Book of Abstracts

VI International young researchers Conference on Invasive Species

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VI International young researchers Conference on Invasive Species

IyrCIS – 2026 Proceedings

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and organized by

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Estación Experimental de Zonas Áridas - CSIC and

the Department of Plant Biology and Soil Sciences – Universidade de Vigo.

Edited by

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(EN) WELCOME

It is a great pleasure to welcome you to the *International young researchers Conference on Invasive Species* (IyrCIS – 2026). This conference serves as a unique and free platform specifically designed to foster collaboration, innovation, and knowledge exchange among young researchers in the field of invasive species.

The world faces numerous challenges regarding invasive species and their impacts on ecosystems, biodiversity, and human societies. It is crucial that you, as young researchers, come together to address these challenges head-on, exploring novel ideas, sharing your findings, and developing effective strategies for the management and mitigation of invasive species.

Throughout this conference, we will be able to delve into diverse topics, from the ecological and economic impacts of invasive species to the latest advancements in monitoring, prevention, and control methods. We will also be privileged to hear four presentations by young experts who will share their valuable insights and experiences.

Let this conference be a catalyst for inspiration, collaboration, and impactful research. Let us board on this exciting journey together to explore the intricate world of invasive species and chart a path toward a sustainable future.

We have curated an enjoyable social program to complement the academic program. You can embark on virtual excursions to the breathtaking locations of Galicia in the Northwest of Spain and explore the beauty of the Cathedral of Santiago (Santiago de Compostela – Galicia, Spain). Furthermore, we also recommend two concerts inspired by traditional Galician music, featuring renowned musician Carlos Núñez and the talented music band Tanxugueiras.

- Visit Galicia (link)
- Visit the Cathedral of Santiago de Compostela (link)
- Concert by Carlos Núñez (link)
- Concert by Tanxugueiras (link)

We sincerely hope that you have a wonderful experience at IyrCIS 2026! This is an excellent opportunity to enhance our education and enrich our lives. Your participation and the dedicated efforts of the organizing and scientific committees have made this event a reality.

Luís González,

on behalf of the Scientific and Organizing Committee.

(ES) BIENVENIDOS

Es un gran placer dar la bienvenida a la *International young researchers Conference on Invasive Species* (IyrCIS – 2026). Esta conferencia sirve como una plataforma única y gratuita diseñada específicamente para fomentar la colaboración, la innovación y el intercambio de conocimientos entre jóvenes investigadores en el campo de las especies invasoras.

El mundo enfrenta numerosos desafíos en cuanto a las especies invasoras y sus impactos en los ecosistemas, la biodiversidad y las sociedades humanas. Es crucial que ustedes, como jóvenes investigadores, se unan para abordar estos desafíos de frente, explorando ideas novedosas, compartiendo sus hallazgos y desarrollando estrategias efectivas para la gestión y mitigación de las especies invasoras.

A lo largo de esta conferencia, podremos adentrarnos en diversos temas, desde los impactos ecológicos y económicos de las especies invasoras hasta los últimos avances en métodos de monitoreo, prevención y control. También tendremos el privilegio de escuchar cuatro presentaciones de jóvenes expertos que compartirán sus valiosas ideas y experiencias.

Permitamos que esta conferencia sea un catalizador de inspiración, colaboración e investigación de impacto. Emprendamos juntos este emocionante viaje para explorar el intrincado mundo de las especies invasoras y trazar un camino hacia un futuro sostenible.

Hemos diseñado un agradable programa social para complementar el programa académico. Podrán disfrutar de excursiones virtuales a los impresionantes lugares de Galicia, en el noroeste de España, y explorar la belleza de la Catedral de Santiago (Santiago de Compostela, Galicia, España). Además, también les recomendamos dos conciertos inspirados en la música tradicional gallega, con la destacada participación del reconocido músico Carlos Núñez y el talentoso grupo musical Tanxugueiras.

• Visita a Galicia (link)

• Visita a la Catedral de Santiago (link)

• Concierto de Carlos Núñez (link)

• Concierto de Tanxugueiras (link)

¡Esperamos sinceramente que tengan una maravillosa experiencia en IyrCIS 2026! Esta es una excelente oportunidad para mejorar nuestra educación y enriquecer nuestras vidas. Su participación y los esfuerzos dedicados de los comités organizador y científico han hecho posible este evento.

Luís González,

en nombre del Comité Científico y Organizador.

(GL) BENVIDOS

É un gran pracer dar a benvida á *International Young Research Conference on Invasive Species* (IyrCIS - 2026). Esta conferencia serve como unha plataforma única e de balde deseñada especificamente para fomentar a colaboración, a innovación e o intercambio de coñecementos entre mozos investigadores no campo das especies invasoras.

O mundo enfronta numerosos desafíos en canto ás especies invasoras e aos seus impactos nos ecosistemas, na biodiversidade e nas sociedades humanas. É crucial que vós, como mozos investigadores, vos unades para abordar estes desafíos de fronte, explorando ideas novidosas, compartindo os vosos achados e desenvolvendo estratexias efectivas para a xestión e mitigación das especies invasoras.

A través desta conferencia, poderemos mergullarnos en diversos temas, dende os impactos ecolóxicos e económicos das especies invasoras ata os últimos avances en métodos de monitorización, prevención e control. Tamén teremos o privilexio de escoitar catro presentacións de mozos e mozas expertas que compartirán as súas valiosas ideas e experiencias.

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• Visita a Galicia (link)

• Visita á Catedral de Santiago (link)

• Concerto de Carlos Núñez (link)

• Concerto de Tanxugueiras (link)

Esperamos sinceramente que teñas unha marabillosa experiencia en IyrCIS 2026! Esta é unha excelente oportunidade para mellorar a nosa educación e enriquecer as nosas vidas. A túa participación e os esforzos dedicados dos comités organizador e científico fixeron posible este evento.

Luís González,

en nome do Comité Científico e Organizador.

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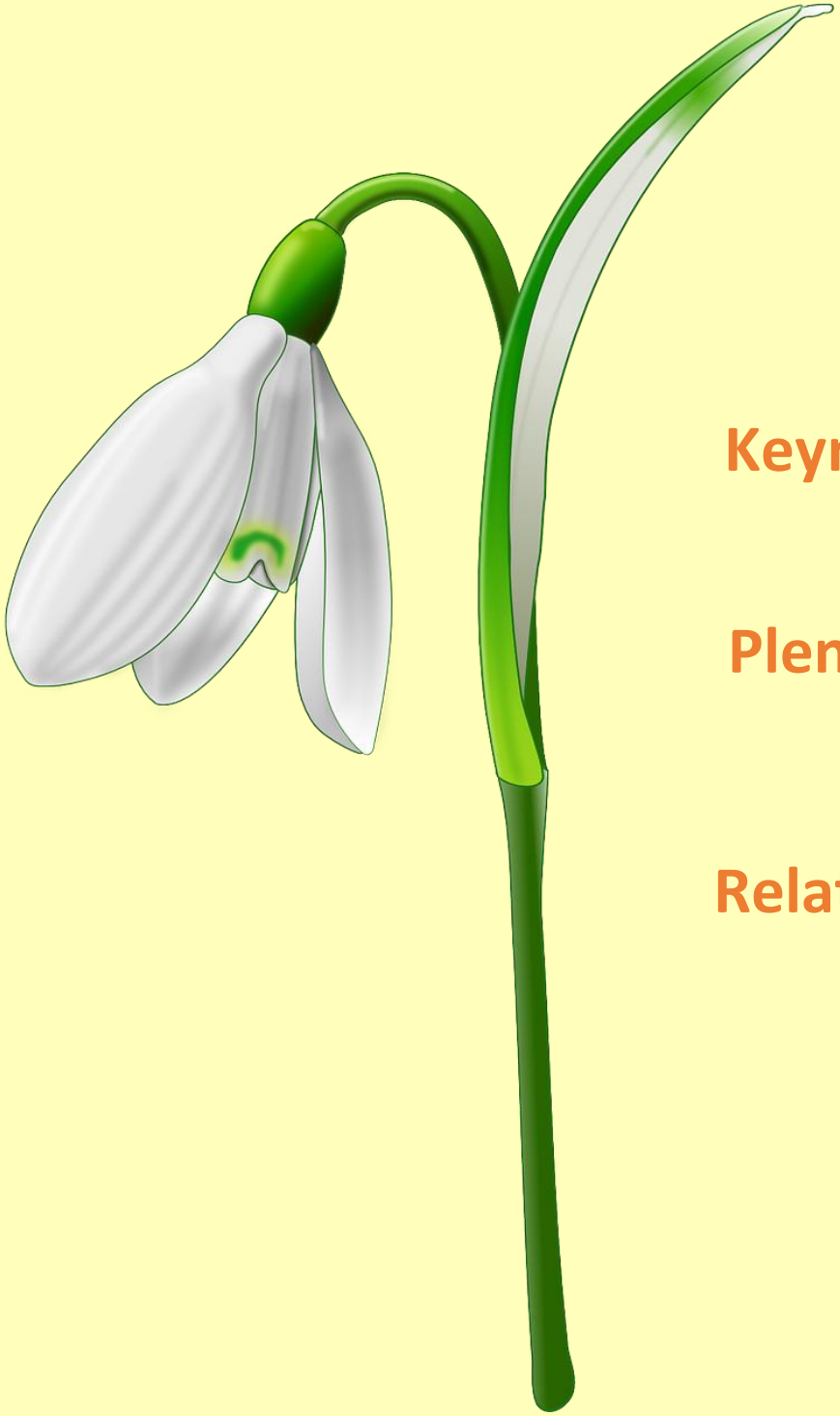

Keynotes

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Plenarias

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Relatorios

Disentangling the complexity of invasion processes using Remote Sensing tools

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The spread of invasive non-native trees (NNTs) can irreversibly alteration native ecosystem composition and functioning. Invasion success is highly complex and depends on invasion-promoting traits, human activities, and disturbance events. Innovative tools to assess eco-physiological traits and structural impacts are essential for understanding native–non-native interactions and informing management strategies. Remote Sensing (RS) collects standardized and multi-scale data offering instruments to unravel the complexity of biological invasions. The most recent RS missions provide free high spatial and temporal resolution imagery, derived by different platforms (i.e., multispectral, thermal, radar). This presentation explores the potential of innovative methodological approaches that combine multiple RS sensors to understand the success ecological strategis of NNTs in invaded ecosystems. In particular, the presentation examines: (1) differences in spectral eco-physiological traits between *Ailanthus altissima* (Mill.) Swingle and native vegetation of a Meditteranean island (Sardinia) for an entire phenological cycle; (2) impacts of *Prunus serotina* Ehrh. and *Robinia pseudoacacia* L. on spectral eco-physiological traits and forest structure in invaded sessile oak and Scots pine forests (Poland); (3) different effects of wildfire on primary productivity and spectral eco-physiological traits between native, *Acacia dealbata* Link, and *Eucalyptus globulus* Labill. forests. *A. altissima* differs from native vegetation during summer indicated higher productivity, canopy biomass, and leaf water content, but lower leaf carotenoid content and bare soil cover. *R. pseudoacacia* showed seasonally temporal shifts on productivity and photosynthetic activity in sessile oak and Scots pine, while *P. serotina* had limited impacts on sessile oak but strong effects on Scots pine. Finally, *A. dealbata* and *E. globulus* forests revealed the higher severity of wildfires, however tha annual productitivy of *A. dealbata* forest remain higher compared to *E. globulus* and native forest also after the wildfires.

These approaches has proven particularly effective to capture ecological features and traits that promote the competition of NNTs.

Keywords: invasive non-native tree, impacts, ecological strategy, spectral eco-physiological trait, forest structure.

Beyond species recovery: restoring plant-herbivore interactions after *Carpobrotus* spp. removal

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Biological invasions are among the major drivers of biodiversity change worldwide. They often transform plant communities and disrupt the ecological interactions that sustain ecosystem functioning. Coastal ecosystems are particularly vulnerable to invasion by some species of the genus *Carpobrotus*, succulent plants that can spread and impact native vegetation by reducing its density, diversity, and cover. To mitigate their impacts, mechanical removal programs have been implemented in several invaded coastal areas. However, an important question remains unresolved: do ecological communities and their interactions recover once the invasive plant is removed? Therefore, we explore the recovery of plant-herbivore interactions following the removal of *Carpobrotus* spp. in coastal ecosystems of the north-west Iberian Peninsula. Multi-year field surveys were conducted across six locations representing two coastal habitats (dunes and shrublands). At each location, we compared invaded plots, non-invaded plots, and plots where *Carpobrotus* spp. had been manually removed in 2018 and 2019. Within each plot, ten quadrats were sampled. In these quadrants, we recorded vegetation features and invertebrate herbivore abundance and diversity, and antagonistic interactions between plants and invertebrate herbivores. These data allow us to evaluate how community diversity, species composition and plant-herbivore interaction networks change during secondary succession after plant invasion removal. Results indicate differences between invaded plots and both non-invaded and removed plots. However, recovery trajectories appear to differ between dunes and shrublands, suggesting that the restoration of ecological interactions may be habitat-dependent. Understanding how ecological interactions respond to invasion removal is key to designing effective restoration strategies and improving the management of invasive plants in coastal ecosystems.

Keywords: *Carpobrotus* spp., coastal ecosystems, plant-herbivore interactions, ecological restoration, biological invasions.

Plant invasions along roads: disentangling spread across environmental gradients in Mediterranean ecosystems

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Linear transport infrastructures are increasingly recognized as key drivers of plant invasions by acting as dispersal corridors that connect otherwise isolated habitats. Roads create persistent disturbance, enhance propagule pressure, and generate novel microhabitats that facilitate the establishment and spread of alien plant species across environmental gradients. In this talk, I review empirical evidence showing that levels of plant invasion are typically higher along roadsides than in adjacent natural vegetation and disentangle the main factors controlling their expansion using the southern Iberian Peninsula as a case study. First, I present the current status of plant invasions based on a 1,300 km roadside survey conducted within the DesFutur project across broad environmental gradients in arid and semi-arid regions. Second, I show evidence for the strong control of macroclimatic drivers on plant invasion and the limited penetration of alien species into Mediterranean mountain ecosystems from roads, highlighting the role of habitat resistance in buffering invasions under harsh conditions, using standardized surveys from the MIREN along six roads in Sierra Nevada and Sierra de los Filabres (Andalucía, Spain). Finally, I demonstrate how this ecological knowledge can be translated into predictive models of spread for a priority invader in the region, *Ailanthus altissima*. Overall, this synthesis highlights that roads function as linear invasion highways, facilitating directional range expansion along environmental gradients. Integrating large-scale surveys, standardized monitoring, and predictive modelling provides a robust framework for understanding invasion dynamics and supports the design of targeted management strategies that prioritize roadside corridors as key control points.

Keywords: mountain ecosystems, road ecology, plant invasion, MIREN.

