



# Book of Abstracts

NEOBIOTA 2022



12th International Conference on Biological Invasions  
Biological Invasions in a Changing World

Tartu, Estonia  
12–16 September 2022





Estonian Naturalists' Society

## **NEOBIOTA 2022**

**12<sup>th</sup> International Conference on Biological Invasions**  
**Biological Invasions in a Changing World**

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12–16 September 2022

# **Book of Abstracts**

Edited by Madli Linder

Tartu 2022

Biological Invasions in a Changing World. Book of Abstracts.  
Neobiota 2022 – 12th International Conference on Biological Invasions.  
Tartu, Estonia, 12–16 September 2022.

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1. *Impatiens glandulifera* (Himalayan balsam), Estonia. Author: Eike Tammekänd.
2. *Procambarus virginalis* (marbled crayfish), Estonia. Author: Eike Tammekänd.
3. *Heracleum sosnowskyi* (Sosnowsky's hogweed), Estonia. Author: Eike Tammekänd.
4. *Perccottus glenii* (Chinese sleeper), Estonia. Author: Aimar Rakko.
5. *Rosa rugosa* (Japanese rose), Estonia. Author: Eike Tammekänd.
6. *Krynickyllus melanocephalus*, Estonia. Author: Maris Sepp.

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## ORGANIZATION

### Organizer of the Conference

Estonian Naturalists' Society, Struve 2, Tartu 51003, Estonia

### Local Organizing Committee (in alphabetical order):

Aveliina Helm	Merike Linnamägi
Jonne Kotta	Tiit Maran
Toomas Kukk	Ülle Reier
Tiiu Kull	Eike Tammekänd
Madli Linder	

### Scientific Committee (in alphabetical order):

Sven Bacher (CH)	Melanie Josefsson (SE)	Helen Roy (UK)
Giuseppe Brundu (IT)	Jonne Kotta (EE)	Roar Sandodden (NO)
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Miia Jauni (FI)		

### Supporters



Info for presenters:

Journal **Diversity** is offering a **Best Presentation award** and is waiting for contributions to a **special issue** „Biological Invasions in a Changing World (NEOBIOTA 2022)“.

One free publication in the **Neobiota** journal will be given as a **Best Talk award**, sponsored by Pensoft Publishers.

**European Weed Research Society (EWRS)** is supporting financially young scientists participating in the joint EWRS-NEOBIOTA session “Relationships between weeds and invasive alien plants (special joint session with EWRS)“.

## Dear Colleagues!

Warm welcome to all the attendees of the 12<sup>th</sup> International Conference on Biological Invasions! We are happy helping to carry the tradition of NEOBIOTA conferences having the history of 22 years by now.

We very much appreciate the opportunity to host NEOBIOTA this year in this corner of Europe. Thank you, NEOBIOTA Board, for the trust and choosing Estonia for hosting! NEOBIOTA conferences have always brought together outstanding biological invasions experts, and we can say that the goal to attract more people from this area when organizing the conference in Estonia has been succeeded. It definitely has brought together more colleagues to this event from the Eastern and Northern European countries than before, but also from the other countries from all over the world having strong traditions of investigating biological invasions, or vice versa, starting in this area. Special greetings go to the representatives from the Czech Republic – the number of experts from there is comparable to the delegates from Estonia, the organizing country.

Biological invasions are one of the main direct drivers of biodiversity loss worldwide. They pose rapidly growing threat to biodiversity, ecosystem services, sustainable development and human well-being. The challenge of halting biodiversity loss and facing this problem is more and more critical under the circumstances of climate change.

When choosing the subtitle for the conference in the end of 2021 – “Biological Invasions in A Changing World” – we could have never imagined how the world would change on 24<sup>th</sup> February this year when our neighbor invaded a sovereign country, happening just at about the same time we announced the beginning the submission of abstracts. And at the times when we were already getting happy about the fading of the COVID-19 pandemic.

I would describe the organization process since then with the same word Sven Jelaska, organizer of the previous conference two years ago used – uncertainty. Hereby I would like to give special thanks to Sven, for sharing his experience of the previous conference, when the pandemic of COVID-19 had just begun.

We had no hesitations of whether the organization of the conference should continue, just a lot of uncertainty. We had to prepare for everything and nothing at the same time. We are thankful for all our cooperators for being understanding under these circumstances.

All the uncertainty and concern about the future is also reflected in the presentations. Undoubtedly the most popular topic was the one about trends – what will happen next? When and in which magnitudes? How much does it cost? How will we cope in the future?

In the name of the Local Organizing Committee we hereby express our gratitude to all of the Keynote speakers for agreeing to contribute to this meeting, some of them having made an effort to get here from the other continents. We are very grateful to the Scientific Committee for peer reviewing the submissions, as well as the session Chairs for their contributions. We would like to thank all who are contributing whether oral or poster presentations. I heard many complaints from the reviewers how difficult the scoring of the abstracts was because of the high quality of them all.

Special thanks goes to the funders, partners and sponsors that provided support for this meeting. And finally, I would like to thank the Local Organizing Committee and the volunteers for their efforts.

Madli Linder,  
Chair of the Local Organizing Committee

## VENUE

NEOBIOTA 2022 will be held in the **University of Tartu Library Conference Centre** located in the Tartu City centre, which provides plenty of accommodation and leisure time opportunities.

Address: W. Struve 1.

**Lunch** will be served in the historic Gunpowder Cellar (Püssirohukelder), 6-minutes walk from the Conference Centre through a picturesque protected town park.

Address: Lossi 28

## PROGRAMME OVERVIEW

12 September 2022	Registration Welcome Reception
13 September 2022	Oral & Express Presentations & Poster Session Neobiota Council Meeting Guided Walk in the Old Town
14 September 2022	Oral & Express Presentations & Poster Session Conference Dinner
15 September 2022	Excursions Free Access to the Posters in the Conference Centre (the library is open 9:00–21:00)
16 September 2022	Oral Presentations, Awarding & Conference Closing

### Registration Desk Hours:

12 September 2022, 19:00–21:00, AHHA Science Centre

13 September 2022, 08:00–17:00, University of Tartu Library Conference Centre

14 September 2022, 08:00–17:00, University of Tartu Library Conference Centre

### Official Tourist & Travel Information:

- Official tourism site of Tartu and Tartu County: <https://visittartu.com/en>
- Official travel guide for the whole Estonia: <https://www.visitestonia.com/en/>
- Official website with information about travelling to Estonia, COVID-19, security situation, etc: <https://www.kriis.ee/en?>

## SOCIAL EVENTS

### Welcome Reception in the AHHA Science Centre

12 September 2022, 19:00–23:00

Address: Sadama 1

Exhibitions are open for Neobiota guests during the reception.

Entertainment: Puuluup – an Estonian nu-folk duo.

### Guided walk in the Old Town and Toome Hill

13 September 2022

Groups start at 19:00 and 19:30 in front of the Conference Centre

### Conference Dinner in Tartu Cathedral White Hall

14 September 2022, 19:00–23:00

Address: Lossi 25

The tower platforms of the Cathedral are open for Neobiota guests until 20:30.

Entertainment: Curly Strings – a famous Estonian folk band.



## EXCURSIONS

15 September 2022

Buses leave at 9:00 or 9:30 from the parking lot near the Conference Centre.

All tickets and lunch packages are included.

### **1. The University of Tartu Botanical Garden & the Beer World Museum**

Guided tours in the botanical garden and the beer museum in Tartu. The length of the walk from the botanical garden to the beer museum is 1.1 km. Duration: approximately 4 hours.

### **2. Barge trip along the River Emajõgi to Lake Peipus**

Delegates will be driven to the historic Kantsi settlement by bus from where the barge sails them to Lake Peipus and back passing through the wetlands of the Peipsiveere Nature Reserve and the largest Estonian wetland delta – the delta of the River Emajõgi. On the way, a guide will entertain you with the stories about Estonian nature and sailing culture. There is a possibility to enjoy the tour outside on the deck as well as inside the barge, there is no need to worry about the weather. There will be almost no walking and the whole trip will last approximately 6 hours.

### **3. Alam-Pedja Nature Reserve**

The tour takes the delegates to Alam-Pedja Nature Reserve where the Palupõhja Nature School and the eradication sites of *Fallopia* spp. will be introduced. The natural biodiversity of the reserve can be enjoyed during the walk on Selli-Sillaotsa hiking trail (4.7 km). The whole trip from Tartu and back takes about 6 hours.

### **4. Karula National Park, Otepää Nature Park & Sangaste Castle**

There will be a chance to examine the scenic hummocky semi-natural landscapes of several South Estonian protected areas. In Karula National Park, a local organic sheep farm and eradication sites of Himalayan balsam will be visited. Sangaste Castle gives a glimpse into the noble manor architecture. You will also be taken to a guided walk (3 km) in a castle forest park famous for its collection of non-native tree species. On the way back to Tartu, the picturesque landscapes of Otepää Nature Park can be enjoyed. The whole tour takes about 7 hours.

### **5. Southeastern wetland and sandstone cliff landscape**

First stop will be the Lüübnitsa viewing tower just on the coast of Lake Pskov, which provides a good view to the lake and surrounding Natura 2000 area. Next, the tour takes you to Meenikunno hiking trail (ca 3 km) to introduce one of the most popular and typical raised bogs in South Estonia. The boardwalk makes the hike convenient and easy for everyone. Another type of protected landscape will be observed in Taevaskoja (meaning Heaven's Hall) hiking trail (3 km) in Ahja River Valley Landscape Reserve. The trail runs along the banks of the river providing extraordinary views to the sandstone cliffs and outcrops, springs and small caves surrounded by coniferous forests. As a relaxing closure to the tour, Estonian craft beer production will be introduced and the beer can be tasted in a small brewery in Käbliku Farm. The whole tour takes about 8 hours and is probably the most challenging in terms of walking.

## DETAILED PROGRAMME

### MONDAY 12<sup>th</sup> SEPTEMBER 2022

- 19:00 – 21:00 Registration  
19:00 – 23:00 Welcome Reception

### TUESDAY 13<sup>th</sup> SEPTEMBER 2022

- 08:00 – 17:00 Registration  
08:30 – 08:45 Welcome Speeches

- 08:45 – 09:15 **KEYNOTE 1 – BERND LENZNER. BIOLOGICAL INVASION SCENARIOS: GETTING A GLIMPSE OF THE FUTURE**

#### ***Trends in the introduction, spread and evolution of biological invasions at different spatial and temporal scales***

Chair: Aveliina Helm

- 09:15 – 09:30 **O1** – Jane Catford  
Addressing context dependence in invasion ecology
- 09:30 – 09:45 **O2** – Bruno Paganeli  
Global analysis of source and destination areas for past and future plant invasions
- 09:45 – 10:00 **O3** – David Richardson  
Collateral damages: military invasions beget biological invasions
- 10:00 – 10:15 **O4** – Franz Essl  
Biological invasions: what is needed for Global Post 2020-Biodiversity Policies?
- 10:15 – 10:30 **O5** – Katelyn Faulkner  
Domesticating the CBD's introduction pathway classification framework – South Africa as an example
- 10:30 – 11:00 *Coffee Break*

#### ***Trends in the introduction, spread and evolution of biological invasions at different spatial and temporal scales (continued)***

Chair: Aveliina Helm

- 11:00 – 11:15 **O6** – Camille Bernery  
Freshwater fish invasions: a comprehensive review
- 11:15 – 11:30 **O7** – Adrián García Rodríguez  
Animal invasions in mountains: a global review of patterns, drivers and potential impacts
- 11:30 – 11:45 **O8** – Arman Pili  
The escalating global problem of human-mediated accidental transport of alien species revealed by exotic herpetofauna interceptions in New Zealand
- 11:45 – 12:00 **O9** – Sara Vicente  
*Acacia longifolia* around the world: tracing the introduction history of a problematic invasive plant species
- 12:00 – 12:15 **O10** – Philip Hulme  
Ornamental invasive plants were marketed earlier and for longer than non-invasive ornamentals in New Zealand
- 12:15 – 12:30 **O11** – Cristian R. Altaba  
Five millennia of invasions: invasibility, exaptations and conservation in the Balearic Islands
- 12:30 – 13:30 *Lunch*

13:30 – 14:00 **KEYNOTE 2 – HANNO SEEBENS. KNOWN AND UNKNOWN OF THE DISTRIBUTION OF ALIEN SPECIES WORLDWIDE**

***Trends in the introduction, spread and evolution of biological invasions at different spatial and temporal scales (continued).*** Chair: Aveliina Helm

14:00 – 14:15 **O12** – Anna Walentowitz  
Paleoecological perspective on the abundance of alien plant species on islands

14:15 – 14:30 **O13** – Hanno Seebens  
Fewer non-native insects in freshwater than in terrestrial habitats across continents

14:30 – 14:45 **O14** – Maria A. Perez-Navarro  
Spatial scale determines whether functional and phylogenetic similarity helps or hinders exotic plants

***Novel tools and methods for detection, mapping, monitoring and control of invasive alien species***

Chair: Arman Pili

14:45 – 15:00 **O15** – Tim Adriaens  
Automated early warning: a pipeline for feeding headline indicators on the state of invasions and to prioritize emerging alien species

15:00 – 15:15 **O16** – Irena Axmanová  
Updated alien plant species lists of European countries in the FloraVeg.EU database

15:15 – 15:30 **O17** – Matthias Grenié  
A barrier to global plant invasion ecology: gaps in trait availability for alien species

15:30 – 15:45 **O18** – Joana Vicente  
A novel remote sensing supporting system to control, monitoring, containment and eradication of aquatic alien plant species – SINVAQUA

15:45 – 16:00 **EXPRESS PRESENTATIONS**

16:00 – 16:45 ***Coffee Break & Poster Session***

***Novel tools and methods for detection, mapping, monitoring and control of invasive alien species (continued).*** Chair: Arman Pili

16:45 – 17:00 **O19** – Jasmijn Hillaert  
An assessment of the invasion of *Vespa velutina* in Belgium five years after its arrival

17:00 – 17:15 **O20** – David Porco  
eDNA-based detection of *Pacifastacus leniusculus* in rivers: ddPCR and LAMP assays optimization and data treatment

17:15 – 17:30 **O21** – Laura Fernandez Winzer  
Catch them if you can: a proposed workflow to ensure new alien species detections from molecular analyses are acted upon

17:30 – 17:45 **O22** – Susan Canavan  
All that Twitters is not gold: does social media reflect invasion science research?

***Relationships between weeds and invasive alien plants (special joint session with EWRS)***

Chair: Ahmet Uludağ

17:45 – 18:00 **O23** – Michael Glaser  
Ancient and recent vascular plant invaders show diverging trends in Central European fields over the past 90 years

18:00 – 18:15 **O24** – Ahmet Uludağ  
The possible impact of the EU Green Deal on plant invasions and weed occurrence in Europe

18:15 – 18:30 **O25** – Necmi Aksoy  
Two new alien species from Turkey in covered banana production: *Pilea microphylla* (L.) Liebm. (Urticaceae) and *Cardamine occulta* Hornem. (Brassicaceae)

18:30 – 18:45 **O26** – Tijana Stojanović  
The bioherbicidal potential of the selected hydrolates towards *Portulaca oleracea* L.

18:45 – 19:30 **Neobiota Council Meeting**

19:00 / 19:30 **Walk in the Old Town** (starting time of different groups)

## WEDNESDAY 14<sup>th</sup> SEPTEMBER 2022

08:00 – 17:00 Registration

08:30 – 09:00 **KEYNOTE 3 – PHILIP HULME. WHAT DO WE REALLY KNOW ABOUT THE DIRECT AND INDIRECT DRIVERS OF BIOLOGICAL INVASIONS?**

### ***Past, current and future drivers responsible for biological invasions***

*Chair: Katelyn Faulkner*

09:00 – 09:15 **O27** – Joshua Brian

A process-driven reframing of the Enemy Release Hypothesis in space and time

09:15 – 09:30 **O28** – Rūta Juozaitienė

Analysing ecological dynamics with relational event models: the case of invasion events

09:30 – 09:45 **O29** – Margherita Gioria

Soil seed banking strategies of invasive plants at home and abroad

09:45 – 10:00 **O30** – Daijun Liu

The impact of land use on alien species incidence and number in local assemblages worldwide

10:00 – 10:15 **O31** – Lisa Tedeschi

The role of (un)recorded introductions in explaining current alien mammals' distribution in Europe

10:15 – 10:30 **O32** – Jan Divíšek

Do alien plants occupy the centre or periphery of the functional trait space in local communities of different habitat types?

10:30 – 11:00 *Coffee Break*

### ***Past, current and future drivers responsible for biological invasions (continued)***

*Chair: Katelyn Faulkner*

11:00 – 11:15 **O33** – Nicole Kinlock

Introduction history mediates naturalization and invasiveness of cultivated plants

11:15 – 11:30 **O34** – Angela Bartlett

Characteristics of Australia's alien flora vary with invasion stage

11:30 – 11:45 **O35** – Krzysztof Podwysoki

Has human leisure activity an impact on the distribution of native and invasive Amphipoda (Crustacea) in Mazurian Lakeland (Poland)?

11:45 – 12:00 **O36** – Fabio Ercoli

The role of temperature in marbled crayfish (*Procambarus virginalis*, Lyko 2017) invasion in Estonian freshwater ecosystem

12:00 – 12:15 **O37** – Vasiliki Balogianni

*Gunnera tinctoria*: successful invader but poor competitor

12:15 – 13:15 *Lunch*

13:15 – 13:45 **KEYNOTE 4 – BELLA GALIL. A CANAL, A SEA, A DISASTER – THE SUEZ CANAL AND THE TRANSFORMATION OF THE MEDITERRANEAN BIOTA**

***Impacts of invasions on native species, communities and ecosystems***

*Chair: Francisco R. Barboza*

- 13:45 – 14:00 **O38** – Guillaume Latombe  
GIRAE: a Generalised approach for linking the total Impact of invasion to species' Range, Abundance and per-unit Effects
- 14:00 – 14:15 **O39** – Alessandra R. Kortz  
Stronger compositional change in plant assemblages worldwide is associated with invasion
- 14:15 – 14:30 **O40** – Sven Bacher  
Are species more harmful in their native, neonative or alien range? Insights from a global analysis of bark beetles
- 14:30 – 14:45 **O41** – Imtiyaz B. Beleem  
Temperature modulates the community-wide effects of an invasive mud crab in a key Baltic Sea macroalgal-dominated habitat
- 14:45 – 15:00 **O42** – Belinda Gallardo  
What are the most important impacts of invasive species on Nature's Contribution to People in Europe?
- 15:00 – 15:15 **O43** – Arnaud Monty  
The impact of aquatic alien plants and crayfish control methods on ecosystem services
- 15:15 – 15:30 **O44** – Mike Fowler  
Increasing abundance of the invasive riparian plant, Himalayan balsam, reverses the effects of environmental variables on community and functional diversity in freshwater macroinvertebrates
- 15:30 – 15:45 **EXPRESS PRESENTATIONS**
- 15:45 – 16:30 **Coffee Break & Poster Session**

***Impacts of invasions on native species, communities and ecosystems (continued)***

*Chair: Francisco R. Barboza*

- 16:00 – 16:45 **O45** – Kristiina Nõomaa  
Novel fish predator causes sustained changes in its prey populations
- 16:45 – 17:00 **O46** – Bruce Osborne  
*Gunnera tinctoria* invasions increase, not decrease, earthworm abundance and diversity
- 17:00 – 17:15 **O47** – Lorenzo Lazzaro  
Impacts of non-native nitrogen-fixing trees in Italy: evidence from the invasion of *Acacia* s.l. and *Robinia pseudoacacia* (Fabaceae)
- 17:15 – 17:30 **O48** – Llewellyn Foxcroft  
The impacts of *Parthenium hysterophorus* on ants, spiders and soil characteristics in Kruger National Park
- 17:30 – 17:45 **O49** – Yohannes Tesfay  
The invasive *Opuntia ficus-indica* homogenizes native plant species compositions in the highlands of Eritrea
- 17:45 – 18:00 **O50** – Martin Hejda  
Do the local within-community impacts of native and invasive dominant plants scale up to the landscape level?

***Novel ecosystems in the Anthropocene***

*Chair: Francisco R. Barboza*

- 18:00 – 18:15 **O51** – Zdeňka Lososová  
Urbanization decreases functional diversity of plant communities: a case study from one Central European city
- 18:15 – 18:30 **O52** – Montserrat Vilà  
Functional assembly of grassland plant species in native communities in Spain and recipient communities in California
- 19:00 – 23:00 **Conference Dinner**

## THURSDAY 15<sup>th</sup> SEPTEMBER 2022

### Excursions

## FRIDAY 16<sup>th</sup> SEPTEMBER 2022

08:30 – 09:00 **KEYNOTE 5 – HELEN ROY. DOCUMENTING AND PREDICTING BIOLOGICAL INVASIONS GLOBALLY**

### ***Biological invasions and climate change***

Chair: Barbara Tokarska-Guzik

09:00 – 09:15 **O53** – Tom Vorstenbosch  
Widespread niche shifts in alien plant species under the non-analogous climate of the sub-Antarctic islands

09:15 – 09:30 **O54** – Marina Golivets  
Distinct futures of native and non-native plant traits in six major habitat types in Central Europe

### ***Biotic interactions in invaded communities and ecosystems, incl. interactions between invaders***

Chair: Barbara Tokarska-Guzik

09:30 – 09:45 **O55** – Aleksandra Wróbel  
Out of thin air: Eurasian jays (*Garrulus glandarius*) enhance the invasion of northern red oak (*Quercus rubra*) via tripartite interactions with native oaks

09:45 – 10:00 **O56** – Peliyagodage Chathura Dineth Perera  
Response of soil invertebrates assemblages on different methods of *Solidago* invaded land restoration

10:00 – 10:15 **O57** – Jonatan Rodríguez  
Assessing the impact of the invasive plant *Carpobrotus* spp. on plant-herbivore interaction networks: a call to implement management strategies

10:15 – 10:30 **O58** – Ryan Beshai  
Biotic resistance or invasional meltdown? Diversity reduces invasibility but not exotic dominance in southern California epibenthic communities

10:30 – 11:00 *Coffee Break*

### ***Biotic interactions in invaded communities and ecosystems, incl. interactions between invaders (continued).*** Chair: Barbara Tokarska-Guzik

11:00 – 11:15 **O59** – Franziska Leonhardt  
From alien species to alien communities: interactions between host- and habitat associated microbiomes in an alien amphibian from the Caribbean

11:15 – 11:30 **O60** – Quentin Groom  
Biotic interaction data and invasive species assessment

### ***Non-native pests and pathogens. Pests and pathogens spread by invasive alien species***

Chair: Ana L. Nunes

11:30 – 11:45 **O61** – Anna Schertler  
Patterns of plant-fungal pathogen linkages in invasions

11:45 – 12:00 **O62** – Venche Talgø  
Impact of *Phytophthora* species on trees and scrubs in Norway

### ***Effectiveness of past and current control measures and native communities restoration efforts***

Chair: Ana L. Nunes

12:00 – 12:15 **O63** – Magdalena Szymura  
Environment-friendly restoration of land degraded by invasive plants: lessons from a six year experiment

12:15 – 12:30 **O64** – Ana L. Nunes  
Management of vertebrate invasive alien species of Union concern, incorporating animal welfare

12:30 – 12:45 **O65** – Madis Põdra  
Eradication of recently established American mink population in the Ebro river basin in Spain

12:45 – 13:00 **O66** – Jakub Těšitel  
Parasitic plants: biotic resistance to plant invasions

13:00 – 14:00 *Lunch*

14:00 – 14:30 **KEYNOTE 6 – EVANGELINA SCHWINDT. MARINE BIOINVASIONS IN SOUTH AMERICA: ACHIEVEMENTS AND CHALLENGES**

***Engaging the public and stakeholders – from landowners to scientists, practitioners and decision makers and back***

*Chair: Ana Novoa*

14:30 – 14:45 **O67** – Ana Novoa  
Assessing global public knowledge and perceptions towards biological invasions and their management

14:45 – 15:00 **O68** – Carla Garcia-Lozano  
Practices and perceptions of IAS local managers in Europe

15:00 – 15:15 **O69** – Jonne Kotta  
Integrating ecological impacts of non-indigenous species within a cumulative effect assessment framework

15:15 – 15:30 **O70** – Theresa Henke  
The social aspects of biological invasions – involving stakeholders in the research on the establishment of European flounder (*Platichthys flesus*) in Iceland

15:30 – 15:45 **O71** – Tomos Jones  
Bridging the semantic divide: how invasion scientists can better communicate with gardeners

15:45 – 16:00 **O72** – Sandro Bertolino  
Restricted access to private properties limits management of invasive alien species

16:00 – 16:15 **O73** – John Wilson  
The regulation of alien species in South Africa

16:15 – 16:45 *Coffee Break*

***Economic and social impacts of biological invasions***

*Chair: Ana Novoa*

16:45 – 17:00 **O74** – Franck Courchamp  
From big data to big collaborations: the InvaCost database on the economic costs of biological invasions

17:00 – 17:15 **O75** – Ross Cuthbert  
Biological invasion costs reveal insufficient proactive management worldwide

17:15 – 17:30 **O76** – Anna Turbelin  
Biological invasions are as costly as natural hazards

17:30 – 17:45 **O77** – Giovanni Vimercati  
Assessing positive socio-economic impacts of alien taxa within a unified framework

17:45 – 18:00 **O78** – Elena Angulo  
The importance of non-English data to understand global patterns in biological invasions

18:00 – 18:30 **Awarding & Closing Ceremony**

## LIST OF EXPRESS PRESENTATIONS

- E1 Tomasz Szymura  
Drivers of spatial bias in neophytes distribution data
- E2 Arman Pili  
Advancing invasion science *in silico*: using *virToad* to simulate spatiotemporal invasion dynamics and management of a global invader for biosecurity decision support
- E3 Joaquim Silva  
Using fire on fire-adapted invasive species – the case of *Hakea sericea* Schrad.
- E4 Mukesh Kumar  
Comparative study of invasive and native shrub functional traits of chir pine forest in the central Himalaya
- E5 Giorgi Kavtaradze  
Invasive alien woody plants in the protected areas of Georgia: invasive range, environmental impact and invaded forest habitats
- E6 Tsungai Zengeya  
Trophic niche of an invasive generalist consumer: Australian redclaw crayfish, *Cherax quadricarinatus*, in the Inkomati River Basin, South Africa
- E7 Andrea Desiderato  
Breath in, breath out: different physiological responses to oxygen and temperature variation of two genetically distinct lineages of *Dikerogammarus villosus*
- E8 Andrew Baggaley  
Inference for epidemic models with time-varying infection rates: tracking the dynamics of oak processionary moth in the United Kingdom
- E9 Jonatan Rodríguez  
Evaluating the effect of plant invasion eradication programs on plant-herbivore interactions in coastal habitats of the northwestern Iberian Peninsula
- E10 Sabrina Dietz  
Reinforcing regulation with voluntary commitments – experiences on the implementation of the Bern Convention's Code of Conduct on Hunting and Invasive Alien Species
- E11 Ana Anđelković  
What motivates volunteers to participate in the control and monitoring of invasive alien species?
- E12 Thomas Bodey  
The economic cost of protecting islands from invasive alien species
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## KEYNOTE SPEAKERS & PRESENTATIONS

Tuesday, 13<sup>th</sup> September 2022, 8:45 – 9:15

### Keynote 1 – Biological invasion scenarios: getting a glimpse of the future

**Bernd Lenzner**

University of Vienna, Vienna, Austria

#### Abstract

Among the five major drivers of biodiversity loss and ecosystem service erosion, biological invasions are the only one driver currently absent from global biodiversity scenarios. Scenarios can be defined as “representations of possible futures for one or more components of a system, particularly for drivers of change in nature and nature’s benefits, including alternative policy or management options” and have been successfully implemented in different contexts like climate change research to design and implement management and adaptation strategies as well as engage and mobilize stakeholders, policy-makers and the general public. Overall, scenarios aim to capture a holistic view of a system at different scales and facilitate the identification of trends, relevant processes, interactions and feedbacks within that system.

