Chapter Italiano
Society for Conservation Biology

Challenging conservation
adattarsi al cambiamento

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Sezione 1

Presentazioni orali

From citizen science to spatial modelling: conservation implications for *Hippocampus hippocampus* and *Hippocampus guttulatus* along the Italian coasts

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Understanding the global distribution and habitat preferences of endangered animals is key to ecology and wildlife conservation. Seahorses' conservation is of global concern as they face multiple threats such as habitat degradation/loss, climate change, bycatch and direct exploitation. Here, we aim to merge an extensive citizen science survey along the Italian coasts with spatial modelling to inform the current and future distribution of *Hippocampus hippocampus* and *H. guttulatus*. Additionally, we investigated to what extent the distribution of the two species are covered by the Italian network of protected areas through gap analyses. Our study collected 52 and 67 presence records by citizens for *H. hippocampus* and *H. guttulatus*, respectively. All these records were validated by both a photographic and a GIS approach, leading to the current most complete dataset of seahorses occurrences compared to iNaturalist, GBIF, OBIS and ACQUAMAPS. Both seahorses exhibited a preference for habitats including *Posidonia oceanica*, corals and algae. Spatial modelling showed that the Italian coasts are currently environmentally fit for both species but such a suitability will decline in future. The gap analyses highlighted that *H. hippocampus* and *H. guttulatus* requires more extensive protection efforts than is currently granted along the Italian coasts. Our study indicates that both seahorses urgently need improved conservation actions and shows how spatial approaches can facilitate assessments of the conservation status of endangered organisms.

Assessing the joint potential of European forests for climate change mitigation and biodiversity conservation

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It is now widely accepted that climate change mitigation and biodiversity conservation are deeply connected and must be faced jointly. Forests are of primary relevance for both these major environmental challenges. Our study aims to assess the synergies and trade-offs between these challenges in European forests. We harmonized forest structural and biodiversity data from 2,282 sampling units across 12 European countries in the framework of the action CA18207 "BOTTOMS-UP". We calculated living trees and deadwood carbon stocks, according to IPCC guidelines, and species richness for six taxonomic groups (Birds, Epiphytic Bryophytes and Lichens, Saproxylic Beetles and Wood inhabiting Fungi, Vascular plants). The species richness of each taxonomic group in each sampling unit was standardized by scaling its value against the asymptotic richness for that taxonomic group at the site scale through rarefaction and extrapolation curves. We used boosted regression trees (BRTs) to estimate the relationship between the scaled species richness of different taxonomic groups in relation to carbon stocks and other covariates, including forest types, management strategies and sampling protocols. We found that carbon/diversity relationship is generally positive for saproxylic and epixylic groups (Saproxylic Beetles and Fungi, Lichens), but varies greatly across taxonomic groups and carbon pools. In view of forest multifunctionality, high levels of both biodiversity and carbon stocks can be achieved synergistically, however we should account for the different responses of different taxa to different carbon stocks.

New evidence on the linkage between long-term niche changes and population trends in birds

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Despite the assessment of long-term dynamics of ecological niche could provide crucial information for investigating species responses to environmental changes, it is a poorly investigated topic in ecology. Here, we present a case study of multi-species niche analysis for 71 common breeding birds in Northern Italy, exploring long-term niche changes from 1992 to 2017 and their relationship with population trends. We (i) quantified the realized Grinnellian niche in the environmental space, (ii) compared variations in niche breadth and centroid, (iii) tested niche divergence and conservatism hypotheses through equivalency and similarity tests, (iv) calculated niche overlap, expansion and unfilling indices, and (v) investigated the association between niche metrics and population trends. Results showed niche conservatism for 56% of the species, while 10% of them highlighted evidence of niche divergence. We detected a general tendency to adjust the niche centroids towards warmer thermal conditions. Increasing populations were positively correlated with the niche expansion, while negatively correlated with the niche overlap, albeit in the latter case at the limit of the significance threshold. We encourage studies correlating long-term population trends and niche changes with a specific focus on cause-effect relationship at both single and multiple-species level, also combining species traits' information.

Introducing VegTrends: an EU-funded project to assess long-term trends in European vegetation and evaluating the effectiveness of protected areas

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Halting biodiversity loss, ensuring current and future provisioning of ecosystem services, and protecting natural habitats are core priorities of worldwide conservation agendas. Yet, across most of the globe, ecosystems are experiencing degradation and fragmentation, many terrestrial habitats are currently assessed as "threatened", and the extent to which existing protected areas effectively safeguard biodiversity is debated. Quantitative assessments of biodiversity change are essential to achieve conservation goals. In particular, as many ecosystem services depend on plants, reliable estimates of long-term vegetation change are needed as a benchmark for future monitoring and reporting, as well as to plan and undertake effective conservation measures. We hereby present VegTrends, a new EU-funded project aimed at i) providing a multi-habitat assessment of temporal changes in taxonomic, functional and phylogenetic diversity of vegetation across biological scales (community and species); ii) evaluating the effectiveness of protected areas (Natura2000 + Emerald Network) in conserving European habitats. Building on an unprecedented amount of previously-disconnected datasets now included in the ReSurveyEurope database, VegTrends will allow producing the first comprehensive and representative report of temporal trends in the vegetation of European open habitats. Specific research questions and the state of the art of the project will be presented, and preliminary insights related to the first aim will be discussed.

Assessing the ecological impacts of native mammal invaders using the Environmental Impact Classification for Alien Taxa (EICAT)

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Human-induced factors like climate change and biological invasions affect biodiversity independently and synergistically, indirectly causing some species to move beyond their native ranges and impact the environment. Those species are referred as “native invaders”, as opposed to invasive alien species, which are instead actively introduced by humans. No studies yet identified and assessed mammal native invaders global impact.
We present a global systematic review of recent (1990 – 2021) literature on environmental impacts caused by seven mammal species (*Cervus elaphus*, *Glis glis*, *Herpestes ichneumon*, *Mus spretus*, *Rangifer tarandus*, *Rupicapra rupicapra*, *Sus scrofa*) with a recognized invasive potential (i.e., invasive in other territories). We classified species and their impacts according to the Environmental Impact Classification for Alien Taxa (EICAT) framework, and compared overall impact mechanisms and categories among different ranges (native, neo-native, alien).
From the 135 papers reviewed, we found that all the study species showed at least one impact within their native range. The most severe impact categories were recorded for *C. elaphus*, *R. tarandus*, and *S. scrofa*. Ranges of impact were non-randomly distributed across study species: for native and neo-native ranges, *R. tarandus*’ observed impacts were higher than expected. Due to impacts’ presence in their native range, and because of their invasive potential, those species can be considered native invaders.
Our results support the pre-adaptation hypothesis, which states that species’ success depends on their adaptation to new environments, worryingly and possibly leading to further ranges expansions. To this end, identify and classify native invaders can be useful to prioritize management and conservation actions.

The impact of high-speed infrastructures on bird diversity in the regional Natural Reserve Fontanili di Corte Valle Re in Italy

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This study analyses the diversity of species, in terms of abundance and richness, of the birds monitored in three different areas of the Regional Natural Reserve Fontanili di Corte Valle Re. The research focuses on the comparison of three areas, designated as Near, Intermediate, and Far, where the nets were located. These areas are increasingly distant from the infrastructures that confine with the north of the Reserve, which are the A1 highway and the high-speed train railway. The monitoring includes the spring-summer and autumn seasons, considering species of birds that are sedentary, nesting, and migratory. The effect of this disturbance on the birds has been quantified, from autumn 2019 to autumn 2022, for a total of seven seasons. We hypothesize that there is a decreasing diversity closer to the source of disturbance, which is mostly attributable to acoustic impacts. The data gathered and analyzed confirm this trend, showing that these impacts must be taken into consideration. In particular, the disturbance seems to influence the species richness more than the total abundance of birds. Some species have a behavioral ecology strongly based on singing to communicate with each other, in their reproductive and defensive strategies. Those species are the ones that suffer the most from acoustic disturbances and, in order to reduce them, it would be useful to install noise barriers between the highways and the reserve. Longer monitoring would be needed to understand how species richness and abundance change during time.

Multiple consequences of increased wild ungulate population inside a Protected Area

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In the last decades, wild ungulates populations in Europe are increased in both managed and Protected Areas. Locally, this situation has detrimental effects on biodiversity and ecosystem function. Large herbivores through bark stripping, browsing and grazing are capable to remove considerable biomass, which can alter plant functionality. This mechanism, similar to a cascading effect, could negatively affect the abundance of invertebrates and other animals along the food chain, especially in crucial life stages like breeding. In this study, we investigate the effects of red deer (*Cervus elaphus*) browsing on bilberry (*Vaccinium myrtillus*) plants and bilberry-leaf-chewing larvae (Lepidoptera), inside a boreal forest ecosystem located in the southern Alps. During a study period of 5 years, data on bilberry plant height and the number of larvae in eight study areas with different treatments (fenced vs. unfenced) were collected. We compared the abundance of larvae and bilberry plants' height between the treatments. Inside the exclosure plots, bilberry was higher and harboured a higher abundance of larvae compared to red deer-access plots. Our results support previous studies on the fact that wild ungulates inhibit bilberry growth and could trigger competitive interactions (via exploitation) with inferior competitors, i.e. the herbivorous larvae. Notably, we suggest a possible knock-on effect between red deer and capercaillie (*Tetrao urogallus*), in particular on chicks, which feed mostly on invertebrates. Future directions will focus on adopting appropriate conservation efforts and understanding how the balance will change with the recent arrival of an apex predator, the grey wolf (*Canis lupus*).

Are we ready for the wolf comeback? Patterns of wolf depredation on livestock in Trentino, Italy

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The wolf (*Canis lupus*) has made a remarkable comeback in the Eastern Italian Alps, including Trentino province, where wolf packs have increased from one to more than twenty in less than ten years. Despite raising important social and political conflicts, as well as causing concrete damages to livestock owners, no study has investigated the real impact of the species on this sector nor has analysed their circumstances and the effectiveness of the preventive measures adopted in this area. We thus investigated wolf depredation dynamics on livestock in the province of Trento by analysing all verified cases recorded from 2013 to 2021. Specifically, we analysed spatio-temporal patterns of predations in relation to livestock species, age, and management, and identified factors that could lead to predation events such as the presence and type of protection measures. Our results are in line with those found in other areas for what concerns spatio-temporal patterns and livestock target species. Specifically, we found that depredations follow the trend of wolf population expansion and increase over the years, and that sheep and goats are the most common target livestock. Noteworthy is the fact that in around 80% of the attacks, the depredated livestock was not protected by any preventive measure. Our study provides useful information on wolf depredation dynamics, stressing the need to implement preventive measures to reduce wolf-livestock conflicts and economical loss by livestock owners.

Past, present and future of *Bombina pachypus* in Liguria and Italy

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In the last three decades the Apennine yellow-bellied toad *Bombina pachypus* has dramatically declined throughout its range in peninsular Italy. From 2007 to 2021, we have carried out several small-scale conservation projects to promote the persistence of the species in Liguria. Using an adaptive management protocol, we released captive-bred and translocated individuals at restored sites, implemented periodic site maintenance, and pursued population monitoring across the region, including surveillance for pathogenic chytrid fungi. Our experience highlights several challenges and opportunities common to small-scale endangered species management. Our reintroductions were affected by the small number of animals that can be collected, given the limited size of the source populations. Captive breeding could help bypass this limit, but its costs and benefits remain to be assessed. Furthermore, in Liguria *B. pachypus* is traditionally linked to man-made waterbodies, which declined following land abandonment and agricultural changes. Collaboration with landowners can be effective but short-lived. A solution might combine reintroductions to more environmentally stable natural sites and managing for long term sustainability. In 2023, we will set up a permanent breeding/headstarting center within the species range. The project must therefore find a balance between the establishment of new sites and the improvement and management of historical ones. These challenges are especially difficult to overcome for small-scale-focused management: a stronger approach involving the creation of national task forces and action plans, helping knowledge sharing and increasing structural capacity is required.

Accounting for multiscale habitat selection improves model predictions for conservation: wolves in human-modified landscapes

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Habitat selection is a hierarchical and scalar process fundamental for understanding habitat choices by animals. Most European wolves live in human-modified landscapes adopting habitat-mediated strategies to co-habit with humans and despite they are considered habitat generalists, some critical behavior, as pups rearing, are habitat-dependent. Through GPS telemetry, wolf-howling and camera trapping during summer, we investigated habitat selection by wolves in the Abruzzo Lazio and Molise National Park (PNALM), where wolves have historically coexisted with humans. We developed multigrain resource selection functions (MRSFs) implemented both at the landscape and territory extents (i.e., 2nd and 3rd order of selection, respectively), using a set of anthropogenic, topographic, and land-cover variables and a generalized linear mixed model. We hypothesized that habitat responses by wolves would vary based on both the extent and the grain and that changes in the ecological domain of wolves would become apparent contrasting different orders of selection. From 2006−2010, we detected 31 RVs in 8 wolf packs. Habitat selection at the territory level showed avoidance of human presence, positive selection of forest cover and proximity to unpaved roads and trails to enhance hunting and traveling efficiency. Habitat choices at RVs also accounted for forest cover but relaxed avoidance of anthropogenic features, with the exception of low-use, linear features (possibly revealing a trade-off between safety and traveling efficiency). Besides clarifying relevant habitat features for territory selection and RVs by wolves, our findings warn against designing such studies irrespective of the hierarchical and scalar nature of habitat selection by wolves.

Projected impacts of climate and land-use change on the herpetofauna of Cilento (Campania, Italy)

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Climate change and natural land conversion are causing drastic alterations in species distribution. Particularly exposed to these threats are amphibians and reptiles, ectothermic animals with limited dispersal ability, and Mediterranean mountains, hosting numerous species adapted to local conditions. That is the case of Cilento, a mountainous, highly biodiverse region in southern Italy protected by a National Park and 30 Natura 2000 Network (N2000) sites.
We evaluated the possible combined impact of climate and land-use change on 11 amphibians and 16 reptiles occurring in the Park and the connected N2000 sites through bioclimatic and area of habitat (AOH) models. The former estimate species' climatic suitability by correlating species presence to climatic characteristics, while the latter classifies the land-use types based on species-habitat relationships. We estimated climatic suitability and AOH for the present and two scenarios of climate and land-use change: one of sustainability (SSP1-2.6) and one of fossil-fueled development (SSP5-8.5).
Most of the species showed significant loss of climate suitability in both scenarios, with the greatest declines estimated for SSP5-8.5. Mountain species appear to be the most affected, while lowland species could gain suitability. As the renaturalization of agricultural land is widespread in both scenarios, most of the species did not show declines due to land-use change. However, significant shifts in the distribution of suitable areas are projected for all species and in both scenarios, posing a crucial challenge for their survival. Our results could inform climate mitigation projects to ensure the long-term protection of herpetofauna inside the studied protected areas.

The flora diversity on taxonomic, functional and phylogenetic levels in semi-natural grassland habitats: A case study of grazed and abandoned alpine pasture in the Southern-Western European Alps

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Diversity and complexity are intrinsically part of nature. In semi-natural grassland habitats, pastoral activities allowed the development of a natural-human ecosystem which have driven the co-evolution of different taxa, leading to the establishment of new and diverse vegetation assemblages. The rational use of alpine pastures is capable to maintain these habitats in balance with the grazing pressure by enriching biodiversity. The latter trend might be reverse in situation of overload and/or underload of livestock, and, especially, with the abandonment of pastoral lands. Many areas in the European Alps are experiencing cessation of grazing activities, thus the phenomena trigger the establishment of secondary vegetation succession, leading to reforestation. As a consequence, it is expected a shift in the vegetation composition of those habitats under different levels of diversity. The EU-CLOE project takes places in three Natural Parks in the South-Western European Alps. The data gathered is used for gaining a deeper understanding of the complexity and diversity of these pluralism of habitats through a multidisciplinary approach that integrates taxonomic, functional traits and phylogenetic analysis. These metrics may shed light on assembly processes, reflected by the structure of the niche occupied by communities, and their degree of functional specialization. Whereas phylogenetic methods can help to better evaluate ecosystem quality status. The preliminary results demonstrate a shift in vegetation assemblages on the three levels of diversity. A complex scenario significantly driven by the history of land-use, degree of grazing pressure and environmental filters to be fully understood for a win-win approach to conservation.

Orthoptera distribution along an altitudinal gradient in the NW Alps: an insight on abundance and detectability

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Orthoptera are often used as indicators of changes in vegetation structure and management practices but still little is known about their distributional responses to climate and land cover changes in mountain areas. This taxon is one of the invertebrate groups used in the Alpine Biodiversity Monitoring Program, a long-term project involving six protected areas in the Italian Alps. Firstly, the Orthoptera data obtained from 2006 to 2019 were used to compile the first checklist for the Gran Paradiso National Park and to update the checklists for Orsiera-Rocciavré and Veglia-Devero Natural Parks. We then focused on elevational changes over time assessing the association between orthopteran species, elevational belts and habitat types throughout time. The results obtained suggested changes over time within orthopteran communities along elevation, probably as a response to the increasing temperature and to the expansion of shrubs and forests occurred in the study areas. Secondly, we used N-mixture models on four target species to assess the effect of climate and habitat requirements on Orthopera abundance accounting for imperfect detection. Ring counts show some limitations but including detectability in the analyses ensure reliable trends of abundance. We found a quadratic relationship between detectability and the mean daily temperature: if it is too cold orthopterans might be less active while, at high temperatures, they might be too reactive to movements and could move away faster. This work is the first attempt to understand the distribution along altitudinal transects of orthopteran communities and the driving forces behind their abundances in the Alps.

New threats for the largest extant population of the critically endangered Aeolian wall lizard (*Podarcis raffonei*) and how to tackle them.