Down the interdisciplinary rabbit hole - shifting from an ecological focus to exploring the human dimensions of biological invasions

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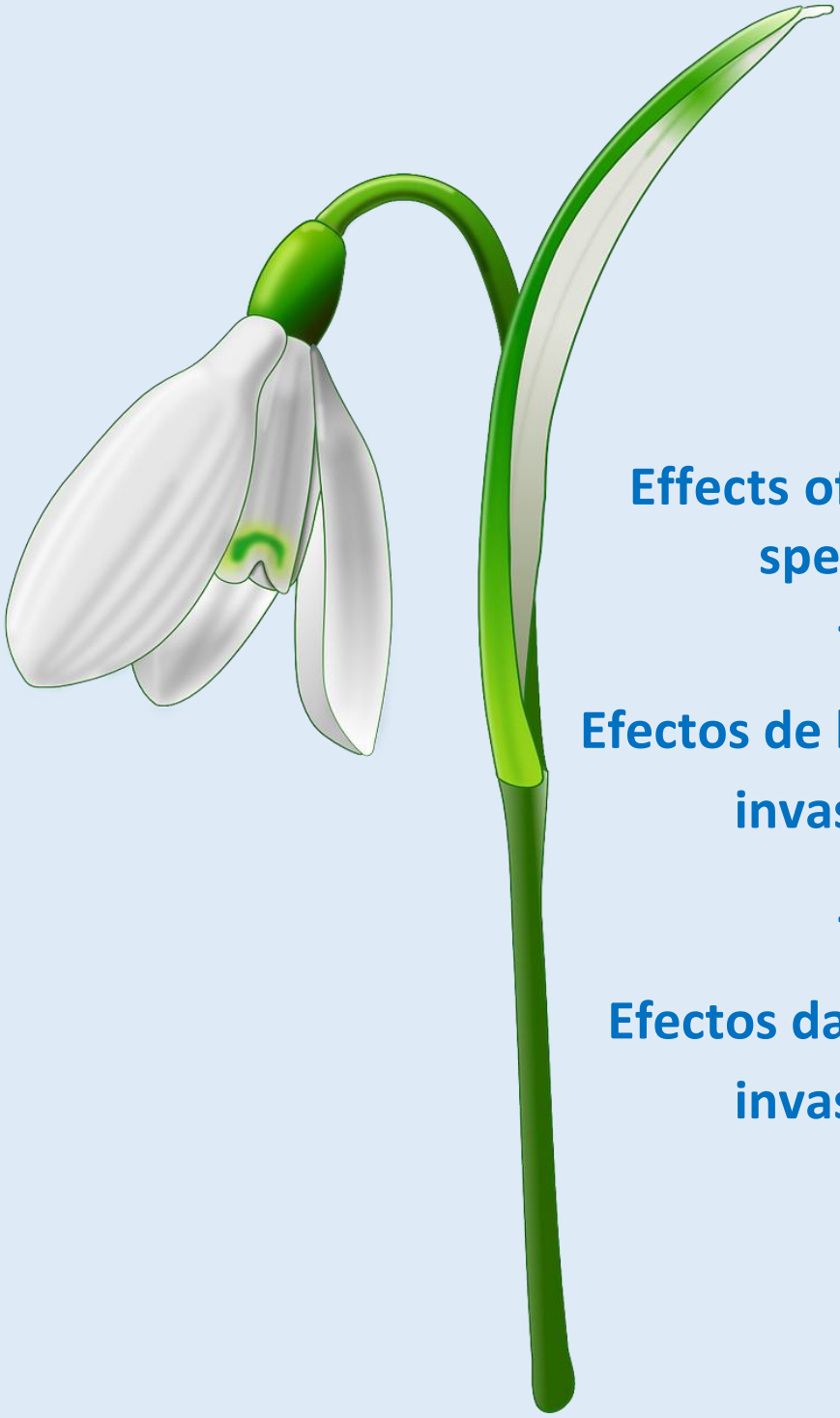
While initial research on biological invasions was mostly rooted in ecological approaches, the development of this scientific field over recent decades underscores the inherently interdisciplinary nature of this global issue. Human dimensions are at its core as human activity is strongly linked to every step of the invasion process, from (un)intentionally driving introductions to actively managing them. Consequently, human dimensions have been increasingly incorporated in research addressing biological invasions and, alongside, new methodologies and approaches have emerged. With different case studies I will present the development of my own academic career where my research over time shifted from an ecological focus to concentrating on interdisciplinary approaches, moving from inspecting the invasion of one fish species in Iceland to addressing terrestrial invasions on larger scales. Within these examples, I will introduce different methodologies that I have applied, from fish sampling to exploring stakeholder perceptions and knowledge via questionnaires and methodologies stemming from the newly established fields of conservarion culturomics and iEcology where I have been utilizing search query and social media data.

Keywords: culturomics, iEcology, interdisciplinary, social perspectives.



Effects of invasive species

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Efectos de las especies invasoras

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Efectos das especies invasoras

First insights into nematode infections in exotic freshwater chelonians in Portugal

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Parasites have increasingly been recognized as essential elements in ecological balance, influencing host populations, trophic interactions, and ecosystem dynamics. In freshwater turtles, the diversity of endoparasites and ectoparasites is strongly associated with geographic distribution, invasive status, host density, and the biology and ecology of different species. This study aimed to identify nematodes present in invasive freshwater turtles captured in the Lisbon Metropolitan Area and the Sintra Natural Park (Portugal), where native species (*Mauremys leprosa* and *Emys orbicularis*) coexist with invasive turtles: *Mauremys reevesii*, *Mauremys sinensis*, *Trachemys scripta*, *Pseudemys peninsularis*, *Pseudemys concinna*, and *Graptemys pseudogeographica*. Turtles were captured using fyke nets, hoop traps, and basking traps, with monitoring lasting at least five days per sampling site. Captured individuals were euthanized under veterinary supervision and necropsied. Parasites were collected from the intestine and organ washings and examined under a binocular microscope. Five nematodes belonging to the genus *Serpinema* were identified: two in *Pseudemys concinna* and three in *Trachemys scripta*. This genus had not previously been recorded in Portugal. These findings highlight the role of invasive turtles as potential vectors of parasites that may affect native species and public health. This work contributes to filling the knowledge gap on parasites of freshwater invasive chelonians in Portugal and to the assessment of risks associated with conservation and public health.

Keywords: parasites, nematodes, invasive species, One Health, conservation.

Sex-specific predation of the non-native invasive American blue crab *Callinectes sapidus* on the Mediterranean mussel *Mytilus galloprovincialis*

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The non-native invasive American blue crab, *Callinectes sapidus* Rathbun, 1896, is spreading across the Mediterranean Sea, endangering native communities, fisheries, and aquaculture. Yet, knowledge on its predation efficacy in the non-native range remains limited, and little is known about potential sex-specific differences in functional responses. This study presents the first functional response analysis of *C. sapidus* outside its native range, comparing male and female crabs preying on the Mediterranean mussel *Mytilus galloprovincialis* Lamarck, 1819 in laboratory conditions. Five mussel densities (2,4,8,16,32) were offered to male and female blue crabs from the Dalyan river (Muğla, Türkiye). Because this study was conducted in the mating season of the blue crab, during which mature females gather more energy than males, we expected females to consume more food. Indeed, females showed a higher proportion of killed mussels, and a higher proportion of eaten mussels at lower prey densities compared to males. Both sexes exhibited a type II functional response, with high attack rates and short handling times, indicating destabilizing effects on prey populations, as observed in other invasive crabs. While attack rates and handling times did not differ significantly between sexes, females showed higher attack rates when considering only eaten prey. This result reflects density-dependent differences in prey consumption, whereby females fully exploit prey more frequently at low prey densities. Functional Response Ratios revealed that female crabs exerted more than twice the predatory pressure of males. These findings are consistent with the greater energetic requirements of adult female blue crabs associated with reproduction and migration, and demonstrate how incorporating sex-specific comparisons can improve predictions of the impacts of non-native species.

Keywords: alien species, crabs, mussels, functional response, predation.

Temperature-mediated competitive effects of invasive juvenile rainbow trout (*Oncorhynchus mykiss*) on puyen grande (*Galaxias platei*) growth

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Freshwater ecosystems in Patagonia face threats from climate change and introduced species. The rainbow trout (*Oncorhynchus mykiss*), introduced in the early 20th century for sport fishing, has become widely established and dominates many aquatic environments in the region, posing a serious threat to native fish such as the puyen grande (*Galaxias platei*). Although previous studies indicate negative effects of salmonids on native galaxiids, the underlying mechanisms remain unclear, especially for early life stages. This study evaluated the effects of *O. mykiss* on *G. platei* performance under coexistence, and whether temperature modulates these interactions. Wild juveniles of both species were captured and assigned to one of three treatments: single-species tanks with *G. platei*, single-species tanks with *O. mykiss*, and mixed-species tanks with both species; each tank contained four individuals, with 5-6 replicates per treatment. Experiments were conducted separately under low (13.4±1.2°C) and high (19.1±0.9°C) temperature regimes. Fish were fed three times weekly at 4% of total tank biomass, and growth was measured via changes in standard length and body mass. Caudal fin lesions were used as a proxy for *O. mykiss* aggression. At low temperature, *G. platei* in mixed tanks showed lower Specific Growth Rates (SGR) than those in single-species tanks. This pattern was absent at high temperature: SGR did not differ between these groups. Conversely, *O. mykiss* in mixed tanks had the highest SGR at low temperature, which decreased significantly at high temperature. Significant interactions between time and temperature effects on SGR were also detected. These results confirm that *O. mykiss* negatively impacts *G. platei* growth through competition, providing evidence relevant to the development of conservation strategies. However, competitive outcomes were temperature-dependent, as the invasive species' impact diminished at higher temperatures. Under projected global warming scenarios, increased thermal stress on *O. mykiss* may reduce its competitive pressure on the native.

Keywords: salmonids, Patagonia, interspecific competition, climate change, specific growth rate.

Oxidative stress responses of the seagrass *Zostera noltii* exposed to the invasive macroalga *Batophora occidentalis* in S'Estany des Peix (Formentera, Balearic Islands)

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Marine seagrasses are essential components of coastal ecosystems, yet their stability is increasingly threatened by biological invasions, which represent one of the main drivers of global marine biodiversity loss. This study investigates the impact of the invasive macroalga *Batophora occidentalis* on the native seagrass *Zostera noltii* within the S'Estany des Peix lagoon (Formentera, Spain). Since its first record in 2020, *B. occidentalis* has rapidly expanded, epiphytizing native species along the lagoon perimeter. To evaluate the resulting oxidative stress, 16 *Z. noltii* samples were analyzed (8 affected by the invader and 8 controls) through a suite of biochemical biomarkers using spectrometric procedures. These included the activity of antioxidant enzymes—catalase (CAT), superoxide dismutase (SOD), glutathione reductase (GRd), ascorbate peroxidase (APX), and glutathione peroxidase (GPx)—the detoxification enzyme glutathione S-transferase (GST), and malondialdehyde (MDA) levels as an indicator of lipid peroxidation. Chlorophyll content was also measured to assess photosynthetic health. Results revealed statistically significant increases in SOD, APX, and GST activities in affected samples compared to controls, suggesting a strong activation of antioxidant defenses and detoxification pathways in response to the presence of B. occidentalis. However, no significant differences were observed in MDA levels or chlorophyll content, indicating that *Z. noltii* currently exhibits sufficient biochemical resilience to prevent permanent cellular damage and immediate photosynthetic impairment despite the induced metabolic stress. In conclusion, although this apparent tolerance highlights short-term resilience, the widespread expansion of *B. occidentalis* may represent a long-term threat to the stability of *Z. noltii* meadows. Continuous monitoring of this invasive process is therefore essential to ensure the conservation of this vulnerable lagoon habitat.

Keywords: *Zostera noltii*, *Batophora occidentalis*, invasive macroalgae, oxidative stress, coastal lagoons.

Using bioacoustics to assess the impact of evergreen invasive plants on bird communities in Wales, United Kingdom

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Invasive alien species are one of the major drivers of biodiversity loss, with birds among the most vulnerable taxa affected by their impacts. However, the potential impacts on bird communities have rarely been investigated, particularly through bioacoustics monitoring and citizen science approaches. Here, we present a pilot study testing the feasibility of using bioacoustic monitoring, supported by citizen scientists, to explore how the formation of an evergreen shrub layer of invasive alien plants *Rhododendron ponticum* and *Prunus laurocerasus*, may influence bird communities in broadleaved woodlands in Wales, United Kingdom. We trained volunteer citizen scientists on how to use passive acoustic monitoring devices (AudioMoths) to record bird calls. We then used BirdNET software to identify bird species from 480 hours of audio recordings. A total of 28 bird species from 17 families were identified from the recordings. Overall, the frequency of bird calls did not differ between the control and invaded plots. However, there was significant difference in the frequency of bird calls based on their trophic niches, suggesting that birds respond in different ways to the presence of invasive alien plants. This pilot study shows that bioacoustic monitoring is an effective tool for investigating invasive species impacts and that it can be integrated with citizen science to assess how invasive evergreen shrubs influence bird communities.

Keywords: AudioMoths, citizen science, Europe, non-native species, sound recording.

Ecological and environmental changes caused by supplemental feeding of an invasive ungulate in Finland

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Feeding wildlife is used to attract animals or support game management, especially for supporting survival during harsh winter conditions. In Finland, supplementary feeding is common for the invasive white-tailed deer *Odocoileus virginianus* (Zimmermann, 1780), which was introduced in the 1930s when four individuals were transported from Minnesota. Since then, the population has increased to ca. 120,000 individuals. As a popular game species, it is actively hunted, but population expansion is causing major changes in the local ecosystem services. The supplementary feeding of white-tailed deer may contribute to these changes by causing negative effects on the animals and the environment. Potential risks include disease transmission, reduced fitness from poor-quality diets, altered movement patterns, habitat degradation, and biodiversity loss. The effects of supplementary feeding of this invasive ungulate have not previously been researched in Finland, but there is a strong need to understand the ecological and environmental changes it causes and the risks it poses.

My PhD focuses on three different aspects of white-tailed deer, as detailed below: (1) Investigating the movements and home ranges of the deer in areas of intensive feeding. This is achieved by combining data from a network of game cameras at the feeding sites and away from them and from GPS-collared white-tailed deer. (2) Investigating the effects of supplementary feeding on the movement patterns of medium and large herbivores and carnivores. For this part of the PhD, the network of game camera traps described above will be used. (3) Investigating occurrences and abundances of zoonoses and other diseases at the supplementary feeding sites. I will describe the spectrum and abundances of diseases at the feeding site compared to a non-feeding site using extensive sampling of soil, feed and feces collected from both sites. The game camera data support the analysis.

Keywords: supplementary feeding, white-tailed deer, movement patterns, disease transmission, satellite linked telemetry, camera traps.