Following an upsurge in global data availability for different facets of biological invasions, recently the first alien species narratives (ASN; i.e. qualitative storylines for biological invasions under multiple future global change assumptions) have been constructed at the global and continental scale. These storylines explore different plausible futures on how biological invasion might turn out under different assumptions on how environmental, socio-economic and societal drivers might develop. Subsequently, the scenarios have been used to develop management strategies for to assess their feasibility under different possible futures and to explore the option space for successful action.

The talk will highlight current efforts for scenario development in relation to biological invasions, how such tools can provide valuable insights into plausible long-term trends following different environmental and social-ecological changes and how scenarios can facilitate management, mitigation and adaptation to future biological invasions. Finally, there will be an outlook on next steps and opportunities to establish stronger links between the biological invasion scenarios with important scenario work like the IPBES Nature Futures Framework and the ongoing Post2020-Global Biodiversity Framework.

***Bernd Lenzner** is a macroecologist and terrestrial ecologist with a focus on global change ecology, invasion biology and biodiversity research. Bernd finished his undergraduate studies at the University of Bayreuth (Germany) studying Geoecology with a focus on landscape ecology and island biogeography. From there he continued to pursue a PhD at the University of Vienna, focusing on patterns and processes of alien plant species distribution and assembly. Currently, Bernd remains a post-doctoral researcher at the Bioinvasions, Global Change Macroecology Group at the University of Vienna, continuing to work on past and future trends of biodiversity patterns and on how environmental, socio-economic and societal drivers interact from a systemic point of view using scenario approaches. Finally, Bernd works on questions at the science-policy interface as an expert to the Invasive Alien Species Assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), and also works on questions related to the Post-2020 Global Biodiversity Framework and the Agenda 2030 on Sustainable Development.*



Tuesday, 13<sup>th</sup> September 2022, 13:30 – 14:00

## Keynote 2 – Knowns and unknowns of the distribution of alien species worldwide

**Hanno Seebens**

Senckenberg Biodiversity and Climate Research Centre, Frankfurt, Germany

### Abstract

The amount of information about the occurrences of alien species has increased tremendously during recent years. The new level of data availability allows identifying global hot and cold spots of alien species richness. However, the hot spots of alien species records coincide well with hot spots of research intensity and it still remains unclear to what level our understanding of the global distribution of alien species is driven by research intensity. Our incomplete knowledge about alien species occurrences can have severe consequences for the assessment of the status of biological invasions and may result in clear underestimations of future developments. It is therefore essential to improve our understanding of the distribution of gaps and how to account for incomplete information in our analyses.

I will provide an overview of the current state of knowledge about the distribution of alien species and will relate it to the distribution of research intensity. I will illustrate the consequences of incomplete knowledge on predictions of future developments and will demonstrate new approaches for quantifying data gaps. Finally, I will outline potential ways to address the issue of incomplete information in scientific analyses.



*Hanno Seebens is a postdoc and principal investigator at the Senckenberg Biodiversity and Climate Research Centre in Frankfurt, Germany. After his study of ecology, he did his PhD on the influence of climate change and variable nutrient loadings on the long-term developments of freshwater plankton in Lake Constance, Germany. He then moved for his first postdoc to the group of mathematical modelling at the marine institute ICBM in Oldenburg, Germany, to learn data analysis and modelling techniques. At that time, Hanno conducted his first analysis on biological invasions about the spread of alien planktonic species by global shipping. After a short stay in the group of Franz Essl in Vienna, Austria, he moved to the Senckenberg institute, where he has stayed until today and has developed his own research agenda on quantitative invasion ecology. Hanno's research focus is understanding long-term dynamics of biological invasions and the spread of alien species through human transport networks using approaches from data analysis and modelling.*

Wednesday, 14<sup>th</sup> September 2022, 8:30 – 9:00

### **Keynote 3 – What do we really know about the direct and indirect drivers of biological invasions?**

**Philip Hulme**

Lincoln University, Christchurch, New Zealand

#### **Abstract**

Alien species are important and well-studied drivers of ecosystem change yet the driving forces of biological invasions themselves are less well understood. There is limited information regarding which direct (biophysical) and indirect (societal) drivers have received most attention, the degree to which multiple drivers have been examined, and the extent of any geographic biases in research effort. Such information is essential to target research on less studied drivers, ensure policies do not focus on only the most tractable drivers, and that future scenarios capture the full range of potential outcomes for invasive alien species. Here, I review the state of knowledge regarding six direct (climate change, alien species, land-use or sea-use change, natural hazards, pollution, and resource extraction) and five indirect (demographic, economic, governance, sociocultural, and technological) drivers of biological invasions. Importantly, I compare trends with knowledge on how these drivers influence biodiversity change. My findings make for rather worrying interpretation. Most research on biological invasions as well as on biodiversity and ecosystem services has focused on anthropogenic direct drivers of ecosystem change rather than indirect drivers. However, the percentage of publications addressing drivers of biological invasions was at a similar level to that found 20 years ago for biodiversity or ecosystem change. As a result, knowledge of the drivers of biological invasions is limited, emphasises tractable drivers over those that require an interdisciplinary approach, and is biased towards developed rather than developing economies. Drivers deemed important for biological invasions were poorly supported by research effort. The absence of a systematic understanding of what factors drive alien species means that attempts to mitigate or forecast biological invasions are likely to fail. Addressing biological invasions in the future requires better orientation of national and international research on drivers in relation to both their actual importance as well as their policy relevance.

**Philip Hulme** is the Distinguished Professor of Plant Biosecurity at Lincoln University, New Zealand, and Director of the Centre for One-Biosecurity Research, Analysis and Synthesis (COBRAS).

*His research interests span the biosecurity continuum and address pathways of introduction, invasive species risk assessment, dispersal and spread as well as impacts on ecosystems, and designing effective management strategies. He has examined invasions in both aquatic and terrestrial ecosystems, the invasion of New Zealand by fungal pathogens, weeds and mammals. He is keen to see a more integrated and transdisciplinary approach to invasion science under the umbrella of One Biosecurity.*





Wednesday, 14<sup>th</sup> September 2022, 13:15 – 13:45

## **Keynote 4 – A canal, A sea, A disaster – The Suez Canal and the transformation of the Mediterranean biota**

**Bella S. Galil**

Steinhardt Museum of Natural History, Tel Aviv University, Israel

### **Abstract**

Invasive alien species have become a concern in marine coastal ecosystems worldwide, but no where more so than in the Mediterranean Sea, where over 1,000 multicellular introduced species have been recorded. The Israeli coast, 190 km long, is the ultimate ‘beach head’ with 465 alien species, of which nearly 90% are considered to have been introduced through the Suez Canal. This is an invasion of calamitous proportions, resulting from the proximity of an ever expanding invasion corridor and a warming sea.

For over a century Erythraean aliens were confined to the Levantine upper shelf, and largely ignored by scientists, conservationists, policy makers and managers. However, in the 1980s, following major enlargement of the canal, increasing seawater temperature and marine heat wave duration, severity, frequency, the rapid spread and injurious impacts of some Erythraean aliens helped raise awareness of the invasion. Recent surveys documented Erythraean aliens beyond the shelf edge to depth of 250 m, suggesting that thermal niche estimations based on the species’ native range likely underestimated their thermal tolerance, and thus their potential bathymetric and geographic expansion.

Bearing in mind that climatic models predict that the Mediterranean Sea will be markedly affected by warming and heat waves, native stenothermal biota unable to shift their range to deeper and/or colder water will likely endure increasing stress and demographic attrition, presaging degradation of native communities on the Mediterranean shelf, perhaps even the upper slope. The synergic and additive effects of warming and the greater volume of trans-isthmian propagules may increase the plausibility of displacement by Erythraean aliens.

***Bella Galil** is a curator (emerita) of Crustacea in Steinhardt Museum of Natural History in Tel Aviv University, Israel. Her research interests include taxonomy of tropical decapod crustaceans, anthropogenic changes of macrobenthos in coastal and deep waters, dynamics/conservation of marine biodiversity, and marine bioinvasions. She has handled benthic surveys and monitoring in nationally important projects, authored 340 peer-reviewed scientific papers and co-authored 4 books.*

*In 1993–1997, she was a chairperson of the executive committee of the Zoological Society of Israel. She has also been a Managing Editor of the Israel Journal of Zoology (1992–1998), and Co-chair of the scientific committee “Living Resources & Marine ecosystems”, CIESM – The Mediterranean Science Commission (2001–2007) – first woman to serve in the above positions. Bella is a founding member of the Israeli Association for Aquatic Sciences (IAAS). In 1989–2003 she co-organized and co-chaired the interdisciplinary workshop on the continental margins of the Mediterranean coast of Israel. She has been member of the Directorate, chairperson of the Scientific Committee of the Nature and Parks Authority, Israel (2007–2012). She is member of the Editorial Board of Biological Invasions, and the member of the Advisory Board of Aquatic Invasions. Since 2005 she has been a member of the Invasive Species Scientific Committee, IUCN. In 2019–2023 Bella contributes to IPBES Assessment on Invasive Alien Species as Coordinating Lead Author.*



Friday, 16<sup>th</sup> September 2022, 8:30 – 9:00

## Keynote 5 – Documenting and predicting biological invasions globally

**Helen E. Roy**

UK Centre for Ecology & Hydrology, Crowmarsh Gifford, Wallingford, Oxfordshire, United Kingdom

### Abstract

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment's message is stark: biodiversity – the diversity within species, between species, and of ecosystems – is declining faster than at any time in human history. Alongside climate change, land and sea-use change, invasive alien species were identified as one of the five top direct causes of biodiversity change. Biological invasions can threaten biodiversity and ecosystems but also human health and economies, particularly through their interactions with other drivers such as climate change. The number of alien species arriving in new regions is increasing globally and there is no sign of slowing.

It is widely recognised that the most effective action against biological invasions is preventing the arrival of invasive alien species. Therefore, there has been increasing focus on horizon scanning to predict which invasive alien species pose an imminent emerging threat. Prioritising invasive alien species in the context of the pathways by which they might arrive can be informative for decision-making. Horizon scanning for invasive alien species that could arrive and pose a threat to biodiversity and ecosystems across Europe has underpinned prioritisation of invasive alien species for risk assessment and subsequently consideration for inclusion within lists of invasive alien species of concern. Invasive alien species can have multiple impacts spanning plant, animal, human and wildlife health; cross-sectoral sharing of information is critical to effective action.

I will share insights into invasion ecology from broad patterns and processes to approaches in surveillance and monitoring, including citizen science, with a focus on predicting biological invasions. I will highlight the importance of collaborative, interdisciplinary partnerships including the forthcoming IPBES global thematic assessment on invasive alien species. Networks established through these initiatives have benefits for people, science and nature.

*Professor Helen Roy MBE is an ecologist at the UK Centre for Ecology & Hydrology. She is fascinated by the ways in which environmental change effects the interactions between insects and other species. Biological invasions have been the focus of much of her research. Helen leads many collaborative national and international research projects. She is leading research for the EC on enhancing understanding and awareness of invasive alien species. Helen leads a Defra-funded project to produce a comprehensive information portal on non-native species in Great Britain which also includes annual reports on status and trends of invasive alien species and the development of an alert system for people to report sightings of concern. Over the last few years she has had the privilege of working with the UK Overseas Territories to predict and prioritise invasive non-native species. Her research on invasive non-native species has received international recognition and she is currently leading a global assessment on invasive non-native species for the Intergovernmental Panel on Biodiversity and Ecosystem Services. Helen also enjoys science communication and public engagement with research which led to her interest in citizen science. She has a passion for ladybirds and has led the UK Ladybird Survey, including tracking the spread of the invasive alien ladybird, Harmonia axyridis, alongside Peter Brown (Anglia Ruskin University) for more than 15 years. Helen is delighted to be the current President of the Royal Entomological Society. Helen was awarded an MBE in 2018 in recognition of her contributions to biodiversity science.*



*Over the last few years she has had the privilege of working with the UK Overseas Territories to predict and prioritise invasive non-native species. Her research on invasive non-native species has received international recognition and she is currently leading a global assessment on invasive non-native species for the Intergovernmental Panel on Biodiversity and Ecosystem Services. Helen also enjoys science communication and public engagement with research which led to her interest in citizen science. She has a passion for ladybirds and has led the UK Ladybird Survey, including tracking the spread of the invasive alien ladybird, Harmonia axyridis, alongside Peter Brown (Anglia Ruskin University) for more than 15 years. Helen is delighted to be the current President of the Royal Entomological Society. Helen was awarded an MBE in 2018 in recognition of her contributions to biodiversity science.*

Friday, 16<sup>th</sup> September 2022, 14:00 – 14:30

## Keynote 6 – Marine bioinvasions in South America: achievements and challenges

**Evangelina Schwindt<sup>1</sup>, Alejandro Bortolus<sup>2</sup>**

<sup>1</sup>Instituto de Biología de Organismos Marinos (IBIOMAR-CONICET), Puerto Madryn, Argentina

<sup>2</sup>Instituto Patagónico para el Estudio de los Ecosistemas Continentales (IPEEC-CONICET), Puerto Madryn, Argentina

### Abstract

Research effort, management strategies and policy responses to marine bioinvasions are unevenly developed worldwide. Through comprehensive literature reviews, the status, trends, gaps and achievements in the marine bioinvasion research efforts along the coastal-marine ecosystems of South America were analyzed. In addition, the current state of multinational collaborations on these matters across the continent as well as the regional advances in current management strategies and policy responses were explored. Despite the publications of the first comprehensive marine bioinvasions assessments between 2001 and 2005, the Pacific and Atlantic coasts of South America remain unevenly developed, with most (90%) research occurring in the Atlantic (vs. Pacific) coast. During the last 20 years, there has been an exponential growth in the research effort in this region, mostly focusing on ecological patterns of non-native species, while other categories of studies, like processes, management, methodological and socio-ecological, have received significantly less attention. The research also shows a high prevalence of national studies, while regional and international collaborations are virtually nil. Countries in South America have made important achievements regarding the study and management of marine bioinvasions, and in their responses through policies. However, changing the unbalance between national and international scientific and governmental collaborations should be a top priority to better deal (financially, scientifically and socially) with marine bioinvasions in a regional and global context. Failing to make these efforts is probably the major threat that hampers the development of successful long-term programs and strategies directed to prevent the introduction of invasive species and to understand their many impacts across the continent.



*Dr. Evangelina Schwindt is the Director of the Coastal Environments Ecology Group (GEAC) at the IBIOMAR-CONICET. Settled in Puerto Madryn, Evangelina currently focuses her research on patterns, processes and consequences of marine invasions. Understanding the importance of the prevention and monitoring programs, she also collaborates with national and regional governments in the management decision making process of biological invasions. She has a broad interest in South America and the need for a more regional collaboration to understand and manage marine invasions. She was a FAO consultant for the National Strategy for Invasive Exotic Species in Argentina, Chair of the Xth International Conference on Marine Bioinvasions, and pool of expert for the second World Ocean Assessment. Currently Evangelina serves as Coordinating Lead Author of the IPBES Assessment on Invasive Alien Species, member Working Group on Biofouling Management (GESAMP), member of Scientific Advisory Committee on Invasive Alien Species in Chile and Associate Editor of Biological Invasions.*

## ORAL PRESENTATIONS

### TRENDS IN THE INTRODUCTION, SPREAD AND EVOLUTION OF BIOLOGICAL INVASIONS AT DIFFERENT SPATIAL AND TEMPORAL SCALES

#### O1

##### Addressing context dependence in invasion ecology

Jane Catford<sup>1</sup>, John Wilson<sup>2</sup>, Petr Pyšek<sup>3</sup>, Philip Hulme<sup>4</sup>, Richard Duncan<sup>5</sup>

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##### Abstract

The context of species invasion matters: it can determine whether, when and where invaders fail or succeed; which systems are resistant or vulnerable to invasions; the impacts that invaders cause; and the approaches through which they may be managed. Context dependence is widely invoked to explain disparate results in invasion ecology. It arises when the magnitude or sign of a relationship varies due to the conditions under which it is observed. Such variation, especially when unexplained, can lead to spurious or seemingly contradictory conclusions, which can limit understanding and our ability to transfer findings across studies, space and time. In this work, we identify two types of context dependence resulting from four sources: mechanistic context dependence arises from interaction effects; and apparent context dependence can arise from the presence of confounding factors, problems of statistical inference and methodological differences among studies. We illustrate our framework, and the issue of context dependence, using empirical examples of plant and animal invasions from different parts of the world. Addressing context dependence is a critical challenge in invasion ecology, essential for increased understanding and prediction.

#### O2

##### Global analysis of source and destination areas for past and future plant invasions

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##### Abstract

Non-native plants (NNP) are threatening biodiversity globally. Identifying areas that have been historically frequent NNP source and destination areas can provide valuable information to mitigate the NNP impact. Here we add a new dimension to NNP research and identify likely future invasion by using the dark diversity concept, the set of species that are currently absent albeit being suitable for an area. We compare NNP source and destination areas in the past and in the future across the world. We used the new database Plants of the World Online which describes native and NNP at level 3 of WGSRPD. NNP dark diversity was estimated probabilistically by exploring which species co-occur in their native ranges with already been established NNP species more often than expected randomly. For NNP dark diversity we only considered species that have been recorded as NNP somewhere. We estimated the frequency of potential source areas in the past and in the future by applying the Hanski connectivity index to distances from NNP occurrence to all native occurrence areas of respective species. Frequent past source areas can still contribute many NNP in the future (Spearman  $\rho = 0.96$ ). In contrast, past and future destination areas differ considerably ( $\rho = -0.28$ ). In the past, frequent source and destination areas tend to overlap ( $\rho = 0.43$ ). In the future, there is a significant negative relationship between the likelihood being sources and destinations ( $\rho = -0.41$ ). While there is strong evidence of no depletion of NNP sources, the future destinations of NNP may likely change. That asymmetry can be the result of the transport revolution which enables more people to access far-off lands, bringing NNP to new suitable areas. Proactive conservation might prevent the realization of NNP dark diversity, if potential NNP, their likely source, and destination areas are known.

### O3

#### **Collateral damages: military invasions beget biological invasions**

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#### **Abstract**

War is a key element of world history and it often involves invasion of enemy territories. Biological invasions are frequently associated with human invasions; there are many examples of species that were either intentionally or accidentally translocated during European colonization of distant lands. Much like colonialism, military activity is intimately associated with the occurrence of biological invasions. In particular, world wars that moved thousands of people, supplies, and foodstuff among continents, have resulted in the global spread of several plant, insect and pathogen species and even vertebrate animals. However, lesser military actions often require huge movements of troops and related material over a short time between distant continents or geographical areas, creating ideal conditions for the accidental transport of species. Here we report several examples of intentional and unintentional introductions of non-native species associated with military operations, including those in which invasive pests were used as weapons. Considering the devastating effect of wars, the introduction of invasive species could be considered minor collateral damage, but many invasions have profound and lasting effects on ecosystems and economies of invaded regions. Regulation of military practices that promote invasions through existing international conventions may not be possible.

### O4

#### **Biological invasions: what is needed for Global Post 2020-Biodiversity Policies?**

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#### **Abstract**

The global patterns and future trajectories of biological invasions are insufficiently understood. Progress in data mobilization, supplemented by new tools for data integration have facilitated the compilation of comprehensive databases of world-wide alien species distributions such as GloNAF (<https://glonaf.org/>). Similarly, the compilation of the Alien Species First Record-database provides a basis for analysing spatio-temporal patterns of alien plant species accumulation (Seebens et al. 2020). Combined, these novel data sources have substantially advanced the understanding of the (macro)ecology of biological invasions, and they provide the foundation for exploring future trends of alien species spread and impacts.

In this talk, we will synthesize key insights into global patterns and drivers of biological invasions, and how this expertise can be harnessed for policy design, monitoring and implementation. We will introduce the Alien Scenarios-Project (<https://alien-scenarios.org/>), which for the first time develops long-term scenarios and models for biological invasions worldwide (Lenzner et al. 2019). Finally, we will provide a perspective on priority actions needed to meet invasion-related targets in the Post 2020-Global Biodiversity Framework (Essl et al. 2020, Leadley et al. 2022).

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## O5

### Domesticating the CBD's introduction pathway classification framework – South Africa as an example

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#### Abstract

Frameworks that group introduction pathways into discrete categories have been developed to improve our understanding and management of biological invasions, and to facilitate reporting to national and international organisations (including the Convention on Biological Diversity, the CBD). We argue that pathway categories need to be CAGED: Compatible – the level of detail of the categories is similar to that of the available data; Actionable – categories link to interventions; General – categories are applicable across the contexts that are of interest; Equivalent – categories are equivalent in their level of detail; and Distinct – categories are discrete and distinguishable. We note that while the CBD's pathway framework, which comprises of six main categories and 44 sub-categories, has been implemented in two scientific assessments of biological invasions in South Africa, implementing the framework has proven challenging. At least for South Africa, the CBD pathway sub-categories are not CAGED. We discuss two options to resolve this: (1) a domesticated version of the CBD framework with categories added or removed to better align to the South African context; and (2) a hybrid model, where the main categories of the CBD framework are retained, but the sub-categories are redesigned based on their relevance to South Africa. Both options have advantages, but the hybrid model balances utility at both national and international levels. Similar exercises to modify the framework for different regional contexts will be important, and as in future new pathways will develop and the relative importance of existing pathways will change, a process for updating and adapting the framework at a global scale may be required.

## O6

### Freshwater fish invasions: a comprehensive review

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#### Abstract

Freshwater fish have been widely introduced worldwide, and freshwater ecosystems are among the most affected by biological invasions. Consequently, freshwater fish invasions are one of the most documented invasions among animal taxa, with much information available about invasive species, their characteristics, invaded regions, invasion pathways, impacts, and management. While existing reviews address specific aspects of freshwater fish invasions, there is still a gaping lack of comprehensive assessments of freshwater fish invasions that simultaneously address pivotal and connected elements of the invasion process. In order to fill this gap, we provided a holistic review, together with quantitative assessments, divided into four major parts: (1) introduction pathways; (2) characteristics of non-native species and invaded ecosystems to explain successful invasion processes; (3) invasion impacts and their mechanisms; and (4) management. We also assessed the future trends of freshwater fish invasions, particularly regarding climate change and the development of human activities. We highlight data gaps and geographic and temporal bias in current databases and point to the basic lack of understanding of several aspects of freshwater fish invasions. Finally, we provide recommendations on the main issues that should be addressed in future studies, particularly concerning the locations, and step of invasion that still need a data collection effort focus. In this presentation, I will summarize the main findings of this review.

## O7

### **Animal invasions in mountains: a global review of patterns, drivers and potential impacts**

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#### **Abstract**

World's mountains cover <15% of the global land area, yet these regions host some of the most biologically diverse and ecologically complex terrestrial ecosystems. The remarkable amount of hotspots of diversity and endemism occurring in mountains of the world also highlights the relevance of the evolutionary legacy located in these regions. While many protected areas have been established in mountains, evidence shows that mountain biodiversity still faces a challenging future due to increasing threats to biodiversity such as climate or land use changes. Nevertheless, the impacts of other major threats to biodiversity in mountains have received less attention. While substantial progress has recently been made on plant invasions in mountains, the status and trends of animal invasions has not been exhaustively assessed to date. In this study, we compiled global distribution data on alien animal species occurring in mountainous regions of the world. We then analyse the spatial distribution and temporal trends, and discuss potential impacts to mountain biodiversity. Additionally, we gathered information on mountain features (e.g. elevation range, latitudinal midpoint, distance to coast, road and population density) to evaluate their influence on the described patterns of animal invasions. We address these questions at the global scale, but also zoom in taxonomically – at the class level – and spatially – by biogeographic realms.

## O8

### **The escalating global problem of human-mediated accidental transport of alien species revealed by exotic herpetofauna interceptions in New Zealand**

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#### **Abstract**

The lacking understanding of the initial stages of the invasion process is taxing to biosecurity. Very limited is known about alien species accidentally transported either as stowaways of transport vectors and/or contaminants of transported commodities, and these transport pathways have been responsible for most of the recently established alien species globally. Here, we provided the most comprehensive account of the global flows of accidentally transported alien species, particularly those deemed non-economical pests, and thereby, who tend to be neglected by biosecurity. We did this by analysing the temporal, geographical, taxonomic, and transport pathway dimensions of a database on alien amphibian and reptile species interceptions (2,510 records) in New Zealand – a country with unparalleled stringent biosecurity. Time-series decomposition of alien species' transport frequency revealed a dynamic trend coinciding with changes in policy and global socio-economic booms and recessions. Geographical analysis revealed that alien species originated from 76 countries across the globe, with the majority of intercepted individuals originating from countries in Asia and Oceania with a high contribution to total imports. Alien species were intercepted in ports across New Zealand, with the majority occurring in Auckland. Taxonomic analysis showed that 242 alien amphibian and reptile species have arrived since 1929. Of these, 133 species have an invasion history, and 68 species have an established population elsewhere. The accumulation of new alien species exponentially increased in time, wherein 45 species were recorded only since 2015. Finally, transport pathway analysis indicated that alien species were most frequently transported as stowaways of personal effects and household goods (92 species). Our study emphasises the substantially underestimated knowledge of the global flows of alien species, which may lead us to make spurious forecasts of alien invaders and invasions, and consequentially, downplay the urgency and resources required to develop and prioritise prevention and early response strategies.

## O9

### ***Acacia longifolia* around the world: tracing the introduction history of a problematic invasive plant species**

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#### **Abstract**

*Acacia longifolia* is a leguminous species native of southeast mainland Australia and Tasmania. This species was introduced worldwide for fixation of sand dunes and ornamental purposes, and today is considered invasive in the European Mediterranean areas, southern Brazil, Uruguay, and South Africa. However, historical introduction records are often scarce or incomplete, hindering the identification of native source populations. This information is crucial for management purposes, especially for sourcing biological control agents. In recent years, genetic studies together with information from historical records have been instrumental at identifying native introduction sources. Thus, in this study, we aimed to understand population structure and invasion history of *A. longifolia* by comparing its native and invasive populations. We collected samples from native (mainland Australia and Tasmania) and invasive (Portugal, Spain, South Africa, southern Brazil, and Uruguay) ranges for molecular analyses using 4 chloroplast and 12 nuclear microsatellites. Population structure analyses identified two clusters – one corresponding to mainland Australia and another to Tasmanian populations – likely due to geographical features (e.g., Bass Strait) that limit gene flow between these regions. Clustering of populations from South Africa and Portugal was also shown (plus a shared chloroplast haplotype), indicating exchange of plants between these two countries. We applied Approximate Bayesian Computation (ABC) analyses to infer the introduction history into each invaded country and identified Tasmania as the native source of introduction into Brazil and Uruguay, yet we could not identify the source of introduction for South Africa or Portugal, and the analysis was inconclusive for Spain due to low number of samples. We attribute these findings to the extensive human-mediated introduction of this species, often consisting of multiple introductions of high number of individuals from different sources. Our results highlight the complexity of tracing introduction histories of *A. longifolia* and should be considered when planning management strategies.

## O10

### **Ornamental invasive plants were marketed earlier and for longer than non-invasive ornamentals in New Zealand**

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#### **Abstract**

Many plants now considered invasive were originally introduced intentionally as ornamentals. Increasingly, evidence suggests that attributes of the ornamental market may explain the success of invasive alien plants, but detailed assessments of this assumption are rare. Here we examine trends in ornamental plant sales over time and test the hypotheses that compared to non-naturalized species, invasive plants with environmental impacts entered the ornamental market earlier and were sold for a longer time. We collected data from dozens of nursery catalogues in New Zealand ranging from 1866 to 1992 for 254 invasive species with significant environmental impacts and their congeners. We evaluated the first date of record for each species and the range of catalogues in which it appears. Our catalogues have captured at least half of the most environmentally detrimental invasives thought to have been introduced or sold as ornamentals, and of these the majority (80%) are recorded in a nursery catalogue before they are known to have been naturalized. We found that these invasives were first sold in nurseries up to two decades earlier on average than other species and were sold in more catalogues across a greater number of years. These results suggest that early introduction and sustained propagule pressure through continued marketing and sale increases the likelihood that a species will naturalize and have environmental impacts. Our results indicate that changing horticultural trends can affect future invasions by altering the available species pool and increasing opportunity. A better understanding of the role of ornamental markets can be used to assess species currently sold today that have the potential to become environmental invaders in contrast to species that pose a low risk and emphasizes the importance of continued engagement with the horticulture industry to minimize the risk of future invasions.