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The Aeolian wall lizard (*Podarcis raffonei*), endemic to the Aeolian archipelago (Sicily, Italy), is one of the most endangered European vertebrates. Its dire conservation status is strongly linked to the complex history of human colonisation of the volcanic islands, which has led to the degradation and destruction of natural habitats and the introduction of the invasive Italian wall lizard, *P. siculus*. On Vulcano island, *P. raffonei* used to be much more widespread in the 1990s when the species was described and has since experienced a strong decline. The promontory of Capo Grosso hosts today the only *P. raffonei* population on a main island of the archipelago, but along with the pending menace of *P. siculus*' arrival on the promontory, a recent land-use change could further threaten the survival of this population. Between April and October, 2022 lizard numbers were investigated through the capture-mark-recapture, repeated counts, distance sampling and independent double observer methods to update the conservation status and assess the effects of pasture abandonment on the Capo Grosso population. Also, morphometric measurements were collected for all captured individuals. The pasture abandonment has led to an increase in vegetation cover thus to a decrease in habitat suitability for the lizards and a higher density of rats. Lizard abundance has dropped and body condition has significantly worsened between 2017 and 2022. These results show how current conservation measures are inadequate; novel and urgent management strategies are discussed.

Unraveling climate risks for plant regeneration by seed in the Mediterranean

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The study of seed regeneration traits leads to the understanding of plant responses to climate change during early life cycle stages. Measuring seed thermal responses is crucial to identify climate risks for regeneration and can inform the implementation of seed-based solutions to environmental and societal challenges. Unfortunately, seed germination data is still scarce for many regions and taxa, and when available it remains disaggregated in multiple non-accessible sources. Our goal is to identify native flowering plants from the Mediterranean basin that exhibit a germination niche compatible with current and future warming scenarios. To this end, we implemented a three steps workflow: (1) we created a database of primary germination data, using a new semi-automated approach to extract data from the literature; (2) applying these data, we model the species' thermal limits for seed germination; and (3) based on these thermal limits we determine the current and future species' thermal mismatches and identify germination syndromes compatible with warming scenarios. The gathered data provides information about regenerative traits that can be used in effective seed-based conservation and restoration actions in the Mediterranean basin.

A comparison between population trends estimation from abundance and occupancy data

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Assessing temporal trends of animal populations is the first fundamental step to identify the underlying drivers of change and to understand how to halt and reverse declines. The data used to estimate temporal trends can be ascribed to two categories: presence/absence or abundance. Abundance is the most straightforward way to assess population trends because it gives direct indication of how the size of a population vary over time. However, accurate abundance measures can be difficult to obtain because individuals of a species can be hard to detect, or because effort-demanding techniques (e.g., capture-mark-recapture) are needed. Conversely, species presence data are easier to obtain because of higher detectability of the species compared to detectability of individuals. However, we can expect that in species suffering declines, first a decline in abundance occurs and only later the species' presence over an area will shrink. For this reason, trend estimation based on presence/absence data might underestimate population declines. Here, we estimated temporal trends of four amphibian species (two frog and two newt species) in Northern Italy, using both occupancy models, based on detection/non-detection data, and abundance models based on counts of egg masses (for frogs) or adult individuals (for newts). We found a declines in the occupancy of three out of four species, however, 95% credible intervals for the trend of abundance overlapped zero for all the species. In contrast with our initial hypothesis, population declines were underestimated by the abundance models, probably because more data are needed to obtain accurate abundance measures.

International trade, land use change, and biodiversity loss: a quantitative analysis in three climate zones

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In today's globalized economy, local industries face a growing global demand for resources and goods, which put pressure on local ecosystems and therefore on biodiversity. This research analyses the relationship between biodiversity and international trade by reviewing the literature on the topic and it proposes a methodology to estimate the number of extinctions according to projections on the land cover area.

The role played by international trade on biodiversity loss has been widely investigated by the literature. While theoretical researches hardly provide a straight answer, empirical contributions conclude that between 25 to 30% of species threats are due to international trade and that developing countries are experiencing the greatest biodiversity loss due to different environmental standards and policies.

The quantitative analysis proposed builds on the assumption that international trade induces land use change in developing countries which, in turn, impacts biodiversity. Specifically, this study assesses the evolution of land cover area for different land uses in four years with the number of projected extinctions due to different land uses and according to different taxonomic groups. The analysis is conducted for three regional aggregations corresponding to different climate zones. It revealed that tropical regions are those expecting major extinctions with respect to temperate and boreal regions; moreover, in tropical regions projected extinctions are growing over time while in temperate and boreal regions are more stable.

Applying this methodology to more recent land cover data can be a way to trace the evolution of projected extinctions over time and act where needed.

Butterfly communities in South Tyrol erode from extensive grasslands to intensively used farmland and urban areas

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The biodiversity crisis occurring in the European agricultural landscapes demands an evaluation of the different land-use practices. In Europe, butterflies are considered an important ecological indicator for biodiversity and a pollinator taxon, especially in grasslands. Most butterfly species require human interventions to sustain their populations and land-use change and intensification are currently responsible for their overall decline.
We compare butterfly communities occurring on 93 sites in seven widely distributed land-use types, viz. extensive meadows and pastures, semi-intensive meadows, vineyards, arable land, settlements, and apple orchards in South Tyrol. Overall, we recorded high diversity in supposedly high nature value (HNV) grasslands, consisting of extensive meadows and pastures. All other land-use types scored significantly lower, with decreasing diversity from semi-intensive meadows to intensive apple orchards. Functional traits uncovered a general trend: extensive grasslands supported communities of more specialized and sedentary species whilst all other non-HNV land-use types supported communities characterized by mobile generalists. Community composition differed among land-use types and was influenced by plant-based indicator values for nutrients, light and temperature.
We found supporting evidence for the effectiveness of regional Agri-Environmental Measures (AEMs) and the general European conservation strategy focused on the preservation of HNV grasslands. We suggest a dedicated subsidies program for extensive pastures, especially at lower elevations, where a diverse and threatened community was recorded. Furthermore, we recommend taking steps leading to an extensification of non-subsidized (semi-)intensive meadows (avoiding additional management intensification) and to a radical change in the management of apple orchards, both would greatly benefit the butterfly fauna in the region.

Biodiversity effect on coastal dunes ecosystem functioning

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Coastal dunes are among the most threatened ecosystems in the Mediterranean basin mainly due to extensive anthropization and the expansion of invasive species. These drivers of change are causing a dramatic decline in coastal dune plant diversity and raising alarm over the potential consequences of species loss on the ecosystem functions that biodiversity provides. Most biodiversity-ecosystem function (BEF) studies agree that species richness begets ecosystem functions. However, biodiversity is a complex and multifaceted concept that, besides the richness and abundance of species (taxonomic diversity), also comprises the diversity of species' functional traits (functional diversity) and phylogenetic lineages in the community (phylogenetic diversity). Therefore, conserving well-functioning ecosystems requires a deeper understanding of how different facets of diversity influence ecosystem functions. To this scope, taking advantage of the remarkable habitat heterogeneity of coastal dune ecosystems, we aim to identify the relative contribution of taxonomic, functional, and phylogenetic plant diversity on multiple ecosystem functions related to productivity, nutrient cycling, water regulation, and decomposition. Data were collected along the coast of the Lazio region in 109 herbaceous plots (2 x 2 m2). In each plot, we conducted a floristic survey and measured several ecosystem function indicators (i.e. aboveground plant biomass, micro- and macronutrients in the soil, soil water holding capacity, decomposition rate, and organic matter stabilization factor). We applied mixed-effect models to disentangle the BEF relationship. Preliminary results highlight the importance of maintaining high levels of all biodiversity facets, not only species richness, in order to ensure functioning across endangered coastal dune habitats.

Disentangling biodiversity and biomass relations in real ecosystems at global scale

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The relationship between biodiversity and ecosystem functioning is becoming a central topic, highly debated in ecology and conservation biology. There is evidence that biodiversity improves ecosystems' ability of sustaining a variety of functions including carbon storage and productivity, which are related to the biomass. Up to now the understanding of the biodiversity-biomass relationship comes mainly from small scale experiments, many of which conducted in grassland ecosystems, frequently under highly manipulated conditions. However, tests have been rarely carried out in natural systems or at large spatial scales. Here we test the relationship between plant species diversity (S) and biomass (Biomass-Carbon Density) on a global scale. We found that globally the relationship between plant species richness and biomass shows an hump-shaped distribution. Additionally, Gross Primary Productivity (GPP) results to be related to plant species richness with a sigmoidal trend. Our results show that maintaining high levels of biodiversity may be crucial for the resilience of ecosystems' functions,and the multiple services they provide.

Why occurrences are not enough: differential effects of ecological variables on amphibian occupancy and reproduction

EB59 Elia Lo Parrino
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Amphibians are the most endangered vertebrate class at a global scale. Assessing the threats to amphibian metapopulations is essential to effectively implement conservation measures. Species distribution models are frequently used to determine how fitness is affected by ecological features. These models rely on detection/non-detection data that are often gathered without discriminating actual populations, where reproduction occurs, from non-reproductive assemblages. Reproduction success is possible under a narrower ensemble of ecological conditions than survival, and these two distinct phenomena may display different responses to the same ecological variables. Thus, without accounting for reproduction occurrence/absence, niche may be overestimated. To investigate the differences between occupancy and reproduction probabilities in amphibians, we used detection/non-detection data of 7 amphibian species collected in 207 waterbodies in Lombardy (Italy) from 2017 to 2022. Observations were classified as “observed with no sign reproduction” (i.e.: sightings of adults) and “reproduction observed” (i.e.: sightings of eggs or larval stages). Data were analyzed using multistate occupancy models to assess the effects of site-specific environmental features, on occupancy and reproduction probabilities. Our results indicated that there were non-negligible differences in the responses of occupancy and reproduction probabilities within most amphibian species. These results highlight the inadequacy of occupancy models that do not account for reproduction in assessing the effects of local ecological conditions on amphibians. Reproduction data are essential to get realistic assessment of amphibian metapopulations responses to ecological stressors and to allow the implementation of efficient conservation measures.

The pantropical decline of mammals is associated with human density and forest fragmentation in the surrounding landscape

EB04 Ilaria Greco[1]

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An outstanding question in the current biodiversity crisis is how bad the “Anthropocene defaunation” really is. Tropical forests are especially impacted, with many mammal species surviving almost exclusively within Protected Areas (PAs). Increasing anthropogenic pressure outside PAs influences biodiversity within, however evidence from in-situ data is lacking. We established TherioTrop, a dataset for 240 species in 37 forests across the pan-tropics systematically collected by 2,021 camera-traps. We used a Bayesian multi-species multi-region model that considers imperfect detection to estimate species richness and community occupancy in relation to anthropogenic pressures in the landscape surrounding PAs. We hypothesized that wildlife changes within PAs are linked to landscape-level processes. In particular: forest loss alters species-area effects lowering mammal richness and occupancy; landscape fragmentation alters source-sink dynamics across PAs, lowering occupancy; proximity to settlements favours human permeability into forest interior or promotes the use of open environments, leading to lowered and higher occupancy respectively; human density acts as both direct stressor and proxy of fear, road traffic, and hunting that can cause the loss of sensitive species, and affect species distribution either promoting range expansion or contraction. We found that richness increased with greater forest cover and decreased with increasing human density, while habitat loss and fragmentation were associated to community occupancy declines. Conversely, human density and proximity to settlements did not explain variations in occupancy, indicating that human activities foster both benefits and costs. Such knowledge is foundational to defining the most effective conditions for sustaining PAs that enhance wildlife and ecosystem conservation.

Il gambero nativo di fiume *Austropotamobius pallipes* complex nel Parco Nazionale delle Foreste Casentinesi: stato di conservazione e minacce

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The native white-clawed crayfish *Austropotamobius pallipes* complex is a protected species and its populations are declining in the entire Europe for several threats such as illegal fishing, climate change, water pollution and the presence of invasive alien species (such as *Procambarus clarkii* and *Procyon lotor*). The purpose of the study was to update the distribution and status of *A. pallipes* complex in the Foreste Casentinesi National Park and the State Reserves within it, comparing the current with the past situation and assessing the potential effects of the threats on the species. In 2021-2022 the sampling was carried out in the central-southern part of the Park, in 41 sites partially and previously monitored between 2012 and 2016. Crayfish were caught by hand along a 100 m transept during the night. Sampled individuals were sexed and measured, and any marks of raccoon presence, such as footprints or predated crayfish remains, were also noted. The results showed a significant reduction in populations, or the local disappearance, in the Tuscan side, whereas, in the Romagna area, the species appeared to be stable or even increase. This difference could be due to a more relevant human impact on the water courses in the Tuscan side caused by illegal poaching, water uptake, discharge in streams and invasive alien species. An efficient management of these threats and an environmental education are needed to halt the decline of the native crayfish in the Park area.

Assessing the representativity and distribution of strictly protected areas on bioregions, ecoregions, habitats, and endangered species in Italy

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In Italy about 5.3% of the territory is represented by strictly protected areas (PAs) within IUCN categories Ia and II. To contribute effectively to the objectives of the 2030 EU Biodiversity Strategy (i.e., protecting at least 10% of the European territory with a rigorous level of protection) the extent of Italian PAs should be increased. Accordingly, we conducted a gap analysis to assess the representativity of Italian strictly PAs on biogeographical regions, ecoregions, habitats, and IUCN Red List species. It resulted that most of the PAs are located in the Mediterranean Bioregion, followed by the Alpine and the Continental regions. Moreover, we found that three of the fourteen Terrestrial Ecoregions of Italy are not protected by any PAs (i.e., Illyrian, Ligurian-Provencal, and Central-Adriatic), while the least represented are the Po Plain and the Sicilia ecoregions. Furthermore, in the framework of the EU Habitat Directive, 8 habitats out of the 132 extants in Italy result not included in any PAs. Finally, among Red List species, 66 plant, 6 amphibian, 13 reptile, 8 mammal, 22 freshwater fish and 10 bird species are not present in any Italian PAs belonging to categories Ia and II. Our findings suggest that the current representation and distribution of strictly PAs of Italy is still incomplete and far from the targets of the EU Biodiversity Strategy. This study, providing a picture of Italian current situation, serves as a basis for future studies, to plan actions according to climate change scenarios and for conservation policies.

Do Natura 2000 protected areas support ecosystem services and biodiversity? An example from Friuli-Venezia Giulia Region (NE-Italy)

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Protected areas, established to preserve ecosystems and protect biodiversity, are essential for a stable and long-term provision of multiple ecosystem services (ESs). Nevertheless, there is not a decisive agreement on the effectiveness of conservation strategies in maintaining or enhancing ESs and preserve biodiversity. The aims of this study were to: 1) assess the effectiveness of protected areas in providing multiple ESs and maintain biodiversity in comparison with nearby unprotected areas and 2) identify possible hotspots of ESs provision and conservation status inside and outside the protected areas. For such purpose we mapped, quantified, and analysed data on ESs, biodiversity and conservation status of Natura 2000 sites that falls within the forest ecosystem in Friuli-Venezia Giulia (Italy). Carbon storage, recreation and wood provision ESs, representative of all the CICES classes, were considered. The InVEST carbon model was used to quantify and map the carbon stocked while the ARIES recreation model was customized and employed to model nature-based recreation ES. Data for ESs quantification, woody plant biodiversity, and conservation variables were retrieved from regional and literature sources and an index accounting for environmental heterogeneity, as indicator of biodiversity, was computed from remote-sensing data. Such study will clarify the effectiveness of protected areas and will reveal whether hotspot areas for ESs and biodiversity conservation coincide and if these are located inside or outside the protected areas. In a context of climate change and biodiversity loss, these data will provide useful information to address effective strategies for regional planning and conservation.

In&Out: comparing plant biodiversity patterns inside and outside protected areas in coastal dune ecosystems of Tuscany

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Coastal dune ecosystems host highly specialized communities, that provide fundamental ecosystem services. However, they are currently among the most endangered ecosystems worldwide because of multiple threats, including urbanization, tourism pressure, spread of invasive alien species and coastal erosion. In the last years, the loss and degradation of dune ecosystems has increased all over European coasts and the current network of protected areas may not be effective in halting this regression. The aim of this study is to analyze plant diversity of Tuscan coastal dunes, comparing its patterns inside and outside protected areas, aiming at assessing their effectiveness for plant and habitat conservation. Specifically, plant diversity will be analyzed first at the taxonomic level, using 474 random plots collected in 2019-2021. Plant species will be distinguished between focal, ruderal and alien groups, and diversity patterns will be separately studied for each one. Along with observed field data, diversity will be analyzed using remote sensing to derive spectral diversity indices, such as Rao's Q heterogeneity and spectral α- and β-diversity. The relationship of these indices with taxonomic diversity will be tested as a possible proxy to be used in conservation practices. Furthermore, plant diversity patterns for the species groups as well as for the spectral indices inside and outside protected areas will be compared. Results will provide information on the effectiveness of protected areas for the conservation of coastal dune plant communities in Tuscany and possibly on the usefulness of remote sensing tools for its assessment.

Drivers of change in mountain areas of the world: a comparison between different mountain ranges

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Despite the recognised impact of climate change and land-use in mountain ecosystems, to date there has been no global assessment of which mountain areas are most affected by the combination of these two factors and what the future situation will be for mountains. Here, we quantify the change in climatic conditions and land use in mountain areas, creating exposure maps to identify the mountain areas that might be most at risk in the present and in 2050, according to different emission scenarios. We estimate different metrics of change (velocity, magnitude of change) of three variables: climate, land-use, and human population density. The velocity of climate change is the lowest metric for mountainous areas, while the magnitude of change is the most relevant. While in many European mountains there is a progressive decrease in human presence and land use, other areas such as tropical mountains will be affected by an increasing anthropogenic pressure. A classification of mountain areas in which climate change acts together with direct human pressure in the future, can be useful to highlight the different management possibilities, as well as the differences between the different emission scenarios in mountain areas.

