussels appeared distended and vigorous resembling the normal morphology as observed in controls and CNS alone. Histological analysis confirmed the Zn damage on mantle's epithelium associated with an increased production of acidic mucosubstances respect to the neutral ones. While in controls, CNS t-Zn and CNS alone, both acidic and neutral mucosubstances were present. Our study thus demonstrate that marine mussels are suitable model for testing the efficacy of nanostructured materials for seawater remediation.

S1.14 Occurrence and ecotoxicological effects of microplastics in the River Lambro (Northern Italy)

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Microplastics, recently re-defined as plastic debris ranging between 1 mm and < 1 mm, represent an emerging issue in all environmental compartments, principally due to the ongoing trend of plastic production and use, followed by their uncorrected disposal. Even if marine ecosystems represent the final compartment for (micro)plastics' accumulation, the inland waters contribute for the 80% to the transport to sea. However, few information about the concentration and impact of microplastics in freshwaters are available. For this reason, the aim of this study was the monitoring and the evaluation of ecotoxicological effects of microplastics collected along the River Lambro that crosses through one of the main Italian urbanized and industrialized areas. Considering that River Lambro receives the effluents of more than thirty wastewater treatment plants, we sampled the water surface in five stations along the river course, until its inlet in the River Po, to map the distribution of microplastics. We used two plankton nets (300 µm mesh) to collect simultaneously floating microplastics in the river both for the quali-quantitative evaluation of microplastics and to investigate the potential effects of the mixture composed by the microplastics and chemicals adsorbed on their surface. Collected debris were separated from the huge amount of organic matter and then characterized in terms of color, dimension, shape and chemical composition, using the Fourier Transform Infrared Spectroscopy equipped with µATR (µFT-IR). The ecotoxicological effects of collected microplastics were evaluated on the freshwater zebra mussel *Dreissena polymorpha* using a biomarkers' suite able to evaluate cellular stress, oxidative damage, geno- and neurotoxicity, covering different levels of the biological organization. Lastly, we also evaluated the uptake of these contaminants in bivalves by the µFT-IR to characterize the microplastics infiltrated in the mussel tissues.

S1.15 Green Infrastructure for mitigating the Urban Heat Island in the Municipality of Rome (Italy): an Ecosystem Services perspective

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Urban areas are characterized by high concentrations of economic activities, employment and wealth, but this is often accompanied by a high environmental impact. Urbanization modifies land cover, affecting matter and energy flow in urban ecosystems, being thus one of the main drivers of the Urban Heat Island (UHI) effect. UHI not only affects directly human health and well-being of the city dwellers, particularly during heat waves, but also contributes to worsen environmental quality. In this work, the Ecosystem Service (ES) of climate regulation provided by Green Infrastructure (GI) has been analyzed in the Municipality of Rome, Italy, in a spatially explicit way and on a seasonal basis. The cooling capacity of different GI elements, and the effect of vegetation cover and tree diversity on the provision of this regulating ES, have been assessed. A land-cover-driven approach was used to calculate UHI indicators from air temperature in the 2013-2017 period, and the seasonal Land Surface Temperature (LST) was modelled, based on Landsat-8 OLI/TIRS images and an emissivity map. The mitigating role of urban and peri-urban forest and street trees was then evaluated through a LST buffer analysis. Finally, a multiple-linear regression model was applied to investigate how land cover features affect LST. GI significantly mitigates the hot summer climate, with an effect that is dependent on the GI element and the environmental constrains to which it is exposed. NDVI and tree cover were the main indicators of the provision of the ES of climate regulation, highlighting that GI elements such as urban and peri-urban forests have the highest potential to provide this ES in a Mediterranean city. Our results lend support to claims that GI is important for an ecosystem-based climate adaptation strategy in urban environments, contributing to the definition of criteria and indicators for decision-making in Mediterranean cities.

S1.16 Purple spot biodeterioration on ancient parchments and red heat deterioration on Chrome(III) tanned leathers are triggered by the same pioneer organisms, the haloarchaea

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Animal rawhides are used for many purposes since ancient times. The peculiar properties that enable their wide application mostly derive from their molecular structure, mainly composed of collagen. Nevertheless, collagen represents a good food source for microbes, often responsible of biological attack and good deterioration.

Biodeterioration has been studied on an ancient rawhide product, historical parchments, where a common alteration is due to isolated or coalescent purple spots. An ecological succession explained this purple spot deterioration, showing *Halobacterium salinarum* as the pioneer colonizator and main culprit of the damage. A heterotrophic microbial succession is the colonization model, the marine salt used to preserve hides being responsible to bring into the hide structure the halophilic pioneer organism which start the succession. Two main colonization phases were identified. In the first phase, halophilic Archaea colonize the hide, followed by halotolerant microbes - according to the Clements model. Conversely, in the second phase, the biodeteriogens are heterotrophic bacteria and fungi present in the environment that, according to the Gleason model, change with the individual history of each parchment and determine the identity of its colonizers.

Interestingly, even present-day Chrome(III) tanned leathers often show signs of biodeterioration, known as red heats. In this study, we analysed salt-cured rawhides and damaged/undamaged Chrome(III) tanned leathers in order to identify the responsible for red heat deterioration, by using a multidisciplinary approach. Standard cultivation methods, molecular, chemical and physical updated technologies, as Next Generation Sequencing (Illumina platform), RAMAN spectroscopy, Light Transmission Analysis, were used. This study (i) demonstrated that also the red heat deterioration process is triggered by halophylic Archaea, including *Halobacterium salinarum*, as in the purple spot deterioration and (ii) shed light on the complex dynamics of hide biodeterioration, giving help to reduce the costly leather colonization and damage.

S1.17 Ecosystem vulnerability: the environmental factors that favour the invasion of alien species

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Biological invasions are one of the greatest threats to the natural ecosystems.

The 5-years INTERREG European project INVALIS (Protecting European Biodiversity from Invasive Alien Species) aims to improve policies to protect biodiversity from the Invasive Alien Species (IAS) bringing together 7 partners from 7 countries (Greece, Italy, Spain, France, Romania, Portugal and Latvia) with the aim of addressing common challenges associated with biological invasions.

One of the main goals of INVALIS is the definition of a methodology in order to gather inputs in each partner region about the most important factors that are responsible for vulnerability to Invasive Alien Species introduction and establishment in their areas.

A lot of literature is devoted to scan the possible determinants of the success of alien species in a given ecosystem. Most of them deal with biological traits of introduced species and with propagule pressure (i.e. the quantity of individuals that can establish in a new ecosystem). Comparatively, less research has been devoted to the capacity or susceptibility of the receiving environment to host and nurture new entrant species.

Our approach has resulted in designing a questionnaire based on that information well-recognized in the literature and in our experience as factors that increase the vulnerability of an ecosystem such as: the level of biodiversity, the anthropogenic impacts, the effects of climate change, the presence of other alien species, the presence of a policy framework and an established strategic planning or management of IAS and finally the presence of the socio-economical conflicts of interest.

Here, we illustrate how the questionnaire has been structured and the background behind the choice of questions.

Finally, we report a preliminary analysis of the results gathered by the response to the questionnaire in Lombardy, a region where, despite a heavy urbanisation, large portions of the territory are protected.

S1.18 Valutazione degli effetti di Imidacloprid sul sistema colinergico del gasteropode acquatico *Stagnicola fuscus*

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Neonicotinoids are systemic pesticides which act on the central nervous system as agonist of the postsynaptic nicotinic-Acetylcholine receptor (nAChRs). They have been widely used in the last 20 years therefore they can be largely found in natural water (1.4 ng/L – 0.32 mg/L) where they could seriously affect wildlife. Beyond data on lethal toxicity determined for model aquatic organisms (LC50 range: 0.195 µg/L – 534 mg/L), few information are currently available about sub-lethal effects on representative non-target species at environmentally relevant concentrations. *Stagnicola fuscus* is a freshwater pulmonate gastropod largely distributed in Italy and Europe. Pulmonated snails constitute a significant part of freshwater biodiversity thus any variation in their communities could affect the whole freshwater ecosystem. The aim of the present study is to evaluate sub-lethal effects on the nervous system of *S. fuscus*, after exposure to imidacloprid at environmentally relevant concentrations (0.1, 1, 10 µg/mL) both *in vivo* and *in vitro*. Effects on cholinergic function was investigated by measuring cholinesterase (ChE) activity in order to gain insight into the effects of the insecticide on the nervous system of *S. fuscus*. Furthermore, an *in vitro* study was performed to investigate a possible direct interaction of the insecticide on the ChE enzyme. Nominal concentrations stability during the test was ensured through high performance liquid chromatography analysis. A significant increase in ChE activity, which was found to be related to only AChE enzyme, was observed upon imidacloprid exposure at concentration of 0.1 and 10 µg/mL. This effect could be a compensatory response of the organism towards nAChRs inhibition. The *in vitro* exposure did not show significant changes in AChE enzyme function, confirming the absence of a direct effect on the AChE enzyme itself. In conclusion, indirect effects of imidacloprid cholinergic function of *Stagnicola* may have serious consequences on organism's health up to population level.

S1.19 Multi-model inference analysis of heavy metals body burden and biological responses of land snails *Cornu aspersum* caged close to an industrial setting

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The use of bioindicator species has become a standard monitoring approach in pollution monitoring however contaminants bioavailability and geographical distribution as well as specie-specific sensitivity, might be affected by several factors. The present study investigates the potential application of the land snail *Cornu aspersum* as indicator of airborne contamination, using heavy metals body burden and several cytological and biochemical responses in specimens caged at various distances from a point source of air pollution represented by an industrial setting. Eleven sites were selected based also on winds direction from the industrial setting and in each site 100 snails were caged in plastic box and left for 30 days. Several oxidative stress responses as lysosomal membrane stability (LMS) and loss of DNA integrity were analysed in hemocytes; catalase (CAT) and glutathione-s-transferase (GST) activities, malondialdeide (MDA) levels and total metallotionein (MTs) content were analysed in hepatopancreas. Heavy metals body burden was analysed as well as soil samples collected below the snail's cages. We used multi-model inference which reveals how snail's biological responses and heavy metal body burden decrease with the distance from the industrial setting, therefore suggesting the suitability of caged snail for monitoring air pollution effects. In addition, *C. aspersum* is confirmed to be responsive to air pollution also in the field as already proved in laboratory-controlled exposure studies. Finally, translocation can be foreseen as an efficient and low-cost tool for air pollution monitoring and effects assessment over a geographical and temporal scale.

S1.20 Tuning the role of forest ecosystem services in improving air quality: calibrating key ecological parameters in the SoilPlusVeg model

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Polycyclic Aromatic Hydrocarbons (PAHs) are ubiquitous environmental pollutants that originate mainly from anthropogenic sources. In Italy, their atmospheric levels often exceed European regulatory thresholds, especially in the Po Valley, causing a considerable human and ecosystem impact. Once emitted, they disperse in the atmosphere (as gas phase or associated to particulate matter, PM) and they can be captured by the plant biomass, the so called "Forest Filter Effect" (FFE). In this context, forests can have an important role in reducing their air concentrations, providing an important ecosystem service (ES), i.e. "air purification". This work focuses on the improvement of a dynamic air-vegetation-litter-soil model based on fugacity (SoilPlusVeg model) that considers the variability of exposure concentrations, meteorological and ecological parameters (Specific Leaf Area, Leaf Area Index, leaf length and density, cuticle thickness, canopy height, timing of budburst and relative abundance of each species that compose a mixed broadleaf woods). It aims to account for the role of different plant species in reducing PAH and PM air concentrations considering their 1) PAH accumulation potential i.e., leaf-air partition coefficient (K_{LA}), 2) PM retention capacity and 3) PAH degradative capability due to phyllosphere microorganisms. Existing and literature data (leaf/canopy traits and uptake parameters) were employed to parameterize the model. The model was used to predict the temporal uptake and release of some PAHs and PM by forests; more specifically, the variation of air quality with time was evaluated under different scenarios in terms of forest species composition (deciduous and evergreen), meteorological parameters (temperature and rainfall) and emission. The overall goal of the model implementation was to show how the variation of the ecological parameters drives the capture and release of PAH and PM in the FFE and the transfer from air to the terrestrial and aquatic ecosystems, providing "air purification" ecosystem service (ES).

S1.21 Green infrastructures and urban well-being by linking natural and social capital

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A socio-ecological perspective recognizes cities as complex socio-ecological systems that represent the right context where the natural and social dimensions are interconnected. These interrelations can be well represented by urban Green Infrastructures (GIs) since they support both the natural and the social capital, by preserving ecosystem services and urban well-being. In this context, the aims of the research are: (1) to collect data about the different urban GIs at urban level, as surrogate of the potential provision of ecosystem services, and (2) to identify suitable and available indicators in the official national database that can describe at the urban level the social capital, according to the Millennium Ecosystem Assessment framework. The results of the correspondence analysis between urban GIs' types and the 116 Italian provincial capitals show that the first three components explain 68% of the overall variance. The Italian cities under study have been ordered according to the complexity degree of GIs, ranging from "Green uncultivated" to "Urban forestation". This has made possible a first link between the complexity of GIs and their potential natural capital provision. The results of the correspondence analysis between the indicators used to describe the social capital and the cities under study show that the first two components explain 94% of the overall variance. The Italian cities have been ordered according to the basic services offered to guarantee a good quality of life as well as the involvement of citizens in the urban decision process. Since the green space can play an important role in fostering social interactions and promoting a sense of community and can support the provision of natural capital at urban level, it is important to have available indicators at urban scale suitable to put the MEA framework into operation and link natural and social capital through GIs.

S1.P1 Comparative ecophysiology of two meta-populations of *Dictyota* sp. living around CO_2 vents: implications for future warming and ocean acidification

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The ocean acidification severely affects the shallowest coastal habitats where macroalgae have a natural value for the structural and functional role they play in benthic communities. The acidification may modify the macroalgal community composition, resulting in a shift or disappearance of some species. Thus, it is important to understand the mechanisms at the basis of species resistance and surviving, as phenotypic plasticity and adaptation strategies. The natural CO_2 vents are a valuable tool to discriminate between phenotypic plasticity and adaptation in benthic organisms; in these environments, benthic organisms have been exposed, for many generations, to different pH and temperature over a long time. This study aimed to evaluate the ecophysiological response of two meta-populations of *Dictyota dichotoma* var. *intricata* living from decades at two pH conditions (8.1 and 6.7) and seasonal temperatures (23 and 26 °C), in order to assess the adaptation potential of this species to global change. The chlorophyll fluorescence analysis in situ revealed that the combination 23°C/pH 8.1 induced the best photosynthetic performance. Compared to the population at pH 6.7, algae living at pH 8.1 and 23°C showed the highest quantum yield of PSII electron transport and electron transport rate, and the lowest quantum yield of non-regulated non-photochemical energy dissipation.

Conversely, the acidified environment plus higher temperatures, stimulated in thalli thermal energy dissipation processes, reducing photosynthesis. Nevertheless, at pH 6.7, Dictyota showed the highest abundance and the biggest thalli. The absence of reproductive structure at pH 8.1 compared to pH 6.7, where the 25% of mature sporophytes were found, suggests a reduction of gene flow in this meta-population, likely due to the partial overlapping of the reproductive season with the other population. A genetic differentiation may be underway, inducing a local adaptation of Dictyota under chronic low pH. Studies on population genetics may confirm this hypothesis.

S1.P2 The ecological role of unmanaged natural conditions and parasite competition in the regulation of a population of *Carassius auratus*

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The ecological role of parasites in living communities is often underestimated. Parasitism do not always have a negative impact but can also be associated with a positive role in promoting biodiversity and communities' stability.

In this study, fish mortality in two aquariums (volume 300 liters) with a different initial number of *Carassius auratus* and with different environmental conditions were assessed. Three parasite species were present: *Argulus sp*., *Gyrodactilus sp*. and *Ichthyophthirius sp*. The condition factor (CF) was measured for all died fishes to describe their health status.

The first aquarium was regularly cleaned and refilled with freshwater, to simulate a natural managed situation, while the second aquarium simulated a natural unmanaged situation.

Fish mortality was higher in managed (97,04%) than the unmanaged aquarium (77.89%) and mainly due to the presence of only one parasite species (44,19% and 52.46%, respectively).

In the managed aquarium, the measured CF values were higher in uninfected fishes (1.0167) followed by fishes infected by two (0.9763), one (0.9668) and three parasite species (0.9287).

In the unmanaged aquarium, the measured CF values were higher in specimens infected by two parasite species (1.0627), followed by uninfected (1.0146) and infected by one parasite species (1.0021).

The results suggest that unmanaged natural conditions and competition among different parasite species reduce mortality rates in parasitized populations of *Carassius auratus*.

S1.P3 Can agricultural fungicides be a source of stress for non-target soil organisms? An ecotoxicological study on *Eisenia fetida* (Savigny, 1826)

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Plant protection products, highly used in agriculture, can represent a source of stress for non-target soil organism and have a negative effect on ecosystems' health. In particular, information on toxicological effects of fungicides are very poor or absent, despite their widespread use. The aim of this study was to evaluate the potential toxic effects of 4 commercial fungicides (Prosaro®, Amistar®xtra, Mirador® and Icarus®) on the earthworm *Eisenia fetida* (Savigny, 1826). Laboratory experiments were conducted using the filter paper test (FPT): *E. fetida* was exposed to increasing concentration of Prosaro® or Amistar®xtra, being the highest dose of treatment the recommended one for the usage in wheat farming. Field investigations were conducted transplanting *E. fetida* in cages in the soil of wheat and durum wheat fields before and during treatment with different combinations of the 4 fungicides. *E. fetida* specimens from laboratory and field work were analysed to evaluate vitality, potential neurotoxic effects (inhibition of acetylcholinesterase activity (AChE)), phase II enzymatic defense (glutathione S-transferase (GST)), oxidative stress (lipid peroxidation (LPO) and catalase (CAT) activity), genotoxic effects (Comet assay) and effect on the immune system (lysozyme activity). Laboratory studies with Prosaro® and Amistar®xtra showed alterations in organism's vitality which increased with increasing treatment doses. Significant alteration of phase II metabolising enzymes (GST induction) and significant DNA fragmentation (Comet assay) with respect to controls were detected at environmentally relevant doses of Prosaro®. A statistically significant induction of GST was found in earthworms transplanted in the fields treated with Amistar®xtra alone and Amistar®xtra + Prosaro®. This study represents a first step towards a better understanding of commercial fungicides toxicological potential to non-target organisms. Data obtained indicate that deeper investigations are needed which should include long term artificial soil tests (AST) and further field studies.

S1.P4 Potential toxicity of polyethylene terephthalate (PET) microplastics to the giant snail *Achatina reticulata*

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Microplastics (µPs) contamination has been confirmed as a dramatic environmental problem. A growing number of studies have documented the presence of µPs in both aquatic and terrestrial ecosystems worldwide, and the exposure to these plastic items might represent a potential threat for living organisms. However, although the capability of organisms to ingest µPs has been reported for several taxa, the consequences of their ingestion remain still poorly understood. In addition, most of studies of µPs effects have been focused on aquatic organisms, while the information on terrestrial ones are very scant. Thus, the aim of this work is to analyze the ingestion and the possible negative effects induced by the exposure to micronized particles of polyethylene terephthalate (PET-µPs), one of the common plastic polymer used in food packaging and widely found in environment, towards the giant snail *Achatina reticulata*. Organisms were exposed via diet for 45 days to two doses (1% and 10% in weight of the administered food) of irregular shaped PET-µPs (size range: 8 and 1,054 µm in length; mean length 220 µm). Ingestion of PET-µPs was confirmed by histological analyses. Potential effects of PET-µPs exposure were assessed at both biochemical and individual level. Effects on the growth rate of giant snails, in terms of mass gain and shell growth, was investigated over the 45-days exposure, while at the end of the exposure, the digestive gland of snails was isolated and used to assess the effects at biochemical level. Modulation of the oxidative status, including changes in the amount of reactive oxygen species (ROS), in the activity of antioxidant (SOD, CAT and GPx) and detoxifying (GST) enzymes, and oxidative damage (i.e., lipid peroxidation levels) were investigated. This study represents the first effort to investigate the potential effects induced by the exposure to PET-µPs on a terrestrial, grazer species.

S1.P5 Air PAH removing by *Ligustrum lucidum* in greening areas of Logroño (Spain)

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Polycyclic aromatic hydrocarbons (PAHs) are widespread organic pollutants, emitted by natural and anthropogenic sources. Due to their mutagenic, carcinogenic and teratogenic activity, US EPA listed 16 PAHs as priority pollutants, and they became targets of environmental investigations.

Plants can provide air purification, through removal and fixation of pollutants in their leaves. Leaf properties and wax content were important determinants of PAH accumulation.

Ligustrum lucidum is an ornamental perennial species, commonly present in urban areas. Because of the waxy layer of its leaves, this species can be able to retain lipophilic pollutants both adsorbed to particles and in gas-phase.

Goal of this study is to evaluate the capability of *Ligustrum lucidum* to capture PAHs removing them from air. At this aim, 50 trees (grid 500 m) were selected inside Logroño municipality, Spain. *Ligustrum lucidum* leaves were collected to analyse PAH contents, by matrix solid phase dispersion extraction and GC-MS/MS quantification. Moreover, measures of Leaf Area Index (LAI) and specific leaf area (SLA), as the ratio between the leaf surface area (LI-3000 area meter) and dry mass (70°C for 48 h), were carried out.

Total PAH contents ranged from 154 to 356 ng g^{-1} d.w., with a mean value of 204 ng g^{-1} d.w. The LAI mean value for 50 selected trees was 3.60 m^2/m^2. Taking into account the PAH concentrations measured in the leaves, and the total biomass of all the trees of *Ligustrum lucidum* in the city of Logroño (about 20 t), the PAHs retained from air can be estimated equal to 4.1 g. These results can be useful to planners to mitigate air contamination in critical areas.

S1.P6 Behavioural effects induced by organophosphorus insecticides in *Daphnia magna*

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Several studies have indicated the presence of chemical contaminants in aquatic ecosystems. Even if measured concentrations are far below those causing acute effects, continuous exposure to sub-lethal concentrations may have detrimental effects on the aquatic species, such as the behavioural changes. Behavioural alterations of key species may could trigger a cascade of indirect effects at higher levels of biological organisation (e.g. the community), for instance by altering the natural competitive and/or prey-predator interactions among species. In this perspective, behavioural ecotoxicology may represent a sensitive tool for improving the environmental analysis of risk for chemical compounds.

In this study, we assessed the behavioural changes of *Daphnia magna* induced by two organophosphorus insecticides: chlorpyrifos (CPF) and chlorpyrifos methyl (CPFm). Individuals (<24 hours-old) were exposed to a series of environmentally relevant concentrations of both pesticides (diluted concentrations of their respective EC50). A video tracking system was developed to track simultaneously different swimming traits of the tested organisms: average speed, average acceleration, time of activity, and total distance moved. After 48 hours of exposure, a significant inhibition of the swimming parameters was observed at the two highest tested concentrations of both insecticides (25 ng L-1 for CPF - 150 ng L-1 for CPFm). It is highly probable that, at these concentrations, both compounds solicit the central nervous system of *D. magna* by impairing its nerve conduction capacity. Being the locomotor performance of species such as *D. magna* an ecologically relevant trait for population dynamics and considering that its disturbance has the potential to spread to long-term population and community levels, a realistic ecological risk due to sub-lethal aquatic presence of both pesticides cannot be excluded.

S1.P7 Human well-being and natural capital exploitation in urban ecosystems

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Urban ecosystems can be conceptualized like living organisms supplied by material and energy flows. Urban metabolism accounts for the flows of materials, energy, resources, food, and people in cities, providing a framework for the study of the interactions between natural and human systems. The sustainable management of cities is based on the sustainable exploitation of natural capital stocks delivering a large set of ecosystem services vital for human economy and well-being. The interplay of environment, economy, and resources taking place within urban ecosystems can be explored and monitored over time using network theory and biophysical environmental accounting frameworks. These perspectives can help understanding how cities use raw and processed resources supplied from larger environmental systems. In this paper, we discuss the need for multicriteria assessment frameworks capable of capturing the complexity of city networks while accounting for matter and energy flows processed to build and maintain urban structures and functions and the production of goods and services. A multicriteria and system-based approach to environmental accounting for studying urban systems can inform city managers and policy makers, stimulating environmental policies based on the notion of "integrated wealth assessment" as the base for a productive and sustainable future.

S1.P8 Micro and nanoplastics uptake and effects on the sea urchin *Paracentrotus lividus*

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In Mediterranean benthic communities, sea urchin *Paracentrotus lividus* is a key species, that preserves ecosystem integrity of shallow subtidal rocky reefs besides being an important fishery resource. These marine invertebrates represent a suitable model for ecotoxicological studies thanks to their ecological relevance, a distinctive immune system and a nearly genetic relationship to humans.

The coastal marine environment can be considered as one of the most impacted environments by microplastics pollution relating to the proximity to urban areas. In particular, the Mediterranean coasts present high abundance of microplastics which are becoming a serious threat to the health of the marine ecosystem due to their possible impact on the marine biota. Recent studies suggested that microplastics can be fragmented into nanosized particles in the marine environment even if nanoplastics have been only recently detected in the water column.

Here, we tested micro and nanoplastics impact on adults of *P. lividus* in terms of uptake, toxicity and bio-nano interactions. For this purpose, we used two different approaches: an *in vivo* exposure study to polystyrene microplastics (PS-MPs, 45 and 10 µm) and *in vitro* study using immune cells namely coelomocytes exposed to polystyrene nanoparticles (PS-COOH, 50nm). *In vivo* results indicated a stress-related reaction to PS microbeads in sea urchins in terms of oxidative stress. Uptake was clearly observed in the digestive and in water vascular systems and it was size-dependent. *In vitro* results showed that PS nanoparticles were uptaken as well as micrometric aggregates but no effects on cell viability and lysosomal stability were observed in phagocytes. Our findings clearly showed how sea urchin *P. lividus* could be a sensitive target of both micro and nanoplastics released in the Mediterranean coastal areas and further investigation should better identify pathways of exposure as well as mechanisms of toxicity.

S1.P9 The INTERREG European project INVALIS: Protecting European Biodiversity from Invasive Alien Species

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Biological invasions are one of the greatest threats to natural ecosystems. Invasive Alien Species (IAS) can act as vectors for new diseases, cause native species' extinction, change ecosystem processes, and reduce the value of land and water for human activities.

The INTERREG European project INVALIS (Protecting European Biodiversity from Invasive Alien Species) aims to improve policies against Invasive Alien Species (IAS). INVALIS brings together 7 European partners: National Center for Environment and Sustainable Development (Greece), Lombardy Foundation for the Environment (Italy), Regional Ministry for Environment and Rural, Agricultural policies and Territory – Regional Government of Extremadura (Spain), Corsican Agency of Environment (France), Bucharest-Ilfov Regional Development Agency (Romania), Institute of Sciences, Technologies and Agroenvironment of the University of Porto (Portugal) and Zemgale Planning Region (Latvia).

INVALIS will enable the participating territorial Authorities to address common challenges associated with biological invasions, such as a) knowledge gaps in ecosystems' vulnerability to biological invasions and species' distribution; b) lack of awareness about IAS environmental and socioeconomic risks; c) low level of cooperation between public authorities and key stakeholders for the implementation of IAS management measures; d) conflicts of interest between concurrent economic activities.

INVALIS aims to contribute to tackling these issues, improving the addressed policies on biodiversity and environmental protection, supporting policy measures for the prevention, early detection, control and eradication of invasive alien species in natural ecosystems. INVALIS will allow the involved public authorities to share practices for a) evaluating natural ecosystems' vulnerability to biological invasions, b) managing/controlling IAS introduction, establishment and spread in their regions' natural environments and c) mitigating the associated environmental and socioeconomic risks.

Finally, among the expected results achieved from the project, there will be the increase of the knowledge and the awareness of local Authorities, NGOs and citizen organizations on the risk posed by IAS.

S1.P10 Uptake and effects of polystyrene nanoparticles on silkworm (*Bombyx mori*) larvae

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The awareness of plastic pollution is rapidly growing and much of the environmental concern involves the fragmentation of larger fragments into micro- and nanoparticles. Quantitative information on occurrence and fate of nanoplastics is generally lacking, in particular data concerning the effects of plastic debris to terrestrial species are very scarce. Furthermore, owing to their small size (1 to <1000 nm following the recent re-classification), nanoplastic particles might infiltrate animal tissues and organs, being the potentially most hazardous class of plastic fragments. In this context, the aim of this study was to evaluate the uptake and the detrimental effects of 0.5 µm polystyrene nanoplastics (PN) on silkworm (*Bombyx mori*) larvae, a well-studied Lepidopteran model system, focusing on development, behaviour and biochemical endpoints associated with oxidative status. Newly hatched *B. mori* larvae were reared ad libitum on artificial diet overlaid with a solution containing 0.5 µg of PN/g of diet/day. Behaviour tests were performed on third instar larvae, while biochemical analyses on fifth instar larvae. The effects on development were evaluated during the entire larval period until the pupal stage. PN uptake and tissue distribution were investigated observing larval cryosections by confocal microscopy. Results showed that polystyrene beads clearly infiltrate in larval tissues and lead to reduced larvae growth and development, which can be linked to the observed sub-lethal effects measured by a biomarker suite. The study pointed out the need to investigate potential risks associated to nanoplastic occurrence also at terrestrial level, identifying *B. mori* as suitable biological model to evaluate the effects of plastic contamination on Lepidoptera.

S1.P11 The dark side of the trout

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In many vertebrate species, individuals can exhibit a large variation in the degree of melanin-based coloration adorning their body. Dark and pale individuals differ in diverse physiological and behavioural traits, suggesting that melanin-based coloration may reveal the individual quality. In fact, the variation in the degree of melanin-based coloration has been associated with sexual behaviour, aggressiveness, maintenance of energy homeostasis, resistance to stressors and body mass, whereby darker individuals are more sexually active, aggressive, efficient in maintaining homeostasis, and resistant to stress than paler ones. In fish, melanin-based signals are often used in dominance interactions, and they have been associated with stress, aggressiveness, boldness, mate preference and reproductive success, supporting the idea that melanin-based coloration can be considered an honest signal of individual quality. Despite these findings, the relationships between melanin-based skin coloration and physiological traits in fish has been scarcely investigated. The present correlative study aimed at investigating the relationships between physiology and melanin-based skin coloration of free-living brown trout (*Salmo trutta* Linnaeus, 1758) individuals sampled in a river from the Gran Paradiso Natural park. We investigated the relationships between body condition, oxidative status (plasma total antioxidant capacity and amount of pro-oxidant molecules) and the degree of melanin-based skin coloration of the brown trout. Our results showed that heavier trout were, on average, darker coloured than paler conspecifics. Moreover, plasma total antioxidant capacity significantly covaried with melanin-based skin coloration. Our findings suggest that melanic coloration of brown trout might serve as a reliable signal to communicate a better antioxidant defence to conspecifics.

S1.P12 Effect of two pesticides (chlorpyrifos and imidacloprid) on the avoidance behavior of earthworm (*Eisenia foetida*)

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Chlorpyrifos (CPF) is an organophosphate insecticide characterized by a P–O–C linkage, it is toxic for aquatic and terrestrial organisms. Its mode of action is based on a rapid phosphorylation of acetylcholinesterase, an important enzyme involved in the neurotransmission processes in organisms. Imidacloprid (IMI) is a neonicotinoid insecticide used to control sucking insects in crops that impacts the nicotine acetylcholine receptors. The earthworm Eisenia foetida was selected as test organism and was maintained at 20±2°C before and during the test. Two section-chambers were filled with 250 mg (dry weight basis) of soil substrate, prepared by mixing quartz sand, kaolin clay and sphagnum peat in the proportion 70:20:10%. The soil was then spiked with the pesticides and adult worms with well-developed clitellum were randomly introduced into the soils. The organisms were exposed simultaneously to the soil samples spiked with the pesticide and to the control soil. After a test period of 48h, the position of the animals was determined. Five different concentrations of CPF and IMI (1, 5, 10, 20 and 50% of 14d-LC50) were tested. Residual concentrations of pesticides were determined over time by GC/MS-MS for CPF and by LC/MS-MS for IMI, respectively. At the end of the exposition, for each replicate the net response (NR, %) on worm behavior was calculated as follows: NR=((C -T)/10) x 100 where: C = sum of earthworm behavior observed in the control soil; T = sum of earthworm behavior observed in the treated soil; 10 = total number of earthworms per each replicate. Earthworms play an important role in agricultural soils, maintaining and improving soil structure and fertility. The avoidance behavior test resulted as an important screening tool in soil eco-toxicology, it is a low-cost method, with very simple test design, and can provide an early warning signal for environmental protection.

S1.P13 Seduction and Repulsion - What you don't expect from a scientific exhibition

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Changing cultural models towards an ecological point of view and increasing awareness of environmental issues has become a priority so urgent that requires continuous experimentation with different methodologies to test their effectiveness. We want to report the results of a project that takes advantage of an educational exhibition as a tool to reach a very wide audience, from school students to adults.

The exhibition, entitled "Seduction and repulsion, what plants don't tell", deal with the communication systems that plants adopt to relate with other living organisms within ecosystems. It is the result of a project shared between the seven Botanical Gardens belonging to the Network of Botanical Gardens of Lombardy, which have collaborated to compose different sections in which the exhibition is divided. Several are the issues proposed to the visitors, introduced in an interdisciplinary way with ideas related to literature, painting or music. Some themes, such as "colour", "deception", "forms" are approached from a phytocentric point of view, while other sections are instead designed to make us reflect on responsible behaviours and direct us towards good practices, like "everything is relative", " we cultivate the city "or" the sunset of seduction ".

Designed to be itinerant and reach diverse audiences, it has been assembled with sustainable materials and designed to give the idea that the content comes out of resealable boxes. The circuitation has involved museums, botanical gardens and other cultural spaces and has reached a total number of 60,000 visitors in four years. Each set-up is always followed by a program of educational laboratories both for schools and for long-life learning. Thanks to the careful training dedicated to educators, in some of the places where these workshops have been set up they have been included as a permanent offer.