Invasive American mink (*Neovison vison*) as a reservoir of *Trichinella spiralis* in Lithuania

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Trichinellosis is a foodborne parasitic zoonotic disease caused by nematodes of the genus *Trichinella*, comprising ten recognized species and three additional genotypes worldwide. In Europe, four species have been identified: *Trichinella spiralis, Trichinella britovi*, *Trichinella nativa*, and *Trichinella pseudospiralis*. Although *Trichinella* infections predominantly occur in wildlife, these parasites also circulate in domestic animals and pose a risk of transmission to humans. Trichinellosis remains a significant public health and veterinary concern, including in Lithuania, where only a limited number of isolates have previously been identified to the species level. This study aimed to assess the prevalence of *Trichinella* nematodes in the invasive American mink (*Neovison vison*, Carnivora: Mustelidae) and to evaluate the intraspecific genetic diversity of the detected species. *Trichinella* prevalence and infection intensity were determined using the artificial digestion method applied to hind leg muscle samples. Species identification was conducted using multiplex PCR, and intraspecific genetic variability was assessed through ITS1 region analysis followed by bioinformatics evaluation. A total of 18 muscle samples from invasive American mink were examined. *Trichinella* infection was detected in 5.6% of individuals, with an infection intensity of 0.92 larvae per gram of muscle. Molecular analyses confirmed the presence of *T. spiralis*, the most pathogenic *Trichinella* species. Ten ITS1 sequences obtained from individual larvae were 100% identical, indicating no detectable intraspecific variation. This study provides the first report of *Trichinella* infection in free-living invasive American mink in the Baltic and Scandinavian regions. The findings highlight the role of invasive American mink as a potential reservoir of *T. spiralis* in Lithuania and emphasize the importance of continued wildlife surveillance to reduce public health riskst.

Keywords: American mink, *Trichinella spiralis*, molecular identification, Lithuania.

Is *Sus scrofa* a disperser of *Elaeagnus angustifolia*? Impacts on vegetation in agroecosystems of northeastern Argentine Patagonia

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Sus scrofa is an invasive species (IAS) with major impacts worldwide. In northeastern Argentine Patagonia (NAP- Monte phytogeographic province), its presence raises questions about effects on native vegetation, agroecosystems, and its potential role as a plant disperser. This study evaluated *S. scrofa* impacts on vegetation in three NAP agroecosystems, hypothesizing direct and indirect effects through rooting disturbance and fruit consumption, with differential impacts on native and invasive plants.

Rooting impact was quantified in shrubland and croplands using systematic 1000 m transects. In parallel, *S. scrofa* diet was analyzed from 39 feces collected in the agroecosystems. Plant and animal components were identified and seeds were recovered for germination experiments.

Recovered seeds of *Condalia microphylla* (native) and *Elaeagnus angustifolia* (IAS) were subjected to laboratory germination experiments. Viable seeds were separated by flotation and incubated for 30 days. Two experiments were conducted for each species: one without mechanical scarification to evaluate the effect of gut passage, and another with mechanical scarification using sandpaper. For *C. microphylla* two treatments were compared using Poisson GLM (seeds from feces vs. seeds from fruits). For *E. angustifolia* only seeds from feces were compared with a random uniform distribution due to its IAS status in Argentina.

Rooting impact was low and localized, occurring mainly in croplands (*Zea mays* and *Medicago sativa*) rather than in native shrubland. The diet was dominated by plant material (~96%), with frequent seed ocurrence (75%), including *C. microphylla, E. angustifolia* and *Prosopis sp.* (native). Most seeds (83%) showed mechanical damage.

Gut passage did not promote germination of *C. microphylla* ($Z=0.699$, $p=0.484$), suggesting a net negative effect due to seed damage. In contrast, *E. angustifolia* germinated after ingestion, although not above random expectation ($p=0.82$), suggesting that *S. scrofa* are unlikely to be effective dispersers but may occasionally contribute to the dispersal of this invasive species.

Keywords: Monte, wild boar, productive systems, diet.

Investigating negative ecological impacts of *Apis mellifera* globally

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Bees are vitally important for pollination, an ecosystem service ensuring pollination of 85% of flowering plants worldwide and 35% of global food production. Bees are economically beneficial, they produce more than 15 billion U.S dollar in crop production annually. Due to their crucial role as pollinators, European honey bees (*Apis mellifera*) have been moved globally by humans intentionally and unintentionally. The native range of European honey bee *A. mellifera* is Europe, Middle East and Africa. They have the capability to move into new geographical areas and have the ability to survive and build their nest in many places. They are likely to impact native ecosystems in these new areas. In this study, we reviewed 50 papers on negative ecological impacts of *Apis mellifera* which have become invasive in many parts of the world (America, Australia, New Zealand and Asia). The species of mellifera were moved globally in the last 200 years, with first instances coming from 1839. We found several negative impacts of invasive bees *Apis mellifera* on native biodiversity and ecosystems. Broadly, these invasive bees affect native biodiversity in the following ways: (i) reducing the fitness of native plants by removing pollen and nectar, (ii) reducing the fitness and diversity of native pollinators via niche overlap, displacing native bees for floral competition, disease transmission (Parasite- *Crithidia bombi* and Virus- *Varroa mite*), aggressive interactions, and hybridisation with congeneric species and their genetic dilution, and (iii) causing ecosystem-level impacts by disrupting native food webs and enhancing the reproductive progress of invasive plant. Our study helps in synthesising knowledge on the negative impacts of a species that is mostly viewed positively, and addresses some pertinent questions around sustainable agricultural practices where the economical benefits can not compensate for ecological costs. Studies like ours address UN Sustainable Development Goal 15 (Life on Land), which is fundamental to maintaining ecological balance.

Keywords: *Apis mellifera*, biodiversity, sustainability, ecological, negative impact.

Predation behavior and foraging disruption of honeybees by *Vespa orientalis* in southern Spain

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The invasive Oriental hornet (*Vespa orientalis*) is emerging as a rapidly expanding threat to pollinators and beekeeping across Spain. While the impacts of the yellow-legged hornet (*Vespa velutina nigrithorax*) on managed honeybee colonies are well documented, information on the ecological and apicultural negative effects of *V. orientalis* remains scarce.
In this study, we assessed the behaviour and predation pressure exerted by *V. orientalis* on honeybee (*Apis mellifera*) colonies across 25 hives distributed among five apiaries in Málaga province (southern Spain). Data collection was conducted during September and October 2025. Each beehive was recorded 12 times at different times of the day, yielding approximately 450 hours of automated, non-invasive video recordings. From each sampling, five minutes of video were analysed to characterize hornet predation patterns, and two minutes were used to quantify honeybee foraging activity. Predation metrics included successful and unsuccessful capture attempts, capture location (flight or ground), and ambush duration. Intraspecific interactions between hornet workers, including trophallaxis and aggressive encounters, were quantified using the semi-automated behavioural tracking software BORIS. The predation pressure exerted by *V. orientalis* on beehives was analysed using linear models. Preliminary analyses revealed a negative relationship between hornet activity and *A. mellifera* activity.
This study represents an important step toward field-scale monitoring of honeybee colonies and advances our understanding of the impact of *V. orientalis* on managed *A. mellifera* hives.

Keywords: *Apis mellifera,* invasive hornet, predation behaviour, *Vespa orientalis.*

Direct and indirect impacts of *Carpobrotus acinaciformis* invasion on dune ecosystems of Lazio, Italy

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Invasive alien plants can directly modify ecosystem functioning and, indirectly, alter native plant and soil fauna biodiversity, supporting functions such as productivity and decomposition. However, these cascading effects and their underlying mechanisms remain unexplored, especially the role of plant intraspecific trait variability (ITV). To address this, we investigate the direct and indirect effects of invasion on ecosystem functions and soil fauna by focusing on Iceplant (*Carpobrotus acinaciformis* (L.) L. Bolus), a widespread invader native to South Africa, in dune ecosystems of central Italy.

Field sampling was conducted on the coastal dunes of Passoscuro, Lazio, in 2024 and 2025, using 15 pairs of invaded and control plots. In each plot, we measured plant richness and cover, soil nematode and springtail abundances, biomass production and decomposition rate. Functional traits (height, specific leaf area and leaf dry matter content) were collected for the five most abundant plant species per plot, accounting for both species-mean traits and ITV. Structural Equation Models (SEM) were applied to disentangle direct and indirect invasion effects mediated by changes in plant community structure, quantified using community-weighted means (CWM) and functional diversity (FD) with and without accounting for ITV.

Results revealed strong direct effects of Iceplant invasion on plant community structure, productivity and soil fauna abundances. Significant indirect effects on productivity, decomposition and soil fauna were also detected, mediated by shifts in CWM and FD. Importantly, incorporating ITV revealed additional indirect effects not captured by mean traits, for example, the mediation of plant height on productivity.

These findings show that plant invasion impacts may not be immediately apparent, highlighting the need for deeper analyses to understand the threat to invaded ecosystems.

Keywords: *Carpobrotus acinaciformis*, invasive plants, dune ecosystems, intraspecific trait variability, indirect impacts.

Summer occurrence of the invasive jellyfish *Craspedacusta sowerbii* in Andean-Patagonian lakes: potential impacts on native food webs

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Craspedacusta sowerbii, a freshwater jellyfish native to the Yangtze River (China), has spread and established worldwide, facilitated by the trade and transport of aquatic organisms, and climate warming. Recent reports indicate its presence in cold-temperate Andean Patagonian lakes of southern Chile and Argentina, particularly during the summer months. These lakes are oligotrophic and highly sensitive to biological invasions due to their low species richness, highly endemic flora and fauna, and lack of native top predators. In this study, we report the occurrence of *C. sowerbii* in two shallow protected lakes (Escondido and El Trébol) in Northern Patagonia (Argentina), and analyze its potential trophic impact. We examine the natural diet of the jellyfish in the population of Lake Escondido and evaluate experimentally its feeding behavior on natural zooplankton, and on different planktonic prey (*Bosmina longirostris, Ceriodaphnia dubia, Daphnia sp.* and *Boeckella gracilipes*). In Lake Escondido, mean jellyfish density was ~24 ± 20 ind m-3, with an aggregated distribution pattern. The individuals exhibited a mean bell diameter of 0.7 ± 0.2 cm and a maximum of 1.3cm, being smaller than those reported by other authors. When fed on natural zooplankton, *C. sowerbii* consumed primarily the most abundant cladoceran *B. longirostris*, whereas copepods and rotifers were consumed occasionally. In single-prey experiments, mortality induced by the jellyfish was higher in *Daphnia sp.*, however, effective ingestion was higher for *C. dubia*, suggesting post-capture selectivity. Our results suggest that *C. sowerbii* may alter the functioning of native pelagic food webs through direct predation on grazers, potentially favoring phytoplankton growth via a top-down control. Further research should explore the indirect influence of this species on phytoplankton assemblages as well as its potential for the redistribution of nutrients in the water column, two key aspects in these oligotrophic lakes.

Keywords: freshwater jellyfish, Patagonia, predation, zooplankton.

Assesing the impact of two invasive parakeets on urban soundscapes

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Invasive exotic species can threaten biodiversity through multiple mechanisms. Over the last decade, the acoustic disturbances of some exotic species have been proposed as a new invasion impact. Indeed, invasive species can be louder than native species, and have longer periods of vocal activity, daily and seasonally. This dominance can disrupt acoustic communication through the masking of native vocal signals. Most studies have focused on species-level responses to invasive calls or songs, through playback experiments. However, it is still unclear how native soundscapes and acoustic communities can be impacted by an acoustic invasion. To address this gap, we chose the monk parakeet (*Myiopsitta monachus*) and the rose-ringed parakeet (*Psittacula krameri*), as they are the two most successful invasive parakeets known for their loud and persistent calling. Combining acoustic indices and automated species detection using BirdNET, we analyzed seasonal recordings sampled in the city of Seville (Spain). We found a significant impact of the parakeets' vocal activity on the characteristics of the soundscapes. In highly occupied soundscapes, the parakeets dominated, monopolising the acoustic space with their loud, frequent and broadband calls, from which the resulting energy was higher than anthropophonic noise. The acoustic occupancy of resident birds decreased with the increased parakeet occupancy. These results varied across parks and seasons. For example, Maria Luisa was the park where parakeets were most vocally active (up to 90%) and residents the least. Our findings suggest that the acoustic disturbances of invasive species can have an impact beyond just the species-level, through the disruption of acoustic communities and native soundscapes, and the introduction of a biological source of noise pollution.

Keywords: acoustic indices, BirdNET, *Myopsitta monachus*, *Psittacula krameri*, urban parks.

Global economic impacts of the invasive common pigeon, *Columba livia*

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Biological invasions, largely driven by human-assisted movement of species, are reshaping ecosystems all over the world, leading to the erosion of native biodiversity and resulting in sustained and irreversible environmental damage. This anthropogenic process also causes widespread socioeconomic impacts. It is crucial to quantify the economic impacts to understand the magnitude and distribution of economic costs, to safeguard our biodiversity, by targeting species, areas, and sectors with maximum damage. *Columba livia*, also known as the Common Pigeon or Rock Dove, is recognised as a bird associated with urban ecosystems globally, but it is rarely recognised as an invasive alien species causing massive economic impacts. This study aims to quantify the economic costs of *Columba livia* by reviewing peer-reviewed articles, government and technical reports, and grey literature. We found that the pigeons have cost the global economy more than three billion USD in the period 1984-2022. When considering only observed and highly reliable costs based only on peer reviewed papers and omitting grey literature, the amount pigeons have cost is still more than 221 million USD (2017 exchange rate), in the time period 1984 to 2022. These costs mainly showcase the government spending in European and Asian countries like Italy, Germany, Spain, Switzerland, South-East Asia, etc., where pigeons have huge impacts on heritage structures, creating significant financial stress. These economic impacts are the tip of the iceberg, because *Columba livia* is invasive in 170 countries, but only 14 countries are found to have documented cost. Our results highlight massive impacts and equally massive gaps in knowledge regarding the impacts of invasive alien species like *Columba livia*. The findings of this research should pave the way for policymakers, researchers and citizens in shaping task forces and policies around biological invasions, their impacts, and effective management practices.

Keywords: biological invasions, *Columba livia*, cost assessment, heritage damage, urban ecosystems.

Plant invasion and its effects on butterfly community composition in three distinct habitats

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In today's world, species invasions are among the major anthropogenic drivers of biodiversity loss and a growing ecological problem. Butterflies often pollinate native, non-native and invasive plants. The study was conducted during a year across three habitat types (i.e, rural areas near agricultural fields, suburban areas near grasslands and man-managed urban parks) in South-West Bengal, India. A maximum of five, 500m permanent transects were selected in each habitat type. Butterflies were surveyed following the 'Pollard Walk' method with required modifications. Weighted NODF, links per species, interaction evenness, vulnerability, interaction strength and plant-pollinator (butterfly-nectaring plants) network were analyzed. In each study area, the flower preference of butterflies was observed and analysed. To our knowledge, this is the first study to investigate the impact of invasive plant species on butterfly communities across multiple habitats in this region. Flowers were grouped into native, non-native, and invasive categories to evaluate which floral type was most preferred by visiting butterflies. Our results show that Connectance (0.210) and Shannon diversity (4.512) were higher in rural areas, indicating a greater number of plant-butterfly interactions and more even species distribution in rural areas. Across all three habitats, the greatest butterfly visitation was recorded on *Lantana camara*, a prominent invasive plant species in India. Other plant species that were frequently preferred by butterflies were also non-native to India. Overall, across all three habitats, butterflies preferentially foraged on invasive and non-native plants for nectar and showed fewer interactions with native plants. There results suggest that an increase on plant invasions may disrupt the ecological balance by decreasing the dependence of native plants. Therefore, native plant conservation initiatives can sustain butterfly populations across the habitats.