Alpine ungulates through camera trapping: defining the environmental and anthropogenic contexts for competition or spatiotemporal segregation between sympatric herbivores

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Red deer (*Cervus elaphus*) abundance and distribution in the Central Italian Alps have increased drastically in the past decades, giving rise to suspicions of competition with sympatric ungulates. Indeed, roe deer (*Capreolus capreolus*) and chamois (*Rupicapra rupicapra*) in presence of red deer seem to be decreasing in density and to be spatially displaced, respectively. Although these trends are concurrent, proof of their causal nature is still lacking, as well as the role of vegetation dynamics and human disturbance in these interactions. Based on vegetation surveys and extensive systematic camera trapping (seasonal and yearly, N=77) in two Alpine areas (Val di Peio, Stelvio National Park and Val di Non, Italy), we analyse densities, habitat use, and daily and seasonal activity patterns of the three ungulates and define the environmental and anthropogenic contexts in which co-occurring large herbivores compete or spatiotemporally segregate. We predict food resource availability and human avoidance to be the main drivers of ungulate activity at different scales: forage availability may shape seasonal activity patterns over habitat and altitudinal gradients, while predictable anthropic activities may primarily affect daily activity patterns and local habitat use. We also expect interference competition to lead to spatiotemporal shifts of the smaller and more specialised species (i.e. chamois and roe deer) in areas of high ungulate density. Understanding community-level dynamics and their drivers, particularly in light of increasing human disturbance and global changes, is of utmost importance to implement science-based management practices in protected areas.

Testing the effect of sample prevalence on probability- and favourability-based SDMs

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Predicting the occurrence probability of species is intrinsically dependent on the quality of the training dataset and, in particular, on the sample prevalence (i.e., the ratio between presences and absences). Whenever the number of presences and absences is not equal within the training dataset, the predictions deviate towards higher values as the sample prevalence increases and vice versa. As a result, probability models of species occurrence with different sample prevalence cannot be directly compared. The favourability concept was introduced to amend this limitation. Indeed, the favourability - i.e., the variation in the probability of occurrence regardless the sample prevalence - could reduce the degree of uncertainty when comparing species distributions despite different sample prevalences.
To test this hypotheis, we investigated the variability of the predictions across different sample prevalences for probability-based and favourability-based SDMs on real species; and we combined multiple individual species distribution models to produce a community-level model (SSDM). According to our results, favourability-based SDM allows to achieve more effective comparisons among species distributions at both population and community level.

Assessing species' exposure to climate change to support extinction risk assessments for the IUCN Red List

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The IUCN Red List is a central tool in biodiversity conservation. To best inform policies, it is crucial that it monitors drivers of extinction consistently, especially those of growing concern, as climate change. However, assessors are currently not able to properly evaluate climate change impact across groups, due to the lack and uncertainty of climate change information and worsened by the discrepancy between "well studied" and "less studied" taxa. For example, 30% of threatened birds are considered threatened by climate change vs 11% of reptiles, despite the latter is a group of ectotherms highly sensitive to temperature. Here, we propose a standardized measure of climate change impact to improve climate change risk assessment. Using terrestrial mammals as study group, we measure the exposure as the difference between the current and the future species distribution, defined using current and future bioclimatic variables. Assuming areas outside the future species range are less likely to be suitable, this measure can directly inform Red List Criteria A and C1 thus allows to identify species that are likely to be threatened by climate change and should be reassessed. Our measure is potentially applicable to all species within the IUCN with range maps.

Modelling environmental suitability and expansion rate of the invasive crayfish *Procambarus clarkii* in the Lombardy region (Northern Italy) across the past 25 years

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Invasive alien species (ICS) are an increasingly critical threat to native species. This is the case of the crayfish *Procambarus clarkii*, which is driving the native *Austropotamobius pallipes* complex to extinction by carrying the crayfish plague (*Aphanomyces astaci*) and increasing biodiversity loss in most of Italian freshwaters. This work aims to investigate the environmental suitability and expansion rate of *P. clarkii* in the Lombardy region (Northern Italy) to predict the areas more at risk of future colonization. All reliable observations of this species in Lombardy, since 1997, were merged into a single dataset from various sources, including the so-called grey literature. We then modelled environmental suitability using Maxent, considering the following environmental predictors: average annual temperature, total annual precipitation, and percentage cover of water bodies. Finally, we tested the relationship between the year of sighting and distance from the first point of introduction using a linear regression model. Distribution models highlighted that the most suitable areas feature temperatures of 14-15 °C, small water bodies, and average annual rainfall of 1500 mm. The best model estimated an expansion rate of 3,6 km/year (adjusted R2=0,42) and therefore the possible colonization of the entire Po plain in the next few years, including the great lakes' shores. Containment and dissemination activities are thus fundamental to avoid any further spread of *P. clarkii* (and hence of the crayfish plague) to uplands where native crayfish populations still survive.

Wildlife Burnout: Global patterns of stress levels in response to anthropogenic disturbance in reptiles, birds and mammals

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Anthropogenic disturbance can trigger biodiversity responses at different hierarchical levels, from individual physiology to entire communities. While conservation research has heavily focused on estimating generalizable patterns of population and community level responses, little effort has been devoted to understanding the generalizability of individual-level physiological responses such as glucocorticoid concentrations, commonly used as proxies of stress levels. Yet the current literature on this topic shows mixed results of animal stress responses to human impact, mainly due to the masking effect of various confounding factors, which hinders the detection of a consistent pattern between disturbance and adaptive physiological responses. In this study we used a phylogenetic meta-analysis to overcome this limitation and unveil generalizable patterns of the effect of human disturbance on stress levels of reptiles, birds, and mammals. We extracted measurements of glucocorticoid concentrations from studies with various levels of human disturbance and calculated the log-response ratio in disturbed vs. non-disturbed sites. Our results highlight an overall consistent increase in glucocorticoid levels due to anthropogenic disturbances in the three taxa. We also show how the interaction of species traits, ecological factors, and type or intensity of disturbance modulates stress response in wildlife. Furthermore, we highlight how study-related choices (e.g., sample type/season, grouping criteria, etc.) may influence measurement outcomes. Our study provides strong evidence to support an overall detrimental effect of human disturbance on wildlife and assesses its magnitude, ultimately giving precious insights to mitigate human disturbance in vulnerable areas and taxa.

The role of the mass and social media on biodiversity conservation

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In the Internet era, most people inform themselves by reading news online. Even local-scale information, by flowing through the broad-scale online networks, may rapidly reach a global audience. The way the media communicate may shape public' perception and awareness, promoting or discouraging tolerance towards wildlife. Public tolerance towards wildlife is pivotal to species conservation and highly depend on the real or perceived risk that species may pose to human safety. Humans have an instinctive fear of potentially dangerous animals, including animal that can harm humans directly (e.g., large carnivores, snakes, spiders) or indirectly, by transmitting diseases (e.g., bats). Importantly, negative attitudes towards wildlife may be amplified by the media. We investigated how online newspapers frame biodiversity and how different news spread on social media. We show how the information delivered by mass and social media is often highly biased towards a sensationalistic view of potentially harmful species and how the overabundance of poorly contextualized news on bat-associated diseases increased bats persecution at the onset of the Covid-19 pandemic. Our works highlight the important role played by the media on biodiversity conservation. Knowing how the media acts is fundamental for anticipating the spread of disinformation and negative feelings towards wildlife. We suggest that working together with journalists by exchanging experiences and engaging in dialogue as a central tool to improve conservation programs. We also provide some hints on how communication messages should be designed and promoted by conservationists and journalists and how public should navigate through the information ecosystem.

Follow the (genetic) flow: Italian wolf genetic variability & anthropogenic hybridization in Central Italy

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Wolf-dog hybridization is a phenomenon that has assumed significant proportions since mid-1980s in Italy and constitutes a threat to wolf genetic integrity, with potential consequences on a morphological, physiological, and behavioral level. Furthermore, it cannot be excluded that the introgression of dog genetic variants could facilitate the permanence of the species in synanthropic situations, exacerbating conflicts with local populations. In this study, through a non-invasive genetic sampling, conducted in Lazio, and the analysis of pre-existing genetic samples referring to the last 30 years, the hybridization patterns and the possible genetic structuring of the wolf population in Central Italy were investigated, comparing genetic variability and connectivity between areas of historical presence and recent colonization. The results show that sample prevalence of hybrid individuals in Lazio is in line with the national average and there are no genetic clusters. There was an increase in genetic variability over time in the areas of historical presence, but no differences emerged, in terms of variability, or genetic clusters between areas of historical presence and of recent colonization in Central Italy. The hybrid individuals' proportion in the population is greater outside protected areas and hybrid individuals have been sampled more frequently at a shorter distance from anthropogenic environments. In particular, a positive correlation emerged between the membership proportions to the wolf cluster (qw) and the distance from pasture areas.

Alien fish eradication in nine mountain Alpine lakes: scientific background and early results from the Project LIFE RESQUE ALPYR

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High-mountain lakes are peculiar ecosystems which support many aquatic and terrestrial species and fundamental ecosystem services. These environments are originally fishless, but man-made introductions occurred for centuries, and especially in the last decades. Fish introduced to high-mountain lakes can be either game species (i.e., salmonids, for recreational angling) and forage fish (i.e., minnows used as baits). Once established, introduced fish assume the role of top predators, affecting native amphibians and aquatic invertebrates, with indirect effects on the surrounding terrestrial ecosystems. The LIFE20 NAT/ES/000369 RESQUE ALPYR (REStoration of aQUatic Ecosystems of protected areas from the ALps and PYRenees) provide for the eradication of alien fish in several mountain lakes using mechanical methods to recover native species and habitats. Part of the project is developing in the Italian Western Alps (Parco Nazionale Gran Paradiso and Parco Naturale Mont Avic). Within this contribution the scientific background and the early results gathered from the field season 2022 will be discussed, with a focus on the initial decrease among fish populations. Mechanical methods include intensive rod-angling, gillnetting, fyke-netting and electrofishing, which are applied with different effort in relation to the surface and characteristics of each treated lake. At the end of the 2022 season, 308,240 minnows (*Phoxinus* sp.), 2,439 brook trout (*Salvelinus fontinalis*), and 20 brown trout (*Salmo trutta*) were removed from 9 lakes. Capture Per Unit Efforts decreased in all, but salmonids decline was apparently faster than that of minnows, which require larger efforts and longer times to be completely eradicated.

A novel approach for surveying flowers as a proxy for bee pollinators using drone images

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The abundance and diversity of plants and bees are important indicators of biodiversity, overall ecosystem health and agricultural production. Worldwide, habitat loss and fragmentation, agricultural intensification, and climate change are major drivers of plant and bee declines. Monitoring these species is essential in the field of conservation to safeguard their diversity and their role within the ecosystem. Traditional in situ methods are time consuming and expensive, while remote sensing (RS) has the advantage of covering large areas by providing repeated, spatially continuous and standardized information. We examined bees and flowering plants using conventional field methods in the grasslands of the Netherlands, collected drone images (RGB) and evaluated whether remote sensing was useful for detecting the diversity and abundance of floral species and subsequently, thanks to the field data, bee abundance and diversity. We used various Machine Learning (ML) methods to evaluate the correlation of this data: Random Forest (RF), Neural Networks (NNET), and Support-Vector Machine (SVM). We found excellent correlations between drone and in situ data estimates for flower species coverage with bee abundance and diversity. Our results suggest that methods based on the coupling of drone imagery and ML can be developed into valuable tools for large-scale, standardized and cost-effective monitoring of flower cover and habitat quality for bees.

Favourable reference values of European terrestrial mammals

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In Europe, there are more than 1200 vertebrates living in terrestrial and freshwater systems. 12 % of them are threatened with extinction and out of these 17% are mammals. The European Union has adopted the Habitat Directive to protect species and habitat, with the specific aim to restore or maintain them in favourable conservation status (FCS). One of the EU Biodiversity Strategy objectives by 2030 is to guarantee the FCS for at least 30 % of species. FCS can be reached when the dynamic population data show that the species are able to thrive in a long term as a viable component of their natural habitats; its range is neither in reduction nor are likely to be reduced for the future and it has and will probably continue to have, a sufficiently large habitat. The conservation status can be monitored within European Member States throughout the establishment of favourable reference values (FRVs) for population (FRP) and for range (FRR). We focused on mammals which are threatened with extinction or listed under Habitat Directive. Using the approach of Biljma and colleagues, we gathered information about biology and distribution of species, their populations and threats and pressures that have affected or are continuing to affect them. We detected population trends and, through a reference-based or a model-based approach, we identified their FRV for population and for range.

Il ritorno della megafauna può restaurare la biodiversità del passato in Europa, ma dobbiamo considerare i problemi di coesistenza con l'uomo

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Severe, size-biased defaunation has degraded megafauna assemblages across Europe after the encroachment of Homo sapiens and the rise of modern societies. Thus, there is a call for ambitious megafauna-community restoration policies. However, managing human-megafauna coexistence is non-trivial, notably since landscapes are rapidly transforming under global environmental changes. We used fossil records and ecological traits to estimate European megafauna biogeography in the deep-past and how extinctions and environmental degradation affect present ecosystems viability. Furthermore, we estimated future megafauna distribution and population densities under scenarios of climate and land-use changes, in combination with different rewilding strategies, to find best trade-offs between the need to restore megafauna-mediated ecological processes and the risks for human livelihood. European megafauna community biomass has dropped by 93.8% from the deep-past to the present. Functional diversity has dropped by 90.8% for herbivores and 83.3% for carnivores. Vegetation consumption has dropped by 88.3% and meat consumption by 68.5%. As a result, the structure of present ecosystems strongly deviates from the evolutionary norm, notably due to decreased functional heterogeneity. While during the end of the Pleistocene overhunting fostered megafauna extinctions, the spreading of agriculture in Europe after the Neolithic have been the major environmental challenge for megafauna more recently. Restoring megafauna-mediated ecological processes in line with the ecosystems' evolutionary norm is possible via reintroductions, but at the cost of a very high potential for conflict. Other rewilding implementations, such as encouraging ranges expansion but controlling population densities via culling, may be more pragmatically approaches in the light of coexistence potential.

Temperate forest functional composition along elevation gradient: disentangling intra- and interspecific trait variability

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Besides the lack of studies to test environmental heterogeneity, trait-based investigation has been considering traits as fixed attributes neglecting intraspecific variation ("ITV"). ITV may play an important role in species coexistence, affecting ecosystem functioning and services. In this study, we focus on common functional traits describing aboveground functional diversity along an elevational gradient. Our questions were: i) does intra-specific trait variability decrease in importance along the elevation gradient? ii) does the increase in elevation confirm the shift from a diverging situation to one of convergence due to less stringent conditions? iii) do the traits selected, respond in the same way along the elevation gradient? Our study area was located in the Parco Nazionale Foreste Casentinesi, Italy. Plots were selected after dividing the elevational gradient into 7 belts (150 m). For each belt, 4 plots were selected (10x10m). Functional traits collected and measured were: vegetative plant height; Specific Leaf Area (SLA); Leaf Dry Matter Content (LDMC); Leaf Area (LA). We quantified two main indices: Community Weighted Mean (CWM) and Rao's Quadratic Entropy (Q) and, to disentangle trait variability we used the Trait flex anova approach. Our observations were in line with the theory of habitat filtering: smaller (decrease in plant height) and with a quicker growing rate (decrease in LDMC) species were found as elevation increased with a greater contribution of species turnover with respect to ITV. Even if the contribution of ITV was small, taking this aspect into consideration can help our understanding of species response towards abiotic variations.

Linking brown bear activities to habitat characteristics: implications for the conservation of the Apennine brown bear (*Ursus arctos marsicanus*)

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We examined third- and fourth-order habitat selection by the Apennine brown bear in the Abruzzo, Lazio and Molise National Park, Italy. Our objective was to explore the relationship between environmental and anthropogenic factors and seasonal activity (foraging and resting) by GPS-equipped adult bears. Based on 6 adult bears (4 females and 2 males), we field inspected 571 GPS locations from 2009 to 2010 in search of evidence of bedding and feeding (insects, herbaceous vegetation, hard mast, soft mast, carcasses) behaviour and described each site through a vector of environmental and anthropogenic predictors. Using GLMMs and model selection procedures, we investigated which factors affected bears' activity, while accounting for seasonality and diel period. We revealed that, during the hyperphagic season, fruit feeding was associated with human settlements proximity, and that the time spent feeding on both herbaceous vegetation and soft mast increased at higher understorey cover. Greater distances to paths and trails corresponded to a higher likelihood of foraging on herbaceous vegetation, hard mast, and large mammal carcasses. Insect (mostly ants) feeding by bears was also positively associated with avoidance of roads during daylight hours. Our study highlights the relevance of vegetation structure, and hence forest management practices, as well as the need for paths closure during critical periods, and the importance of ensuring suitable habitats away from roads and human settlements. Understanding the environmental context in which bears perform specific activities may foster enhanced foraging opportunities for bears and contribute to maintaining long-term habitat suitability through more efficient management actions.

Assessment of priority species inside and outside the protected areas within the European Union

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N2k PAs are a crucial tool to slow global biodiversity loss. Even though their representativity across taxa and bioregions remain uncertain. Previous studies about PAs effects on species diversity didn't consider confounding factors (i.e. land use), crucial to detect their representativity and effectiveness. To overcome these problems we used Propensity Score Matching (PSM) to test if PAs contain more priority species than outside. We choose as matching covariates variables that are usually linked to biases in N2k PAs location: bioregions, artificial surfaces, forest and semi-natural areas, agricultural areas, and terrain ruggedness index. Using reported species data from the Birds and Habitats Directives with a resolution of 100 km2 we calculated alpha diversity within each cell for different groups of taxa: amphibians, arthropods, birds, fishes, mammals, molluscs, non-vascular plants, reptiles, and vascular plants. To assess differences in alpha diversity between protected and non-protected cells, we fitted a generalized linear mixed model. The results highlighted a common pattern, with a higher number of species inside than outside N2k PAs. Among bioregions, total species richness and species richness of amphibians, arthropods, birds, and mammals were significantly higher inside PAs than outside except for the Boreal region. These results highlight as N2k PAs don't play the same role among bioregions and don't have the same representativity across different taxa. Therefore, the aim of the 2030 European Biodiversity Strategy to extend the N2k to reach 30%, must consider the less represented taxonomic groups and their heterogeneous representativity across bioregions.