## O11

### Five millennia of invasions: invasibility, exaptations and conservation in the Balearic Islands

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#### Abstract

The Balearics are the most isolated archipelago in the Mediterranean and have experienced an increasing influx of exotics at least since human settlement over fifty centuries ago, causing deep transformations of native ecosystems. The uneven arrivals became superimposed upon preexisting differences among insular communities, initially giving rise to novel assemblages on each island, but eventually tending to converge on biotic homogenization. However, the process has been a complex one, with two main constraints: the widely disparate susceptibility of insular biotas to invasion, caused by strikingly contrasting geological and evolutionary histories, and the presence among invaders of traits enabling establishment, largely linked to their continentality (or its inverse the insularity index). The outcome is a fine mosaic of alteration states, with quasi-native remnants interspersed among various stages of human influence. Understanding these dynamics is key for the development of conservation strategies aimed at curbing the tide of biological invasions, restoring functional assemblages and ensuring survival of endemic taxa. Each biogeographic setting needs its own tailored, sound set of conservation goals and guidelines, but old islands provide fruitful laboratories and benchmarks.

## O12

### Paleoecological perspective on the abundance of alien plant species on islands

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#### Abstract

Current changes in island vegetation are caused among others by the introduction and spread of alien plant species. While current invasion statuses are well-known and insular biodiversity is being monitored, a paleoecological perspective on alien plant species abundance and the speed and magnitude of introductions on islands is largely missing. By matching long-term low-resolution pollen data with short-term high-resolution plant data, we quantify the changes caused by alien plants on islands globally during the last 5000 years. In general, alien plants have been present in many systems but started to increase massively only during the last 1000 years, without any signs of slowing down. Thus, although humans have altered the vegetation on islands for centuries and millennia, the recent increase in alien plants is unprecedented. We show that palynological data can be used to obtain a historic perspective on the development of alien plant abundance on islands.

## Fewer non-native insects in freshwater than in terrestrial habitats across continents

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### Abstract

Biological invasions are a major threat to biodiversity in both aquatic and terrestrial habitats. Insects represent an important group of species in freshwater and terrestrial habitats, and they constitute a large proportion of non-native species. However, while many non-native insects are known from terrestrial ecosystems, it remains unclear how they are represented in freshwater habitats. Comparisons of the richness of invaders relative to the richness of native species between freshwater and terrestrial habitats are scarce, what hinders syntheses of invasion processes.

Here, we compiled data from three regions: Europe, North America and New Zealand to determine whether non-native insects are under- or overrepresented in freshwater compared to terrestrial assemblages. We then contrasted the richness of non-native and native species among freshwater and terrestrial insects for all insect orders in each region. Using binomial regression, we analysed the proportions of non-native species in freshwater and terrestrial habitats across the three regions.

Overall, the proportion of non-native species was significantly lower in freshwater than in terrestrial habitats. In most freshwater insect orders, non-native species were under-represented, while they were over-represented in a number of terrestrial orders. This pattern occurred both in purely aquatic orders and in orders with both freshwater and terrestrial species. It was also consistent across the three investigated study regions. Our study provides broad and consistent evidence that invasions of freshwater insect species are relatively rare, in contrast to terrestrial insects and contribute to a growing appreciation of drivers and impacts of biological invasions.

**O14**

**Spatial scale determines whether functional and phylogenetic similarity helps or hinders exotic plants**

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**Abstract**

Darwin's naturalization hypothesis suggests that successful invaders should be functionally different from resident species due to competitive exclusion. However, the opposite could also be expected; functionally and phylogenetically similar species may have a higher chance of establishing in a new range since they may already possess traits that are suited to the local conditions. These apparently contradictory hypotheses have been tested with inconclusive results. Some studies have suggested a possible co-occurrence of the two phenomena at different spatial scales. Here, using plant cover data from a long-term grassland experiment in the US, we examined the relationship between native and exotic plant species cover (as a proxy for species performance) and their phylogenetic and functional similarities from the resident community at two different spatial scales. We found a consistent positive relationship between species cover and phylogenetic similarity particularly in case of exotic species at both local and neighbourhood scales, however, trends in functional similarities varied across spatial scales. At larger spatial scales, exotic species were more abundant when they were more functionally similar to the rest of species of the community, while functionally dissimilar exotic species were more abundant at local scales. These results point out the relevance of spatial scale in predicting the success of exotic species. Specifically, they suggest a sequential process of invasion whereby closely related species are more likely to overcome environmental filters that take effect at larger spatial scales, after which species that are more functionally distinct become more abundant at local scales due to limiting-similarity competition. Spatial scales and community assembly rules, therefore, provides a powerful tool to improve our knowledge about the drivers and consequences of invasions.

# NOVEL TOOLS AND METHODS FOR DETECTION, MAPPING, MONITORING AND CONTROL OF INVASIVE ALIEN SPECIES

O15

## Automated early warning: a pipeline for feeding headline indicators on the state of invasions and to prioritize emerging alien species

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### Abstract

Imagine you're automatically alerted when a new alien species appears in your country, a new introduction pathway opens or an established species jumps out of its lag phase and increases in protected areas. We showcase an operational workflow generating indicators for the state of invasions based on openly published checklist and occurrence data on GBIF using data from the TRIAS project in Belgium. Checklist indicators include headline indicators at country level: the (cumulative) number of new introductions of alien species in time and the pathways associated with alien species introductions. R functions were developed to break this information down to taxa, environments, native ranges and degree of establishment. Indicators can be restricted to the Union Concern species of the EU Regulation. Occurrence based indicators provide information at species level. Pre-processing creates an occurrence cube with data aggregated at 1 km level. From this cube we build indicators of (re)appearing and emerging species in Belgium. Emerging species show a significant increase in their occupancy or number of observations in recent years. Generalized Additive Modeling and simple decision rules were applied to analyse the time series of occupancy and number of observations inside and outside protected areas of the NATURA2000 network. We used all data on alien and native species at the rank of class as a covariate to compensate for survey effort bias. Several ranking procedures were then applied to create a prioritized list of species to inform decision making and provide trend information useful for risk assessment and risk management. The seamless, open data flows and open software tools allow for yearly updates when new checklist information or new datasets are added to GBIF. As such, it can easily be applied to other countries or regions of the world wanting to strengthen their evidence base for IAS policy and management.

## Updated alien plant species lists of European countries in the FloraVeg.EU database

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### Abstract

Macroecological research in invasion ecology depends on evaluation and assignment of the alien status of plant species in different regions of Europe. The development of national checklists of alien floras in many countries started in the 1990s based on the compilation and expert evaluation of available floristic records for particular countries. Subsequently, continental-scale databases containing regional data on alien plants, such as DAISIE, GloNAF and Euro+Med PlantBase were developed. However, there are still gaps and inconsistencies among existing checklists and databases of alien plant species in terms of their timeliness, completeness, comparability, data quality and consistency of species categorization. Moreover, information on alien plants is insufficient for some European regions.

The aim of our project is to compile an overview of recently published national and regional alien checklists across European countries. We unify the taxonomy and nomenclature, invasion and residence-time status categories and other information provided for the non-native species using a standardized methodological approach. Based on the adjusted species lists, we compare alien floras across Europe and identify main gaps in data availability and quality. So far, we have digitized complete or partial alien checklists for 50 European territories (countries or bigger islands and archipelagos with distinct history and biogeography). We continue searching for available checklists and evaluating them. Based on all available information we assess the native-archaeophyte-neophyte status of species with respect to individual European countries. Species-status data become part of our recently developed online database FloraVeg.EU containing information on ecology and biogeography of European flora and vegetation.

Acknowledgements: This research was supported by the Czech Science Foundation (EXPRO grant no. 19-28491X).

O17

## A barrier to global plant invasion ecology: gaps in trait availability for alien species

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### Abstract

The increasing global changes affecting natural ecosystems increase the spread and impact of alien plant species. While native plant community ecology have highly benefited from the functional approach to better understand it, global alien plant functional ecology is still as its infancy. The lack of trait data for alien species in global databases prevents alien plant ecology to seek generality beyond the specificities of invaded ecosystems. In order to properly estimate the trait acquisition to be done, we are performing a thorough review of global trait resources available for alien plants. We are then providing a priority list of species, based on impact of the species and spread, for which the traits data should be first acquired. We believe syntheses efforts from the alien plant community could highly fill this gap.

O18

## A novel remote sensing supporting system to control, monitoring, containment and eradication of aquatic alien plant species – SINVAQUA

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### Abstract

Aquatic areas include some of the most exposed and vulnerable ecosystems to biological invasions. The total eradication of aquatic invasive alien species is difficult and costly, therefore the most efficient measures are those aimed at prevention and early detection, allowing control actions more likely to be successful. We have developed a prevention system based on remote detection to early warning and rapid response to the introduction and spread of aquatic invasive alien plant species, constituting a tool to support Plans for the prevention and management of invasive alien species, as well as training stakeholders and managers. The SINVAQUA system has been developed and tested for two target species: *Egeria densa* (listed in the Portuguese Law-decree nº 92/2019) and *Eichhornia crassipes* (listed in the European Regulation No 1143/2014).

SINVAQUA allows to: (i) make decisions on biological invasion and nature conservation measures based on spatially explicit knowledge, (ii) reduce efforts in monitoring changes “in loco” by municipal/local technicians, (iii) improve the coordination and planning of control actions; and (iv) contribute to the advancement of research in the academic-society-companies-governance arena, through the reinforcement of environmental knowledge and innovation of detection methods in a digital era.

The system converges with European objectives regarding the planning and management of water resources, nature conservation and biodiversity, by supporting the prevention and control of aquatic invasive alien plant species, namely the European Union Biodiversity Strategy for 2030, the European Water Framework Directive, National Strategy for Nature Conservation and Biodiversity 2030, and the 2030 Agenda for the Sustainable Development Goals (SDG 15). In addition to the convergence with these initiatives, SINVAQUA supports the implementation of the Regulation (EU) No 1143/2014.

This study has been funded by the Portuguese Government through the Application 27, Pub. Notice 9678/2021 “Nature conservation and Biodiversity: Prevention and control of aquatic invasive alien species.”

O19

### **An assessment of the invasion of *Vespa velutina* in Belgium five years after its arrival**

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#### **Abstract**

In the region of Flanders (northern Belgium), the first nests of the Asian hornet, *Vespa velutina*, were reported in 2016 and the species has been spreading since. Surveillance for Asian hornets and their nests was organized using a citizen science approach through the platform [www.vespawatch.be](http://www.vespawatch.be). Reportings of observations are synchronized with [www.inaturalist.org](http://www.inaturalist.org). After positive evaluation of an observation by the iNaturalist community, a coordinated network of volunteers initiates nest detection using the wick bait station method. This ultimately leads to nest destruction. To make the best use of volunteer time it is necessary to have an up-to-date overview of active outbreaks of *V. velutina*, i.e. areas with hornet activity indicating the presence of an undetected nest nearby. To this end we created an interactive online map using Leaflet, the open-source JavaScript library for R and Github ([https://inbo-vespawatch.shinyapps.io/VespaWatch\\_app/](https://inbo-vespawatch.shinyapps.io/VespaWatch_app/)). The usefulness of this approach was tested in the management season 2021. Furthermore, trends in invasion dynamics during the first years since its introduction, habitat preference for nest building and species interactions of *V. velutina* in Belgium are discussed.

O20

### **eDNA-based detection of *Pacifastacus leniusculus* in rivers: ddPCR and LAMP assays optimization and data treatment**

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#### **Abstract**

eDNA-based detection methods are becoming tools of choice for invasive species detection in aquatic environments. Here we tested and optimized two of them, ddPCR and LAMP, in order to detect the North American crayfish species *Pacifastacus leniusculus* in streams of Luxembourg.

ddPCR is a very sensitive detection tool that can partially mitigate inhibition effects due to the high number of reactions for a single sample (between 10K and 20K). However, we found that inhibitors present into water significantly impact the signal in term of fluorescence amplitude of positive amplification events (droplets). This phenomena, allied to the inherent artefactual generation of high fluorescence droplets could jeopardize the use of a shared threshold among samples from different origin, and thus the accurate assignation of the positive droplets which is particularly important for low concentration samples such as eDNA ones: amplification events are scarce, thus their objective discrimination as positive is crucial. We propose a new, simple data treatment that can mitigate these effects in order to get an optimal and consistent detection.

LAMP assays are becoming increasingly popular in the field of invasive species detection but are still underused in eDNA-based monitoring. Here, we designed a LAMP assay to detect *P. leniusculus*. Benchmarked against ddPCR results, no correlation was found between ddPCR absolute concentration measurements and the number of LAMP-positive technical replicates. However, we showed that using dependent technical replicates could significantly enhance the detection sensitivity of the LAMP assay.

The methodological improvements developed here could be applied to other assays and might allow for a more efficient use of eDNA-based detection of invasive species in aquatic ecosystems.

## O21

### Catch them if you can: a proposed workflow to ensure new alien species detections from molecular analyses are acted upon

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#### Abstract

Improving our detection of invasive alien species is crucial for management, but too often there is a break in communication. In South Africa, the polyphagous shot hole borer (*Euwallacea fornicatus*) was first recorded in 2012 but no action was taken until a separate observation was made in 2017. The five-year gap from detection to action allowed the invasive species to spread around the country and kill thousands of trees. Learning from this experience, this study aims to develop a workflow from molecular observations to flag new introductions and identify actions to be taken, specifically to: a) improve lists of alien plants of Southern Africa; and b) identify threats that need to be acted upon. More specifically, the workflow compares a list of 9,819 species collected in South Africa from 'The Barcode of Life Data System' with three different datasets: Plants of Southern Africa (POSA = 39,795 records); a watchlist of species of concern for South Africa from Faulkner et al. (2014) (400 species); and a list of high risk pests. For the first aim, if a plant species is present in the DNA database but it is not in the POSA database, it is flagged as a potential addition to the lists of alien species of South Africa that might need to be confirmed through a field visit. For the second aim, if a species in the DNA database is present in the watchlist or the list of high-risk pests, then an incursion response is triggered. Improving the flow of information from detection to action can potentially create a faster, more responsive biosecurity system aiding in the control of invasive alien species.

#### Reference

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## O22

### All that Twitters is not gold: does social media reflect invasion science research?

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#### Abstract

Public awareness is essential for communicating current environmental issues, including biological invasions, but how much people are aware of them is very difficult to assess using conventional methods. As such, the drivers of public awareness on the invasion of alien species are largely unknown, and researchers commonly refrain from attempts to quantify them. Culturomics (i.e., the analysis of large bodies of digital data) provides potentially promising tools to fill this gap. Here, we extracted and analysed data collected from Twitter (i.e., the most popular microblogging platform) to understand the main topics discussed by the public when posting about biological invasions. We extracted all tweets from the past 15 years containing the term “invasive species” which included 563,022 tweets posted by 165,754 user accounts. We conducted quantitative textual analysis, and found the tweets could be most coherently divided into 40 topics with the most prevalent terms relating to management, public engagement and components of ecosystems. Taxa that were most mentioned included cat (*Felis catus*), carp (family: Cyprinidae), pig (*Sus domesticus*), and lionfish (*Pterois* spp.). Taxa that were associated with viral tweets (i.e., largest ratio of retweets to tweets) included possum (order: Didelphimorphia), earthworm (phylum: Annelida), and goat (*Capra hircus*). There was an over-representation of tweets mentioning invasions by mammals, as well as island habitats. The results of this research indicate that there are particular taxa and topics related to biological invasions that are overrepresented on Twitter and attract more engagement online. This information can be used to identify mismatches between scientific outputs and public discourse to help target public campaigns and improve communication of science to the public.



## RELATIONSHIPS BETWEEN WEEDS AND INVASIVE ALIEN PLANTS (SPECIAL JOINT SESSION WITH EWRS)

O23

### Ancient and recent vascular plant invaders show diverging trends in Central European fields over the past 90 years

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#### Abstract

Arable fields, i.e. agricultural sites planted with crops and regularly managed, have been an important feature of Central European landscapes for thousands of years and are habitats for a unique aspect of its flora. However, in recent decades, they have been affected by drastic changes in land use, and, more recently, climate change and the spread of alien species. Studying these past changes provides important insights into ongoing dynamics, e.g. the spread of alien species that could exhibit damage to agriculture, human health and livelihoods as weeds.

Here, we present the results of occupancy modelling of over 300 vascular plant species found in arable fields of Central Europe (Germany, the Czech Republic, Slovakia, Switzerland, Liechtenstein, Austria, Hungary, Northern Italy, Slovenia, Croatia) over the past 90 years using data from over 20,000 vegetation plots of the AgriWeedClim database (Glaser et al. 2022). Occupancy modelling (*sensu* Outhwaite et al. 2018) allows overcoming biases common in vegetation plot data by hierarchically combining an occurrence and a detection model. We show how alien species introduced a long time ago (i.e. archaeophytes), more recent aliens (i.e. neophytes), and native species have changed in occurrence. Further, we analyze how species with different ecological preferences (Ellenberg Indicator Values) have changes in occurrence over time. We then discuss the observed differences among native species, neophytes and archaeophytes in the context of historical environmental change.

Our results show that changes in land use have had a large effect on vascular plants' occupancy leading to the loss of some typical species, and neophytes are a species group showing large gains and thus merit increased monitoring.

#### References

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- Outhwaite, C. L. et al. (2018). Prior specification in Bayesian occupancy modelling improves analysis of species occurrence data, *Ecological Indicators*, 93, pp. 333–343. doi: 10.1016/j.ecolind.2018.05.010

**The possible impact of the EU Green Deal on plant invasions and weed occurrence in Europe**

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**Abstract**

Over the last two decades the European Union (EU) has been implementing sustainable policies for the biodiversity and nature preservation and the human well-being increase. The European Green Deal, in line with the United Nations sustainable development solution, is the EU's commitment to face the global environmental problems and reach better world and society while encouraging other continents to join EU Farm to Fork and Biodiversity Strategy for 2030 that followed the Green Deal. Invasive Plant Species (IPS) and weeds have been the greatest challenge for the global change and modern agriculture. The new invasions frequency has increased in recent years due to the awareness and monitoring of farmers and scientific community and the climate change which created suitable habitats for their spread and establishment. Europe is considered particularly vulnerable since the agricultural policies do not provide a response to this multidimensional problem. Nevertheless, global instability considering energy, prices and trade is adversely affecting the European agricultural systems' sustainability, hence the noxious weed introduction could potentially undermine the entire agri-food chain. As IPS are directly affecting the biodiversity, they are an obstacle to achieving one of the main sustainable growth strategies' goals. The IPS management in the EU is starting to fall short of effective herbicides with intensive soil tillage being avoided, which could lead to the eradication and control failures. Therefore, increasing efforts are being made to find new active ingredients, with the emphasis on biological control and biopesticides. Focusing on the agroecological solutions and developing new technologies for the prediction, detection and monitoring of infestations could contribute to the IPS integrated management. The future scientific work concerning weeds and plant invasions in Europe should concentrate on developing and adopting the worldwide protocols and including related disciplines and parties.

O25

### Two new alien species from Turkey in covered banana production: *Pilea microphylla* (L.) Liebm. (Urticaceae) and *Cardamine occulta* Hornem. (Brassicaceae)

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#### Abstract

Banana producing in Turkey has increased for the last two decades because of expanding covered production to tackle with unsuitable weather conditions present in open field production. A weed survey was carried out in covered and open field banana productions in the Mediterranean region of Turkey in 2021–2022. 68 species from 25 families were recorded. *Pilea microphylla* (L.) Liebm. (Urticaceae) and *Cardamine occulta* Hornem. (Brassicaceae) were detected first time and deposited in DUOF and MKUBK Herbaria for flora of Turkey. *P. microphylla* is native to Americas and *Cardamine occulta* to China, Japan and tropical Asia. Both species have been recorded in Europe as well as in other continents as alien species. There are 14 *Cardamine* L. spp. taxa in Turkey of which some are native wild edible plants such as *C. hirsuta* L., *C. amara* L., *C. pratensis* L. There has been no record of *Pilea* spp. so far. Introduction pathways of both species have not been clear. *P. microphylla* has been introduced either intentionally by ornamental trade, production or use, or unintentionally via agricultural propagation materials such as banana seedlings, peat, soil, etc. In the case of *C. occulta* unintentional introduction is more probable. Both species are weeds in disturbed areas including banana plantations in some countries. In the Mediterranean region of Turkey, *C. occulta* was found at 58.39% and *P. microphylla* at 29.81% of banana greenhouses but neither of them was seen in open banana fields surveyed. Spread of the species has been attributed to manure that has been used in excessive amounts in banana cultivation as well. Their average special densities in greenhouses detected were 9.18 individual/m<sup>2</sup> (12.83% coverage) and 5.51 weed/m<sup>2</sup> (9.48% coverage) for *C. occulta* and *P. microphylla*, respectively. It is apparent that warm, wet, and muddy environment of banana greenhouses encourages both species. We suggest an intensive eradication program to prevent further spread of both species in other crops and natural areas.

O26

### The bioherbicidal potential of the selected hydrolates towards *Portulaca oleracea* L.

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#### Abstract

In the Republic of Serbia *Portulaca oleracea* L. is considered as an invasive weed species commonly occurring in the fields, vineyards, dunes, beaches, riverbanks and along the roads, in sunny places. It is one of the most problematic weeds in agricultural production due to its allelopathic effects towards several cultural crops, including wheat, soybean, maize, onion and lettuce. To this day, the frequency of its occurrence in the organic production is estimated to be reaching 50%. Since the aim of the study was to find the ecologically acceptable compounds which could replace the synthetic herbicides, in a series of the biological tests the *P. oleracea* seeds were treated with the mint, lavender and oregano hydrolates in the concentration levels of 10, 20, 50 and 100%. The obtained results showed that the 100% lavender hydrolate completely inhibited the *P. oleracea* seed germination, while the 10, 20 and 50% concentrations led to the germination reduction of 78, 88 and 92%, compared with control. When 20% oregano hydrolate was applied only 30% of the *P. oleracea* seeds germinated, while the 10% hydrolate application led to the germination of 72%. The higher hydrolate concentrations completely inhibited germination. In comparison with the other tested hydrolates, mint hydrolate expressed the least inhibitory effect, since the highest applied hydrolate concentration (100%) led to the germination of 9%, while the least applied concentration (10%) led to the 72% germination, compared with control. The applied hydrolate concentrations of 20 and 50% led to the 59 and 51% germination. The comparison of the mean hypocotyl and epicotyl lengths of the *P. oleracea* seedlings expressed the statistically significant differences for both parameters between the control and the treated variants. The obtained results accentuate the potential of the hydrolates to be used in the biological control of *P. oleracea*.

# PAST, CURRENT AND FUTURE DRIVERS RESPONSIBLE FOR BIOLOGICAL INVASIONS

O27

## A process-driven reframing of the Enemy Release Hypothesis in space and time

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### Abstract

The enemy release hypothesis (ERH) remains an important and commonly invoked hypothesis to explain the success of alien species in their non-native range. However, evidence for it is frequently highly contradictory, preventing effective syntheses about the role it plays in invasion biology. Here, we review evidence for the ERH and demonstrate that many contradictions can be reconciled by viewing the ERH through three key processes: the loss and fitness effects of specialist enemies; the gain and fitness effects of generalist enemies; and the directional evolution of growth and defence. These processes vary with temporal scale (time since invasion) and spatial scale (geographic location in the invaded range), and thus differ in importance across the invasion process. Further, there are six key contexts that alter the likelihood of these processes occurring and their relative strength: phylogenetic relationship between native and invasive species; the type of enemy; temporal and spatial asynchronicity between invaders and enemies; resource availability; number of invasion events; and the existence of within-species trade-offs. We develop an integrated framework which incorporates these processes and contexts and mechanistically explores how they influence invasion success in space and time, reconciling multiple invasion hypotheses related to the loss of enemies. We use our framework to highlight why and how studies of the ERH may differ, and provide key considerations to advance our knowledge concerning its role in invasions globally.

O28

## Analysing ecological dynamics with relational event models: the case of invasion events

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### Abstract

Spatio-temporal processes play a key role in ecology from genes to large-scale macroecological and biogeographical processes. For analyzing such spatio-temporally structured data timing and time-ordering of events is particularly important. This study presents a generic method – relational event modelling – for studying spatio-temporal patterns of biological invasions at large spatial scales and by including variables that drive these dynamics. Relational event modelling (REM) relies on temporal interaction dynamics that encode sequences of relational events connecting a sender to a recipient at a specific point in time.

We present a relational event model case study of the spread of alien species, which are species that are introduced accidentally or deliberately into geographical regions outside their native range. In this context, a relational event represents the new occurrence of an alien species given its former distribution. By considering the bipartite network of species and regions, we embed the first records process into a relational event setting in order to detect drivers of invasions in the presence of complex confounding. Thus, taking the temporal sequence of occurrences into account, the relational event model identifies commonalities among species' spread and their relation to underlying variables. Using years of first records of 16,019 established alien species from major taxonomic groups we have shown that the relational event model can be used constructively in environmental science to model time-stamped ecological interactions, such as the invasive species process, without having to resort to more traditional simplifications. Combining the first records data with other spatio-temporal information, enables us to discover which factors have been driving the spread of species across the globe.

O29

## Soil seed banking strategies of invasive plants at home and abroad

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### Abstract

Understanding the main drivers of invasions by alien plants is key to predict and prevent potentially harmful introductions and to manage current invasions. Forming reserves of seeds that retain their viability over multiple regeneration seasons is a strategy that allows a species to persist in the soil as latent propagules while spreading mortality risks through time. Evaluating whether naturalized flowering plants use similar seed banking strategies in the native and alien range and under which conditions they form persistent seed banks can provide important insights into the role of seeds in the invasion process. To address this issue, we used global soil seed bank data (GloSSBank) to test two hypotheses, in a phylogenetic framework. First, we tested whether 223 naturalized species use a similar seed banking strategies (transience versus persistence) and form seed banks of comparable densities at home and abroad, based on local data collected at 5,345 sites. Second, we tested the effect of seed bank properties, species traits (seed dormancy, seed mass, and life form), and local environmental and climatic conditions on the probability of 2,350 native species to become naturalized (naturalization incidence) and the extent (number of regions) of naturalization, based on local data collected at 11,893 sites. Overall, local seed bank type and densities of naturalized species were similar in the native and alien range. The ability of forming persistent seed banks affected naturalization incidence and extent directly, while seasonal precipitation and temperature had an indirect effect via seed bank properties and seed traits. These findings suggest that the ability to form persistent (versus transient) seed banks is a useful preadaptation leading to naturalization in the alien range. They also provide new insights into relationships between environmental variables, seed bank and species properties, with naturalization incidence and extent.

O30

## The impact of land use on alien species incidence and number in local assemblages worldwide

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### Abstract

At the regional scale, the naturalization of alien species has been intensively analysed during the recent decade. However, the spread of alien species across local assemblages is much less documented. Human land use is generally assumed to facilitate alien establishment at this scale, but this pattern is mainly supported by studies of vascular plants in temperate regions so far. Here, we use a worldwide collection of >11,000 local assemblages from five taxonomic groups – ants, birds, mammals, spiders and vascular plants – to document levels of local invasion and analyse the relationship between the incidence, number and proportion of alien species and type and intensity of human land use. We find that on average across the five groups, 20.9% of assemblages contained at least one alien species. The degree to which particular land use types and levels of management intensity foster alien species varies across taxonomic groups. In general and across groups, however, primary ecosystems are least invaded, or at least not more invaded than any other land use type. These findings support ambitious conservation and restoration goals as pristine ecosystems may not only help rescuing native biodiversity but also constrain the establishment of biological invaders.