Keywords: invasive, butterfly, connectance, interaction, non-native.

Invasion process

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Proceso de invasión

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Proceso de invasión

Invasive raccoon dog (*Nyctereutes procyonoides*) as a definitive host of *Sarcocystis* species

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Raccoon dog (*Nyctereutes procyonoides*) is an opportunistic omnivore, native to East Asia and invasive to the rest of the world. It can live in a variety of environments, ranging from forests, river valleys, agricultural to farm environments. Due to dietary and habitat variety, it plays an important role in parasites spread, together with *Sarcocystis*. These parasites infect a wide range of animals such as reptiles, birds, and mammals. *Sarcocystis* species' lifecycle is dixenous and includes prey-predator host relationships. After intermediate host (IH) ingests contaminated water and/or food, *Sarcocystis* spp. undergo asexual reproduction in muscles and tissues. Then definitive host (DH) consumes IH' tissues, sexual reproduction happens in the intestine and after some time sporulated oocysts and individual sporocysts are shed in faeces into the environment.

Throughout the 2019–2025-year period, 26 raccoon dogs were collected across Lithuania. Light microscopy of their intestinal scrapings was employed to test the presence of *Sarcocystis* spp. oocysts and/or sporocysts in the samples. The investigation was followed by a two-step nested PCR targeting either cox1 or ITS1 gene regions. Nested PCR amplifies target DNA, improving detection sensitivity. In total, samples were tested for 23 different Sarcocystis species that use ungulates, birds, and rodents as their IH.

As a result, a total of 19 different *Sarcocystis* species, of which 16 use ungulate as their IH, one that uses birds, and two that infect rodents were identified in the investigated samples. Only three samples remain negative for presence of *Sarcocystis* spp. The most common species was determined to be *S. gracilis* (46,2%), while the least common were *S. venatoria* and *S. rileyi* (3.8%). Coinfection level was relatively high and was in the range from one up to nine Sarcocystis species, with six samples having at least two species. The results provide valuable information on the role of raccoon dogs in *Sarcocystis* parasites spread.

Keywords: definitive host, *Nyctereutes procyonoides*, *Sarcocystis* spp., *cox1*, *ITS1*.

Differing phylogeny & traits of ornamental woody plants across the invasion continuum

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More than three quarters of all naturalized alien plant species worldwide have been introduced as ornamentals, and many have become invasive. Several studies have shown that some traits that make alien species valuable as ornamentals may also be influential on the invasion process. However, it is not understood whether alien species share similar traits at different stages of the invasion continuum (non-established – naturalised – invasive).
Here, we analyse phylogenetic and trait differences between native and alien species, and among alien species across the invasion continuum, in ornamental woody plants in Spain. We applied an integrated approach using the Trait Probability Density framework to study structural differences among these groups of species. We gathered data on 20 acquisitive, reproductive, stress-tolerance and aesthetic traits from 526 ornamental woody species cultivated in 59 parks, belonging to 27 cities across mainland Spain.
In general, we found clear phylogenetic differences, but high trait redundancy across species. Alien species have higher phylogenetic richness than native species, but both groups overlapped functionally in every trait type. All species groups exhibited unimodal or bimodal functional distributions for acquisitive and stress-tolerance traits. In contrast, reproductive and aesthetic traits showed multimodal distributions, with 4 weakly connected clusters, of which only 2 persisted in later invasion stages. In addition, invasive species displayed longer flowering periods and higher Nitrogen content in leaves.
Our results suggest the existence of a strong pre-introduction, anthropogenic filter associated to ornamental selection. This filter homogenizes acquisitive and stress-tolerance traits and constrains the available trait profiles for the development of biological invasions.
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Keywords: urban ecology, functional traits, invasive species, ornamental plants, invasion continuum.

Not just *Trachemys scripta*: new turtle introductions and nesting evidence in Portugal

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Non-native freshwater turtles are increasingly reported in Portugal, yet the diversity of introduced species remains poorly documented beyond the widely known *Trachemys scripta* and Mauremys sinensis. In 2024 and 2025, surveys were conducted across 39 sites in mainland Portugal to assess the occurrence of non-native freshwater turtles. Seven non-native species were confirmed at seven sites, revealing a broader diversity of introductions than previously recognized. *Trachemys scripta* remained the most frequently recorded species (n = 68). In addition, *Mauremys sinensis, Graptemys pseudogeographica*, and multiple *Pseudemys* species were recorded, particularly in urban and peri-urban areas such as Lisbon and Sintra.

Notably, a high number of juvenile *M. sinensis* (n = 12) were captured, suggesting possible reproduction in the wild. Furthermore, the first evidence of nesting behaviour by *G. pseudogeographica* was documented in Sintra, indicating potential establishment of this species under Portuguese environmental conditions. These findings support the hypothesis that both regulated and illegal non-native pet turtles are being released into natural ecosystems, increasing propagule pressure and favoring the establishment of new taxa.

Overall, this study highlights the growing complexity of freshwater turtle introductions in Portugal and reinforces the need for enhanced surveillance, improved regulation of the pet trade, and stronger preventive actions to reduce releases. Given the unknown ecological impacts of newly introduced species, early detection and rapid response strategies are essential to mitigate future invasions and protect native biodiversity.

Keywords: non-native species, *Mauremys sinensis*, *Graptemys pseudogeographica*, introductions, nesting, pet trade.

An invasion-fire cycle driven by *Acacia dealbata* in northern Portugal

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An invasion-fire cycle occurs when an invasive alien species (IAS) alters the fire regime of an ecosystem in a way that favours its dominance. Empirical assessments of such cycles are essential, as when they occur, ecological impacts and management needs can differ substantially from those of invasion or fire acting independently. We hypothesized that such a cycle is occurring in northern Portugal due to the invasion of *Acacia dealbata* Link, and applied modelling approaches to evaluate it. First, a dynamic model was developed in STELLA to assess the combined effects of site susceptibility and fire frequency on the population dynamics of *A. dealbata*. Second, fuel models were implemented in BehavePlus to compare fire behaviour in *A. dealbata* invaded stands against other dominant land-cover types of the region. The results show that fire promotes *A. dealbata* establishment and spread by increasing landscape susceptibility to invasion and enhancing population regeneration. Landscape susceptibility - measured on a 0-1 scale from not susceptible to highly susceptible - was up to 0.04 higher in high fire frequency scenarios. Similarly, population structural diversity - calculated using the Shannon index - was up to 1.4 higher in high fire frequency scenarios. In turn, Mann-Whitney test results showed that *A. dealbata* alters fire behaviour in invaded areas. While stands are still in the shrub stage, fires spread rapidly and burn intensely, facilitating further invasion (rate of spread: 23.3 m min^{-1}; fireline intensity: 10,964 kW m^{-1}). As stands grow into trees, fire spread and intensity decrease due to structural features (rate of spread: 1.1 m min^{-1}; fireline intensity: 61 kW m^{-1}). These findings suggest that an invasion-fire cycle may be occurring in northern Portugal. Having a case-specific understanding of invasion-fire interactions is crucial for developing targeted management strategies and reduce ecological impacts.

Keywords: invasion-fire interactions, biological invasions, silver wattle, fire behaviour, modelling.

A tale of three invasive grasses: nested niches on oceanic islands reveal scale-dependent shifts in *Cenchrus setaceus* (Forssk.) Morrone, *Melinis repens* (Willd.) Zizka, and *Setaria parviflora* (Poir.) Kerguélen

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Biological invasions pose a challenge for species distribution models (SDMs) because inferred niches can shift with spatial scale and invasion stage. Here, we introduce a Nested Hierarchical SDM (NHSDM) framework that explicitly links global and regional niches to enhance both transferability and management usefulness. We model three invasive C4 grasses, *Cenchrus setaceus* (Forssk.) Morrone, *Melinis repens* (Willd.) *Zizka* subsp. *repens*, and *Setaria parviflora* (Poir.) Kerguélen, by combining worldwide occurrence records with a high-resolution regional workflow for the Canary Islands. NHSDMs include global and regional ensemble models and yield two integrative outputs: (i) a covariate-augmented regional model that incorporates the global prediction as an additional predictor, and (ii) a multiplicative consensus between global and regional projections.

To diagnose scale effects, we propose two metrics: the Variable Importance Divergence Index (VIDI), which measures shifts in predictor importance across scales, and the Gradient Response Deviation Index (GRDI), which summarizes differences in the shape of predictor–response curves. We project climatic suitability under current conditions and late-century scenarios (SSP3-7.0, SSP5-8.5; 2071–2100) and quantify spatial overlap among species. NHSDMs reveal marked, species-specific scale dependence: *C. setaceus* shows broad warm-xeric suitability and a comparatively low VIDI (consistent responses across scales), whereas *M. repens* and *S. parviflora* exhibit mesic–montane affinities and higher VIDI and GRDI, indicating stronger scale-driven shifts, particularly in precipitation seasonality. Despite only moderate environmental niche overlap, projected spatial co-occurrence increases, especially under SSP5-8.5. Overall, pairing scale-aware modeling with explicit diagnostics provides a transparent basis for forecasting invasion dynamics and prioritizing island management under climate change.

Keywords: invasive plants, grasses, climate change, Canary Islands, SDMs.

Are non-indigenous peracarids spreading in marinas of the southern Iberian Peninsula? Insights from using arborescent bryozoans as monitoring tools

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Recreational boating plays a significant role in the introduction and spread of non-indigenous species (NIS), facilitating a progression in their invasion process. Periodic monitoring in recreational marinas has been widely recommended as a key management strategy for the early detection of NIS; however, its utility for providing information on temporal trends at a regional scale remains poorly explored, especially for small organisms such as amphipods. Here, we examine spatio-temporal changes in amphipod communities from recreational marinas by comparing data from 2011 and 2019 in the southern Iberian Peninsula, a region characterized by high recreational boating pressure. To this end, we sampled 13 marinas across the study area, using the bryozoan *Bugula neritina* (Linnaeus, 1758) as a biomonitoring tool in both years. We detected five NIS that were present in both 2011 and 2019. Comparisons between years revealed that most species were found in a significantly higher number of marinas in 2019, indicating their ongoing spread. This spread was context-dependent, with the intrinsic characteristics of the marinas significantly influencing the number of NIS, their abundance and their community structure. Our spatio-temporal analysis highlights the progression in the invasion process of amphipod NIS in the southern Iberian Peninsula, underscoring the need to incorporate such information into management strategies to effectively prioritize control efforts.

Keywords: invasion dynamics, recreational boating, mobile epifauna, temporal trends, secondary dispersal.

Predicting invasion risk in ornamental plants: functional traits and human-aided drivers in Catalonia

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Invasive plant species are a major driver of biodiversity loss and ecosystem alteration worldwide, generating substantial ecological and economic impacts. Ornamental horticulture is one of the main pathways of introduction of alien plants; however, the factors determining why some species become invasive while others remain naturalized are still not fully understood.

We hypothesized that both functional traits and human-assisted factors jointly increase the probability that an ornamental alien plant becomes invasive. This study aimed to identify key functional traits and human-related factors associated with invasiveness in ornamental alien plants to improve risk assessment and early warning strategies. Catalonia (NE Spain), a highly connected Mediterranean region, was used as a study system. We compiled 500 ornamental alien plant species from the EXOCAT database and characterized functional traits (growth form, dispersal diversity, native range size) and human-related variables (minimum residence time, introduced range size, introduction pathway diversity). Bayesian phylogenetic regression models were fitted to 212 naturalized and invasive species and compared using LOOIC and Bayesian R^2 to identify the most supported predictor combination.

The best-supported model (R^2 = 0.216) included minimum residence time, native range size, dispersal diversity, and growth form. The probability of invasiveness increased with longer residence time and greater dispersal diversity. Woody species showed a higher likelihood of being invasive than herbaceous species, contrasting with previous findings in Mediterranean ecosystems. Unexpectedly, native range size showed a negative relationship with invasiveness, potentially reflecting untested interactions or introduction biases linked to ornamental selection.

These results highlight the combined influence of functional traits and human-mediated factors in shaping invasion outcomes. Integrating these predictors into risk assessment frameworks can strengthen preventive management and improve prioritization of high-risk ornamental species in Mediterranean regions.

Keywords: biological invasions, ornamental plants, functional traits, residence time, risk assessment.

Using ecoacoustics for the study of invasive species

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Pet trading of wild vertebrates has led to the widespread introduction of exotic species, which can cause damage to native species and ecosystems. Many bird species have successfully established feral populations through escapes or releases. Early detection is a cornerstone of effective management, since detecting the expansion of non-native populations at an early stage increases the likelihood of successful containment/eradication and helps reduce long-term damages. Spain represents a particularly suitable case study within Europe for investigating invasive bird species, due to the presence of several well-established non-native populations in urban and peri-urban areas. The aim of this study is to verify the presence of alien bird species in the region of Andalusia (Spain), around the city of Sevilla, using autonomous recording devices and compare it with their known distribution area to test early-stage detection and assess passive acoustic monitoring (PAM) as a long-term, low-effort monitoring method. We studied the presence of alien birds across natural habitats and farmlands in the Doñana Greater Ecosystem, with a total of 36 monitoring points. We collected data in the spring of 2025 using PAM with AudioMoth devices and analyzed the recordings utilizing BirdNet automatic detection. Our results confirmed the presence of three invasive species outside of their known distribution area: the rose-ringed parakeet (*Psittacula krameri*) and the monk parakeet (*Myiopsitta monachus*), which represent a potential ecological concern due to their competitive dynamics; and the common waxbill (*Estrilda astrild*), which is generally considered less problematic, as it tends to occupy more anthropized lands, coexisting therefore more easily. However, ongoing agricultural expansion and increasing habitat anthropization could facilitate their spread, potentially altering its interactions with native communities and increasing its ecological impact in the future. In conclusion, ecoacoustics proves to be a very effective methodology for the early detection of problematic species.

Keywords: ecoacoustics, early detection, PAM, parakeet, waxbill.