S1.P14 Investigating the Heat shock protein response involved in coral bleaching across scleractinian species in the central Red Sea

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Coral bleaching continues to be one of the most devastating and immediate impact of climate change on coral reef ecosystems worldwide. Due to the increasing frequency and severity of these events, there is an urgent need to improve our understanding on the cellular mechanisms involved in the bleaching process and in the different susceptibility of corals. In fact, as sessile organisms, corals cannot migrate to new environmental optima and therefore they rely mainly on their physiological and cellular stress responses, which represent the first line of defense in reducing the potentially harmful effects of unfavorable conditions. In this context, molecular chaperones such as the Heat shock proteins (Hsps) are fundamental cytoprotective components important in protein folding, and for this reason represent useful biomarkers of the cellular homeostasis and stress condition.

A major coral bleaching event occurred in the central Red Sea near Thuwal (Saudi Arabia) in 2015 and affected differently the various coral species showing different bleaching susceptibility among taxa, growth forms and sites. In our studies, the expression of Hsp70, Hsp60 and Hsp32 was analyzed in healthy and bleached colonies of four different coral species (belonging to two different families and showing two different growth forms) in order to understand the Hsp baseline expression and to investigate the cellular changes that occur at the onset of bleaching. In each species, both the Hsp70 and 60 showed a similar pattern of expression, while the Hsp32 modulation indicated an elevated oxidative stress in all the bleached colonies of all the species. In addition, the basal levels of Hsps in healthy colonies as well as the modulation of the Hsp expression and the fold change in bleached colonies appeared to be taxa specific and growth form specific, thus providing useful information about the susceptibility to stress.

S1.P15 Food security and natural capital management: the case of Lebanon

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Food is a basic human need and therefore it is crucial to find ways to draw sustainable food production and consumption patterns. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. A world population approaching 9 billion by 2050 will lead to an increased food demand and related exploitation of natural capital stocks. Indeed, food production is a major driver of soil degradation, biodiversity loss, greenhouse gas emissions, and water depletion. In this study, we implemented a multicriteria environmental accounting framework capable of assessing both natural capital depletion and environmental impacts due to food production in Lebanon. In addition, alternative dietary patterns were investigated to assess their impact on natural resources management. Results will support policy makers committed to ensure food security for human well-being and long-term sustainable exploitation of natural capital stocks.

Sessione 1A:
Ecologia del Comportamento e Stress Ambientali in memoria del Prof. Nicola Saino

S1A.1 Microbiome, immune function and survival of nestling and adult barn swallows

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Microbiomes, the ensemble of genes of the bacterial communities that live symbiotically with all metazoans, are considered second genomes for the host, which code for traits that the hosts had not to evolve by themselves. The number of genes of the microbiomes outnumbers that of the hosts by orders of magnitude and microbiomes are increasingly considered important determinants of the host's fitness. In humans, gut microbiomes were shown both to affect and be affected by the immune system of the host. However, studies of the relationships between microbiomes, immune system, and host fitness in wild species are still in their infancy.

Here, we present the results of two related studies on the cloacal microbiome (CM) of the barn swallow *Hirundo rustica*. The first one showed that the more the CM of adult barn swallows differed from the average CM of that population, the lower the probability that that individual survived to the next breeding season. The second one showed that, in the nestlings of the same species, the same index of deviation from the average CM structure was related to an index of the ability of the nestling to rise a cellular-mediated immune response assessed *in vivo* by the phytohemagglutinin (PHA) skin test. In particular, a less typical CM was associated to a lower response to the PHA skin test.

Together, the results of these two studies, indicate that also in this wild bird species, the microbial community inhabiting the lower gut trait covaries with the functioning of the immune system and therefore the ability of the individual to cope with parasites, pathogens and, generally, environmental stress, ultimately affecting individual survival and fitness.

S1A.2 First technical attempts to try unveiling the unknown about long-distance migration of barn swallows: from correlations on ring recoveries to machine learning on geolocator measurements

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As one of the fundamental drivers of ecosystems, climate deeply influences the behavior, other than the spatial distribution and temporal dynamics, of plant and animal populations. Migratory birds are among the most sensitive taxa to its ongoing change, as they need to fine-tune their phenology according to the climatic conditions in breeding and wintering areas. To investigate how and to what extent alterations of climate regimes may determine key changes in the movement ecology of migratory birds, a detailed knowledge of their staging sites, a trustable reconstruction of their migration routes and of the time schedules of their journeys is very necessary. The classic methods for studying migration, such as bird ringing, can now be complemented by new technologies, such as GPS loggers of light level geolocators, that allow to record proxies of organisms' positions throughout their routes. Focusing on a model species, the barn swallow (*Hirundo rustica*), we have been working along three main directions. First, we developed a method to investigate the occurrence of climatic connections between the African wintering and European breeding areas of this migratory passerine bird. Surprisingly, significant correlations between the average temperatures in the wintering and breeding locations of individuals emerged at the precise weeks of individuals' spring migration. Such correlations proved to be robust to the randomization tests of the wintering sites and of temporal sensitivity. Second, we reconstructed migratory routes of 88 barn swallows using the measurements provided by light level geolocators, verifying the repeatability of the estimation method we used. The results obtained allowed us to start unveiling and discussing different possible migratory strategies used by individuals, as well as potential effects of the year of migration on many indicators of the migration schedules obtained from the reconstructed routes. Third, using the routes data as reconstructed in the second research step, we have automated a long manual phase of data pre-processing by implementing filters based on Machine Learning algorithms. The migratory routes reconstructed using the automated pre-processing are completely comparable with those obtained from the manual selection of geolocator data. The work confirms that models based on data gathered with ICT devices may be helpful tools to let us gain insights on the influence of environmental and climate changes on species and ecosystems connectivity.

S1A.3 How temperature stress reflects the behaviour of sit-and-wait Namibian spiders

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In extreme environments like hot deserts, temperature represents a stress factor playing a key role in determining any activity in the animal world, from digging to foraging and from mating to reproduction as well as it is a determining factor in forcing functional traits. Some *Ariadna* spiders inhabiting the Namib Desert excavate nearly vertical cylindrical burrows thickly lined with silk. We have chosen for such natural microcosms, characterized by rather small burrows with silk, in one of the hottest deserts in the world. Burrows' depth and amino acid composition of the silk mirror the climatic conditions of the investigated sites. Alanine and Glycine are the most abundant amino acids, with a prevalence of Alanine, constituting together at least 61% of the chemical composition of the protein material, differently from what occurs in known spidroins. High percentages of Proline, Serine and Threonine and low percentages of Leucine complete the peculiarity of these proteins. All their thermal properties were investigated by differential scanning calorimetry, showing that there are significant differences in their amino acid assembly due to the environmental habitat features like soil granulometry and surface temperature. Actually, temperature matters the most. Together, these ecological processes make the actual habitat temperature at the bottom of the burrow the strongest determinant for a constant metabolic rate of soil ectotherms as computed according to the Metabolic Theory of Ecology (MTE). This MTE approach is in fact appropriate to assess faunal thermoregulation. Here we show that these peculiar sit-and-wait spiders are able to thermoregulate behaviourally by digging until the most appropriate soil depth.

S1A.4 Melanin-based plumage coloration and life-history in the barn swallow (*Hirundo rustica*)

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Bird colouration has always been fascinating for scientist involved in studies of evolution of ornaments. Bird feather colours can be structural or due to a wide range of pigments, including melanin. Melanins are not acquired through diet but synthesized endogenously into dedicated organelles. Despite the strong genetic control of melanin synthesis, environmental variables and physiological condition can influence melanogenesis, suggesting that the degree of melanism can honestly signal individual quality and have a role in sexual selection processes. Identifying any association between melanisation and fitness traits is pivotal to any study of the evolution of melanin-based colouration. I will summarize the main findings of several studies in recent years aimed at investigating the causes and consequences of melanin-based colouration in the barn swallow *Hirundo rustica*. By adopting correlative and experimental approaches, we showed that melanin-based plumage coloration can act as a signal of nestling quality, demonstrating the parental ability to differentially invest in paler and darker offspring. We also provided evidence that ventral plumage colouration reflects telomere length and covaries with parasite infection. Finally, we investigated the role of melanin-based coloration in intersexual interactions. Darker individuals have higher seasonal but not lifetime reproductive success, because they suffer a viability disadvantage compared to paler conspecifics. Overall, our work significantly deepened the understanding of the functional role of individual variation in melanin-based colouration in avian species.

S1A.5 Sex-specific foraging tactics are affected by wind conditions in a sexually-size dimorphic seabird

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Flexibility in foraging behaviour is a key trait in individual life history strategies, promoting adaptive responses to changing environmental or demographic conditions. Such flexibility is expected to be especially pronounced in marine predators that forage in highly dynamic environments and pursue ephemeral and patchily distributed prey. Individual characteristics, social interactions and resource availability may all affect foraging behaviour and promote divergence in foraging tactics between and within populations. The adoption of specific foraging tactics by individuals could be driven by a complex mixture of intrinsic (e.g. energetic requirements) and extrinsic (e.g. wind conditions) factors. We GPS-tracked nestling-rearing parents of a sexually-size dimorphic marine avian top-predator, the Scopoli's shearwater (*Calonectris diomedea*), across multiple foraging trips to investigate intra-individual variation in foraging tactics, and the effect of sex and wind conditions on inter-individual variation. Males are heavier than females (19%) in spite of similar wing structure and size, implying a higher wing loading. We identified two distinct foraging tactics, fine-scale and coarse-scale foraging. The former was characterised by lower flight activity, shorter travel distances and more intensive prey searching behaviour compared to the latter. Individuals were not consistently adopting a specific foraging tactic. Males were more likely to adopt fine-scale foraging compared to females. With increasing wind intensity, both sexes shifted to coarse-scale foraging, likely to exploit the energetic advantages of dynamic soaring. We conclude that sex-specific foraging tactics reflected the interplay between sex-specific energetic optima originating from sex differences in morphology and a reduction of the niche overlap between the sexes. By adopting flexible, sex-specific foraging tactics, shearwaters likely optimized their energy expenditure during the energy-demanding nestling rearing period. Our study outlines the importance of both intrinsic and extrinsic factors in shaping inter-individual variation in foraging behaviour.

S1A.6 Elder barn owl nestlings flexibly redistribute parental food according to siblings' need or in return to allopreening

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Kin selection and reciprocation of biological services are distinct explanations invoked for the origin and evolutionary maintenance of altruistic and cooperative behaviours. Although these behaviours are considered as non-mutually exclusive, the cost-to-benefit balance to behave altruistically or reciprocally cooperate, and the conditions promoting a switch between such different strategies have rarely been tested. Here we examined the association between food gift, allopreening and vocal solicitations in wild barn owl (*Tyto alba*) broods under different food abundance conditions: natural food provisioning and after an experimental food supplementation. Allofeeding was mainly performed by elder nestlings (hatching is asynchronous) in prime condition, especially when the cost to renounce to a prey was small (when parents allocated more preys to the food donor and after food supplementation). Nestlings preferentially shared food with siblings that emitted very intense calls (i.e. very hungry siblings), thus potentially increasing indirect fitness benefits, or the ones that provided large allopreening to the donor (i.e. the most cooperative siblings), thus possibly promoting direct benefits from reciprocation. Finally, allopreening was mainly directed towards older siblings, perhaps in the hope to be fed in return. Helping behaviour among relatives can therefore be driven by both kin selection and direct cooperation, although it is dependent on the contingent environmental conditions.

S1A.7 Field experiments shed light on the effects of artificial illumination on bats

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Artificial lighting at night (ALAN) represents an increasingly concerning threat to ecosystems worldwide, altering persistence, behaviour, physiology and fitness of many organisms and their mutual interactions, in turn affecting ecosystem functioning. Bats are sensitive to ALAN because they are obligate nocturnal and feed on insects which are often also responsive to lights. Here we present field experiments aimed at exploring reaction of bats to LED lighting. We experimentally illuminated drinking sites (cattle troughs) in beech forests the Abruzzo Lazio and Molise National Park (central Italy) and ponds in the Negev Desert (Israel). Moreover, in the above-mentioned National Park we tested the effects of LED lighting on prey-predator interactions at riverine ecosystems, comparing bat and insect reactions in terms of bat activity and prey insect abundance and diversity, respectively, on artificially lit vs. unlit nights. ALAN affected adversely drinking behaviour in most bat species: forest and desert species showed the strongest reactions. At the Italian foraging sites, artificial light influenced both insect and bat assemblages in taxon-specific directions: insect abundances increased at lit sites, particularly due to an increase in small dipterans near the light source. At foraging sites, composition of insect assemblages also differed between lit and unlit sites. Total bat activity declined at lit sites, but this was due to the response of the most abundant species, *Myotis daubentonii*, while opportunistic species showed no reaction or even an opposite pattern (*Pipistrellus kuhlii*). We show that ALAN interferes with bat drinking activity and that illumination along rivers may affect trophic interactions between bats and insects, altering community structure and dynamics. Mitigation may include part-time lighting, automatic illumination that switches on only when necessary, or full cutoff lighting, but based on our findings we strongly recommend that lighting near bodies of water is avoided unless strictly necessary, since adverse effects might persist even when such mitigation measures are taken.

S1A.8 Independent and combined effects of egg pro- and anti-oxidants on gull chick phenotype

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Maternal effects represent a powerful tool by which mothers can influence the offspring phenotype and fitness. In oviparous species those effects can be mediated by egg size and quality. The mother transfers components such as steroids and antioxidants to the egg, molecules that can influence offspring developmental trajectories. However, the combined effects of different egg components are mostly unknown.

We investigated the independent and combined effects of an experimental increase of egg corticosterone (the main mediator of the avian stress response, with pro-oxidant and immunosuppressive effects) and vitamin E (an anti-oxidant) on yellow-legged gull (*Larus michahellis*) nestlings' phenotype.

We increased yolk concentration of corticosterone and vitamin E of freshly laid eggs by injecting a physiological dose of the two components, both independently and in combination. We then analysed the effects on chick post-natal growth, as well as on blood total antioxidant capacity (TAC) and total oxidant status (TOS).

Increased egg vitamin E and corticosterone negatively affected chick body mass after hatching relative to controls, whereas the combined administration of the two components reversed those effects. Chicks hatching from eggs with increased vitamin E and corticosterone had higher TAC compared to those hatching from eggs treated with either vitamin E and corticosterone.

This study showed for the first time that vitamin E can have negative effects on offspring phenotype, while the increase of both vitamin E and corticosterone eliminated those effects. These results suggest that the egg is a co-integrated environment in which all maternal components interact with each other. Therefore, changes of single molecule can affect offspring traits that depend on the concentration of interacting molecules. Our findings imply that mothers must balance their concentrations to optimally shape the offspring phenotype.

S1A.9 Behavioural responses to human disturbance in birds of alpine ecosystems

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Mountain habitats are threatened by several factors, including human activities at high elevation, although the negative impacts can sometimes be balanced by positive effects related to human presence. However, knowledge of such interactions is limited in alpine ecosystems. In the study reported here, we assessed the extent of behavioural responses of the Alpine Chough *Pyrrhocorax graculus*, a bird species found in high-elevation habitats, to differing levels of human disturbance in two alpine sites, a ski resort area with tourists year-round ('disturbed site'), and a natural park with little human activity ('undisturbed area'). As the accessibility and distribution of food is a potential factor affecting bird behaviour, we focused on the availability of food types to better discriminate between the effect of food and direct disturbance. We found that human presence was negatively associated with intake rates and amount of time spent in a foraging patch ('stay time'). Moreover, vigilance and flushing distances were shorter in the disturbed site than in the undisturbed area. However, intake rates were highest and stay times were shortest in the site where anthropogenic food (mostly discarded food items) was available. The abundance of a key prey type, grasshoppers, changed significantly over space and time and was lower in the more developed ski area, probably due to the presence of ski pistes. In conclusion, the study highlighted that human disturbance potentially affects foraging behaviour in Alpine Choughs, but the effects could be both positive and negative. Further investigations are needed to better disentangle the effects induced by direct and indirect disturbance and, more generally, to evaluate the potential benefits and negative effects of anthropization on mountain biodiversity.

S1A.10 Adverse effects induced by a maternally-transferred emerging contaminant to the yellow-legged gull (*Larus michahellis*)

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Increasing evidence is accumulating for the chemical contamination of ecosystems by the so-called emerging pollutants, mainly referring to human and veterinary pharmaceuticals, personal care products and various industrial additives, which may induce toxic effects towards non-target organisms. Although a mess of studies has investigated the effects induced by the exposure to diverse emerging pollutants towards aquatic species, the information on terrestrial organisms is still scarce. This study was aimed at exploring the embryotoxicity of Triclosan (TCS), an antimicrobial agent used in diverse personal care products, to the yellow-legged gull (*Larus michahellis*) induced by the *in-ovo* injection of 150 ng TCS/g egg weight. Soon before hatching we investigated the effects induced by TCS on embryo morphological traits, including body mass, tarsus length and head size, as well as on oxidative and genetic endpoints, by measuring the amount of reactive oxygen species (ROS), the activity of antioxidant (superoxide dismutase and catalase) and detoxifying (glutathione S-transferase - GST) enzymes, the levels of lipid peroxidation and DNA fragmentation in embryo liver. After the injection, the concentration of TCS measured in the yolk of unincubated eggs (159 ± 35 ng/g wet weight) was close to the expected concentration. Triclosan was found in residual yolk, liver and brain of embryos. However, TCS did not significantly affect embryo morphological traits, while it caused an overproduction of ROS and an increase of the GST activity, inducing the onset of both oxidative and genetic damage. This study demonstrated, for the first time in a wild euriecious bird species with mixed habits, that maternally transferred TCS to developing embryos might represent a potential threat for offspring.

Sessione 2:
Capitale Naturale ed Ecosistemi Terrestri

Prof. Carlo Blasi
Dipartimento di Biologia Ambientale, Università degli Studi di Roma "La Sapienza"

Biodiversità e Infrastrutture verdi per la conservazione attiva e sostenibile degli ecosistemi terrestri

L'attenzione verso il Capitale naturale è legata alla Strategia per la Biodiversità per la quale è centrale la relazione tra biodiversità e servizi ecosistemici. Non si parla più infatti solo di tutela della biodiversità, ma si evidenzia l'esigenza di conoscere e cartografare gli ecosistemi e i loro servizi.
La Strategia per la biodiversità chiede anche di realizzare le Infrastrutture Verdi intese come modello territoriale sistemico per il recupero ambientale e la valorizzazione sociale, culturale ed economica. Per la prima volta si sottolinea l'esigenza di sostenere la tutela della piena funzionalità degli ecosistemi evidenziandone anche il valore economico.
Le linee guida della prossima Strategia promuovono il benessere e una vita in equilibrio con la natura. Solo in questo modo si potranno avere anche vantaggi sociali ed occupazionali.
La legge 28 dicembre 2015, n. 221 (Disposizione in materia ambientale) ha delegato al governo la realizzazione della remunerazione dei servizi ecosistemici. Nel contempo ha previsto la costituzione del Comitato per il capitale naturale che ha elaborato tre rapporti sullo Stato del Capitale naturale. Gli ecosistemi terrestri (con particolare attenzione alle foreste) sono stati descritti e valutati in funzione delle proprie caratteristiche e in considerazione del contesto ambientale di riferimento. Negli ultimi due anni la valutazione ha preso in considerazione anche l'impatto determinato dal consumo di suolo. Con il terzo rapporto è stato esaminato il consumo di suolo nei Parchi nazionali.
Dall'insieme delle esperienze emerge l'esigenza di migliorare l'integrazione tra le discipline ecologiche con le discipline di carattere sociale, economico e territoriale. Vengono presentati inoltre il progetto in atto finalizzato alla red list degli ecosistemi d'Italia e un possibile progetto integrato finalizzato alla tutela, recupero e valorizzazione della fascia costiera.

S2.1 Cave vermiculations and microbiota, an ecological journey

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Caves constitute fascinating ecological niches for microorganisms, among which the chemolithoautotrophic constitute the main primary producers of these ecosystems. The role of cave microbiota in the formation of speleothems and other structures like vermiculations is still debated. Vermiculations are enigmatic deposits of incoherent particles, observable on walls and ceilings of worldwide natural or artificial caves, varying in morphology, color and size. They teem with life and represent interesting systems to understand the ecological role of biota in the cave ecosystem.

The aim of this study was to contribute to the understanding of vermiculation nature and of the ecological interactions involved in their genesis and development. To this end, an integrated approach including geochemical, microbiological and microscopic surveys, was applied on 11 vermiculation types from Pertosa-Auletta Cave (Campania, southern Italy), exhibiting an exceptional diversity and abundance of these structures.

XRD analyses revealed that vermiculations are mainly composed of calcite, with variable fractions of minor constituents like quartz, clay minerals, siderite and feldspars. Wide variations in Al, Ba, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, S, Si, Sr, Ti, V and Zn concentrations among vermiculations were highlighted by elemental analysis, due to substrate characteristics and deposition of exogenous inorganic and organic matter. 16S rRNA NGS survey showed that *Proteobacteria* (48.0%) was the most abundant phylum in the *Bacteria* domain, followed by *Acidobacteria* (11.6%), *Actinobacteria* (7.1%), *Nitrospirae* (5.8%), *Firmicutes* (4.3%), *Planctomycetes* (3.2%), *Chloroflexi* (1.9%) and *Gemmatimonadetes* (1.1%). *Archaea* (0.1%) and a significant percentage of unclassified microorganisms (13.1%) were also observed. FE-SEM and CLSM confirmed the presence of microorganisms and of their activity, supporting the hypothesis of a direct involvement of microorganisms in the development of vermiculations, through the production of organic matter, precipitation of secondary minerals, sediment trapping and binding, etching or pitting of the host rock.

S2.2 Conservation and ecosystem services by bats in urban habitats

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Bats are among the most common mammals in urban habitats worldwide, yet they often represent conservation priorities due to their unfavourable conservation status. Despite being often persecuted and conflicting with people, urban bats are also increasingly seen as welcome guests in urban parks and gardens, due to their role of suppressors of pest insects such as mosquitoes, and their presence is often encouraged, e.g. by the use of bat-boxes.

Here we present a series of case studies, all focussing on the multifaceted relationship between bats and urban environments, ranging from the community/landscape to individual/habitat selection scales. By using multiple approaches such as modelling and field studies based on acoustic sampling and radiotracking, we highlight that urban habitats filter bat communities and favour species that are morphologically adapted to fly in open areas, produce larger litters and show higher behavioural plasticity; we also found that water habitats and wooded areas greatly influence bat activity and species richness in urban landscapes. Among the species found in Italian cities, *Pipistrellus kuhlii* proved to be the most effective exploiter of urban habitats, whose characteristics may even enhance the species' reproductive output.

Our analyses highlight the filter imposed by urban areas to bat assemblages, as well as the importance of a number of habitat types and landscape elements at different spatial scales that should be targeted for management to maintain viable urban bat populations and the ecosystem services they provide.

S2.3 The vanishing natural capital of mountain grassland: sustainable management recommendations from the Italian Alps

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In Europe, permanent semi-natural grasslands decreased due to conversion to other land-uses or abandonment. Remaining ones have been subject to marked intensification, which are increasingly impacting mountain regions. This determined a dramatic loss in natural capital and related ecosystem services, witnessed by the severe decline of biodiversity harboured in formerly low-intensity grasslands.

We investigated the effects of the modernisation of the dairy farming system on birds (used as biological indicator of the wider biodiversity) along a gradient of hay meadow intensification in Trentino (NE Italy).

Bird communities were surveyed at 63 landscape units equally subdivided into areas dominated by extensive and intensive hay meadows, and areas formerly dominated by meadows but partially converted into other agricultural land use. This environmental gradient mirrors in space the temporal gradient of the agricultural changes that have recently occurred in the Alps. Community composition, species richness, and the richness and abundance of meadow-specialist species were analysed according to environmental predictors (i.e. landscape, meadow management, and topography), and to spatial factors.

Meadow conversion drove a shift in community composition towards assemblages dominated by generalist species at the expense of meadow specialists. The cover of intensive meadows was negatively correlated with species richness, whereas the number of meadow specialists was negatively correlated with the cover of early-mown (i.e. within the third week of June) meadows. Mowing date was, in turn, related to elevation, with meadows at higher elevations mown later in the season, and to meadow intensification (the use of liquid manure leads to earlier and more frequent mowing event per year).

Multiple environmental and management traits of hay meadows affect an animal group at the top of the trophic web within this agroecosystem; conservation implications derived from bird ecology in meadows could likely inform conservation actions to halt further natural capital depletion in the Alps.

S2.4 An eco-physiological model coupling plant growth and aphid population dynamics

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Aphids alter plant development and can transmit lethal viruses, thus representing a major threat for crops. In agronomy, mathematical models describing temporal plant growth dynamics have rarely been coupled to pest population models. In ecology, resource-consumer models have been often applied to plant-pest systems, but they usually adopt a simplistic description of the plant, which is not suited to address agronomic issues. In the present work, we extended a classical plant growth model, describing carbon and nitrogen assimilation and allocation, by integrating *i*) aphid population dynamics *ii*) the development of plant defences. We demonstrate the model against field observations from peach *Prunus persica* plants subjected to different fertilization and irrigation regimes, infested by the green aphid *Myzus persicae*. Our results suggest that aphid infestation induces the plant to produce defensive compounds that impair aphid ingestion rate and fecundity. Moreover, both plant and pest biomass positively respond to an increase of fertilization and irrigation, thus suggesting the existence of mechanism of bottom-up control in the plant-pest system. The proposed framework enables novel predictions on aphids control through cultural practices, along with possible effect of climate change which is expected to alter water availability in the next future.

S2.5 Effects of anthropogenic habitat alteration on plant-pollinator interactions and on pollinator's foraging

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Global change, urbanization and agricultural practices impact habitats and shape interactions between pollinators and plants. As a consequence, there is high risk of compromising the extent of pollinator's population and the efficiency of ecosystem service of pollinating plants. These two aspects were investigated in the field with both an experimental manipulation and intensive field surveys. Firstly, we investigated if social pollinators show compensating reactions after a strong reduction in their population size by adjusting their foraging strategies. Secondly, plant – pollinator interactions were investigated along a gradient of disturbance from well-conserved natural habitats to intensive agricultural and urban landscapes. By using an interdisciplinary approach based on molecular identification of species, we revealed that: (a) social pollinators collect a large diversity of plants but their foraging strategies did not change during the condition of decreased population size; and that (b) plant-pollinator interactions differs between land-use types. In light of the current global change, the growing size of cities and the intensification of agriculture worldwide, our studies provide evidences that the way humans transform habitats can impact on both mutualistic interactions and the extent of pollinators populations, which bears implications for sustainability issues.

S2.6 Functional biodiversity and pest ecology in New Zealand ryegrass pastures

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Difficulties of measuring functional diversity in pastoral ecosystems limit our comprehension of how biodiversity organization affect pest ecology, hindering effective pest management strategies. This contribution advances the hypothesis that availability of trophic niche space and reduced functional diversity in New Zealand ryegrass pastures promote pest invasiveness and consumption of cultivated plant species (*Lolium* spp.). We used isotopic analyses of *Listronotus bonariensis* (Curculionidae) and many other sympatric species to quantify the trophic niche of this abundant invertebrate pest, and its intra- and inter-specific isotopic similarity across 8 pastures in New Zealand (4 “young”, cut 1 year before sampling, and 4 “old”, cut 5 years before). Bayesian mixing models were applied to quantify the feeding of *L. bonariensis* on different plant sources.

Density and isotopic distribution of *L. bonariensis* varied between pastures. The observed trophic-functional variability of the pest was explained by the consumption of different plant organs of *Lolium* spp. (the cultivated species in the studied pastures) and, to a lesser extent, of other qualitatively lower plant species. Invasion success, measured as the percentage of *L. bonariensis* on the total of invertebrate organisms, was higher in younger pastures, being tightly related to the availability of trophic niche space within communities, while it was not related to taxonomic diversity. In parallel, consumption of *Lolium* spp. decreased with increasing density of potential natural enemies (i.e. predators and parasitoids). Results emphasized the effectiveness of isotopic analysis for understanding the relationship between biodiversity organization and pest success in invaded pastures, clarifying mechanisms of intraspecific niche segregation in the pest, and effects of natural enemies on its trophic ecology. These may represent key ecological aspects promoting the success of the invader, and should be taken into account for effective integrated management strategies aimed at preserving local biodiversity while reducing pest invasion.

S2.7 Valuation of ecosystem services in an alpine protected area: the case study of the Gran Paradiso National Park

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Mountain areas provide a large number of ecosystem services because of their high multifunctionality but they are also fragile environments that face severe threats from unsustainable exploitation or climate changes. The valuation and modelling of ecosystem services in order to define the current state and future trends in ecosystem conditions is crucial to define sustainable management strategies. We started a project in the Gran Paradiso National Park which is the oldest protected area of the Italian Alps and it is under protection status since about one hundred years. The aim is to map the current status of ecosystem services with selected indicators and to project future ecosystem services delivery under different scenarios of change. In this first part of the project we focus on soil organic carbon stock in alpine forests and prairies. We estimate carbon stock for soils for different habitats of forests and prairies by collecting samples in 87 plots (42 of forests and 45 of prairies). Results show that prairies and forests store a significantly different stock of soil carbon and average stocks are presented. When valuing ecosystem services, most of the attention is focused on the final value itself, missing the mechanisms and relationships that lies behind the ecological processes and that determine the ecosystem functioning. Many of interdependencies between biodiversity, ecosystems structures, ecosystem functions and benefits to humans are not yet fully understood because of their complexity. In particular, forests' species, structural and functional diversity are usually linked with high delivery of ecosystem services, compared to forests with lower levels of diversity. We then investigated the relationship between carbon stock, some habitat biophysical characteristics and biodiversity levels. Relationships among soil carbon stock and relative dominance and richness of trees species were found, as well as relationships between biodiversity and litter carbon stock. These results will support the Park's ecosystem services monitoring program.

S2.8 Effects of wildfire on soil properties and microbial community in Mediterranean area

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Soil has an important role as a habitat and gene pool and serves as a platform for human activities, landscape and heritage. These functions are worthy of protection because of their socio-economic and environmental value. Wildfires, particularly frequent in the Mediterranean area, can have profound effects on soil functioning. The aims of this research were to evaluate the effects of wildfires on soil chemical and microbial characteristics and if these ones were also affected by different plant covers (herbaceous, black locust and holm oak). Soils were sampled at severely burnt sites and adjacent unburnt sites within the Vesuvius National Park, after one year since the large wildfire occurring in summer 2017. The results showed that the wildfire noticeable increased soil microbial abundance. In burnt soils covered by holm oaks, the bacterial DNA significantly decreased, whereas fungal DNA increased; moreover, the wildfire stimulated the growth of ammonia oxidizers in soils under black locusts, where also the highest N amounts were measured. Besides, the reduced fungal abundance highlighted in burnt soils under herbaceous species could be the main responsible of the higher soil mineralization rate detected. The overall evaluation highlighted that the burnt soils, as compared to the unburnt ones, showed faster organic matter mineralization leading to C losses. The wildfires induced deep changes in soil characteristics and biodiversity especially under holm oaks and black locusts, suggesting that vegetation covers show different strategies as response to wildfires and consequently providing different tools to recover damaged terrestrial ecosystems in management practices.

S2.9 The concept of natural capital as a practical tool for biodiversity conservation in urban areas

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There is an increasing interest in the application of the concept of natural capital to value and hence preserve biodiversity. However, this concept is also object of severe theoretical critiques, because it reconceptualises nature anthropocentrically, from something intrinsically ‘good’ to a commodity for humans. Also, the concept of natural capital might suggest that nature can be substituted for other types of capital, which would be extremely dangerous for nature conservation. Thus, monetizing nature might be risky, leading to the wrong idea that we can trade ecosystems for money. While these critiques may be true in general terms, establishing whether monetizing nature may be useful or deleterious should be evaluated case by case. Some of the most promising applications of the concept of natural capital are in the field of urban ecology. Urban ecosystems are the product of human activities, yet they usually host a lot of fragments of natural ecosystems predating the urbanization processes. These enclaves of natural habitats may represent important reservoirs of biodiversity, which are under the pressure of further urbanization. Thus, in urban areas, there can be a strong competition between opposing interests: preserving green spaces or transforming them into houses and infrastructures. Showing that the actions needed to replace the functions of a green space converted into a built up area (e.g. the cost of the water treatment plants needed to replace the sewage services provided by a wetland) would have a cost superior to the economic benefits gained by its conversion, would be an effective conservation strategy. Also, showing that nature is monetary important in a context, such as cities, in which citizens have a clear and direct perception of this, may help developing their attitude to preserve nature also in natural habitats of which they do not have direct experience

S2.10 Nitrogen availability and soil microbiome control cigarette butt decomposition

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Cigarette butts (CBs) are the most common waste on Earth. However, CB fate and biological effects remain untested under realistic ecological conditions. We investigated the interactive effects of N availability and microbiome composition on CB decomposition over a 5-years manipulative experiment. A total of 12000 CBs were artificially smoked and decomposed according to the litterbag method in two field conditions, differing for soil microbiota, texture, and chemical fertility: sand dune and grassland. To control for water availability and temperature effects, litterbags were also incubated under optimal conditions in mesocosms with soil from either field site, or without soil. Ten bags for each condition were harvested for mass loss assessment after 1, 3, 6, 12, 24, 36 and 60 months. CBs were characterized for total C and N content, by ^{13}C-CPMAS NMR in solid state, by HPLC-DAD-ESI-QTOF-MS on methanol extracts, and by SEM observation. Microbiota was assessed on DNA libraries prepared after extraction by commercial kit, amplification with 16S rRNA and BITS2F/B58S3 primers for bacteria and fungi, respectively, and sequencing. Ecotoxicological assays of CB leachates were carried out on *Aliivibrio fischeri* and *Raphidocelis subcapitata* according to standardized protocols. CBs followed a three-step decomposition process: at the early stage a ~15.2% mass loss was independent of decomposition conditions; during the subsequent two years CBs decomposed very slowly, taking thereafter different trajectories depending on N availability and microbiome composition. In presence of soil a consistent N transfer, after de-acetylation, promoted cellulose transformation into an amorphous material, rich in aliphatic compounds. In absence of soil, CB persistence and morphology were almost unaffected after 5 years of decomposition. CBs ecotoxicity, first peaking following artificial smoking, increased after 3 years of decomposition. As such, it could be most exacerbated in urban environments, where CBs are commonly discarded and degradation is hampered by the absence of soil.