## The role of (un)recorded introductions in explaining current alien mammals' distribution in Europe

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### Abstract

Biological invasions are amongst the main drivers of biodiversity change and decline (1) but despite increasing efforts, the spread of invasive species continues unabated (2). As we recently showed (3), alien mammal species in Europe are no exception, and despite increasingly tight regulations and growing awareness, their ranges continue to expand (3).

We present an analysis on propagule pressure (intensity of introduction) for 71 alien mammal species in Europe, whereby we predicted each species' range size based on location of introduction, residence time, dispersal distance, and generation length of the species. To investigate the role of socio-economic factors (related to anthropogenic activities and introduction pathways) in explaining the differences between observed and predicted alien mammals' range size, we calculated the proportion of the observed range compared to the predicted range (filling ratio) for each species. We then used it as a response variable in a generalized mixed model, to quantify the effect of a wide array of event-, species-, and location-level predictors on filling ratio. Predictors included, among others, location of introduction, propagule pressure (adding, notably, unsuccessful recorded introductions), climate matching, and human footprint index.

We found that environmental or biotic factors may limit species' spread, as many alien mammals' observed ranges were significantly smaller than predicted. However, we found that the pathway of introduction and propagule pressure played a major role in determining alien mammals' range sizes. These factors ultimately depend on human behaviour rather than environmental characteristics or species traits and ecology. In this light, preventing additional introductions is key to limiting the further spread of alien mammals already established in Europe.

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## Do alien plants occupy the centre or periphery of the functional trait space in local communities of different habitat types?

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### Abstract

We examined functional trait differences between native and alien species in 24,918 local communities of six habitat types of the Czech Republic. We asked whether alien species integrate into the center or periphery of the trait space of each community, and whether the observed pattern is consistent across habitat types. We hypothesized that alien species occupying the center might compete with native species. Conversely, if they occupy the edge, they are likely filling empty niches in the community. We used vegetation-plot data from the Czech National Phytosociological Database and data on species functional traits (e.g., maximum height, SLA, seed weight etc.) from trait databases and literature. We classified alien species into non-invasive naturalized and invasive species according to the introduction-naturalization-invasion concept. We then developed two types of null models to test for trait differences between alien and native species in each vegetation plot. When we considered each trait separately, we did not find any consistent differences between native and alien species (either naturalized non-invasive or naturalized invasive species) across habitat types. However, when we measured the average distance of alien species from the center of the trait space of native community in each vegetation plot, we found similar patterns for all habitat types. Based on these preliminary results, it appears that alien species are more likely to occupy the periphery of the trait space in each plot, with invasive species being situated further from the centre than non-invasive naturalized species. We also plotted standardized trait distances calculated for alien species in invaded plots against environmental characteristics of those plots derived from species ecological indicator values. Although all relationships were weak, the amount of nutrients and moisture correlated positively with the tendency of invasive species to occupy the periphery of the community's trait space, but negatively with light and temperature.

## O33

### Introduction history mediates naturalization and invasiveness of cultivated plants

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#### Abstract

Species characteristics and cultivation are both associated with alien plant naturalization and invasiveness. Particular species characteristics are favored for cultivation, obscuring the relationship between traits and naturalization success. We sought to better understand the drivers of naturalization and invasiveness by analyzing relationships with species characteristics and cultivation and by disentangling the direct effects of characteristics from the indirect effects mediated by cultivation. We used a comprehensive dataset of 17,396 alien plant taxa introduced to Great Britain before 1850, a country with one of the most well-documented histories of plant introductions. We integrated this with cultivation data from historical and modern records of botanic gardens and commercial nurseries and with trait data. Accounting for time since introduction, we quantified the influences of cultivation and species characteristics on present-day naturalization and invasiveness in Great Britain. Larger native range size, earlier flowering, long-lived herbaceous growth form, and outdoor cultivated habitat were all associated with naturalization. However, these relationships between characteristics and naturalization largely reflected cultivation patterns. The indirect, mediating influence of cultivation on naturalization varied among species characteristics, and was relatively strong for growth form and weak for native range size. Cultivation variables, particularly availability in present-day nurseries, best explained invasiveness, while species characteristics had weaker associations. Human influence on species introduction and cultivation is associated with increased probability of naturalization and invasiveness, and it has measurable indirect effects by biasing the distribution of species characteristics in the pool of introduced species. Accounting for human cultivation preferences is necessary to make ecological interpretations of the effects of species characteristics on invasion.

## O34

### Characteristics of Australia's alien flora vary with invasion stage

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#### Abstract

Humans selected plants to introduce beyond their native ranges. Therefore, traits of past invaders may identify which species have had the chance to invade, rather than which species would become invasive given the chance. Accordingly, we used a comprehensive list of 34,122 known alien plant species introduced to Australia, to examining failed introductions, as well as successes. We investigated: (1) similarities and differences in plant characteristics across invasion stage, and (2) drivers for alien species' failure or success. Along with plant traits, minimum residence times and numbers of introduction pathways were assessed, as these relate to potential frequency of introductions. Key findings were that characteristics of Australia's alien flora vary with invasion stage. Plants with longer residence times and more introduction pathways were more likely to naturalise and/or become invasive. These findings provide understanding of how non-random selection influences the types of plants that go on to naturalise and/or invade.



O35

### **Has human leisure activity an impact on the distribution of native and invasive Amphipoda (Crustacea) in Mazurian Lakeland (Poland)?**

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#### **Abstract**

Invasive Alien Species (IAS) cause the decreasing of native species diversity on a local and global scale. The Ponto-Caspian region is among the most important donors of invasive Amphipoda for European inland waters. Due to the construction of canals and heavy boat traffic, the Ponto-Caspian Amphipoda spread in European rivers. Four of these species: *Echinogammarus ischnus*, *Dikerogammarus haemobaphes*, *Dikerogammarus villosus* and *Pontogammarus robustoides* invaded Mazurian Lakeland in north-eastern Poland. In our study we surveyed the distribution of these invasive species in the region and checked if tourist pressure (understood as boats density in each lake) can promote the spread of Ponto-Caspian invasive Amphipoda. We sampled Amphipoda in 14 lakes and associated rivers in 2014 and 2016. Obtained data were compared with the published and unpublished data from 2001–2008. Our comparison showed appearance of two new invasive Amphipoda in the region in 2014 – *D. villosus* and *E. ischnus*. Additionally, we found that the relative abundance and frequency of the two species is rapidly increasing, while it decreases in the case of two older invaders (*D. haemobaphes* and *P. robustoides*). The native *Gammarus lacustris* disappeared from one lake where it had previously coexisted with invaders but is still present in isolated lakes where the invasive amphipods are absent. The results of Non-metric Multidimensional Scaling suggest that the recreational boats can be the most significant vector of spreading invasive amphipods in the region while occurrence of the native species can be associated with good water quality, well developed shoreline and the presence of silence zones supporting the natural conditions in the lakes.

O36

### **The role of temperature in marbled crayfish (*Procambarus virginalis*, Lyko 2017) invasion in Estonian freshwater ecosystem**

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#### **Abstract**

Biological invasions are crucial issues worldwide and marbled crayfish (*Procambarus virginalis*, Lyko 2017) is one of the examples of freshwater invaders spreading across Europe. Its high growth rate, reproduction, and adaptability to new habitats make *P. virginalis* a successful invader. *P. virginalis* is a warm water species, but a previous mesocosm study found that it adapts well to colder temperatures. However, investigations of the role of temperature in marbled crayfish invasion in natural habitats are scarce. The aim of this study was to assess whether the temperature is the main factor that affects marbled crayfish establishment and distribution in the artificially warm outflow channel of the Power Plant in the Narva Reservoir, Estonia. We hypothesised that warmer water temperature and temperature gradient along the channel affected the establishment, distribution, and trophic niche of marbled crayfish. Temperature loggers were deployed for one year along the channel to record temperature variations. Stable isotope analyses of carbon and nitrogen were performed to assess trophic niche and diet of marbled crayfish. Although no temperature gradient was recorded, water temperature in the channel was significantly warmer than in reservoir, providing a suitable habitat for the establishment of marbled crayfish. Stable isotope analysis showed spatial and seasonal trophic niche shifts, indicating different diets and trophic positions between the head and mouth of the channel, and between summer and autumn, respectively. In particular, marbled crayfish diet at the head of the channel mostly comprised macroinvertebrates and macrophytes, as opposed to mostly periphyton at the mouth of the channel. Seasonally, marbled crayfish diets shifted from primary consumers in spring to primary producers in autumn. Our findings showed that temperature had an important role in marbled crayfish establishment in the invaded channel; however, the population distribution was likely affected by other ecological aspects, such as food sources availability rather than temperature.

***Gunnera tinctoria*: successful invader but poor competitor**

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**Abstract**

Invasive species have sometimes been thought to disproportionately benefit from an increase in resources compared to many resident species. However, whether inter-specific resource competition plays a major role in successful invasions, and under which environmental conditions invasive species are competitively superior, remains unclear. Here, we investigate how nutrient supply affected the establishment and growth of the N-fixing invasive species *Gunnera tinctoria*, in the absence or presence of different levels of competitive pressure. We explored the hypothesis that nutrient additions will not facilitate *G. tinctoria* invasions, regardless of the competitive pressure applied by the native grasses, by simulating four competitive pressure treatments in a greenhouse experiment, under fertilized and unfertilized conditions. Significant increases in biomass, leaf area, plant nutrient content, N-utilization and carbon assimilation were found under fertilized conditions that could facilitate invasions but only when competition was absent. This could indicate that either the greater productivity of *G. tinctoria* is related to the increased availability of nutrients, such as P and K that are enhanced in plant tissues and/or that this species has some capacity to utilize soil mineral nitrogen when higher concentrations of nitrogen are available. This would challenge the evidence that *G. tinctoria* depends exclusively on N fixation to meet its N requirements. In contrast, when any level of competition was present, fertilization caused a significant decrease in the probability of survival and plant performance, indicating that fertilization could restrict the invasion, perhaps by significantly increasing the biomass of the competing grass. These results indicate that the increased N availability disproportionately benefited the native grass, rather than the invader. Based on these results *G. tinctoria* might not be as good a competitor as initially thought and factors, other than a higher competitive ability, are likely to be responsible for the successful early colonization and establishment of this species.

## IMPACTS OF INVASIONS ON NATIVE SPECIES, COMMUNITIES AND ECOSYSTEMS

O38

### **GIRAE: a Generalised approach for linking the total Impact of invasion to species' Range, Abundance and per-unit Effects**

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#### **Abstract**

The total impact of an alien species was conceptualised as the product of its range size, local abundance and per-unit effect in a seminal paper by Parker and colleagues in 1999, but a practical approach for estimating the three components has been lacking. Here, we generalise the impact formula and, through use of regression models, estimate the relationship between the three components of impact, an approach we term GIRAE (Generalised Impact = Range size × Abundance × per-unit Effect). We discuss how GIRAE can be applied to multiple types of impact, including environmental impacts, damage and management costs. We propose two methods for applying GIRAE. The species-specific method computes the relationship between impact, range size, abundance and per-unit effect for a given species across multiple invaded sites or regions of different sizes. The multi-species method combines data from multiple species across multiple sites or regions to calculate a per-unit effect for each species and is computed using a single regression model. The species-specific method is more accurate, but it requires a large amount of data for each species and assumes a constant per-unit effect for a species across the invaded area. The multi-species method is more easily applicable and data-parsimonious, but assumes the same relationship between impact, range size and abundance for all considered species. We illustrate these methods using data about money spent managing plant invasions in different biomes of South Africa. We found clear differences between species in terms of money spent per unit area invaded, with per-unit expenditure varying substantially between biomes for some species. GIRAE offers a versatile and practical method that can be applied to many different types of data to better understand and manage invasions.

O39

### **Stronger compositional change in plant assemblages worldwide is associated with invasion**

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#### **Abstract**

Alien species are regarded as one of the five main drivers of biodiversity change, but we still need to better understand how these processes shape species turnover. We focused on the vascular plants available in the BioTIME database and identified the origin (native or alien) of all species in each assemblage (defined as an individual study in which plant abundance was sampled at the community level in at least two years) according to the GloNAF database of naturalized floras of the world. To test the prediction that invaded sites are experiencing stronger rates of compositional change than uninvaded areas, we computed total Jaccard (and its partitioning into turnover and nestedness) in areas with and without aliens. We focused on the year-to-year change and then computed the median value for each assemblage. We also verified whether patterns of alpha diversity change play a role in such changes. We found that alien species are typically rare in the analysed assemblages. We provide strong evidence that there is greater compositional change (total Jaccard index) between consecutive years in invaded assemblages than in non-invaded ones. Species replacement (turnover) is the most important form of compositional change. No differences in nestedness and median species richness were found between areas with and without aliens. Our results show that there is greater compositional rearrangement in the invaded assemblages than in sites without aliens. These results highlight the importance of considering multiple components of biodiversity when evaluating biodiversity change, crucially in the context of invasions. They also raise questions about what rates of turnover could be considered healthy in natural ecosystems and after which threshold could elevated rates of turnover change ecosystem function.

O40

### **Are species more harmful in their native, neonative or alien range? Insights from a global analysis of bark beetles**

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#### **Abstract**

Anthropogenic environmental modifications such as climate change are causing species to move beyond their native ranges. As this phenomenon will increase in the future, it is crucial to determine whether range-expanding species, or neonatives, are more or less likely than natives and aliens to impact their recipient ecosystems. We compared impact magnitudes of bark beetles from their native, neonative and alien ranges, simultaneously.

We formulated four scenarios about the magnitude of environmental impacts in different ranges (native, neonative, alien) based on hypotheses commonly used in invasion biology. We tested these scenarios globally on *Dendroctonus* bark beetles, asking in which range they have the most harmful impacts. Impacts reported in the literature were assessed with the IUCN Environmental Impact Classification for Alien Taxa (EICAT).

We found that bark beetles cause the most harmful impacts in their native ranges, followed by the neonative ranges, while impacts in their alien ranges are lowest. This indicates that the more dissimilar the environment is from that in the native range, the lower the probability of high impact magnitudes. Our results align with several non-exclusive hypotheses, e.g. preadaptation, while they do not support others, e.g. enemy release. The results are in contrast with previous studies on vertebrates and plants, which found no or mixed differences in impact magnitudes with biogeographic origin.

Our analysis suggests that bark beetles, like other keystone species abundant in their native ranges, have generally lower impacts when introduced to novel environments due to lack of preadaptation or biotic resistance.

O41

## Temperature modulates the community-wide effects of an invasive mud crab in a key Baltic Sea macroalgal-dominated habitat

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### Abstract

The North American mud crab *Rhithropanopeus harrisii* has rapidly extended its distributional range to the north-eastern Baltic Sea in the last decades. The establishment of *R. harrisii* in this region has imposed severe risks to the structure and functioning of native coastal ecosystems, which are largely bottom-up regulated and characterized by the general absence of crabs or functionally equivalent predators. The mud crab occurs in soft- and hard-bottom, both vegetated and unvegetated, Baltic Sea habitats, and feeds on resident invertebrates and macrophytes. Despite recent observational and experimental research efforts, we mostly ignore the community/ecosystem-scale consequences that the pressures exerted by this novel predator might have on key Baltic Sea macroalgal-dominated habitats (e.g., those dominated by the brown alga *Fucus vesiculosus*) and how abiotic drivers modulate them. The present study experimentally assessed the community-wide effects of *R. harrisii* on *F. vesiculosus* habitats and associated invertebrate communities under different temperature regimes. Under summer temperatures, *R. harrisii* decimated invertebrate communities imposing a severe predation pressure on bivalves, amphipods and snails. The drastic decrease in biomass of these three groups most likely triggered an overall increase of filamentous algae and particulate organic matter altering the overall flow of energy and cycle of matter in the system. Under winter temperatures, mud crabs remain dormant and drastically reduced their feeding rates. Interestingly, *R. harrisii* individuals were able to tolerate transient freezing conditions, showing that the species can withstand the severe winter temperatures of the north-eastern Baltic Sea. The obtained results shed light on the community-wide impacts of *R. harrisii* on *F. vesiculosus* dominated habitats and how temperature modulates them, providing insights into the ecological impacts of the invasion under expected environmental changes.

O42

## What are the most important impacts of invasive species on Nature's Contribution to People in Europe?

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### Abstract

The potential for nature to contribute to human quality of life in the form of material, nonmaterial, and regulating contributions is declining since 1970; the mismatch between the provision and demand of ecosystem services may be amplified by invasive species. Global reviews and meta-analyses report pervasive impacts of invasive species on biodiversity and ecosystems underpinning Nature's Contribution to People (NCP), yet the spatiotemporal patterns of such threat remain largely unknown. In this presentation we will identify 1) NCP that are most frequently affected by IAS, 2) invasive species that are responsible for the greatest current and potential impacts, and 3) synthesise spatial patterns of invasive species threat to NCP. The research focuses on 94 invasive species of Union Concern (terrestrial and freshwater), at the European scale. We found that the most frequently affected NCP in Europe are physical and psychological experiences (74% of species), habitat creation and maintenance (69%), the regulation of detrimental organisms (57%), provision of food and feed (52%), and the formation and protection of soils (44%). Among invasive species of Union Concern, terrestrial and aquatic plants accounted for the majority of reported impacts on NCP, with species such as the water hyacinth, water cabbage and giant salvinia scoring highest. Species distribution models using climate and human predictors identified the areas that are most favourable to the establishment of invasive species of Union Concern. Models suggest a considerable potential for expansion of invaders under the current climate conditions (14–99%). We further investigate spatial trends in the location of hotspots (sites combining a high probability of invasion and at the same time high NCP provision) and critical areas (high probability of invasion but low NCP provision) in Europe. Understanding such spatiotemporal patterns is fundamental to advance research of IAS impacts beyond biodiversity.

O43

### The impact of aquatic alien plants and crayfish control methods on ecosystem services

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#### Abstract

An increasing number of field managers are engaged in actions aiming at controlling invasive species, notably in aquatic and riparian ecosystems. Though, control actions may influence how ecosystems function and provide services to humans. When faced with the choice of which control method to use, managers and decision makers typically consider the cost, feasibility or effectiveness of methods. More rarely do they consider the impact that the intervention will have on ecosystem functioning and services. This consideration is one of the focal points of the LIFE RIPARIAS project (2021–2027). Ecosystem Services (ES) evaluation typically relies on a matrix relating ES to ecosystem types. We developed a conceptual framework based on adapted ES matrices and ran a comprehensive literature review of the control methods for EU-listed aquatic plants, riparian plants and crayfish. The results of the review were screened by experts and stakeholders in order to select best practices for each species. A one-day workshop was held with experts and stakeholders to identify the relevant ES in this context, challenge our conceptual framework and prepare an online survey. On the basis of this expert consultation, we evaluated ES evolution for each control method, considered for two different time scales: one year and five years after the intervention. The evaluation was relatively consensual among experts from different countries. The results showed that whatever the species group, the choice of a control method may influence provisioning, regulation and cultural services. When control methods had negative impacts on ecosystem services (notably for aquatic plants), the influence was typically highest after one year. Despite the inherent subjectivity of expert-based assessment, the present study illustrates how a comprehensive ES evaluation can be useful to support managers in selecting most appropriate control options.

O44

### Increasing abundance of the invasive riparian plant, Himalayan balsam, reverses the effects of environmental variables on community and functional diversity in freshwater macroinvertebrates

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#### Abstract

Invasive species cause major eco-evolutionary and socio-economic impacts within the non-native habitats they occupy, yet little is known about their impacts across ecosystems. We investigated how Himalayan balsam (*Impatiens glandulifera*), an invasive riparian plant, affects adjacent aquatic biodiversity, by sampling freshwater macroinvertebrate communities and corresponding physical, chemical and biotic environmental variables in 123 sites in South Wales, United Kingdom. Our study sites exhibited strong natural gradients in Himalayan balsam abundance on the riverbanks (absent to dominant), as well as gradients in the other biotic and abiotic variables in the river and riparian zones. We sampled >13,000 macroinvertebrates individuals across 64 species (39 families) and six functional feeding groups (scrapers, shredders, gatherers, filterers, omnivores and predators), to test how variation in Himalayan balsam abundance interacted with local environmental variables to influence community and functional diversity metrics. Our statistical models explained 61% of variation in community diversity and 50% of variation in functional diversity. In the absence of Himalayan balsam, there was a positive relationship between physical river characteristics (increased width, depth, velocity and decreased elevation) and both community and functional macroinvertebrate diversity. Increasing balsam abundance nullified and, in some cases, reversed the direction of these environment-diversity relationships, demonstrating an important, novel impact of an invasive species on biodiversity in an adjacent ecosystem. Partitioning the interaction between Himalayan balsam abundance and environmental variables shows that increasing balsam abundance drives important changes in the relative abundances of all functional feeding groups, sometimes through different environmental pathways. For example, filterers show strong increases in abundance with increasing river width, depth and velocity in the absence of balsam, but show no increase from low abundance when balsam is abundant and dominant. These findings highlight how invasive species can drive changes in community and functional diversity across ecosystems through complex interactions with local environmental conditions.

O45

### Novel fish predator causes sustained changes in its prey populations

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#### Abstract

Ecosystems are simultaneously regulated by bottom-up (resources) and top-down forces (predators). However, because predator-prey interactions operate on spatial scales beyond the reach of manipulative experimentation, the actual roles of predators remain poorly understood. In ecosystems where predators are naturally absent, biological invasions provide a unique experiment to shed light on the large scale and long-term effects of predators in the recipient ecosystem. We combined data from long-term benthic monitoring, environmental conditions, and a census of round goby population to identify changes in the dominant benthic bivalve population (*Mytilus trossulus* and *Macoma balthica*) following round goby (*Neogobius melanostomus*) invasion. This study demonstrates a substantial change in the food web, with earlier primarily bottom-up regulated communities facing strong top-down control effects. The introduction of a novel predator to a species-poor ecosystem substantially reduced dominant invertebrate populations in a large part of the study area, sometimes with a time lag of 1–3 years. In general, the effects were less in high productivity areas. In some cases, community recovery was observed but rarely to pre-invasion levels, raising the question of the ability of bivalve communities to act as a natural filter. This study demonstrates long-term trends in benthic communities and by excluding possible effects due to the changing environment provides more evidence that invasive species transform coastal ecosystems over time and space.

O46

### *Gunnera tinctoria* invasions increase, not decrease, earthworm abundance and diversity

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#### Abstract

Invasive plants can modify soil properties and their biotic communities through changes in soil physicochemical properties or the amount and/or quality of litter inputs. Although these modifications are generally assumed to result in negative impacts on soil organisms there is little detailed experimental information to support this. To assess this we focused on one important group of soil organisms, the soil earthworms, and how these were affected by *Gunnera tinctoria* invasions, on Achill Island, Co. Mayo, Ireland. We compared replicated (n = 5) areas invaded by *G. tinctoria* with uninvaded semi-natural grasslands, as well as with areas subjected to mechanical removal or herbicide treatment as part of a control/eradication experiment. Modifications in physiochemical properties included lower soil temperatures and higher soil pH during the summer in invaded areas, yet little effect on C and N stocks, or soil moisture. Marked differences in litter were observed, however, with invaded areas having c. 20-fold higher (above-ground) litter input than uninvaded ones, as well as a lower C:N ratio (17 vs. 29). This was associated with a significantly higher overall abundance and biomass of earthworms in invaded plots (375 individuals m<sup>-2</sup>, 115 g biomass m<sup>-2</sup>), compared to the uninvaded control (130 individuals m<sup>-2</sup>, 45 g biomass m<sup>-2</sup>), with the removal and herbicide treatments having intermediate values. Earthworm communities comprised 10 species, typical for Irish grasslands, dominated by the common endogeic species *Allolobophora chlorotica*, *Aporrectodea caliginosa* and *Aporrectodea rosea*. Both earthworm species richness and Shannon diversity were significantly larger in invaded areas, but only in spring samples. Based on this new information, plant invaders may increase the abundance and diversity of earthworms, mainly due to much larger litter inputs, increased soil pH and possibly lower soil temperatures in the summer.

**Impacts of non-native nitrogen-fixing trees in Italy: evidence from the invasion of *Acacia* s.l. and *Robinia pseudoacacia* (Fabaceae)**

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**Abstract**

Non-native nitrogen-fixing trees are known to be among the most harmful invasive alien plants (IAPs), although their negative impacts on the ecosystem have not always been assessed in the different parts of the invasive range. The assessment of the impacts of these IAPs appears of relevant interest for an informed prioritization of the management efforts. We aimed at providing evidence on the ecological impacts of the main invasive nitrogen-fixing trees in Italy in a number of habitat types.

Accordingly, we started, within the Alien Species Working Group of the Italian Botanical Society, a sampling of several case studies of invasion on the whole national territory, through paired vegetation plots (invaded vs non-invaded) for different target IAPs, invaded native habitats and areas/regions. The sampling design foresees the survey of structure and biodiversity of native and invaded plant communities. We included an assessment of the impacts on the topsoil via profile photos and analysis of the main chemical characteristics (N-C-P and pH) of soil samples (A and O horizons).

More than 300 plots have been sampled in 8 regions (Calabria, Lazio, Molise, Apulia, Sardinia, Sicily, Tuscany, and Trentino Alto-Adige) for 5 species all belonging to Fabaceae: *Acacia dealbata*, *A. mearnsii*, *A. saligna*, *Vachellia karroo* and *Robinia pseudoacacia*, and further data was collected during spring 2022. We individuated more than 15 different natural vegetation types invaded (including habitats worthy of conservation according to Dir. no. 92/43/EEC). The impacts on biodiversity indices such as species richness, plant abundance and cover of canopy and shrub layer, showed high variability among the different IAPs and habitats, but with a general trend towards a degradation of the native biodiversity. The soil profiles showed relevant patterns of changes in the soil horizon stratification, most likely due to the changed condition of litter accumulation and degradation.



O48

## The impacts of *Parthenium hysterophorus* on ants, spiders and soil characteristics in Kruger National Park

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### Abstract

The primary source of *Parthenium hysterophorus* in Kruger National Park (Kruger) was the accidental introduction into south-eastern region of Kruger in approximately 2001. The plants spread rapidly by seed across the south of Kruger, with the highest abundances recorded along the Crocodile and Sabie Rivers. *Parthenium hysterophorus* has the potential to disrupt natural ecosystems, altering ecosystem function in native grasslands, open woodlands, riparian habits and floodplains. It has been suggested that *P. hysterophorus* also has allelopathic properties, inhibiting the germination and growth of co-occurring plants. Additionally, it is potentially very effective at altering below ground nutrient pools and enzymatic processes. Due to concerns over the potential impacts of *P. hysterophorus* in Kruger, we explored various ecosystem-level and biodiversity indicators to gain insights into future potential scenarios. We collected samples in 2015 and 2017, at three different sites, namely *Acacia* dominated vegetation, Sabie River riparian zone and a disturbed area. Soil samples were extracted from under *P. hysterophorus* plants and a nearby uninvaded site. Amongst others, we analysed various nutrient levels including phosphorus, nitrogen, organic matter, soil humidity, and the enzymes urease, phosphatase and  $\beta$ -Glucosidase. Early results showed that in 2015, soil humidity and phosphorus levels were significantly higher in invaded patches across all sites. Organic matter and nitrogen were only significantly different in the *Acacia* dominated site, where both were higher in invaded patches. Urease showed the opposite trends, where it was significantly higher in non-invaded patches across all sites. These nutrients and enzyme analyses provide insights into the potential changes that *P. hysterophorus* could precipitate in highly biodiverse riparian zones and moist *Acacia* savanna.