Pathways and early detection of non-indigenous species threatening a future Marine Protected Area in the central Mediterranean

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The introduction of non-indigenous species (NIS) poses a major threat to marine biodiversity, particularly in conservation areas. This study was conducted in Monastir Bay, Tunisia (central Mediterranean) to assess the presence, potential introduction pathways, and early establishment of NI benthic species threatening the Kuriat Islands, a site proposed as a future marine and coastal protected area (MCPA). A multi-method monitoring approach was applied. Underwater visual surveys were carried out around the Small Kuriat Island to document established NIS within the future protected area. Based on intense maritime traffic linking the mainland to the islands, the Monastir marina was identified as the most likely introduction hub. Rapid Assessment Surveys (RAS) were therefore conducted at five stations within the marina to characterize the NIS pool at the source area. In parallel, experimental colonization plates, including antifouling-treated and untreated panels, were deployed to detect early-stage fouling communities and to assess the short-term effectiveness of antifouling coatings. RAS recorded 24 species, including 13 non-indigenous and 3 cryptogenic taxa, of which 7 were classified as invasive. Underwater visual surveys identified 23 species around the Small Kuriat Island, including 5 invasive NIS. Colonization plates revealed 27 species, comprising 10 non-indigenous and 2 cryptogenic taxa, demonstrating their effectiveness for detecting small-bodied and early-stage organisms. Antifouling-treated plates showed a complete inhibition of biofouling development; however, the short deployment period and low fouling on control plates limited the robustness of this result. The three methods demonstrated detection complementarity. Notably, *Halophila stipulacea* was detected by both RAS and underwater surveys, indicating its establishment from marina habitats to the future MCPA and suggesting ongoing range expansion. Overall, 61 species were recorded across all methods, including 24 non-indigenous and 6 cryptogenic species, several listed on the UNEP-MAP/CAR-ASP priority list. These findings highlight significant biological pressure on a future protected area, emphasizing the need for baseline data, and integrated long-term monitoring to inform effective management and reduce NIS introduction risk.

Keywords: non-indigenous marine species, early Detection, future MCPA, Kuriat Islands, central Mediterranean Sea.

An overlooked invasion: the case of the moss *Campylopus introflexus* in the Balearic Islands

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Campylopus introflexus is an acidophil acrocarpic moss considered to be invasive in Europe. Although many historical records for the Balearic Islands exist (in Mallorca and Menorca, most of them warning about its invasive potential), this species has not been officially considered as invasive or for management in the archipelago. In this study, we present new distribution data on the species for the Balearic archipelago and analyse its invasive potential. Data was obtained from bibliographical resources and field work conducted by the authors between 2021 and 2026. In the last five years, *Campylopus introflexus* has more than doubled its area of occupancy after several new records reported for Mallorca (from 6 to 14 1 km x 1 km UTM grids). In this island, it has also increased its altitudinal range (from 480 to 620 m.a.s.l. to 180 to 630 m.a.s.l.). Moreover, *C. introflexus* has been reported producing sporophytes for the first time in the Balearic Islands. *Campylopus introflexus* tends to rapidly cover all the available substrate surface (mainly decaying wood), displacing other accompanying mosses and lichens. It has been recorded growing together with regionally endangered species (such as *Dicranum scoparium*), in areas near important hotspots of endangered species, including Natural Parks. Our results suggest that, although historically overlooked, *C. introflexus* may present an invasive behavior in the Balearic archipelago, as reported by different studies in other mediterranean regions. Some of the new records have been found in well studied areas from a bryological point of view, for which it may be considered as an indicator of an expansion process. The reported capacity of sexual reproduction may indicate that a spore bank exists, which urges the need to map and manage this species. Official management plans should be considered before this species develops a more aggressive invasive behavior in the Balearic archipelago.

Keywords: Balearic Islands, *Campylopus introflexus*, endangered bryophytes, invasive, moss.

Is the pacific oyster (*Magallana gigas*) invading northern Portugal? Early and concerning findings

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The Pacific oyster *Magallana gigas* (Thunberg, 1793) is among the most widespread invasive species worldwide. Its broad distribution results from multiple introductions by aquaculture activities in Europe, America, and Australia over the last centuries aimed at compensating the decline of native oyster populations. Due to its high adaptability, *M. gigas* can establish self-sustaining populations in the wild, spreading across soft-bottoms and rocky shores of estuaries and coasts. In several regions, *M. gigas* exhibits an invasive behaviour, displacing native species and altering ecosystem functioning.

In North Portugal, an area with no historical records of native or non-native oyster species, a population of *M. gigas* was recently found in the recreational marina of Póvoa de Varzim (PV). Subsequent surveys in December 2025 across natural and artificial habitats detected this species in three additional localities: Leça da Palmeira (LP), Viana do Castelo (VC), and Vila Praia de Âncora (VP). To quantify oyster abundance and size-frequency structure among localities, oyster density and shell length were measured, distinguishing between alive and dead specimens and assigned them to 5 cm size-classes.

Results showed significant differences among localities, with slightly higher values of abundance in LP than in VC. Size-class structure also varied among localities, with individuals in the 5-10 cm size class accounting for more than 50% of the population at each port. LP contained the largest proportion of individuals in the 10–15 cm size class, while VP was dominated by smaller size-classes. Individuals larger than 15 cm were uncommon and were only observed in VP.

Our findings suggest that, in this early stage of the invasion, minor observed differences could be due to biotic factors operating at small-scale. These data provide a baseline for future monitoring and management strategies to control the spread of the species in North Portugal, particularly in artificial habitats.

Keywords: invasive species, pacific oyster, artificial structures, North Portugal, monitoring.

The exotic mammal trade is causing invasion concerns in India

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International trade in exotic animals is one of the primary pathways introducing species into newer ecosystems. Despite that, the species' identity, exporting countries, reasons for imports, and impacts are largely unknown. The main objectives of our research were twofold: First, to create a country-specific database on animals imported into India via the legalised exotic animal trade. The second objective was to investigate the taxonomic, spatiotemporal and sectoral distributions of imported species of invasion concern, and their observed and potential impacts. We found that in the last 48 years (1977-2025), India has imported more than 1591 individuals from 92 unique mammalian species, of which at least eight are invasive in India or globally. One species, Elephas maximus (Asian elephant), is native to mainland India, but invasive on Indian islands. The other seven are globally invasive, but only potentially invasive in India due to no documented impacts. The maximum imports were seen during 1985-1990, incoming from Singapore, Germany, Canada, the United States and Indonesia. The predominant reasons for imports have been zoos, circuses, commercial trade, reintroduction purposes, and educational purposes. Economically, four of these eight species have accounted for global losses of 2.91 billion USD in 41 years. Ecologically, the main impact of the invasion has been predation, overgrazing and outcompeting the native taxa. Our work underscores the increasingly visible conflict between biodiversity frameworks and trade policies in a megabiodiverse country like India. This research provides a strong foundation for developing more nuanced legal and policy provisions around the exotic legal animal trade, addressing SDG 15 and targets 5, 6 and 15 of the Kunming-Montreal Global Biodiversity Framework.

Keywords: international legal trade, invasion, CITES, invasive mammals.

Update on the alien flora of the Pityusic Islands

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Introduced species represent an environmental problem that is particularly relevant in the flora of the Balearic Islands. Although the Pityusic Islands do not stand out for having a high number of records, intense tourist pressure and extensive gardening activities suggest a considerable impact that may be overlooked due to lower sampling effort or limited recording of these taxa. This study aims to update and analyze the alien flora of the Pityusic Islands by compiling all known records and providing a first approximation of abundance based on the number of localities per species. To this end, bibliographic sources, online platforms, and databases were reviewed, and unpublished data from the last five years were included. The results show a notable increase in previously unrecorded species, representing 30.0% of the alien flora of Ibiza and 36.5% of that of Formentera. Collectively, recent surveys have increased the known alien flora of the Pityusic Islands to 356 taxa (339 in Ibiza and 164 in Formentera). The characteristics of this alien flora are similar to those of the Balearic Islands as a whole, although slight variations are observed, attributable to the greater aridity of the Pityusic Islands and possible differences in gardening practices. Temporal variation and the number of records per species reveal significant information gaps and a strong dependence on sporadic studies, especially in Formentera. This limits the understanding of the true impact of alien flora and highlights the need for more detailed cartographic studies and continuous monitoring of this issue.

Keywords: alien, flora, Ibiza, Formentera, Pityusic Islands.

Mitogenome phylogeography of the tick *Dermacentor marginatus*: insights into the drivers and pathways of dispersal

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Dermacentor marginatus is one of the most widespread tick species in Europe, North Africa, and parts of Asia. Current predictions forecast a further expansion into new areas over the next decades, with recent records accumulating outside the historical range. Unlike other tick species, *D. marginatus* mainly feeds on mammals, including domestic species (e.g., cattle, horses, dogs), and has almost never been reported on birds. In this context, understanding the phylogeographic structure of the tick is important to clarify the role of humans in shaping its distribution. Moreover, shedding light on the possible dispersal routes and on the dynamics of population expansion and contraction can help predict future demographic changes under climate change scenarios.

In this study, we sampled *D. marginatus* specimens across its distribution range and applied an amplicon-based approach with Illumina sequencing to obtain their complete mitochondrial genomes. During sequence assembly, we identified repetitive elements that could not be resolved using Illumina short reads and that haven't been characterized in previous literature. Therefore, we applied Nanopore sequencing on a selected number of samples to determine the length and structure of these repetitions.

Repetitive elements cover three different sites of the *D. marginatus* mitogenome, with two of them showing large length variation among specimens. The construction of a complete and accurate mitochondrial reference allowed us to infer phylogenetic relationships within the species. The obtained mitogenomes cluster into distinct and very divergent haplotypes. At the small, regional scale, no geographic clustering is observable among samples; however, on a large, continental scale, the results suggest a limited ability to perform migrations compared to other ticks. These results are consistent with the inability of the tick to feed on birds, which limits their dispersal capacity. Expanding sampling locations to other areas, particularly islands and North Africa, will allow us to better estimate the role of humans in shaping the distribution of the tick.

Keywords: ornate sheep tick, ectoparasites, mitochondrial genome, phylogenetics, domestic animals.

Invasive exotic arthropods of northeastern Argentina: between national public policies and regional reality

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Despite being one of the groups with the highest number of invasive species globally, in Argentina, the invasive exotic arthropods (IEA) are poorly studied and their effects on human health, food production and the economy are often underestimated. The aim of this study was to evaluate the Argentinian list of IEAs and its relationship with the records in the provinces of Chaco, Corrientes and Formosa. We carried out a bibliographic search using the Official List of Invasive Exotic Species published in Argentina and academic search engines such as Google Scholar. We recorded 45 species of IEA in the national list, representing only 6% of the total species. The search engines allowed us to identify 13 new records for these provinces, reaching a total of 19 invasive and potentially invasive species in the NEA region. This study highlights the importance of a regional approach to the problem of IEAs to generate early warning and prevention tools, especially for those species which are not currently included in the Argentinian list.

Keywords: inventory, northeastern Argentina, prevention.

Distribution of the Chinese mitten crab (*Eriocheir sinensis*) in the Tagus River basin

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The Chinese mitten crab (*Eriocheir sinensis* (Milne-Edwards, 1853)) is native to East Asia and listed among the IUCN's 100 worst invasive species worldwide. In Portugal, it is included in the National List of Invasive Species and is currently established in the Tagus River basin. The species exhibits a catadromous life cycle and has known ecological and economic impacts in freshwater and transitional ecosystems.

A sampling campaign was conducted from June to December 2025 to update the distribution of the species in the Tagus River basin, across the main channel, tributaries, and estuary. The site selection focused on their potential susceptibility to invasion and the highest potential for capture along the main migration routes. Captures were conducted using baited traps and electrofishing.

Contrary to previous studies, no crabs were detected immediately downstream of the Belver dam. According to reports from fishermen and residents, the current upstream limit of the species distribution is approximately 104 km north of the estuary; however, no individuals were captured or observed at this site. The species was detected at several sites along the main river stretch. The results confirm the presence of the species in the tributaries Almonda, Sorraia, and Zêzere rivers, as previously reported, and reveal new areas of invasion in the Almansor and Alviela rivers. In the estuary, the species was also detected and remains well established, with some commercial capture.

In conclusion, the results indicate a slight retreat in the upstream distribution of the species along the main channel of the Tagus River, possibly due to difficulties in overcoming new physical infrastructures. Nevertheless, the detection in new tributaries demonstrates a lateral expansion of the invaded area.

Keywords: *Eriocheir sinensis*, invasive species, Tagus River, Tagus Estuary, freshwater ecosystems.

Taxonomic and functional comparison of animal communities associated with anthropogenic marine debris in Madeira

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Throughout history, natural materials such as macroalgae and volcanic pumice have acted as temporary rafts for coastal species, enabling short-distance dispersal despite their ephemeral nature. Today, however, the oceans are increasingly saturated with anthropogenic marine debris (AMD). Durable and highly buoyant items, particularly plastics, can greatly enhance the long-distance transport of organisms between distant coastal ecosystems and support (semi) permanent "neopelagic" communities of coastal and neustonic species capable of surviving and reproducing in the open ocean.

Our study examined the arrival of floating marine debris (FMD) on the beaches of Madeira Island (Northeast Atlantic) and the community changes during the stranding events, when associated fauna is exposed to predators, ultraviolet radiation, and desiccation. We compared the composition of biotic communities attached to FMD at different stages of the stranding process: floating (FMD), newly stranded (NSD), and not-newly stranded debris (NNSD). We them evaluated the potential progressive loss of taxonomic and functional groups during the stranding process, with particular attention to differences between mobile and sessile species. Additionally, the presence and number of Non-Indigenous Species (NIS) associated with these items were also assessed. To do so, DNA-based analyses were combined with species-level morphological identification of both mobile and sessile fauna.

A total of 93 items were analysed: 14 FMD, 21 NSD, and 58 NNSD, with 110 taxa identified, 52 till species level, of which 7 were NIS, being Zeuxo turkensis confirmed as a first record in Madeira. Clear patterns of richness and abundance decrease were revealed, with the mobile community component being the most affected one. This demonstrates the importance of incorporating mobile taxa-adapted sampling methodologies into future bioinvasion monitoring frameworks, as overlooking these components may underestimate the diversity and invasion potential of organisms transported by marine debris, and, consequently, the true scale of NIS arrival on coastal ecosystems.

Keywords: marine bioinvasions, marine litter, rafting dispersal, biofouling, invasive species.

Evolution as a disruptor of invasive Argentine ant supercolonies

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The introduction of alien species into new habitats stands as a pressing economic and ecological challenge but also serves as a focal point for unveiling evolutionary processes. The introduction of the Argentine ant (*Linepithema humile*) constitutes one of the most fascinating phenomena associated with species introductions because it led to the spreading of a single supercolony through thousands of kilometers (in Europe, from Northwest Spain to Greece). It was assumed that the high invasiveness of the species mainly relies on an effect derived from its introduction: the lack of aggression among colonies. However, recent studies show that local adaptations and consequent evolutionary divergence could involve the disruption of the Argentine ant "empire" into a mosaic of competitive colonies. Understanding this phenomenon could be the clue to managing the expansion of alien species, especially those organized in supercolonies. We focused on the effect of isolation according to the colonization ontogenesis by comparing the divergence of mainland and island populations in areas that were initially (Spain) and currently (Greece) colonized. We analyzed the morphology, aggressiveness, cuticular hydrocarbons, and genetic diversity of ant workers. All colonies sampled belonged to the most spread supercolony in Europe (main supercolony) except one of the two sampled in Crete (Heraklion; Greece), which resulted to be a new supercolony not registered in Europe. The Heraklion supercolony showed a different chemical and genetic profile and lethal aggressiveness towards the other Greek colonies, including the other Crete colony. Following our expectations, differences between islands and mainland colonies were higher in Galiza than in Greece. Differences between island and mainland did not follow a unique pattern, suggesting different divergence processes due to different local adaptations. Our study suggests that the Argentine ant colonies' local adaptations are capable of triggering competition among colonies and, therefore, limiting the invasiveness of this species.