S2.11 Chemical and biological variations in soils along a land-use gradient

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Soil consumption and degradation are among the greatest threats of modern human societies. Land-use change, urbanization, and climate change might affect the complex and delicate soil ecosystems. In turn, such changes in soil quantity and quality could have many negative effects for human societies, from a reduction of crop yield to a lower stocking of atmospheric CO_2 as well as several risks for biodiversity. Thus, studies concerning soil quality in different land-use scenarios are timely and pivotal.

In this study, we have measured several biological and chemical variables from 78 soil cores deriving from 13 different land-uses within the same geographical area and the same parent material, i.e. the Gargano in southern Italy. We have sampled an array of quasi-pristine soils from forest ecosystems to coastal maquis soils as well as pastures and croplands at different degree of alteration. We have studied the co-variation of chemical variables (e.g. soil organic matter, pH, cellulose) with several soil enzymes using a two-block partial least square approach. Moreover, we have computed a soil quality index (AI3) based on three important soil enzymes. Our results showed that, even if some forest ecosystems predictably showed higher quality than most agroecosystems, this was not always the case. An expert-based assessment of soil quality on the base of land-use was not always coherent with chemical and biological results. Such evidence is particularly important both in term of understanding drivers of soil quality and in developing new approaches to soil ecology that could work in different land-uses, both natural and agricultural.

S2.12 Subterranean spiders are suitable models for ecological studies

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Being light-deficient and receiving poor energy inputs, caves and subterranean ecosystems are generally regarded as extreme environments, characterized by low abundance and diversity of organisms. Because of their remarkable adaptations, cave-dwelling animals offer unique opportunities for studying evolutionary and ecological processes. Among subterranean taxa, spiders are distinctive for their ecological role of top predators and for the variety of functional adaptations, therefore representing undervalued models for studying adaptations, competition and speciation processes. However, compared with other animal groups, the potential of spiders as model organisms is still under-expressed. In this presentation, we illustrate our studies on subterranean spiders, with reference to the basic concepts of ecological niche, competition, adaptation, speciation and dispersal. Furthermore, stemming from the results of statistical models and physiological tests attesting the sensitivity of subterranean adapted spiders to temperature alterations, we provide evidence supporting the role of subterranean spiders as bioclimatic indicators in the perspective of climate change.

S2.13 Nano cerium oxide influences the growth of two spontaneous plant species

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The tumultuous development of nanotechnology, a new emerging field of science, and the consequent increasing use of new materials in different products and applications are considered a potential threat not only to the human health but also to the environment. The effects of engineered nanomaterials (ENMs) on living organisms and the possible transfer along the trophic chain are still not so studied. Therefore, not trivial questions are raised on the potential risks due to the entry of these materials into the food chain. Released ENMs accumulate into environmental compartments where they can establish complex interactions with the biota. Currently, the environmental impact of ENMs is almost completely unknown. So far, studies regarding plants consider cultivated species whereas the effects of ENMs on spontaneous are poorly investigated. Cerium oxide nanoparticles ($nCeO_2$) are among the most widely utilized ENMs in Europe and have a great potential to accumulate and adversely affect the environment owing to their widespread applications in commercial products. A greenhouse factorial pot experiment is carried out to study the response of two spontaneous plant species (*Diplotaxis tenuifolia* L. DC. and *Holcus lanatus* L.) to different concentrations of $nCeO_2$ having different dimensions (25 nm and 50 nm, respectively). Plant growth parameters as well as $nCeO_2$ uptake and bioaccumulation are investigated. In both species, all $nCeO_2$ treatments produce a greater development of roots if it is compared with control, in particular at 20 mg kg^{-1}. The same observation could be extended to leaf area, with higher values in treated plants than in control ones. ICP – MS analysis highlight that, at the same high concentration of $nCeO_2$ (200 mg kg^{-1}), plants absorb more 25 nm particles than 50 nm, because $nCeO_2$ 50 nm tend to join together and their uptake is more difficult.

S2.14 Short-term effects of fires on properties of soils with different pre-existent plant covers

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Soils support the terrestrial life forms and provide fundamental ecosystem services. In Mediterranean Regions, fires exert an important role in regulating plant biodiversity and soil quality. Aims of the research were to evaluate temporal trends of some properties of burnt soils and the role of pre-existent plant covers on the same properties. To reach the aims, surface (0-10 cm) soils were collected in summer and autumn 2018, and in winter 2019 inside the Vesuvius National Park, where intense fires occurred in summer 2017. The samples were collected under specimens of *Quercus ilex* L., *Pinus pinea* L., *Robinia pseudoacacia* L. and uncovered. The soils were analysed for pH, organic matter and water contents, microbial and fungal biomass, respiration, enzymatic activities, and phytotoxicity through *Lepidium sativum* L. The results highlighted that, over the time, soil pH decreased from sub-alkaline to neutral, organic matter content remained almost constant, whereas water content increased. A shift of the microbial community was observed as the fungal biomass increased whereas the bacterial one decreased. Changes in the biological activities likely responded to seasonality rather than the passed time since fire occurrence. Over the time, root elongation of *L. sativum* showed high and constant toxicity. The overall evaluation showed that the soil abiotic properties were higher under *Q. ilex* and the lower under *P. pinea*; the microbial and fungal biomasses were higher under *Q. ilex* and lower in uncovered soils; respiration was higher under *Q. ilex* and lower under *P. pinea*; the enzymatic activities were higher under *Q. ilex* and lower in uncovered soils; the phytotoxicity was lower under *Q. ilex* and higher under *P. pinea*. In conclusion, the research highlighted short-term effects of fires on both abiotic and biotic soil characteristics and a mitigation of their negative effects in soils previously covered by *Q. ilex*.

S2.15 Influence of fire on dung beetles in a pastured site in Central Apennines (Italy) and implications for ecosystem services maintenance after reforestation

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Dung beetles provide ecosystem functions that translate into important ecosystem services, ranging from biological pest control to soil fertilization. Many of these ecological processes can be negatively affected by habitat modifications that impact on dung beetle communities. Fire and grazing are important forms of disturbance in grasslands. However, grazing can influence positively dung beetles by providing them with additional dung supply. The effect of fire is still poorly known. We investigated the impact of fire on dung beetles in three habitats (pinewood, beechwood and prairie) in a burnt high altitude pastured area (Gran Sasso Massif, Abruzzi) of paramount importance for the dairy sector in central Italy. Sampling was done by using pitfall traps baited with cattle dung. We compared community structure in burnt and unburnt sites representative of the three habitats. The abundance of dung beetles was higher in the prairie than in the two forest habitats, with no effect of fire. This can be explained by the fact that livestock rarely enters the forests, so dung is more abundant in the prairie, which can therefore support denser populations. Communities of burnt and unburnt sites did not differ in terms of indexes of richness (Chao 1), dominance (Simpson), and equitability (Pielou), but Shannon-Wiener diversity was higher in the burnt sites. Fire may enhance diversity because burnt woodlands tend to become more open and hence more similar to prairies. Also, plants growing in burnt areas may be richer in nitrogen, which might enhance dung quality for coprophagous beetles. The pinewood showed the lowest diversity. Thus, this man-made habitat is not optimal for dung beetles. These results suggest that high altitude communities of dung beetles are not severely affected by fire, and that reforestation with pines might have negative impacts on these insects, thus compromising the ecosystem services they play.

S2.16 Trends of bioclimatic suitability of water spiders in Italy: a conservation perspective

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It is widely recognised that wetlands and associated biodiversity are rapidly declining, mainly due to changes in land-use and climate, eutrophication and pollution. The diving bell spider *Argyroneta aquatica* and the fen raft spider *Dolomedes plantarius*, are closely associated with standing water, from which many aspects of their life-history depend. The Italian distribution of these species is mostly limited to the Po Plain, representing the southernmost limit of the species ranges. Future climate and land use changes, are expected to have serious impacts on the survival of these species, with major effects on peripheral populations. Accordingly, both species are mentioned in national laws and Red Lists of several European Countries. In addition, *D. plantarius* was classified Vulnerable by the IUCN Red List in 1996. Concerning Italy, *D. plantarius* is listed in the provisional Invertebrate Red List, and both species are under the protection of regional legislation of Regione Lombardia. Here we provide an updated frame of the existing knowledge on the distribution of these species in Italy and we point out the potential present and future distribution of the Italian populations obtained via Species Distribution Modeling. We predict a declining trend in the current suitable range of these species in Italy, with a remarkable loss of suitability throughout the investigated area. Besides, the Italian situation is particularly critical due to the geographical isolation of the populations at the periphery of the species range, and to the presence of the Alpine barriers that prevent the species dispersion northward. On these results, we provide an estimation of the current and predicted Extent of Occurrence (EOO) and Area of Occupancy (AOO) by means of the newly developed R package *red - IUCN redlisting tools*, paving the way towards the assessment of the regional IUCN status of these species of elevated conservation concern.

S2.17 Passive sampling of gaseous mercury: a tool for ecological risk assessment and contaminated land management

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Mercury (Hg) is a bioaccumulative and toxic metal which is hazardous to human and wildlife health. Due to its long lifetime and ubiquity in the atmosphere, Hg is a contaminant of global concern with wet and dry deposition processes dominating its delivery to terrestrial and aquatic ecosystems. An improved monitoring of Hg in the atmosphere is paramount, as well as required by the Minamata Convention on Mercury. The new passive sampler (PAS) for gaseous Hg developed at the University of Toronto by the group of Prof. Wania has provided for new, unparalleled capability for source identification and quantification, as well as global scale monitoring. The intrinsic advantages of the passive sampling approach (limited costs, spatial resolution, long-term deployments) and the specific features of the new PAS (high analytical accuracy and precision, applicability over a wide range of concentrations) made available concurrent, high-spatially resolved, time-averaged (weekly to seasonal) gaseous Hg concentrations. Here we report our recent and ongoing collaborative research using this methodology in and around the mine of Abbadia San Salvatore (Mt. Amiata, Central Italy), a major source of atmospheric Hg at both local and global scale, despite the closure of the mine thirty-six years ago and recent partial remediation works. By using geospatial interpolations tools, an unprecedented visualization of the spatio-temporal patterns of gaseous Hg dispersal at the site was achieved by sampling simultaneously with a high number of PASs. We further show how the resulting Hg concentrations maps can be employed to estimate Hg emissions and identify areas where Hg inhalation exposure of the local population may be of concern. We also discuss expanding potential applications of this versatile technique for supporting effective Hg emission reduction efforts at contaminated sites.

S2.18 Evaluation of Ecosystem Services in relation to land consumption

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Land consumption is one of the major sources of land degradation and loss of ecosystem functions. A high loss of agriculture and natural soil is due to land consumption and this causes also a biodiversity decline. Starting from the Convention on Biological Diversity the preservation of biodiversity, the sustainable usage of its components and the rightful distribution of the benefits offered by ecosystems have become increasingly important. During the last few years, through a process driven by the agreement on the Global Agenda and the Sustainable Development Goals and the Tenth Conference of the Parties (COP 10) of Biodiversity Convention, the need of methods and tools to evaluate and monitor ecosystem services has become evident, in order to elaborate data on ecosystem status and evolution for the decision makers, supporting their choices among different locations for planning and designing at different scales.

Since 2016 ISPRA produces the evaluation of the loss of the main soil ecosystem services produced by the increasing of land consumption. ISPRA research is focused on the variation of soil ecosystem services related to land consumption occurred between 2012-2017 in Italy. Eleven soil ecosystem services are selected and analyzed for the Italian territory, on the base of available data at national level. The evaluation is made using different tools, as InVEST or BIGBANG, chosen for each service considered and integrate information from soil functions to agricultural practice and climate.

The evaluation is performed both in biophysical and economic terms. The economic evaluation is proposed to reveal the importance of soil functions to humans and foster the public debate in order to support the reduction of urbanization. The biophysical approach is the base to evaluate ecosystem services and it is necessary to ensure a proper protection of soil functions in the land transformation processes.

S2.19 Ecosystem services in National Parks: identifying suitable indicators

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The concept of ecosystem services is creeping into policy strategies of government and non-government organisations, and among these there are protected natural areas. Mountain areas are facing increasing pressures and they need knowledge-based conservation and management strategies that aim to support ecosystem functioning and the benefits associated. Indicators of ecosystem services that support the environmental certification process of the natural protected areas are today discussed and developed with decision-makers in order to integrate ecosystem services research with valuation for conservation policies. We started a project on ecosystem services valuation in the Gran Paradiso National Park by applying selected indicators and conducting specific field campaign to implement new indicators. Considering the need for national parks to start a monitoring program of their ecosystem performance by means of services provision, the selection of proper indicators became an impellent issue. In collaboration with the park management, we followed a framework to identify potential indicators starting from those already introduced in the last Eco-Management and Audit Scheme certification (EMAS). These last indicators were selected as a synergy between traditional EMAS indicators and new environmental parameters to be measured. The synergy between past certification and the new monitoring program for ecosystem services valuation will greatly facilitate the inclusion of ES valuation into Park's activity. New indicators have been also proposed and discussed in reference to their applicability, cost, replicability, comparability and easy interpretation. The main issues regard the need to critically analyse the possible synergies between past certification and ES monitoring, the need of common indicators for protected areas by selecting both exiting indicators and proposing new.

S2.20 Effects of the co-presence of the anionic surfactant sodium lauryl ether sulphate and pesticide chlorpyrifos on a natural soil microbial community

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Chlorpyrifos (CPF) is an organophosphate insecticide currently used in agricultural which can be found as a soil contaminant. Microbial degradation can play an important role in its removal and its main transformation product is 3,5,6-trichloro-2-pyridinol (TCP). Surfactants are compounds used for different purposes and owing to their use in high amounts can be environmental contaminants. Sodium lauryl ether sulphate (SLES) is an anionic surfactant widely used, including in the excavation industry, as the main component of foaming agents. SLES residual concentrations can occur in the spoil materials reusable as by-products for different environmental goal, including its mixing to agricultural soils. Surfactants are able to solubilize hydrophobic compounds, through their incorporation into the core of micelles in solution, and their presence can influence a pesticide fate, including its bioavailability. The aim of the present study was to evaluate the persistence of both SLES and CPF when they simultaneously occur in an agricultural soil. CPF and SLES half-lives (DT50s) were determined and the effects on the soil natural microbial community were evaluated. Soil microcosms were set-up using soil samples treated with SLES (70 mg/kg) or CPF (2 mg/kg) or with both compounds. At selected times soil sub-samples were collected for chemical and microbiological analysis. SLES was analyzed by the MBAS method, while CPF and TCP with a GC-MS, preceded by soil extraction. Microbiological analyses were performed in order to assess the microbial abundance, cell viability, dehydrogenase activity and structure. The results showed that both CPF and SLES concentrations decreased during the experimental time, but the halving times were not affected by their co-presence. On the other hand, the formation of TCP was favored in the co-presence of SLES. At the same time, the microbial populations were more active and abundant and a shift in the microbial community structure, favoring the Gram-negative bacteria, main responsible of its degradation was also observed.

S2.21 Why "landscape services" is a more ecological attractive concept than "ecosystem services" for environmental management

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Environmental management needs to take into account the interactions and interdependencies in the social-ecological network and, as a result, it is a very complex endeavour. The European Landscape Convention as well as the Convention for the Safeguarding of the Intangible Cultural Heritage and the Framework Convention on the Value of Cultural Heritage for Society have given to the landscape a higher status in environmental management for sustainability. Based on the idea that landscapes are seen as spatial socio-ecological systems delivering functions valued by humans, and that humans change the landscape to improve its functioning, to obtain added ecological, social and economic value, the concept of ecosystem services should be replaced by landscape services when dealing with environmental management. This because landscapes, rather than ecosystems, are felt by stakeholders as the place where they live, work and depend on for their quality of life, and landscape services would be a more appropriate term, as it would enable the consideration of both natural and cultural aspects, spatial patterns, and the involvement of stakeholders. This paper aims at conceptualizing and discussing the effects of landscape composition and configuration on the provision of landscape services, taking into account the possible synergies and trade-offs among the provision of services as well as the appropriate spatio-temporal scales. From the results it is possible to conclude that the ecological concept of landscape services is more suitable than ecosystem services in supporting environmental management. In addition, it gives a multidisciplinary connotation to services based on the recognized landscape multifunctionality, it allows the data mapping, the identification of the appropriate spatial scale for the provision of specific services, and the involvement of stakeholders through the inclusion of their preferences.

S2.22 Microbial biomass and growth rate in three forest soils contaminated with PAHs

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Polycyclic aromatic hydrocarbons (PAHs) are organic compounds with mutagenic, genotoxic and carcinogenic properties. Although PAHs in soil can cause toxicity to microorganisms, the microbial community is able to degrade these compounds through the synthesis of extracellular enzymes with oxi-reductase activity. Since the use of indigenous microorganisms in bioremediation processes can reduce the risks associated with hydrocarbon contaminated soils, a better understanding of the effect of hydrocarbon contaminants on soil microorganisms may be of help in assessing the recovery potential of a soil.

The aim of the research was to study the microbial community responses to PAH contamination of soils belonging to three different Mediterranean ecosystems: holm oak, black pine and beech woods. Each soil was divided in three aliquots subjected to different treatments: spike with phenanthrene, pyrene and benzo[a]pyrene. The soils were incubated in unlit mesocosms under controlled conditions. After 4, 108 and 360 days PAH concentrations (microwave extraction and GC-MS/MS quantification), microbial growth rates (radioactive tracer incorporation techniques) and structure of microbial community (PLFA and ergosterol content) were measured. A permutational MANOVA (Multivariate Analysis of Variance) was performed to test the differences in PLFAs, ergosterol and microbial growth among treatments and sampling times. Along 360 days of incubation, PAH contents decreased in all the mesocosm types. Benzo[a]pyrene showed a slower decrease due to its low water solubility and high tendency to sorb to soil organic fraction, that make it scantly available for microbial community. The NMDS (Non-metric multidimensional scaling) results showed a clear separation among sampling times but not among the added PAHs for the three investigated soils. After 360 days from contamination no effects on the microbial community structure was observable, probably thanks to the high percentage (26.4% in holm oak, 38.0% in black pine and 31.5% in beech woods) of organic matter present in the investigated soils.

S2.23 Characterization of bacteria from a tunnelling construction site involved in sodium lauryl ether sulphate biodegradation

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The anionic surfactant Sodium Lauryl Ether Sulphate (SLES) is the main component of most foaming agents used for mechanized tunneling. Huge amounts of soil debris are produced during the excavation process and SLES biodegradability is a key point for the re-use of the excavated soil. SLES degradation depends on the presence of natural microbial populations colonizing the spoil material in the temporary deposit at the construction site. The aim of this study was to identify bacteria able to degrade SLES and to explore their bioremediation capacity for possible bioaugmentation purposes. Enrichment cultures were performed using as inoculum a spoil material collected from a real tunnelling construction site. Aliquots of soil were added in flasks containing minimal medium (MB) enriched with different SLES concentration (25, 50, 100, 200 mg/L) and maintained in the dark on a shaker at 130 rpm and 28°C. The pre-grown cultures from each condition were transferred to fresh media for other 7 days several times. The bacterial isolates that showed the highest growth rate, expressed as optical density (OD), contained 200 mg/L of SLES. It was tested the capacity of the bacterial isolate to grow on 14 different SLES concentrations (from 0.5 mg/L to 4g/L). At 24 hours the highest optical density value was observed in the culture medium enriched with 250 mg/L of SLES. Therefore, this concentration was used for the subsequent degradation experiment. At 9 hours, when the bacterial growth in MB+SLES 250 mg/L reached the maximum growth rate, 94% of SLES was biodegraded. The DNA was extracted and then sequenced with the Illumina method. *Pseudomonas* was the most abundant genus. The overall results confirm that SLES degradation can be performed bacterial species belonging to Gamma-Proteobacteria. The identification and isolation of natural bacterial strains able to degrade SLES has a great potential for bioaugmentation purposes in order to shorten the residence time of spoil materials in the construction sites.

S2.24 Early colonization of constructed Technosols by microarthropods

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One third of the soil of the world is moderately or severely degraded. At the same time, the continuous use of natural resources produces a large amount of waste materials. Recycling waste material in order to create Technosols is now considered as an appealing ecological and economic opportunity. Recent studies highlighted that Technosols can attract and host a large part of soil organisms, being an important reserve of biodiversity. Thus, the aim of this study is to investigate the early colonization (4 years) of constructed Technosols supporting meadow vegetation, by microarthropod community. The hypothesis behind is that, after 4 years, the microarthropod community structure will be similar to a typical grassland community.

Technosol has been built using three distinct technogenic parent materials: paper-mill sludge (PS), thermally-treated industrial soil (TIS) and green-waste compost (GWC). In order to establish a meadow, a mixture of grass plants was seeded in November 2007. Surface soil (5 cm deep, 5 cm diameter) was sampled for microarthropods in the first half of April of each year (2008 to 2011). Microarthropods were separated into 3 groups: Acari, Collembola and other microarthropods, and collembolans were identified at the species level. To study colonisation pathways along years, we conducted a functional trait-based approach using several functional traits, extracted from the BETSI database (http://betsi.cesab.org/).

Total microarthropod and collembolan densities increased significantly from the first year to the last year, changing also in species assemblages. Functional structure and composition of collembolan communities varied during the colonization. The functional richness significantly increased in the last year compared to the first year. However, after four years of experimentation microarthropod taxonomical and functional composition greatly differentiated from those found in other soils (meadow, forest or arable land), rejecting the hypothesis and suggesting that the community was still not mature.

S2.25 Regulating Ecosystem Services: supply and demand for air quality improvement and local temperature mitigation in the Municipality of Rome

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Urban areas are the result of dynamic interactions between socio-economic and biophysical processes; as a consequence, these are generally characterized by a high population density and intense economic activities. Urban living condition, which generally includes amongst others poor air quality, higher temperatures than the surroundings and noise pollution, is a serious threat for human health and wellbeing.

In this framework Nature Based Solutions (NBS) such as Urban Green Infrastructure (UGI) may contribute to improve human quality of life delivering Ecosystem Services (ES). Regulating ES leads, amongst a large variety of benefits, to cleaner air and water and to a mitigation of Urban Heat Island (UHI) effect, thus decreasing mortality and morbidity caused by air pollution and heatwaves. European Commission pushes toward the implementation of NBS as a cost-effective and sustainable way to cope with environmental, societal and economic challenges. A comprehensive and sustainable urban planning process should aim to adequately manage land use and land cover within urban areas in order to maximize the supply, namely the provision of ES, in areas where demand, defined as the need that society shows for a specific ES, is higher. In this framework ecological studies can support urban planning by providing information on ES dynamics regarding both supply and demand, thus identifying priority areas where proper land-use policies may produce remarkable benefits. In this research we mapped supply and demand for air quality improvement and local temperature mitigation in the Municipality of Rome in order to find areas where imbalance occurs. Elaborations were conducted in GIS environment by mean of spatially explicit environmental (including remote sensing, vegetation physiological and structural parameters, pollutant concentrations) and population density data.

S2.P1 Estimation of the avoided soil loss due to the application of the Desert-Adapt measures

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IPCC identified Mediterranean ecosystems as the most likely to be affected by climate change, with a tendency towards drier and hotter conditions. In Southern Mediterranean areas, already experiencing significant soil degradation and loss, a further exacerbation of climatic conditions will significantly affect soil and water capitals, ecosystem services and crop productivity. The LIFE project Desert-Adapt aims at enhancing the resilience and capacity to adapt to future climate change of these Mediterranean areas by applying an integrated land management plan (Desertification Adaptation Model DAM). In this study, we evaluated the impact of the applied land use and management measures on *potential soil erosion* by means of the Universal Soil Loss Equation. Four scenarios were analysed: actual scenario (business as usual BAU), future scenario with land use change (LUC), future scenario with SOM increase (SOM+), future scenario with LUC and SOM increase (LUC-SOM+). To calibrate the USLE model for the BAU scenario the variables used as inputs and outputs were taken from the real data measured in the 10 field sites of the project (4 in Italy, 3 in Spain and 3 in Portugal). Results indicate that the DAM application resulted in enhanced erosion control in most project sites. Soil loss was forecasted to decrease from an average of 11.7 ton/ha/y for the BAU scenario to an average of 7.71 tons/ha/y for the future scenario LUC-SOM+. According to the classification on potential soil erodibility proposed by Cencetti et al. (2005), all project sites showed a decrease in the degree of erodibility and 4 of them even changed erodibility class from high to medium. In this TIER I approach, the level of uncertainty for some of the sites was very high, indicating the need for a further analysis with finer modelling approaches, which will be the next step of the implementation plan.

S2.P2 Multitrophic interactions in a microscopic world: the role of *Lasioptera donacis*, *Arthrinium arundinis* and *Tripius gyraloura* in the biological control of *Arundo donax*

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The giant reed *Arundo donax* L. is among the most invasive plants on the planet and the biological control with insects seems the best long-term option for managing this weed. A candidate control agent is the leaf miner *Lasioptera donacis* Coutin (Diptera, Cecidomyidae). The insect cycle involves symbiosis with a saprophytic fungus (*Artrinium arundinis*), whose spores are deposited by the females during ovideposition. Furthermore, larvae of *L. donacis* are parasitized by the nematode, *Tripius gyraloura*. Trophic relationships between these species are not clear, limiting our understanding of the mechanisms underlying the control of *L. donacis* on *A. donax*.

In order to understand the multi-trophic plant-fungus-insect-nematode interactions, stable isotope analyses of the four species, as well as the quantification of *L. donacis* infestation by *T. gyraloura*, were performed in three Mediterranean populations (central Italy). Bayesian Mixing models suggested that the larvae fed both on the leaf sheath of *A. donax* and the fungal mycelium colonising the reed. We provided novel evidence indicating that larvae of *L. donacis* can display an omnivorous trophic behavior, and are able to feed on the reed even in the absence of the fungus. All the studied populations of *L. donacis* presented some individuals infected by the nematode. Nevertheless, the nematode did not modify the trophic behavior of the insect larvae, suggesting no impact of *T. gyraloura* on the control mechanism of *L. donacis* on *A. donax*. Our results support the importation of *L. donacis* in areas invaded by the reed without the need of a concomitant importation of the fungus *A. arundinis*. Since the effects of the fungus on other plant species or its virulence towards native plants are not yet known, it may represent an effective approach to the biological control of *A. donax* able to limit indirect and undesired effects on the invaded ecosystems.

S2.P3 Antiradical activity of the leaves of *Juglans regia*: influence of intercropping

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The application of a dedicated forest management seems to represent a valid remedy to mend those so-called "tired soils" (deprived soils owing to intensive agriculture) which are a global problem that is as timely as ever. Under a circular economy prospect, a challenge is represented by recovering plant material with little apparent economic value, such as leaves, that results from this type of management.

In this context, a former agricultural site was identified in Brusciana (Florence, Italy) where various forest associations have been established, namely white poplar (*Populus alba*) and common walnut (*Juglans regia*) (K), which were also intercropped along with other species such as hazelnut (*Corylus vellana*) (C), Italian alder (*Alnus cordata*) (A), and autumn olive (*Eleagnus umbellata*) (E). In order to evaluate possible economic and pharmaceutical value of leaf material deriving from the plantations, the antiradical activity of alcoholic extracts, rich in polyphenols, from common walnut leaves was tested using the DPPH and ABTS assays. The results show that the antiradical activity of walnut leaves is very high. However, both DPPH and ABTS assays show variations depending on the intercropping. In fact, in presence of autumn olive, both antiradical activities are much lower than the others. This could mean that there is an interaction between plants, which is shaped by soil.

S2.P4 How landscape transformations will change the role of tenebrionids in providing ecosystems services in arid lands? A case study in Central Asia

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Tenebrionids play extremely important ecosystem services as macrodetritivores essential to nutrient and energy cycling in Central Asian arid lands. The Ulan Buh Desert (Gobi Desert, China) is of paramount socio-economic relevance in Inner Mongolia and various measures have been adopted to facilitate human presence. Thus, vegetated lands are now embedded into true desert sectors. We investigated here the tenebrionid community structure in the Ulan Buh Desert along a vegetation gradient to gain insight into the possible response of these beetles to landscape alteration. Sampling was done with pitfall traps in three sites with different vegetation cover. Species abundance distributions were fitted by the geometric series model, which expresses the “niche pre-emption” hypothesis. Community structure was investigated using different measures of diversity, dominance and evenness. The three investigated sites showed similar species-abundance patterns, but the most dominant species varied among them. This suggests that the local environment operates a filtering action on the same basic fauna, allowing different species to dominate under different conditions. Thus, landscape transformation by moderately increasing vegetation cover (for example for sand fixation) will probably change local species composition, but not the basic community organization. Overall, the highest total abundance was observed in the true desert site, which is consistent with the ecological specializations of these beetles to cope with aridity. However, this site had a community structure similar to that observed in the site with denser vegetation. By contrast, the site with intermediate conditions showed a higher diversity and evenness. Thus, intermediate conditions of plant cover favour tenebrionid diversity, whereas a denser cover or a very sparse cover increase the dominance. This suggests that tenebrionids may act well in nutrient cycling at intermediate cover density, but their role in providing this ecosystem service in areas with denser vegetation promoted by anthropization might be diminished.

S2.P5 Melanisation controls decomposition dynamics of lichen thallus

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Decomposition of plant residues is a fundamental process of C cycle, widely studied to disentangle the effects of environmental conditions and litter molecular composition on decay rates in natural ecosystems. In the case of lichens, the rate of thallus degradation by soil microbiota may also be affected by peculiar biological and molecular properties of these symbiotic organisms. Among these, dark, melanin-like pigments, a variety of compounds that play a role in stress tolerance across several kingdoms, characterise the lower cortex of many foliose and fruticose lichens, due to heavy deposits at cell wall level. In this study, we tested the hypothesis that the melanised lower cortex protects lichens from degradation by the soil micro-flora. Five replicates of *Hypogymnia physodes* (L.) Nyl. samples with intact (M+) or mechanically removed (M-) lower cortex were buried under soil collected at two different forest ecosystems: spruce (S) and chestnut (C). Samples were enveloped in a 40 µm nylon mesh to exclude soil micro-fauna, incubated in controlled aerobic conditions (RH ~ 100%, T~15 °C, water potential between 0 and -1 MPa) and collected after 50, 100, and 150 days for mass loss assessment by gravimetric measurement and C and N content analysis. Mass loss rate and C/N ratio were consistently higher in M- compared to M+ samples in both soils, and in C compared to S soil within each type of lichen material, supporting the controlling role of cortex melanisation and highlighting interactive effects of soil properties and micro-flora on lichen decay rates. Consistently, microscopic observations showed thalline upper cortex and medulla more fragmented than the melanised lower cortex in all samples. As such, our study sheds a light on often neglected organisms that contribute to multiple functions and services in terrestrial ecosystems, such as nutrient cycling, water flux regulation and soil formation.

S2.P6 Measuring urban tree diversity in four cities of the River Po Plain: implication for ecosystem functioning

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According to the United Nations Report, the 55% of the current population lives in urban areas and it is estimated to increase up to 68% by 2050. Therefore, this will increase people vulnerability to environmental impacts, such as raising temperatures, air pollution and urban flooding. Green Infrastructure (GI) can mitigate these impacts offering a comprehensive set of ecosystem services. High diversity in urban areas, especially in terms of floral species and GI types, supports higher ecosystem functions and resilience.

The aim of this study is to estimate the urban diversity in 4 Italian cities, in the River Po Plain, with different history and urban development framework: Pavia, Mantova, Ferrara, Rimini. For each city, public green areas, public tree census as well as total population and municipal surface were considered. Moreover, the main diversity indices were calculated to estimate the respective biodiversity levels: Shannon-Wiener (H'), Pielou (J) and Margalef (d) indexes.

The results showed that Ferrara has the lower percentage of public green area on municipal surface (3%), while Rimini and Pavia have the higher percentage (12% and 11%). Moreover, Rimini has also the highest amount of green per capita. In terms of tree community indices, Ferrara is the city with the higher biodiversity level (J= 0,72, H' = 3,83) while Pavia is the last (J=0,41, H'=2,04).

In conclusion, the results show substantial differences among the 4 cities in terms of biodiversity indices, species composition and public green surface per capita, which reflect the respective urban characteristics. Such features are expected to correspond to differences in the provided ecological functions and effects on population that should be taken into account for the future urban planning and management.

S2.P7 Soil organic matter to reduce reactive nitrogen leaching in lowland agricultural soils

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Leaching experiments were conducted on a large (19.6 cm i.d.) intact soil column of 60 cm length. The soil column was retrieved in an experimental agricultural field (Ferrara, Italy). The soil (Hypocalcic Haplic Calcisols) is cultivated with a rotation of wheat and maize with synthetic fertilizers at a rate of 170 kg-N/ha/y. A rainfall simulator with an 8 channels high precision peristaltic pump (Minipuls-3 Gilson, UK), was employed to reproduce a storm event of 230 mm in 2 days. In the first experiment (U) 100 kg-N/ha of urea were employed as amendant, in the second experiment (RS) residual straws left in the field were employed and in the third experiment (C) 30 t/ha of mature compost were applied. Soil column effluent was continuously collected via fraction collector (Redifrac Pharmacia Biotech, SE) and water samples were analysed for total N, NO_3^-, NO_2^-, NH_4^+, DIC and DOC. Results highlight an elevated peak of NO_3^- (130 mg-N/l) in the U experiment due to complete urea nitrification in the upper soil horizon and a sharp decreasing trend of NO_3^- due to mixing and dilution with rainwater and partial denitrification. The RS experiment showed a smoothed NO_3^- peak (18 mg-N/l) with concentrations of DOC and DIC similar to the previous experiment. The C experiment showed flat NO_3^- concentrations (16 mg-N/l on average) in the eluted waters due to slow nitrification. DOC increased respect to the previous experiments, because of the dissolution of labile organic C pool present in the compost, which potentially trigger denitrification in groundwater. Overall, reactive N export was 385 mg-N in U, 69 mg-N in RS and 189 mg-N in C. This study shows that mitigation strategies to limit reactive N loadings, like residual straw incorporation and compost amendment, could decrease NO_3^- leaching towards groundwater after storm events.