O49

## The invasive *Opuntia ficus-indica* homogenizes native plant species compositions in the highlands of Eritrea

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### Abstract

Invasion by exotic species is recognized as one of the major threats to biodiversity. The effects of invasion by *Opuntia ficus-indica* (Cactaceae) on the species diversity, richness and composition of invaded dry shrub land communities were studied at three sites in the highlands of Eritrea, East Africa. Investigations were made whether the presence of *O. ficus-indica* causes a negative effect on the native biodiversity in a region rarely studied so far. The vegetation in invaded and uninvaded plots with similar habitat conditions was sampled and differences in the species composition, diversity and richness were compared between the plots. The overall plant species composition differed significantly with invasion by *O. ficus-indica*. The invasion by *O. ficus-indica* also led to a significant homogenization of community compositions. The species richness and Shannon diversity index did not differ significantly between the invaded and uninvaded plots. Nevertheless, we still detected species with significantly lower occurrence in the invaded plots (*Psiadia punctulata*), but also species which preferred invaded plots (*Plectranthus hadiensis*). We conclude that *O. ficus-indica* exerts a negligible effect on the species diversity and richness, but that it affects species composition and that there are species which suffer due to its presence. Due to the continuous pressure of the invasion by *O. ficus-indica* on the species composition and dry climates, further homogenization in the native species diversity is to be expected in the future for the highlands of Eritrea.

O50

## Do the local within-community impacts of native and invasive dominant plants scale up to the landscape level?

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### Abstract

Plant invasion science has made massive progress in documenting the community-level impacts of alien plants, including their comparisons with those of native dominants. However, the impacts on larger spatial scales covering regional landscapes remain poorly understood. To gain insights into this issue, we recorded the impacts of 10 native and nine invasive dominant plants in the Czech Republic on species richness and diversity at the local scale, by comparing plant communities with high versus low cover of the dominant species. To estimate the impacts of the same dominant species on a large scale, we compared the dissimilarity of the plots and separated its nestedness and turnover components. We tested whether (i) native and invasive dominant plants impact the large-scale diversity of vegetation by making it more homogenous; (ii) these effects differ between native and invasive dominants; and (iii) the impacts of dominant plants on the local scale relate to their impacts on a large spatial scale. We found that both for natives and invasives, the low-dominance plots were less similar than the high-dominance plots, suggesting that the former harbour more plot-specific species.

Further, the low-dominance plots showed a lower share of the nestedness component of dissimilarity, and the dissimilarity between high- and low-dominance plots was greater for invasive dominants, suggesting their stronger impacts. There was a positive relationship between the impacts on the local scale and the large scale for diversity but only a marginally significant one for native richness or the nested component of dissimilarity. Our preliminary results suggest that dominant plants, both native and invasive, exert impacts on vegetation at the landscape level by making it more homogenous and that this effect is stronger for invasive dominants.

## NOVEL ECOSYSTEMS IN THE ANTHROPOCENE

O51

### Urbanization decreases functional diversity of plant communities: a case study from one Central European city

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#### Abstract

Urbanization is a strong environmental filter that drives changes in plant species composition. It causes that urban plant species have similar traits that are suitable for the urban environment. However, urbanization operates differently on distinct axes of trait variation in response to different environmental conditions. Here, we used a trait-based approach to detect the effect of urbanization on functional diversity of plant assemblages in Central European city. The flora of Brno was systematically sampled in the period from 2011 to 2021. The presence of all spontaneously occurring species was recorded in grid-cells of 1.1 × 1.5 km. The study area covers the entire city, with a long urban gradient from the city centre to the suburban habitats. We collected a dataset of 1,643 spontaneously occurring taxa within the city. We analysed the effect of urbanization on functional diversity separately for axes of trait variation related to plant size spectrum, leaf economic spectrum, reproduction, and life span. We found that the effect of urbanization on community trait diversity is important across all distinct axes of trait variation. We confirmed a decrease of functional diversity with the increasing severity of urbanization. Detected contraction of trait space of urban plant communities threatens their resilience and limits the capacity of urban ecosystems to respond to further global changes.

Acknowledgements: I thank all the data contributors, who sampled the data.

O52

### Functional assembly of grassland plant species in native communities in Spain and recipient communities in California

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#### Abstract

We took advantage of the large unidirectional invasion of annual plant species of Spanish origin into California grasslands to understand community functional convergence after invasion. By conducting coordinated floristic surveys and analysis of plant identity and traits in grasslands in California and Spain, we investigated the role of exotic plant species in the functional assembly of donor and recipient communities. Overall, we found 139 plant species in Spain and 95 in California. In Spain, all species were native. In California, half were exotics. All exotic species found in California grasslands were native to Spain. Invaded California grasslands were more similar in species composition to Spanish grasslands than some Spanish grasslands were among themselves.

There were clear differences in the functional structure of Mediterranean grassland communities both between and within ranges in relation to the environmental gradient. Paradoxically, the most acquisitive communities occurred in less productive sites, highlighting that a rapid resource acquisition strategy might allow species to avoid long periods of drought. In Spain, species that invaded California were more acquisitive than species not known to be invasive somewhere. Yet, we did not find significant differences for most traits. This might reflect preadaptation of the entire species pool to the management practices that have taken place in Europe for millennia. In contrast, in California, exotic species differed with natives in most traits. Exotic species were more acquisitive in resource use than native species especially under favourable conditions, but functionally converged with natives in less productive sites. This indicates that niche differentiation between native and exotic species in California is subject to the influence of abiotic filters. Our results show that plant trait comparisons between native and exotic species are context dependent and that a correct interpretation of filtering processes in community assembly requires a biogeographical perspective.

## BIOLOGICAL INVASIONS AND CLIMATE CHANGE

O53

### Widespread niche shifts in alien plant species under the non-analogous climate of the sub-Antarctic islands

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#### Abstract

The islands of the Southern Ocean are among the most isolated in the world with globally unique climatic conditions. They experience little seasonal variation, with high precipitation and temperatures that rarely drop below 0 °C, culminating in a climate that can be regarded as hyper-oceanic. Since their discovery around the turn of the 19<sup>th</sup> century alien plant species have reached the islands by both deliberate and accidental movements. As a result, the highly specialized and partially endemic flora of the sub-Antarctic are under the continuous threat of repeated alien plant introductions, human disturbance, and climate change. In this study, we quantify the similarity between the climatic ranges of the sub-Antarctic islands and the worldwide realized climatic niches of alien plant species present on them to investigate whether these species underwent a climatic niche shift while establishing in these unique habitats. This is achieved by determining the degree of overlap between the bioclimatic conditions of a species' complete geographic distribution worldwide and the range of bioclimatic conditions present on the entire habitable landmass of each island group. We found that almost all alien plant species currently present in the sub-Antarctic are occurring outside of their full realized niches of their native and alien ranges off the islands. Moreover, the occurrences of these plant species in habitats with a maximal annual temperature, as well as the temperature seasonality and annual range of the islands in the Southern Ocean are entirely novel. Our results thereby function as a representation of the complexity of alien plant invasion in highly specific climates. As more regions are expected to approximate the climatic conditions of the sub-Antarctic under climate change, the region can additionally provide valuable insights into biological invasions in future no-analog climates.

O54

### Distinct futures of native and non-native plant traits in six major habitat types in Central Europe

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#### Abstract

Many plant traits covary with environmental gradients, reflecting shifts in plant adaptive strategies under changing conditions and thus providing information about potential consequences of future environmental change for vegetation and ecosystem functioning. Despite extensive efforts to map trait-environment relationships, the existing evidence remains too heterogeneous and often unconvincing, being at least partially due to insufficient consideration of distinct trait syndromes for certain growth forms and habitats. Moreover, it is yet unclear whether traits of non-native and native species respond similarly to environmental gradients, which thus limits our ability to assess future plant invasions and their impacts. Here, using comprehensive data for Germany and the Czech Republic and a full Bayesian multilevel modeling framework, we assessed macroecological relationships between major plant traits and environmental variables for native and non-native woody and herbaceous species assemblages across six broadly defined habitat types. Subsequently, we projected the trait change in these assemblages and quantified the change in trait difference between native and non-native plants under plausible future environmental scenarios until 2081–2100. Our models depicted multiple ecologically realistic trait-environment relationships and captured several important distinctions associated with plant biogeographical status and woodiness within and across habitat types. Traits are projected both to increase or decrease to varying degrees across and – in many cases – within habitat types and the overall magnitude of this change is expected to be on average higher for non-native than native plant assemblages and under more extreme scenarios.

## BIOTIC INTERACTIONS IN INVADDED COMMUNITIES AND ECOSYSTEMS, INCL. INTERACTIONS BETWEEN INVADERS

O55

### **Out of thin air: Eurasian jays (*Garrulus glandarius*) enhance the invasion of northern red oak (*Quercus rubra*) via tripartite interactions with native oaks**

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#### **Abstract**

Developing new interactions with native species, either positive or negative, can affect the pace and pattern of invader encroachment into new areas. Animal seed dispersers can greatly enhance the spread of invasive plants. Emerging seed dispersal mutualisms might also result in indirect interactions between non-native and native plants, mediated by shared dispersal agents. We investigated direct and indirect interactions between Eurasian jays (*Garrulus glandarius*), invasive northern red oaks (*Quercus rubra*) and native pedunculate oaks (*Q. robur*) in a lowland forest of Central Europe. We estimated the probability of acorn removal for both oak species in single vs. mixed treatment, and the effects of acorn length, width, and weight. We also radio-tracked removed acorns to determine their fate. While jays preferred to harvest the native acorns, they also removed almost all offered acorns of the invader. The removal rate of non-native acorns increased when the two oak species co-occurred, and was modulated by acorn traits: jays selected northern red oak acorns that were long and narrow. In comparison to pedunculate oak acorns, those of the invader were transported at shorter distances and were more likely to be consumed rather than cached. Altogether, seed dispersal of northern red oak by jays was less intense and brought smaller benefits relatively to the dispersal of pedunculate oak. Yet, these differences were moderate, and jays might represent a crucial disperser of northern red oak in the invaded range. Our results highlight the role of keystone native seed dispersers in the expansion of non-native plants. Furthermore, they illustrate how dispersal quantity of non-native plants can be facilitated by the presence of native plants that attract shared seed dispersers.

O56

## Response of soil invertebrates assemblages on different methods of *Solidago* invaded land restoration

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### Abstract

Plant invasions have a negative effect on biodiversity, including soil invertebrates. The process of restoration of lands degraded by invasive plant species is connected with changes in above and belowground plant communities, which can affect soil mesofauna communities. We hypothesized that the abundance and composition of soil mesofauna organisms will correlate with applied methods of land restoration. From the practical point of view, we would like to find the method, which is effective for *Solidago* removal and maintaining the high biodiversity and abundance of soil mesofauna. The field experiment was concerned with *Solidago* species control, where various seed mixtures with methods of seed introduction (sowing mixtures: grasses, grasses with legumes, seeds collected from the seminatural meadow, and applying of fresh hay), as well as the different frequency of mowing (1, 2 and 3 times per year), was established in April 2020. The experiment was arranged in a completely randomized design with four replications. Soils were sampled using a circular sampler (10 cm diameter and depth) and soil mesofauna was extracted using the Tullgren funnels method. Soil invertebrates were identified to orders and two cases (Diplopoda, Diplura) to classes using light microscopes. Richness and diversity indices were calculated to describe the general properties of soil mesofauna communities. In 2021, seed mixtures with semi-natural meadows and grasses with three times mowing reduced *Solidago* spp. coverage. Results revealed that mowing intensity negatively influenced soil mesofauna. Mowing twice a season decreased the occurrence of mesofauna taxa, but not their diversity. Considering the seed introduction method, the plots where grasses with legumes were sown, were the most suitable for the most mesofauna taxa. Mowing once per year and sowing grasses with legumes is the most convenient for the soil mesofauna abundance among studied restoration strategies.

Keywords: biodiversity, edaphic fauna, biological invasions, grassland restoration, *Solidago* eradication

O57

### **Assessing the impact of the invasive plant *Carpobrotus* spp. on plant-herbivore interaction networks: a call to implement management strategies**

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#### **Abstract**

Invasive alien species have become dominant components of many ecosystems, resulting in a drastic reduction of biodiversity in many invaded areas. Plant invasions coexist and compete with native ones, facing a new array of herbivores and altering many trophic interactions. Over the last decades, many researchers have focused on assessing plant-pollinator interaction networks. However, little is known about the impact of invasive plants on plant-herbivore interaction networks. Here, we assessed how the presence of *Carpobrotus* spp. affects plant and herbivore species composition and plant-herbivore interaction networks in coastal areas of the northwestern Iberian Peninsula. We compared communities invaded and non-invaded by *Carpobrotus* spp. to evaluate differences in plant and herbivore species composition (i.e., alpha- and beta-diversity) and changes in plant-herbivore networks due to the invasion. In order to compare the host association by herbivores between invaded and non-invaded zones, we surveyed ten coastal locations, including both invaded and non-invaded plots. Our results show clear differences between zones concerning plant-herbivore interaction networks. Herbivore species composition was altered by *Carpobrotus* spp., where non-invaded plots had significantly higher modularity and degree of specialization and a more significant number of plant-herbivore interactions. In contrast, *Carpobrotus* spp. reduces the plant-herbivore diversity network size, resulting in a less balanced network structure. Overall, our results suggest that *Carpobrotus* spp. alters herbivore communities by increasing the abundance of generalist herbivores and reducing native plant diversity. Based on our observations, appropriate management strategies should be developed that take into account the deterioration of plant-herbivore interaction networks.

O58

### **Biotic resistance or invasional meltdown? Diversity reduces invasibility but not exotic dominance in southern California epibenthic communities**

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#### **Abstract**

High community diversity may either prevent or promote the establishment of exotic species. The biotic resistance hypothesis holds that species-rich communities are more resistant to invasion than species-poor communities due to greater interspecific competition. Conversely, the invasional meltdown hypothesis proposes that greater exotic diversity increases invasibility via facilitative interactions between exotic species. To evaluate the degree to which biotic resistance or invasional meltdown influences marine community structure during the assembly period, we studied the development of marine epibenthic “fouling” communities at two southern California harbors. We found that fewer exotic species established as total and exotic richness increased during community assembly and that this effect remained after accounting for space availability. We also found that changes in exotic abundance decreased over time. Throughout the assembly period, gains in exotic abundance were greatest when space was abundant and richness was low. Altogether, we found greater support for biotic resistance than invasional meltdown, suggesting that both native and exotic species contribute to biotic resistance during early community development. However, this resistance may not reduce the total dominance of exotic species.

O59

## From alien species to alien communities: interactions between host- and habitat associated microbiomes in an alien amphibian from the Caribbean

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### Abstract

Alien species do not come alone! While invasive species have received increasing attention, the role of their associated microbiome has largely been ignored in the analysis of invasion processes. We investigated microbial communities associated with Johnstone's whistling frog, *Eleutherodactylus johnstonei*, one of the most widely and successfully expanding alien amphibian species. To test for regional differences of the microbiome and interactions between host-associated and environmental microbiomes, we used a 16S metabarcoding approach to analyze skin-, gut- and habitat-associated microbial communities in both the native range St Lucia, as well as the exotic range including Guadeloupe, Colombia and European greenhouses. The microbiome of *E. johnstonei* shows clear geographic variation and changes particularly in the exotic range. Gut microbiomes appear more stable than skin microbiomes, as indicated by less regional differences in alpha diversity, a higher abundance and number of core microbiome taxa, as well as lower community dispersion. We provide evidence that an intensified interaction between skin associated and environmental microbial communities in exotic regions contributes to a higher regional distinctness of skin microbiomes. The proportions of microbiota shared between skin- and habitat-associated communities are higher in exotic regions and several taxa are enriched in both skin and environmental communities. Thus, we assume a bi-directional exchange: *E. johnstonei* acquires microbiota from the environment and releases potentially invasive microbiota into the environment. Experimental approaches are needed to proof these transfer processes and investigate their harmful, beneficial or neutral effects for the alien amphibian and native species.

O60

## Biotic interaction data and invasive species assessment

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### Abstract

The impacts of invasive species on biodiversity can be reduced to ten different mechanisms, eight of which concern direct interactions of one species on another (Blackburn et al. 2014). Likewise, the impacts of invasive species on humans can often be reduced to interactions with humans, or on crops and livestock that humans manage. It is therefore essential that we understand how, and with which species, invasive species interact with.

Two tools for the management of invasive species are the risk and impact assessments. These assessments review the existing evidence for impact and evaluate what impacts could or are occurring, and what are, or would be, the magnitude of these impacts. Experts are recruited for these assessments to bring local knowledge and focus on the most pertinent issues. Yet, while it is universally agreed that invasive species assessments are a useful tool, there are so many potential and actual invasive species, and so many invaded and potentially invadable areas, that invasion biologists and managers can be overwhelmed by the sheer volume of potential assessments that they could do. Furthermore, as written texts, these assessments are not easily updated in the light of fresh evidence. Needless to say, risk and impact assessments are therefore most likely to be conducted only on the most obvious targets, because there is such a large cost to assessing a species.

In this presentation we demonstrate a data-driven approach to invasive species assessment, based upon the analysis of biotic interaction data that aims to reduce the time and cost of assessments. We put the case for the mass mobilization of such data and the development of methods and tools to make such data more useful, more accessible and more understandable by experts conducting assessments.

### Reference

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# NON-NATIVE PESTS AND PATHOGENS. PESTS AND PATHOGENS SPREAD BY INVASIVE ALIEN SPECIES

O61

## Patterns of plant-fungal pathogen linkages in invasions

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### Abstract

While the spread of alien fungal pathogens and plants can have wide-ranging effects on native biota and human livelihoods, their impacts will depend on the interspecific interaction patterns arising in regions of introductions. These range from enemy release, co-introduction with the alien host, to novel associations that may emerge via pathogen spillover; thus, fungal pathogen invasions potentially influence both, alien and native plants. Alien fungal pathogens that encounter naïve hosts can cause high mortality rates, with subsequent population decrease and cascading effects on entire communities and ecosystems, for example by altering species interactions or removing keystone species (Dickie et al. 2017). Bufford et al. (2019) found novel associations between plant pathogens and plants to be common, and taxonomic similarity of hosts to be the strongest predictor. Indeed, phylogenetic signals in host ranges of several groups of plant pests and pathogens have been found, suggesting that ecological impacts of an invading pathogen will strongly depend on the phylogenetic composition of the recipient community itself (Gilbert et al. 2012).

In this study, we utilize global databases on regional taxon distributions (i.e., the Global Naturalized Alien Flora (GloNAF) for alien plant occurrences, the Alien Pathogenic Fungi Database, and the Global Inventory of Floras and Traits (GIFT) for native plants) to investigate associations between alien fungal pathogens and plants in regions of introductions globally. We assess differences between functional and taxonomic groups of fungal pathogens and examine their observed host range by comparing phylogenetic distances between original and new plant hosts. Doing so, we explore to which extent native plants in invaded regions are at risk to experience spillover events and which fungal pathogens pose the greatest risks.

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O62

## Impact of *Phytophthora* species on trees and scrubs in Norway

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### Abstract

The *Phytophthora* genus contains around 200 described species worldwide. Hereof, many alien, invasive pathogens threatening woody and herbaceous plants in Europe. In Norway, we have detected 45 *Phytophthora* spp., hereof 24 species in randomly selected samples from the rhizosphere of imported woody ornamentals during the last five years. Many of the introduced *Phytophthora* species have spread and established in plants, soil, and waterways, especially in and around urban areas. In the capital Oslo alone, a total of 20 *Phytophthora* spp. have been isolated. The consequences of bringing these invasive *Phytophthora* spp. into the country are evident on several plant species in both cultivated areas and in natural environments. There are several cases where trees and shrubs in landscaping areas, private gardens, orchards, and Christmas tree fields have died or been seriously damaged from *Phytophthora* attacks, e.g. *Rhododendron* spp. by *P. ramorum*, apple trees (*Malus × domestica*) by *P. plurivora*, and noble fir (*Abies procera*) by *P. cambivora*. Concerning damage to plants in natural environments, grey alder (*Alnus incana*) is very vulnerable. Isolations of oomycetes from dying grey alder show that *P. cambivora* dominates, but also *P. alni* and *P. uniformis* are present in Norway. European beech (*Fagus sylvatica*) is also commonly attacked by *Phytophthora* spp.; *P. cambivora*, *P. plurivora*, *P. cactorum* and the less aggressive *P. gonapodyides*. The broad range of *Phytophthora* species that are established in Norway are of great concern. Nobody currently knows the effects they may have on the Norwegian flora in the future.

# EFFECTIVENESS OF PAST AND CURRENT CONTROL MEASURES AND NATIVE COMMUNITIES RESTORATION EFFORTS

O63

## Environment-friendly restoration of land degraded by invasive plants: lessons from a six year experiment

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### Abstract

Semi-natural grasslands are habitats of high environmental value, which are often threatened by invasive alien plants, which have also overgrown abandoned fields. We present results of six year experiment testing different methods of eliminating invasive *Solidago* species and adding seed to restore valuable species-rich grassland. Three removal treatments (herbicide spraying, rototilling, turf stripping) and two seed addition methods (direct sowing of a fast-growing grass species mixture, spreading of fresh hay collected from a semi-natural meadow) were examined alongside control treatments (no removal, no seed addition). The experimental plots were mowed twice a year, and the vegetation composition, biomass production, hay chemical composition, and fodder quality were assessed.

Results of the study show that lands degraded by invasive species can be restored to valuable grasslands, but the process needs time. Importantly, the effectiveness of herbicide treatment was found not to be significantly superior to that of the other *Solidago* removal methods after six years, indicating that methods that are less harmful to the environment can be used on a long-term basis, with equal outcomes. Moreover, the use of fresh hay as a seed source was not only beneficial to biodiversity but also most effective in suppressing the invasive species. The recommended method of old-field management is based on simple turf stripping with fresh hay addition as seed source, and subsequent regular mowing twice a year.

Additionally, it should be emphasized that a realistic evaluation of experimental site restoration outcomes should be performed from a longer time perspective. The short-term (i.e., 2 and 3 years) observations document only the temporal stages of vegetation succession, which could differ substantially after 5 or more years, resulting in misleading conclusions regarding the excellent effect of herbicides or of commercial seed mixtures of fast-growing grasses on long-term restoration success.

O64

## **Management of vertebrate invasive alien species of Union concern, incorporating animal welfare**

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### **Abstract**

Since 2015, IAS have been regulated at the EU level by EU Regulation 1143/2014. The Regulation currently lists 22 vertebrate species of Union concern and requires that animal welfare is taken into consideration when managing them. It acknowledges that *'eradication and management of IAS may induce pain, distress, fear or other forms of suffering to the animals, even when using the best available technical means'*. It further states that when applying management measures *'Member States shall ensure that animals are spared any avoidable pain, distress or suffering, taking into account as far as possible the best practices in the field and without compromising the effectiveness of the management measures'*. Under an EC-funded project ran by IUCN, together with a consortium of six partners, a manual for the management of vertebrate IAS of Union concern that explicitly assesses the impacts to animal welfare, alongside effectiveness and costs, of lethal and non-lethal measures that are available to eradicate, control, or contain these species, has been produced. This was done in consultation with a large number of experts and stakeholders within the EU. The goal of this manual is to support Member States and others in deciding which measures to use for the humane management of the vertebrate IAS of Union concern, or similar species. The manual describes management measures along an axis of welfare impact to permit decision-making that selects the methods producing the least negative welfare impacts.

This presentation will provide a detailed overview of the process undertaken to produce this manual, as well as all the information contained in it. It will also showcase a variety of freely available dissemination materials that have been produced under the project, with the aim to make the information within them reach the widest range of users possible (scientists, practitioners, policy decision makers, etc.).

O65

## **Eradication of recently established American mink population in the Ebro river basin in Spain**

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### **Abstract**

Spain currently holds one of the last wild populations of the critically endangered European mink. In recent years, the species' status has drastically worsened due to the invasion of the alien American mink. The impact of conservation measures (namely, culling campaigns) implemented since the early 2000s has been insufficient to stop the expansion of the invasive mink and the subsequent decline of the native species.

In 2014, as a part of the project LIFE LUTREOLA SPAIN (2014–2019), an experimental trapping campaign was carried out to compare the efficiency of two different methods: conventional (terrestrial) live-trapping and mink raft method. The use of mink rafts was determined to be approximately seven times more effective to capture American mink and, therefore, it was used as the principal method in eradication actions thereafter.

More than 1200 mink rafts (1 raft/1 km of river) were installed between 2015 and 2017 in whole project area, 557 of which were placed in the European mink core distribution area, the Ebro river basin. As a result, the American mink was successfully eradicated in the area between 2015 and 2016. Since 2017, monitoring network was established to detect possible recolonization of alien mink. Our results show that eradication of the local American mink population can be a viable and achievable objective when both adequate trapping strategy and effective method (mink raft) are involved.

O66

## Parasitic plants: biotic resistance to plant invasions

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### Abstract

Biological control-based approaches significantly contribute to management of plant invasions. They mostly rely on the Enemy Release Hypothesis which implies releasing a specialized enemy of the invader to achieve its suppression. Parasitic plants may be however be used within the alternative Biotic Resistance Hypothesis framework (Levine et al. 2004), which relies on antagonistic ecological interactions between the invader and its generalist native enemy. The BRH-based biocontrol may also be used against expansive species (native invaders) and does not include introduction of an additional alien organism. Recent evidence suggests mainly root hemiparasites of Orobanchaceae and parasitic vines of genera *Cuscuta* and *Cassytha* with relatively wide host ranges as potential biocontrol agents (Těšitel et al. 2020). Among these, the use of root-hemiparasitic *Rhinanthus* species to suppress expansive grass *Calamagrostis epigejos* has already been implemented as a standard tool of grassland restoration in the Czech Republic.

Our recent project focuses on gathering systematic empirical evidence on the interactions between invasive and expansive plants and root-hemiparasites in the Czech Republic. We have conducted an extensive pot experiment testing parasite-invader combinations. Pilot field trials were consequently established for the promising associations. Among the candidate invader-hemiparasite pairs, we identified *Melampyrum arvense* and *Odontites vernus* as hemiparasites, which may suppress alien invaders *Solidago gigantea*, and *Symphyotrichum lanceolatum*. For these, we established detailed field experiments. Just after one year, *Melampyrum* proved to be highly successful against *Solidago* and moderately against *Symphyotrichum*. With *Odontites*, we encountered establishment issues, which we hope to resolve. Additional hemiparasite-host combinations also undergo experimental trials.

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# ENGAGING THE PUBLIC AND STAKEHOLDERS – FROM LANDOWNERS TO SCIENTISTS, PRACTITIONERS AND DECISION MAKERS AND BACK

O67

## Assessing global public knowledge and perceptions towards biological invasions and their management

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### Abstract

Whether the public regards invasive alien species as problematic, beneficial or inconsequential, and whether the public supports or opposes their management, depends on people’s knowledge and awareness of the phenomenon of biological invasions and peoples’ perceptions of particular invasive alien species. Understanding public knowledge and perceptions is therefore crucial in order to avoid conflicts over and opposition to the management of invasive alien species, and can help establish priorities as to which invasive species to manage and how to ensure maximum social benefits or target acceptable management approaches. However, understanding and generalising what drives public knowledge and perceptions of invasive alien species is not an easy task, since they are highly dependent on the local social-ecological context. Aiming to assess if knowledge and perceptions towards invasive alien species and their management differ across society in different countries globally, we conducted an exploratory study across all inhabited continents. We administered questionnaires to members of the public in 54 different countries (i.e., Algeria, Argentina, Australia, Botswana, Brazil, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Dominican Republic, Ecuador, Egypt, Estonia, France, Germany, Ghana, Honduras, India, Indonesia, Israel, Italy, Ivory Coast, Japan, Kazakhstan, Kenya, Mexico, Namibia, New Zealand, Nigeria, Peru, Philippines, Portugal, Puerto Rico, Romania, Russia, Saudi Arabia, Serbia, Singapore, South Africa, Spain, Sweden, Switzerland, Tanzania, Thailand, Turkey, Uganda, Ukraine, United Kingdom, USA, Vietnam and Zambia). We obtained a minimum of 400 responses per country, covering a wide sample from individuals with different demographic characteristics and experience with invasive alien species, living in different socio-cultural and landscape settings as well as under different institutional, governance and policy contexts. Here, we present the results obtained from these questionnaires and discuss the context-dependency of public perceptions of invasive alien species globally.