Keywords: agonism, bottleneck effect, genetic drift, pest management, recognition.

Management

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Manejo

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Manexo

Citizen science for invasion monitoring: insights from four years of Alien Bioblitz in the Canary Islands

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Early detection is critical for effective management of invasive species, and citizen science has emerged as a promising approach to support large-scale monitoring efforts. The Alien Bioblitz initiative was designed to collect records of exotic species within a short, intensive sampling window, enhancing public participation and generating valuable biodiversity data. The project has been operating in the Canary Islands for four consecutive years (2022–2025), building a growing dataset of georeferenced observations across the archipelago. Through taxonomic and spatial assessments, we aimed to identify the most ubiquitous taxa, evaluate potential taxonomic biases, and determine the geographic areas with the highest sampling effort. Additionally, we applied First Record Distribution Models across the entire archipelago to predict areas where the establishment or naturalization of exotic species is most likely and to identify priority locations for future awareness and monitoring campaigns. Preliminary results indicate that Cactaceae, particularly species of the genus *Opuntia*, are among the most frequently recorded taxa. Other highly observed species include *Cenchrus setaceus* (Forssk.) Morrone and *Lantana camara* L., both recognized for their invasive potential. However, marked inter-island differences were detected in species composition, reporting frequency, and sampling intensity. These differences appear to be influenced not only by ecological factors but also by the presence and engagement level of local collaborating entities and participants. Our findings underscore the value of short-term, high-intensity citizen science campaigns as effective tools for early detection and spatial risk assessment of invasive species. Integrating participatory monitoring with predictive modeling offers a strategic framework to optimize surveillance efforts, prioritize management actions, and strengthen collaboration between scientific institutions and local communities across oceanic island systems.

Keywords: oceanic islands, BioBlitz, FRDM, citizen science.

Effects of non-native willow removal in a multi-invaded riparian ecosystem from northwest Patagonia

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The removal of woody invasive species is widely recommended to mitigate damage and restore native ecosystems. However, such actions may lead to unexpected outcomes, particularly in multi-invaded ecosystems. In this context, the objective was to determine the ecological effects of controlling non-native willow (*Salix* × *rubens*) and their interaction with introduced herbivores in a riparian ecosystem. The study was conducted in a riparian shrub–woodland along the Chacabuco Stream (NW Patagonia, Argentina). In autumn 2021, we implemented a one-time experimental willow removal in areas with low invasion. The experiment followed a block design with ten plots with removal and ten without removal; within each plot, two subplots were fenced to exclude herbivores and two remained exposed to herbivory. Over four years, we evaluated different attributes of natural plant community regeneration (understory species cover, as well as height, browsing, and abundance of woody saplings) and light availability.

Over the four years, willow removal and herbivory strongly influenced natural regeneration. Following removal, light availability increased and promoted the growth of all vegetation strata, particularly perennial non-native grasses and herbs. Additionally, species diversity and browsing on woody species increased after willow removal. In contrast, herbivores delayed regeneration, especially affecting palatable native woody species, which showed reduced cover and height outside exclosures. Herbivores also promoted the establishment of non-native herbs, increasing their cover and richness regardless of willow control. Species composition was not affected by willow removal nor herbivory.

Willow removal produces unexpected effects on riparian plant communities, such as facilitating secondary invasions and promoting the browsing of native woody species. These effects are further modulated by introduced herbivores that compromise native vegetation regeneration. Therefore, the establishment of exclosures is a recommended action to complement the management of non-native willows. This study highlights the importance of studying invasive species control at an experimental scale to account for pre-treatment conditions and to guide interventions from the start.

Keywords: invasive species management, riparian ecosystem, non-native herbivores, *Salix x rubens*, northwest Patagonia.

Matrix population models as tools for feral horse management

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When developing management strategies to minimize the impact of large invasive herbivores, maximizing efficiency is essential, as resources are generally limited and the consequences of control interventions are often uncertain. Key components associated with success include population age structure and dynamics, the presence of natural regulators such as predators, and socio-economic implications of different management methods. Since 1942, a population of feral horses has inhabited a natural reserve of mountain grasslands in Argentina, where it produces multiple impacts on the native ecosystem and represents a serious conservation concern. The objective of this work was modelling its population dynamics to evaluate the effects of different management strategies under simulated scenarios. We projected population trends using matrix models incorporating demographic stochasticity. We developed a function to test the effects of combinations of removal frequency and intensity, together with varying levels of predation pressure. Predation emerged as a relevant contributor to herbivore population regulation. The most effective method of achieving population eradication was frequent removal of adult females (every 1-3 years). If the goal is instead to maintain the population below an ecological impact threshold, removals should shift to a maintenance regime in which extraction matches recruitment.

Keywords: feral horses, management, matrix population model, natural grasslands.

Estimating the economic burden of invasive alien species in Morocco: a potential $1.14–$5.13 billion annual threat

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Biological invasions pose a substantial threat to biodiversity and economies globally, yet robust cost assessments for North Africa have historically been lacking. Following the recent completion of the first comprehensive national-scale assessment, this study presents estimated economic costs of invasive alien species (IAS) in Morocco. By synthesizing data from the InvaCost database and harmonizing species inventories, we identified 343 IAS established in the country, representing approximately 1.11% of Morocco's biodiversity.
Economic modeling, adjusted for socio-economic and climatic variables, reveals that biological invasions could inflict a projected annual cost ranging from US$1.14 billion (conservative estimate) to US$5.13 billion (maximum scenario) on the Moroccan economy. Our models suggest that damage costs consistently exceed management expenditures by up to two orders of magnitude, highlighting a reactive rather than proactive approach to invasion management. The agricultural sector appears to bear the heaviest burden, driven by high-cost insect pests such as *Phenacoccus madeirensi*, *Bemisia tabaci*, and *Cydia pomonella*. Furthermore, public health and fisheries are increasingly impacted by species like the Asian tiger mosquito (*Aedes albopictus*) and the common carp (*Cyprinus carpio*), respectively.
These findings provide the first monetary baseline for the potential impacts of biological invasions in Morocco. We discuss the uneven geographic distribution of these projected costs, with major urban and coastal centers (e.g., Marrakech-Safi, Casablanca-Settat) facing the highest economic exposure. These results underscore the urgent need for targeted policy interventions and increased investment in prevention and early detection to mitigate this growing socio-ecological crisis.

Keywords: biological invasions, economic impacts, management strategies, Morocco, InvaCost.

Object detection of the invasive species *Opuntia ficus-indica* from Google Street View Imagery

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The spread of invasive plant species represents a growing ecological and economical challenge, particularly in regions where early detection and monitoring resources are limited. *Opuntia ficus-indica* (prickly pear cactus) is an invasive plant than grows in arid and semi-arid regions because of its rapid propagation and its resilience to extreme environmental conditions. Traditional monitoring approaches rely heavily on field surveys, which are time-consuming, costly, and spatially constrained. Google Street View represents one of the largest publicly available repositories of street-level imagery, offering extensive geographic coverage and temporal updates. Despite its potential for environmental applications, street-level imagery remains largely underexplored for invasive plant detection, and, to the best of our knowledge, no object detection model has yet been specifically trained to identify *Opuntia ficus-indica*. Advances in deep learning, particularly in real-time object detection architectures such as YOLO, create new opportunities to leverage this large-scale visual data source for ecological monitoring. This project investigates the feasibility of training object detection models to identify *Opuntia ficus-indica* in Google Street View images collected across Sicily, where this plant is widely distributed. A manually annotated dataset comprising 3,155 Google Street View images has been constructed, and different YOLO-based architectures are currently being tested to assess their detection performance. Model performance is assessed using standard detection metrics, including precision, recall, and mean Average Precision (mAP). Future work will focus on developing an interactive and scalable monitoring tool that enables rapid, cost-effective management of invasive species. The proposed framework aims to support temporal analysis of species spread, allowing stakeholders to visualize distribution patterns and monitor invasion dynamics over time.

Keywords: invasive species monitoring, *Opuntia ficus-indica*, Deep learning, object detection, YOLO, Google Street View.

Monitoring non-indigenous species hotspots: a baseline study from Monastir Bay, Tunisia

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Marine ecosystems face escalating threats from biological invasions that destabilize native communities and compromise ecosystem function. The Mediterranean Sea, a renowned biodiversity hotspot, is experiencing accelerated non-indigenous species (NIS) introductions driven by intensified maritime traffic, ocean warming, and acidification. Despite these pressures, research efforts have concentrated in the northern Mediterranean, creating a critical knowledge gap in the southern region that hinders effective management and prevention strategies.

To address this deficiency, our study applies MarineGEO's standardized fouling community protocol, constituting the first systematic NIS monitoring effort in Tunisia's southern Mediterranean waters. Twenty-four PVC settlement panels were deployed in late August 2024 across four strategically selected sites in Monastir Bay: an aquaculture farm, a fishing harbor, a marina, and a site adjacent to a grounded vessel near the Kuriat Island Marine Protected Area. Monthly photographic surveys tracked biofouling succession over a 90-day immersion period, allowing evaluation of community composition and temporal dynamics across contrasting habitat types. Relative abundance of biofouling taxa was estimated from panel images using PhotoQuad software with a stratified 100-point count approach.

Our findings revealed 27 confirmed NIS with significant spatiotemporal variation in community structure. The marina exhibited the highest diversity, while the fishing harbor showed the lowest. Notably, the ascidian *Didemnum* cf. *perlucidum* dominated open-water environments (aquaculture and grounded ship sites), whereas the bryozoan *Celleporaria inaudita* was abundant in artificial harbor settings. These results underscore the value of standardized monitoring protocols for identifying high-risk invasion hotspots and tracking biofouling succession patterns. Our research provides essential baseline data to support targeted NIS management strategies in Kuriat Island Marine Protected Area and contributes to filling the knowledge gap in southern Mediterranean marine biodiversity monitoring.

Keywords: non-Indigenous species (NIS), biofouling, Mediterranean Sea, invasion hotspots.

Quantification of carbon stocks of invasive *Opuntia* species in Tenerife, Canary Islands

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Carbon sequestration by terrestrial ecosystems is a key strategy to mitigate global warming. However, the management of global change drivers such as invasive plant species can alter carbon cycling, as usually control actions require the removal of large amounts of biomass, resulting in carbon stock loss and CO_2 release during decomposition. Thus, quantifying this carbon footprint is essential to integrate carbon balance into invasive species management. As an example of this potential impact, we estimated the spatial extent, dry biomass, and carbon content of the invasive species *Opuntia maxima* and *Opuntia tuna* on Tenerife (Canary Islands), selected due to their widespread distribution, high productivity, and capacity to alter invaded ecosystems. The area occupied by both species was quantified through field cover sampling, while biomass was estimated from species-specific biomass sampling per unit area. Based on these data, we assessed their contribution to the island's terrestrial carbon stock, as well as the potential carbon footprint associated with their removal. Also, we developed an allometric equation to facilitate future biomass estimations of *Opuntia* spp. The contribution of both *Opuntia* species to the carbon storage of Tenerife's terrestrial vegetation (≈ 100,000 tons) is mainly due to the species' high productivity and wide distribution, despite their low carbon accumulation capacity (> 85% water content and 31.5% carbon content in dry biomass). These estimates show that the carbon footprint generated by invasive species control in heavily invaded ecosystems can be significant (over 50% of *Opuntia*'s carbon stock is in natural protected areas). These findings highlight the importance of incorporating carbon footprint assessments into invasive species management, where restoration of native vegetation should be considered to compensate for carbon losses. This approach will help identify strategies to mitigate the carbon footprint of control actions, ensuring that management contributes to both biodiversity conservation and climate change mitigation.

Keywords: allometric equation, biomass, carbon footprint, management, scrub.

Current distribution and abundance of the invasive crab *Percnon gibbesi* in the Balearic Islands: insights into 25 years since colonization

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Percnon gibbesi (H. Milne Edwards, 1853) is a tropical decapod crustacean, first reported in the Mediterranean Sea in 1999, simultaneously in the Balearic Islands and the Strait of Sicily. Since this first report, this crab has extended its home range across the Mediterranean and was listed in the Spanish Catalogue of Invasive Alien Species in the Royal Decree in 2013. The objective of the study is to provide an updated assessment of the distribution and abundance of *P. gibbesi* in the Balearic Islands since 1999.Data was collected through citizen science platforms (Biodibal, GBIF, Bioatles). The obtained records were validated by experts and complemented with reports from published literature and field surveys. Over 500 dated records were validated and georeferenced according to Darwin Core standards. Results show a high presence of this species in the Balearic Islands, with the highest incidence in Ibiza and the lowest in Formentera. This species is mainly found in rocky areas, particularly in boulder fields with many crevices and poorly developed algal coverture. Densities ranged from 0.03 to 4.20 ind/m^2, with substantial spatial variation. Most records were concentrated between June and October, coinciding with warmer months and likely reflecting both increased species visibility and higher observer activity during the summer. Since its first reports, the annual number of records has increased. Additionally, over 60% of the occurrence records originated from citizen science initiatives, highlighting their value in early detection and monitoring of invasive species. This trend likely reflects both the continued expansion of the species and the growing impact of citizen science platforms in documenting its presence. These findings confirm the wide establishment of *P. gibbesi* in the Balearic coastal ecosystem and underscore the importance of integrating citizen science into long-term ecological monitoring strategies.

Keywords: Balearic Islands, crab, invasive, Mediterranean, *Percnon gibbesi.*

Spreading northwards and southwards, but in the end, spreading: range expansion of two non-indigenous sponges in southern European waters

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In recent decades, shipping and aquaculture have increased the dispersal of marine species beyond their native ranges. Consequently, ports, marinas, and aquaculture facilities have become major hotspots for the introduction of non-indigenous species (NIS). In these areas, artificial structures provide suitable substrates for fouling assemblages, often dominated by NIS. Sponges possess several biological traits (i.e., high phenotypic plasticity and tolerance to environmental stress) that favour their dominance in fouling communities. However, records of NIS sponges remain scarce and geographically biased, suggesting that their non-native ranges may be underestimated.

Since December 2021, several surveys to detect NIS sponges were conducted in different localities of the Atlantic coast of the Iberian Peninsula. Surveys involved visual inspection, snorkelling and SCUBA diving in natural rocky shores and artificial habitats (ports, marinas and aquaculture facilities). When present, sponges were collected and identified based on skeletal architecture and dissociated spicules.