S2.P8 Supporting learning on the ecosystem services approach through role playing game simulation in secondary schools

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The ecosystem service (ES) approach has gained importance because of the capacity to connect the functions that the ecosystems and landscapes can provide, with the end users that benefit from them, as well as with the multiple actors that can affect the delivery of the ES flow. Education about ES could be an effective means of communicating the importance of maintaining and managing the ecosystems for the multiple benefits they provide. Traditional learning methodologies, as frontal courses, can fail to produce the understanding and support learning on the complex relationships embedded in the management of natural resources, and landscape management, such as the connections between landscape functionality, the capacity of the ecosystems and landscapes to provide benefits for the civil society and multiple beneficiaries, and the stakeholders involved in the decision-making process.

This study applies a role-playing simulation approach to the learning process of students of different secondary schools. We tested the validity of the approach by means of pre- and post-survey comparisons. We replicated the experiment on a series of schools of different scientific subjects to verify the influence of previous knowledge and learning on the comprehension of ES arguments.

The learning approach was effective in producing learning, especially with respect to the series of learning objectives specified for the experiment, related to the understanding of the capacity of landscapes to provide ES, the relationship between ES supply and demand, and the interactions between actors in ES management. Such innovative learning methods, as role playing game simulations, has the potential to support learning-by-doing for the benefit of landscape protection and management, where environmental and socio-economic factors influence the decision-making process.

S2.P9 Linking bacterial and eukaryotic microbiota to litter chemistry: combining next generation sequencing with 13C CPMAS NMR spectroscopy

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Microbial succession over decomposing litter is controlled by biotic interactions, dispersal limitation, grazing pressure, and substrate chemical changes. Recent evidence suggests that the changes in litter chemistry and microbiome during decomposition are interdependent. However, most previous studies separately addressed the microbial successional dynamics or the molecular changes of decomposing litter. Here, we combined litter chemical characterization by ^{13}C NMR spectroscopy with next generation sequencing to compare leaf litter chemistry and microbiome dynamics using 30 litter types, either fresh or decomposed for 30 and 180 days. We observed a decrease of cellulose and C/N ratio during decomposition, while lignin content and lignin/N ratio showed the opposite pattern. ^{13}C NMR revealed significant chemical changes as microbial decomposition was proceeding, with a decrease in O-alkyl C and an increase in alkyl C and methoxyl C relative abundances. Overall, bacterial and eukaryotic taxonomical richness increased with litter age. Among Bacteria, Proteobacteria dominated all undecomposed litters but this group was progressively replaced by members of Actinobacteria, Bacteroidetes, and Firmicutes. Nitrogen-fixing genera such as *Beijerinckia* and *Rhizobium* occurred both in undecomposed as well as in aged litters. Among Eukarya, fungi belonging to the Ascomycota phylum were dominant in undecomposed litter with the typical phyllospheric genus *Aureobasidium*. In aged litters, phyllospheric species were replaced by zygomycetes and other ascomycetous and basidiomycetous fungi. Our analysis of decomposing litter highlighted an unprecedented, widespread occurrence of protists belonging to the Amebozoa and Cercozoa. Correlation network analysis showed that microbial communities are non-randomly structured, showing strikingly distinct composition in relation to litter chemistry. Our data demonstrate that the importance of litter chemistry in shaping microbial community structure increases during the decomposition process, being of little importance for freshly fallen leaves.

S2.P10 Environmental drivers of the proliferation of urban spiders and their webs in the down-town district of Turin (NW-Italy)

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Due to air pollution, web aggregations of weaving spiders living in urban environment may entrap dirt particles over time, determining an aesthetic impact on building facades and street furniture. In Europe, the most common species causing aesthetic nuisance is *Brigittea civica* (Lucas) [Araneae: Dictynidae]. In spite of the socioe-conomical relevance of the problem, the ecological factors driving the proliferation of this species and its webs in urban environment are poorly described and the effectiveness of potential cleaning activities has never been discussed in scientific literature. Over one year, we studied the environmental drivers of *B. civica* webs in the arcades of the historical down-town district of Turin (NW-Italy). We selected a number of sampling plots on arcade ceilings and we estimated the density of *B. civica* webs by means of digital image analysis. In parallel, we collected information on a number of potential explanatory variables driving the arcade colonization, namely artificial lighting at night, substrate temperature, distance from the main artificial light sources and distance from the river. Regression analysis showed spider web coverage increased significantly with higher light intensity, with major effects related to the presence of historical lampposts with incandescent rather than halogen lamps. We also detected a seasonal variation in the web coverage, with significant higher values in summer. Stemming from our results, we are able to suggest good practices for the containment of this phenomenon.

S2.P11 Environmental matrix effects on stress biomarkers in forager honey bees in Umbria

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Umbria Region is considered as the "green heart of Italy" for its prominent and variegated nature. The heterogeneous territory and the introduction of heavy metals into environment following the activity of urbanized or agricultural sites may directly impact living organisms or affect their trophic networks. A crucial role in bioindication is showed by the honey bee, Apis mellifera ligustica (Spinola, 1806), for its sensitivity to changes in environmental parameters and their ability to accumulate contaminants. The aim of the present research was to investigate the effects of the environmental matrix on several oxidative stress biomarkers, such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (SeGPx), glutathione S-transferase (GST), glutathione reductase (GR) in gut and acetylcholinesterase (AChE) in head of forager honey bees. The investigation was carried out on randomly selected samples collected from thirty-six honey bee colonies located in urban, forested and agricultural areas. Enzyme activities were analyzed by means of generalised additive models (GAM), taking into account several environmental parameters and bioaccumulation levels of eight heavy metals: Cd, Pb, Cr, Ni, Zn, Cu, Mn, and Fe. Honey bees showed different body accumulation levels of heavy metals through the sampling sites, with the exception of Pb and Fe. Moreover, a principal component analysis on heavy metals in bees assessed their joint impact on the enzyme activities. In particular, the activities of SOD, CAT and GST showed a statistically significant positive correlation to the first component, mainly driven by high concentrations of Cr, Fe, Mn, and Zn, acting as essential micronutrients in agriculture. In contrast, no correlation was recorded between first principal component and SeGPx, GR and AChE. Resulting data suggest that response of cited biomarkers (SOD, CAT and GST) in forager honey bees may be a suitable tool assessing metals contamination of urban, forested and agricultural areas.

S2.P12 Effect of fire on soil biology quality in high-altitude habitats in Central Italy, with implications for soil ecosystem services management

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Edaphic microarthropods play crucial roles in soil ecosystem services, such as water supply, nutrient cycling, and flood and erosion control. Fire is a large-scale disturbance regime destroying the preferred part of the soil habitat for most soil organisms, i.e. the litter and uppermost humus layer. We investigated the effect of fire on the edaphic fauna in three habitats (a pinewood reforestation, a natural beechwood and a grassland) in a burnt upland plain in the Abruzzi (Central Italy) one year after the fire event. Microarthropods were sampled with a standard procedure commonly used to calculate the index of soil biological quality (QBS-ar). We compared soil samples from burnt and unburnt sites for all three habitats by using: (1) the ecomorphological index EMI, which is based on the degree of morphological adaptation to the edaphic life; (2) the QBS-ar index, resulting from the highest EMI value recorded in each burnt and unburnt habitat; and (3) the taxonomic composition of the various communities. We used ANOVAs to test the effect of fire on QBS-ar values and a SIMPER analysis to highlight the relative response of different taxa to fire. In general, burnt habitats had lower QBS-ar values than the unburnt ones. The unburnt beechwood had higher QBS-ar values than the pinewood (both burnt and unburnt) and the burnt grassland, whereas no significant difference was found with the unburnt grassland. The burnt pinewood was the habitat with the lowest QBS-ar values. The taxa mainly responsible for between-habitat differences were Pseudoscorpionida, Symphyla and Diplura. These results suggest that not only fire affects negatively soil arthropods, but also that pinewoods have low quality soils, which are particularly vulnerable to fire. Thus, using pines for reforestation would be likely inappropriate for post-fire recovering of soil services, for which microarthropod groups are important.

S2.P13 Carbon pool in agricultural soils of Southern Italy affected by flooding

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The soil as a part of natural capital offers key services for the agricultural sector, such as food provisioning, carbon sequestration, nutrient cycling and water regulation, which are all interconnected. It contains about 1500 Pg of organic carbon (to 1 m of depth) worldwide exceeding the quantity of C stored in phytomass and atmosphere. The soil organic carbon (SOC) regulates the main ecosystem services offered by soil, therefore, its reduction can seriously threaten them. SOC decrease is particularly worrying in the Mediterranean basin characterized by climatic conditions favoring the decomposition (drought, low water retention capacity, low depth) and unsustainable agricultural practices that increase erosive processes. The aim of this study was to investigate the changes in SOC pool in the agricultural soils of Southern Italy, affected by flooding of the nearby river causing many concerns in the population due to direct damage to materials and possible pollution. Soil samples were analyzed from 12 sites (9 flooded and 3 not flooded) to determine the organic carbon content and bulk density, known to be useful properties for assessing the ecosystem's carbon storage service. Combining this data with the soil depth, soil carbon pool per hectare was calculated for each soil. Results indicated higher values of C pool in flooded soils compared to non-flooded ones, pointing out that the flooding events can positively affect the ecosystem service of carbon storage. This could translate, in the long term, into an increase in crop yields too.

S2.P14 Habitat suitability predicts individual performance and reproductive fitness in the alpine endemic spider *Vesubia jugorum* (Simon, 1881)

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To date, the relation between habitat quality and functional traits related to species' fitness has been tested almost exclusively in plants. For the first time, we investigated the degree to which morphological and reproductive traits in a terrestrial invertebrate varied along a gradient of habitat quality projected via Species Distribution Models (SDMs).

We performed SDMs to model habitat suitability for the alpine spider *Vesubia jugorum* (Araneae: Lycosidae) in order to investigate species-environment relations and project habitat quality across the species' range, using climatic, topographical and geomorphological predictors. We collected specimens in 40 locations across the species' range and measured their body size and egg-case size as functional traits related to reproductive success. We investigated the degree to which functional traits measured in individuals collected across the species' range varied along the gradient of habitat quality projected by SDMs.

The models revealed a positive relation between the probability of presence and cumulative precipitation, percentage of rock and duration of snow coverage. Body and cocoon size of *V. jugorum* were positively related with habitat quality as approximated via SDM projections: the largest individuals, and the females with the largest cocoons, occurred in the core of the species' distribution, where the amount of predicted high-quality habitat was greatest. This area roughly corresponds to the massif of Argentera, in the Southwestern Alps, an area encompassing several Pleistocenic refugia, as reported for many other endemic species–especially plants–occurring in the region.

Our work provides the first evidence of a significant positive association between projected habitat quality and morphological and reproductive traits in a terrestrial invertebrate. Given that *V. jugorum* is classified as Endangered in the IUCN Red List, measuring variation in its morphological traits may represent a practical, non-invasive means of assessing population health through time and as climate changes.

S2.P15 Monitoring of Land Cover in Italy through remote sensing

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Monitoring the land cover and its evolution is critical for safeguarding and enhancing the environment. The use of free multispectral data provided by the Sentinel satellites as part of the Copernicus program, allows for the creation of an innovative semi-automatic classification system of land cover able to providing diachronic information with high spatial, temporal and thematic details. One of the main purposes of this study is to develop a methodology to allow for the production of periodic map updates, in particular detecting land cover changes.

ISPRA has produced a land cover map for the whole Italy referred to 2018 using Sentinel 1 and Sentinel 2 data, maintaining their specifications in terms of maximum spatial resolution (10m) and reference system (WGS84 UTM). In order to ensure consistency with future Copernicus products, the classification system was designed considering the definitions of land cover produced at European level by the EAGLE group (EIONET Action Group on Land monitoring in Europe).

The adopted classification system refers to: abiotic surfaces, Vegetated surfaces (broad-leaved and coniferous, permanent and periodic herbaceous vegetation), Water surfaces.

The processing is defined for each class in order to produce an intermediate classification and is based on the elaboration of multitemporal spectral indices (such as NDVI, NDWI or NDSI) to distinguish vegetated and non-vegetated areas, to reconstruct the phenological trend of vegetation and reduce seasonal variability. The processing phase includes the classification through a rule-based approach to integrate the various parameters and spectral indices and an integrated multitemporal analysis of Sentinel-1 and Sentinel-2 images. Following the intermediate classification of the individual classes, an appropriate phase of integration between the classes was carried out.

S2.P16 Nutrient elements in a bean ecotype "Lenzariello" from the Alto Casertano area, Campania Region, Italy

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The particular geo-pedological and climatic conditions of Campania have allowed the development of a varied horticulture and fruit-growing, cultivating a wide range of species even with very different thermal needs. The rediscovery and study of local varieties, in addition to being a means to safeguard cultivars at risk of genetic erosion, allows enriching the offer of existing products and expanding the range with native varieties, which are characterized by specific nutritional and health properties, being not levelled on common organoleptic standards.

Beans are one of the vegetable products whose biodiversity has been preserved the most as a result of their progressive marginalization in modern food, legumes are used less than in the past; the bean is a plant mainly cultivated by elderly "guardian farmers", for a sort of "cultural resilience", which have continued to preserve the seed accurately from year to year, re-seeding it, up to our days. The bean is an annual, bush or climbing plant; seeds stored in a cool, dry place can withstand a few years, then lose their germination capacity.

The goal of this work was, therefore, to test the contents of some macro- and micro-nutrients essential (Na, Mg, Ca, Fe, Zn, Mn) in a bean ecotype, the bean "Lenzariello", recovered by the custodian farmers present in the Alto Casertano area. In particular, beans were sampled in three different areas: Caiazzo, Villa S. Croce and Ruviano to evaluate if the different chemical-physical characteristics of the soil affect the content of essential nutrients. The results showed high nutrient content of this variety compared to commercial species, regardless of the cultivation fields.

S2.P17 Bioavailability and cometabolism of pyrene in chemotactic bacteria

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Polycyclic aromatic hydrocarbons (PAHs) are poorly available in soils due to their interaction with the matrix. Bacterial chemotaxis promotes the contact probability between degrader organisms and pollutants, increasing bioavailability and thus biodegradation rates. *Pseudomonas putida* G7 is known to be able to use naphthalene as a growth substrate and to respond chemotactically to naphthalene and salicylate, a common intermediate in PAH metabolism, showing smooth movement and positive taxis. We have used the strain G7 as a model organism for evaluating the possible role of motility in bioavailability of high molecular weight PAHs adsorbed. For this purpose, batch incubation experiments, using the strain G7 in mineral medium with ^{14}C-labelled pyrene loaded on silicone o-rings (which acted as a passive dosing system) were set up. The time course evolution of the ^{14}C-pyrene equivalents in culture fluids revealed a linear increase in the presence of G7, achieving concentrations well above the equilibrium concentration observed in abiotic controls. HPLC quantification indicated the transformation of pyrene into water-soluble metabolites. Interestingly, strain G7 was unable to mineralize pyrene (<0.1%), indicating that this was a co-metabolic reaction. To evaluate the adsorption of pyrene to cell surfaces, culture fluids were centrifuged and supernatants and bacterial cells were analyzed independently. Only after 48 h a major fraction of ^{14}C-label was detected in the pellet, indicating the sorption of pyrene to bacterial cells. In sand-filled percolated columns we were able to test how salicylate influenced bacterial transport through a change in motile behavior; in fact, it promoted accessibility of strain G7 to distantly located ^{14}C-pyrene, dosed in o-rings. Compared to the chemoeffector-free controls, salicylate significantly stimulated bacterial transport. The concentration of pyrene in column effluents evidenced that the bacteria were mobilized to the distant pyrene source. The overall results indicate that bacterial motility and chemotaxis can be relevant for long-distance bacterial transport in soils, and contribute to co-metabolize poorly bioavailable contaminants. These results can have implications for the development of more efficient bioremediation strategies.

S2.P18 Climate-driven convergent evolution of plumage colour in a cosmopolitan bird

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The investigation of phenotypic diversity across geographical gradients is pivotal to understanding the evolution and adaptive functions of alternative phenotypes. The aim of the present study was to examine whether the polymorphism in ventral plumage colouration observed in the cosmopolitan common barn owl group was determined by climatic factors, such as temperature and rainfall, consistently with Gloger's and Bogert's biogeographical rules. We analysed the variation in heritable melanin-based plumage colour according to annual temperature and rainfall in 9110 individuals of the cosmopolitan barn owl, with three distinct evolutionary lineages representing its entire distribution range: the Afro-European *Tyto alba*, occurring between Scandinavia and South Africa, the American *T. furcata*, found from Southern Canada to Patagonia, and the Australasian *T. javanica*, living between the Himalayan Plateau to Tasmania. Although the geographical distribution of colour morphs is heterogeneous among the lineages, in all of them plumage colour becomes darker at increasing annual rainfall, indicating a convergent selection of darker morphs in humid habitats possibly to improve camouflage against the dark environment and/or to repel water more efficiently. Moreover, in *T. alba* and *T. furcata*, melanisation increases at decreasing temperature, suggesting its possible role in thermoregulation. These findings provide convincing evidence of repeated evolution of similar body colouration patterns at a worldwide scale compatible with the main biogeographical rules, while emphasizing the possible role of melanin-based traits in animal adaptation to climate change.

S2.P19 Loss of soil organic carbon in areas at desertification risk of Southern Europe

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Soil organic matter (SOM) is a key component of the natural capital in terrestrial ecosystems because it is involved in many ecosystem services, such as food provisioning, water retention, C sequestration and nutrient cycling. Soil microbial biomass is the living part of soil organic matter regulating the processes of nutrient transformation and cycling, and soil organic matter decomposition. Soil organic matter loss due to desertification processes may cause a reduction of SOM-related ecosystem services. Within the LIFE DESERT-ADAPT Project "Preparing desertification areas for increased climate change", carried out in areas at risk of desertification in Italy, Spain and Portugal, we evaluated the changes in total organic C (C_{org}) and microbial biomass C (C_{mic}) in soils differing for plant cover (woodland, shrubland, grazing land, cropland). Overall, 10 study areas were selected (4 in Italy, 3 in Spain and 3 in Portugal). In each area, several sites with different plant covers were chosen to evaluate C pool changes among different plant covers, in each country, and among different countries, for the same plant cover type. Results generally showed very high decrease of soil C_{org} and C_{mic} in shrublands, grazing lands and croplands, as compared to woodlands of each country. Compared to Italian and Spanish soils, Portuguese ones showed the lowest absolute values of C pools, also in woodland. To address this alarming condition observed in studied soils, site-specific Desertification Adaptation Models (DAMs) are being applied in private and public lands selected within this LIFE Project, in order to improve land quality, soil conservation, plant support and, consequently, socio-economic development.

S2.P20 Does the Alpine Chough (*Pyrrhocorax graculus*) track grasshoppers along the altitude gradient above the treeline?

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Mountain ecosystems undergo several transformations due to variations in land use, temperature raise and recreational activities. These modifications can lead to changes in the alpine environment such as the decrease of invertebrate prey for birds. However, few studies focus on the trends of different groups joint by trophic links. The Alpine Chough, *Pyrrhocorax graculus*, has a grasshopper-based diet during the summer corresponding to the reproductive period. In the present research we describe the spatio-temporal distribution of Alpine Choughs and grasshoppers in two areas of the north-western Italian Alps characterized by different level of human disturbance. The aim of the study was to verify whether the spatio-temporal distribution of birds was similar to the one of grasshoppers, highlighting potential differences between areas. In 2017, to study Alpine Chough spatio-temporal trend, we focused on two highly frequented zones within the study areas where we recorded bird flock size, altitude and day. To evaluate grasshopper abundance trend, we realized periodical (twice a month) altitudinal transects. We analyzed the relationship between flock size and grasshopper abundance, altitude, period and site using GLMMs. Results showed that in both areas flock size increased with grasshopper abundance. This trend, however, changed according to elevation since at higher altitude the relationship became negative. Moreover, grasshoppers showed a highly variable abundance according to the sampling plot (i.e. microhabitat features) that birds seemed unable to follow. In conclusion, natural prey availability and bird distribution proved to have similar trends, however we do not know to what extent Alpine Choughs are able to follow small-scale prey abundance variations. Furthermore, given that the abundance of grasshoppers was significantly lower in the disturbed area, we hypothesize that human activities may negatively influence the general abundance of prey and the foraging behaviour of the predator as well.

Sessione 3:
Capitale Naturale ed Ecosistemi Marini ed Oceanici

Prof. Roberto Danovaro
Università Politecnica delle Marche e Stazione Zoologica Anton Dohrn

Natural Capital and Ecosystem Services in Marine Ecosystems

Ecosystem services (the benefits people derive from functioning ecosystems) are increasingly being recognized as essential to sustainable human well-being. These services are increasingly threatened by human activities and global change. Oceans and coasts provide a significant portion of ecosystem services, which are related to the biodiversity and the natural capital. We need to significantly improve our understanding of the complex interconnections between ecosystems services and biodiversity and of how natural capital can make sustainable the human well-being, allowing us, at the same time, to make better management decisions. In addition, an effort should be made to include the deep ocean, which represent more than 95% of the ocean biosphere and are typically neglected in all assessments. The Mediterranean Sea, on the light of the multiple stressors, impact of human activities and global change is a timely and unique test bed to facilitate these advances, with applications to a broad range of critical marine issues, in addition, this miniature ocean provides tolls to anticipate the potential changes occurring in world oceans in the coming decades.

S3.1 Ocean acidification effects on top-down control of the key species *Paracentrotus lividus* in marine benthic ecosystems

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Oceans are becoming increasingly acidic due to anthropogenic emissions, dramatically threatening a wide range of marine species and, through cascading effects, also marine ecosystems and coastal communities economies. This study investigates the effect of Ocean Acidification on prey-predator interaction in one relevant trophic cascade of Mediterranean benthic ecosystem, involving the key species *Paracentrotus lividus*. The aim is to assess potential disequilibrium in top-down control mechanisms, to take into account also for planning management action in changing oceans.

An integrated approach of laboratory and field experiments has been implemented. Sea urchins have been firstly exposed to experimental OA conditions for three months in laboratory aquaria, measuring different morphological and mechanical parameters (test thickness, spines length, tenacity, robustness) as a proxy for their ability to defend from a predator attack. Then, they were directly exposed to predation pressure, transferring all the specimens in the field within a Marine Protected Area, where predation pressure is generally high due to the reserve effect.

Acidic-conditioned sea urchins presented thinner and less robust tests and shorter spines then lab-controls and wild-controls, suggesting decreased defense ability. Conversely, substrate tenacity did not change according to lowered pH. After 72 hours of *in-situ* experiment, predation rate on acidified sea urchins was around 90%, significantly higher than the control treatments (81% and 58% for lab-controls and wild-controls respectively).

These results suggest that under future Ocean Acidification scenarios, sea urchins defense strategies will be greatly compromised, as well as their survival chance to natural predators, enhancing trophic disorders due to other anthropogenic stressors (*i.e.* overfishing) and producing dramatic cascading effects on coastal ecosystems.

S3.2 Ecosystem functioning and efficiency loss in degraded coastal ecosystems: a case study from *Cystoseira spp.* meadows and barren grounds in the Mediterranean Sea

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Habitat loss, fragmentation and degradation have been recognized as major threats for biodiversity worldwide. This particularly affects ecosystems based on habitat-forming species, considered as ecosystem engineers able to sustain high levels of associated biodiversity and ecosystem functioning, thus ensuring high levels of productivity. In the Mediterranean Sea canopy-forming algae form some of the most diverse, productive and valuable ecosystems along intertidal and shallow subtidal rocky coasts, as those formed by *Cystoseira spp.* The effects of *Cystoseira spp.* forests regression have been so far assessed mostly on biodiversity, but few studies have been conducted on the loss of ecosystem functioning and efficiency. Even fewer studies have been conducted on the smallest biotic components, prokaryotes and meiofauna, which have a prominent role in the biogeochemical cycles, matter recycling and transfer of energy and organic matter along the food web. The aim of the present study was to investigate the relationships between biodiversity and ecosystem functioning and efficiency in macroalgal forests vs barren grounds in six areas of the Western-Central Mediterranean Sea, characterized by the co-occurrence of these alternative states. To test the null hypothesis that biodiversity, ecosystem functioning and efficiency did not vary between macroalgal forests and barren grounds, we investigated the organic matter degradation rates, prokaryotic abundance and biomass and their relationships with meiofaunal (at higher taxonomic level) and nematode diversity (in terms of structural and functional/trophic diversity and life-strategies). All the investigate variables showed a significant and positive effect of the presence of algal forests and a strong relationship between biodiversity and ecosystem functioning. Our results indicate that the loss of *Cystoseria spp.* forests and their transformation into barren grounds lead to the collapse of ecosystem functioning and efficiency. We provide evidence that the restoration of algal forests is essential to recover the ecosystem functioning of degraded hard bottoms.

S3.3 Whale shark seasonal presence, residence time and habitat use in the Gulf of Tadjoura, Djibouti

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Whale sharks (*Rhincodon typus* Smith, 1828) are generally associated with environmental factors that drive their movements to specific locations where food availability is high. The Gulf of Tadjoura (Djibouti) is widely recognized as an important site where the whale shark seasonally aggregates. However, despite an increase in the number of studies, information on the whale shark ecology is still lacking. In order to understand which factors influence the presence of whale sharks in Djibouti, during 2016-2018, the surface zooplankton community was sampled from October-February. The residency patterns of whale sharks was investigated by photo-ID surveys. Visual matches of the unique spot patterns of each shark were validated by I^3S pattern-recognition software. During 2015-2018, 190 individuals were identified, of these, 84.6% were males and 15.4% females, confirming Djibouti as a male-based aggregation site Excluding the single-sighting sharks, 62.8% of individuals were only observed in 1 year, 29.1% in 2 and 8.1% in 3 consecutive years. Analyses of samples collected in presence of whale sharks showed a taxonomic composition mainly composed by copepods (82.3%). Among non-copepods, Luciferidae, Chetognata and Appendicularia were the most abundant taxa. Among multiple sampled sites, whale sharks occurred in bays that showed higher zooplankton biomass ($Z = -2.85$; $p = 0.0043$). A temporal trend in zooplankton biomass was found, with an increase in October-December and a decrease up to February. Records of whale sharks correlated significantly with mean zooplankton biomass over the sampling period ($r = 0.65$; $N = 22$; $p = 0.0012$). The relationship was more evident in January, when zooplankton biomass had already started to decrease ($R^2 = 0.6$, $N = 22$, $P < 0.0001$). This study supports the hypothesis that the temporal trend in zooplankton biomass is the primary driver for the whale sharks use of Djibouti as a feeding ground during those months.

S3.4 Reduced genetic connectivity among Mediterranean populations of the sunset cup coral (*Leptopsammia pruvoti)* assessed by 2bRAD sequencing

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Marine bioconstructions such as coralligenous formations are hot spot of biodiversity and play a relevant ecological role in the preservation of biodiversity by providing carbon regulation, protection and nursery areas for several marine species. For this reason, the European Union Habitat Directive included them among priority habitats to be preserved. Despite their ecological role is well-established, connectivity patterns are still poorly investigated, representing a limit in conservation planning. The present study pioneers a novel approach for the analysis of connectivity in marine bioconstructor species, which often lack suitable genetic markers, by taking advantage of next generation sequencing techniques. We applied the restriction site associated 2b-RAD approach to genotype over 1,000 high quality and filtered Single Nucleotide Polymorphisms in 10 population samples. The results revealed the existence of a strongly supported genetic structure, with highly significant pairwise F_{ST} values between all the population samples, including those collected few kilometers apart from each other.

All in one, our results highlight the importance of assessing connectivity in species belonging to coralligenous habitats as, due to their limited dispersal ability, they might require specific spatial conservation measures.

S3.5 Natural capital and ecosystem services assessment in marine ecosystems

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The awareness about the importance of evaluating and conserving natural capital stocks has increased among both scientists and policy makers. The concept of ecosystem services has been developed to remark the vital support provided by nature to human economy and well-being. Marine and coastal ecosystems are among the most productive environments in the world and their stocks of natural capital offer a bundle of vital ecosystem services. The exploitation of marine ecosystems generates goods, services but also environmental impacts. In this context, environmental accounting represents a useful tool for the assessment of multiple aspects dealing with marine resources exploitation, among which the most relevant are the sustained environmental costs, received benefits, and generated impacts. The Italian Ministry of the Environment and Protection of Land and Sea funded a research programme for the implementation of an environmental accounting system for all the twenty-nine Italian Marine Protected Areas (MPAs). The main goal is the assessment of the biophysical and economic value of natural capital stocks and ecosystem services flows generated by MPAs. In this paper, we present the main results of this research programme at local and national level. The developed environmental accounting system can play an important role for the management and monitoring of MPAs, supporting both local managers and policy makers committed to ensure conservation of natural resources and sustainable development targets.

S3.6 An integrate approach to detect change in the natural capital: the case of the deep-water red shrimps in the North-western Ionian Sea

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Fisheries resources are provisioning ecosystem services contributing for food security and human nutrition. Unfortunately, the percentage of stock fished at unsustainable level is progressively increasing on Mediterranean and global scale. This is the case of the deep-water red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus* two of the most valuable deep-water resources of the Mediterranean Sea. Their fluctuating abundance and exploitation condition have been largely documented in the North-western Ionian Sea in the last two decades. Abundance oscillations have been observed for both shrimps with an increase of *A. foliacea* during 2003 and 2013 complementary to the decrease of *A. antennatus* which did not exhibit any trend. Most probably, a hydrographic regime shift manifested during the transient phenomenon, with warmer and higher salinity waters, could have favoured *A. foliacea* and not *A. antennatus* which shows a much wider depth distribution. In relation to these observed changes, two mass-balance Ecopath models were implemented to describe the demersal assemblages sampled. Data of Biomass (t/km^2), Production and Consumption annual rates, Diet, Landings and Discards (t/km^2) have been used to model the effect of the regime shift occurring in the food webs during the late 90s. The Keystoness index (KSi) has been calculated for each Functional Group (FG) to assess the temporal changes in their trophic impacts. The deep-water red shrimps have been represented as two single FGs. In the contest of several changes recorded in the food-webs during two temporal snapshots (1995-1997 vs 2005-2007), an increased keystone ranking of *A. foliacea* was observed during 2005-2007 while no change was detected in the keystone role of *A. antennatus*. This latter integrate approach seems to confirm the different dynamics of these deep-water resources, highlighting the need of assessment and management with respect to both climate change and direct anthropogenic pressures, such as the fishing activity.

S3.7 Plastic-associated harmful phytoplankton assemblages in coastal and off-shore habitats of the Mediterranean Sea

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The Mediterranean Sea is a sensitive ecosystem exposed to densely coastal urbanized zones, which can increase marine debris. Among marine debris categories originating from sea-based and land-based source there is the plastic debris. Plastics (micro and macro plastics) in marine environment are durable and persistent pollutants that may alter pelagic and coastal ecosystem functions. They represent a substrate that can be colonized by micro- and macro-organisms enabling their dispersal from native to new habitats. Plastic debris has been considered to play a role in the dispersal of toxic compounds having implications for humans and marine organisms across the marine food web. This study aims to identify and quantify target harmful phytoplankton taxa potentially attached to numerous samples of micro -and macro -plastics collected in the coastal waters and off-shore of the Mediterranean Sea by the quantitative PCR assay. Moreover, FTIR spectroscopy allowed the identification of plastic polymers of the collected samples. All plastic samples were positive for the presence of both Dinophyceae and Bacillariophyceae by qPCR and some of them were found positive for the toxic species of dinoflagellate *A. pacificum*, *A. minutum*, *O.* cf. *ovata* and diatom *Pseudo-nitzschia*. Strains of *A. pacificum* isolated from plastic debris and analysed by LC-HRMS resulted to produce PST (paralytic shellfish toxin). Moreover, the capacity of plastic surface to be colonized rapidly by harmful phytoplankton species was demonstrated *in vitro* calculating their adhesion rate. The dinoflagellate *A. pacificum* adhered to the plastics most rapidly, followed by some diatom species. The results of the present study demonstrated the presence of noxious microbiota attached to the plastics floating in the Mediterranean Sea. The potential risk of harmful microalgae dispersal associated with plastic pollution was illustrated as well as the potential chemical compounds transfer through the trophic chain with consequent implications for human health and marine ecosystem.

S3.8 Echinoculture as a potential tool to mitigate harvesting pressure on natural sea urchin stocks: first steps towards an eco-sustainable approach

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Sea urchins play a key ecological role because, being herbivore, can greatly impact habitat structure. At the same time, they are highly exploited species as their gonads are considered a delicacy. One of the most critical consequence of the high global demand is the decline in sea urchin natural stocks due to the uncontrolled harvesting. Despite the implementation of passive conservation measure, stock decline of the most important commercial species is ongoing, highlighting the need of an active intervention. Echinoculture is identified as a profitable option for sustainable sea urchin production, being able to fill the gap between market demand ad natural supplies. However, some bottlenecks, such as the use of natural juveniles and the lack of proper sustainable diets, still exist and lead to use natural resources that are already widely exploited by human activities. To move towards a higher sustainability of echinocolture, we aimed at the formulation of low-impact and sustainable feeds for *Paracentrotus lividus*. First, we identified proper ingredients for manufacturing sustainable feeds, by testing different terrestrial vegetables and marine macroalgae, and their effects on *P. lividus* gonad yield and quality. Then, new low-cost and fully eco-friendly feeds, made of only food processing and fishing industry discards, were formulated and their effectiveness evaluated in terms of gonad production and quality. After 12 weeks, we observed a significant increase in gonado-somatic index and lipid content, as well as an improvement of gonad colour and a faster gonadal maturation in *P. lividus* fed with the new sustainable feed, compared with wild specimens. Despite this represents a small-scale pilot study, these encouraging results highlight that sustainable echinocolture is feasible and represents a promising tool to mitigate harvesting pressure on natural stocks, but further research is needed to develop large-scale practices.