**O68**

## **Practices and perceptions of IAS local managers in Europe**

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### **Abstract**

Despite funding to carry out management plans having increased since to the introduction of Regulation (EU) No 1143/2014 on invasive alien species (IAS) in 2015, IAS continue to accumulate across European countries. Reports on the status of IAS across Europe are not homogeneous and even some mandatory information for the IAS (EU) Regulation is missing for some EU states. In this study, we surveyed around 2,000 local managers across Europe to canvas their opinion about the status of IAS and the barriers to effective management since 2015. The responses captured information about: (i) trends in IAS numbers, invaded sites, and impacts; (ii) management measures applied; and (iii) factors that limit or would improve IAS management in their areas. Results show that all taxonomic groups have increased in species' numbers, the area they occupy, and the impacts they cause. Most managers are unaware of trends or management actions for vertebrates and invertebrates, whereas they feel more confident about the status of plants probably because it is the most highly managed group. More than half of the respondents are dedicated to monitoring, controlling and/or preventing the introduction of IAS, while restoration is the least considered action. Eradication of IAS is only feasible in singular, small places (e.g. mountain lakes). Local managers coincide in indicating that additional research on new methods for IAS control and long-term funding are needed to achieve their management objectives.

**O69**

## **Integrating ecological impacts of non-indigenous species within a cumulative effect assessment framework**

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### **Abstract**

The introduction of non-indigenous species (NIS) is a major driver for global change in species biogeography, often associated with significant effects to recipient ecosystems and the services these provide to humans. Therefore, integration of NIS and other human-induced pressures into a single framework, such as the cumulative effects assessment (CEA), is needed to enhance the decision-making process. Here, we introduce a novel CEA concept involving: 1) meta-analysis of published or raw data that indicate individual and/or synergistic impacts of non-indigenous species and other human pressures (effect-size estimates coming either from experimental manipulations or ecosystem changes observed before and after impact), 2) modelling of the spatial distribution of native and non-indigenous species, and 3) integrating the impact data and species distribution within a CEA framework. The developed algorithm is available online for use by marine managers and/or policymakers for better informed and more advanced marine management.

**O70**

## **The social aspects of biological invasions – involving stakeholders in the research on the establishment of European flounder (*Platichthys flesus*) in Iceland**

Theresa Henke, Guðbjörg Ásta Ólafsdóttir

University of Iceland Research Center of the Westfjords, Bolungarvík, Iceland

### **Abstract**

Biological invasions and the induced impacts on invaded environments have attracted attention of scientists since the 1960s. Most often, invasion science has focused solely on biological and ecological perspectives, vastly ignoring potential anthropogenic factors. Considerations of human and social perspectives have increasingly gained attention in recent years. Involving these components enables scientists to understand how biological invasions inflict changes beyond ecological levels and also offers opportunities to gather data from people directly impacted. As a case study, stakeholders were involved in research on the establishment of the European flounder (*Platichthys flesus*) in Iceland. The objective was to understand how they perceive this non indigenous species and to collect further data on the distribution of *P. flesus*. *P. flesus* is a flatfish species that has been reported in Iceland since 1999 and can currently be found in most parts of Iceland. Considering that *P. flesus* can co-occur with highly valuable salmonids in freshwater habitats, recreational fishermen as well as managing parties selling fishing licenses were identified as important stakeholders. Using anonymous online surveys, stakeholders were approached and asked to answer questions about their knowledge and previous experiences with *P. flesus*. To investigate their perception, participants were asked to rank their agreement on various statements concerning *P. flesus*. Additionally, semi-structured interviews were held to gain a more in-depth understanding of what drives people's perception. Through this stakeholder involvement, more than 100 locations have been collected on where *P. flesus* has been encountered, strongly improving previous distribution maps. Furthermore, the results indicate not only a highly negative perception among the recreational fishing sector but also outline specific concerns regarding *P. flesus*' impacts on native species. For international comparison, a similar online survey was conducted in countries throughout *P. flesus*' native range, revealing a strong difference in perception between Iceland and native countries.

**O71**

## **Bridging the semantic divide: how invasion scientists can better communicate with gardeners**

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### **Abstract**

A continuing challenge for invasion science, despite efforts to reach consensus, is the ambiguity of terminology preventing effective dialogue between stakeholders. Ornamental horticulture is the main introduction pathway for non-native plants and gardens are a source of potentially invasive plant species. Gardeners are therefore an important stakeholder with a role in reducing the risks of non-native species escaping, and in identifying 'future invaders'. For this reason, we asked gardeners to define an 'invasive plant' as part of a survey in the United Kingdom and Ireland. The survey was launched at a public engagement exhibit at the Royal Horticultural Society's Chelsea Flower Show in London. Our exhibit, attracting 12,000 visitors over six days, showcased ornamentals that had previously been reported by gardeners as invading or taking over their gardens. It stimulated dialogues, with one visitor saying "Most of my garden is here!" echoing comments of many others. This shows that many ornamentals considered invasive remain popular, either due to a lack of awareness of invasive species or of understanding of their impacts.

A thematic analysis of the survey responses highlighted areas of consistency between the perception of gardeners of 'invasiveness' and those broadly adopted in invasion science. It also showed there to be differences in perception where gardeners thought 'invasiveness' to also apply to other problematic plants such as 'thugs' or weeds in gardens, which are not considered invasive by invasion scientists or in relevant environmental policies. We found considerable interest amongst gardeners in this issue. There is a clear opportunity to develop mutually beneficial dialogue between invasion scientists and gardeners. However, to achieve this goal, a shared understanding of vocabulary is required. This is critical if we are to successfully encourage 'pro-environmental' or sustainable gardening on the issue of invasive species through environmental policy instruments.

## O72

### Restricted access to private properties limits management of invasive alien species

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#### Abstract

Eradication implies the removal of all reproductive animals from the managed population. Therefore, the complete range of species' presence should be accessible to managers. Landowners denying access to their properties can obstacle the success of the intervention jeopardizing control activities. We present 1) three case studies in which restricted private property access prevented or significantly delayed the local eradication of invasive Eastern grey squirrel (*Sciurus carolinensis*) populations in Italy, and 2) a review of other cases where non-cooperative interactions with owners of land and private properties hampered the eradication or management of invasive vertebrates, invertebrates and plants.

In the Lombardy region, a planned eradication did not start in one area. In another area, the eradication failed for the refusal from the owner of a large private property to grant access to managers. In the Umbria region, the lack of collaboration from an Italian financial institution delayed 15 months the removal. In these case studies, a single person or institution denied access, preventing or delaying eradications. We retrieved 29 papers: 26 reporting difficulties in controlling or eradicating invasive species because of restricted access to private properties and three that explicitly declared the support of citizens and the possibility to act on private lands.

According to our review, in many cases, the denial of access occurs in a general climate of mistrust or opposition to the project due to a limited engagement of local people. Landowner opposition may depend on individual attitudes towards invasive species management. Bottom-up approaches aiming at involving stakeholders can increase the probability of achieving IAS eradication, but appropriate legislation is essential to effectively address non-cooperative behaviours in eradication projects.

## O73

### The regulation of alien species in South Africa

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#### Abstract

The regulation of alien species in South Africa dates back over 160 years, but only in 2014 were comprehensive lists of regulated taxa promulgated. In this talk we briefly review the history of regulating alien species in South Africa; provide details of the process used to develop and revise the current regulatory lists; outline a process to provide scientific evidence to underpin the lists; outline key issues that have emerged during the past eight years of implementing the lists; and discuss future options. We highlight the development and use of the "Risk Analysis for Alien Taxa" framework and how it aligns with global standards on impact assessment and pathway classifications. We also discuss the formation of a scientific advisory panel to assist the process "the South African Alien Species Risk Analysis Review Panel (ASRARP)". We would appreciate feedback and insight, particularly in the context of the current development of a national strategy on biological invasions for South Africa.



## **ECONOMIC AND SOCIAL IMPACTS OF BIOLOGICAL INVASIONS**

**O74**

### **From big data to big collaborations: the InvaCost database on the economic costs of biological invasions**

Franck Courchamp

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#### **Abstract**

Ecology has entered a period of “big data” whereby potential exploitation of very large datasets seems limitless and often exceeds the working capacities of individual researchers or even teams. Another feature of the evolution of our discipline is the increase of Open Access philosophy, both for input and for output of research projects, which multiplies the number of providers and of beneficiaries of such big data. There is here a huge potential for increased collaboration and communal benefits of exploiting large data set in large, open collaborative networks. We provide the example of our experience with InvaCost, a database developed to centralize and standardize the economic costs of biological invasions in the world.

Once the database was built, it was used to generate, in just over two years, more than fifty original manuscripts. Beyond scientific production, this project has given rise to numerous collaborations between over a hundred scientists from dozens of institutes in nearly forty countries, and a group of young colleagues sharing a common adventure and now developing collaborations on other projects.

Through this example, I will highlight the strategy put in place to bring together a large number of actors around a common issue, and will analyze the points that a priori had appeared to me as essential for the success of this project, and those that a posteriori also proved crucial. In all likelihood, this type of organization could be advantageously taken up again (and certainly improved!) for other projects involving large data sets and multiple collaborations, in ecology and beyond.

## Biological invasion costs reveal insufficient proactive management worldwide

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### Abstract

The global increase in biological invasions is placing growing pressure on the management of ecological and economic systems. However, the effectiveness of current management expenditure is difficult to assess due to a lack of standardised measurement across spatial, taxonomic and temporal scales. Furthermore, there is no quantification of the spending difference between pre-invasion (e.g. prevention) and post-invasion (e.g. control) stages, although preventative measures are considered to be the most cost-effective. Here, we use a comprehensive database of invasive alien species economic costs (InvaCost) to synthesise and model the global management costs of biological invasions, in order to provide a better understanding of the stage at which these expenditures occur. Since 1960, reported management expenditures have totalled at least US\$95.3 billion (in 2017 values), considering only highly reliable and actually observed costs — 12-times less than damage costs from invasions (\$1130.6 billion). Pre-invasion management spending (\$2.8 billion) was over 25-times lower than post-invasion expenditure (\$72.7 billion). Management costs were heavily geographically skewed towards North America (54%) and Oceania (30%). The largest shares of expenditures were directed towards invasive alien invertebrates in terrestrial environments. Spending on invasive alien species management has grown by two orders of magnitude since 1960, reaching an estimated \$4.2 billion per year globally (in 2017 values) in the 2010s, but remains 1–2 orders of magnitude lower than damages. National management spending increased with incurred damage costs, with management actions delayed on average by 11 years globally following damage reporting. These management delays on the global level have caused an additional invasion cost of approximately \$1.2 trillion, compared to scenarios with immediate management. Our results indicate insufficient management — particularly pre-invasion — and urge better investment to prevent future invasions and to control established alien species. Recommendations to improve reported management cost comprehensiveness, resolution and terminology are also made.

## O76

### Biological invasions are as costly as natural hazards

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#### Abstract

Both biological invasions and natural hazards, such as storms, floods, and wildfires, can be disastrous phenomena. Despite the inherent diversity among individual events in time, space, magnitude and intensity, parallels can be drawn between biological invasions and natural hazards. Indeed, their occurrences are each difficult to predict and control, both have vast environmental, health and socioeconomic impacts, and for many, their frequency is predicted to increase in the future. Invasion impacts are often irrevocable and insidious, yet awareness of biological invasions remains low compared to natural hazards, and investments in the management of invasions largely underfunded and delayed. Recent studies highlight the huge economic cost of biological invasions, but how does it compare to economic losses from other natural hazards? Here, we contextualise the size of economic costs from biological invasions relative to that of natural hazards, helping to raise awareness and political leverage. Using observed economic damage cost data on biological invasions and natural hazards for the period 1980–2019, we show that economic losses from biological invasions were of a similar magnitude to that of other natural hazards. However, invasion costs have increased most rapidly from 1980–1999 to 2000–2019 relative to natural hazards. Comparable economic impact magnitudes of biological invasions to natural hazards and burgeoning cost growth urge commensurate recognition, coordination and action towards invasive alien species in political agendas.

## O77

### Assessing positive socio-economic impacts of alien taxa within a unified framework

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#### Abstract

Some alien species have positive socio-economic impacts on humans, and the consideration of such impacts is crucial to develop effective management strategies that account for conflicts of interests among stakeholders. Alien species may provide food, timber or other natural resources for people, control medical or agricultural pests, enhance ecosystem services or reduce ecosystem disservices. Such benefits are often reported in the literature, but we still lack a unified approach for their classification, so that different species can be systematically and rigorously compared across taxonomic groups and contexts in light of their positive effects on humans. A critical obstacle to the development of such an approach was the difficulty to identify a common metric to measure highly diverse socio-economic impacts. Monetary approaches can quantify some aspects, for instance the income generated by logging alien trees or the economic returns of classical bio-control programs, but they are of little use to assess impacts concerning intangible and cultural resources or health. Conversely, approaches based on ecosystem services can measure a wider spectrum of gains acquired by humankind from nature, but their metrics are generally difficult to compare. We propose that the theoretical and methodological approach used in the Socio-Economic Impact Classification of Alien Taxa (SEICAT), which assesses negative impacts of alien species on human well-being, can be extended to capture their benefits. To address this, we developed SEICAT+, a framework based on the capability approach that adopts increases in peoples' activities as a metric for evaluating positive impacts on human-well being. We show that SEICAT+ can assess impacts of different magnitude and that span across all constituents of well-being (e.g. material/immaterial assets, health or safety). We also discuss limits and shortcomings of the new framework and explore its use in combination with other impact assessment frameworks.

## The importance of non-English data to understand global patterns in biological invasions

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### Abstract

It is a fact that English, the dominant language to communicate science, limits our understanding of global patterns. It is also a fact that language is an essential factor in applied sciences, for both acquisition and transfer of knowledge and practice. This is particularly true for biological invasions, which are responsible for substantial biodiversity declines and high economic losses all over the world, and where language is an essential factor for both acquisition and transfer of knowledge between researchers and stakeholders and practice. Moreover, because management actions operate often at small scales, such as local or country levels, strong links are required between researchers and stakeholders. Here, we present the steps and outcomes of this collective initiative, where researchers of 15 nationalities provided new insights on the necessity to enrich scientific knowledge with multi-language collaborations.

Data searched in 10 different languages, contributed to filling up the gaps of the InvaCost database, which is the first public repository of the monetized impacts of biological invasions worldwide, increasing global cost estimates of invasions by 16.6% (US\$ 214 billion). We added new cost information – mostly from management actions at finer spatial scales – for 249 new invasive species and 15 new countries. We show the importance of considering data disseminated in non-English sources – coming from both available literature and local stakeholders – to complete the global picture of the economic costs of invasive alien species.

## EXPRESS PRESENTATIONS

### E1

#### **Drivers of spatial bias in neophytes distribution data**

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#### **Abstract**

Management of biological invasions needs ecological knowledge, which can be derived from models. Unfortunately, the lack of appropriate data on the invasive species distribution is an obstacle to modeling. In this study, we qualify the effect of low sampling effort on models performance of twenty invasive species and detect environmental correlates of the lower sampling effort. The data on the presence and absence of neophytes in a 2 × 2 km square grid was derived from an atlas of neophyte distribution in the Polish part of the Carpathian Mountains and its foreground, Central Europe, ca. 31,000 km<sup>2</sup>. The overall neophyte richness was modeled, and areas with the largest negative values of model residuals were considered as being potentially undersampled. Next, the distribution of another 20 invasive species, consisting of an independent sample, was modeled, with the exclusion of the potentially undersampled squares. Finally, the distribution of the undersampled squares was explained using environmental variables. The results revealed that the exclusion of potentially undersampled squares significantly increased the performance of invasive species distribution models (iSDMs). Undersampling affected about 30% of sampled squares and increased the performance of iSDMs by 7% on average. The increased performance was the greatest in the case of frequent species. The spatial distribution of undersampled squares was correlated with the presence of damp sites, usually located in lowlands. We did not confirm a significant effect of lower sampling effort in remote areas. It can be concluded that the “target species group” approach allows for distinguishing undersampled areas. However, the pattern of undersampling in the case of invasive plant species differs from those usually observed. We found that it was associated with a low invasion level in remote areas, and routine exclusion or downweighting of such areas as undersampled could thus be misleading in modeling invasion by plant species.

## Advancing invasion science *in silico*: using *virToad* to simulate spatiotemporal invasion dynamics and management of a global invader for biosecurity decision support

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### Abstract

The escalating impacts of invasive alien species on ecosystems and human societies warrant the development and application of tools that can reliably predict biological invasions and management outcomes at spatial and temporal scales relevant to on-the-ground management. A powerful ecological modelling paradigm for addressing theoretical questions and applied issues on biological invasions is individual-based modelling (IBM). In demonstrating this promise, we developed *virToad* (Pili et al. 2022) – an IBM of a globally significant alien invader, the cane toad (*Rhinella marina*). We built *virToad* to develop system understanding and predict the cane toad's local- to landscape-scale spatiotemporal population dynamics, and ultimately to explore, optimize, and recommend cost-effective management responses against its invasion. We designed *virToad* to make population dynamics an emergent consequence of the cane toad's fitness-maximizing behavioural responses to mechanistic constraints (e.g., water availability, kin selection), and to management actions. We then used *virToad* to simulate cane toad population dynamics in the absence of management, and under alternative management strategies implemented at a spectrum of effort: hand-capturing and trapping of juveniles and adults, fencing waterbodies, and trapping and chemically suppressing tadpoles. *virToad* simultaneously reproduced empirical patterns of the cane toad's population densities, detection probabilities, distributions, and spatial segregation – signifying high structural realism. Model analysis revealed that the cane toad's population dynamics are most sensitive to relatively well-studied parameters controlling growth, development, survival, and water ecophysiology – signifying confidence in model predictions. Simulation experiments indicated that the efficacy of competing management actions varied significantly, and that only moderate to high effort hand-capturing and trapping of juveniles and adults has the potential to suppress invasions. Through *virToad*, we showed that IBMs are indispensable tools enabling researchers and practitioners to understand, defensibly forecast, and respond more efficiently to the impending challenges wrought by alien species invasions.

### Reference

Pili, A. N., Tingley, R., Chapple, D. G., & Schumaker, N. H. (2022). *virToad*: simulating the spatiotemporal population dynamics and management of a global invader. *Landscape Ecology*, 37, 2273–2292.

## E3

### Using fire on fire-adapted invasive species – the case of *Hakea sericea* Schrad.

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#### Abstract

Fire has been used as a fuel management tool to reduce fire hazard, but an uninformed use of fire may contribute to increase the problem of plant invasions in areas dominated by fire-adapted invasive species. There are many examples of fire-adapted invasive plant species. The Fabaceae, Proteaceae and Myrtaceae families include good examples of these species. Here we present an overview of the role of fire in promoting plant invasions, but also possible solutions of using fire as a control tool, with a particular focus on *Hakea sericea* Schrad. This prickly shrub of Australian origin, has expanded in several world regions, including South Africa, New Zealand and the Iberian Peninsula. It holds a canopy seed bank with serotinous follicles, whose dehiscence is triggered by fire. A set of experimental plots was established in Central Portugal in the frame of project Aliens & Flames aimed at studying the effects of slash and burn treatments on *H. sericea*. Results showed that the burn treatments caused a massive germination of seedlings, whereas the slash treatments induced the resprouting of 61% of the plants. Nevertheless, when combined (slash followed by burn), the two treatments caused a major impact on the invasive plant population, allowing native plants to establish and dominate the plots after two years. Our results also showed that fire should be conducted with maximum residence time, to kill the seeds and decrease dehiscence rate. In conclusion, fire can be a solution to control fire-adapted invasive shrubs holding canopy seed banks such as *H. sericea*, but management should follow very specific technical guidelines to obtain the aimed results.

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## E4

### Comparative study of invasive and native shrub functional traits of chir pine forest in the central Himalaya

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#### Abstract

Plant invasion has been identified as one of the major threat to forest ecosystems biodiversity, soil nutrient dynamics, ecosystem services and wellbeing across continents. The primary goal of this study was to compare the differences in the functional traits between invasive alien (*Ageratina adenophora* (Spreng.) and *Lantana camara* L.) and native (*Berberis asiatica* Roxb. Ex DC., *Pyracantha crenulata* (D. Don.) M. Roemer and *Rubus ellipticus* Sm.) shrub species of chir pine (*Pinus roxburghii* Sarg.) forest in the central Himalaya. Three 0.5 hectare chir pine forest stands were selected and 20 individual seedlings of similar diameter were tagged for comparative studies of leaf traits, growth pattern, and biomass accumulation in structural organs of each invasive alien and native species. Our one-way ANOVA and Tukey's post hoc test results showed that both invasive alien species have significantly ( $p < 0.05$ ) higher SLA, LWC, total chlorophyll content, foliar nutrient (N and P), RGR, LMR, SMR, nutrient uptake, and nutrient use efficiencies than native species. Leaf litter decomposition rate and nutrient release were also significantly ( $p < 0.05$ ) higher in case of the both invasive alien species. Native species, *R. ellipticus*, shared some of the traits, such as leaf area, chlorophyll content, RGR, LAR, LMR, and nutrient uptake efficiency with invasive alien species. The majority of traits differed among invasive alien and native species, implying that the success of invasive alien species is best described by being functionally distinct from native species. These findings showed that invasive alien species have advanced functional traits that could be contributing to their rapid proliferation in the central Himalaya.

## E5

### **Invasive alien woody plants in the protected areas of Georgia: invasive range, environmental impact and invaded forest habitats**

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#### **Abstract**

Invasive alien woody species (IAWS) are a threat to local forest biodiversity, especially in the protected areas, where red-listed, vulnerable species (VU) are frequently occurring and the natural processes may be significantly affected. Here we present the results of study, which was a part of a scientific project – "Survey of Potential Invasive Alien Woody Species (PIAWS) in the Protected Areas of Georgia". This is the first detailed study related to this issue, in the whole region of South Caucasus. We focused on all protected areas of Georgia that are threaten by woody species invasion. Field study was conducted in 12 different categories of protected areas representing various environmental conditions. In total we analyzed 33 sample plots, 130 nested sample plots (to estimate regeneration), 14 soil probes and more than 460 field records. To assess the invasiveness potential and impact of the most important IAWS, we used invasiveness ranking system for non-native woody plants for local uses, which was elaborated based on existing ranking systems (Matthew L. Carlson et al. 2008) and Environmental Impact Classification for Alien Taxa (EICAT) and Generic Impact Scoring System (GISS).

Our study results show that the group of IAWS with the high potential invasiveness and impact are: *Robinia pseudoacacia*, *Ailanthus altissima*, *Gleditsia triacanthos*, *Acer negundo*, *Paulownia tomentosa*, *Brucea javanica* (L.) Merr., and *Ligustrum japonicum*. The listed species have wide range of negative impacts on the forest habitats, under different biotic and abiotic factors.

This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG) [grant number: FR-18-3569].

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## Trophic niche of an invasive generalist consumer: Australian redclaw crayfish, *Cherax quadricarinatus*, in the Inkomati River Basin, South Africa

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### Abstract

Trophic niche analysis can be used to assess ecological opportunities available to alien species in areas of introduction that might aid their establishment, define their functional role, and inform on their potential impacts. This study assessed the trophic niche utilised by an invasive population of the Australian redclaw crayfish, *Cherax quadricarinatus*, in the Inkomati River Basin, South Africa. It evaluated the hypothesis that the euryphagous feeding strategy of redclaw crayfish may allow it to shift its niche width and niche position by altering its feeding strategy in response to fluctuations in resource availability. Gut content and stable isotope analyses were used to determine trophic niche and trophic interactions. Redclaw crayfish were shown to be omnivores and their diet consisted mainly of algae, plant material and invertebrates. Small sized individuals had a constricted niche width and fed primarily on invertebrates, while larger individuals expanded their niche width to include larger proportions of plant material. Crayfish caught from lotic environments had a higher proportion of invertebrates in their diet than crayfish from lentic environments, and the species exploited a wider niche in summer than in winter. These differences are likely related to differences in productivity among habitats and fluctuations in resources availability. There was significant niche overlap (>60%) between redclaw crayfish and the Sidney's river crab (*Potamonautes sidneyi*), but not with other native invertebrates. Both species are omnivores and have similar functional roles, possibly making redclaw crayfish functionally redundant in this ecosystem. Even though both species mainly feed on resources (plant material and invertebrates) that are not normally limiting, the redclaw crayfish invasion might be an accelerator of ecosystem processes such as shredding and decomposition rates of plant material. There is therefore a need for further studies to examine potentially altered ecosystem functions caused by crayfish invasion in the Inkomati River system.

## E7

### **Breath in, breath out: different physiological responses to oxygen and temperature variation of two genetically distinct lineages of *Dikerogammarus villosus***

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#### **Abstract**

*Dikerogammarus villosus* (Sovinsky, 1894) is an amphipod crustacean recognized as one of the worst freshwater invasive species of Europe. Its native range is in the Ponto-Caspian region where it inhabits mostly estuaries and the lower sectors of rivers. In the last decades, it spread across many European freshwater bodies, frequently dominating the entire benthic community and endangering local fauna. The invasion started from two different sources: the Dnieper and the Danube deltas. The initial genetically distinct populations did not get into contact along their respective invasion routes, increasing the possibility for ecological and physiological differentiation. In our study, we aimed to test experimentally potential physiological differences between these two lineages inhabiting separately two Polish rivers (the Oder and the Vistula). Our results show that the animals from the Danube lineage (collected from the Oder River) display higher respiration rates, regardless of their size and sex. On the other hand, animals from the Dnieper lineage (collected from the Vistula river) showed higher sensitivity to oxygen and temperature variation displaying higher death rates at higher temperatures (>30 °C). These findings may explain why the lineage from the Danube already managed to spread across the whole western Europe while the one from the Dnieper is still restricted to central-eastern Europe. Furthermore, our study shows how physiological adaptations may occur at the population level, implying the need for more systematic studies taking into account also the molecular intra-specific diversity to better foresee the future spread of invasive species as well as properly understand the mechanisms behind them.

## E8

### **Inference for epidemic models with time-varying infection rates: tracking the dynamics of oak processionary moth in the United Kingdom**

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#### **Abstract**

Invasive pests pose a great threat to forest, woodland and urban tree ecosystems. The oak processionary moth (OPM) is a destructive pest of oak trees, first reported in the UK in 2006. Despite great efforts to contain the outbreak within the original infested area of South-East England, OPM continues to spread. Here we analyse data consisting of the numbers of OPM nests removed each year from two parks in London between 2013 and 2020. Using a state-of-the-art Bayesian inference scheme we estimate the parameters for a stochastic compartmental SIR (susceptible, infested, removed) model with a time-varying infestation rate to describe the spread of OPM. We find that the infestation rate and subsequent basic reproduction number have remained constant since 2013 (with the basic reproduction number,  $R_0$ , between one and two). This shows further controls must be taken to reduce  $R_0$  below one and stop the advance of OPM into other areas of England. Our findings demonstrate the applicability of the SIR model to describing OPM spread and show that further controls are needed to reduce the infestation rate. The proposed statistical methodology is a powerful tool to explore the nature of a time-varying infestation rate, applicable to other partially observed time series epidemic data.

## Evaluating the effect of plant invasion eradication programs on plant-herbivore interactions in coastal habitats of the northwestern Iberian Peninsula

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### Abstract

Coastal areas encompass habitats of high conservation value that are currently severely affected by plant invasions in many parts of the world. The clonal invasive species of *Carpobrotus* are among the most problematic plant species invading these types of habitats. In recent years, eradication programs have been carried out at several locations along the northwestern coast of the Iberian Peninsula to control this invasive plant. Here, we evaluate how the removal of this plant affects plant-herbivore interaction networks and ecological succession dynamics after the removal. To achieve this, we compared different communities (invaded, non-invaded and removed) to assess differences in plant and herbivore species composition and changes in plant-herbivore interaction networks after the removal of *Carpobrotus* spp. In order to compare plant-herbivore assembly among areas, we surveyed six coastal locations that included invaded, non-invaded and removed plots. In removed plots, *Carpobrotus* plants were hand-removed by uprooting in 2018 and 2019 thanks to volunteer programs. Our results show clear differences in plant-herbivore networks between invaded, non-invaded and removed plots. Interestingly, network-level parameters indicated that removed plots were more similar to non-invaded plots than to invaded plots, exhibiting greater network size and plant diversity. For species-level parameters, we found higher herbivore specialization ( $d'$ ), herbivore linkage level (degree) and interaction strength in non-invaded and removed plots than in invaded plots. Overall, our results suggest that the removal of *Carpobrotus* spp. from invaded areas may allow the recovery of plant-herbivore interactions after two or three years of succession, reaching levels similar to those in non-invaded areas. Considering our observations, management strategies based on plant removal should be implemented in coastal areas invaded by *Carpobrotus* spp. to reduce the impact of this invasive plant on biodiversity and favor the conservation of native habitats.