Here, we provide new data on the distribution of two NIS sponges, *Chalinula loosanoffi* and *Paraleucilla magna*, along the Atlantic coast of the Iberian Peninsula. Both species were primarily recorded on artificial substrates such as floating pontoons and mussel ropes, and *P. magna* was also found in natural habitats like rocky shores and seaweeds. *C. loosanoffi*, is native to the northeastern United States and was previously reported from the Dutch coast. It is here recorded for the first time in the Iberian Peninsula, representing its southernmost biogeographical record in Europe. *P. magna* was originally described from southeastern Brazil and is widely distributed in the Mediterranean Sea. It is newly reported from southern Spain (Cádiz), southern Portugal (Faro), and the southern Galician Rías (northwestern Spain), the latter constituting its northernmost record.

Our findings highlight the role of boating and aquaculture as vectors for NIS dispersal and underscore the need to integrate overlooked phyla in NIS monitoring programs.

Keywords: non-indigenous species, sponges, fouling, artificial structures, range expansion.

Trading beauty: an assessment of the ornamental fish trade in India through the lens of pet traders

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Ornamental Pet trade is a crucial driver for species invasion which is driven by the interest and demand of the hobbyist, traders and fish keepers. The lack of regulations is pushing the native species on the verge of extinction. Around 22,000 species of fish recorded globally, 11% are found in Indian waters, among which 300 species of fish belong to ornamental fish category. India is one of biodiversity hotspots with many endemic species which are under risk of existence due to ornamental pet trade market due to huge demand of export and trade. The current study focusses on status of introduced species through pet trade especially in case of ornamental fishes through questionnaire-based interview to each domain of stakeholders in various states of India. Suitable statistical models will help to understand the most traded species, perspective of hobbyist, fish keepers which can inform a promising management for the outsourcing of our native species through trades (especially coral fishes, cichlids, catfishes) and ecological risk associated with it. Such research is crucial to spread awareness among fish keepers for potential impact of these ornamental pets thereby reducing its demand. Studies on ornamental pet trade is severely lacking in Indian subcontinent which is resulting in rapid species loss. A thorough assessment of ornamental fishes in trade from the pet traders, hobbyists, fish keepers is warranted which may help to understand the real picture of ornamental fishes either imported or exported from India to safeguard the indigenous diversity and prevent species invasion. The study will also help to understand species of high demand of ornamental market and its perspective from various stakeholders, along with band fishes in trade market so that proper management practices can be adopted strengthening regulations in pet trade market in India.

Keywords: invasion, ornamental species, pet trade, biodiversity, management.

Behavioral learning and the effectiveness of angling as a control method for invasive predatory fish

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Biological invasions represent a major threat to freshwater ecosystems, and recreational fishing is increasingly used as a vector for introduction and as a potential management tool for invasive fish. However, angling effectiveness may be constrained by behavioural plasticity and learning. This study investigated whether juvenile largemouth bass (*Micropterus nigricans* (Lacépède, 1802)) can modify their behavior in response to fishing stimuli by observing individuals of the same species being caught and by measuring how quickly they learn to avoid artificial lures. Experiments were conducted with 24 naive juveniles held in divided tanks under treatment (visual exposure to conspecifics fishing) and control conditions. Standardized fishing sessions were conducted over 5 consecutive days, and behavioral responses were quantified using generalized linear models. A total of 81 interactions, 16 hooking events, and four catches were recorded, with all catches occurring exclusively in the control tanks. Fish exposed to the treatment showed significantly fewer interactions with the bait, and these interactions decreased over time, indicating learning or habituation. In contrast, aggressive attacks towards conspecifics increased over the course of the experiment and were strongly influenced by individual identity. These results suggest that *M. nigricans* rapidly adjusts exploratory and social behaviours in response to angling stimulus, with important implications for the effectiveness of angling-based management and recreational fisheries in invaded freshwater systems.

Keywords: largemouth bass, non-native fish, management, fishing activity, capture susceptibility.

Enhancing aquatic invasion detection: a multi-temporal spectral approach to monitoring *Pontederia crassipes*

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Invasive Aquatic plant species, particularly the Water Hyacinth (*Pontederia crassipes*), pose severe threats to freshwater ecosystems and economic activities. Accurate mapping of invaded areas is necessary for efficient management, but riverine systems pose challenges due to water-level fluctuations and spectral interference from water and riparian vegetation. To overcome these, remote sensing methodologies in aquatic systems are often complex and context-dependent. In this research, we hypothesise that models utilising composite training data (encompassing the plant's life cycle) and multi-temporal spectral features outperform those relying on static, single-date information. We applied a Random Forest workflow to a Sentinel-2 time series to map the invasion dynamics of Water Hyacinth from July to October 2025 in a dynamic river in northern Portugal. High-resolution Unmanned Aerial Vehicle (UAV) imagery was used to digitalise invaded areas, thereby supporting the analysis of distinct spectral signatures associated with different biomass levels. We evaluated the performance of models trained on single-phenological stages versus composite models that integrated signatures from multiple growth stages. Furthermore, to enhance detection, the performance of single-date spectral variables was compared with temporal 'deltas' (variables calculated as the spectral difference between the monitoring date and a pre-invasion baseline). The results validated the study's hypothesis, revealing that composite spectral models (integrating signatures from multiple phenological stages) significantly outperformed single-date models. While individual spectral signatures performed adequately at the time of collection, their accuracy diminished as the invasion progressed. The analysis also identified that 'deltas' were the features that most contributed to the discrimination of Water Hyacinth. In our research, by successfully mapping the invasion's spatiotemporal dynamics, we identified an exponential growth phase in mid-August. Ultimately, these findings confirm that open-access, medium-resolution satellite imagery offers a viable and scalable solution for the operational monitoring and management of aquatic invasions.

Keywords: invasive plant species, Sentinel-2, multi-temporal, random forest.

Projected expansion of the invasive fern *Cyrtomium falcatum* in the Canary Islands under cmip6 climate

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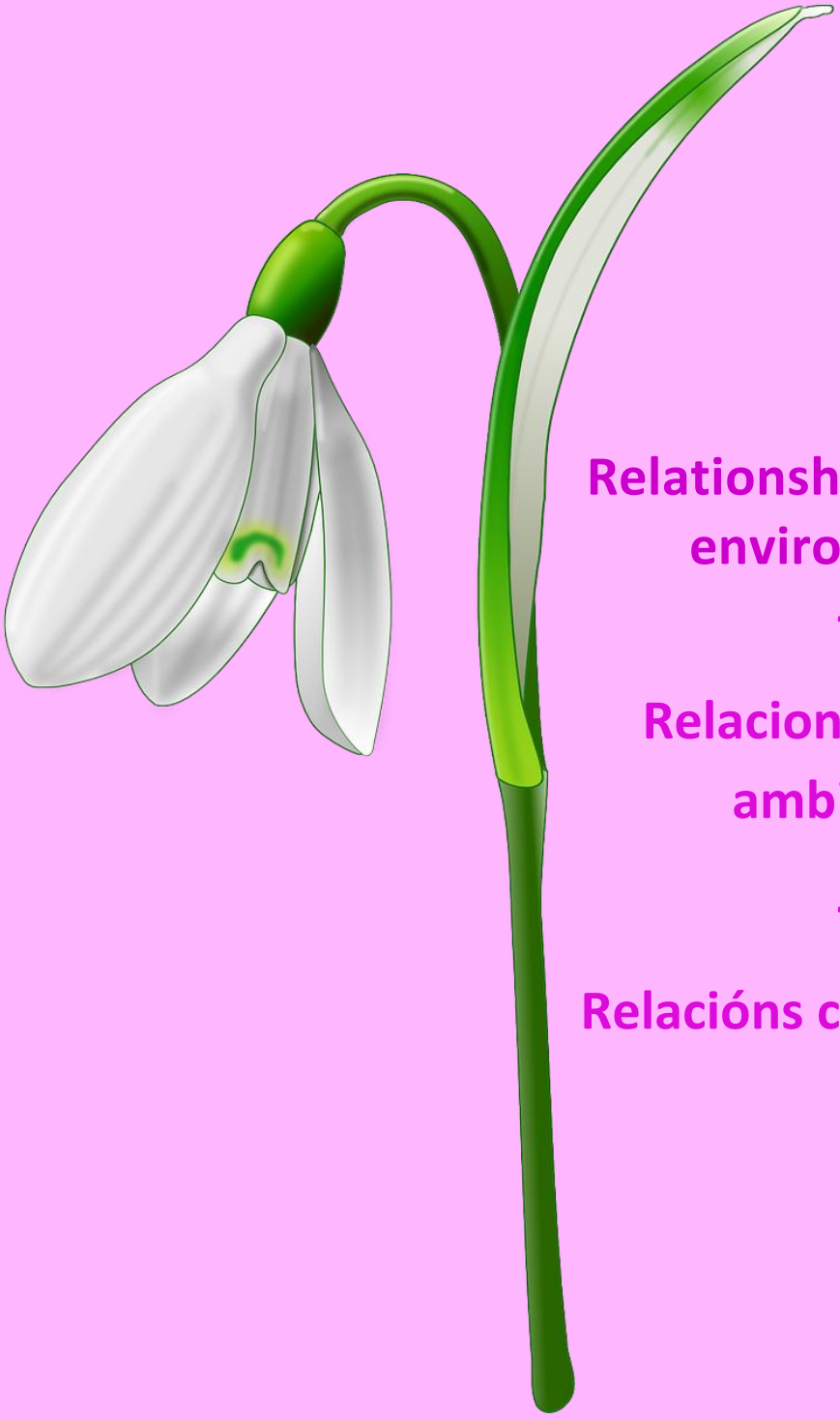
Cyrtomium falcatum (L.f.) C.Presl is an East Asian fern that has become invasive in several subtropical and temperate regions. In the Canary Islands (Macaronesia), it is naturalized and appears to be expanding from a still-fragmented distribution. The species exhibits broad ecological amplitude, colonizing humid, shaded habitats such as forest margins and moist ravines, but also highly disturbed sites including stone walls, urban gardens, road cuttings, seepage slopes and other anthropogenic substrates. Its preference for persistently moist soils under canopy or rock cover, together with frequent occurrence in managed landscapes, raises concern for native flora and island ecosystems under climate change and ongoing urban expansion.

We assessed current and future habitat suitability for *C. falcatum* across the archipelago using presence-only species distribution models (SDMs) implemented in *Biomod2*. High-resolution bioclimatic predictors were selected after screening the complete set of available climatic variables for collinearity, and georeferenced occurrence records were used to calibrate contemporary suitability. Models were projected to 2071-2100 under three CMIP6 Shared Socioeconomic Pathways (SSP1-2.6, SSP3-7.0 and SSP5-8.5), using a representative ensemble of general circulation models selected for their performance and reliability in the Macaronesian region.

Across scenarios, projections indicate a substantial net increase in climatically suitable area, particularly within mid-elevation belts and north-facing sectors. La Palma shows the largest projected niche gain, with suitability extending to over half of the island's surface by 2071-2100. High-suitability zones are also predicted in peri-urban and infrastructure-dominated landscapes, suggesting that disturbance, connectivity and human-assisted dispersal may accelerate spread and facilitate incursions into nearby natural habitats and protected areas.

These findings highlight a growing invasion risk for *C. falcatum* and support proactive management, including targeted surveillance in predicted hotspots, rapid response and early removal of nascent foci, and reinforced monitoring along corridors linking anthropogenic habitats to conservation sites. Prioritising La Palma could yield immediate benefits.

Keywords: invasive fern, Macaronesia, Canary Islands, Biomod2, species distribution modelling.



Relationship with the environment

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Relaciones con el ambiente

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Relacións co ambiente

Industrial farming of edible insects in India: biogeographic trends, ecological risks and regulatory gaps

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The meteoric rise and industrailisation in edible insect farming is because it is proposed as a more sustainable alternative to traditional meat. Our study investigates taxonomic identities, biogeographic origins, and emerging ecological risks, as well as spatiotemporal distribution of companies and biosecurity practices they follow.

Out of the 13 species across five orders commonly farmed in India, order Diptera (flies), Coleoptera (beetles), and Blattodea (cockroaches and termites), and species, Black soldier fly (*Hermetia illucens),* Mealworm (*Tenebrio molitor),* and Superworm (*Zophobas morio)* are the most widely reared. The native range for most species is Neotropical and Palearctic regions. Most companies were founded in 2018 - 2025, concentrated in Southern and Central Indian states. Edible insect usage in India occurs largely in the feed sector, led by the aquaculture, aviculture, pets, and livestock industries. These insects have high invasion potential, and acting as reservoirs of parasites and pathogens of vertebrate and invertebrate diseases. When the companies farming these insects were contacted for biosecurity protocols, these requests went unanswered, casting doubts on the regulatory practices followed.

We propose that a continued rise in the edible insect industry in the absence of an adequate regulatory framework poses the risk of significant, multi-dimensional impacts on India's environment. Since the rise in edible insect farming in India is very recent, the complete ambit of ecological consequences is yet unclear, but there are lessons to be learnt from other countries where these very species have caused substantial ecological impacts. Failure to address this emerging concern would be inconsistent with India's commitments under Sustainable Development Goals 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production) and 15 (Life on Land), as well as the Kunming-Montreal Global Biodiversity Framework, especially targets 6, 10 and 15, which emphasise sustainable business practices, and identification and mitigation of biodiversity-related risks.

Keywords: biological invasions, biosecurity, ecological impacts, global change, sustainability, species trade, transport.

Climatic niche dynamics of South African introduced plants in France: conservatism or shifts?

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Understanding the climatic niche dynamics of exotic species is essential for predicting potential invasion areas and associated impacts, as well as for understanding the mechanisms underlying invasion success. Although biogeographic origin can indicate potential climatic pre-adaptations associated with the native range, comparative analyses of niche dynamics within France's diverse climates remain limited. This study evaluates the invasion potential of four plant species established in France (*Arctotheca calendula*, *Carpobrotus acinaciformis*, *Carpobrotus edulis*, and *Oxalis pes-caprae*), with the expectation that, given their shared South African origin, they would exhibit similar climatic niche dynamics in France. To test this, we quantified and compared their climatic niches in both their native and introduced ranges to detect niche shifts or conservatism, and to determine whether they occupy analogous or novel climatic conditions in France. Results indicate that while niche overlap between species' ranges was very limited to low, niche stability was high across all species, supporting the hypothesis of climatic niche conservatism. *O. pes-caprae* demonstrated the strongest conservatism with full niche equivalency, whereas the other three species exhibited partial niche shifts. Notably, *A. calendula* and *C. edulis* showed significant niche pioneering, expanding into wetter and more climatically stable environments in France compared to their native South African habitats. These results highlight that, while niche dynamics are not uniform across species, the South African species examined here show both evidence of niche conservatism and dissimilarity in France. Such variation likely reflects species-specific invasion strategies, suggesting that climatic pre-adaptations, as inferred from biogeographic origin, are not the sole determinants of niche dynamics in non-native species. Species' ecological characteristics, eco-evolutionary mechanisms, and native niche breadth may also represent key drivers of niche differentiation across ranges. Ultimately, these findings will support invasive species management in France by helping prioritize high-risk species and identify regions where niche shifts may increase invasion potential.

Keywords: analog vs non-analog climate, France, niche dynamics, plant invasions, South Africa.