S3.9 Seagrasses compartments constitute a highly variable microenvironment for the associated epiphytic microbial community

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Understanding the structure and the driving forces that shape the microbial community associated with seagrasses is still a challenge, and previous studies have had various outcomes.

In this study, we analyzed the microbial communities associated with monospecific patches of *Posidonia oceanica* and *Halophila stipulacea* found in the same area. The aim of this work was to assess the driving shaping forces of the seagrasses microbial epiphytic communities. We have, thus, analyzed the epiphytic microbial communities associated with the aboveground and belowground plants compartments in the same environmental conditions and compared them with the microbial communities within the environmental matrices (seawater and sediment).

The identification of the microbial communities has been performed by the 16S rDNA amplicon sequencing approach. To highlight the environmental frame of the study and the environmental pressure subjected by the plants, the environmental biochemical features such as and plants biochemical markers have been evaluated.

The outcome of this study showed that the microbial communities within the seawater surrounding the two plant species patches were identical and only slightly different in the corresponding sediments, with an almost complete overlap of replicates. The microbial communities associated with the two species of seagrass, instead, showed a high variability between the species and even within the species, although they appear to be highly diversified between leaves and root/rhizomes, suggesting that seagrass constitute a highly variable microenvironment. Hence, it can be supposed that, on the base of the available pool of microbes, specific members are included or excluded in the plant associated community according to microenvironmental conditions. Each replicate of plant associated microbial communities, in fact, presented a different profile dominated by few families that could potentially perform redundant metabolic jobs, suggesting that the plants epiphytic microbial profile might be taxonomically but not functionally different.

S3.10 Modelling Macroalgal Forest Distribution at Mediterranean Scale: Present Status, Drivers of Changes and Insights for Conservation and Management

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Macroalgal forests are one of the most productive and valuable marine ecosystems, but yet strongly exposed to fragmentation and loss. Detailed large-scale information on their distribution is largely lacking, hindering conservation initiatives. In this study, a systematic effort to combine spatial data on *Cystoseira* C. Agardh canopies (Fucales, Phaeophyta) was carried out to develop a Habitat Suitability Model (HSM) at Mediterranean scale, providing critical tools to improve site prioritization for their management. A georeferenced database on the occurrence of 20 *Cystoseira* species was produced collecting all the available information from different sources. Data were associated to 55 predictor variable layers in the (ASCII) raster format and were used in order to develop the HSM by means of a Random Forest, a very effective Machine Learning technique. Knowledge about the distribution of *Cystoseira* canopies was available for about the 14% of the Mediterranean coastline. Absence data were available only for the 2% of the basin. Despite these gaps, our HSM showed high accuracy levels in reproducing *Cystoseira* distribution so that the first continuous maps of the habitat across the entire basin was produced. Misclassification errors mainly occurred in the eastern and southern part of the basin, where large gaps of knowledge emerged. The most relevant drivers were the geomorphological ones, followed by anthropogenic variables proxies of pollution and urbanization. Our model shows the importance of data sharing to combine a large number of spatial and environmental data, allowing the selection of areas with high probability of *Cystoseira* occurrence. This approach encourages the use of this modelling tool for the prediction of *Cystoseira* distribution and for supporting and planning conservation and management initiatives, including restoration. The step forward is to further refine the spatial information of presence-absence data about *Cystoseira* canopies and environmental predictors to address species-specific assessments.

S3.11 Is there a link between coralline barren habitat and megafauna abundance and biodiversity in shallow rocky reefs?

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Despite megafauna is recognized as important component in most marine ecosystems, factors affecting its distribution are still poorly investigated. The aim of this study was to assess whether the presence of a mosaic of habitats, largely determined by sea urchin grazing, may potentially influence megafauna abundance and biodiversity. The study was performed during summer 2010, in the upper infralittoral of the Ustica Island. The abundance and biodiversity of megafauna were assessed in barren (BAR) and forest (FOR) state to test the specific hypothesis that both variables are higher in BAR than FOR. Data were collected by UVC along six strip transects of 50 x 5 m (250 m^2) parallel to the coast, at a depth of 5 m. The experimental design included two factors: State (St), fixed with 2 levels (FOR and BAR) and Patch (Pa), random and nested in State with 2 levels (1 and 2). There were 6 replicates for each combination of factors. Data were compared by permutational MANOVA. Abundance of megafauna resulted significantly higher in the BAR than in the FOR (pseudo $F_{1,2}$ = 9.28; P-MC = 0.002). A total of 14845 specimens belonging to 20 species were surveyed in the BAR and a total of 3961 specimens belonging to 17 species were recorded in the FOR. BAR and FOR states are remarkably different in terms of species richness (S) of megafauna: BAR host 8.58±0.1920 (average number of species ± SE) while FOR 5.58±0.35. *Arbacia. lixula*, *Paracentrotus lividus, Marthasterias glacialis, Coscinasterias tenuispina, Holoturia tubulosa* were the major megabenthic species in terms of abundance followed by *Anemonia viridis*, *Aiptasia mutabilis*, *Stramonita haemastoma* and *Patella caerulea*. This study suggests that there may be a strong link, between the distribution and abundances of megafauna and the barren habitat often perceived in the collective imagination as a lifeless landscape.

S3.12 Marine ecosystem services trade-off assessment: a methodological approach to inform maritime spatial planning

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Strategic natural resource management is of central interest for long-lasting and sustainable socio-economic development, especially in the marine realm, where ecosystem services (ES) and trade-offs assessment are backward compared to land-based studies. Marine/Maritime Spatial Planning (MSP) represents an opportunity to spatially allocate human uses at sea to favor socio-economic development, supporting the sustainable use of its resources. In the Adriatic Sea, which is a severely used and highly ecologically valued marine area, the need for informed and balanced measures of resource exploitation is urgent, and claims for MSP to meet both conservation and socio-economic regional objectives. This study proposes a method to understand and assess potential trade-offs between multiple ES. The study takes as example the relationship between the supply of multiple supporting ES and the provisioning ES related to fishery activity, recognized as pivotal among the diverse uses in the area. The method supports the identification of pair-wise trade-off relationships between ES. The spatial analysis depicts areas revealing high ES delivery potential, and heavy fishing activity that could lead to the impoverishment of the capacity of the marine ecosystems to provide the delivery of ES due to environmental damage. The results are discussed in order to support the elaboration of spatial management measures to cope with the fishing industry needs and conservation. Our study highlights the necessity in including ES trade-off assessment in MSP to explore potential conflicts between economic activities and the delivery of multiple ES because of marine environment integrity.

S3.13 Meiofaunal and nematode biodiversity trends in tropical subtidal habitats

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The increasing human impact and the effects of climate changes are producing a rapid alteration in the marine habitats in Maldivian atolls. Meiofauna is an important benthic component and a good bioindicator of environmental changes. Previous studies have focused attention on meiofauna of shallow water habitats revealing a high biodiversity, while the community from the reef slopes were almost unknown. Thus, a sampling campaign was carried out in May 2013 from Felidhoo and Malé Atolls. Several abiotic factors were considered in this study, among which the type of reef slope (i.e. inner/ outer), depth (from 19 m to 66 m) and inclination (from 10° to 90°). The statistical analysis revealed that the greatest dissimilarities (ANOSIM) of the meiofaunal communities were between types of slope followed by depth while inclination and atoll did not appear significant. The highest meiofaunal diversity was found in the outer reefs. Several uncommon meiofaunal taxa were found, even if nematodes and copepods were the dominant groups within the community. The nematode community included a total of 174 genera, in 37 families mainly represented by Desmodoridae, Chromadoridae and Xyalidae. Like meiofauna, also the nematode fauna resulted mainly influenced by the type of slope. Oncholaimidae and Linhomoidae, families typical of low levels of hydrodynamic conditions were mainly associated with the low wave energy of the inner slopes, whereas Draconematidae and Desmoscolecidae, which are indicators of high hydrodynamic stress, were mainly found in the outer reefs, where ocean currents and waves are strong.

S3.14 Large-scale sea urchin culling drives the reduction of barren grounds in the subtidal rocky habitats in the Mediterranean Sea

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Increasing anthropogenic pressures are causing long-lasting regime shifts from high-diversity ecosystems to low-diversity ones. In the Mediterranean Sea, large extensions of rocky subtidal habitats characterized by high diversity have been completely degraded to barren grounds, featured by the dominance of sea urchins whose grazing combines with the impact of overfishing. The identification of specific actions aimed to reverse this trajectory of change is fundamental for the development and implementation of large-scale management strategies. Some studies showed a positive effect of sea urchin removal on the recovery of overexploited subtidal rocky habitats. To date, the practice of extensive sea urchins culling has been already applied in some areas of the world, but never in the Mediterranean Sea. During the project MERCES we test this approach in the no-take zone of the MPA of Porto Cesareo (SE of Italy), covering an area of 1.2 hectares, at about 5 meters depth. The consequences of sea urchin removal, carried out in spring 2015, were monitored at regular intervals, covering a time span of 3 years, and compared with two external controls. Results show a progressive reduction of the barren grounds in the fully protected area after the beginning of the experiment. By contrast, very low recolonization of sea urchins was observed in the time frame covered by the experiment, so that any additional culling was necessary. Since the barren reduction within the MPA has been largely driven by turf forming algae, caution is needed in the interpretation of the outcomes in terms of restoration and results are discussed considering the factors involved in the observed shift.

S3.15 A Modelling Approach to Analyse Plastics Exposure for *Balaenoptera physalus* in the Pelagos Sanctuary

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Marine plastic pollution is emerging as an environmental and biological threat to marine ecosystems worldwide, although the full extent of its impacts is still largely unknown. To provide further knowledge on its possible impact on marine biota, we investigated the risk of plastic ingestion for an emblematic species, the fin whale *Balaenoptera physalus*, whose feeding grounds in the Mediterranean Sea are located within the Pelagos Sanctuary, the largest Marine Protected Area in the north-western Med. We analysed the spatiotemporal patterns of marine plastic litter concentration within Pelagos over a decade (2000-2010), during which we modeled the release and transport by surface currents of plastic particles from the three major sources of plastic pollution: mismanaged waste along coasts, maritime routes and discharge from rivers. Complementary to particle tracking, we estimated fin whale presence in Pelagos using an existing habitat suitability model based on bathymetry and chlorophyll-a satellite data. We produced maps of the risk of exposure to microplastics via food ingestion for the fin whale interlacing plastic litter distribution in the area with the suitable habitat estimated for the species. The highest risk values were located in the Central Ligurian Sea, with clear contributions from all the three major sources of plastic litter, yet showing remarkable spatial and interannual variability. Our modeling approach can be applied to other taxa and/or MPAs, thus possibly providing support in the design of informed policies aimed at addressing the complex issue of marine plastic pollution.

S3.16 Natural capital, habitats and fishery resources in the south-western Adriatic and north-western Ionian seas: cues for an ecosystem approach to marine resources management

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Marine biodiversity is the natural capital source of habitats and fishery resources. These latter have been assessed in the last two decades in the GFCM (General Fisheries Commission for the Mediterranean) and STECF (Scientific, Technical and Economic Committee for Fisheries) management advice framework, as well as part of national and international study projects. Most demersal stocks in the Mediterranean results unsustainably fished and the situation along the Italian seas is not an exception. The management of the demersal resources has been generally carried out following the outcomes of conventional stock-oriented modelling and relevant reference points, while the role of the habitat used by the different species has been poorly considered. An ecosystem approach to fishery management (EAF) including spatial considerations and integrating the protection of vulnerable and sensitive habitats is considered an emerging issue. The studies on the demersal resources carried out in the south-western Adriatic and north-western Ionian seas over the last thirty years mainly by scientific surveys (e.g. MEDITS) allowed the investigation of diversity of the demersal species assemblages, fluctuations of abundance of non-commercial and commercial fish populations as well as the exploitation status of these latter. In addition, these studies allowed the identification of nursery and spawning areas for several commercial species, proving a significant role of the habitat built by benthic species for the life cycles of demersal fishes, crustaceans and cephalopods (essential fish habitat). Some case studies are presented to aim at a holistic management approach robust to uncertainties, suitable for management perspectives accounting for ecosystem objectives.

S3.17 Addressing ecological principles for the EB-MSP in the deep Mediterranean Sea

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The deep sea is still one of the main great challenge on Earth, both for scientific research and natural resources exploitation. In the Mediterranean Sea, the deep sea covers about 79% of the basin, including habitats potentially able to deliver multiple ecosystem services and numerous resources of high economic value. Thus, the deep Mediterranean Sea represents an important part of the new frontier and its exploitation is embedded within the European Blue Growth Strategy goals.

Marine Spatial Planning has been identified as key instrument for spatially allocating maritime uses in the sea space avoiding spatial conflicts between activities, and between activities and the environment. Indeed, MSP incorporates the ecosystem-based approach (EB-MSP) to balance both socio-economic and environmental objectives, in line with the Maritime Spatial Planning Directive and the Marine Strategy Framework Directive. Despite MSP is under implementation in Europe, the Directive does not specifically address the deep Mediterranean Sea, despite this falls both in territorial waters and in High Seas. This complicates the management framework of the deep-sea marine areas. Moreover, a certain level of cumulative impacts in the deep Mediterranean has been already identified and likely underestimated because of paucity of knowledge related with deep-sea ecosystems. Thus, the implementation of scientific knowledge and the establishment of a sustainable management regime of deep-sea resources and space is urgent.

This study aims at reflecting on the best available ecological knowledge on the deep Mediterranean Sea to incorporate conservation objectives in EB-MSP. We propose a framework to include key ecological principles in the relevant phases of any EB-MSP processes taking in consideration existing socio-economic and conservation scenarios in the region. Here, we resume some guidelines to overcome limits and bottlenecks while ensuring protection of deep-sea ecosystems and resources.

S3.18 A Mediterranean-wide metapopulation model for the seagrass *Posidonia oceanica*

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The seagrass *Posidonia oceanica* is a benthic foundation species endemic to the Mediterranean Sea. It is a key component of coastal seascapes across the Mediterranean large marine ecosystem, where it plays fundamental ecological, physical and economic roles. Here we propose a basin-wide metapopulation model for *P. oceanica*, accounting for both local demographic processes (inter-annual survival, vegetative growth, sexual reproduction) and the spatial connectivity provided by current-driven dispersal of seagrass fruits. Model simulations are used to identify hotspots of *P. oceanica* population abundance, realized connectivity and long-distance dispersal. Multi-functional hotspots, i.e. coastal areas that rank high in all of the considered metrics, and that could thus serve as priority candidates for protection, are also singled out. Our results indicate that *P. oceanica* hotspots are unevenly distributed in the four main sub-basins of the Mediterranean Sea, and along both the European and the African coastline. Our analysis also reveals the existence of a remarkable geographical gap in protection: in fact, while many of the hotspots located along European coasts are at (or at least close to) protected sites, the great majority of the hotspots lying on African coasts lack any form of protection. Therefore, our work may show how results from metapopulation modeling can be used to inform the prioritization of conservation actions in the Mediterranean large marine ecosystem.

S3.19 Oceanic factors affect the stock-recruitment relationship of the European eel

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Sustainable management of the European eel (*Anguilla anguilla*) is challenging due to the different spatial scales and the wide geographic range at which the life history of this panmictic, catadromous species takes place. Eels reproduce in the open ocean and spend most of their pre-reproductive live in coastal and continental waters: the interplay between local and global stressors requires a management perspective embracing the whole stock over the entire life cycle and geographic span. Recent modelling analyses have unveiled the role of main continental drivers, such as habitat loss and overexploitation, in the decline of the global eel stock over the last decades. Additional studies combining evidence from oceanographic campaigns with the results of simulations with biophysical models have begun to shed light on the oceanic migration of eel larvae. However, there is still considerable uncertainty on the effects of environmental variables on the success of the reproductive phase and, ultimately, on the dynamics of the global stock. To improve our understanding of the link between the continental and oceanic phases of the eel life cycle, we carried out a statistical analysis to assess how the stock-recruitment relationship of the global European eel stock is affected by oceanic factors such as temperature, salinity and the North Atlantic Oscillation (NAO) index. Our results suggest that 1) the main environmental factors affecting the success of the oceanic phase are the surface temperature of the Sargasso Sea during reproduction and the early stages of the larval migration, as well as the value of the NAO index when eel larvae enter the North Atlantic Current; and 2) increasing sea surface temperatures have a negative effect on eel recruitment, while positive NAO values are associated with enhanced recruitment. We derived a stock-recruitment relationship explicitly incorporating these variables that can be used to improve existing models describing the dynamics of the global eel stock.

S3.20 Impact of plastic litter on early growth stages of coastal dune plants

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Plastic pollution is ubiquitous and involves all environments, including coastal dunes which are among the most valuable habitats worldwide. Coastal dune plants play a fundamental role in dune formation and stability but are subjected to macro-plastic entanglement. However, the effects of plastics on dune plant communities and dune system stability are unknown. In the present study, we investigated the impact of plastic fragments derived from non-biodegradable high-density polyethylene bags (PE) and compostable starch-based (COMP) bags buried in foredunes on seedling emergence, morphology and biomass production of three ecologically relevant dune species *Thinopyrum junceum*, *Ammophila arenaria* and *Glaucium flavum*. Non-biodegradable bags are a large component of beach litter. Compostable bags have recently been introduced to reduce plastic pollution, but their behavior in natural habitats is poorly known. We predicted that bags would affect seedling emergence and development, and that the magnitude of their effects would vary due to different plastic type, behavior in the environment and species sensitivity. Both virgin bags and bags exposed to dune conditions were used to examine whether weathering would reduce or alternatively exacerbate their effects. Both bag types reduced seedling emergence percentage irrespectively of weathering and species. Virgin MB bags also delayed the emergence of *A. arenaria* seedlings. Six months after emergence, *T. junceum* seedlings from MB and PE bag plots had lower aboveground biomass, and those from PE plots had also altered root system compared to controls. Few *A. arenaria* seedlings from PE plots survived, and those emerged from MB ones were smaller than controls. No *G. flavum* seedlings survived regardless of treatment. These findings showed that both non-biodegradable and compostable bags are a threat to foredune habitat. They also highlight the need of informing people and managers about the impact of the incorrect disposal of the so-called eco-friendly plastics on dune ecosystem health.

S3.21 Living in a high CO_2 world: benefit or cost for coastal fish assemblages?

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Ocean acidification (OA), one of the main side effects of climate change, is namely threating marine biodiversity and ecosystems functioning. OA can represent a serious threat for seafood resources and negative effects are expected for fish (*i.e.* physiological and behavioral changes, decline of catches, loss in structural, functional and trophic diversity) with consequences for the ecosystem services, the ecological and the economic standpoints.

Here we used a Mediterranean shallow CO_2 vent to assess the impacts of OA on trophic structure and diversity, isotopic niche and trophic levels of coastal fish associated to *Cymodocea nodosa* seagrass meadows. In particular, we analysed and compared the isotopic signature (carbon and nitrogen stable isotopes) of nine coastal fish species (*Coris julis*, *Chromis chromis*, *Diplodus vulgaris*, *Gobius bucchichi*, *Labrus viridis*, *Scorpaena porcus*, *Symphodus ocellatus*, *Symphodus tinca, Thalassoma pavo*) long-term exposed to high pCO_2 / low pH conditions (low-pH site) against fish living in two normal pH areas (control sites).

We used mixing models to elucidate organic matter pathways supporting each fish species. Overall, the analysis at fish species level showed only slight differences in the role of organic matter sources among the low-pH site and the two controls. A clear ^{13}C-depletion was detected in the low-pH site compared to both controls, due to volcanic input of ^{13}C-depleted CO_2, which is uptaken by primary producers and transferred to higher trophic levels. Accordingly, community-wide isotopic metrics highlighted a clear shift in the isotopic niche towards lower $\delta^{13}C$ in the low-pH site. However, contrary to the expected negative impacts of OA, no functional and structural changes were present both in terms of fish trophic diversity and trophic levels, underlining the complexity of the response to OA and suggesting possible benefits (*i.e.* enhanced food resources) to balance the higher energetic cost of living in a high CO_2 environment.

S3.22 New insights into the ecology and corallivory of *Culcita* spp. (Echinodermata: Asteroidea) in the Republic of Maldives

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Although corallivory is increasingly recognized as a relevant threat affecting the structure and the integrity of coral reef habitats, to date the ecological information about some species of coral consumers are still limited. In this study the population distribution and the corallivorous behaviour of the cushion sea star *Culcita* spp. were investigated in the south region of Faafu Atoll, Maldives. Most of the sea stars were found on reef slopes within 10 m of depths and in areas characterized by a low live coral coverage. Our results revealed a feeding preference of the sea star for corals belonging to the genera *Pocillopora* and *Pavona* and a consistent avoidance of the genus *Porites*. Furthermore, the majority of the consumed corals were small colonies (< 10 cm diameter), even if *Culcita* spp. appeared to be able to prey upon larger coral colonies. Our study contributes to extend the knowledge on this little studied coral-consuming organism, whose predilection for specific colony sizes and genera and its constant predatory pressure on corals may generate local shifts in coral community composition and structure. It may also affect reef recovery following other stressing events in an already impacted environment such as the Maldivian reefs.

S3.23 Food addicted fish: impact of the invasive alien algae *Caulerpa cylindracea* Sonder on the central nervous system of *Diplodus sargus*

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The non-native clonal macroalga *Caulerpa cylindracea* Sonder is widely distributed across the NW Mediterranean. This seaweed can alter the structure and functioning of benthic assemblages as well as sedimentary organic matter attributes. Recent studies revealed that the seabream *Diplodus sargus* has included *C. cylindracea* in its diet. This results in altered physiological characteristics of the fish and potentially detrimental consequences on its population dynamics. Mechanisms that lead this species to maintain these algae among its preferred food items is unknown. To shed light on this issue, we exposed *D. sargus* to a mixed diet made of shrimps and fragments of *C. cylindracea* for 30 days in mesocosm. Controls were fed with shrimps only. At end of the conditioning period, fish were suppressed, after having being anesthetized. Before suppression, a group (n=3) was left fasting from the mixed diet for 12h. Brains were sectioned with a vibrating microtome and the sections, preserved in a cryogenic liquid, stored at -20°c until analysis. Sections were incubated with a monoclonal antibody for tyrosine hydroxylase and inspected under epifluorescence confocal laser microscope to measure neurons' area, perimeter and soma circularity. We report here that only specimens left fasting from *C. cylindracea* were characterized by a significant decrease of neurons' soma area and perimeter. The decrease of neurons' soma is a typical response to withdrawal which occurs also in drug-addicted mammals. Our results demonstrate for the first time ever that the reason by which *D. sargus*, once occasionally ingested the algae, maintains it among its preferred food items is the result of a typical addiction mechanism that involves the central nervous system.

This is a contribution to the project "Impact of Invasive Alien Species on Sardinian ecosystems" funded by Fondazione di Sardegna and Regione Autonoma della Sardegna (CUP: F72F16003100002)

S3.24 Rate and pattern of movement of *Culcita* sp. (Echinodermata: Asteroidea) revealed by underwater photogrammetry

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The ability of movement, in terms of direction and velocity, has multiple implications on the biology and ecology of organisms. Thus, studies on the movement of organisms are important for understanding population and individuals dynamics and the interactions and impacts on the environment. Coral-eating seastars may have an important role in influencing coral cover, especially in the aftermath of a coral mortality event. The cushion-seastars of the genus *Culcita* is a non-obligate corallivorous considered to delay coral recovery in the Republic of Maldives, after the coral bleaching events in 2016. In this context, knowing movement patterns may reveal key aspects on the impact of the seastars on the recovery of the Maldivian coral reef. The present study aims to quantify the rate and pattern of movement of the cushion-seastar *Culcita* sp.. A new approach has been used by the involvement of Unmanned Aerial Vehicle (UAV), or drone, to spot and obtain a rate of movement of specimens of the cushion-seastar. We followed 12 individuals on a sandy lagoon of Magoodhoo island, Faafu Atoll, Republic of Maldives. Photogrammetry was obtained by flying a commercial drone and ≈ 600 pics were collected. Preliminary results showed an average of 1,7 m/h during the night, while little movement has been observed during the daylight. The path chosen by the specimens showed a significant directionality. Currents did not influence the movement path suggesting that specimens choose the direction independently from environmental conditions. The direction was constantly pointed towards the reef suggesting that specimens may detect cues from the reef where they can hide. Furthermore, the use of drone and photogrammetry revealed an excellent tool for studying movement and path without influencing the individuals.

S3.25 Natural capital related to vulnerable and threatened species in the central Mediterranean: change in diversity and abundance and habitat influence on the elasmobranch community

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The cartilaginous fishes represent a valuable natural capital within the marine ecosystems as they are the oldest and most ecologically diverse vertebrates filling the upper levels of aquatic food webs with possible top-down control on the midlevel consumers. Because of their K-selected life-history (e.g. slow growth, late attainment of sexual maturity, long life spans, low fecundity) these species are particularly vulnerable to the human activities, mainly to the overexploitation, and many of them are at risk of extinction. Although sharks and skates play a key role in the biological communities, the effects of their decline on the marine ecosystem, due mostly to fishing activity, are still poorly known.

Considering data coming mainly by scientific surveys (e.g. MEDITS) carried out in the last thirty years, the authors provide information on the species diversity and fluctuations of abundance of the chondrichthyes caught on the soft bottoms of the north-western Ionian Sea, focusing the analysis on the species composition change and variable vulnerability and exposure to fishing of the different species. In this respect, recent acquisitions on the distribution and abundance of elasmobranches in sensitive habitats of the Ionian and South Adriatic Sea, such as cold-water coral habitats and canyons, are reported. Since these habitats, less accessible to fishing, can provide a natural refuge for these vulnerable species, large-scale connected protected areas can be a potential management option for the cartilaginous fish conservation.

S3.26 Sea-ice dynamics and food web structure in Antarctic shallow benthos

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Ross Sea is a biodiversity hotspot and important climate-change reference area. Here, sea-ice dynamics drive the organisms' life and nutrients exchange between ecosystem compartments. Expected changes in sea-ice dynamics can impair the Antarctic biodiversity architecture. However, few scientific data on Antarctic food web structure, vulnerability to biodiversity loss and sea-ice changes exist. To study Antarctic marine food webs, which are crucial to understand how Antarctic marine ecosystems will be affected in the future, basal resources and marine invertebrates were collected in Terra Nova Bay (Ross Sea), before and after sea-ice break-up. Each sample was analyzed isotopically. Bayesian isotopic mixing models were used for food web reconstruction and then food web metrics were quantified. We hypothesized that the activation of primary producers following sea-ice break-up affected numbers and qualities of trophic interactions, food web metrics and vulnerability to species losses. Differences in food web topology between the two periods were observed. Number of Taxa and linkage density were higher before than after the thaw. After ice break-up, sympagic production inputs allowed consumers to specialize on abundant resources at lower trophic levels. Foraging optimization by consumers translated into a simpler food web, with lower potential competition for resources and shorter food chains on average. Basal sources and Antarctic key species as *Adamussium colbecki* (Bivalvia) played key roles in the interconnection among species in both study periods. In conclusion, it was possible to measure key food web properties and identify key species playing a critical role in food web structure and functioning. These results may be translated into supporting information to establish valuable reference baselines and management strategies for the biodiversity conservation in the Ross Sea.

S3.27 On the truevalues of our seas: environmental accounting in a marine protected area by means of emergy analysis

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Marine and coastal ecosystems are subjected to continue anthropogenic pressure generating a threat for the biodiversity and long-term sustainability of marine environment. The overexploitation in order to generate goods and services for human well-being have to be controlled to maintain a good status for any marine ecosystem. In this perspective, the presence of Marine Protected Area can be considered as crucial, because if used properly it becomes an important tool to achieve a trade-off between nature conservation and human activities from a sustainability point of view. Sometimes, an integrate approach of evaluation, taking into account both human preferences and biophysical needs, can be difficult to obtain. According to these objectives, Emergy analysis shape as a procedure able to provide integrated information about natural and human-driven resources supporting ecological functions and economic activities. In particular, Environmental Accounting Emergy-based provides a measure of Natural Capital (biophysical value of stocked biomass) in terms of natural resources consumption required to support generation of goods and fruition of services. The purpose of this work is to illustrate the procedural and methodological approaches, with field-testing of materials and methods, necessary to carry out an environmental accounting analysis in a marine protected area. The investigation has been performed in the MPA “*IsoleCiclopi*”in order to provide a scenery of performance, impact and environmental sustainability of the activities carried on the marine reserve in relation to the renewable natural resources present. The cost-benefit approach can assess the productivity of investing in environmental management and conservation. This integrated methodology may also help scientists, policy-makers and local managers to implement ecosystem administration according to the principles of sustainable development.

S3.P1 Effects of contaminated marine sediments on marine invertebrates

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Marine sediment can accumulate persistent hydrophobic organic contaminants, such as polychlorinated biphenyls, polycyclic aromatic hydrocarbons, dichloro-diphenyl-trichloroethane and heavy metals. The maintenance dredging operations for coastal ports and waterways consist mainly in removing sediments to improve the ship traffic. Sediment-bound pollutants pose major concerns not only for marine environment but also for human health, showing combined effects that are still largely unknown on sediment-dwelling organisms, as well as the change in toxicity on weathering. New guidelines for the disposal of dredged materials have been prepared internationally and they can be used to classify sediment samples with regard to their potential for toxicity and to identify contaminants.

In the present work we tested the possible toxigenic effects of sediment on marine organisms. As biological reference model we used the sea urchin *Paracentrotus lividus*, considered as an interesting species to study the ecotoxicological response of marine benthic invertebrates to environmental toxicants. The first step consisted in the setting-up of a microcosm, in which adult *P. lividus* were incubated for two months in the presence of contaminated sediments. Eggs and sperma were collected from these sea urchins exposed to the polluted sediments and then fertilized, checking three significant checkpoints in the sea urchin embryonic development by microscopic observations (i) fertilization success; ii) first mitotic division (two blastomeres); iii) pluteus stage) in order to reveal possible toxic effects. Molecular effects were also detected on these embryos, following by Real Time qPCR the expression of fifty genes involved in different functional processes. The proposed project represents a new initiative because to our knowledge microcosm studies are not available to study possible toxigenic effects of polluted sediments on marine invertebrates. Moreover, it can contribute to understand the cellular mechanisms that underlie the possible responses of benthic organisms to contaminated sediment exposure.

S3.P2 Vertical gradient and spatial variability of Coralligenous reefs in Sardinia: the interactive effect of depth and location

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Coralligenous reefs are important service providers of the Mediterranean coastal systems mainly due to CO_2 sequestration, marine bottom stabilization, and biodiversity enhancement. In fact, they are produced by carbonate deposition of encrusting coralline algae and, to a lesser extent, by the calcareous skeletons of invertebrates (e.g., bryozoans, calcareous tube worms, scleractinians), being a hotspot of species. Nowadays, coralligenous reefs are affected by several local (e.g. sedimentation, eutrophication and mechanical impacts) and global stressors (warming and acidification). In this work the vertical distribution of coralligenous reef assemblages has been extensively investigated in Sardinia. A multifactorial design was used to estimate how consistent the differences in the structure of the assemblages among depths were across different spatial scales. Four locations (100s of km apart) were selected and two areas (100s of m apart) were randomly chosen within each location. At each area, 10 photographs (10s of m apart) were taken during spring 2019 at 17, 22, 27, 32, and 37 m of depth, using quadrats 50x40 cm, and the importance of each taxon has been expressed in percent cover. PERMANOVA has highlighted an interactive effect of the location x depth, while Pair wise comparisons and MDS evidenced the higher dissimilarities among shallow assemblages, mostly depending on the location, but not the area. The PERMDISP has estimated the relative variability associated to each scale per each depth and SIMPER analysis has identified the species/taxon mostly contributing to the dissimilarities. In this effort, cover of necrotic tissue or bleached species was also estimated. This work represents a first step of wider descriptive investigation aiming to generate accurate hypotheses about adaptability of species depending on their occurrence, to predict resistance to global stressors and to address eventual restoration management under a climate change scenario.

S3.P3 The trawl ban in the Gulf of Castellammare (NW Sicily): a successful tool for the sustainable management of demersal fisheries

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The Gulf of Castellammare (Tyrrhenian Sea, NW Sicily) has been subject since 1990 to a trawl ban that covers 200 km^2, most of which on the continental shelf. The trawl ban was thought as a fisheries management measure to recover the depleted fish stocks in the area. The effectiveness of the ban was assessed through several research surveys carried out between 1985 and 2005, before and after the application of the trawl ban. The data collected after the ban were compared with (a) data from two control areas subject to trawling, and (b) data from the Gulf of Castellammare before the ban. The results showed a clear increase of fish biomass in the Gulf of Castellammare as a direct effect of protection. Only species with a short life cycle and deep distribution like the pink shrimp, *Parapenaeus longirostris* do not seem to be influenced by the limitation of the fishing effort. The other species, in particular the red mullet *Mullus barbatus*, showed a strong increase in density. The trawl ban confirms an effective measure of fish resource management. However, there is a need to keep a high level of control and enforcement of the ban and to ensure scientific monitoring to verify the effectiveness of this management tool.