## E10

### **Reinforcing regulation with voluntary commitments – experiences on the implementation of the Bern Convention’s Code of Conduct on Hunting and Invasive Alien Species**

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#### **Abstract**

Hunters play an important role in preventing, reducing and managing IAS. They are key actors regarding the monitoring and regulation of established IAS populations. At the same time, hunters must pay special attention to certain hunting practices such as restocking or when engaging in some forms of animal-aided hunting in order to avoid the introduction of new IAS into Europe.

To help hunters avoid introducing or spreading IAS, the Bern Convention, with the technical support of the IUCN SSC Invasive Species Specialist Group and the European Federation for Hunting and Conservation (FACE) developed the Code of Conduct on Hunting and Invasive Alien Species (CoC on H&IAS) which was adopted at the 33rd Standing Committee of the Bern Convention in December 2013. This CoC on H&IAS presents 7 Principles that hunters should follow to contribute to the protection of Europe’s biodiversity and to implement IAS regulations.

After the adoption of the CoC on H&IAS in 2013, FACE and the International Association for Falconry and Conservation of Birds of Prey (IAF) formed an initiative to frequently publish reports on activities undertaken by hunting associations around Europe to combat the spread of IAS. These reports discuss a range of practical solutions and concrete examples of European countries to meet the requirements mentioned under each of the 7 principles of the CoC on H&IAS. Through this report, FACE and IAF show that both organisations and their members are considering this topic as being highly important and underline how Europe’s hunting community is engaged in the management of IAS. The efforts by hunters as outlined in the reports successfully prove that voluntary sets of rules are efficient and pragmatic tools to translate regulations on IAS into guidelines that are possible for stakeholders to implement and engage with.

## E11

### What motivates volunteers to participate in the control and monitoring of invasive alien species?

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#### Abstract

Projects dealing with invasive alien species (IAS) are becoming increasingly reliant on volunteers' help for the initial detection of new invaders, mapping distribution of established IAS and their subsequent control and/or eradication. Successful design of IAS projects requires us to be aware of the motivations guiding volunteers to participate in such initiatives. We conducted a meta-synthesis of the available literature from various disciplines to extract, analyze, and synthesize the relevant information on volunteer motivations. Iterative categorization of the 233 motivation statements recorded in the analyzed studies (n = 28) resulted in a conceptual framework identifying 15 different motivations. An important outcome of this study is the description of three motivations specific for the IAS context: 1) supporting IAS management, 2) protecting native species and habitats, and 3) livelihood/food/income protection or opportunities. In addition, we report on differences in motivations between participants in IAS monitoring vs. IAS control projects as observed in the literature. Similarly, different target groups (land-owners, hunters, divers, etc.) exhibited specific patterns in motivations affecting their participation. Finally, we highlight ethical issues which occur in practice and also provide recommendations for future research and project design.

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## E12

### The economic cost of protecting islands from invasive alien species

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#### Abstract

Biological invasions represent a key threat to insular ecosystems, with pronounced impacts across environments and economies. The ecological impacts have received substantial focus in the literature, but the substantial socio-economic impacts are poorly synthesised in comparison. We utilised the InvaCost database, the most comprehensive global assessment of published economic costs of invasive species, to assess reported economic impacts on islands worldwide. Specifically, we analysed socio-economic sector costs across differing expenditure types, and examined temporal trends in spending, across islands that differ in their political geography – island nation states, overseas territories and offshore islands of continental countries. We based this assessment on 2,183 unique cost entries comprising 4,881 annual costs. A total cost of over US\$36 billion has occurred on islands between 1965–2020 as a result of invasive alien species' impacts. Nation states incurred the greatest total and management costs, with offshore islands of continental countries incurring costs of similar magnitude, both far higher than those in overseas territories. Damage-loss costs were significantly lower, but patterns were qualitatively similar across islands of differing political geographies. This predominance of management spending suggests important knowledge gaps in the extent of many socio-economic impacts. Nation states spent the greatest proportion of their GDPs countering these costs, at least one order of magnitude higher than in other locations. Most costs were borne by authorities and stakeholders, demonstrating the key role of governmental and NGO bodies in addressing island invasions. Temporal trends revealed cost increases across all island types, potentially reflecting efforts to tackle invasive species at larger, more socially complex scales. Nevertheless, the already high economic costs of island invasions substantiate the importance of biosecurity in reducing and preventing costs to reduce strains on limited financial resources and avoid this dire threat to multiple sustainable development goals.

## E13

### The IUCN EICAT standard: its past, present and future

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#### Abstract

The Environmental Impact Classification for Alien Taxa (EICAT) is the IUCN global standard for measuring the severity of environmental impacts caused by fungi, plants and animals living outside their natural range. This tool alerts scientists, conservation practitioners and policy makers to the potential consequences of alien species, can guide the development of prevention and mitigation measures, and may assist in the prioritisation of management actions. An overview of how EICAT was developed, what it consists of, what assessments have been done so far, how they are showcased and what is planned for its future, will be presented.

## POSTER PRESENTATIONS

### TRENDS IN THE INTRODUCTION, SPREAD AND EVOLUTION OF BIOLOGICAL INVASIONS AT DIFFERENT SPATIAL AND TEMPORAL SCALES

#### P1

#### Gastrointestinal parasites of Egyptian geese *Alopochen aegyptiaca* (Linnaeus, 1766) in Western Europe

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#### Abstract

Egyptian geese are neozotic birds of North America, Europe and parts of the Arabian Peninsula. They live not only in the countryside near fresh water bodies but more often in many urban habitats in Central Europe with close contact to humans and their pets.

In the present study, 114 shot Egyptian geese and 148 non-invasively collected faecal samples of wild Egyptian geese from eleven different federal states in Germany and two Cantons of Luxembourg were examined. Thirteen metazoan endoparasite species in twelve different genera were identified. The main endoparasites found were *Hystrichis tricolor*, *Polymorphus minutus* and, in lesser abundance, *Cloacotaenia* sp. and *Echinuria uncinata*. Adult stages of *Echinostoma revolutum*, an anthrozoonotic heteroxenic trematode, were found in 7.89% of the animals examined post mortem. *Hystrichis tricolor* and *Echinostoma revolutum* were additionally identified by molecular analysis. All species found have also been described in native waterfowl. Thus, it seems that Egyptian geese in general have a lower parasitic load, although they live in community with native waterfowl, which may be a hint for greater immunocompetence of the invader.

It is remarkable that certain parasite species occur more frequently in certain regions. This could be an indication of the migration behaviour of Egyptian geese. Differences between animals from rural and urban habitats were also observed.

A parasitological anthrozoonotic risk to the urban human population from Egyptian geese in parks and swimming pools is present, especially with regard to *Echinostoma revolutum*, but appears to be not higher than from native waterfowl.

The present study represents the first large-scale survey on gastrointestinal parasites of free-ranging Egyptian geese.

## P2

### Distribution and pathways of introduction of alien plant species in Romania

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#### Abstract

Biological invasions are one of the main drivers of modern human-induced species losses. Research on the distribution of alien species and their introduction pathways is essential for understanding and tackling the invasion process. With this study, we aim to contribute to filling this gap and to provide a visualization of national patterns of species invasions, origin and pathways. Patterns of recorded species distribution and pathways of introduction were mapped and visualized using data from an exhaustive database following a major review of the published literature. The present study provides a systematic analysis of invasive and potentially invasive plant species in Romania. The number of occurrences has increased steadily after 1950s, with new species being continuously introduced. We used chord diagrams to visualize the relationships between introduction pathway and geographical origins of the alien plant species, which revealed that species originate mainly in North and Central America, while the dominant pathway for species invasions was horticulture. Mapping of the species occurrences has revealed several hotspots of recorded alien plant species which concentrate on urban areas. Our results provide an important ground in drafting management and action plans, as well as a good starting point for various analyses as this database is further developed and regularly updated.

## P3

### Riparian areas as conduits of plant invasions in the Middle Danube Basin in Serbia

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#### Abstract

Strong invasion pressures affect riparian areas worldwide, turning them into points of spread of invasive alien plants (IAPs). Given this, and the general lack of IAPs data for Serbia, the aim of our study was to provide insights into plant invasion patterns in the riparian areas of Serbia (Middle Danube Basin area). A total of 250 field sites, distributed along 39 rivers and six canal sections, were studied during a four-year period (2013–2016) for the presence and abundance of IAPs. Distribution patterns of dominant IAPs, differences in invasion levels across different catchment areas and between river and canal field sites were studied at the landscape level. Meanwhile, effects the proximity to roads/railway lines, housing areas, different land-use types, and dominant vegetation on site has on invasion levels were investigated at the local scale. Results show that IAPs with a well-known weedy behavior, long history of cultivation and strong affinity for riparian areas prevail in the study area. Differences in invasion levels between catchment areas were revealed. The Timok and Danube catchment areas support highest invasion levels, with Sava and Zapadna Morava also having high numbers of IAPs. Other catchment areas are less subjected to invasions, with the lowest invasion levels observed along the canal network. At the local scale, agriculture in proximity of the field site and dominant vegetation on site are significant predictors of the invasion level. Meanwhile, contrary to expectations, proximity to roads/railway lines and housing areas is not related to the invasion level at the local scale. Finally, as our study provides the first systematic overview of IAPs distribution data for riparian areas of the Middle Danube basin in Serbia, it should enable the development of future management plans and serve as a basis for long-term monitoring of IAPs.



## P4

### Genetic reconstruction of the invasion history of *Gambusia* spp. in India: exploring introduction routes and population structure of Mosquitofish

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#### Abstract

Biological invasions are the second largest threat to terrestrial, freshwater and marine ecosystems. In India, freshwater ecosystems are under severe threat due to the negative impacts of Invasive Alien Fishes (IAF). *Gambusia* spp. (Mosquitofish) were first introduced to India for the biocontrol of mosquitoes. However experimental and field studies have shown the severe impact of *Gambusia* spp. on rotifers, crustaceans, water beetles, odonates, frog tadpoles, and native and economically important fishes. Mosquitofish compete for resources, predate upon, and display aggressive behaviour towards native biota (Raja & Ravikanth, 2020). Genetic reconstruction of the invasion history of IAF allows us to identify their origin, understand the routes of introduction, and estimate the magnitude of these introduction events. We sampled 15 different locations across India and collected over 300 individuals of *Gambusia* spp. Individual mosquitofish were ethically euthanized and preserved in 95% ethanol at -20 °C. The collected samples were taxonomically identified and subjected to DNA isolation and screened for mitochondrial gene variation of cytochrome b (cytb). We also used eight microsatellite markers to understand the population structure and genetic variability of *Gambusia* spp. in India. Our study is the first to provide mitochondrial gene sequence variation of *G. holbrooki* and *G. affinis* across different populations in India. Contrary to existing literature, our large-scale study reveals a wider presence of *G. holbrooki* across the country. Our study also provides the first evidence of multiple introduction events of *G. holbrooki*. The microsatellite study reveals the allelic richness across the *G. holbrooki* populations. The result helps to identify unrecognised trade routes and introduction events of IAF. It has tremendous application in developing policies towards regulating the ornamental fish trade such as controlling the inflow of IAF and site prioritisation based on severity to effectively manage invasion events.

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## P5

### Plant invasions along rural-to-urban gradients: different emerging patterns at different scales

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#### Abstract

Besides their present or future detrimental effects on ecosystems, alien plant invasions represent opportunities to understand the processes associated with range expansion and colonization of novel environments. In western Europe, cities display warmer and drier conditions than the temperate climate of rural areas. Urban-to-rural gradients thus exhibit climatic variations at scales ranging from kilometers to meter, due to the urban heat island effects and microclimatic effects. We present a synthesis of studies performed between 2018 and 2021 about the patterns of plant invasions along rural-to-urban gradients, at different ecological and spatial scales – a comparison of 24 species at large geographical scale, a more detailed comparison of 8 species at regional scale, and two studies of the within-species phenotypic variation along local rural-to-urban gradients (study models: *Veronica persica* and *Matricaria discoidea*). Citizen science, species distribution modelling, field-measurements of functional traits and reciprocal common gardens were used, and several model species were considered (trees, shrubs and herbaceous plants). Three patterns clearly emerged: 1) alien species from warmer native ranges were more often found in urban areas, whereas alien species from colder ranges were more rural; 2) trait variation along the gradients was mainly due to very small-scale variations in environmental conditions, in particular light availability; and 3) no evidence was found for local adaptation to urban conditions but environmental maternal effects and phenotypic plasticity were key in the response to urban conditions. Each pattern emerged at a given scale, and linking the patterns highlights the difficulty to combine different scales in ecology. For instance, functional trait variation along gradients was similar for species from both warmer and colder native ranges, despite they distribute differentially. We discuss the reasons for this apparent between scales and propose future research avenues to better understand the role of urban areas in present and future plant invasions.

**Catalogue of alien plants of the Czech Republic: a new edition**

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**Abstract**

In 2002, the Czech Republic became one of the first countries in Europe and globally with a comprehensive, specialized catalogue of its complete alien flora, including not only naturalized and invasive but also casual species and providing information on the introduction history and ecology of the taxa on the list (Pyšek et al. 2002). This original checklist included 1,378 alien taxa and was updated ten years later, with the number in the second edition increasing to 1,454 (Pyšek et al. 2012). The two papers together represented an up-to-date account of the taxonomic diversity, dynamics of introductions, regional abundance, habitats, and source regions of the Czech alien flora. The data were fed into continental and global databases such as DAISIE, GloNAF, as well as national Pladias database (Chytrý et al. 2021) and used in numerous analyses addressing the ecology of plant invasions. Here we report the third edition of the Catalogue to be published in 2022 that will contain changes to the species lists due to additions of new introductions and deletions due to improved taxonomic and ecological knowledge. All taxa were carefully revisited to update the information on their residence time (archaeophyte vs neophyte), invasion status (casual, naturalized, invasive), and time of introduction to the country. The work will be completed with the first thorough assessment of invasive plant species in the Czech Republic using the IUCN EICAT scheme to classify the environmental impacts of biological invasions.

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## P7

### Terrestrial and freshwater alien invertebrates in Sicily and Malta (Central Mediterranean)

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#### Abstract

The Mediterranean is an important biodiversity hot-spot of global importance. Due to their central and strategic positions which allow for many commercial, cultural and international transit exchanges, the islands of Sicily and Malta also tend to be on the front line of the arrival of new alien organisms which threaten local biodiversity. The “FAST” Project (Fight Alien Species Transborder) aims to safeguard the biodiversity of the two islands by directly counteracting the phenomenon of biological animal and plant invasions. To this end, it was fundamental to build an up-to-date database of non-indigenous terrestrial and freshwater animal taxa with particular attention to invasive alien species (IAS), highlighting for each species the introduction pathways, ways of dispersion and degree of invasiveness in the two islands. The creation of such a database is a pre-requisite for any future work related to the management of such organisms in the field (containment/eradication of IAS), citizen science (dissemination of knowledge) and export of management models of IAS applicable to other territories. The construction of the database required consultation of the main international databases (DAISIE, ISSG, CABI, GRIIS, GBIF); national databases (the checklist of the Italian fauna, speciesinvasive.it); various publications concerning single taxa or groups of taxa occurring in Central Mediterranean territories; as well as the addition of unpublished data collected personally by scientists involved in the project. Database construction was nevertheless met with difficulties such as prolific discrepancies in the sources consulted and considerable gaps in ecological and ethological knowledge on some taxa. For species introduced before the year 1500 and which have since become naturalized, the term “parautochthonous” was used. In the two islands, over 900 species of non-indigenous and cryptogenic species have been identified so far.

## P8

### Changes in occurrence and abundance of alien plant species over eight years along the Labe River

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#### Abstract

Riparian corridors belong to the most invaded habitats worldwide, but long-term studies that could enlighten changes in the abundance of aliens over time are rather scarce. Here, we focused on changes in alien plant species occurrence and abundance between 2012 and 2019 at seasonally emerged gravelly river beds along the Labe River in the north-western part of the Czech Republic. This unique habitat is of conservation concern because regular flooding maintains competitively weak plant species, such as the critically endangered annual *Corrigiola litoralis*.

We selected 10 sites located along a 35 km long segment of the Labe River, of which seven represented natural habitats and three human-made habitats. All vascular plant species were determined, and their covers were estimated in 4 × 4 m plots during regular monitoring performed each year of the investigated period by the Povodí Labe service.

Almost 200 plant species were recorded, of which 69 were aliens, including eight casuals, 39 naturalized and 22 invasive species. The number and cover of alien species increased over time, with a minimum in 2014 (24 alien species and 7.5% of the total cover) and a maximum in 2017 (42 and 30.5%, respectively). The most common alien species, found in 70% of plots, was *Eragrostis albensis*, a casual neophyte grass of unclear origin first recorded in the Czech Republic in 1968. The cover of some neophyte species, such as *Ambrosia artemisiifolia*, *Amaranthus albus*, and *Xanthium albinum*, increased over time while others like *Acer negundo*, and *Juncus tenuis* decreased in plots. Our results indicate a rapid increase of alien species on gravel river beds over eight years, which could have a negative impact on native plant communities.

## Biogeography of neophyte invasions in European plant communities

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### Abstract

Human-induced alien plant species spread is among the most serious threats to biodiversity worldwide. Several studies have shown that the magnitude of alien invasions as well as potential impact on native species vary regionally and across different habitats, but is largely consistent within a given habitat across regions. Here we use the most comprehensive dataset of vegetation plots available (the European Vegetation Archive) covering most of the European continent to explore and understand biogeographical and ecological patterns of neophyte invasion in a wide range of habitats (forests, shrublands, grasslands, wetlands, coastal, and man-made habitats).

We mapped neophyte invasion levels across regions and habitat types, and identified regions and habitats with the highest and lowest concentrations of neophytes. We compared different metrics of invasion levels (absolute neophyte richness, relative neophyte richness, absolute neophyte cover, and relative neophyte cover), both at the level of habitat species pools and individual communities. To interpret the current distribution of neophytes in Europe we also analyzed relationships with broad-scale environmental and human-linked factors. In addition, we assessed the habitat specificity of the most frequent neophytes, and compared their life forms and regions of origin.

We identified ~850 neophytes of non-European origin in the dataset and found a lot of local variability in geographical patterns of different invasion metrics, as well as alien species representation according to the area of origin. Our preliminary results suggest that there are many habitat-specific invasion hotspots related to locally specific species introduction pathways, planting history and overall human pressure. To some extent, such hotspots are biased by the amount of available data which is much higher in some regions (e.g. Czech Republic, Denmark, Netherlands) compared with the others. In general, the main differences in invasion metrics, thus, seem to be attributable rather to habitat-specific ecology than biogeography.

## P10

### **Spread of alien plants along the Trans-Siberian railway: the effect of biogeographical zones**

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#### **Abstract**

We present results of the field inventory made in railway areas along the Trans-Siberian railway (Trassib). The uniqueness of Transsib as a model system for studying the alien plant species diversity is due to isolation from the road network and crossing two disconnected parts of the world.

We aim at making an inventory of plant species at a large part of Russia along the Transsib (the Trans-Siberian railway) in relation to the biogeographic regions of occurrence and the native ranges. Our data allow to analyse if there are differences in the composition and features of flora accompanying Transsib along the west-east longitudinal gradient. We focus on the analysis at spatial pattern of the distribution a west-east gradient.

We used vegetation sampling in areas of the railway stops. We analysed the origin of the found species in Russia and in the global in relation to the area where they occur. Sampling was done in several habitat types along the railway ranging from rails to neighbouring vegetation. The ordination methods were used to assess the role of habitat.

We found in total 579 species in the 239 study plots. In European part there was 61 plots, 111 in Siberia and 67 in Far East. In European releves, 264 species were found, 388 in Siberia, and 201 in Far East. 98 species were unique to the European part of Russia, 208 to Siberia and 81 to the Far East.

Proportion of alien species (alien to each region) was significantly different between the regions, but there were no differences in the identity of habitat or urbanity. Vegetation data on species composition analysed by multivariate methods (RDA) on habitats and urbanity showed significant differences. Species occurring in studied habitats created clear groups growing in the railway neighbourhood (rails) and the adjacent areas.

**Expansion and potential distribution of the hybrid Japanese knotweed (*Reynoutria bohemica*) and of the South African ragwort (*Senecio inaequidens*) in Aosta Valley (Northwestern Italian Alps)**

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**Abstract**

The potential expansion of invasive alien plant species (IAPS) in mountains has not been as extensively investigated as for animals, despite the threat IAPS represent for the conservation of native biodiversity (Bartz & Kowarik, 2019). Here we report on the recent expansion of the hybrid Japanese knotweed (*Reynoutria bohemica*) and of the South African ragwort (*Senecio inaequidens*) in Aosta Valley (Northwestern Italian Alps).

In Aosta Valley, *Reynoutria* spp. was first observed in 1976 and since then it spread in the region, reducing local biodiversity, exposing the soil to erosion risk and damaging infrastructures. *Senecio inaequidens*, first reported in 1990, has rapidly spread, mainly along the railway and in disturbed areas.

The potential distributions of these two species were investigated using occupancy models which take into account “imperfect detection” i.e. the issue of not detecting a species even if present (Guillera-Arroita, 2017). Not considering the detection probability typically causes an underestimation of the real occupancy and biased relationships with environmental variables (Lahoz-Monfort et al. 2014). We found that the detection probability ranges from 0.39 for *Senecio inaequidens* to 0.71 for *Reynoutria bohemica*. The best fitting models allowed us to map the species potential distribution in Aosta Valley, identifying the areas most subjected to the risk of expansion.

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## P12

### **Railways as a source of alien plants: a pilot study of the Central European freight corridors**

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#### **Abstract**

Invasive species have a negative impact on the structure and functioning of entire ecosystems; many of them spread into the new regions by escaping from cultivation or are being introduced as an admixture of various commodities. One of the main pathways of introduction and spread is railway transport. We conducted a field survey along the freight railway corridor Břeclav – Kolín – Prague – Děčín (Central Europe, Czech Republic) in 39 localities such as railway stations, railway yards and important railway junctions. Each locality was divided into three zones reflecting the type of management and land use: (i) rails and embankments, (ii) wider surroundings of the station, and (iii) surroundings of buildings. The abundance of each plant species in each zone was recorded using a semi-quantitative scale of occurrence: 1 = occasional, 2 = rare, 3 = scattered, 4 = abundant, 5 = dominant. The inventory at these localities was compared with historical data to determine (i) whether alien species continue to spread, (ii) whether there is a relationship between the time of introduction and the invasion stage (casual, naturalized or invasive in the Czech Republic), and (iii) to record newly introduced species. Preliminary results from a part of the studied freight corridor (13 localities) show that the number of alien plants is increasing, and several invasive species have started to spread along the rails in past years. In total, we found 13 new invasive species compared to historical data. Several invasive species (*Ailanthus altissima*, *Solidago canadensis*, *Conyza canadensis*) frequently form dominant stands in the wider surroundings of the railway stations. The data can be used to evaluate the spread of alien species and predict the invasion potential of newly introduced alien species.

## P13

### **A database of alien plants present in Sicily and Malta: a comparison between two close Mediterranean islands with a common management plan**

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#### **Abstract**

The development of a common database of alien plant species present in Sicily and Malta is one important target of the FAST project funded under Interreg V-A Italia-Malta 2014-2020 call 2/2019. The project, in full coherence with European strategy for the protection of the biodiversity, will counteract the introduction, naturalization and spread of invasive alien species (IAS) that damage the natural and seminatural environments in Sicily and in Malta by means of: (i) their recognition and categorization within priority's scale; (ii) their control and/or eradication in some Natura 2000 sites; (iii) the identification and management of pathways and the means of introduction and dispersal; (iv) the data processing of guidelines and adoption of best practices and (v) education and environmental awareness by several means of communication.

Our work, has made it possible to create a common database of the alien plant species recorded from the two islands. Data was retrieved from both the scientific literature and from our own field studies. This made it possible to quantify the alien species reported so far for the two islands (almost 600 in Sicily and over 450 in Malta) as cryptogenic, casual, naturalized and invasive. The comparison between the alien plants present in Sicily with those present in Malta highlighted the fact that even though the habitats and the surface area are different, the number of alien species is high on both islands and many species are also in common to both. Some alien taxa invasive to Sicily have yet to arrive in Malta. Hence the need to develop effective prevention strategies.

Using a prioritization scale, a small number of species that are mostly invasive or that potentially could become more invasive were chosen (about 150 for Sicily and 100 for Malta), of which most are in common to both islands.

## P14

### Generative reproduction of *Carpobrotus* spp.: the effect of genotype and environment on seed germination

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#### Abstract

Species of the genus *Carpobrotus* (mainly *C. acinaciformis*, *C. chilensis* and *C. edulis*) are considered among the most problematic invasive plants of rocky shorelines and dunes worldwide. Despite intensive research, the taxonomy of *Carpobrotus* spp. remains problematic and the genus is considered a complex of species that easily hybridize and are difficult to distinguish. In a recent study, we identified three genetic clusters of *Carpobrotus* ecotypes in their native (i.e., South Africa and California) and non-native (i.e., New Zealand, Southern Europe and South America) ranges. Here, aiming to explore the capacity for germination and early establishment of each of these groups, we performed a germination experiment with 13 populations from the native and invasive ranges covering the three identified clusters. The seeds were exposed to five temperature regimes and various moisture, salinity, pH, and nutrient levels. We found differences in total germination and early growth that can be assigned to the cluster, origin (native and non-native) and environmental factors, with better germination at higher temperatures and nutrient levels.

## P15

### A synopsis on *Acacia* s.l. introduction, establishment and spread or failure in Italy

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#### Abstract

One of the first detailed European descriptions of a specimen classified as *Acacia* s.l. (from the Americas) was in 1625 by Tobia Aldini. Aldini included an illustration and description of a plant growing in Cardinal Odoardo Farnese's Garden in Rome which he named *Acacia Indica Farnesiana* (now *Vachellia farnesiana*). But it was only after the beginning of the nineteenth century that a considerable number of *Acacia* s.l. species have been introduced in Italy for many different purposes. However, to date, no specific study addressed the exact number of species introduced, the pathways and localities of first introductions, the diverse introduction histories and outcomes, including establishment and spread or failure in Italy. In fact, up to now, most of the studies have mainly focused on a limited number of quite well known established or invasive species, which provides only a limited view of the full picture.

This project started in 2020 and it was supported by a dedicated team of botanists within the Italian Botanical Society (*Società Botanica Italiana*, SBI). Data collection retrieved information available in scientific and grey literature, index semina, horticultural catalogues, herbarium data, field surveys, and in any other available source.

The first results of this study paint a rather complex picture, both in terms of a quite high number of diverse *Acacia* s.l. species introduced in Italy and of their status in the introduction-naturalisation-invasion continuum. Importantly, many species were tested in forestry provenance trials under the control of the public forest authority, at the beginning of the twentieth century, and many of these plots have been conserved so far, representing an important historical document and a natural laboratory for dedicated studies.



## P16

### What recent discoveries of new alien plants introduced in metropolitan France?

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#### Abstract

Invasive alien species (IAS) are recognized as one of the main causes of biodiversity loss in the world. Currently, in metropolitan France, for the flora, several alien species are already considered invasive. However, many others appear to have been recently introduced into the wild and may become invasive in the future. To limit these future invasions, it is therefore necessary to anticipate and to act in particular shortly after the introduction of these plants into the environment, according to the principle of early detection and rapid response. To do this, in this changing world, it is essential to carry out "alerts" on newly introduced and potentially invasive alien plants.