Crowded mountains: long-term effects of human outdoor recreation on a community of wild mammals monitored with systematic camera-trapping

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Outdoor recreation in protected areas (PAs) has become an increasingly popular activity globally, yet the long-term effects on wildlife are poorly known. Reconciling human access to nature and wildlife conservation requires sound evaluations of how outdoor activities affect biodiversity in the long run. We aimed to assess whether tourism in and around a PA of the world-renown Dolomites affected wild mammals in the long term, and if it elicited spatial or temporal avoidance. We detected mammals by systematic camera-trapping over seven consecutive summers at 60, consistently sampled, sites and estimated trends in occurrence at community and species levels through a dynamic community occupancy model, combined with site use intensity and an index of nocturnality. Overall, 70% of the 520,000 images obtained depicted humans, whose presence intensified over the 7-years period. Nonetheless, both community and most species-level occurrences increased. However, human activities caused a strong temporal avoidance in the whole community, especially in most disturbed sites, and the nocturnality of the community increased at increasing rates of human passage. Spatial avoidance of human recreation was instead observed only for bigger-sized species. Our study shows that wild mammals modulate their temporal activity in relation to the intensities of human activities, and that sensitive species also spatially avoid humans. While these responses may represent effective coping strategies, given that trends in occupancy were positive or stable, unforeseen drawbacks of forced nocturnality and altered spatial patterns might impact wildlife persistence even within PAs, with potential ecosystem-level consequences.

Assessing the impact of terrestrial protected areas in abating threats to mammals

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Protected areas play a key role in conserving biodiversity and have been shown to prevent extinctions and reduce human pressure on habitats. Currently protected areas cover roughly one sixth of the worlds' land yet this is not enough to halt the decline in biodiversity. Protected areas have been criticized for not being effective in achieving their conservation objectives, and one big gap in the research is knowing how effective protected areas are in reducing threats to species globally. The IUCN Red List of Threatened Species provides information on the extinction risk of species globally and includes the main threats that are contributing to their decline. I will present preliminary results of counterfactual impact evaluation using statistical matching techniques to estimate the effectiveness of protected areas in reducing each of the threats included in the Red List threat classification for mammals globally. Using publicly available global threat maps, the current level of each threat in protected areas is compared to matched areas that are not protected based on covariate similarity (e.g. distance to roads, elevation, crop suitability, etc). The results from this study can facilitate conservation planning and prioritization by understanding which threats can be abated by protected areas. The results can also be useful for the establishment of targets to abate threats to the level necessary to halt and reverse biodiversity loss, feeding into or assessing the new targets currently being developed by the Convention of Biological Diversity for the post-2020 global biodiversity framework.

Biological traits of a new alien spined loach (Actinopterygii: Cobitidae) in the Malone stream drainage (Piedmont, NW Italy)

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Alien species introduction is a significant threat to freshwater fishes. The last report on freshwater fish status in Piedmont showed the presence of 23 alien species (corresponding to 43% fish species) that represent a massive change in the local communities and a hardly reversible impact. A new alien species, the spined loach *Cobitis cf. elongatoides*, has been recently discovered in Po River drainage . In this study, the biology and ecology of the species have been investigated to understand its invasive dynamics better. The study was conducted along the Malone stream, where freshwater fish were sampled using an electric stunner. The new species has been massively found along the stream, always in syntopy with the native Italian spined loach *Cobitis bilineata*. The almost exclusive presence of females and the coexistence of the native congeneric spined loach suggest that the alien species reproduces asexually by gynogenesis, using native males as sperm donors. This is a common phenomenon among native *Cobitis* species in central and eastern Europe. The occurrence points recorded from 2019 to 2022 show the spread of the species at least 5 km upstream. The possible impacts mainly concern the competition with the benthic native species *Cobitis bilineata* and the Lombardy brook lamprey *Lampetra zanandreai*. Considering the already significantly compromised freshwater fish communities in Italy, control measures are proposed to contain the invasion of the alien spined loach.

Trophic structure of a pond community dominated by an invasive alien species: Insights from stomach content and stable isotope analyses

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Invaders affect native species across multiple trophic levels, influencing the structure and stability of freshwater communities. Based on the 'trophic position hypothesis', invaders at the top of the food web are more harmful to native species via direct and indirect effects. However, introduced and native predators can coexist, especially when non-native species have no ecological and behavioural similarities with natives, occupy an empty niche, or natives show generalist anti-predator strategies effective at the community level. At present, conservation efforts are focused on eradicating invaders, but their removal may lead to unexpected outcomes. This highlights the need to consider invaders in a whole-ecosystem context before active management is applied. Stomach content and stable isotope analyses were combined to investigate a pond system dominated by invaders to understand the effects of the interactions among upper-level predators and lower-level members of the food web on the whole community structure. Both diet and isotopes showed that invaders contributed to the diet of natives and invaders. A significant isotope overlap was found among upper-level predators. Stomach content analysis suggested that predators reduced the potential competition including additional prey in their diet. Both native and non-native upper-level predators, consuming invaders, do not to exert a strong suppressive effect on native species. This research confirms the importance of studying food webs to identify ecological conditions that forecast the potential for deleterious impacts before management is applied. In cases where invaders cannot be eradicated, management efforts should follow a conciliatory approach promoting the coexistence of natives with invaders.

Behavioural and biochemical stress responses of *Cherax quadricarinatus* after exposure to acoustic signal in tank

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Anthropogenic sound is recognized as a major environmental stressor that, in the long term, can have negative consequences on species. In recent years, there has been growing attention to the potential negative impact of noise pollution on species, with great concern about the significance of impacts on aquatic animal life.

This study examined the effects of acoustic stress on the behavior and biochemical parameters of the freshwater shrimp *Cherax quadricarinatus*.

The experiment was conducted in a tank equipped with an audio and video recording system using ten groups (five control and five test) of three adult shrimp (30 animals in total). Animals in the test group were exposed to acoustic signals [a linear sweep from 10 to 200 kHz lasting 1 s, with a sound pressure level between 138 and 157 dBrms (re 1lParms)] for 45 minutes. Behavioral parameters such as, total acoustic signals emitted, movement velocity, angular velocity, distance moved, no. of fights, encounters, tail flip and biochemical parameters such as pH, osmolarity, protein concentration and enzyme activities (alkaline phosphatase, esterase and peroxidase) were evaluated. Exposure to the acoustic signal produced significant changes on the specie's total acoustic signals emitted and no. of fights. Enzyme activities show significant changes, with significantly lower values in stressed animals. These results suggest that high-frequency stimuli induce both a behavioural and physiological response, thus suggesting that acoustic stress may have an effect on the species.

Detailed seafloor cartography leads to the identification of benthic vulnerable marine ecosystems

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Oceans and coastal areas provide essential services to human well-being. The United Nations 2030 Agenda promotes the conservation and sustainable use of marine resources, which require detailed knowledge of the spatial distribution of i) complex and productive benthic biocoenoses and ii) the anthropic activities. This information is generally lacking, especially for the deep sea, limiting our ability to identify the relevant benthic biocoenoses highly vulnerable to demersal fishing practices and internationally recognised as vulnerable marine ecosystems (VMEs).
The Ligurian Sea is a highly exploited basin of the Mediterranean Sea with an extensively urbanised coastline. Its shallow-water biocoenoses structure and distribution are well known, but at intermediate and high depths, only scattered information was available until a few years ago, when new evidence suggested the existence of highly vulnerable gorgonian forests and coral reefs. Extensive remotely operated vehicle explorations were carried out in 170 sites from 30 to 1800 m depth to characterise these uncharted biocoenoses. A large QGIS database was created, including i) data regarding benthic biocoenoses distribution, structure, and health status, and ii) a detailed mapping of the anthropic use of the sea (i.e., fishing grounds, aquaculture sites, shipping routes, communication cables, and offshore platforms). This information allowed the creation of the first network of mesophotic and bathyal Ligurian VMEs adopting the EU and FAO's vulnerability criteria.
This georeferenced dataset represents a practical tool to implement effective conservation measures and monitoring programs along a wide bathymetric gradient, highlighting the fundamental role of spatial mapping in marine benthic ecosystem conservation.

Predicting the impact of fishing on cetacean abundance in the European seas

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Cetaceans have been historically harvested, and while commercial whaling has decreased in the last two centuries, new threats have emerged. Currently, the IUCN Red List classifies 26% of the cetacean species as threatened, and lists the direct and indirect effects of fishing as the main causes of decline. Yet, while many studies have documented the impact of fishing activities on cetaceans no study has yet quantified in the overall population density reduction in the European seas. This study aimed to quantify the influence of fishing effort on cetacean abundance in the European seas. We gathered 972 population density estimates for 17 species from the literature. Then we modeled cetacean population density as a function of species traits, environmental and anthropogenic variables, including fishing effort. We used the model to predict a hypothetical no-fishing baseline, as well as spatial prediction of fishing impact on cetaceans’ populations. The final model explained 75.5% of the deviance, and fishing effort figured as the third most important environmental variable. The resulting spatial projections suggest an overall decline in population density of 44% due to fishing effort in 2020 compared to the hypothetical natural baseline. These findings highlight the detrimental effect of fishing on cetaceans in European seas, and identifies areas that require regulations and protection. The collected density estimates and model predictions can inform future Red List assessments. Our study can be a starting point for additional research focused on how to meet the needs of humans’ and cetaceans’ conservation alike.

Analysis of the distribution, conservation status, and phenotypic variation of populations of *Bombina pachypus* (Bonaparte, 1838) in the Latium Region

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The Apennine yellow-bellied toad is an endemic Italian amphibian at risk of extinction due to population decline and a significant reduction in mature individuals. Our study is focused on two main objectives: 1) to update knowledge about the distribution and conservation status of populations in the Latium region, and 2) to analyse phenotypic traits (colour) to analyze intra- and inter-population variability.
In 2021, in only 14 (one site with hybrid individuals) out of 35 sites of historical presence we confirmed the presence of the species; in 2022 we confirmed the presence in 14 localities and discovered a new unreported site.
In 2021-2022, populations abundance ranged 1-18 mature individuals with low or absent recruitment: 60% of the populations consisted of fewer than 7 individuals and reproduction was observed in only 47%. No environmental parameters were found to be correlated with local extinction.
At the phenotypic level: variation in the proportion of ventral yellow correlates with geographic distance between populations, and the back color changes according to the substrate, these features being likely linked to cryptism; these results are important for selecting suitable individuals and sites for concrete conservation actions.
An encouraging finding is the absence of chytridiomycosis in all the study populations, which makes it possible not to exclude any of the current sites from future restocking programs.
This research evidences (i) the poor conservation status of *Bombina pachypus* populations in Latium, (ii) the phenotypic variability and the color-matching background, and (iii) what are the potential sites for future restocking/reintroductions.

Evaluation of aesthetic and ecological value following the recolonization dynamics of coralligenous reefs

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Coralligenous reefs are one of the most important ecosystems in the Mediterranean Sea, as a biodiversity hotspot and for the provision of goods and services. Following the shipwreck of the Costa Concordia at the Giglio Island, the coralligenous assemblages in the wreckage area were highly affected by human-related disturbances. After the wreck removal, several restoration efforts have been carried out to favor natural recolonization of the reefs. The scope of this study is the assessment of the dynamics, in term of aesthetic and ecological values, of the coralligenous following the restoration events. The photomosaic sampling technique was used to studying five impacted stations, photographed every six months (from summer 2017 to summer 2021). Then, the photomosaics were analyzed to map the taxa present in the area and to quantify their coverage percentage. Subsequently, diversity was analyzed to assess the dynamics of the assemblages. The aesthetic value was evaluated through a deep learning algorithm applied on 50 cm x 50 cm photographs. The results revealed a significant increase of both ecological and aesthetic quality of the reefs during the study period. In several studies, the positive relationship between the aesthetic and ecological value of a portion of the landscape (and therefore also with its biodiversity) has already emerged. Similar studies are useful to evaluate the effectiveness of restoration intervention on damaged natural ecosystems, as they also take into consideration the human perception of nature.

The influence of landscape and habitat heterogeneity in shaping mountain bird communities in the Alps

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In Europe, the heterogeneous Alpine landscape has been shaped by abiotic and biotic processes over millions of years and, in recent millennia, by human activities. These mountain regions host many endemics and species adapted to extreme environments and are thus considered important biodiversity hotspots. Understanding the main drivers of biodiversity loss in mountainous areas, particularly in human-influenced landscapes, has been a research goal in recent decades. Birds are a key component in most ecosystems. They are highly sensitive to environmental changes, especially to habitat loss and degradation, making them an important bioindicator for ecological studies regarding global change scenarios. Understanding how environmental change affects bird communities is essential to identify distributional factors and potential impacts of global change to then develop effective conservation strategies.
Within the long-term project Biodiversity Monitoring South Tyrol, bird communities were studied along land-use intensity and elevational gradients in the Province of Bozen. By modelling topographic and climatic variables, landscape composition, configuration, and heterogeneity, assessed in the field or remotely, we investigated the main patterns driving the taxonomic and functional diversity of mountain bird communities. Results showed that habitat heterogeneity is crucial for shaping rich and diverse bird communities. Furthermore, to mitigate land-use change impacts on birds in the Alps, a complex landscape structure with near-natural elements and a mosaic of different land-use/land-cover types should be promoted, while preserving heterogeneity in cultivated areas and the continuity of forests. Finally, the results confirmed that extensive grasslands and wetlands are fundamental habitats for bird conservation.

Applied research for conservation of two falcon species in the intensive agricultural area of the Po Plain

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Global anthropogenic changes, altering the climate and natural environments, cause radical reshuffling in the distribution of animal species, such as local extinctions or new colonisations. Recently, these processes have led to an exceptional condition of breeding sympatry between two falcon species of high conservation value in the agricultural-intensive area of the Po Plain: the lesser kestrel (*Falco naumanni*) and the red-footed falcon (*Falco vespertinus*). The particular artificial and intensive context encourages the study of habitat selection of the two species, with the aim of proposing targeted and correct agricultural practices. Through direct observations of hunting individuals, the foraging habitat was defined, resulted to be the same for the two species: low vegetation and harvested crops were preferred, conditions that maximise accessibility to prey. These characteristics are found in alfalfa and winter-cereal crops, which are managed with repeated cutting precisely during the breeding season of the two species in the Po Plain. These crops probably represent a habitat-surrogate of the original steppe habitats, and their maintenance is therefore essential. In the same study, we analysed the success of a direct conservation measure such as the provision of nest-boxes, carried out over several years and in the context of various projects. The measure showed substantial effectiveness for both species, sustaining a positive population trend, suggesting that in addition to habitat quality, the availability of suitable breeding sites may also be a limiting factor for falcon populations in the Po Plain.

Insects as indicators of Key Biodiversity Areas

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Key biodiversity areas (KBA) are sites that, if preserved, can ensure the persistence of biodiversity in the coming years. The sites are selected according to global standard criteria. The new KBA standard criteria are rapidly becoming a reference methodology among conservationists because of its ability to identify regions of the planet hosting unique biodiversity. However, 79% of currently accepted KBAs on a global scale are triggered by bird species, revealing an important gap of knowledge of the distribution of KBAs for non-avian taxa. Attempts to include insect species in the KBA network were made using different approaches depending on the geographic scale of the analysis, as well as on the target taxa and data availability. However, so far a method to systematically apply KBA criteria and scan geographic regions to detect potential KBAs was not available. A recently developed methodology is now available for this scope and was already tested on amphibians and reptiles of Italy using Area of habitat maps as surrogates for species’ population distribution. We aimed at detecting potential KBAs through the implementation of the same systematic approach in order to find potential KBAs for bumblebees species (Genus *Bombus*) in Italy. Moreover, we estimated the percentage of new potential KBAs for insects that is already included in the current network of KBAs, as well as in the national protected areas. This represents a first attempt of a systematic application of KBA criteria on insect taxa and revealed significant limitations of the KBA criteria approach for such species.

Climate change effects on plant biodiversity of small Mediterranean islands

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The Mediterranean basin encompasses around 10,000 islands and islets which host a considerable portion of the region's plant biodiversity. Due to reduced population sizes and isolation from the mainland, plant species on islands are potentially susceptible of extinction, especially due to emerging environmental stressors such as climate change. Here, we present the working plan of a PhD project aimed at assessing the vascular plant diversity of small Mediterranean islands and quantifying its response to ongoing climate change. To do so, we will first compile all available vegetation plot data in the study area, in order to describe plant biodiversity patterns in terms of species richness and composition. Secondly, we will select a subset of plots with high location precision and accessibility to be resurveyed after about 40 years from the first assessment. Therefore, a cooperative resurvey effort will be organized, involving colleagues from different countries. To assess the effect of climate change on species diversity, climatic data for the last 40 years for each island will be obtained through a cooperation with CMCC, the Italian Focal Point of the IPCC (https://www.cmcc.it/). Resurvey data will be used to test for deviation from the expectations of the Equilibrium Theory of Island Biogeography, under the assumed effect of a warmer climate on plant species diversity. We expect that our results will provide a view of the current state of plant biodiversity on Mediterranean islands and insights for effective conservation policies in the context of climate change.