S3.P4 Preliminary data on the presence of potentially harmful microalgae along the coast of Magoodhoo Island (Maldives Archipelago)

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In the last years, Harmful Algal Blooms (HABs) are increasing their frequency and magnitude as a result of changes in oceanic climate, increased eutrophication and enhanced long-distance dispersal in ballast waters and they are currenlty affecting coastal marine communities both in the Mediterranean Sea and in tropical waters. Among HAB producing species, harmful benthic microalgae represent an emergent phenomenon and some of them are nowadays considered as the largest cause of HABs. Harmful algal blooms could affect the natural capital, causing serious problems for the conservation of habitats and biodiversity, for the human health and the economic activities related to the exploitation and coastal waters and, in particular, of reefs.

In order to detect the presence of potentially harmful benthic microalgae that could be responsible of mucilage or/and toxic blooms along the coasts of the Island of Magoodhoo (Maldives Archipelago), an investigation has been performed there in November 2018. Two linear transects of about 100 m were considered perpendicularly from the coast and samples of water and ephilithic material were collected using a brush-sampler on hard substrata (1 meter of depth) in three different sites 50 m for each (n=3). Cell identification and count were conducted with an inverted microscope according to Utermöhl's sedimentation method.

The preliminary results highlighted the presence of different species of potentially harmful microalgae in all the collected samples. Both toxic and mucilage-producing species mainly belonging to Bacillariophyceae and Dinoflagellata were overall recorded.

Even if preliminary, these results suggest the importance of designing and defining an *ad hoc* monitoring program, in order to forecast and quickly detect HABs in the coastal waters of Magoodhoo Island.

S3.P5 A mesophotic hotel: the octocoral *Bebryce grandicalyx* as a host

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Mesophotic coral ecosystems are widespread and harbour rich coral reef communities below 30 m and down to 150 m depth. Although in recent years the knowledge of these charismatic ecosystems has increased, many aspects are still to be explored, including, for instance, symbiotic associations. During surveys of the upper mesophotic reef of Dharanboodhoo Island, Republic of the Maldives, a novel, previously unreported association between an octocoral, a sponge, and a hydrozoan was discovered.

The octocoral *Bebryce* cf. *grandicalyx* was commonly found at depths ranging from 40 to 50 m. A closer inspection of the colonies revealed the presence of two frequent associates. The octocoral was always overgrown by a sponge, which fully covered the colony, leaving uncovered only the polyps. Additionally, in most of the observations, hydrozoans belonging to the species *Zanclea timida* were found as epibionts of the octocoral. Hydrozoan polyps reached high densities, covering almost all the available space, except for octocoral polyps, and were partially embedded in the sponge. The three organisms were well integrated with each other in a stable way, given also the high prevalence of the associations. Moreover, a parasitic interaction seems to be excluded and the possible advantages gained by each associate are discussed.

In addition to the recurring three-way association, other invertebrates were found dwelling on the octocoral and sponge surface, including barnacles, entoprocts, amphipods, flatworms, foraminiferans, and ophiurans. It is difficult to define the ecological interactions among these organisms, but their presence is likely related to an increased habitat availability provided by the stable association between the octocoral and the sponge.

This and other multi-taxa associations need further investigation to characterise the possible positive and detrimental effects on the whole association systems, especially in the light of the current decline of both shallow and mesophotic coral reefs.

S3.P6 Ecosystem services assessment: a case study of *P. oceanica* meadows in the Northern Tyrrhenian Sea, Italy

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The coastal marine domain is characterized by physical and ecological conditions that favour and determine conflicts between different uses of natural resources. In this context the Natural Capital analysis is a valid emerging management tool for marine conflicts resolution (EU Marine Strategy Framework Directive and EU JRC Scientific and Policy Report 2014) in particular in the Mediterranean Sea, where marine ecosystems are characterized by high biodiversity with benthic biocenosis that can be used as a tool to support coastal planning, conservation, and monitoring programs. In this study, we considered the Mediterranean benthic biocenosis as classified by Pérès and Picard as a working tool and propose a basic spatial unit for the assessment of marine ecosystem services. Focusing on high-resolution local-scale analysis, this work presents an accurate identification of the different biocenoses for the coastal area of Civitavecchia in the Northern Tyrrhenian Sea, Italy, and ecosystem services benefits assessment of *Posidonia oceanica* meadows. The result of the economic evaluation of *P. oceanica*, in the coastal area of Civitavecchia is in line with other studies that had applied a similar methodology. This work represents the first example of application of the benthic biocenosis as a tool for the economic evaluation of the associated benefits and the first study applied to the coastal area of the Northern Tyrrhenian, in Italy.

S3.P7 Skeleton eroding band (SEB): a worldwide distributed coral disease

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Coral diseases are an emerging threat affecting coral reefs worldwide but only a few studies are considering them during ecological surveys. An example is the disease named Skeleton Eroding Band (SEB) which lacks detailed epizootiology studies although it is known to be one of the most diffuse coral diseases in the Indo-Pacific area. In particular, beside the identification of the pathogen responsible of the disease, recognized as being a folliculinid ciliate named as *Halofolliculina corallasia*, little information is present about the diversity and distribution of this syndrome. Recently, macroscopic signs resembling SEB have been found affecting the Caribbean regions, giving the possibility to rise a new coral disease named Caribbean Ciliate Infection (CCI).

The research here proposed aims to increase, through the integration of ecological, morphological and, for the first time, molecular data, the knowledge of the skeleton eroding band disease and to investigate the potential similarities with the protozoan-like syndrome affecting the Caribbean coral reefs. Ecological surveys were carried out in three different regions, the Indo-Pacific, the Red Sea and the Caribbean Sea, during a period between June 2017 and November 2019. From a morphological, morphometric and molecular point of view, individuals observed on several coral fragments collected in the three regions appear to be identical, suggesting that they belong to the *Halofolliculina* genus and, most likely, they could represent the same species *Halofolliculina corallasia*. Thus, data obtained in this work may support the hypothesis that protozoans affecting corals in the Indo-Pacific and the Caribbean belong to the same species. Therefore, our study increases the host range and extends the widespread distribution of Skeleton eroding band disease to a global scale.

S3.P8 The impact of microplastics on natural capital and ecosystem services in marine ecosystems

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The identification of models capable of describing the development of ecosystems has been a major target of systems ecology and ecological modelling. Marine ecosystems are open and hierarchically self-organized systems, characterized by complex networks and emergent properties. The complexity and openness of marine ecosystems represent a challenge for the implementation of environmental accounting models focusing on the assessment of mass and energy flows converging for the generation of natural capital stocks.

Marine and coastal ecosystems are among the largest contributors to global primary production. Microplastics potentially pose a threat to this important ecological function sustaining marine food webs and human economy. In this regard, recent studies have shown negative impacts of microplastics on individual algae or zooplankton organisms with possible negative effect on primary and secondary productivity at ecosystem level.

In this study, the use of ecological networks analysis is proposed to assess the potential impact of microplastic concentrations at ecosystem level and their negative effects on marine natural capital stocks and the delivery of ecosystem services.

The scope and goals of this study are in line with the United Nations Sustainable Development Goal (SDG) number 14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development”.

S3.P9 Possible shifts in quantity and biochemical composition of sedimentary organic matter in the deep Ross Sea (Antarctica) 20 years after ROSSMIZE

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The Southern Ocean, the deepest ocean worldwide, covers 30% of the global ocean surface and plays a key role in global biogeochemical cycles. Thus, changes in the functioning of Antarctic deep-sea ecosystems would have a major impact at the global scale. Recent results indicate the presence of temperature shifts related to altered hydrodynamic regimes in the Ross Sea. Nevertheless, the effects of these changes on Antarctic benthic ecosystems are mostly unknown, yet. To investigate the impacts of these changes on biodiversity and ecosystem functioning, the project BEDROSE revisited in 2017 the same sites investigated during the ROSSMIZE cruise (X Antarctic Expedition, 1994-1995). During the austral summer 2017, we collected sediment samples at ca. 500 m depth from two locations (namely site B and C), already visited in 1995, and analyzed them in terms of organic matter (OM) quantity, biochemical composition (protein, carbohydrate, lipid and phytopigment contents) and degradation rates (protein degradation). The two sites were characterized by the same differences observed in 1995, with OM contents in site B much higher than those observed in site C. The sediments of both sites showed OM contents higher than those observed 20 years ago, with biopolymeric C contents in 2017 ca. 2-3 folds and 2 folds higher (site B and C, respectively) than those in 1995. OM nutritional quality decreased in both sites as a possible consequence of the increased OM degradation rates in the sediment. Our results fit with a plausible scenery of a warming stimulated increase of primary production in the water column, associated with increased inputs of OM to the deep sea and a stimulation of the benthic activities.

This is a contribution to the project "BEnthic biodiversity and ecosystem functioning of the Deep ROss Sea in a changing Southern Ocean" funded by the PNRA.

S3.P10 Assessment of the ecosystem services provided by dune habitats along the Veneto coast

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Despite their important role for both nature and society, dune habitats are threatened by land use change and degradation. The assessment of the ecosystem services (ES) provided by these habitats can contribute to counteract these trends by highlighting how society benefits from the presence and good status of these habitats. This work, carried out within the project Life REDUNE, aims at quantifying the provision of three ES in the dune habitats of three Natura 2000 sites located along the Veneto coast. Furthermore, the potential provision and trends of these ES along the whole Veneto coast is explored. The ES assessed are carbon sequestration by dune vegetation, recreational activities, and materials accumulated along the beach. In the three Natura 2000 sites, carbon sequestration has been quantified as the carbon content in the primary production of dune vegetation, the recreational activities in dune habitats have been valued using the travel cost method, and by estimating the number of visitors enjoying these habitats, and the accumulated materials have been quantified as the percentage of beach covered by materials of different typologies. To explore the provision of these ES beyond the Natura 2000 sites, the presence of dunes has been estimated based on available habitat mapping and Corine land cover data, and their evolution analyzed by comparing the land cover data between 1990 and 2018. The results highlight that, despite their limited presence along the Veneto coast, dune habitats play an important role as carbon sinks and as factor that enhance the tourist attractiveness of the area. These results can contribute to the management of dune habitats by bringing strong argumentations for their conservation and restoration.

S3.P11 The role of an ecosystem engineer's density in driving its own response to a heat wave and in modulating the community functioning

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Ecosystem functioning depends on the number of specie and their role in the system (e.g. keystone species/ecosystem engineer). To date, the linkage between extreme climatic events and ecological responses and whether responses are driven by the density of the keystones remain uncertain. The bivalve *Mytilaster minimus* (Poli, 1795) is an ecosystem engineer that form dense mussel beds, increasing spatial complexity and hosting biodiversity hotspots across the intertidal Mediterranean rocky shores. Here, we evaluate the effects of a heat wave on the metabolic functioning of 3 components: the whole mussel bed (mussels + associated species), the *M. minimus* individuals alone at different density and the species associated to the bivalve without mussels. In autumn 2018, in Western Sicily, along 3 levels of density of the bivalve (low, medium, high), we randomly scraped 6 quadrats 10 x 10 cm (N = 54). Replicates were divided in two groups, one exposed to increasing temperature (up to 38 °C) and the other maintained at environmental temperature. We adopted the heterotrophic oxygen consumption (mg/l O_2 $l^{-1}h^{-1}g\text{-}DW^{-1}$) as a proxy of ecosystem functioning. Under both treatment conditions (CTRL, HW), the metabolic rates of *M. minimus* alone did not differ from the metabolic rates of the mussel beds as a whole community, showing the key role of the bivalve in driving the functioning. In both cases, rates decrease with the increasing of the density of the mussels. In addition, thermal stress didn't affect any of the three components. However, at medium density, both the metabolic rates of the mussel alone and those of the mussel bed were affected by the thermal stress. We hypothesize that a balance between facilitation and intraspecific competition, that varies according to density and environmental conditions, could explain that pattern.

Sessione 4:
Capitale Naturale ed Ecosistemi Lagunari e di Transizione

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Natural Capital, Lagoon or Transitional Ecosystems

Lagoon or Transitional Ecosystems are a particular type of systems where seawater mixes with fresh water from their continental catchments. This border situation determines the existence of intense gradients that make them globally one of the most productive ecosystems, but at the same time fragile ecosystems that can develop communities with an important diversity and complex mechanisms of self-regulation. These systems occupy about 12 % of the world coastlines and they constitute important buffering zones between catchments and sea with respect to water quantity and quality. Despite their small size compared to the ocean, the lagoonal influence on the genetic diversity of marine populations, adaptations to climate change of marine species is very high. These shallow water bodies support important habitats such as wetlands, mangroves, salt-marshes and seagrass meadows. This typical, mosaic landscape provides support for a rich biodiversity, including vital habitats for bivalves, crustaceans, fish and birds. They provide a physical refugium from predation and are used as nursery and feeding areas for some species.
Historically, coastal lagoons have always attracted humans and supported their associated activities. Taking advantage of their geographical location and natural resources, many of these systems have been utilised for fisheries and for collecting materials from plants, algae and animals for direct or indirect human consumption. Transitional Ecosystems are also characterized by harbouring a large part of the human population that may depend directly on these ecosystems. For this reason, these are one ofthemost threatened ecosystems inthe world.
The natural capital of coastal lagoons, including the variety of ecosystem services and biodiversity are therefore essential for human well-being. In addition, coastal lagoons provide well-being not only to the people living around the lagoon but also to people living in inland areas, who may also be dependent on the trade and use of goods and services.

S4.1 Using filtration activity as an indicator for shellfish health in heterogeneous coastal systems

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Lagoon and coastal transitional areas are exposed to highly variable environmental parameters (e.g. temperature, salinity, dissolved oxygen). This variability can be exacerbated by climate change, which can bring species close to their tolerance limits. This can lead to different levels of stress being perceived by an organism, acute and chronic, leading to both sub-lethal (e.g. growth suppression) and lethal effects. Coastal transitional areas are often home to rich and diverse communities and are also locations of importance for aquaculture activities. It is thus essential to understand how farmed species will respond to environmental changes, and how intensity, frequency and duration of extreme events could affect their survival

With continuous environmental data collection in situ available, it is possible to obtain accurate measurements of potential stressors, their variability, and timing of stressful/extreme events. However, measurements of individual stress are usually taken at single time points, making it difficult to pinpoint the exact drivers of such response. Therefore, these measurements could be complemented by high frequency sampling of metrics, related to organism behaviour, which could be used as a proxy for stress.

We will address the potential use of gaping behaviour as stress indicators for mussel health. Gaping behaviour, including median valve gape angle, frequency of opening and closing and time spent open or closed can give useful information on organisms' metabolic status. These data will be collected in two transitional coastal zones, i.e. the Venice Lagoon, Italy and the Wadden Sea, Netherlands, by means of an innovative biosensor, produced by NIOZ, which detects also water temperature and pressure. Time series of the above variables will be complemented by those of Salinity, Dissolved Oxygen, Chlorophyll-a collected every 15 minutes within the mussel farm. These data will be processed using time series analysis methodologies, in order to identify cause-effect relationships among potential sources of stress and the gaping behaviour.

S4.2 Energetic constraints to colonisation of transitional water ecosystems by amphipods

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Individual energetics is a basic phenotypic component, which depends from both intrinsic and extrinsic factors. The former consists in differential influences of sex, stage of maturity and phenotypic traits, including individual body size and other size-dependent traits; the latter includes many abiotic drivers, which could characterize the different ecosystem types.

In aquatic ecosystem, both temperature and salinity are considered as the main community drivers. The response to temperature is well defined and predictable while the response to salinity changes are less known, information is limited to a small number of species and data seem to show even strong heterogeneity among species. It could be due to still limited knowledge on metabolic costs of osmoregulation of aquatic macroinvertebrates to salinity variations.

The aim of this work was to understand the role of metabolic constraints in niche filtering processes of amphipod species in transitional water ecosystems. The amphipod species were selected according to their ecosystem type, including marine, brackish and freshwater species. The animals were collected in transitional water ecosystems (i.e. lagoons and river mouth) located in South Italy. Here, we describe the standard metabolic rates (SMR) of different amphipod species related to changes in salinity (0-35) using open-flow respirometric system at fixed temperature (18° C). The SMR at individual level ranged between 0.18 and 7.13 J d^{-1}. The marine and brackish origin species showed higher metabolic rate when salinity decreased, in contrast the freshwater species exhibited an opposite trend.

S4.3 Environmental factors driving parasite community composition of European eel in the Comacchio lagoon

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Parasites represent a ubiquitous component of aquatic communities. Occurrence, burden, distribution and also pathogenicity of parasites are affected by numerous abiotic and biotic factors acting at different scales and having direct effects on parasites or indirect on hosts. Complex relationships link parasites, host and their common environment.

This research is based on a long-term monitoring of the parasite fauna of European eel *Anguilla anguilla* from Comacchio lagoon (North Adriatic Sea). The great majority of studies on parasite community of eel in Europe have been carried out in freshwater ecosystems, rivers and lakes, whilst little is known with reference to saline or brackish lagoons. Three hundred forty-five eels were collected and analyzed between 1997 and 2017 with the following aims (i) to describe the parasite component community and its temporal trend over 20 years of study, (ii) to compare the eel parasite community of Comacchio with those of *A. anguilla* from other Mediterranean coastal lagoons and (iii) to determine the influence of environmental variables (i.e. temperature, salinity, season, density of hosts) and host characteristics (i.e. stage, size) on occurrence and burden of the parasite species.

The total component community was composed of 10 species of helminth endoparasites with complex life cycles requiring different host species (i.e. mollusks, crustaceans, annelids, fishes, birds). The relative abundance of the parasite species varied over time but the parasite community in Comacchio lagoon appeared stable with little change in composition over 20 years. Despite overall similarities in parasite fauna between different coastal lagoons, a salinity-dependence of parasite community structure emerges.

S4.4 Marine and resident fish movements in a North Adriatic brackish lagoon

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Brackish lagoons are vulnerable aquatic environments that host specifically adapted fish species, as well as marine species on a temporary basis, furthermore act as nursery grounds for several of the most commercially exploited fish families.

In this study we used long-term passive fishing gear data, to investigate how meteorological factors (i.e. wind and rain) and enviromental variabiles (i.e. moon and tides) affected resident and marine fish movement between inner and outer habitats.

Results indicated that meteorological factors had effects comparable to seasonal and annual variations, for wind and rain, and thus are potentially relevant drivers of the movement of fish species between coastal lagoons and marine habitats; in the same way fish movements was influenced by moon and tide factors, respectively. Overall, the magnitude of the effects related to the moon parameters were smaller than most environmental parameters examined, but still larger than e.g. the presence of invertebrate prey (lagoon shrimp) or some of the tide factors.

Ultimately, this information could improve the understanding of the drivers in these ecosystem as well as potentially provide useful insights for improved fisheries management.

S4.5 Nitrogen dynamics in a Po River Delta lagoon: a new set of measurements to investigate changes in the last 20 years

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Different studies postulate that the response of aquatic ecosystems to reduced nutrient inputs (e.g. following the nitrate and wastewater directives) may be delayed by decades, due to combinations of internal stocks and slow changes at the community level.

To assess the effectiveness of management practices we analysed the nitrogen (N) dynamics of the Sacca di Goro, a microtidal lagoon downstream the heavily exploited Po River watershed. Since the mid 80's this system hosted recurring macroalgal blooms, resulting in dystrophic events, anoxia and massive death of the clam *Tapes philippinarum*, a cultivated species supporting the local economy. This system was heavily studied during the 90's, including external nutrient loads, internal recycling and processes in the water column and sediments. Outcomes from such measurements were synthesized through the Ecological Network Analysis (ENA), a modelling tool that provides a whole system representation of nutrient circulation as well as information about the relationship between N loading and internal recycling.

In this work, we present the outcomes of a new set of measurements, carried out 20 years after the initial system characterization and after substantial improvements of upstream agricultural practices and sewage treatment plants and downstream clam cultivation practices, but also along dramatic and unpredictable meteorological anomalies due to climate change.

Sampling activities tackled three key macroareas, representing different conditions within the lagoon. Benthic fluxes of oxygen and dissolved inorganic nitrogen (DIN) were measured as well as rates of nitrification, nitrification-coupled (Dn) and water nitrate (Dw) denitrification, anaerobic ammonium oxidation (anammox) and dissimilatory nitrate reduction to ammonium (DNRA). Also the N loading from the main tributaries were quantified.

Outcomes from this set of new measurements will be used to implement the construction of a new model in order to analyze the effects of different loads and biological communities on whole lagoon N cycling.

S4.6 Ecosystem services' mapping and modeling in the Venice lagoon: an analysis from a sustainability perspective

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The Venice lagoon is a complex social-ecological system which provides a broad set of ecosystem services (ES). The aim of this work is to analyze the sustainability of the patterns of multiple ecosystem services provided in different lagoon sub-basins. To do so, we jointly analyze the results of a quantitative mapping of 13 ES and the results of a modeling application which simulates the dynamics of the same set of ES over time. The mapping results allow to characterize the different lagoon sub-basins in terms of the patterns of multiple ES provided, whereas the modeling results allow to explore how the ES provision in each sub-basin can evolve under a business as usual scenario and a climate change scenario. This evolution provides an indication whether the current ES provision is sustainable (non-declining ES trends) or unsustainable (declining ES trends). The results show that the ES trends under the business as usual scenario are related to the composition of the patterns of multiple ES in each sub-basin: they are sustainable where the patterns are dominated by regulating ES, and are instead unsustainable where patterns are dominated by ES mediated by human activities. This suggests that a relative indication on the sustainability of the patterns of multiple ES can be already obtained from the analysis of the mapping results. Furthermore, an association was found between the modeled trends and the sub-basins' degree of confinement, suggesting that confined and not-confined areas might have different management requirements. Finally, the results suggest a negative evolution of ES provision under the climate change scenario, with most of the sub-basins showing a declining ES trend. In the light of this, possible management are proposed for the different areas of the lagoon, showing how the joint mapping and modeling of ES can contribute to the management of complex social-ecological systems.

S4.7 The role of transitional areas as blue carbon sinks: the case study of the Stagnone di Marsala (Italy)

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The importance of transitional ecosystems like coastal lagoons is globally recognized due to their fundamental ecological roles as, among others, they yield high primary and secondary production, are nursery areas and blue carbon sinks; they also provide key ecosystem services such as coastline protection, water quality improvement, climate change mitigation. Despite their role and services provided, transitional ecosystems are deeply affected by anthropogenic pressures.

The Stagnone di Marsala is a hypersaline coastal lagoon located in the north-western part of Sicily (Italy). This important transitional ecosystem is characterized by shallow waters and is connected with the open-sea by two channels that allow sea water circulation. The Stagnone di Marsala is widely recognized as an important biotype for its great naturalistic value and is included in the Sites of Community Importance and Natura 2000 Sites.

In particular, the presence of seagrasses (extensive meadows of *Cymodocea nodosa* and patches of *Posidonia oceanica*) largely contributes to the ecological value of the lagoon. These seagrasses not only provide important habitat for many organisms, but contribute to sequester and store a large amount of carbon in the soils and, consequently, to mitigate climate change.

However, the Stagnone di Marsala is under threat due to the increase in temperature and salinity and anthropic pressure (intensive cultivations, urbanisation, saltworks, tourism, etc) and is experiencing the regression of important species such as the seagrass *P. oceanica*.

The main objective of this study is to assess the carbon sequestration capacity of seagrass meadows in this peculiar ecosystem. Results provided evidence for the role of the Stagnone di Marsala as an important carbon sink and underlined the importance of environmental management plans to maintain or implement ecosystem services.

S4.8 An allometric approach at potential scenarios of future coastal ecosystems

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According to both ecological theory and empirical evidences, global warming will lead to an increase in metabolic costs of individuals proportional to individual body size. Thus, it is important to investigate how temperature dependent variations of individuals energetic may affect the individual behavior and population dynamics. There is a very direct linkage between feeding behavior and metabolism because the quantity of energy acquired through foraging must meet the organism`s energetic requirements for survival, growth and reproduction. The aim of the present study is to evaluate the individual traits mediating the response individual metabolism and resulting space use behavior to global warming. For this purpose, the covariance of Standard Metabolic Rate (SMR) and space use behavior has been analyzed across a water temperature gradient mimicking the expected temperature rise in the next decades (RCP2.6 IPCC scenario). In particular, we tested the hypothesis that increase in temperature should lead to anticipated patch departure. The SMR assessment was carried out using flow through microrespirometric techniques on male specimens of gammarids as model organisms. The space-use behavior of those animals has been monitored using a novel recording technology, that allowed us to collect a great number of individual observations (N=96). The results of the study showed the existence of a significant relationship between individual SMR and foraging behavior: the time spent foraging on a resource patch decrease with the increase of SMR. This relationship is consistent across the tested gradient of individual size and temperature that influence the individual SMR. Even a limited increase in temperature (1.2 °C) had a significant influence. Upon examination of the residuals, it appears that the small animals move more at higher temperature, while the large animals kept constant their movement.

S4.9 Seasonal dynamics of *Posidonia oceanica* beach-cast wracks in a Sicilian beach: an overlooked system for carbon dynamics

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Seagrass detritus accumulates along the coasts forming beach-cast wracks. Being subject to environmental gradients and hydrodynamism, the size and composition of beach-cast wracks may vary in space and time. Also the composition may vary depending on both proximities to and productivity of the adjacent seagrass meadows. Despite their dynamic nature, seagrass beach-casts provide important ecosystem services, by contributing to the nutrient and carbon flow between marine and terrestrial systems, supporting beach biodiversity and trophic webs and protecting the coastline from erosion. However, the knowledge about beach-cast dynamics, ecological role and functions is still fragmented and deserves a greater effort. Here, we aimed to assess the seasonal dynamics of beach-casts in terms of mass, nutrient and carbon content, and composition. The study was conducted in November 2018 and February 2019 in a Sicilian beach (Capo Feto, TP), adjacent to large nearshore *Posidonia oceanica* meadows. Surficial and deep (0.5-2 m) seagrass beach-cast samples were collected through a handsaw along the seaward side of the wrack, at three equidistant sites (100 m).

Beach-cast mass (kg DW m coastline^{-1}) exhibited wide temporal fluctuations, significantly decreasing from November to February, as an effect of the winter sea storms. A higher mass was also evident in the deep layer than in the surficial one only in November, suggesting a higher compactness of deep layers in the highest beach-cast wracks. Accordingly, nitrogen and organic carbon content (kg DW m coastline^{-1}) showed the same pattern revealing a key role of the beach-cast as a nutrient source between adjacent systems. Despite the high seasonal variability, beach cast composition was rather constant over time, showing an overall dominance of seagrass detritus, and an increase in sediment in the deep layers. This indicates a relevant input from the adjacent *P. oceanica* meadow and confirms the role of *banquette* as sediment trap.

S4.P1 Habitat diversity and nekton distribution in the Venice lagoon: a predictive approach to characterise typical communities and guide conservation

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Estuaries and coastal lagoons are composed of complex habitat mosaics, which support diversified nekton communities. In the Venice lagoon saltmarshes and seagrass meadows are two major features of shallow water areas, occupying different portions of the sea-mainland gradient and hosting markedly different nekton assemblages. While saltmarshes provide shelter and nursery habitats for marine migrant juveniles and euriecious residents, seagrasses constitute privileged reproductive and foraging grounds for resident species that are highly dependent on this habitat during most of their life cycle. This work gathers multi-annual seine-net observations of nekton in the two habitats, and develops habitat-specific, multi-species Generalised Linear Models. The aim of this study is to highlight the main factors affecting species distribution and predict the typical assemblage composition to be expected under varying environmental and habitat characteristics. Saltmarsh assemblages are influenced by water temperature, salinity and location within the saltmarsh. Some species of conservation and commercial interest, such as *Aphanius fasciatus*, *Pomatoschistus canestrinii* and *Chelon ramada*, gather in marsh creeks, while others, including *Crangon crangon* and *Platichthys flesus*, prefer exposed marsh edges. Similarly, seagrass nekton is influenced by physico-chemical characteristics, but shows also a clear response to meadow floristic composition, canopy height and percent cover. In particular, species of conservation concern such as *Syngnathus typhle* and *Nerophis ophidion* differ in terms of seagrass cover and canopy height preferences. In a future perspective of increased human pressures and climate change, this work sheds some light on the key nekton assemblage features to be expected after successful habitat restoration throughout the heterogeneous mosaic of the Venice lagoon. Providing a synthesis of recent works on nekton response to habitat restoration in this ecosystem, the study emphasises the primary role of saltmarsh and seagrass functionality and diversity in maintaining biodiversity, preserving threatened species and managing fishery resources in coastal lagoons.

S4.P2 The history of the introduced parasite *Anguillicoloides crassus*: insights from the case study of the Comacchio lagoon

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Most fish in wild or cultivated populations are infected and their translocations involve of necessity the translocations of their parasites. By the last century, parasitic helminths have changed and expanded their geographical ranges as a consequence of the human transportation of fish for differing purposes. This is the case of the nematode *Anguillicoloides crassus* which was introduced into Europe from East Asia around 1980, through transfer of live *Anguilla japonica* for consumption, and then spread. This parasite is considered a serious pathogen for the European eel *Anguilla anguilla*: monitoring the occurrence and understanding the ecological factors which drive the burden of *A. crassus* in its endangered host are of prime importance for the conservation and management of eel populations. The first report of *A. crassus* in the Comacchio lagoon dates back to 1997. From 2005 to 2017 on numerous occasions 303 eels (yellow and silver) were sampled from the same site and examined in search of *A. crassus* in the swimbladder: 15 eels (5%) were infected, the intensity of infection ranged from 1 to 5 and a total of 27 parasites were found. The prevalence and abundance remained low throughout the period of the investigation and had increase slightly from 2005-6 to 2013-17. These parameters were much higher in eel populations from freshwater localities. Low levels of *A. crassus* similar to those found in Comacchio lagoon were reported in other Mediterranean lagoons with survivorship declining with increasing salinity.

A. crassus could be an excellent colonizer but the conditions of the study area limited its invasiveness and pathogenic effects. The infection due to this parasite appears to be of little or no importance in the decline of eel population.

S4.P3 Salinization effects on deltaic areas: The Po river delta case study

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Salinization increases occur naturally in coastal areas over time. Nowadays, these episodes are very important and more frequent, due to human activity and climate change, with an increase in water demand, in particular for agriculture. Salinity influences aquatic communities, both directly and interacting with other environmental parameters. This may influence the ecosystem response and its functionality.

Few studies describe the effects of coastal salinization in rivers and/or ponds. Therefore, the aim of this study is to analyse macrobenthic community changes in two different aquatic ecosystems in the Po river delta, as a response to the salinity increase. Macrobenthic communities of three arms and 16 perennial ponds of the river Po delta, subjected to increasing salinization phenomena, were analysed along a salinity gradient.

The results emphasize a loss of species with community simplification and trophic changes in both aquatic systems. The salinization up to polihaline levels cause a dramatic loss of biodiversity both in taxonomic and biological and functional terms. The riverine sites, characterized by increasing seasonal ranges of salt water intrusion, hosts disturbed community that are only partially resilient to cyclic salinity variations. In the ponds system, the community is resilient to moderate levels of salinity.

Since anthropogenic activities and climate change aggravate the salt water intrusion in coastal areas, management measures are required for the conservation of aquatic biodiversity and its natural capital.

S4.P4 Bioaccumulation of trace elements in Kentish plover (*Charadrius alexandrinus*)

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The Kentish plover *Charadrius alexandrinus* is a small wader of Family Charadriidae, breeding in wetlands and coastal areas of Europe, North-Africa, Middle-East and Central-Asia. Its population size is declining all over its distribution range, and the cause of the decline has been recognized in habitat loss and fragmentation, increased human uses of the sandy coastal areas for commercial and recreational purposes, and increased predation by birds and mammals taking advantage of human activities. In contrast, the possible contribution of environmental contamination to the decline of the species has been largely disregarded. To verify whether contamination may be a factor affecting conservation status of Kentish plover populations, a non-invasive study of trace element accumulation in tail feathers of the Kentish plover was performed along the coastline of the northern littoral strip of the Venice Lagoon. Body burdens in feathers of 11 trace elements including toxic metals/metalloids and essential elements (As, Cd, Co, Cr, Cu, Hg, Ni, Pb, Se, V, Zn) were quantified by ICP-MS, then concentrations were normalized to feather's age calculated using ptilochronology in order to obtain daily deposition rates. Mercury emerged as a major threat to the conservation of the species at local scale: feather concentrations were above the adverse-effect threshold (5000 μg kg^{-1}) in 11 out of 13 analyzed birds. These data underline a probable risk of Hg-related toxicosis, that may lead to impairments in the reproductive success of KP, and of other water birds with similar feeding habits. Also Cd and Se occurred at levels that may impact on the conservation status of the studied species at local scale, even if to a lesser extent than Hg.

S4.P5 The nursery value of the Venice lagoon for the gilthead seabream *Sparus aurata*

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Transitional water ecosystems play an important role as nursery areas for many marine species. The conceptualization of a nursery habitat is complex, and hence the assessment of the nursery value of an area for a given species should ideally consider several characteristics of the population, such as density, growth, survival and movements. In this work we combined several approaches for defining the potential nursery value of the northern sub-basin of the Venice lagoon for *S. aurata*. The suitability of different areas of the lagoon were assessed using a previously developed stage-specific distribution model. The spatial predictions were obtained using as inputs the main abiotic parameters (temperature, salinity, dissolved oxygen, turbidity), recorded in 16 stations of the northern Venice lagoon during 5 sampling campaigns of spring 2016. During the same period, beach seine samplings were carried out in 16 stations for comparing density, length frequency and diet in different part of the lagoon. Results suggest that smaller individuals (standard length < 20 mm) tend to prefer areas closer to the sea inlet, while specimens with a standard length between 20 and 35 mm are more likely associated with confined zone of the lagoon. *S. aurata* individuals enter the lagoon until late April and concentrate in sea influenced areas, where they eat mainly Harpacticoida and Amphipoda. In the inner stations, where they eat also Cyclopoida, Polychaeta, Decapoda and Mysidacea, they start growing from late March, showing a quick size increase, probably due to the optimal conditions. These results highlight that the two size classes considered are associated with different environmental conditions, different habitats, even if mainly saltmarshes, and use different resources during their permanence within the lagoon, suggesting a complex pattern of lagoon utilization, and suggesting that different approaches need to be integrated for the definition and management of lagoon nursery habitats.