Calcification response of *Halimeda incrassata* to elevated atmospheric CO_2

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Biological invasions pose a major threat to biodiversity, with the potential to disrupt ecosystem functioning and alter community structure. *Halimeda incrassata* (J. Ellis) J.V. Lamour. is a tropical calcareous macroalga that, since 2011, has become established and rapidly expanded across sandy bottoms of the western Mediterranean, modifying sediment grain size and affecting the associated benthic biota. This study aims to evaluate the response of this alga to increasing atmospheric CO_2 concentrations. Two pH treatments were established by manipulating pCO_2 levels, representing ambient (435 ppm) and elevated CO_2 conditions (1500 ppm). The higher level was selected to simulate an extreme future ocean acidification scenario. A control microcosmos design was used comprising 6 aquaria of 6.5 L, 8 individuals per aquarium, 2 treatments and 3 replicates. Specific growth rate, calcium carbonate content (% $CaCO_3$) and pigment composition (chlorophyll *a*, *b*, and *c*, carotenes, and pheopigments) were measured. The specific growth rate remained stable but not significant (1.34 % day^{-1} ± 0.69). In contrast, % $CaCO_3$ showed a significant effect of pH, as well as a significant pH × time interaction. Post-hoc comparisons indicated no significant differences between treatments at *t0* and *t1*. However, from *t2* onwards, calcification under ambient conditions was significantly higher than under acidified pH, with the magnitude of this difference increasing progressively toward the end of the experiment. It reached 95.0 % under pCO_2 435 ppm, but remaining at 78.0 % under pCO_2 1500 ppm past 27 days, including 14 days of acclimatation. Regarding pigment composition, no statistically significant differences were observed between treatments. Overall, the results indicate that elevated CO_2 concentrations exert negative effects on the calcification of *H. incrassata*, which may influence its role in sediment production and the ecological impact of its biological invasion in Mediterranean benthic ecosystems.

Keywords: *Halimeda incrassata*, ocean acidification, calcification, atmospheric CO_2, benthic ecosystems.

Thermal response of the invasive brown alga *Sargassum muticum* under simulated marine heatwaves scenarios: insights from embryological to biochemical levels

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Sargassum muticum (Yendo) Fensholt is one of the most aggressive marine invaders worldwide. Native to the western Pacific, this phaeophyte has spread extensively through unintentional introductions.

Since its first detection in 2011-2012 on Atlantic coast of Morocco, Sargassum muticum has rapidly established forming persistent and dense populations in shallow rocky habitats with marked seasonal dynamics. In this study, we hypothesis that its invasive success has been increasingly linked to its capacity to tolerate environmental stressors linked to climate change, especially ocean warming and marine heatwaves, becoming frequent and intense globally. The aim of this study is to assess the tolerance of this invader to global warming scenarios by conducting tests under controlled laboratory conditions at different temperatures (10, 15, 20, 25 and 30°C) mimicking present-day and extreme warming conditions. This tolerance was assessed by monitoring the effect of different culture temperatures on the development of the algae's embryonic stages and the evolution of the biochemical composition of adult thalli through the analysis of biometric (weight and size), physiological (photochemical ratio Fv/Fm) and biochemical (phenolic compounds and chlorophyll markers over 5 days. The results reveal that *S. muticum* exhibits maximum growth performance between 20 and 25°C, characterized by stable photosynthesis efficiency (Fv/Fm > 0.70), high chlorophyll content and significant increase in biometric parameters. In contrast, exposure to 30°C, induced a significant decrease in Fv/Fm <0.7 and enhances the secretion of stress indicators, particularly phenolic compounds, as well as a decline in biometric parameters. Interestingly, although this elevated temperature reduced the efficiency of zygote release and attachment, it accelerated their development, with approximately 60% of them reaching an advanced stage within 72 hours. Statistical analysis confirms these variations, highlighting the thermal adaptability of this invader. The thermal adaptability of *Sargassum muticum*, particularly during the early stages of its development, suggests that the ongoing ocean warming could enhance its invasive success and facilitate its persistence under future climate change scenarios.

Keywords: *Sargassum muticum,* climate change, invasive species, adaptative physiology.

Evaluating the transferability of different species distribution modeling algorithms across native and invasive ranges using virtual species

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Biological invasions are a major driver of global biodiversity loss, making it essential to identify regions at high risk of exotic species establishment. Species distribution models (SDMs) are widely used for this purpose; however, their performance varies depending on the algorithm and context. In this study, we evaluated the accuracy and transferability of different SDM algorithms. Based on bioclimatic variables, 100 virtual species were generated according to environmental suitability and accessible areas. A cellular automaton was implemented to simulate native and invasive ranges based on dispersal capacities. SDMs were fitted using eight widely applied algorithms with presence-background data under default parameter settings. Performance was assessed via Pearson correlation between true occurrence probability and predictions in native and invasive ranges. Overall, models performed better in the native range than in the invasive range, with a mean correlation across species and algorithms of 0.71 and 0.50, respectively. Maxent achieved the highest mean correlation (native range = 0.88; invasive range = 0.62), followed by BRT (0.87 and 0.60) and MaxNet (0.83 and 0.63). Random Forests (0.62 and 0.51) and its downsampled variation (0.79 and 0.52) showed intermediate performance. In contrast, SVM (0.38 and 0.21), GLMs (0.59 and 0.38), and GAMs (0.63 and 0.49) exhibited lower predictive accuracy. While default configurations were used, species specific tuning could potentially improve model performance. Nevertheless, this study provides a comparative assessment of model transferability under standardized conditions, offering valuable insight into how widely used algorithms perform when predicting invasive species distributions. Future research should investigate whether the observed performance among algorithms stem from environmental extrapolation challenges where models encounter non-analog climates in the invasive range or inherent structural limitations of the algorithms when handling truncated environmental gradients. This distinction is crucial for improving the reliability of forecasts regarding the potential spread of exotic species.

Keywords: algorithm performance comparison, biological invasions, model exploration, species distribution models, virtual species.

A genomic perspective on population density–dependent responses of the New Zealand mudsnail

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Global biological invasions are escalating at an unprecedented rate, while the mechanisms sustaining successful establishments remain a subject of intense debate. In aquatic ecosystems, population density is a primary determinant of an invader's ecological footprint governing both direct impacts through trophic links and competitive interactions, and indirect economic consequences. The freshwater New Zealand mudsnail (*Potamopyrgus antipodarum*) is a globally distributed invader that significantly alters ecosystem structure and function. Its detrimental ecological impacts are primarily driven by the extraordinarily high population densities it achieves in invaded areas. Population density is a main determinant of the extent of intraspecific competition, which in turn can affect dispersal, behavior, and life-history outcomes. While previous research has demonstrated that growth and reproductive performance in *P. antipodarum* are strongly conditioned by population density, the molecular mechanisms underlying these responses have not been characterized.
In this study, we evaluated whether individual growth rates are differentially affected by conspecific density in invasive versus native lineages. We used six asexual triploid lineages: three from native New Zealand lake populations and three from invasive populations in the United States. Juvenile snails from these lineages were subjected to two density treatments: low (10 individuals/L) and high (33.3 individuals/L). We also used RNA sequencing analysis to identify genes that are differentially expressed under varying density conditions and to determine if a divergent molecular response exists between native and invasive groups. Preliminary results revealed that high density significantly reduced growth rates in both groups, with the magnitude of this effect differing among lineages. These results suggest lineage-specific sensitivity to population density, independent of invasion status. Integrating phenotypic and genomic insights may help explain why specific lineages become successful invaders while others do not. Characterizing the genetic basis for density sensitivity is critically important for effectively predicting and mitigating these destructive biological invasions.

Keywords: biological invasions, *Potamopyrgus antipodarum,* population density, RNA-Seq.

From invader to sentinel: assessing the bioindicator potential of *Percnon gibbesi* in Mediterranean coastal waters

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Marine coastal sites in the Mediterranean region are under long-term anthropogenic pressure, which has intensified in recent years due to increased tourism and the associated release of xenobiotics. In parallel, globalization has facilitated the spread and establishment of invasive species in coastal ecosystems. To determine whether an organism is a suitable model in ecotoxicology and environmental monitoring, detailed biological and ecological knowledge is required, particularly regarding its physiological responses to environmental stressors. This study represents a first step toward establishing such knowledge for the invasive crab *Percnon gibbesi*, which is widely distributed along the Balearic coast of Mallorca. The species was evaluated as a potential sentinel of coastal water quality at three sites with contrasting levels of human influence: Port Adriano and Portals Vells (high impact) and Alconàsser (low impact). Microplastics (MPs) in surface waters were used as indicators of anthropogenic pressure, and a suite of biomarkers related to immune function, moulting, detoxification, and antioxidant defences were measured in five tissues to obtain an integrative assessment of physiological condition. Additionally, in vitro assays were performed to evaluate the sensitivity of two key metabolic enzymes to environmentally relevant xenobiotics commonly associated with plastic pollution. Biomarker responses revealed that immune, endocrine, and antioxidant systems were the most responsive at sites with higher MP abundance, indicating a measurable physiological adjustment to local environmental conditions. In contrast, detoxification and neurotoxicity markers showed no consistent differences among locations. Lipid peroxidation levels remained unaltered, suggesting that antioxidant defences were sufficient to prevent oxidative damage under the observed conditions. In vitro exposure assays demonstrated that several xenobiotics associated with plastics inhibited detoxification enzymes, whereas moulting-related enzymes were not directly affected. Overall, these findings support the suitability of *P. gibbesi* as a sentinel species for monitoring anthropogenic impacts in Mediterranean coastal waters, although further studies integrating chemical analyses and controlled exposure experiments are warranted.

Keywords: *Percnon gibbesi*, ecotoxicology, invasive, xenobiotics, Mediterranean sea.

Social aspects

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Aspectos sociales

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Aspectos sociais

Mainstream media drive online interest in UK invasive non-native species

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Invasive non-native species (INNS) are one of the main drivers of global biodiversity loss. Understanding public awareness and perceptions is critical for successful management of INNS impacts. However, measuring them using traditional methods, such as surveys, has historically been limited by financial and time constraints. Conservation culturomics - the use of digital data to assess human-nature interactions - can provide a cheap and efficient solution to these constraints. Indeed, internet search volumes provide a proxy for public interest in INNS. We used Google Trends to assess the relative search volumes (RSV) for scientific and common names of the Great Britain Non-Native Species Secretariat's risk-assessed INNS in the UK from 2009 to 2023. To understand what drives RSV, we reviewed online content correlating with peaks in search interest (≥1.5 standard deviations above the mean search interest for that species). Factors influencing RSV over time included seasonal changes in the species (such as flowering periods for plants) and the appearance of the species in the media (such as television features on nature documentaries). We explored how peaks in RSV are correlated with online content, looking at types of media (blogs, social media posts, forum discussions etc.) and what topics are covered when INNS are discussed online (management, impacts, cultivation of the species, etc.). Correlations between RSV and mentions in mainstream media such as television and national news articles suggest that media engagement plays an important role in driving online interest in INNS. This growing interest is vital to ensure community understanding and support for INNS reporting, containment and eradication programmes, helping to limit biodiversity loss.

Keywords: UK, Google, media, public, awareness.

Citizen science: fresh insights & new records on Hommayda (*Oxalis pes-caprae* L.) in Lebanon

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Among the multiple threats to biodiversity in Lebanon, invasive plant species (IPS) remain largely overlooked. Preventing and managing IPS spread requires a knowledge base and research capacity that are currently lacking in Lebanon. This dual challenge -lack of specialists and deprioritization of the issue has enabled the uncontrolled propagation of IPS across all regions of the country. Addressing this biodiversity threat requires comprehensive and coordinated efforts to build knowledge capacity, develop and apply preventive and management measures, and adapt legislation. Participatory science offers an opportunity to engage the public by including them in data collection, helping to highlight the importance of IPS. This study uses a citizen-based approach to map the spatial distribution and document the socio-cultural significance of one of the most widespread IPS in Lebanon, *Oxalis pes-caprae* L. (locally known as Hommayda). Data are collected through a structured bilingual (Arabic/English) questionnaire comprising 25 questions addressing occurrence, habitat type, temporal persistence, perceived impacts, and human use. Preliminary results indicate the widespread presence of *O. pes-caprae* across diverse habitats nationwide. Our findings show that *O. pes-caprae* is strongly embedded in childhood memories, local traditions, and rural cuisine, and is perceived as providing ecological and cultural benefits. However, there is low public awareness of its invasive status, which may represent a conflict when attempting to reduce the spread and utilisation of *O. pes-caprae*. By highlighting the social embeddedness of *O. pes-caprae*, this study raises critical questions regarding management feasibility and public acceptance of control measures. It calls for further ecological assessment to clarify the species' impacts and inform evidence-based decision-making regarding its status and management in Lebanon.

Keywords: invasive species management, *Oxalis pes-caprae*, public perception, biodiversity conservation, Lebanon.

Species list - Lista de especies - Lista de especies

Acacia dealbata

Aculus taihangensis

Aedes albopictus

Ailanthus altissima

Apis mellifera

Arctotheca calendula

Batophora occidentalis

Bemisia tabaci

Boeckella gracilipes

Bosmina longirostris

Bugula neritina

Callinectes sapidus

Campylopus introflexus

Carpobrotus acinaciformis

Carpobrotus spp.

Carpobrotus edulis

Celleporaria inaudita

Cenchrus setaceus

Ceriodaphnia dubia

Chalinula loosanoffi

Columba livia

Condalia microphylla

Craspedacusta sowerbii

Crithidia bombi

Cydia pomonella

Cyprinus carpio

Cyrtomium falcatum

Daphnia sp.

Dermacentor marginatus

Dicranum scoparium

Didemnum cf. *perlucidum*

Elaeagnus angustifolia

Emys orbicularis

Eriocheir sinensis

Estrilda astrild

Eucalyptus globulus

Galaxias platei

Graptemys pseudogeographica

Halimeda incrassata

Halophila stipulacea

Hermetia illucens

Lantana camara

Linepithema humile

Magallana gigas

Mauremys leprosa

Mauremys reevesii

Mauremys sinensis

Melinis repens

Micropterus nigricans

Myiopsitta monachus

Mytilus galloprovincialis

Neovison vison

Nyctereutes procyonoides

Odocoileus virginianus

Oncorhynchus mykiss

Opuntia ficus-indica

Opuntia maxima

Opuntia spp.

Opuntia tuna

Oxalis pes-caprae

Paraleucilla magna

Percnon gibbesi

Phenacoccus madeirensi

Pontederia crassipes

Potamopyrgus antipodarum

Prunus serotina

Pseudemys concinna

Pseudemys peninsularis

Pseudemys spp.

Psittacula krameri

Robinia pseudoacacia

Salix × *rubens*

Sarcocystis spp.

Sargassum muticum

Setaria parviflora

Sus scrofa

Tenebrio molitor

Trachemys scripta

Trichinella britovi

Trichinella nativa

Trichinella pseudospiralis

Trichinella spiralis

Varroa mite

Verticillium nonalfalfae

Zizka subsp. *repens*

Zophobas morio

Zostera noltii

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