Modelling the Eurasian beaver range expansion in Europe: uneven future trends and possible conservation issues

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The Eurasian beaver (*Castor fiber*), a keystone species and landscape-capable ecosystem engineer, was close to extinction until the 19th century. Thanks to legal protection and reintroduction programs, the species has now recolonized much of its past range.
We model its potential distribution for both current and future conditions at European scale. We produce fine-tuned species distribution models for rivers and their sub-basins, using climate change scenarios, predicted changes in river flow, also including topographic and human disturbance variables. We then assess suitability-related issues within Italian and Portuguese protected areas, supporting possible reintroductions.
We find that the Eurasian beaver's current suitability is comparable to its known distribution. However, we note that some potentially-suitable spots occur in Italy (where the Eurasian beaver was recently recorded for two areas), while the Iberian Peninsula and the Balkan countries host scattered suitable spots. Future scenarios show a decrease in environmental suitability in large areas of central and northern Europe due to projected changes in climate and river flows. While the Italian protected areas have different levels of suitability based on the geographical sector considered, the Portuguese protected areas generally include territories with scarce suitability.
Our results may be useful to support the large-scale management of the Eurasian beaver, both for countries already hosting the species and those interested in its reintroduction. The framework proposed may be useful for studies on other species, also in different study areas, in an approach that starts from the biogeography to arrive at the conservation.

Between wolves and humans: spatiotemporal activity patterns of Alpine ungulates under varying predatory and human pressures

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Preys and predators are assumed to be engaged in a spatiotemporal race: preys may seek to avoid predators, either by exploiting areas where the predators are absent or by being active at times the predators are not. In anthropogenic habitats, humans may add to (human disturbance hypothesis) or buffer (human shield hypothesis) the influence of predators on prey behaviour. Through extensive systematic camera trapping (N=127 over 6 months), we monitored three Alpine study areas (Valfurva Stelvio NP, Val di Peio Stelvio NP, Alta Val di Non - Italy) which differ by the presence status of a large apex predator (wolf, Canis lupus: absent, occasional and stably present), and by the type and degree of human disturbances. We investigate the activity patterns and habitat use of three sympatric ungulates (red deer, *Cervus elaphus*; roe deer, *Capreolus capreolus*; chamois, *Rupicapra rupicapra*) in order to assess how preys respond spatiotemporally to wolf presence in anthropogenic contexts. Particularly, we test for the human disturbance vs. human shield hypotheses. We expect complex spatiotemporal interactions between the two hypotheses, driven by the degree of anthropogenic pressure: we expect ungulates to use wolves' fear of humans as a shield in case of low or non-lethal human disturbance; however under higher levels of human disturbance we predict ungulates to prioritise human avoidance over anti-predator response, especially in areas of recent wolf return. As wolves are progressively recolonizing the Alps, this study will help uncovering the processes underlying animal distribution and behaviour in rapidly changing and anthropic environments.

The utility of functional traits in assisting marine conservation: Mediterranean outbreak-forming species response to increasing temperature

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Global warming and the more frequent and intense heat waves alter marine ecosystems and the services they provide. While some species are negatively affected by a changing environment experiencing decreasing performance and mass mortality events, other species are taking advantage of these warmer conditions. The corallivorous polychaete *Hermodice carunculata* is an outbreak-forming species severely impacting shallow benthic communities and coastal fishery activities due to its voracity and omnivorous feeding habits. It is considered a "native invader" in the Mediterranean basin presenting high growth and reproduction rates, as well as broad tolerance to environmental conditions. Here we experimentally investigated the thermal performance (by using respiration rate as a proxy of metabolic functioning) and feeding rate of the species through a wide temperature range. Thermal optima and thresholds of the species were identified, confirming the warm-water affinity of the species that may easily be able to cope with increasing temperature conditions. Also feeding rate was positively correlated to temperature, highlighting the increasing threat that the species may suppose to shallow coastal benthic biodiversity. Outputs from this study can be considered as basal key information assisting natural ecosystem management and conservation, as well as ecosystem-based economic activities directly interacting with the species in the current and future scenarios of climate change.

Diversity, distribution and conservation status of wild terrestrial orchids: a Mediterranean perspective

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The Mediterranean biome consists of five regions (Mediterranean Basin, California, Southwestern and Southern Australia, the Western Cape Region of South Africa, and Central Chile) occurring in six continents. Despite the less than 2% of the world surface is covered by this biome, it harbours more than 20% of the plant diversity and more than 500 milion human inhabitants. The massive urbanization emerged specifically in the last decades has caused changes in land use and landscape management driving the declining of species that have benefited from human interactions for millennia. Al global scale, the biological diversity of this biome is threatened by the disproportionate growth of human activities increasing the extinction risk of endemic taxa. Orchids counts more than 28000 species and there is no place on Earth available to life that does not have its unique orchid community. Although one-third of the orchids known are geophyte, more than an half of the extincted species belong to this growth form suggesting that this trait emphasizes the species decline. Considered that all Mediterranean orchids are terrestrial, our aims are: i) define how many species live in the Mediterranean biome and how many taxa are endemic to these peculiar ecoregions; ii) evaluate the functional diversity within and between the five Mediterranean ecoregions measured adopting traits as pollination strategies, growth forms (rhizome vs bulb), habitat preference and fire flowering induction; iii) investigate the conservation status and national Red Lists for prioritising conservation actions.

Impiego della diversità oscura a supporto delle strategie di recupero della vegetazione forestale distrutta da eventi meteorologici estremi

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Increasingly frequent extreme weather events are a clear signal of climate change and are among the biggest challenges for biodiversity conservation today. Planting is the traditional method used for forest vegetation recovery, but it often ends with uncertain outcomes other than being expensive. In this study, we used dark diversity to evaluate the spontaneous recovery process of forest vegetation destroyed by a storm. The study area coincides with the reforestation of spruce (*Picea abies*) on the summit of Mount Campo Dei Fiori in Varese, severely damaged by the storm Alex in October 2020. We carried out 22 floristic-vegetation relevés, 14 of which were in points already surveyed in 2007, to estimate the dark diversity of control and disturbed areas and compare it with the observed one. The observed diversity in the disturbed areas was not significantly different from the control areas, but it tends to be characterized by ruderal or synanthropic species. However, disturbed areas appear to have a significant lower dark diversity, meaning that the occurrence of the storm in spruce areas strongly compromised the recolonization potential. The analysis of dark diversity allowed us to identify the main expectable forest recolonization processes. In particular, we were able to identify a set of deciduous broadleaf species that will be able to colonize the summit area more quickly, favouring the formation of transitional forest ecosystems more resilient to extreme events.

The challenge of setting restoration targets for macroalgal forests under climate changes

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The process of site selection and spatial planning has received scarce attention in the scientific literature dealing with marine restoration, suggesting the need to better address how spatial planning tools could guide restoration interventions. In this study, for the first time, the consequences of adopting different restoration targets and criteria on spatial restoration prioritization have been assessed at a regional scale, including the consideration of climate changes. We applied the decision-support tool Marxan, widely used in systematic conservation planning on Mediterranean macroalgal forests. The loss of this habitat has been largely documented, with limited evidences of natural recovery. Spatial priorities were identified under six planning scenarios, considering three main restoration targets to reflect the objectives of the EU Biodiversity Strategy for 2030. Results show that the number of suitable sites for restoration is very limited at basin scale, and targets are only achieved when the recovery of 10% of regressing and extinct macroalgal forests is planned. Increasing targets translates into including unsuitable areas for restoration in Marxan solutions, amplifying the risk of ineffective interventions. Our analysis supports macroalgal forests restoration and provides guiding principles and criteria to strengthen the effectiveness of restoration actions across habitats. The constraints in finding suitable areas for restoration are discussed, and recommendations to guide planning to support future restoration interventions are also included.

Planning conservation strategies based on a multi-scalar and multispecies approach to assess habitat connectivity and roadkill risk area

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Fragmentation and habitat loss caused by human activities are among the major threats to biodiversity, acting at different spatial and temporal scales. Linear infrastructures such as roads could interrupt habitat connectivity, thus representing a serious threat to the animal population. In this study, we quantified habitat connectivity and roadkill patterns of forest mammal species in Friuli Venezia Giulia Region (NE Italy). Specifically, we aimed at i) assessing the relationship between habitat connectivity degree and roadkill risk, and, on these bases, at ii) identifying the sites where mitigation measures should be planned and those to preserve. We used a multispecies and multi-scalar (i.e., using different spatial resolutions) approach to model habitat connectivity and roadkill risk grouping species in low, medium and high mobility, based on their dispersal ability. To model the connectivity, we used Circuitscape and we created 27 scenarios for each mobility species group combining different resistance values for each land use class (setting values of minimum and maximum resistance for forest and urban areas, respectively). On the other hand, roadkill data were modelled through species distribution models and predicted for the entire road network. In this way, a roadkill risk map for each mobility species group was obtained. The overlap between areas with high conservation value (e.g., corridors) and areas with a high roadkill risk allowed the identification of priority areas that need management and restoration of habitat connectivity. The proposed approach can be used to plan effective conservation actions for different species with different dispersion capabilities.

Descrivere e valutare la biodiversità: un approccio epistemologico pluralista

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The identification of a "Unity of Biodiversity" as the basis for conservation results to be challenging: the establishment of a single criterion may prove to be ineffective, as in the case of some entity-based approaches (whether genes, species, or ecosystems) or some process-based approaches (e.g., functional). In my opinion, a pluralistic method able to diversify and integrate the models used in explanation and evaluation should be used. Qualitative and quantitative aspects, structural and functional traits, and spatial and temporal perspectives should be considered otherwise biodiversity would be reduced to its single components entailing its complete and overall significance lost. An analogy can be developed between the evolutionary reconstructions made by Stephen Jay Gould, derived from the "actative triangle" (according to which the three vertices historical, structural, and functional are, by themselves, necessary but not sufficient for an exhaustive explanation of the evolutionary phenomenon, which, for that matter, lies in the middle of the triangle), and a pluralistic approach to conservation. I intend to demonstrate that to reach a coherent and complete view of the biodiversity phenomenon and its conservation, it is necessary to consider all its different characterizing factors, creating a "conservation triangle". The latter explores the issue at a macroscopic level: the factors are indeed more than three, but they can be merged by creating sets that correspond to the three vertices that will be proposed. It is essential to emphasize the fact that the usefulness of such an epistemological tool will not have to be absolutized: it will need a case-by-case contextualization, preventing it from becoming a dogmatic epistemological filter that precedes our observations instead of proposing their explanation.

Predicting the functional compostion of coastal dunes using UAV-based remotely sensed data

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Plant and community functional composition provide valuable insights in ecosystem functioning. However, sampling activities are often cost and time demanding. As an alternative approach, remote sensing could allow to retrieve information about plant communities and their functional composition from the spectral signal of the canopy. In this study, UAV-based remote sensing was used to estimate the functional composition of herbaceous plant communities in coastal dune ecosystems. In 2022, coastal dune species composition as well as their functional traits were measured, and canopy multispectral data were acquired in one of the few remnants of natural vegetation in the northern Adriatic coastline, namely “Valle Vecchia” site. Specifically, plant species richness and abundance have been assessed in 84 plots along with a suite of plant functional traits, namely leaf mass per area (LMA), leaf dry matter content (LDMC), water potential at turgor loss point (Ψtlp), vein length per unit mass (VLM), carbon and nitrogen content and isotopic composition. Plot level functional composition was assessed both in terms of functional diversity indexes and in terms of community weighted means (CWMs) for each functional trait. The effectiveness of spectral data in predicting plot-level CWMs was tested using Partial Least Square Regressions (PLSR), while multivariate statistics was used to explore taxonomical (TD), functional (FD) and spectral (SD) diversity patterns. Plant spectral properties proved to capture variation in the functional composition of coastal plant communities, highlighting the potential of remote sensing tools to monitor ongoing biodiversity changes.

Sezione 2

Speed talks

Studying the past to understand the future: effect of Quaternary climatic oscillations on phylogeography and historical demography of Italian endemic Alticini species

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The climate is one of the main factors that influence the distribution of ecosystems on planet. Over the past two million years the climate on Earth has undergone periodic fluctuations, playing a key role in structuring current biodiversity patterns, either through species extinction or by shaping the distribution of species and their genetic diversity. The comprehension of the variety of species responses to past climatic changes might provide insights on how species will respond to ongoing climate change. The role of the Italian peninsula as a key glacial refugium for temperate species is well established, however most of the studies on Italian endemic species have focused on vertebrates. This makes our appraisal of the ecological response of species to past climatic changes far from complete. In this study we carried out a comparative phylogeographic assessment on three temperate species of Alticini (Coleoptera, Chrysomelidae) endemic to the Apennine, using multilocus DNA sequence datasets. We compare population structure using phylogenetic trees and haplotype network and reconstructed the historical demography under the Extended Bayesian Skyline Plot model. We observed sharply different phylogeographic patterns and demographic histories, corroborating the idiosyncratic nature of temperate species response to past climatic changes. Our results also confirmed the Apennine as an important reservoir of genetic diversity and provides direction for biodiversity conservation strategies in terms of conservation units and priority areas.

The reconquest of Rome: the effects of the saturation of urban environments by the peregrine falcon (*Falco peregrinus*)

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Birds constitute one of the groups most adapted to live in cities, and many of them can benefit from the urban environment. Recently, the peregrine falcon (*Falco peregrinus*) is, next to the kestrel, the bird of prey that most exploited the urban habitat. Its success is due to the abundant presence of preys (starlings, doves, swifts) and due to the large availability of nest sites on tall buildings. In the last fifteen years, peregrine falcons have colonized most of the urban area of Rome, with over more than 20 breeding pairs. The increasing number of urban couples is reaching the saturation of territories in the city area and the first negative effects on productivity seem to emerge. The dynamics of peregrine falcon settlement within Rome and the presence of density-dependent behaviors in the urban populations were evaluated by monitoring the breeding pairs nesting in the city and collecting data from recovery of young and adults individuals rescued within the urban area. The peregrine falcon, today considered as Least Concern in Italy by the IUCN red list, was an extremely endangered species just fifty years ago. The conquest of cities by this avian predator is an iconic example of a fast and effective change adaptation and coexistence with human presence.

The invasive blue crab *Callinectes sapidus* thermal response: predicting metabolic suitability maps under future warming Mediterranean scenarios

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One of the consequences of climate change and globalization is the recent proliferation of the invasive swimming American blue crab *Callinectes sapidus* in the Mediterranean Sea. Highly aggressive and opportunistic, *C. sapidus* causes numerous socio-ecological impacts such as loss of local biodiversity or economic losses for artisanal fisheries for example. To determine the effect of climate change on *C. sapidus*, its thermal tolerance was studied through experiments based on the metabolic response of the species (measurement of respiration rates). The thermal performance curve showed a CTmax at 40°C and an optimum at 24°C. Respiration rates increased between 12°C and 24°C and decreased up to 30°C. At higher temperatures (>30°C), a noticeable increase in respiration rate values was observed from 32°C, before the organisms died at 40°C. Based on the metabolic rates, thermal habitat suitability (THS) maps were developed for current and future temperature conditions in the Mediterranean Sea. The entire basin has favorable conditions for maintaining *C. sapidus* populations in both current and future scenarios. The future scenarios show an average increase of +0.2 in THS over the year suggesting that the species will survive all year in the future. The present study provides a better understanding of the ecological performance and potential distribution of *C. sapidus*. Thermal suitability maps can be an effective visual tool to help managers and conservation practitioners address biodiversity conservation measures and identify specific areas of current and future vulnerability to implement blue crab's management measures in the Mediterranean Sea.

Lichen rarity in Alpine changing environment: still a core problem

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It is well known that the climate is warming rapidly at high elevations, implying that alpine species are expanding their range upwards. Understanding changes to mountain and alpine vegetation is consequently essential, and lichens are excellent indicators of environmental changes because of their great reliance on external climatic conditions.The Aosta Valley (Northwestern Italy) is an Alpine valley with almost entirely mountainous territory, with a mean altitude reaching 2100 m a.s.l., and the presence of remote districts, hosting high biodiversity, potentially threatened by global change. This area includes four ecoregions (alpine, subalpine, montane and dry-submediterranean), making possible an ecoregional assessment of species rarity. Furthermore, the lichen flora in Aosta Valley has been extensively explored, reducing the possibility of overestimating species rarity due to a lack of data. Species considered rare in one environment and strictly bound to a certain bioclimate, can access different ecoregions and survive thanks to the finding of narrow microclimatic niches. Therefore, analysing functional traits and niche specialisation is crucial in alpine environment. Since rarity patterns are linked to the extinction risk, understanding them is essential for habitat conservation in global change scenarios. Analyses on lichen rarity pattern at regional level, based on a dataset of over 6000 literature, field and herbarium data, and results of a diachronic analyses (resampling after 100 years) on lichen assemblages in an alpine area are presented.

Hotspots of risk for mammal species and Nature's Contributions to People under global warming

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The current climate change induced by the anthropogenic release of greenhouse gases in the atmosphere have led to an increase in frequency and intensity of extreme climatic events, such as fires, droughts, and extreme temperature. The coaction of climate change with the influence of anthropization on natural ecosystems have already impacted on biodiversity, leading to an increase of species extinction rate, and on Nature's Contributions to people (NCP) generating irreversible deterioration of their functions, like reduction in the regulation of freshwater, air quality, and regulation of extreme events. In the future, the number of mammal species and the supply of NCP will decrease due to the direct impact of climate change on their ecosystems, behaviors, and physiology. To determine synergies between biodiversity conservation and NCP preservation, I developed a comparative extinction risk model for mammal species sensitive to fire, drought, and extreme temperatures, and used it to predict their probability of extinction under future climate change. I also projected risk to NCP affected by the same stressors and produced global maps to identify hotspots of biodiversity and NCP risk. Thus, I found several areas where high cumulative risk for species matches a risk of NCP loss from global warming under different scenarios. These hotspots represent high priority land areas for policy and management intervention and climate mitigation actions. Preserving these regions could contribute to reducing habitat loss halting human-induced extinctions, and safeguarding ecosystems that provide essential services such carbon storage and water to maintain ecosystem resilience.