S4.P6 The use of very high resolution images for the estimation of *Posidonia oceanica* beach-cast morphology

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Posidonia oceanica is an endemic Mediterranean seagrass that forms wide and dense meadows from the surface to depths of about 40 m. During fall and winter, due to aging and storms, leaves and rhizomes break away from the seagrass meadows and accumulate on the shores (from a few centimeters in the water to several meters inshore) forming conspicuous beach-casts of *P. oceanica* detritus. These structures have received increasing attention in the last decade for the potential ecosystem services they provide in protecting the coast from erosion, linking marine and terrestrial food chains and contributing to carbon and nutrients fluxes. However, seagrass beach-cast morphology is not easy to estimate because: i) beach-casts have a complex dynamics; ii) they can reach very large extensions; iii) their shapes are not comparable with standard geometric figures. The aim of this study was to investigate the morphology and dynamics of *P. oceanica* beach-casts in three beaches of Sicily (Capo Feto, Maragani and Scala dei Turchi) characterized by different productivity of the nearshore meadows. A remote sensing approach was used to assess the beach-cast extension, morphology, volume and derivate parameters. In particular, very high resolution drone images, combined with GPS field data, were used to obtain a 3D-reconstruction of *P. oceanica* beach-casts. Generated ortophotos and digital elevation model were imported into geospatial analysis software to quantify volumes and their spatial and temporal evolutions. The 3D-model allowed to accurately estimate different levels of seagrass detritus accumulation. This approach enables to achieve a more detailed and complete understanding on the role of *P. oceanica* detritus beach-casts in coastal marine dynamics. This might also contribute to gain a better insight into the ecosystem services they provide.

Sessione 5:
Capitale Naturale ed Ecosistemi delle Acque Interne

Prof. Pierluigi Viaroli

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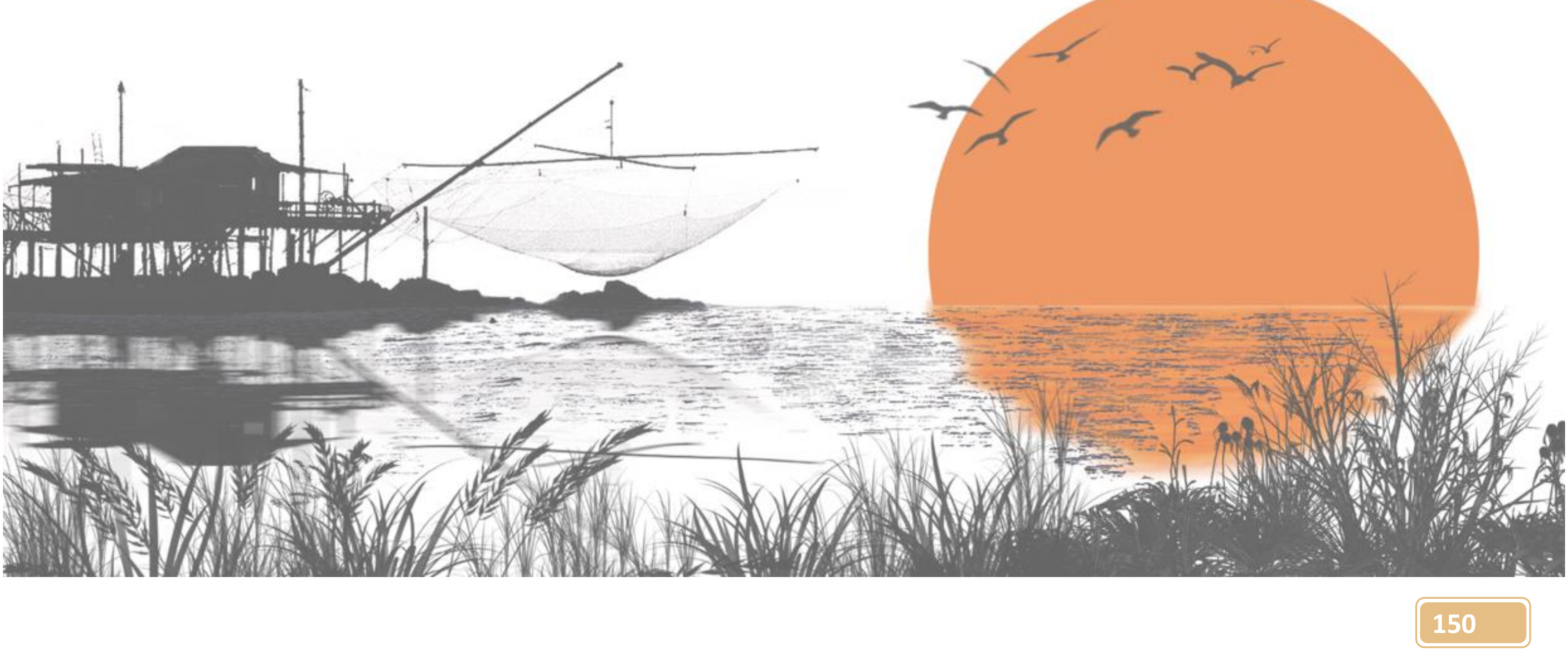
Natural capital, goods and services from inland waters: from water supply to aquatic ecosystem perspectives

Inland waters are appreciated for their great value, but primarily as freshwater suppliers for multiple uses: drinking water to human and livestock, irrigation, power generation, industrial production. Paradoxically, water is valued as an essential good, but aquatic ecosystems are almost often neglected, misvalued and threatened. While rivers and lakes are commonly perceived as “aquatic entities”, a great variety of aquatic ecosystems are disregarded. Indeed, inland waters are complex networks of streams and rivers of different order and magnitude, deep and shallow lakes, a wide variety of wetlands, canals, ditches, springs and groundwater depending ecosystems. They are interconnected by surface and belowground flows and by the atmospheric water cycle, forming the so called “fluvial filter”. The challenge is how to identify their functions and to account for their value, especially for the less known, and consequently most threatened, components.

In this talk I will address three main points, referring to Italy, with emphasis on the Po river watershed where water scarcity and pressures on inland waters are potentially leading to a feedback loop: the business as usual approach, which primarily addresses freshwater availability and provision through grey infrastructure, e.g. dams and reservoirs; a new green-oriented perspective, largely based on the Millenium Ecosystem Assessment initiative, which identifies a wide variety of services to the human society provided by inland water ecosystems; the appraisal of the value of neglected and misvalued (eco)systems, namely canals and ditches, floodplain wetlands, and even sand and gravel pit lakes, in terms of provisioning goods (e.g. water and wood biomass), regulation services (e.g. water purification and storage), and flooding contrast.

The latter point strongly supports restoration ecology as a fundamental tool to recover, repair and reconstruct degraded aquatic ecosystems.



S5.1 Macrofauna and roots reduce CH_4 production and attenuate nutrient recycling in organic-rich fluvial sediments

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Organic-rich freshwater sediments display millimetric oxygen and nitrate penetration and are sources of methane to the water column and to the atmosphere via diffusion and ebullition. Radial oxygen loss by submersed aquatic plants and burrow irrigation with O_2 and NO_3^- enriched water by macrofauna can significantly alter the subsurface sediment volume where respiration processes alternative to methanogenesis occur. We tested this hypothesis in perifluvial organic sediments colonized by the submerged phanerogam *Vallisneria spiralis* and the oligochaete *Sparganophilus tamesis*. Gas ebullition and diffusive fluxes were measured in microcosms maintained under controlled laboratory conditions over a period of two weeks. Four conditions were reproduced: sediments alone, sediment with oligochaetes, sediment with plants and sediment with plants and oligochaetes. Microcosms with sediments alone released the largest methane volume whereas sediments with plants and macrofauna released the lowest amount. The presence of the oligochaete had comparatively a stronger effect than that of the macrophyte. Simultaneously, the bioturbation activity of the oligochaete enhanced the production of N_2 and the consumption of oxygen and nitrate, suggesting increased rates of aerobic respiration and of denitrification. The presence of plants attenuated net N_2 losses from the benthic system likely due to the competition between assimilative and dissimilative N-related processes.

S5.2 Macroinvertebrates in riverine systems with different degree of intermittence: influence of community dynamics and environmental variables at different spatial scales

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Streams and rivers are among the most complex and dynamic natural systems, having a fractal and hierarchical organization, with time- and scale-dependent factors affecting community structures. In order to cope with this complexity, the present study has been divided into three sections related to different spatial scales, aiming to disentangle the main drivers affecting the distribution of macroinvertebrates. In the first section, we worked at the among-microhabitat level, considering environmental and spatial variables as covariates for community data in geostatistical and variance partitioning models. Then we analysed the structuration of communities among mesohabitats in river segments, evaluating their spatial and temporal variability by means of mixed models. At last, we performed a broad-scale study, focussing on the distribution of organisms among a wide set of streams. All sections have been carried out in watercourses belonging to Northern Apennines (Po River Basin) and in the framework of the project NOACQUA (Prot. 201572HW8F). For microhabitat level we highlighted a dominance of trophic factors in determining the distribution of organisms, but with a significant contribution given by spatial variables. Moreover, the dominance of environmental or spatial factors resulted to be season-dependant. Considering the second section, we found a strong influence of the mesohabitat in structuring communities, with different mesohabitats hosting different and exclusive taxa. Such difference tended to decrease during summer, due to the homogenizing effect of flow reduction. Then, for the broad-scale, the hydrological regime resulted to deeply affect macroinvertebrate communities, leading to a decrease of alpha diversity and to an increase of beta diversity (coupled with greater randomness) in communities of intermittent streams. All these findings offer insights in the frameworks of biomonitoring, restoration and community modelling since they highlighted the importance of drivers which are often omitted in ecological studies.

S5.3 The reintroduction of the Beluga sturgeon (*Huso huso*) in the Po river basin, between science and improvisation

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The growing interest for the reintroduction of the Beluga sturgeon (*Huso huso*) in the Po river basin is involving an increasing number of actors who, with different methods and different strategies, act independently both at national and international level.

This contribution has the purpose of: a) briefly introducing the status of the species in its distribution area; b) reporting the results of recent analyses of the geographical pattern of genetic variability across the whole distribution area, with the aim of providing and discussing useful information for an informed planning of conservation activities; c) illustrating progresses in terms of development of international conservation guidelines that led to the recent approval by the Bern Convention of the Pan-European Action Plan for Sturgeons; d) highlighting the need of a coordinated strategy for the restoring of the Beluga sturgeon in Italy.

S5.4 Ecology and the impact of anthropogenic activities determine the fate of antibiotic resistance in waters

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In the last five years a huge number of papers tackled the up to then unknown fate of determinants of antibiotic resistance in waters. This massive scientific production shed light on the sources of pollution, on the possible interactions within allochthonous and resident bacteria, and on the role of different environmental parameters in shaping the resistomes of the aquatic bacterial communities. Still, due to the complexity of the ecosystems and of the conditions leading to the acquisition of antibiotic resistances, it is unclear if aquatic environments can be considered a risk factor for human health and how they can act in promoting the persistence of resistances and their further spread in human pathogens.

This presentation will review the most important discoveries of the last years in the field by coupling experimental studies and large-scale surveys in order to summarize the impact of human activities on natural systems both as point (WWTPs) or diffuse sources of pollution (agriculture, urban areas) and the ecological interactions in the environment promoting the spread and the persistence of resistances also without direct antibiotic selective pressure.

S5.5 Aperiodic Seasonal Drought (ASD) and ecosystem processes: preliminary results of ongoing research on leaf litter breakdown and invertebrate assemblages in the Aterno River (Abruzzo, Central Italy)

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Global warming and human pressures are the main drivers of the qualitative and quantitative alterations of freshwater resources. In temperate climate regions most of the perennial rivers and streams are becoming intermittent. The Aterno River is one of the most important Central Apennine watercourse (as total length and discharge volumes). However, in the last years some reaches of the river dried completely. These seasonal droughts occur irregularly on a multiannual temporal scale and can be recognized as "aperiodic seasonal droughts (ASD)".

In contrast with the large literature on the effects of seasonal or supra-seasonal droughts on naturally intermittent rivers, little is known about the ecological impacts of ASD on former perennial streams.

For this reason, we started a long-term study on two reaches of the Aterno River: a control site with a natural discharge regime (no complete flow cessation in summer months) and an impact site subjected to irregular events of complete seasonal drought.

Our study was aimed to assess between-site differences in macroinvertebrate assemblages and ecosystem processes (leaf-litter breakdown). Benthic invertebrates were sampled with a Surber net while leaf litter breakdown was evaluated by considering the dry mass loss of *Populus nigra* leaves after about 40 days of submersion (leaf-nets methodology). However, during the period of investigation (from January 2018 to May 2019) no drought events were recorded at the impact site and both sites showed a similar discharge regime.

This condition allowed us to test the "*drying memory*" hypothesis. We hypothesized that the ecological impacts due to ASD on ecosystem structure and processes may extend their influence after the return of natural flow conditions. Our preliminary results seem to confirm our predictions: the breakdown rate of poplar leaves was significantly faster at the control site; some differences were also observed in the structure and composition of macroinvertebrate assemblages.

S5.6 Droughts in Alpine streams: impacts on the diversity of macroinvertebrate communities and insights on their recovery

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Water scarcity is one of the most relevant threats for rivers around the world, given the combined effects of climatic and anthropogenic pressures on water supplies. Also “historically perennial” watercourses, like Italian Alpine streams, now are shifting from permanent to intermittent systems. This represents a recent phenomenon caused by local (i.e. water abstraction and damming) and global (i.e. climate change) impacts. Compared to other parts of Europe, such as Southern Italy and Andalusia where the drying phase is a natural part of the annual flow regime, biological communities of our Alpine streams have not evolved adaptations and strategies to face the drought phases. Therefore, the biodiversity loss derived from these hydrological alterations in our mountain streams may vary, from modest to dramatic, resulting in incalculable impacts also on the functionality of lotic ecosystems. We present here an overview of our studies dealing with the response of benthic invertebrate communities to drought and flow intermittency in Alpine streams (Northwestern Italy). First, the impacts of drying conditions on the diversity of macroinvertebrate communities were evaluated in a large-scale survey by comparing permanent and intermittent sections of fifteen selected streams. Then, the resilience ability of macroinvertebrate communities was investigated by means of a field study and a mesocosm experiment. Our results show that drought and flow intermittency act as filters that significantly reduce the taxonomic and functional biodiversity of macroinvertebrate communities in Alpine streams, especially among the most sensitive invertebrates such the EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa. Moreover, the drift from the upstream sections seems to be main driver of the post-drought recovery of macroinvertebrate communities, despite the stream-specific variation in flow can directly alter the recolonization process. This work was supported by the project PRIN Bando 2015 prot. 201572HW8F Progetto “No Acqua”.

S5.7 Productivity in Alpine streams: what do we know?

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One of the most intriguing but also problematic and for this reason less considered topic in stream ecology is related to productivity, considered not in a specific, selected compartment but in a more global perspective. Unlike what happens in terrestrial but also in some lentic environments, primary and secondary productivity in streams and rivers are not strictly coupled because of the importance of allochthonous, terrestrial energetic inputs. In facts, the global productivity of a selected stream reach depends not only on the instream characteristics but also on the primary productivity of the drainage basin. This is particularly true in the Alpine or generally montane lotic environments that generally are considered highly heterotrophic systems. In this study we reviewed the main techniques and studies used to asses primary productivity in flowing water systems (i.e., biomass accumulation on artificial substrates, oxygen or carbon dioxide chambers or open field measurements, other chemical assessment or use of benthic chlorophyll-a as a proxy). We also considered results of studies investigating secondary productivity, mainly related to benthic macroinvertebrates and fish, expressed as density of organisms and/or dry mass per unit area. Beside this literature review, we present here some preliminary data related to a sampling project carried out in the upper section of the Po river, inside the Parco del Monviso, coordinated by the Center for the Study of Alpine Rivers – ALPSTREAM. In a moment in which global climate change alters the hydrology of Alpine rivers and at local level pressures and water demands continue to grow, increasing our knowledge about the productivity of these systems (and the consequences of its possible alterations) is more and more necessary.

S5.8 A new protocol based on the epilithic $\delta^{15}N$ values for the environmental monitoring of the Nitrogen inputs in aquatic ecosystems

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Nitrogen stable isotopes analysis of macroalgae and epilithic associations is a widely employed technique in the environmental monitoring of the origin of Nitrogen human-derived inputs. In a previous study, we determined four Nitrogen input classes ('inorganic', 'non-impacted', 'moderate and high organic') each one associated to an epilithic isotopic Nitrogen signatures ($\delta^{15}N$) range. However, a probabilistic and statistically robust protocol for the assignment of the epilithic $\delta^{15}N$ values to the appropriate class of Nitrogen input is still missing. This lack represents a problem for the interpretation of the results as well for the planning of possible management actions. We propose a protocol for the Bayesian determination of four Gaussian distributions, each one describing a Nitrogen impact class, based on the observed $\delta^{15}N$ values of littoral epilithon in the volcanic lake Bracciano (Central Italy). This lake, which is the most important water reservoir for the city of Rome and an important touristic destination, was affected by a long period of drought. To determine robustly if types and magnitudes of the inputs changed in space and time and which zones were more affected, the Gaussian distributions were coupled with GAM model estimates at different spatial and temporal resolutions. The results of this research highlight that, in 2017, the organic Nitrogen classes decreased because of tourism reduction. However, on a multi-annual scale, despite these reductions, both organic and inorganic human-derived inputs occurred and affected different lake areas. In conclusion, the proposed protocol has three main advantages: it helps in sampling procedure allowing the monitoring prioritization of coastal areas, it assesses ecosystem services facilitating the measurement of ecosystem quality and it can be extended to other freshwater and marine ecosystems with few recalibrations.

S5.9 Fish community responses to antecedent hydrological conditions in the Júcar River Basin District (Eastern Iberian Peninsula)

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In the last decades many studies have proven the paramount impact of flow regimes on the structure of lotic ecosystems, both through formative events (i.e. floods and droughts) but also during ordinary flows, which temporarily and spatially regulate the habitat availability.

Human demand for water is steadily increasing and scientists are challenged to define ecosystem needs clearly enough to guide policies and management strategies. However, field studies demonstrated that a variety of interacting factors, such as, presence of barriers (waterfalls or dams), temporal changes in habitat structures and climate change, affect the abundance, composition and distribution of fish assemblages.

This work, through quantile regression, tested hypotheses to elucidate the effect of antecedent hydrological conditions over fish community characteristics.

A large monitoring database collecting and homogenizing the existing information on fish fauna in the Júcar River Basin District (Eastern Iberian Peninsula) was gathered and used to evaluate biological metrics related to auto-ecological information (i.e. fecundity and maturation age) and discriminating between native, translocated and exotic (i.e. non-Iberian) species. The resulting dataset was complemented with metrics related to the measured daily discharge at the nearest gauging site (i.e. station or dam). The final dataset comprised more than 300 sampling events from 1997 to 2017.

Most of the significative relationships described a limiting action of the analysed hydrological variables, confirming that antecedent hydrological conditions act as limiting factors. First and second previous hydrological years were associated with fish community metrics within a coherent pattern. Metrics related to richness and abundance of exotic species showed the higher proportion of significant associations, particularly spring flows and annual minima and maxima.

The flow-ecology relationships described in this work shall be particularly useful both to manage ecological alterations and to maximise the environmental benefit of reducing anthropogenic exploitation of water resources, especially under the current climate trends.

S5.10 The role of species introduction in modifying the functional diversity of native communities

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Although one of the most evident effects of biological invasions is the loss of native taxonomic diversity, contrasting views exist on the consequences of biological invasions on native functional diversity. We investigated this topic using Mediterranean fish communities of inland waters and distinguishing between exotic and translocated species invasion. Our results confirmed that introduced species were widespread and in many cases the invasion was severe. Exotic and translocated fish species had substantially different geographical distribution patterns, perhaps arising from their differences in introduction timing, spread and invasion mechanisms. We also found a clear decreasing trend of functional dispersion along an invasion gradient, confirming our hypothesis that the invasion process can diminish the relative diversity of ecofunctional traits of host fish communities. There are also some evidences that translocated species are more ecofunctionally similar to native ones, compared to the exotics.

S5.11 Longitudinal gradient of CPOM degradation in the Po river (NW Italy)

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Alpine streams are increasingly suffering the effects of anthropogenic pressures because of water withdrawal, morpho-hydrological alterations and the effects of climate change. For these reasons, drought occurrence is becoming more frequent in Alpine stream ecosystems, which are known to be particularly fragile and vulnerable to the effects of this phenomenon. The aim of the study was to investigate CPOM degradation longitudinal patterns in the Po river, in four stations from upstream to downstream, where drought events are becoming more frequent. In particular, using leaf litter bags of chestnut and oak we investigated the CPOM degradation process above and below the treeline, in both perennial and recently intermittent reaches, by measuring the following: i) mass loss variations; ii) macroinvertebrate colonization patterns; iii) microbiota communities (fungi and bacteria) involved in the process. We hypothesized that the CPOM decomposition in the upstream and forested sites would be driven by a relevant contribution of the shredder functional feeding group, and that this trend will decrease moving downstream, according to the river continuum concept; moreover, we expect that in sites with permanent flow CPOM degradation process would be driven by a relevant contribution of both macro- and micro-consumers, while in the intermittent ones would be explained primarily by the role of micro-consumers. With continued drought conditions and changing CPOM subsidies, the variation of biodiversity, richness and density of colonizer communities could result in altered Alpine stream ecosystems.

S5.12 Testing metabarcoding for macroinvertebrate biomonitoring in intermittent rivers

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Understanding macroinvertebrate community dynamics in intermittent rivers is limited due to low taxonomic resolution. This holds especially true for groups with difficult taxonomy or for juvenile individuals for which the concept of taxonomic sufficiency, i.e. using taxonomic levels above species, is generally used. DNA metabarcoding is emerging as an affordable genetic tool to overcome identification problems since it allows inferring community composition from an unknown bulk sample. Here, we applied DNA metabarcoding of the mitochondrial Cytochrome c Oxidase subunit 1 gene (COI) to study macroinvertebrate community dynamics in the Trebbia river, Northern Italy, as part of the NOACQUA project funded by MIUR (Prot. 201572HW8F). Macroinvertebrates were collected in December 2017 and July 2018 at six sites along the river course, with the last 2 sites being intermittent. A total of 129 and 69 taxa were identified with metabarcoding and morphological identification, respectively. Mean family richness recognized with metabarcoding was significantly lower when comparing per sample richness. Beta diversity patterns inferred by both methods were consistent across taxonomic levels ($r > 0.9$), although the use of operational taxonomic units (OTUs) provide a still significant correlation ($r \sim 0.8$) but a different ecological interpretation. Turnover component of beta diversity turns out to be more important than nestedness when shifting from higher (i.e. morphology-based) to lower (metabarcoding) taxonomic levels and OTUs. Metabarcoding proved to be a powerful method to complement morphological analysis in intermittent rivers, but both primer efficiency and reference database accuracy need to be improved to have more accurate diversity estimates.

S5.13 Macroinvertebrate community structure in relation to environmental variables in five Alpine streams fed by shrinking glaciers

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The general aim of this work was to characterize the structure and functional features of macroinvertebrate communities in five streams fed by glaciers with different size and shrinking rates, in three mountain groups (Brenta Dolomites, Ortles-Cevedale and Adamello Mt., Trentino, NE Alps).

Eight sites were selected within ca 2 km downstream of the glacier snout, between 2115 and 2858 m a.s.l., spanning five kryal, two glacio-rhithral, and one glacial pond. Their "glaciality level" was quantified using: distance from the snout and % of glacier cover in the catchment; isotopic and geochemical parameters [e.g. $\delta^{2}H$ and $\delta^{18}O$ composition, conductivity and chemical content of surface water]; channel stability and water temperature; food availability (estimated as epilithic chlorophyll a and BPOM); food web structure [e.g. relative importance of allochthonous and autochthonous food sources using stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes]; % of *Diamesa* sp. (Diptera Chironomidae) and presence of *Diamesa steinboecki*. Altogether the environmental parameters define the "glacial influence" on biota.

In all, more than 15,000 macroinvertebrates were sorted from 80 benthic samples collected in early and late summer 2018, of which 80% chironomids. Taxa distribution was analysed in relation to all environmental parameters defining the glacial influence.

Comparisons with previous data available for two of the studied streams, highlighted as shrinking glaciers are resulting in upstream migration of a) specialist species tracking retreating glaciers until they disappear, b) generalist species to sites once exclusive for kryal species, c) local species extinction of the "ice fly" *D. steinboecki*, d) increase in alpha diversity close to the glacier residues with ameliorated environmental conditions, e) different response times to climate change of physical habitat (e.g. thermal and hydrological regime) and biota.

S5.14 Impacts affecting the natural capital of the large and deep lakes south of the Alps: long-term research and challenges in management

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The deep subalpine lakes (DSL) (Maggiore, Lugano, Como, Iseo, and Garda) constitute the most important water district in Italy, totaling 121 km^3 of water and about 80 % of the Italian total freshwater volume, including artificial lakes. The surface of their drainage basin is 15,536 km^2, whereas about 20 % of the whole River Po watershed and their outflow contribute about 40 % of the River Po discharge. Located in one of the most densely populated and highly productive areas of the country, the DLS represent a priceless natural capital -and an essential strategic source of water supply for agriculture, industry, fishing, and potable use, and an important resource for recreation and tourism. In the last decades, the DSL were increasingly threatened by several anthropic pressures such as climate change, new micropollutants and emerging toxigenic cyanobacteria and invasion of allochthonous species, working independently or synergistically. Climate change in particular is affecting the lakes by decreasing frequency and depth of mixing events and causing temporary meromixis, affecting oxygen and nutrient levels, and changing phenology and community structure of plankton. The synoptic results obtained in the framework of the investigations (including the Long-Term Ecological Research network, LTER-Italy) carried out in the DSL will be critically presented and discussed, highlighting the value of a solid scientific knowledge aimed at preserving and improving their functionality and their value as natural capital.

S5.15 Survey of PFAS concentrations in zooplankton and pelagic fish collected in three subalpine Italian deep lakes

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Determination of 20 PFASs in zooplankton and in a fish species of commercial interest (*Alosa agone*) has been carried out in three Italian subalpine lakes (Maggiore, Como, Iseo). Moreover, the assessments of the risk for humans and predators for fish consumption were performed. Lakes Maggiore, Como and Iseo are among the largest and deepest Italian ones. They constitute an important water source for drinking, agricultural and industrial purposes in Northern Italy and they have an important role for fishing and as touristic attraction. The sampling campaigns lasted two years and were carried out every season. Zooplankton samples and fish of Lake Maggiore was the most contaminated, with mean concentrations of 7.5 ± 5 ng g^{-1} ww and 14.4 ± 3.8 ng g^{-1} ww respectively, as sum of all PFASs analysed. In both matrices (zooplankton and fish) PFOS was the most predominant compound in all lakes (ranging from 30% in Lake Iseo to 67% in Lake Maggiore in zooplankton and from 56% in Lake Iseo to 90% in Lake Maggiore in fish) despite the normative restrictions. In Lake Maggiore, fish concentrations are always greater than the EQS_{biota} (9.1 ng g^{-1} ww) adopted in Directive 2013/39/EU. However, there is no evidence for a risk for humans considering the real consumption of lacustrine fish, while a moderate risk of secondary poisoning for predators could be not excluded and therefore more detailed studies are required.

S5.16 The thermal regime of alpine streams: natural controls and effect of hydroelectric power production

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Since the earliest studies water temperature was recognized as one of the most important drivers in stream ecosystems, shaping both biodiversity and ecosystem functioning. The temperature is critical to aquatic organisms through its effects on metabolic rates and thus on growth. Moreover, water temperature relates to the outbreaks of disease, to the toxicity of numerous substances, to the ability of fish to migrate and to many other ecosystem attributes.

Despite the recognized biological importance of water temperature, stream thermal regime alterations were rarely quantified in bioassessment programs and quantitative information about the natural thermal regime of Alpine are lacking.

In the present study we monitored water temperature of streams belonging to the Alpine catchment of Serio River (Italy), in reaches selected as representative of different natural conditions and human alterations. The collected data, with air temperature, flow estimates and diversion rates of hydroelectric power plants, were used to produce quantitative models able to predict the temperature of stream water. Those models describe the effects of meteorological conditions on thermal regime for snowmelt/stormwater and karst-fed streams. This is the basis for the evaluation of natural thermal regime, allowing to reconstruct temperature time series. The developed models can also be used to evaluate the thermal alterations due to the presence and management of high-altitude reservoirs and run-of-river hydroelectric power plants.

Further research is needed to properly describe the relationships among selected characteristics of thermal regime and biological communities. Similarly, to what was done in the last ten years for the development of flow-ecology relationships, emphasis must be placed to the effects of thermal regime on the ecological parameters used for bioassessment. This kind of information will allow to predict or to describe changes within the biological communities and in ecosystem functions and ultimately to properly manage and conserve the Alpine stream ecosystems.

S5.17 Microplastic colonization by primary producers: a mesocosm experiment across a biogeographical gradient

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Every year millions of tons of plastic material are manufactured globally. Up to 10% of the plastic produced each year worldwide ends up in the aquatic environments, affecting these crucial natural resources. Different studies have highlighted that microplastics (MPs, <5 mm) constitute suitable substrates for the formation of biofilms, as microplastic surfaces represent a distinct habitat for several organisms. However, the understanding of the formation of biofilm on these particles and the consequences that this could have for aquatic ecosystems are poorly investigated. The aim of the present work is to understand to which extent microplastics can influence the growth of primary producers in aquatic systems across a biogeographical gradient. To achieve this goal, the periphyton establishment on two different plastic polymers was assessed through mesocosm experiments performed within the Iberian Pond Network (IPN) in six different locations situated in a variety of bioclimatic regions, including semi-arid, Mediterranean, temperate and alpine environments. Three enclosures were deployed in five ponds in each location. Three experimental treatments were implemented in each pond: 6 g of High-density polyethylene (HDPE), 6 g of Polyethylene terephthalate (PET) or a mix of the two polymers. Different parameters were measured in each pond: water temperature, pH, conductivity, chlorophyll-a and nutrients. After one month, the microplastics were collected and the chlorophyll-a in-vivo was measured in the field using an AquaFluor fluorometer. Species composition was assessed in the laboratory using an inverted microscope and flow cytometer was employed to obtain additional information such as density and particle size. Preliminary results indicate that periphyton biomass and species composition differ depending on polymer type and vary across the region, depending on the environmental conditions and local species pools. Our results will help to better understand the implications of the presence of microplastics in aquatic systems.

S5.18 Short term influence of sediment drying and organic matter enrichment on benthic metabolism, nitrogen and phosphorus recycling

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The littoral zone of lakes provides several ecological functions and services and is a key component of aquatic ecosystems. Here, the water-sediment interface is a biogeochemical hotspot, where nutrients are transformed, buried and recycled to the water column. Yet several anthropic pressures affect littoral zones of lakes which may influence benthic metabolism with possible implications for N and P biogeochemistry and provided services. Human exploitation of water resources and extreme hydrological events affect the magnitude and timing of water-level fluctuations inducing repeated drying-rewetting cycles of the sediment surface, while excessive growth and decay of primary producers, increase sediment organic matter (OM) enrichment. The main purpose of this work is to analyze the effect of short-term sediment desiccation and rewetting and OM enrichment on sediment features and benthic metabolism. The main focus is on biogeochemical processes: sediment capacity to accumulate and sequester reactive N and P, organic matter mineralization rates and the balance between benthic net autotrophy and heterotrophy, net N_2 and N_2O fluxes, dissolved inorganic N and P exchanges across the water-sediment interface and their stoichiometry. The effect of drying/rewetting cycles was simulated under laboratory conditions, by incubating reconstructed sediment microcosms under different desiccation and OM enrichment levels. The results indicate that exposure to air significantly influences the recycling of inorganic nutrients at the water-sediment interface. Exchange rates and fluxes depend on the extent of exposure and on the organic matter enrichment. Negligible or non-significant differences were measured between control and wet sediments. Desiccation affects exchangeable P and N pools within the sediment and increases their release after rewetting along with N_2 and N_2O production. The effect is transitory and about the 80% of dissolved inorganic nitrogen and phosphorous are released within one hour after rewetting.

S5.19 Effects of river drying and rewetting on hyporheic metabolism and nutrient cycling

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Over the past thirty years, the frequency and duration of droughts has increased dramatically across Europe, causing perennial streams to shift to intermittency even in temperate regions, modifying stream ecosystem processes and related services. The aim of this study is to investigate the effects of drought on metabolism and nutrient cycling in streams hyporheic zone, that is recognized as a ‘’hot spots’’ of biogeochemical processes. We analysed the effects of sediment desiccation on nutrient regeneration and uptake before and after drying and how intermittent and perennial microbial communities and their associated activities differ in their response to desiccation and in their capacity to recover after drying. We carried out a laboratory experiment using sediment perfusion cores, filled by hyporheic sediments collected from 10 perennial and 10 intermittent streams in Austria during the flowing phase. Sediments were immediately placed into the mesocosms after sampling, transported to the laboratory and connected to a peristaltic multi-channel pump operated in flow-through mode. All mesocosms were exposed to three hydrological conditions: flowing phase (2 weeks); drying phase (7 weeks) and rewetting phase (2 weeks). The experiment lasted 11 weeks in which we carried out five samplings: during flowing phase, 24 hours, 3 days, 1 week and 2 weeks after rewetting. We hypothesize that 1) drying-wetting sequence may favour the succession of red-ox conditions that stimulate the coupling of nitrification and denitrification, setting to zero methanogenesis and may have important effects on sediment biogeochemistry and on nutrient dynamics; 2) drying results in a decrease of bacterial abundances and activities immediately after re-wetting; 3) intermittent streams show a faster recovery to drying events due to adaptions of the microbial community than perennial streams.

This study is carried out within the project PURIFY (GZ B769828 “ACRP10 – PURIFY – KR17AC0K13643”) and supported by NOACQUA project (PRIN 2015, Prot. 201572HW8F).

S5.20 N legacy along gradients: How water and land uses drive river-groundwater interaction in the Ticino, Adda and Oglio Rivers (Northern Italy)

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Anthropogenic impacts on N dynamics in agricultural watersheds are investigated by N budgets that hypothesize but do not quantify N accumulation in soils and groundwater. A key issue for exploited river basins of Northern Italy is to understand how fertilized agricultural land and irrigation practices drive N transfer between surface and groundwater. We hypothesize river- nitrate polluted groundwater interactions during irrigation periods. Large fractions of river discharge are diverted to irrigate permeable soils by flooding, a practice that enhances nitrate transfer from soils to groundwater and from groundwater to rivers via springs and river-groundwater interactions. As a result, nitrate displays sharp increase in stretches without point N inputs and crossing areas with springs. Aim of the work, within the Fondazione Cariplo INTEGRON project, is to integrate N budget at the watershed scale with the role of groundwater as N source, quantifying N-rich groundwater input to rivers. We calculated and integrated soil N budgets for Oglio, Adda and Ticino basins with experimental N mass balances. We performed seasonal reach-scale N mass balances in segments crossing the spring area. For all basins N sources (manure and synthetic fertilizers) exceed sinks (crop uptake) resulting in N surplus and contamination risk. Reach-scale N and conservative parameters balances suggest diffuse nitrate contamination from the groundwater to the river. N surplus correlates with reach-scale N balance with an increasing gradient, along the Ticino, Adda and Oglio rivers. In the irrigation period, groundwater contributes 31, 54 and 93% of river flow and 27, 76, 93% of N load for Ticino, Adda and Oglio rivers, respectively. These data highlight a N legacy, due to a feedback loop between soil and water use, with irrigation acting as driver of N transfer. Data are discussed in the framework of climate change, decreasing water availability and alternative irrigation and agricultural practices.

S5.21 L'analisi dei Water Ecosystem Services (WES) per l'identificazione degli ERC in alcuni bacini idrografici della Regione Emilia Romagna

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The approach used is based on the evaluation of the economic benefits deriving from the improvement of the water quality and the SE flow. The study area concerns the basins of the Lamone, Ronco-Bidente and Marecchia rivers with an area of approximately 2,096 km^2 (48 municipalities in the regions of Emilia-Romagna, Marche and Tuscany).

S5.22 Towards the achievement of WFD goals in agricultural watersheds: the role of vegetated ditches in reducing nitrate export

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The interest on agricultural ditches as effective filters to buffer nitrate pollution has been raised only recently. Although ubiquitous elements of human-impacted watersheds, they still remain largely understudied and rarely included in restoration programs compared to wetlands and vegetated buffer strips. Here, we summarize recent findings about nitrogen removal via denitrification in the capillary ditch network of the Po River lowland, a worldwide hotspot of eutrophication and nitrate contamination. Several experimental approaches (laboratory incubations, open-channel methods, GIS-based upscaling models) at multiple spatial scales (mesocosm, whole-reach, watershed) were applied to parameterize denitrification in relation to biotic (e.g. presence of macrophytes and biofilms) and abiotic drivers (e.g. nitrate availability, water velocity, temperature) and evaluate its relevance at the entire drainage network scale and in the context of agricultural nitrogen excess.
Outcomes demonstrate the pivotal role of emergent vegetation in sustaining the ecosystem function of denitrification thanks to its complex synergistic action with bacteria. Vegetated ditches express the highest mitigation potential in summer when macrophytes act as ecosystem engineers and promote the development of denitrification hotspots. Biofilms on senescent stems maintain the depuration capacity in winter with a positive response of denitrification along a wide range of nitrate availability. Also hydrodynamic conditions regulate nitrogen removal in slow-flow waterways, by affecting the supply of nitrate to the bioactive surfaces.
Simulated scenarios of vegetation restoration suggest that ditches may offer new management opportunities for effectively buffering agricultural nitrogen excess. Maintenance of aquatic vegetation could be a low-cost tool to be incorporated into the implementation strategies of the EU Water Framework Directive with potentially improved water quality at the watershed level and in the coastal zones.

S5.23 Environmental risk of emerging contaminants in an Alpine stream influenced by seasonal tourism

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In the last decades, there has been an increasing concern about the risks posed by pharmaceuticals and personal care products (PPCPs) in water resources. Despite the awareness of the widespread of PPCPs presence in many aquatic systems, very few studies have investigated the potential risk of these chemicals towards wildlife communities of high-altitude freshwaters such as the Italian Alps. Many of these environments are characterized by high seasonal flux of tourists. Moreover, the occurrence of PPCPs associated with tourism has been documented in Alpine water bodies downstream of sewage treatment plants (STPs).

In this context, the twofold aim of this study was to increase the knowledge about the ecological risks of PPCPs on Alpine streams subjected to touristic pressure, and to investigate the capability of a predictive approach as a useful tool for risk management.

The Vermigliana stream (Passo del Tonale area, Trento, Italy) was selected as the case study representative of Alpine touristic areas. Two monitoring campaigns were performed upstream and downstream of the STP during high (February) and low (late June) touristic season.

The Environmental Risk Assessment (ERA) highlighted a potential risk for aquatic organisms during winter, mainly due to antibiotics, nonsteroidal anti-inflammatory drugs, antibacterials, and surfactants.

The ecological data relating to the community of benthic macroinvertebrates suggested, in terms of relative composition, a high ecological state (STAR-ICMi index) and a high water quality (IBE index). However, the macroinvertebrate community structure, investigated in terms of species richness and abundance, showed a lower complexity (alpha diversity) downstream of the STP in comparison to the upstream one.

The findings on macroinvertebrates confirm the ERA prediction on the effects of PPCPs, and strengthen the usefulness of the adopted predictive approach as a tool to plan adequate risk management actions.

S5.24 Investigation of wastewaters as anthropic pollution source of pharmaceuticals and antibiotics in aquatic system

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Chemical compounds are commonly used in industrial/agricultural processes and in our everyday life (clothes and cleaning products, for example). Sources like municipal wastewaters significantly contribute to the spread of chemicals into the environment, in particular of micropollutants which are usually not removed from conventional wastewater treatment plants (WWTP). Even if in low concentrations (usually ng or μg per Liter), chemicals are constantly released into the environment where they can persist and therefore bioaccumulate with potential adverse impacts on different organisms. Pharmaceuticals, in particular, are frequently detected in waterbodies and as these compounds are biologically active, they may pose a risk for human health and the environment.
The aim of this study is to understand the efficiency of micropollutants' removal in WWTP and the impact of sewage plants on the receiving waterbodies.
Water samples representing a 24h period, were collected at the entrance and exit of three WWTP located in Lombardy region. After their pre-concentration and extraction, liquid chromatography-tandem mass spectrometry was used for quantitative analysis of ten pharmaceuticals (e.g. anti-depressive, analgesic, cardiovascular and anti-epileptic compounds), one industrial compound, one transformation product and around twenty antibiotics belonging to ten different classes. The selected WWTP are linked to different anthropic pressures, like hospitals or densely urban areas. We investigated a possible correlation between the anthropic impacts and the chemical composition as well the seasonal differences between the sampling campaigns. For one WWTP, we also analysed a sampling point located 5km downstream of the WWTP in order to derive the dilution factor of the chemical substances in the river. Especially for antibiotics, the release in the aquatic system generates a constant pressure on bacteria, leading to an increase in the prevalence of antimicrobial resistance genes (ARG) and facilitating the spread of the acquired resistance from environmental microbes to human or animal pathogens.

S5.P1 Presence and origin of adult Adriatic sturgeons in the Po river basin 25 years after the first restocking

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The Adriatic sturgeon (*Acipenser naccarii*) is an anadromous species endemic of the Adriatic region. During the last 30 years, this species experienced a dramatic decrease, reaching the brink of extinction. In 2010, the IUCN updated its status to “Critically endangered and possibly extinct in the wild” since no reproduction had been officially registered in the previous 20 years. The existence of this species in the wild is strictly tied to the release of individuals produced from a single captive broodstock descending from about 50 individuals collected in the wild (F0) in 1977. Starting from the 90ies, over 250.000 F1 juveniles were released within different restocking programs. Nowadays, if survived, many released juveniles should be mature. The present project aimed at assessing the presence of adult individuals in the Po River by catches, visual census and eco-sonar surveys and at investigating their origin (released versus wild) by genetic analyses. More than 30 adults were recorded, largely exceeding our expectancies. Out of the 10 animals for which genetic analysis were possible, four were compatible with a released origin and six were probably wild. These results represent the first evidence that the Adriatic sturgeon, even if generated in captivity, can survive in the Po River and, considering their large size, reach the age of maturity. Additionally, the presence of individuals not genetically compatible with the F0 broodstock suggests that at least some animals of wild origin are still present in the Po River.

S5.P2 Relationship between the concentration of polycyclic aromatic hydrocarbons in fresh water and the aquatic moss *Fontinalis antipyretica*

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Polycyclic aromatic hydrocarbons (PAHs) are a group of mutagenic and carcinogenic pollutants. Aquatic mosses are widespread in most European rivers and, due their morphological features, can accumulate and retain xenobiotics and are excellent tools for the monitoring of freshwater. To use the aquatic mosses in active biomonitoring it needs to overcome the lack of sufficient material and the variability among organisms of a population. In the environmental field, the biotechnological development of plant organism clones for the monitoring of toxic compounds, represents a sustainable system and a low-cost technology. Therefore, the moss *Fontinalis antipyretica* Hedw. has been selected as biomaterial of this study. Goal of this research is to monitor PAHs in 22 rivers of Galicia, NW Spain, by a clone of *F. antipyretica.* At this aims the moss cultivated in vitro, under controlled conditions of light and temperature in bioreactors, and devitalized is used to fill bags (7 x 7cm). Five moss transplants were exposed at selected sites of the rivers during 7 days. Contemporaneously, in order to check the feasibility of the *F. antipyretica* clone to reflect PAH levels in water, samples of water were collected using an autosampler (ISCO 3700). PAH concentrations were analysed in water samples by liquid-liquid extraction whereas in moss samples by MSPD, followed by PTV-GC-MS/MS. The concentration of total PAHs in the water ranged from 0.010 µg/L (river Umia, river Anllóns) to 0.214 µg/L (river Louro). The fact that the river Louro flows along an industrial area could have contributed to the higher concentrations in that site. The most of rivers showed water PAH content of about 0.020 µg/L.

The analyses of mosses are in progress.

S5.P3 Variation of the near-bed conditions and diversity of macroinvertebrate communities along the river continuum

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Fluvial habitats inhabited by aquatic macroinvertebrates exemplify how abiotic factors operate at multiple scales to influence habitat conditions that in turn affect the community composition. In particular, near-bed conditions, such as hydraulic forces and substrate characteristics are widely believed to be primary factors accounting for microhabitat selection of benthic macroinvertebrates, based on their ecological and biological traits. In this study, benthic macroinvertebrates were intensively sampled along a 2.2 km stretch of the Black River (Michigan, USA) following a multi-scale approach. A total of 110 transects were established every 20 m of stream distance and two sample points were randomly selected on each transect. Sampling points were assigned to a transect group (N= 22), each representing a 100 m length of stream and containing ten points. At each sampling point (N = 220) within a transect macroinvertebrates were collected within a 0.25 m^2 area using two Surber samplers with 500µm mesh. The general aim of the study was to evaluate patterns in biodiversity across nested spatial scales (i.e., sampling points, transects, transect groups) along the river continuum. Also, the response of macroinvertebrate richness and abundance to the near-bed conditions was statistically tested. We found that the larger spatial scales contributing the most to total diversity of macroinvertebrate communities: the turnover in taxa among transects and transect groups was significantly higher than that accounted for by the smaller spatial scales. Moreover, the Froude number and the substrate size were the abiotic factors that mainly affected the richness and abundance of macroinvertebrates in the Black River. These results stress the importance of using a multi-scale approach to identify drivers of community structure and diversity within a stream system.

S5.P4 Inferring the invasion history of the red swamp crayfish (*Procambarus clarkii,* Girard 1852) through the mitochondrial DNA variation

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The red swamp crayfish *Procambarus clarkii* (Girard, 1982) is one of the most threatening freshwater species widely introduced all over the world.

The aim of this study is to provide a better understanding of the populations genetic structure and the demographic history of *P. clarkii* populations in Italy. Mitochondrial control region sequences were investigated in samples from 4 Italian lakes (Trasimeno, Bolsena, Posta Fibreno and Candia). All sequences obtained were aligned with the reference sequence NC_016926.1 and standardized to a reading range of 718bp to assess the D-loop variability. Seven haplotypes were found in all sites. HT01 was the most frequent haplotype (44%) and was found in Trasimeno, Bolsena and Candia lake. HT03 showed a frequency of 22% and was recorded for Lake Posta Fibreno and Candia. HT03 displayed the same sequence of the Louisiana *P. clarkii* sample reported in another study (GenBank, accession number KC556864.1).

Retracing dispersal pathways of an invasive species as *P. clarkii* is gainful for strategies attempting to prevent and control its spread.

S5.P5 How efficient is the sampling of macroinvertebrates with the surber screen?

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In biomonitoring, much discussion has been done on index and metrics choice, often neglecting a simple but fundamental aspect: how reliable are our samplings? Different sampling devices have been proposed to collect macroinvertebrates in lotic ecosystems (such as artificial substrates, Hess samplers, D- or U-nets) and among these devices the Surber net is one of the most known and used. Several studies have tested the performance of the Surber net and demonstrated that, in general, this sampling device is more efficient in collecting macroinvertebrates than others, but the intrinsic efficacy of this device has not been evaluated yet. In this study, we tested the efficiency of Surber net in collecting stream macroinvertebrates by comparing two samples collected consecutively on the same plot. Differences in the percentage of benthic taxa and individuals between the first sample and the cumulative sample (first + second sample) were statistically tested in relation to selected environmental factors, i.e. substrate characteristics, water depth and velocity. Benthic macroinvertebrates were sampled from 78 different plots within a single stream reach of the Bormida river (NW Italy). A total of 49,318 invertebrates, belonging to 50 taxa were collected. In general, our results confirmed that Surber net is a reliable and efficient device, but rare taxa may be missed. In particular, we found that substrate size, water depth and velocity can significantly affect sampling efficiency, especially concerning the total taxa richness, EPT taxa richness and density. To our knowledge, this is the first study investigating the intrinsec efficiency of the Surber net and our findings provide useful insights for sampling stream macroinvertebrates, especially in the framework of biomonitoring and biodiversity assessment.

S5.P6 Microplastics affect the substrate choice in *Ephemera danica* Müller, 1764. Preliminary results

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Although studies on plastics mainly focus on detrimental impacts in marine rather than inland waters, rivers are considered a major pathway for microplastics (0.1 µm < MPs < 5 mm). MPs represent an issue of concern for their wide distribution and potential health risks related to ingestion and accumulation, and habitat degradation. Since only few studies examine the effects of plastic on freshwater benthic invertebrates, our study aims at increasing the knowledge of the effects of MPs on some riverine dwelling invertebrates, and specifically how MPs affect larvae of the burrowing mayfly *Ephemera danica* in the substratum choice. Individuals of the burrowing mayfly inhabiting the River Licenza (central Italy) were collected, transported to the laboratory, reared in glass tanks, and inserted for 1h into experimental boxes containing 3 substrates: sediments of the collection sites (S); MPs; a 50-50 mixture of S and MPs (S-MPs). Then, burrowing mayflies in each substrate were counted, photographed (to survey the body length by an image analysis software), and released. Our outputs indicated that *E. danica* seemed to colonize mainly artificial substrates (MPs + S-MPs = 81%) (χ^2, $p<0.01$), contrasting with our expectations that mayflies prefer original river sediments. Additionally, the substrate composition did not affect the body size of the mayflies (Kruskal-Wallis, ns). Even if MPs seemed to affect the preference of the substrate in *E. danica*, these preliminary results require more investigations to evaluate whether natural burrowing mayfly populations are influenced by the sediment composition change, since MPs occurrence can make river bed and banks unstable and then more susceptible to the water action. This is mainly due to the substratum weight, lighter when MPs are involved (pers. obs.). Thereby, the elective habitat of *E. danica* may be mechanical stressed and reduced, leaving mayflies to be dragged downstream as drift.

S5.P7 *Pacifastacus leniusculus* (Decapoda: Astacidae): biological and ecological traits of an invasive crayfish naturalized in NW Appenninic streams

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The introduction and the diffusion of invasive species represents, in addiction to habitat disruption, one of the major causes of biodiversity loss. Actually, inland waters are one of the most affected habitats, due to the invasion of allochthonous organisms. In particular, the introduction of crayfish species is one of the most significant problems in Italian and European waters. In Italy, *Procambarus clarkii* and *Orconectes limosus* are steadily installed, but recently a new alien decapod has been reported in the NW Appennine: *Pacifastacus leniusculus*. The aim of this study is to investigate the taxonomy of this species, in order to have further information about: i) biometrics; ii) trophic range; iii) biological and ecological characterization of the sites in which this allochthonous can be found. Our research has been carried out in the Valla river, where this invasive crayfish was reported, with different sampling techniques; we performed more than 15000 biometric measures and more than 300 gut content analysis. This population, identified as belonging to the nominal subspecies *P. l. leniusculus,* is extremely vital, well organized and with remarkable expansion abilities, especially during summer. Considering the population density and the wide trophic range, this population has a remarkable impact on the invaded stream ecosystem, in terms of abduction of resources such as CPOM and FPOM and predation of a wide range of invertebrates and small vertebrates. To confirm this, the presence of the autochthonous species *Austropotamobius pallipes,* in the examined hydrographic network is almost sporadic and discontinuous, while is still abundant and widespread in the adjacent streams not invaded yet by the signal crayfish. A first step for deploying any strategy of containment is to learn more about the ecological traits of this crayfish, a cold stenothermal species whose distribution range can be extended where the last populations of *A. pallipes* persist.

S5.P8 Does climate change impact on pelagic food webs and natural capital in deep subalpine lakes?

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The principal large subalpine lakes are important sources of fresh water and they are significant from economic and environmental point of view. Lakes food webs are variable and complex and they influence community structure, ecosystem functions and contaminant concentrations in top predators. In the last years, analyses of long-term data sets provide increasing evidence on the sensitivity of water bodies to climatic fluctuation. Climate change is considered one of the most severe threats to earth and aquatic ecosystems and the ecologist concern about the effects that global warming can have on biological communities is increasing. Small size and fast reproducing zooplankton organisms are key component of aquatic food webs because they are the principal connector between primary producers (phytoplankton) and the upper levels of the pelagic food webs (Fish). The main aim of this study is to achieve generalized information on how climate variation can affect zooplankton population dynamics in relation to different lakes trophic evolution. In order to reconstruct how climate interacts with other anthropogenic pressure we combine the analysis of long-term limnological dataset to paleolimnological studies.

Our results suggest that in deep lakes winter climatic variability trigger a cascading effect that involve the entire lake ecosystems, modifying lake chemical, physical and biological characteristic. The effects of climate on zooplankton population dynamics can indirectly affect the entire lakes food webs and interfere with some lakes management strategies.

S5.P9 Cryoconite holes: a unique ecosystem with high potential of pollutant accumulation

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Cryoconite ecosystems are hotspots of biodiversity and microbial activity, which develop on the surface of glaciers. They are dark sediments deposited in glacial ablation zones, able to absorb the solar radiation, quickening the melting of the underlying ice. They are a unique environment consisting of a mineral and an organic fraction that supports diverse communities including viruses, archaea, bacteria, eukaryotes and meiofaunal organisms. There is some evidence of their ability to accumulate inorganic and organic pollutants.

Understanding the magnitude of this accumulation potential is important to quantify the impact on these ecosystems. Moreover, the fact that cryoconite holes in Alps glaciers are ephemeral, entails the release of these potentially harmful substances into the aquatic environment.

During summers from 2012 to 2016, we collected cryoconite sediments from Morteratsch and Forni Glaciers in order to determine the presence of a series of current use pesticides together with radionuclides and elements, as Sb, Se and Hg.

The analysis revealed the presence of the insecticide chlorpyrifos in both the glaciers, with an increasing trend in the last years. Two herbicides (terbuthylazine and metolachlor) were sporadically detected in both areas. Cryoconite holes are highly enriched in atmospheric derived radionuclides, both in natural and anthropogenic ones with similar concentrations on the two glaciers. Not only radionuclides, also heavy metals and volatile metalloids are accumulated in these ecosystems.

Furthermore, it was identified an ecosystem service provided by the cryoconite community which has been investigated for pesticides. Cryoconite, thus, might act as a "biofilter" for organic pollutants on glaciers by accumulating them but it has been shown that they can also promote their biodegradation thanks to the metabolic versatility of cryoconite bacteria, contributing to the removal of a relevant fraction of pesticides deposited on glacier ablation areas.

S5.P10 Nitrogen removal via denitrification in *Phragmites australis* sediments along a nitrate gradient

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Insights on nitrogen removal capacity to increasing nitrate loadings is essential for properly designing, restoring and managing wetlands and canals with the aim of maximizing denitrification and their role as buffers against nitrate contamination and eutrophication. Although common reed (*Phragmites australis*) is frequently used to remediate nitrogen pollution, no information is available on how nitrate concentration may affect denitrification rates. In this study, we measured denitrification in outdoor *P. australis* vegetated and unvegetated mesocosms incubated in summer (biomass peak, water temperature 26°C) and winter conditions (senescent stems with biofilms, water temperature 12°C). After spiking mesocosms with nitrate concentrations typical of agricultural drainage water (50−800 µM), denitrification was quantified by the simultaneous measurement of nitrate consumption and dinitrogen gas production. For all tested conditions, nitrate availability exerted a significant positive effect on the denitrifying community which promptly modified its activity to variable substrate concentration. Vegetated sediments resulted more efficient in adapting their mitigation potential to nitrate increase, by showing one order of magnitude rise in both summer (53−429 mmol N m^{-2} d^{-1}) and winter (3−22 mmol N m^{-2} d^{-1}) along the nitrate gradient. Since denitrification rates followed Michaelis–Menten kinetics, the range 50-500 µM represents an optimal environmental situation for *P. australis*-mediated depuration systems against nitrate loadings.

S5.P11 Effective strategies to monitor best practices impact on groundwater quality in lowland agricultural soils

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Lowland coastal areas as the Po Delta, are often intensively cultivated and affected by nitrogen imbalance due to fertilizers leaching. To address this, issue several agricultural best practices have been proposed, like limiting increasing soil organic matter. In this study, soil and groundwater samples were analysed for organic/inorganic C and N species using nested mini-wells placed every 50 cm in the saturated zone and soil cores collected every 30 cm in the unsaturated zone. The experimental sites were set in two contrasting soils, one in a freshwater loamy soil and the other in a brackish clay soil. In each site, controlled plots with standard agricultural practices and with different agricultural best practices were considered (compost amendment and no tillage, compost amendment with minimum tillage, compost amendment and tillage). Despite the water table depth in both sites was shallow (1-2 meters below ground level), tracer tests highlighted that residence times in the vadose zone ranged from 2.9 to 5.2 years. Thus, the groundwater samples' concentrations were representative of former standard agricultural practices and not of the ongoing experimental best practices. On the other hand, soil core samples collected in the vadose zone, showed statistically relevant differences among the tested agricultural practices. In fact, all the plots cultivated with the addition of organic soil conditioner (compost) showed concentrations of ammonium nitrate and nitrite lower than standard agricultural practices. The agricultural technique of compost amendment and no tillage seems the most effective to prevent the percolation of reactive nitrogen species in groundwater. The concomitant monitoring of soil and groundwater combined with tracer tests allowed to distinguish between ongoing and former agricultural practices. This is a key aspect, since monitoring only groundwater in standard long-screen wells could have produced misleading results due to intra-borehole mixing and failing to capture changes induced by ongoing practices.

Sessione 6:
Capitale Naturale e Contabilità Ambientale

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Natural Capital and Environmental Accounting

Healthy ecosystems are capable of maintaining their structures and functions, ensuring the generation and maintenance of natural capital stocks and ecosystem services flows. The impacts of human activities on ecosystems cause habitat degradation and biodiversity loss, and, as a consequence, can seriously affect their capacity to provide benefits to humans. In this context, environmental accounting represents a useful tool to assess the biophysical and economic value of natural capital and ecosystem services. In particular, environmental accounting allows the assessment of multiple aspects dealing with natural resources exploitation. Among these aspects, the most relevant is the assessment of sustained environmental costs, received benefits, and generated impacts. The biophysical and economic assessment of natural capital value is much needed to convey the importance of natural resources in support of human economy. A multicriteria perspective to environmental accounting is necessary to capture the interplay of environment, economy, and resources. In this regard, it is noteworthy the recent rift in science dealing with the alternative use of ecological and social approaches for assessing the value of natural resources.

S6.1 Ecological Goal Functions and the assessment of natural capital value

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The identification of principles explaining the development of ecosystems has been a major target of systems ecology and ecological modelling. Such principles, called Goal Functions (GFs), can be viewed as propensities towards which the evolution of ecosystems is oriented. GFs can be used to characterize the state and the functional and structural features of ecosystems, providing information about the changes in ecosystem configurations and dynamics over time. GFs can be grouped in three main categories, namely the biotic, the network, and the thermodynamic GFs. From a thermodynamic viewpoint, ecosystems favour those system configurations able to use matter and energy inputs more efficiently, maximizing the flux of useful energy and the rate of material recycling, building ordered structures dissipating entropy flows in their external environment. Healthy ecosystems are capable of maintaining their structures and functions, ensuring the generation and maintenance of natural capital stocks and ecosystem services flows. The biophysical assessment of natural capital stocks is based on the evaluation of matter and energy flows invested by nature for their generation. Among the thermodynamic GFs, emergy and eco-exergy are recognised as functions able to explain the role of matter and energy flow exchanges in the functioning of ecosystems. In this paper, the emergy and eco-exergy methods are discussed in relation to the assessment of natural capital value.

S6.2 The value of ecosystem services provided by the Sacca di Goro lagoon: is environmental accounting a sufficient argument for ecological conservation?

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Environmental accounting systems are gaining increasing attention as instruments to value natural resources and measure the consequences of their exploitation. Coastal lagoons are highly productive systems supplying a variety of Ecosystem Services (ES) that are threatened by human activities.

This study assesses the environmental value of the Sacca di Goro lagoon (Northern Italy), an intensive exploited system that was subjected to extended aquatic vegetation loss and where conflicts between different uses arise. The four most relevant ES were measured in biophysical and monetary terms: clam provision, water quality regulation, carbon storage and recreational opportunities.

The results showed that clam provision, the main indirect driver of vegetation loss during the past decades, was the most monetary valuable service provided by the lagoon. The monetary accounting of other considered services can only partially justify a different management strategy focused on habitat conservation and multifunctionality of the lagoon.

Economic valuation based on marked rules promotes provisioning services with higher and direct marked values, while not guarantying the supply of other ES. The possible success of such approach relies on the increase of marked values for regulation and cultural services.

However, the ongoing trend for their increasing demand could enhance their value, thus supporting multiple ES and habitat conservation in future.

S6.3 Evaluating the performance of Marine Protected Areas: an adaptive management framework to assess the reserve effect on natural capital and local coastal communities

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Marine Protected Areas (MPAs) are increasingly being established worldwide to protect and conserve natural capital stocks from a variety of anthropogenic threats on coastal and offshore marine ecosystems. Characterized by linked social, economic, and ecological dynamics, MPAs represent complex conservation and management tools to support the achievement of sustainability goals in coastal social-ecological systems (SESs). When effective management measures are in place, MPAs are able to meet the multitude of objectives they are designed for, supporting at the same time the achievement of large-scale sustainability goals. Assessing the effectiveness of MPAs in reaching their objectives is of fundamental importance for their adaptive management and decision making processes. Several indicators and integrated methodologies can be found in the literature to assess ecological and socio-economic features and management effectiveness. Despite the considerable growth of the science of MPAs in the last decades, the challenge of how assessing and promoting their success still persists. A comprehensive assessment of MPAs performance needs to take into account their broad range of objectives, encompassing the ecological, socio-cultural, and economic spheres. In this study, a novel quantitative framework to assess the effectiveness of MPAs from a SES perspective is presented. The proposed framework includes indicators linked to nature conservation, socio-economic and management objectives. Finally, the results of the application of such multicriteria assessment framework to the case study of the Cerbère-Banyuls Marine Reserve (France) are discussed.

S6.4 Assessing potential indirect land use change due to biogas crops and its impact on ecosystem services: the case study of Emilia Romagna region

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Ecosystem services (ES) benefits include tangible products, such as food and fuel, regulating services that make our environment more liveable, and experiential values such as aesthetic appreciation and recreation. ES are highly vulnerable to a number of impacts due to the complex effects of human use of natural resources and subsequent land use change. Assessment of the impact of change in land use with respect to ecosystem services is necessary in order to evaluate the effective sustainability of biofuels production. Soil is a finite resource, meaning its loss and degradation is not recoverable within a human lifespan. The natural area is under increasing pressure of intensification and competing uses for cropping, forestry, urbanization, to satisfy demands of the growing population for food and energy, and for raw materials extraction. Soils need to be recognized and valued for their productive capacities as well as their contribution to food security and the maintenance of key ES. The different possible uses of the land have been giving rise to a competition, where climate policies, energy and food requirements do not seem to find a sustainable integration in the territories, so that we start talking about "food-energy-environment trilemma".

In recent years, the Emilia Romagna region has seen the proliferation of biogas plants, that implies a direct and indirect use of land.

Considering the importance of soils for biofuel sustainability, the aim of this study is to analyse and evaluate the potential impacts due to indirect land use changes on ES due to biogas crops, in comparison with food crops (with and without agricultural residues production) and abandoned or marginal land. The sustainable biogas potential has been calculated and discussed in the case of Emilia Romagna region, to highlight how a proper management of agroecosystem is crucial to allow the trade-offs among ESs and ensuring the integrity of ecosystems function and processes.

S6.P1 Modelling the performances of different tree species to remove airborne particulate matter

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The high concentration of airborne Particulate Matter (PM) is a serious health issue worldwide. Particularly, the Po plain area in the Northern Italy is one of the areas with the worst air quality in Europe, because of its morphological conformation. Green Infrastructures can play an important role in reducing PM air concentrations, thus improving air quality and human well-being.

The ability of trees to remove PM depends on leaf traits which change according to the species. The ability of trees to remove particles from the air is often assessed with models or tools which can used for decision making processes. However, the reliability of results depends on the model accuracy, which is seldom validated with field measures and usually consider a single deposition velocity for all species.

The aim of this study were to: i) calibrate a PM (PM2.5 and PM10) removal index based on species leaf traits with field measures and ii) estimate the PM removed by two streets located in the city of Ferrara (Po plain, Northern Italy) implementing the iTree Eco tool in order to capture the variability of different species.

The calibration of the PM removal index showed that foliar shape, leaf length and venation of broadleaved species were the most important traits affecting PM deposition. The results highlighted the relevance of maintaining and promoting selected urban tree species to ameliorate the air quality in high polluted cities.

These findings contribute to a better understanding of relevant leaf traits that can increase the reduction of PM concentrations in urban environments and can be used for improving the accuracy of model estimations as decision support tool for the urban green planning and management.

S6.P2 Land use and carbon storage changes in the Volta river basin (West Africa): an unsustainable trend

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Atmospheric CO_2 concentration has increased to over 400 ppm due to anthropogenic emissions resulting from the use of fossil fuels and land use change. Global ecosystems act as natural pools, absorbing about 60% of anthropogenic emissions (over 400 Gt), while the remaining 40% is responsible for the increasing atmospheric CO_2 concentration which contributes to climate change. In this study, we estimated the changes in terms of carbon sequestration and storage service in the Volta river basin (West Africa), an area of 400,000 km2 including 6 countries, for the years 1975, 2000 and 2013 using the dedicated InVEST tool.

The results showed a loss of 464.2×10^6t C during the period 1975-2000 (equal to 12% of total carbon, for an annual rate of -0.48%) and a loss of 371.2×10^6t C during the period 2000-2013 (equal to almost 11%, for an annual rate of -0.84%). The carbon storage capacity loss during the overall period 1975-2013 was 835.4×10^6t C (equal to almost 22%, for an annual rate of -0.57%).

The present study represents a first assessment of the consequences of land use change in the Volta river basin, where deforestation, forest degradation and agricultural land expansion are the most important drivers impacting local ecosystems.

Without adequate policies to mitigate the phenomenon, the carbon storage and sequestration capacity of the basin is expected to further decrease, as a consequence of the ongoing socio-economic trends, such as population growth and increasing industrialization of agriculture.

The adoption of policies concerning the conscious use of land and water resources is needed in order to mitigate the climate change while increasing ecosystem services in West Africa.

S6.P3 Overcoming the "salinity segregation'": exploring the semantics of aquatic ecosystem-services in a trans-dominion dimension

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Ecosystem Services, i.e. the benefits that people obtain from ecosystems, formalise the strong bond between natural systems, both aquatic and terrestrial, and human development. To categorize ecosystem services pertaining to the different aquatic fields, we searched and downloaded from ISI/Web of Science every paper that presented any of the words river, lake, sea and ocean together with the term "ecosystem services". We then extracted from the papers belonging to the different aquatic domains the top terms (i.e. the word that appears more frequently in titles and abstracts) and used those to build a words network, in which shared terms links different domains. Analysing the network, we highlight i) what services are more often perceived to be provided by each aquatic domain, ii) how tightly the domains are connected through shared semantics.

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Abstract book a cura di Elisa Anna Fano, Luisa Giari, Fabio Vincenzi e Alexandra Nicoleta Muresan

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