Interaction between coastal gillnet fisheries and wintering seabirds in a proposed Natura 2000 Site

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Bycatch, the incidental capture of vulnerable species in fisheries, has been recognized as one of the main conservation issues affecting seabird species globally. According to recent estimates, 200.000 seabirds drown each year in European waters as a result of bycatch. Bycatch rates vary widely geographically due to fishing activity, environmental conditions, and the occurrence of different bird species. The majority of bycatch research in Europe is concentrated on the Baltic Sea and North Sea, whereas there is still a significant knowledge gap in the Mediterranean Sea. The aim of this study is evaluating bycatch impact on the most vulnerable seabird species in gillnet fisheries in a coastal area of the Northern Adriatic Sea. The survey was conducted over the winters of 2021–2023. Data on distribution of wintering seabirds, fishing effort as well as bycatch rate during fishing trips were gathered in order to assess high-risk zones and factors influencing bycatch. The findings could help define the eventual spatio-temporal mitigation actions required in that marine area designated as a priority for conservation under the Habitats Directive 92/43/CEE.

Preserving landscape diversity is crucial for bat diversity in mountain areas

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In recent decades, Alpine landscapes have been affected by land-use changes. While agricultural activities at high elevations and in remote regions have frequently been abandoned, those at the main valley bottoms were intensified. These trends can also be observed for South Tyrol, with negative impacts on biodiversity. All Italian bat species are protected by national and international laws and most of them are sensitive to land-use changes. In this context, exploring threatened bat species' responses to anthropogenic disturbances can provide insights to develop and apply effective conservation practices. We collected standardised acoustic data using bat detectors covering the main habitat types and elevational range in South Tyrol and then estimated bat activity, species richness, and taxonomic diversity.
The highest bat activity was observed in riparian forests followed by wetlands, settlements, vineyards, and intensive apple orchards. Overall, the main factors shaping bat abundance and richness were habitat types and landscape structure. According to our models, the highest diversity was found close to water sources, in heterogeneous landscapes, and at low and medium elevations.
Results showed that bat diversity is supported by heterogeneous and highly structured landscapes. Small protected areas play a crucial role in the conservation of threatened bats. This is particularly relevant for those embedded in a highly anthropogenic and homogeneous landscape, such as the intensified valley bottoms. Future analyses will explore small-scale landscape effects on bat diversity to develop adequate conservation strategies, fill knowledge gaps for specific protected areas and support a bat-friendly landscape planning.

In situ conservation and the role of zoos in adapting species focused conservation to the challenges of biodiversity loss: two examples from Italy and UK

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Conservation relies on effective actions to successfully limit the loss of biodiversity we're going through, and these actions can have multiple targets: from ecosystems to single species or even populations. One kind of institution that has long focused on so called species focused conservation are zoos. While the more recognizable role of zoos in species conservation is captive breeding of endangered or extinct in the wild species, zoos also participate in in-situ conservation where they either implement or support actions in the field. Zoos achieve this either by conducting projects directly or by providing vital support to researchers and organizations. Here, I present two examples of zoos getting involved with in situ conservation where I am involved: i) the project Chester Zoo (the largest UK zoo) is implementing for the conservation of a critically endangered antelope, the Mountain bongo (*Tragelaphus eurycerus isaaci*) in Eastern Africa; ii) the support Fondazione ARCA (the charity of the largest zoo in Northern Italy, Parco Natura Viva) provides to researchers and organizations to conduct species focused conservation actions in the field. The cases I'll present are but two examples of the concerted effort that modern progressive zoos are implementing to respond to the challenges of conservation, species by species.

Can functional approaches open new conservation opportunities for aquatic carnivorous plants in Europe?

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Carnivorous plants (CPs) include iconic species at the brink of extinction: about 25% of CPs are at high risk of complete vanishing due to global climate and land-use changes. This is particularly true for aquatic ecosystems, where water pollution and drought represent major threats for aquatic CPs, typical of low-nutrient habitats. However, knowledge of physical-chemical features of waters and sediments does not seem enough to elaborate effective conservation strategies for these sensitive macrophytes, suggesting the existence of hidden processes regulating CPs-environment relationships. Classical approaches need to be implemented to offer a survival chance to these extraordinary plants. In the frame of a short-term scientific mission of the Cost Action CA18201 ConservePlants, a pilot study has been launched to explore the functional traits of 8 threatened CPs (*Aldrovanda vesiculosa*, *Utricularia australis*, *U. bremii*, *U. intermedia*, *U. minor*, *U. ochroleuca*, *U. stygia* and *U. vulgaris*), focusing on the Třeboň Basin area, a protected UNESCO Biosphere Reserve. An ad hoc protocol for measuring morphological and biochemical traits has been designed for *A. vesiculosa* and aquatic bladderworts, starting the data collection. Nineteen wild populations and the collection in the Institute of Botany of the Czech Academy of Sciences in Třeboň, Czech Rep., were investigated. Preliminary results show high plasticity within species, while leaf dimension, leaf dry matter content and pigments content are driving between-species variability. This is a first functional attempt to better understand the spatiotemporal patterns of these iconic species, disentangling their eco-functional niches from which effective management strategies could then be implemented.

Diversity of beetle species and trophic group along gradients of deadwood suggests weak environmental filtering

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A change in local environmental characteristics may: favour the abundance of species with special traits, while other species decline; or favour species with different traits at the same time, without an increase in average species abundances. In this work, we analysed the beetle assemblage over five forest sites located protected areas along the Apennines (Italy). From 2012 to 2018 we surveyed five deadwood types in 193 plots to characterise the deadwood gradient: standing dead trees, snags, dead downed trees, coarse woody debris, and stumps. We modelled species relative abundances and trophic traits occurrences against the deadwood variables using joint species distribution models. Out of 462 species, only 67 showed significant responses to at least one deadwood variable. Similarly, trophic categories showed mostly negative responses to deadwood variables. Abundance indicated clear increases with species richness among sites only for phytophagous and saproxylophagous. Similarly, trait occurrence did not change with species richness among sites except for phytophagous and saproxylophagous, which showed positive relationship. However, trait occurrence increased significantly with species richness within some sites. We found that increases in species richness do not result in decreases in species abundance of a given trophic category, but rather null or positive relationships were found pointing toward low competition. Our findings suggest that in Mediterranean mountain forests there is still room for increasing the level of naturalness, at least for what concerns deadwood management. On one side, this suggests that competition for deadwood substrates can be low, on the other side it indicates that increasing deadwood volume and types to improve overall beetle diversity may increase overall beetle abundances.

Sezione 3

Poster

Butterfly monitoring through citizen science: preliminary results from a local project in Rome

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The alarming growth of human impacts on natural ecosystems and the consequent biodiversity loss require increasing data on species to develop conservation strategies. Citizen science (i.e, scientific initiatives of amateur-scientist cooperation) have proven to be an effective tool for data collection, especially if applied to specific taxa. Butterflies are suitable targets for such initiatives, as they are charismatic and easy to detect and identify. Moreover, they are extremely sensitive to environmental changes, providing valuable information for nature management. In this context, our study aims at assessing the butterfly diversity of Decima Malafede Nature Reserve (Rome, Italy) through a cooperative initiative involving volunteers and experts. Data collection started in 2021 and 3 different methods were employed: 1) species monitoring along a 1 km two-sections transect within a semi-natural area of the Reserve, joining the European Butterfly Monitoring Scheme project; 2) random data collection in different habitats in the study area; 3) targeted investigation of protected species. During the two years, a total of 48 species were found, highlighting Decima Malafede as one of the richest reserves of Rome. Results showed a difference in species composition and number between the two sections of the transect, probably influenced by adjacent land use and cover. Moreover, a new population of the endemic species, listed in the annexes of Habitat Directive, *Zerynthia cassandra* was discovered within the SAC “Sughereta di Castel di Decima” and data on the presence and abundance of its hostplant, eggs and larvae were collected.

Tiny seabirds on a tiny Island: launching ‘stormies’ into the Marine Strategy jungle

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The Mediterranean Storm Petrel (*Hydrobates pelagicus melitensis*) is a difficult species to survey, usually breeding in remote islands and sites that are hard to access. The Italian population was estimated between 1,700 and 2,500 breeding pairs, located in a handful of colonies around Sicily and Sardinia. The main breeding sites known so far have been located in marine caves. However, their presence on other Islands is difficult to detect with conventional methods, especially when nests are scattered under boulders or in cliffs. This entails knowledge gaps in the species abundance and distribution, hampering the collection of time series of data. A preliminary study was carried out on Toro Island (South Sardinia), where the first breeding pairs were recorded back in 1987, during the CNR programme on the “Minerva” vessel. This site has now been chosen for being one of the few islands naturally lacking black rats, which are incompatible with storm petrels. The local population size was totally unknown. Our aim was to build up and test a census protocol based on diurnal playback, according to method widely used in the UK. The preparatory protocol allowed us to find 48 occupied sites in a limited study area, of which 34 responded at least once to playback. Regular monitoring in future will provide high value trends in order to implement conservation on land and enhance the GES (good environmental status) across vast feeding areas at sea.

Pastures adaptation strategies to climate change impacts in the Alps: the LIFE project PASTORALP in the Gran Paradiso National Park

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In the Alps, traditional agro-pastoral practices have shaped alpine pastures creating unique habitats rich in biodiversity. However, these habitats are becoming increasingly sensitive and fragile because of climate change associated with the abandonment of mid-altitude grasslands. The LIFE project PASTORALP (October 2017 - March 2022) aims to assess the vulnerability of these ecosystems and to create adaptation strategies to climate change for a proper pastoral management of alpine grasslands. The project involved several partners including the Ecrins National Park in France and the Gran Paradiso National Park in Italy, using both as test areas. In the Noaschetta Valley (Orco Valley, TO) in particular, some adaptation strategies identified by the project were tested by applying active pasture management. The stakeholders (public and private, political, administrative and technical) were directly involved in the decision-making process in order to identify the adaptation strategies taking into account their applicability, possible success factors and operational difficulties. As a Park Authority, we also identified the possible impacts on biodiversity due to the change in pastoral management and drew up a guideline on how to reduce the direct impact on fauna and flora. The strategies identified were applied directly in the field, refined throughout the duration of the project and collected in a web platform with the aim of proposing concrete and easily replicable activities in other Alpine contexts, to mitigate the effects of climate change.

Development of a PCR-RFLP tool for the taxonomic identification of the commonly occurring cetacean species of the Mediterranean Sea

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The Mediterranean Sea is host of a highly biodiverse marine fauna, counting at least twenty-five species of cetaceans. Eight of them are commonly distributed throughout the whole basin whereas the remaining fifteen are considered as vagrant or occasional visitors. Stranded or adrift cetaceans are often found in a conservation status that does not allow for a reliable and easy morphological species recognition therefore, a simple and cost-effective molecular identification protocol is an asset of fundamental importance in the conservation of cetaceans species. A four-enzyme PCR-RFLP protocol targeting a 439bp fragment of the mitochondrial gene cytb was devised to identify all the eight commonly occurring species of Mediterranean cetaceans. An alignment of DNA sequences was produced preferring entries from the Mediterranean to test the applicability of the protocol. DNA was extracted from 44 samples drawn from stranded animals, morphologically identifiable with certainty despite their conservation status. Sampling date and location, along with the conservation status of the animals, were made clear to the molecular biology team. Two additional samples were analyzed as blind samples to unbiasedly test the protocol. The bioinformatic hypotheses were lately confirmed by the experiments on all the 46 samples. This new knowledge could be particularly useful for both biodiversity conservation purposes and forensics investigations, as the protocol allows to retrieve important information not just from live or recently dead animals, but also from non-identifiable decaying carcasses in advanced state of decomposition or fragmented remains found either stranded on shores or adrift in the water.

Effect of human disturbance on the density of meso and macro mammals in the central Apennines

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Current trends confirm a dramatic decline in mammal populations, many of which have become completely dependent on protected areas. However, these areas do not solve the problem of population isolation where the surroundings are drastically altered by human activities. Hence the importance of ecological corridors, areas that connect patches of suitable habitat and facilitate the movement of individuals between populations. But corridors hardly persist in highly urbanized contexts, so considering the effect of human activities is essential to estimate their effectiveness. The study area is the ecological corridor linking the Sirente Velino Regional Park with the Abruzzo, Lazio and Molise National Park (ALMNP), in the Central Apennines, Italy. I will quantify the presence of several wildlife species, among which *Cervus elaphus* (red deer) and *Capreulus capreulus* (roe deer), with camera trapping. In the area, 14 camera traps were placed, following a random sampling, and using a grid of 2.5 km per side. I will use the Random Encounter Model (REM) to estimate population densities for each species in the area. Then, I will use generalized linear mixed models (GLMM) to assess the effects several variables of human activities, among which land use and population density. I expect that the results obtained will contribute to the management of the species analyzed, identifying which ones have the most difficulty crossing the corridor, and which are the most critical issues they encounter. The project will be carried out in collaboration with Rewilding Apennines, partner of Rewilding Europe.

Maintaining regions of high biodiversity value help preserve regulating Nature's Contributions to People under climate change

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Increasing human pressures are driving global biodiversity loss, dramatically affecting the provision of Nature's Contributions to People. Here, we estimated how preserving regions with a high biodiversity value could reduce the risk of diminishing the provision of NCP, and thus contributing to the achievement of different Sustainable Development Goals (SDGs). I analysed four different scenarios of global environmental change from CMIP6, selecting few data proxies of regulating NCP indicators to measure the change status of NCP in the future, specifically, the regulation of air quality (NCP3), climate (NCP4) and freshwater quantity (NCP6). For each indicator, I evaluated whether risk from environmental change to the provision of regulating NCP is higher or lower within priority conservation regions compared to not priority regions.
I found higher levels of regulating NCP within biodiversity regions both in the present and the future for all indicators, which highlights the spatial congruence between biodiversity and NCP. Moreover, air quality and climate regulation indicators show rapidly increasing levels within high biodiversity regions, especially under higher emission scenarios. Understanding the spatial relationship between NCP and biodiversity is essential for sustaining human well-being and securing Earth's life support systems. Identifying the relative contribution of high biodiversity areas to NCP provision allowed to pinpoint possible synergies between the achievement of multiple SDGs under alternative future conditions.

Monitoring coastal-marine biodiversity supported by a citizen science: the case of wild coast cascade in the central adriatic

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Citizen Science (hereafter CS) in biodiversity studies is quite effective as it allows the collection of large amounts of species occurrence data with reduced costs and time in very large areas, favoring at the same time public awareness processes.
We explore the potential of CS for monitoring marine-coastal biodiversity in central Adriatic supported by a iNaturalist project called Wild Coast CASCADE.
The study area comprises the Abruzzo and Molise Region coasts including two LTER sites (Long Term Ecological Research Network: IT20-003-T- Saccione mouth and Ramitelli reclamation area, IT20-002-T-Trigno mouth-Petacciato seashore).
Wild Coast CASCADE records include 3600 observations referable to over 700 species with the most frequent taxon being Reptiles (28.5%) followed by Plants (20.9%).
"Research" quality records reach the 81% of the observations thus useful for scientific purposes and of those the most represented are Plants (227 taxa) and Insects (156 taxa). 19 species are included in the IUCN Red List, while 48 species are introduced.
The high number of observations recorded in two years confirms the ability of CS to collect biodiversity data useful to support monitoring campaigns of species of conservation concern. The inclusion on E-LTER network has a great potential for inter sites analysis.

Managed forests and conservation of Habitat Trees

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Biodiversity conservation can be pursue by integrative approaches, that try to combine Habitat Trees (HT) conservation and economic management of forest ecosystems.
We applied the R.A.DA.R. method in high forests of Natural Reserve of Lago di Vico, a small protected area located in Latium, Italy, to: (a) identify and manage HT in order to quantify the Stand Ecological Value (SEV); (b) investigate which factors influence the density, abundance and richness of Tree-related Microhabitats (TreM).
The obtained results confirm the validity of the method, which gives back at the same time a simple and comprehensive picture of the biodiversity potentially accommodated by forest stands, as a function of the HT's density. The estimated SEV describes the forest stands in an original way, providing information that cannot be deduced from the canonical dendrometric parameters and is configured as a valid support for any management choices. Moreover, significant associations of density, abundance and richness of TreM with some dendrometric and topographic parameters are confirmed.

Impact of 2019-2020 summer season fires on the mammals and birds habitat in Australia

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Australia has been affected by devastating forest fires during the 2019-2020 summer season. They began in June 2019 and continued until the end of February 2020, killing billions of animals and destroying their habitat. Here, we quantify the loss of habitat for Australian forest mammals and birds due to fires. We also assessed the potential change in their threat status using the IUCN Red List criteria. In particular, we evaluated the loss of habitat in relation to different environmental variables: management zones, protected areas, and accessibility. We created a burnt areas map, and we overlapped it with species’ habitat models. Through a mixed logistic regression model, we modeled the effect of the three environmental variables on the percentage loss of habitat. Our results show that the majority of species experienced fires within their habitat, and at least 10 mammals and 6 birds could have potentially deteriorated in conservation status. The most impacted region were located in the South-Est of the Continent. Notably, Wilderness Areas (Ib category) lost on average 50 % of their habitat. The fires spread especially in remote areas, more difficult to access, where the detection of fires and the intervention could have been less rapid.

Restoring a native halophyte in the Venice Lagoon

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The invasive halophyte *Sporobolus anglicus* has been introduced to control coastal erosion and subsequently established as an aggressive invader in the Venice Lagoon. Given the severity of saltmarsh loss occurring in this highly anthropized lagoon, restoration interventions have been carried out mainly using dredged sand to increase saltmarsh elevation yet resulting on having different types of sediment between natural and restored saltmarshes. Previous investigations have reported the almost total displacement of the native *S. maritimus* from the invasive *S. anglicus* and the total absence of the native species on restored saltmarshes in the Venice Lagoon. Through a manipulative experiment we tested if sediment grain size was limiting the spreading of the native *S. maritimus* on restored sites. Assuming that the type of sediment was the limiting factor for the survival of *S. maritimus*, we transplanted clumps of both the native and the invasive halophytes in plots with two different sediment treatments: silty sediment from a natural marsh and sandy sediment from a restored marsh. S. maritimus almost completely died in all treatments while *S. anglicus* had a much higher survival rate. Our results suggest that *S. maritimus* is highly vulnerable to mechanical stresses (e.g, uprooting from erosion events), while *S. anglicus* is more resistant to manipulations. Therefore, the invasive species seems more capable to spread through propagules, ultimately increasing its success of colonisation and thus, replacing the native *S. maritimus*. These results should be considered when planning conservation actions that aim to facilitate the spreading of the native species instead of the invasive one.

Otters reconquering Latium. The case of the re-expansion in Central Italy along the Tyrrhenian side.

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Once widespread across the Italian peninsula, the Eurasian otter drastically declined in the ’70s of the last century, and by the onset of this century its distribution was limited to few river basins of Southern Italy. In recent years a slow but constant re-expansion in its former extent of occurrence has been documented in different portions of the range. Following this trend, the Italian WWF promoted a systematic monitoring of regions where the species was declared either extinct or recorded at few new locations. Within the project we undertook a systematic otter survey in Latium region following a modified version of the standard method proposed by the IUCN/SSC Otter Specialist Group. We selected 54 10x10 km cells (ETRS89 LAEA projection) covering the areas whose selection was based on habitat suitability, historical occurrence and proximity to areas of current otter occurrence in the neighbouring regions, searching for otter signs along 600 m of river shore, either walking or using a canoe. We found otter signs at 15 out of 187 checked transects. Positive sites were included in 14 grid cells over 54 (25,9%). All otter signs were found in Southern Latium, whereas no signs were recorded in Northern Latium. Otter signs were widespread in the Garigliano watershed. However, the low density of spraints suggests an early stage of colonization. These findings confirm ongoing recovering of the otter in its former range, witness the occupation of a new watershed and claim the establishment of new protected areas along the Garigliano.

Monitoring of hazel dormouse (*Muscardinus avellanarius*) and its vulnerability in the "Lago di Pertusillo" Site of Community Importance in the Province of Potenza, Basilicata

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The hazel dormouse, *Muscardinus avellanarius*, is a rodent species included in the Annex IV of the "Habitat Directive" (92/43/EEC) and in the Annex III of the Bern Convention. Therefore, the monitoring of hazel dormouse must be considered as a primary action for the conservation of its populations. This glirid rodent is very sensible to loss and fragmentation of its habitat, and it is affected by alteration of structural connectivity (hedgerow networks) essential for trophic resources and nests building. During a survey conducted in the Basilicata region, specifically in a highly anthropically impacted zone of the Val d'Agri area in the province of Potenza, dormouse was discovered, for the first time, in a little forest patch among three ENI oil and natural gas wells. The forest is located approximately 2 km far away from the border of the Site of Community Importance (SCI) of the Pertusillo Lake, a protected area in the highest part of the Val d'Agri that includes the municipalities of Grumento Nova, Montemurro and Spinoso, in which the dormouse was never monitored. Despite its monitoring would be a priority, annual or pluriannual data are lacking for this area. The aim of this study is to begin the analysis of demographic trends of this species and the effects of pollution and forest management in the "Lago del Pertusillo" SCI, in order to monitor its population status and act efficiently against possible damaging effects. Here, preliminary data about the methods used and results on demographic and environmental factors are presented.

Movement and habitat use patterns of male brown bears during mating

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During the reproductive period, the physiological needs associated with mating can drive significant changes in animal behaviours. For polygamous species, larger ranges and greater movements during the mating season may be advantageous due to the increased probability of encountering several different mates. The brown bear *Ursus arctos* is a solitary carnivore that has an extended reproductive season lasting for approximately 2.5 months from mid-May to July. Moreover, brown bears are polygamous, i.e., reproductive individuals of both sexes mate a variable number of times with a variable number of partners during a given mating season. Using long-term telemetry data from the Finnish Karelia brown bear population, we tested here the possibility that male brown bears show specific movement patterns and space use behaviours during their breeding season. Brown bear males moved at a higher speed over greater net and total distances during the mating season compared to the post-mating season, i.e., during the mating season all three movement parameters increased their frequency in areas characterised by human presence, activity and infrastructure. In addition, independently of the period, male bears: (1) covered shorter daily distances at a lower speed in forested habitats; (2) travelled slightly faster and longer total distances in open areas; and (3) increased daily distances and speed in proximity to main roads and human trails. During the breeding season, the need to mate seemed to trigger roaming behaviour in adult males, making them more inclined to accept human risk and disturbance, and willing to move within human-altered areas.

Gestione adattativa di orsi problematici: il ruolo della personalità e capacità cognitive nei protocolli operativi

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Human-bear coexistence is a widespread conservation problem that can be critical when bears interfere with human activities by engaging in "problematic behavior". To manage these bears, standardized operational protocols are usually applied without considering the individual's reaction. Our study investigated whether using an adaptive approach could lead to better results than the standardized one.
We performed a literature review about the result of operational protocols application, bear cognitive abilities and study of its personality. We also administered a questionnaire to experts around the world in order to evaluate the different response and variability in applying protocols to different individuals. Finally, we analyzed a case study of a problematic female, F1.99, living in the Maiella National Park, to assess her cognitive abilities.
Combining results of the literature review and questionnaires, we found out that i) the application of standardized protocols rarely leads to a success; ii) the same methods may work with some individuals but not with others; iii) bears show cognitive abilities but little is known about the study of their personality. F1.99 revealed high abilities to avoid protective measures by breaking the means used and modifying feeding behavior.
The few data in the literature suggest that cognitive abilities and personality could play an important role in defining the bear's response to management activities. Adapting the action protocols, considering how bears encode the environment through their cognitive abilities and how the personality of each bear influences its choices, could increase the success of problem bear management and decrease the onset of critical behavior.

Disentangling the role of invasive alien species in coastal dune pollination networks

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Biological invasions are one of the major threats to biodiversity. Although the direct impact of invasive alien species on local populations is highly studied, the effects they have on species interaction networks are rarely explored. In particular, the role of invasive plants in plant-pollinator networks, which have significant effects on evolutionary dynamics and ecosystem functions, needs to be untangled. This study aims at exploring the effects of the presence and abundance of *Carpobrotus* species, highly competitive invasive alien plants with prominent and attractive flowers, on coastal dune pollination networks. To understand how pollination network structure change between invaded and uninvaded sites, surveys were conducted in two protected areas along the Rome coastline: the State Natural Reserve of the Roman Coast (invaded) and the Castelporziano Presidential Estate (uninvaded). Plant-pollinator interactions were counted and species were identified in 16 plots, visited 2 times per month from April to August 2022. Results suggest that pollinator communities diverge in terms of species composition and abundance between protected areas, with implications for the structure of interaction networks. *Carpobrotus* species have shown a strong affinity with some generalist pollinators. Interestingly, areas invaded by *Carpobrotus* had shorter flowering season than non-invaded ones, thus decreasing trophic resources for pollinators. These results indicate a potential impact of invasions on pollination networks via reduction of complexity. Future in-depth studies addressing different anthropogenic impacts and management actions on species interactions could provide key information for species and ecosystem conservation.

Ecological profiles of mammalian viral carriers

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In the last decades the health and socio-economic burden of diseases emerged from mammals created a growing interest in the identification of likely carriers of future human viral diseases. Understanding the patterns that drive associations between viruses and mammalian species is of particular interest for both ecological and health-motivated research. Here we analysed the virome of 1,350 wild mammals in order to detect relationships between viral susceptibility and mammals' characteristics (life-history, ecology, climatic requirements and phylogeny). Also, we broke down viral diversity into groups according to viruses': i) genomic structure and replication, ii) taxonomy and evolution, iii) ecology, highlighting different components of the complex virome of mammals. We applied the same subdivision to just zoonotic viruses to determine differences in the traits that predict general carrier status compared to zoonotic carrier status in mammals. For the most part, we found consistent patterns between general and zoonotic carriers and across different viral groups. Our results suggest that large-bodied mammals that fall on both the extreme ends of the fast-slow pace of life continuum could be more prone to act as carriers for most viral groups, probably due to trade-offs in immunity, exposure to viral infections and—in the case of zoonotic carriers—contact with humans. These findings highlight the need to further discern traits that make species intrinsically susceptible to viruses from extrinsic confounding factors (e.g., direct exploitation by humans), with the aim of better directing viral surveillance strategies in wildlife.

Predicted incidence of climate change: an assessing of global change predictor trends on Italian protected areas

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Strictly protected areas (PAs), those i.e., belongings to IUCN categories Ia and II, covers about 5.3% of Italian territory and are regarded as a fundamental tool for the preservation of biodiversity. For instance, 124 European directive's habitats and 665 Red List species between plants, amphibians, reptiles, mammals, birds and freshwater fish are protected within their borders. However, climate change poses a significant threat for conservation. Average temperature has increased in Italy by 1.1°C and it's projected to further rise in the future. Moreover, it's highly probable that Italian PAs will be affected by multiple phenomena detrimental to their integrity such as extreme temperatures, woodfires, droughts, extreme precipitation, erosion, rise in sea level and in salt wedge. Here we assess the predicted incidence of climate change on PAs for two different IPCC scenarios, namely RCP 8.5 "business as usual" and 4.5 "strong mitigation policies". To do so we carry out an analysis of the trend of ten global change indicators during three time periods (i.e., 2021-2050; 2041-2070; 2071-2100). The preliminary results of this study may be adopted as a basis for future studies and climate change-oriented conservation policies.

Changing of the potential distribution for endemic tree species of Socotra Archipelago: the case of *Commiphora* spp.

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The Archipelago of Socotra is one of the richest biodiversity areas in the world. The high levels of endemism at all taxonomic levels and its cultural peculiarities have led to its recognition as a UNESCO World Heritage Site. Due to different threats (e.g. climate change, human impact, soil degradation processes) many species are facing conservation problems. Among these, four endemic species of the genus *Commiphora* have been evaluated as “near threatened (NT)”. Since then, no further assessments have been made and little is known about the distribution and the ecology, essential information to provide the foundations for ecological restoration works on the island. The aim of this work is to ecologically characterise the species by mapping them, defining their ecological niche, and their behaviour in CMIP6 scenarios for defining target areas for future reintroduction. Distributional data were taken in the field, trying to cover their distribution range. Spatial analyses were carried out using bioclimatic, topographic and soil variables. As a climate model for future scenarios, the CMCC-CESM2 was chosen, due to the lower bias level for the region. These environmental data were processed into Google Earth Engine and then, the datasets were split into testing and training points to model the potential distribution, which is necessary for the use of the ensemble model applied (GAM, MaxEnt, RandomForest).
The preliminary results show an ecological differentiation at climatic and edaphic levels, whilst in every future climate scenario, the distribution dramatically decreases, posing a challenge for the conservation of these four endemic species.

Opportunities and challenges for the EU Common Agricultural Policy reform to support the European Green Deal

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The Common Agricultural Policy (CAP) is the European Union's main instrument for agricultural planning, with a new reform approved for 2023-2027. The CAP intends to be aligned with the European Green Deal, a set of policy initiatives underpinning sustainable development and climate neutrality in the EU, but several flaws cast doubts about the compatibility of the objectives of these two policies. We reviewed recent literature on the potential of CAP environmental objectives for integration with the Green Deal: protection of biodiversity, climate change mitigation and adaptation, and sustainable management of natural resources. We found the CAP lacks appropriate planning measures, furthering instead the risk to biodiversity and ecosystem services driven by landscape and biotic homogenization. Funding allocation mechanisms are not tailored to mitigate agricultural emissions, decreasing the efficiency of climate mitigation actions. The legislation subsidizes farms making extensive use of synthetic inputs without adequately supporting organic production, hindering the transition towards sustainable practices. We recommend proper control mechanisms to be introduced in CAP Strategic Plans from each Member State, to ensure the EU is set towards a sustainable production and consumption path. These include proportional assignment of funds to each CAP objective, quantitative targets to set goals and evidence-based interventions, and relevant indicators to facilitate effective monitoring of environmental performance. Additionally, both the CAP and the Green Deal should maintain ambitious environmental commitments in the face of crisis, to avoid further degradation of the natural resources on which our production systems stand.

Conservation of the threatened lichen *Lobaria pulmonaria*: hints from field experiments

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The macrolichen *Lobaria pulmonaria* (L.) Hoffm. is an endangered epiphytic forest lichen very sensitive to air pollution and intensive forest management; it is considered an indicator species of long ecological continuity of forest ecosystems and was probably widely distributed in the past. Although red-listed and legally protected in several European countries, this species has been declining during the last decades due to air pollution and habitat fragmentation. Such negative effects are expected to be exacerbated by climate change in the near future. This species has been used as model species in several experiments, thus its eco-physiology is quite well known. Nevertheless, how this should be translated into better forestry practices aimed at enhancing the conservation of *Lobaria pulmonaria* has been far less investigated. In a series of experiments carried out in Mediterranean mixed forests, we tested the effectiveness of forestry retention coupled with microclimatic conditions, forest patches dimension and indirect impact of climate change on *Lobaria* using in situ and ex situ transplanted thalli/fragments. As a proxy of the overall vitality of transplants, chlorophyll a fluorescence emission and total chlorophylls were measured at specific time intervals during the experiments, while to obtain an indicator of long-term effects growth rates were calculated. Our results suggest that north-exposed thalli are able to survive and grow even in logged stands, indicating that correct forest management could allow the survival of *Lobaria*'s populations. At the same time, adult thalli seem to survive even on alien invasive tree species such as *Robinia pseudoacacia* L.

First steps towards the conservation of endemic Italian Salvia species through population genomics

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Salvia is a common taxon in the collections of botanical gardens due to its long history of medicinal and culinary use. Twenty-five species can be found in the wild in Italy; *S. pratensis* is one of the most common and is closely related to some endemic taxa with debated species rank (*S. ceratophylloides, S. saccardiana, S. haematodes*). We are interested in studying the distribution of genetic diversity in wild populations of *Salvia pratensis* and related taxa to inform species delimitation and define a conservation strategy that can be applied by botanical gardens to potentially any ex situ collection. To reach these goals, we will characterize a collection of samples from wild populations of *Salvia* in Italy with Genotyping-By-Sequencing (GBS) to obtain genomic variation data. We have sequenced and assembled the genome of *S. pratensis* to use as reference for population genomics and we have gathered a collection of samples across a large portion of the Italian territory thanks to our network of collaborators. We will analyse genomic variation in the collection by combining a population structure approach with phylogenomic analysis to investigate separation between endemic taxa and detect admixture and gene flow between populations. Finally, we would like to identify markers from GBS to barcode species and phylogeographic variation that can be easily produced with Sanger sequencing by botanists that do not have access to genomic information. The project is still in progress and I would like to discuss our results in genome assembly and population sampling.

Fattori ambientali per la formazione di "Animal forests" in habitat costieri mediterranei

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Animal forests dominated by octocorals contribute greatly to the Mediterranean biodiversity. Octocorals generate stable microhabitats through the presence of their dense erect colonies that influence the current flow, increase concentration of organic matter at seabottom level and high spatial heterogeneity. These conditions facilitate the colonization and survival of an high micro/macrofaunal associated biodiversity. In our study, we investigated the density and distribution of the three most common octocorals capable of forming animal forests in the Mediterranean Sea: *Eunicella cavolini*, *Eunicella singularis*, and *Paramuricea clavata*. The aim of this study was to understand the different contributions of the environmental variables influencing the densities of the studied species, in three localities of the central Tyrrhenian basin. GLM models were used to identify the relationship between species density and environmental ones. Density data of the species were extracted from shallow (10-50 m) video transect taken by ROV and scuba divers, while geomorphological and physicochemical features were acquired through acoustic surveys or downloaded from Copernicus Marine Environment Monitoring Service. The three species showed a spatial separation. *Eunicella cavolini* and *P. clavata* showed an association with coralligenous habitats and a relation with geomorphological features that can be favor an higher transport of organic matter. On the other hand, *E. singularis* exhibited higher densities on light exposed surfaces, probably due to algae symbiosis and mixotrophy of this species. Given the ecological role, extended sampling coverages and models capable of capturing the drivers of animal forests formation represents essential tools for the conservation of these threatened habitats and will be further investigated in the next future.

Biodiversity Monitoring South Tyrol: A multi-taxon long-term monitoring scheme in an Alpine region

EB113 Chiara Paniccia

Eurac Research

The growing need for baseline data for assessing efforts to reduce the rate of biodiversity loss highlights the importance of long-term biological data sets. This is particularly relevant for mountain regions and protected areas, which are considered global biodiversity hotspots and refugia.
In 2019, a long-term biodiversity monitoring scheme was established in South Tyrol. Using standardized protocols, the Biodiversity Monitoring South Tyrol (BMS) aims to survey species groups considered highly sensitive to climate and land-use changes across different spatial scales. Several taxonomic groups are sampled according to standard protocols and following a stratified sampling design for the most representative habitats in the province from near-natural to strongly anthropogenically altered habitats. The multi-taxon approach includes soil fauna, vascular plants and bryophytes, orthopterans and butterflies, birds and bats, and freshwater macroinvertebrates. In addition, data on abiotic factors, landscape structure, and land-use management are collected. In total, 320 terrestrial sites and 120 aquatic sites are monitored, covering the entire South Tyrol province (7,400 km2).
Our results are and will provide applied solutions on sustainable management practices in agriculture and forestry, as well as on current impacts of global changes, such as extreme events or the spread of invasive alien species. The results are also useful for evaluating and improving conservation efforts for protected species and habitats, within and outside protected areas, and for providing decision support for spatial planning and nature conservation strategies. In addition, ecological indicators will be developed to assess the effect of climate changes through time and scales on mountain ecosystems.

Sentinel-2 time series analysis for monitoring multi-taxon biodiversity in mountain beech forests

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Biodiversity monitoring represents a major challenge to support forest ecosystems. In this context, remote sensing is a powerful tool, continuously providing free data at a different range of spatial and temporal scales. In particular, Sentinel-2 (S2) mission has great potential to produce reliable proxies for biological diversity. In the Gran Sasso e Monti della Laga, (GSML) and Cilento Vallo di Diano e Alburni (CVDA) National Parks, we surveyed living trees, deadwood, and Tree-related Microhabitats. Yet, we sampled the beetle fauna, breeding birds, and epiphytic lichens. We calculated the richness indices, which provide quantitative information on different aspects of biodiversity. Then, to produce variables for biodiversity assessment, we exploited S2 data acquired in the four years, 2017-2021. S2 images were used to construct time series spectral bands and photosynthetic indices, from which 91 harmonic metrics were derived. For each taxon and multi-taxon community, relationships between S2 metrics, biodiversity indices, and forest structural variables were investigated. Overall, 241 beetle, 27 bird, and 59 lichen species were recorded. The diversity indices were higher for the multi-taxon community than for the single taxa and were generally higher in the CVDA site than in GSML, except for the bird community. The highest values of the median absolute Pearson correlation were recorded for multi-taxon and beetle communities in CVDA, and for lichen and beetle communities in GSML. Our results demonstrate that S2 data can be used for identifying potential biodiversity hotspots, showing that the herein presented harmonic metrics are informative for several taxa inhabiting forest ecosystems.

Fin whales in a changing sea: acoustic presence in relation to sea surface temperature (Svalbard Islands, Norway)

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The Arctic marine environment is experiencing strong changes in habitat conditions due to global warming. Increasing temperatures might affect migrating species, inducing changes in occurrence, and timing of arrival at suitable areas. In this study, we examined the acoustic occurrence of fin whales (*Balaenoptera physalus*) in relation to sea surface temperature, in Svalbard Islands (Norway), a summer feeding ground for the species. This environmental parameter has been considered a proxy to investigate habitat suitability for the species, since it prefers areas with water temperature up to 7° C and low ice coverage. From 2014 to 2020, data were collected through an autonomous acoustic device, located in Kongsfjorden (Western Svalbards) at 75m depth. Weekly water temperature satellite data were downloaded from Copernicus Marine Service, covering up to 40 km from the fjiord. Results show that water temperature oscillated between 4° C and 8° C in summer and 0° C – 2° C during winter. Fin whales occurred all year round, with the presence rate of vocalizations positively correlating with sea surface temperature ($P < 0.05$, $rho = 0.21$). This suggests that proper environmental conditions enable the persistence of the whales also during the Polar Night. The increase in vocalizations during the Polar Night was due to the presence of songs, supporting the hypothesis that non-migratory individuals find suitable conditions for mating. These preliminary results may represent a new ecological strategy carried out by fin whales in the Arctic region and could be an input to future investigations about species' responses to environmental changes.

Monitoring grasslands from above: linking spectral to local plant diversity

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Biodiversity monitoring is crucial for ecosystem conservation, yet field data collection is limited by costs, time, and extent. Recently, ecologists proposed a set of “essential biodiversity variables” (e.g., species traits and community composition) that should benefit from integrating remote sensing with in-situ observations. Increasing evidence suggests that remotely sensed spectral diversity (SD) is linked to plant diversity. However, studies testing such a relationship at fine scales have reported conflicting findings, especially in challenging ecosystems such as grasslands, whose biodiversity is threatened by degradation and fragmentation. With the advances in Unmanned Aerial Vehicles (UAV) sensors, it is now possible to overcome spatial resolution constraints and theoretically capture the direct link between the spectral information at the canopy level and the characteristics of plant species. Thus, this study aims at assessing the applicability of SD for plant diversity monitoring at the local scale by testing eight different SD metrics. Functional and taxonomic diversity were calculated based on data collected in 196 1.5 × 1.5 m experimental plots situated on a mesic meadow. Spectral information was collected using a UAV-borne multi-spectral sensor measuring reflectance across six bands in the visible and near-infrared range at 3 cm spatial resolution. Our findings suggest that SD relates better to functional than taxonomic diversity at this scale, with the SD metrics tested showing differences in their performances. Moreover, the strength and sign of the relationship depend on the functional traits considered.

Spatiotemporal overlap between three sympatric canids in Croatia

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Direct and indirect competition shapes activity patterns of species with similar ecological niches. These interactions are commonly asymmetric and, in carnivores' guilds, smaller predators tend to adapt their temporal and spatial niche to avoid risky encounters with the larger competitors. The aim of this research was to evaluate the spatiotemporal overlap among the grey wolf (*Canis lupus)*, the golden jackal (*Canis aureus*) and the red fox (*Vulpes vulpes*), and to assess whether the fox would show different activity patterns when in sympatry with other canids. Automatic camera traps were active in 124 different locations in Croatia in the 2018 – 2020 period, during which 2255 recordings of the target canid species were collected. The data was analysed to determine the detection frequency of the species, and the predators' use of space and time was compared through linear modelling and Kernel density functions.

The results revealed an overall low spatial overlap (30-45%), with the lowest overlap between the jackal and the wolf. By contrast, the carnivores' crepuscular and nocturnal nature was reflected in the substantial overlap (80-91%) of temporal patterns. No camera trap recorded jackal as the only canid species at the site.

Fox activity patterns differed in locations where the two larger carnivores were present, showing a higher detection frequency (which indicates a more intense use of space) and a minimal but statistically significant shift in the use of night-time. These findings confirm the role of fine-scale niche adaptations in the coexistence of the considered species.

Impacts of high-speed infrastructures on bird diversity in the regional Natural Reserve Fontanili di Corte Valle Re, Italy

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The impact of anthropogenic disturbances in ecology is a topic of great scientific interest, and it is essential to recognize its characteristics and effects to monitor and protect exposed communities. This study analyses the diversity of species, in terms of abundance and richness, of the birds monitored in three different areas of the Natural Reserve Fontanili di Corte Valle Re. The research focuses on comparing three areas, designated as Near, Intermediate, and Far, where the sampling nets were located. These areas are increasingly distant from two big infrastructures, a highway and a high-speed railway, that confine with the northern part of the reserve. The monitoring includes spring and autumn, considering species of birds that are sedentary, nesting and migratory. Disturbance's impact on birds was quantified in seven seasons from autumn 2019 to autumn 2022. Furthermore, a seasonal species-specific analysis was conducted, in order to observe how the presence of each species varies among the seasons during the different years. The hypothesis is that diversity should decrease closer to the source of acoustic disturbance. . Our findings confirm the expected impact. . In particular, the disturbance influences the species richness more than the total abundance of birds. In fact, some species have a behavioral ecology that is strongly based on singing to communicate with each other in their reproductive and defensive strategies. Those species are the ones that suffer the most from acoustic disturbance and, in order to reduce it, it would be useful to install noise barriers between the highways and the reserve. A longer monitoring would be needed to understand how and whether species richness and abundance change during the next years.

Recovery, characterization, and valorization of some autochthonous legumes of Alto Molise

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The recent environmental changes, caused by socio-economic modifications and improper human activities on the environment, have deeply modified natural ecosystems, generating adverse effects on plant biodiversity. In particular, agro-biodiversity is highly endangered, and autochthonous landraces, characterized by high genetic variability and strong adaptation to stress conditions, are currently threatened with extinction because of their progressive replacement by commercial varieties. This study aims at recovering and preserving autochthonous legume landraces - 3 autochthonous lentils (*Lens culinaris* Medik.) landraces from different villages of the Molise region (Capracotta, Rionero Sannitico, and Agnone), 1 from Umbria (Castelluccio di Norcia, IGP), 1 from Lazio (Rascino) and 1 commercial variety (Turca Rossa) - characterizing them at different levels with a multi-integrated approach (morphological, genetic, and metabolomic analysis), in order to explore their diversity and peculiar aspects which could play an important role in their conservation. The morphological and genetic analysis were performed respectively through 9 International Board for Plant Genetic Resources (IBPGR) descriptors and 8 Inter Simple Sequence Repeat (ISSR) molecular markers in order to evaluate phylogenetic relationships among populations and in order to identify and discriminate their diversity. The metabolomic analysis will be carried out by NMR and mass spectrometry in order to identify minor and/or novel metabolites and the most important differential metabolites that can be enhanced from a nutritional and nutraceutical point of view, supporting the conservation activities of local varieties.

Project ECOWOLF: ecological interactions of the wolf (*Canis lupus*) during the recolonization of the eastern Alps

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The grey wolf (*Canis lupus*) is a top predator known to reshape the complexity of foodwebs, triggering a trophic cascade effect on forest habitats, from predator to prey to, potentially, the smallest organisms, i.e. parasites and microbes. The ECOWOLF project aims to study whether predatory behaviour changes with the recolonization status; that is, whether well-established (stable, reproductive) packs are more specialized in certain prey species with respect to newly established packs. Since different diets and nutritional status imply variations in predator-prey interactions, as well as gut parasite and microbiota compositions, multiple ecological interactions could be reshaped by these behavioural shifts. The dietary niche of wolf packs at different recolonization stages in the eastern Alps will be defined through ecological modelling of the interactions of different levels within the ecosystem. Feeding preferences will be assessed through the morphological and metabarcoding analyses of scats collected non-invasively in the field, while the gut microbiota and parasite community, with greater emphases on taxa which exploit trophic interactions to conclude their cycle, will be characterized using metataxonomics. Results will provide a new perspective on the predatory behaviour of the wolf during the process of recolonization of the Alps and how this influences the entire trophic cascade. Microbiota and parasite community diversity and composition are expected to be associated with the complexity of wolf diet, i.e specialist versus opportunistic as well as wild versus domestic. Outcomes will improve our knowledge about how anthropization impacts on the health status of the natural ecosystems inhabited by the wolves.

Small-scale fishery is a driver of habitat loss

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Fishery is one of the most impacting human activities and is responsible for habitat loss in marine systems. While the effects of large-scale fisheries have been largely investigated, impacts of small-scale fisheries (SSF) on seafloor integrity is more often assumed than quantitatively investigated. We carried out a literature review at global-scale, resulting in 19 studies with quantitative data on sessile benthic bycatch and only one documenting habitat loss driven by SSF. We also conducted a fine-scale assessment within a Mediterranean Partially Protected Area (PPA). Results showed that 513 m2 of *Posidonia oceanica* meadow are removed annually by local SSF within the PPA, considering bycatch, fishing effort and shoot density. Although this value is an indication of the effect of fishery, it under-represents the actual impact. Knowledge on fishing effort and fine-scale mapping are critical to assess habitat loss, suggesting the need for specific recommendations for eco-sustainable local fisheries.

A machine learning approach for the conservation of the two European seahorses in Taranto, Southern Italy

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Seahorses are key model species for environmental quality assessment. The two European species *Hippocampus guttulatus* and *H. hippocampus*, are particularly sensitive to the effects of anthropogenic activities and ecosystem changes due to their peculiar ecological and biological traits (i.e. small body size, paternal care, low mobility, sedentary adults and monogamous mating). Also, they are listed on CITES Appendix II and are classified on the IUCN Red List as "Data Deficient" at European level and "Near Threatened" along the Italian coasts.
Information on the current distribution of these two species is scattered, patchy, and mainly focused on small-scale studies and survey them is make difficult by their cryptic nature and sedentary behaviors.
The objective of the present study is to characterize and assess the status of the population of seahorses inhabiting Mar Piccolo di Taranto (a semi-enclosed sea in Apulia - Southern Italy) gaining data also on their distribution. By combining the use of underwater cameras for a non-invasive acquisition of valuable datasets of images and a machine-learning and computer vision automated pipeline we were able to detect, count and re-identify seahorses at individual level. For the validation, we trained a YOLOv5 neural network on a dataset of 1200 images, manually annotating frames containing seahorses. We then applied a n-fold cross-validation to evaluate the average precision of our model.
Preliminary results showed an average precision of 82%, suggesting this approach as a valuable tool to monitor natural population and to develop specific conservation actions to preserve them.

Case report of *Caretta caretta* late nests in Tuscany (Italy) during 2020 nesting season

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Tartamare

The loggerhead turtle (*Caretta caretta*) is the only sea turtle species nesting along the Italian cost and the most abundant species in the Mediterranean. Since 2000 its nesting area has been in expansion and since 2013 we have found nests also in Tuscany. The Tuscan coastline is an extremely built environment and this could be a disturbance for a female sea turtle. Nowadays chosen beach characteristics are unknown in Tuscany but it's known that sea turtles return to lay eggs where they were born (natal homing). Actually new studies dimostrate that "pioneer turtles" reach new nesting sites, never used before, maybe thanks to the global warming. During 2020 nesting season, in Tuscany there were two unusual nests, laid in the middle of August and so called "late nests" for our latitudes. Even if at the beginning the temperature was suitable for embryonic development, the autumn season came too fast as a fast temperature decrease didn't allow the embryos to finish their development and be born with a 0% success of these nesting events. This analysis is the first documentation of two nesting events of loggerhead turtle with alive embryos in November, even if the temperature were too low for their birth, and further investigations are needed. It's important to know these nest cases for a deeper knowledge of the ecology of *Caretta caretta* at our latitudes and for a better management of them in the future with more specific actions and conservation effort.

Mapping diversity: how do environmental heterogeneity patterns change in space and time?

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Under Global Change where ecological heterogeneity patterns are in continuous evolution, it is important to have an efficient method to assess how an area changes over time to apply adequate conservation efforts. In this context, remote sensing data are a powerful tool to assess ecosystem changes, being gathered at different spatial and temporal resolutions. In this work, we developed algorithms to estimate spatio-temporal changes of ecological heterogeneity. We applied beta diversity indexes like Sorensen, Jaccard and Rao's Q on land use and NDVI time series. The results show how much land use and vegetation biomass changed in the study area, highlighting the spots which underwent a higher amount of change.

Identify and classify mammal species responding to human-induced environmental changes and their impacts

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Species can positively respond to climate change, shifting or expanding their ranges and/or increasing their population numbers. Some of them can even exert environmental impacts in their own native range, and are termed “native invaders”: their characteristics, spread dynamics, and impacts caused are substantially different from those of native or alien species.

We reviewed recent literature (1990-2021) on seven mammal species responding positively to climate change and with a recognised invasive potential. Using the Environmental Impact Classification for Alien Taxa (EICAT) framework, we gathered and classified 137 impacts.

The most common impact mechanism was grazing (almost 70% of the total impacts). Two of the three most impactful species showed impacts both in their native (75% of the impacts for reindeer *Rangifer tarandus*) and alien ranges (54% of the impacts for wild boar *Sus scrofa*), while red deer *Cervus elaphus* showed equal impacts in both ranges. For wild boar and red deer, the number of impacts in the alien ranges was lower, but those were also assigned to higher impact categories. We found that those species can compete (even leading to local extinctions) and hybridize with natives, transmit pathogens, and modify ecological communities.

We successfully identified wild boar, reindeer, and red deer as native invaders, due to the presence of conspicuous (i.e., of impact categories above the Minor level) environmental impacts inside their native ranges. It is urgent and of paramount importance to identify species that can become or already are native invaders, to successfully avoid their secondary spread and impacts, and potentially properly manage them.

Relationship between macroparasite infections and physiological stress in Eurasian red squirrels *Sciurus vulgaris*

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When a parasite co-evolves with its host, the host may develop defense mechanisms to reduce the parasite's impact on its fitness. Instead, if the parasite is acquired via spillover from an invasive species, it may affect the new host's survival or alter its ecology. Furthermore, particularly stressed individuals may compromise their immunity, increasing their vulnerability to parasites. Here, we assessed the relationship between macroparasite infections and physiological stress (quantified as the concentration of fecal glucocorticoid metabolites, FGMs) in Eurasian red squirrels S*ciurus vulgaris*, focusing on two nematodes: *Trypanoxyuris (Rodentoxyuris) sciuri*, the main red squirrels' helminth, and *Strongyloides robustus*, acquired via spillover from the invasive species *Sciurus carolinensis*. We modeled the probability of infection by *T. sciuri*, and the probability and intensity of infection by *S. robustus*, using different parasitological indices as response variables and FGMs, environmental and individual parameters as independent variables. Our findings suggest that FGMs do not significantly influence the probability of infection by *T. sciuri*, nor the probability and intensity of infection by *S. robustus*. However, in areas where *S. vulgaris* and *S. carolinensis* co-occurred, red squirrels have higher FGM levels and probability of acquiring *T. sciuri*. We also showed that the red squirrel population density is positively associated with both the probability and the intensity of infection by *S. robustus*. These results highlight how the complex physiological mechanisms involving stress and parasites depend closely on the study system, revealing the need to understand how native species cope with parasite-mediated invasions in order to promote their conservation.

Comparing two camera trap-based methods for estimating wildlife population densities

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Abundance and density of animal populations are critical information to guide population management and conservation efforts. Recently developed camera trap-based models represent a cost-efficient non-invasive alternative to estimate population densities. Two approaches that allow to estimate population density without individual recognition are Random Encounter Model (REM) and Distance Sampling-Camera Traps (DS-CT), making them widely applicable for medium and large mammal monitoring, however, their performance has not yet been thoroughly tested and compared. Here we compare these two approaches, paying particular attention to the ease and time for obtaining key model parameters from field data and their overall cost-effectiveness. We deployed 20 camera traps in a 130-ha reserve in Soriano del Cimino area (Viterbo province) and collected data between July 2022 and October 2022. We focused our comparison on 3 species: roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*) and badger (*Meles meles*). Our results showed comparable density estimates between REM and DS-CT. All key model parameters could be obtained from camera trap data, minimizing field sampling labor. In the context of ongoing efforts for automatizing some of these approaches for rapid and effective wildlife monitoring, REM emerges as a more promising option, requiring less human-supervision and manual effort and being less impacted by the violation of some key assumptions of DS-CT, whose reliability is heavily dependant on cameras performance. Our study identifies REM and DS-CT as valuable tools for wildlife monitoring, allowing researchers to carry extensive multi-species monitoring programs with low human sampling effort on elusive and nocturnal mammalian species.