To determine the current alerts to be provided to actors confronted with IAS, the French Biodiversity Agency, with the support in particular of the network of the National Botanical Conservatories, is currently conducting a project dedicated to this topic for France. This project identifies information on alien plants recently discovered in the natural environment from many resources (floristic catalogs, botanical bulletins, botanist experts, etc.). It assesses afterwards whether or not these plants pose a risk of invasion, based in particular on their invasiveness in other neighboring or similar regions of the world, by consulting international databases and risk analyzes. Ultimately, this work will lead to the production of a report and an indicator on current alerts, which will be accompanied by maps and statistics, and also by traits on introduction success. The concerned plants will eventually require to be regulated but above all to be monitored and managed to prevent their possible invasions.

This poster will aim to present the results of this project, highlighting a few significant examples of plants and several interesting figures on characteristics.

## P17

### How do social-ecological factors affect long-term population dynamics of the American mink across its invasive and native ranges?

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#### Abstract

Hunting bags are often used as an indicator for long-term mammal population dynamics, but their quality and methods of collection vary greatly between countries, from mandatory reporting, to census surveys or hunters' estimates. Here, we use hunting bag data to analyse the population trends of the American mink (*Neogale vison*) across 10 European countries (invasive range) and Canada (native range) over a period of at least 16 years, across each country. We estimated mink *per-capita* growth rates using intraspecific feedback and two social-economic predictors potentially reflecting hunting effort and the global mink fur industry: mink pelt prices and global mink pelt production. In addition, we used the North Atlantic Oscillation (NAO) as a large-scale environmental index and competitor species' population abundances, either the European polecat (*Mustela putorius*) or the pine and stone marten (*Martes martes*, *M. foina*), as covariates. Intraspecific density dependent feedback was present in Canada (native range) and 7 out of 10 European countries (invasive range). Social-economic factors were generally better predictors for mink *per-capita* growth rates than the biotic factors. This indicates that the invasive American mink's hunting bags are driven by intraspecific feedback and human action, and hunting bags are not yet a reliable proxy for population dynamics across all countries. A common European code of gathering hunting bags of mink, as well as taking social-economic interactions into account should help achieve better estimates in the future.

## P18

### Distribution and abundance of invasive alien woody species in the protected areas of Georgia

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#### Abstract

Determination of distribution status and abundance of invasive alien woody species (IAWS) are issues of significant importance for relevant and efficient management, especially in the protected areas, due to absence or lack of experience. Here we present the results of study, which was a part of a scientific project – "Survey of Potential Invasive Alien Woody Species (PIAWS) in the Protected Areas of Georgia". We focused on all major IAWS, which were identified in 12 different categories protected areas of Georgia, particularly *Robinia pseudoacacia*, *Ailanthus altissima*, *Gleditsia triacanthos*, *Acer negundo*, *Paulownia tomentosa*, *Brucea javanica* (L.) Merr., and *Ligustrum japonicum*. We determined distribution and abundance of IAWS using field data collected on the 33 sample plots, more than 460 records and GPS waypoints. The data included species distribution, habitat, abundance, landform and other remarks. All information was gathered using ArcGIS Collector application. ArcGIS pro software was used for data analysis and mapping the geographical distribution. Our research results show that the distribution pattern and abundance levels of target species are different in mountain and lowland forest habitats as well as under different biotic and abiotic factors. Our study also revealed some of environmental and geographical thresholds that affect distribution and abundance of target IAWS. For instance, *Robinia pseudoacacia* and *Ailanthus altissima*, which were distributed in almost every study site in high abundances, both in lowland and mountain forest habitats (reaching the height of 890 m above sea level). *Gleditsia triacanthos* was highly abundant in riparian and lower mountain forest habitats (reaching highest altitude of 450 m above sea level).

This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG) [grant number: FR-18-3569].

## P19

### Accounting for evolutionary processes during large-scale plant invasion: the case of *Carpobrotus* spp.

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#### Abstract

Non-native species often undergo adaptive shifts in genotype and phenotype frequencies to become invasive. Accounting for evolutionary processes during the expansion of invasive plants can give crucial information on large-scale context dependencies during invasion. We explore this in the genus *Carpobrotus*. This genus is considered as a complex of species that easily hybridize and are difficult to distinguish. In a recent study, we identified three genetic clusters of *Carpobrotus* spp. in their native (i.e., South Africa and California) and non-native (i.e., New Zealand, Southern Europe and South America) ranges. We developed SDMs and compared the climatic global niche with the niches of the identified clusters in their non-native ranges to assess whether populations are in equilibrium with their environment (i.e., within or outside of their global and regional niches) and to infer the demographic population dynamics of clusters (i.e., adaptation, colonization, equilibrium or sink populations). We found that not all populations of the same genetic cluster were completely in equilibrium, nor constricted in a unique demographic process. That is, populations of the same genetic cluster may be under different eco-evolutionary processes, likely due to differential biotic characteristics of the recipient ecosystem and/or introduction events. Thus, given that large-scale invasion patterns are shaped by evolutionary processes, complementing population ecology, genetic information and ecological niche studies can help to inform site-based management strategies for the invasion of *Carpobrotus* spp.

## P20

### Prioritisation of pathways of invasive alien species in Slovenia

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#### Abstract

Invasive Alien Species (IAS) are recognized as one of the major threats to biodiversity and its related ecosystem services. Many IAS are introduced unintentionally, therefore the management of the IAS pathways is very important. For good results, prioritisation and further focused management of key pathways are needed. Different methods can be used for prioritisation. In Slovenia we have decided to analyse the presence and distribution of individual species in the wild in Slovenia and in neighbouring countries, as well as past trade and online commerce in Slovenia. Furthermore, we have assigned a weight (importance) from 0–3 to each species based on their distribution in Slovenia and in neighbouring countries, and on the presence of trade. To evaluate the significance of each pathway of introduction, the weight of each species using it was summed up and pathways were ranked based on their total number of points. As a result, priority pathways are those through which most species enter and spread, and the routes used for the spread of species that are more widespread and that have a greater impact in nature (with a higher weight).

As such, the most important pathways of introduction in Slovenia for 66 IAS of Union concern, are: (1) escape from confinement – pet animals/aquarium/terrarium species (including live feed for such species), (2) escape from confinement – ornamental purpose other than horticulture and (3) unaided – natural dispersal across borders.

This methodology can be easily adopted to reprioritise pathways for additional species.

## P21

### SynHab: a global synthesis of plant invasions across habitats

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#### Abstract

Recent databases on alien species distributions have played a major role in enhancing our understanding of factors that determine the patterns of alien species occurrence around the globe. Here we present the SynHab database, resulting from the project Macroecology of plant invasions: global synthesis across habitats. The SynHab project aims to summarize available data on distributions of naturalized plant species in different habitats, representing specific vegetation types in regions of the world. Currently, SynHab database contains around 130 datasets from all continents at the resolution of countries. The database includes ca 7,000 plant species, meaning that some information on habitats is available for about half of the known world's naturalized taxa included in GloNAF database. This allows us to test key hypothesis in invasion biology, increase our understanding of their association in specific habitats, and make predictions about future invasions.

## Compiling the national list of invasive alien species of Greece: the plant taxa

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### Abstract

A research program entitled "Compilation of the national list of invasive alien species (IAS) of Greece and organization of a methodology for risk assessment" funded by the Ministry of Environment and Energy is carried out since September 2021, for the implementation of EU Regulation 1143/2014. The scientific working group consists of researchers from the National and Kapodistrian University of Athens, the Hellenic Centre for Marine Research and the University of the Aegean. The list of IAS includes 126 species in total (74 terrestrial, 30 marine and 22 freshwater). Of the terrestrial species, 32 are plants, 14 invertebrates and 28 vertebrates. Among the 32 plant species, 10 were added to the list following a Horizon Scanning (HS) procedure. Fifteen plant species are considered invasive in Greece (*Acer negundo*, *Amorpha fruticosa*, *Azolla filiculoides*, *Bidens frondosa*, *Carpobrotus edulis*, *Cotula coronopifolia*, *Datura stramonium*, *Heliotropium curassavicum*, *Matricaria discoidea*, *Nicotiana glauca*, *Opuntia ficus-indica*, *Robinia pseudoacacia* and *Solanum elaeagnifolium*). Eleven species are included in the List of species of Union Concern. Among them, four (*Acacia saligna*, *Ailanthus altissima*, *Ludwigia grandiflora* and *L. peploides*) are already established in Greece, one (*Pennisetum setaceum*) has been observed as a casual escape from cultivation, and six (*Eichornia crassipes*, *Elodea nuttallii*, *Hydrocotyle ranunculoides*, *Impatiens glandulifera*, *Myriophyllum aquaticum* and *M. heterophyllum*) are known as either cultivated or added through the HS procedure. Two more species, *Phytolacca americana* (already established) and *Pistia stratiotes* (cultivated, added after the HS), are nominated to be included in the List of Union Concern. Finally, *Egeria densa*, *Fallopia baldschuanica*, *Reynoutria japonica* and *R. × bohemica*, added after the HS, are included in the list of IAS of the European and Mediterranean Plant Protection Organization (EPPO). Most of the plant species have been introduced as ornamental, while seed contamination is another common introduction pathway.

## P23

### No changes in the invasion level of primary and secondary grasslands in Central Hungary over the past decade

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#### Abstract

Ecosystems are constantly and seriously affected by changing land use, land cover and climate, inducing changes also in the level of invasion. We conducted a repeated survey to assess land-use change and its impact on the invasion of primary and secondary dry grasslands in the Kiskunság, Hungary. The aim was to study whether (1) the land use of the study sites, (2) the level of invasion and (3) the cover of the most important invasive alien species changed during the study period.

Between 2007 and 2009, we established a network of sampling sites to study the main habitat types of the Kiskunság, Hungary. The survey used 20 × 20 m plots with a stratified random design and was repeated in primary, namely never ploughed open and closed dry grasslands and secondary, namely abandoned agricultural fields, i.e. old fields in 2019–2021. We distinguished young (1–7 years old), medium (8–20 years old) and aged (21–57 years old) old fields according to the time of abandonment in 2007.

The studied grasslands remained the same habitats. There were land use change only in old fields: 64% of young, 45% of medium and 10% of aged became mostly ploughed again. The lowest proportion of invasive alien species was found on grasslands and the highest on young and medium old fields. The proportion of invasive alien species did not change with time. The most important invasive alien species was *Asclepias syriaca*, an invasive perennial clonal herb species. The cover of *Asclepias* increased on young old fields and decreased on medium old fields.

Although several old-field habitat disappeared, on the remaining ones the level of invasion did not show great changes. Thus old fields are important habitats that can preserve many native species, but are also prone to invasion, thus worth to conservation management.

## P24

### Parrots on the run: patterns of escapes of potential invaders in an uninvaded country

Pavel Pipek

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#### Abstract

Ring-necked parakeets *Psittacula krameri* belong to the most noticeable invaders in Western Europe, and it is estimated that they can also establish in eastern countries, despite a harsher climate. It is well settled that the incursions are a result of escapes from captivity, but little is known about how often such events occur and what are their subsequent fates. Such information would improve our understanding of the first stages of the invasion process and help us develop appropriate measures to prevent or slow down the invasion. In this study, I focused on parrots' escapes in the Czech Republic. First, I obtained data about general patterns of escapes of different species of parrots via webscraping from two main websites dedicated to lost and found pets. The most frequently reported were budgerigars, cockatiels and grey parrots, followed by ring-necked parakeets, monk parakeets and Senegal parrots. Second, I collected information about ring-necked parakeets reported as lost, observed, or found between 2011 and 2020 on various online sources, including social media. When the fate of an animal was unknown or some details were missing, I contacted the owners directly. In total, I collected data on 259 reported escapes, of which 185 were with known subsequent fate; only 61 returned to their owners. In most cases, birds were recaptured within several kilometres from their homes, but some went further, with the longest dispersal distance being 200 km. I also analysed 72 reported captures and 54 observations that could not be matched with the escapes. Only a fraction returned to their owners, which can be partly attributed to the fact that in Czechia parrots do not have to be registered unless they are CITES species. Several individuals were observed to survive one or more winters, suggesting the species' potential for establishment.

## **Invasive alien plants in Poland – results of combining theoretical and practical aspects**

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### **Abstract**

The dynamic nature of biological invasions makes it necessary to regularly review and update risk assessments for alien species. This is, for instance, because a species that used to be considered non-invasive may manifest its invasiveness due to climate change.

The study reviews the state of research on invasive alien plant species in Poland, including the main fundamental and applied research providing the basis for (i) the preparation of a list of invasive alien plant species for Poland; (ii) assessing the degree of invasiveness of the analysed species, based on the adopted criteria and proposed methodological solutions. In this work, a new (= 'verified') version of the list of invasive plant species has been prepared, combining theoretical and practical aspects, on the basis of earlier studies and on the list of invasive alien plant species considered to be a threat to the EU.

The presented list of invasive alien vascular plant species for Poland includes 121 species, of which 11 are still absent from Poland (but included in the list of species of the Union concern, and likely to become invasive in Poland in the near future). The remaining 110 species account for 3.2% of all vascular plant species in Poland, estimated at 3,476 taxa.

A total of 20 species have not been recorded in the natural environment so far, but are present exclusively in cultivation in Poland, 56 species occur in the natural environment, while 34 are found both in cultivation and in the wild.

The categorization (risk assessment) of invasive alien species, along with identification of the most threatened types of natural habitats is often used in practice in the management of invasive alien plants in Poland. The results of our research have contributed to the development of legal regulations at the national and regional levels.

**Current distribution and participation in plant communities of *Grindelia squarrosa* in Europe**

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**Abstract**

*Grindelia squarrosa* (Pursh) Dunal is an alien plant species of North American origin which is very well acclimated to conditions of low precipitation, low nutrient, high elevation, and large variations in temperature. It is able to colonize various types of habitats, including arid ones. For this reason, we consider the current state of distribution and the role in the structure of plant communities of *G. squarrosa* in Europe. Based on the generalization of literature and herbaria materials and databases, a map of the distribution of *G. squarrosa* in Europe is presented at different spatial scales. The status and introduction pathways of the species vary in different regions of Europe, e.g. in Ukraine it is assessed as a transformer, in the south-western European part of Russia, and in Moldova, it is considered an invasive plant; in Poland and some other Western and Eastern European countries as naturalized, while in Spain and Romania it is a potentially invasive alien species. In other European countries, the species has so far been recorded at single localities or has not yet been confirmed. In some countries, the species has shown rapid spread over a short period of time. In Ukraine, current data document the occurrence of *G. squarrosa* in more than 500 localities (including almost 200 in the last 5 years); in Moldova, the number of localities increased from 18 (1987) to at least 64 (2018). As a result of the high invasiveness of the species, new plant communities began to form. In general, this species is recorded in communities of several vegetation classes. In terms of ecological indicators, the optimum of the species is in the Steppe zone. The most vulnerable biotopes are grasslands and lands dominated by forbs, mosses or lichens (dry grasslands, woodland fringes and clearings, and tall forb stands). Among the types of vegetation, the most endangered are the grasslands of the Steppe and Forest-steppe zones within Ukraine and the adjacent territories.

# NOVEL TOOLS AND METHODS FOR DETECTION, MAPPING, MONITORING AND CONTROL OF INVASIVE ALIEN SPECIES

P27

## Hard to deal with: attempts for eradication of marbled crayfish from a small urban pond

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### Abstract

Marbled crayfish is an emerging invasive species worldwide. It poses a serious threat for many freshwater waterbodies due to its parthenogenetic mode of reproduction and high adaptability to new environments. Evidence from natural localities increasing especially in urban areas (propagule pressure effect). The established population of invasive crayfish is nearly impossible to eradicate. It is assumed that successful eradication is possible in early detected population and only at sites which enable the eradication. That seemed to be a situation of the small urban pond (0.26 ha) in Prague, Czech Republic. Due to co-operation with municipality the pond harvesting was organized (November 2020), all crayfish found (134 ind.) were removed, pond stayed 2 months drained and then lime was applied at the pond bottom. Then the pond was slowly filled again and predatory fish (perch) were released. No crayfish were observed in the surrounding brook neither upstream nor downstream the pond. Next year (October 2021) the pond harvesting was repeated. Marbled crayfish was detected again in lower counts (61 ind.). Large animals prevailed with high proportion (37.7%) of reproducing ones (16 with eggs, 4 with juveniles, 2 with glair glands) that is higher proportion than previous year (21.6%; 9 with eggs, 6 with juveniles, 14 with glair glands). Higher effort was given to inspection of cavities under large boulders, where we found several burrows. Gypsum casts of four burrows explained the unsuccessful effort from the last year. The biggest cast was deeper than 0.4 m. To cope with this problem a lime solution (lime milk) was applied to the places of expected cavities between and under stones followed again by dry winter period for 2 months. Results will be known this autumn, but it is obvious that also the assumption of relatively easy marbled crayfish removal can be misleading.



## P28

### How to tackle with invasive plant species and sustainable energy production

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#### Abstract

The changing environment and climate pose several challenges for us. Climate-friendly solutions are needed for energy production, and invasive plants are rapidly invading man-made areas. Roadsides and untapped areas could provide (zero-emission) biomass for energy and fertilizer production, but also an effective control site for certain invasive species. Species such as *Lupinus polyphyllus* are mainly spread through roadsides and the IAS management plan focuses on mowing as a control method.

Most promising method for limiting garden lupin by roadsides has been shown to be mowing as roadsides are regularly mowed for safety. Continuous mowing can restrict plant growth effectively and reduce seedling production. Most effective result could be gained by timing mowing correctly. This has shown to be more difficult than expected. And quite often mowing has hardly any effect on restricting invasions as it's done too late.

If plants are taken to biomass treatments with seeds, there is a species-dependent varying risk for their survival. Our studies checked seed survival through tunnel and windrow composting, BMP and farm-scale AD, laboratory stress experiments. Species that had physical, chemical or deep dormancy mechanisms were most likely to survive. These species were *Heracleum* sp., *Rosa rugosa* and *Lupinus polyphyllus*. Field experiments with mowing 1–3 times per growth season highlighted importance of early season mowing in restricting risk. But it revealed also weak points of mowing as a management type. Average production of these areas is about 27 TS (%ww). These untapped areas could anyway be brought to energy production and support the increase of distributed energy production.

## P29

### Camera-trapping in support of the control of Chinese muntjac in a suburban park in Belgium

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#### Abstract

Chinese muntjac (*Muntiacus reevesi*) is a small-sized deer of Asian origin. In the United Kingdom, a large population has developed that causes ecological and economic damage. To avoid a similar scenario on the European continent, Member States have included muntjac on the list of species of Union concern (Regulation 1143/2014). Indeed, muntjac is currently present in isolated populations only in a few countries.

We report on the species' status in Flanders (Belgium). Here, muntjac was increasingly observed throughout the region over the past decade. Genetic analysis indicates that many sightings represent independent releases and escapes. These introductions run parallel to the strictly enforced ban on muntjac. With the captive population now strongly decreased, the priority for management shifts to the control of feral populations.

By means of camera traps, we supported the attempted removal of a feral population in a public woodland park near the city of Antwerp. A network of traps was operated from December 2020 to May 2022, spanning two periods of control (in which high seats were staffed at morning and evening hours during winter).

The data show activity peaks at dawn and, particularly, at dusk, but also suggest a shift in activity during control. Despite intense management on a small surface area, only a limited number of animals were culled. This illustrates the secretive nature of muntjac, allowing it to thrive well in a suburban park with intense levels of recreation. It seems unlikely that current efforts will effectively eradicate the local population, although control may help to turn the population from a source into a sink.

To prevent muntjac from becoming a vertebrate pest at the continental scale, we call for an increased exchange of knowledge on population status across Europe. Sharing camera trap data also undeniably holds potential to increase the effectiveness of management.

## P30

### Citizen Science as a valuable tool for monitoring of alien taxa, *Rhagoletis completa*

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#### Abstract

The walnut propeller (*Rhagoletis completa*) is the new important invasive species that is classified as a true fly of the family Tephritidae. In Europe, its larvae develop in the walnuts. Yield losses are often more than 50%, at the beginning of the invasion or in good years for the occurrence of *R. completa*, the larvae can destroy the whole harvest.

In the Czech Republic, the walnut propeller was first discovered in 2017 in South-Eastern Moravia in the area bordered by Znojmo, Brno and Hodonín, from where it is gradually spreading inland. Due to the area of expansion and abundance, it probably crossed the border from Slovakia or Austria several years earlier, but with a low incidence it escaped attention. In 2019, increased harmfulness on walnuts was already reported, and the whole harvest was often destroyed (premature fall of unripe walnuts). The area of occurrence in Moravia and Bohemia was so large in 2020 and especially in 2021 that the general public was also involved in monitoring within the Citizen Science project NAJDI.JE!

The created map will be used to predict the further spread of this invasive species. The speed of spread of adults from the area of occurrence of larvae in walnuts can be up to tens of kilometers thanks to active flight with the help of wind. Because it is very difficult to distinguish adults of *R. completa* from other propeller species, we focused our attention primarily on monitoring the presence of larvae in walnuts.

Thanks to a detailed mapping of the occurrence of this pest, it is possible to predict the further spread of this species, and subsequently we can apply protection in time, such as glue boards, or food attractant within insecticide.

## P31

### Steam treatment for sustainable control of Bohemian knotweed in soil masses

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#### Abstract

Invasive plant propagative material can be introduced to new regions as contaminants in soil. Therefore, moving soil should be done only when the soil has been verified to be free of invasive species. Stationary soil steaming as a non-chemical control method has the potential to disinfect soil masses contaminated with invasive species. We investigated the possibility of thermal control of propagative material of Bohemian knotweed (*Reynoutria × bohemica*) in two experiments using a prototype of a soil steaming device. Five soil temperatures of 60, 70, 80, 90 and 99 °C with an exposure duration of 3 min were tested. In each replicate and target temperature, rhizome cuttings containing at least two buds and shoot clumps were placed at the bottom of a plastic perforated basket and covered by a 7-cm soil layer. Each basket was placed in the steaming container and steam was released from the top and vacuumed from the bottom. Soil temperature was monitored by 10 thermocouples and steaming was stopped when 5 of the thermocouples had reached the target temperature. The basket was then removed from the steaming container after 3 min. Plant materials were taken out and planted in pots. Buds sprouting was followed for 8 weeks. Non-steamed plant materials were used as controls. Results showed 100% rhizome death at soil temperatures of ≥70 and 99 °C in the first and second experiments, respectively. Shoot clumps death was obtained at ≥90 °C in both experiments. These results showed that steaming at 99 °C for 3 min can guarantee control of Bohemian knotweed in infested soils supporting the steam treatment as a potential method of disinfecting soil against invasive species. However, depending on the intended re-use of the soil, further studies are needed on the effect of potential negative impacts of high temperatures on the soil quality.

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## Application of spectral signature of selected Invasive Alien Plants (IAPs) of Malta and Sicily for ecological monitoring

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### Abstract

The detection and characterization of spectral signatures offer an efficient and cost-effective method for the assessment and monitoring of the distribution range of IAPs. The development of geospatial technology, specifically remote sensing, is no longer limited to satellite imagery. In fact, in the last decade, consumer-grade Unmanned Aerial Vehicles (UAVs) have extended the accuracy of vegetation mapping.

Spectral characterization of the most widespread IAPs of the Maltese Islands (including *Agave* spp., *Ailanthus altissima*, *Arundo donax*, *Cardiospermum* spp., *Ricinus communis* and *Opuntia ficus-indica*) is being used to produce vegetation maps in Special Areas of Conservation (SACs) of the Maltese Islands, including L-Inħawi tax-Xlendi u tal-Wied tal-Kantra (Gozo); Rdumijiet ta' Malta: Mix-Xaqqa sal-Ponta ta' Bengħisa (western coast of Malta) and Il-Magħluq tal-Baħar ta' Marsaskala (southern Malta). All mentioned localities are protected areas of the Natura 2000 network of the Maltese Islands.

Using open access satellite imagery available from the USGS Earth Explorer portal, published data from the SintegraM project and novel material from dedicated UAV surveys, the spatial distribution and range expansion of IAPs will be assessed and validated by ground-truthing. The variability of the spectral signature due to the species phenology and seasonal illuminance is considered in the classification method used for the vegetation mapping.

The workflow of the methodology will be easy to follow, accessible to everyone and reproducible. The dynamic mapping of IAPs over time would set the baseline for future conservation measures and facilitate the science-based management of the protected areas.

This work is supported by the FAST Project "Fight Alien Species Transborder" Programme INTERREG V-A Italia-Malta 2014–2020.

## P33

### **The LIFE RIPARIAS project – *Reaching Integrated and Prompt Action in Response to Invasive Alien Species***

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#### **Abstract**

There is still a critical need to underpin IAS management with a coherent, replicable and transparent workflow for decision making.

The LIFE RIPARIAS project develops an innovative evidence-based workflow, optimising the management of invasive freshwater crayfish and aquatic and riparian plants within a multiregional pilot area in Belgium.

Specifically, the project:

- Improves data flows from existing early warning and surveillance systems, kept separately by regions, local authorities and NGOs, to IAS managers by ensuring interoperability and enhancing surveillance. Fifteen taxa of emerging aquatic and riparian species listed under the IAS regulation are targeted, as well as a set of taxa not yet of EU concern.
- Develops guidelines and objective criteria for prioritising management actions and apply priority actions in pilot river sub-basins. For emerging species, the objective is early detection and rapid eradication; for widespread species, two distinct management objectives are foreseen depending on species distribution: 1) containment of populations in core areas; 2) maintenance of pest free areas.
- Improves data flows from management actions to policy-makers by monitoring and assessing IAS management efficiency in support of the reporting obligation pursuant to the EU Regulation on IAS.
- Promotes the replication of the evidence-based workflow for IAS management decision making in Europe and improving the transfer of experience and best IAS management practices.

A strong collaboration between the three involved Belgian regions is key to success as IAS establish and spread beyond geographical and administrative borders. The ten project partners include public bodies, academia and associations, and are all committed to work together to tackle the many challenges ahead.

This project, with a running period of six years, is co-funded by the LIFE programme of the European Union and the three Belgian regional authorities (LIFE19 NAT/BE/000953).

## Ecological niche dynamics of invasive alien plant species of European Union concern in Italy

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### Abstract

Niche shifts between the native and invaded ranges of invasive alien plants have been challenged, even though they represent an important factor in predicting areas of potential invasion by alien species. On the assumption that niche is conserved during the invasion process, we investigated the extent to which niches of invasive alien plants of European Union concern (IAPEU) are conserved or shifted comparing the native with the invasive range with a special focus on Italy, due to the availability of a very accurate mapping produced by a dedicated working team of the SBI. The estimated niche for the native region was projected onto each invaded region to generate potential distributions. Niche dynamic analyses were performed using three metrics to compare invaded and native niches: niche overlap; niche equivalence and niche similarity. Additionally, we identified the proportion of unfilled, stable, and expanded niches within the environmental space by overlapping the native and invasive niches. While the overlap values measured the proportion of niche conserved, the expansion values estimated the proportion of niche expanded; unfilling indicates the native niche is non-overlapping with the exotic niche. We found, that when analog climate niches are compared between species distribution ranges, some are conserved, while others expand their ranges. Niche analyses could support, the management of the 19 IAPEU. These non-native species are already present in Italy, although they have quite different patterns of distribution. Our results are useful to demonstrate that while subsets of species tended to occupy analogs of their original native niche, under some environmental conditions niche shifting was observed. These findings can be used to identify areas at risk of the recent introduction of neophytes, and develop future monitoring programs for prioritizing control efforts, which enables the effective use of ecological niche models to forecast invasion in other regions.

**P35**

### **iPhenology – a new approach to analyze phenological patterns**

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#### **Abstract**

To halt the spread of Invasive Alien Species (IAS), it is critical to understand which factors lead to successful invasions. Among these factors, the phenology of invasive plants is one of the most crucial and understudied aspects. Phenology explores the timing of recurring biological events. The capability to reach pivotal reproductive stages such as flowering and seed production in new environments is a prerequisite for species to persist across geographical ranges. In particular, studies on the latitudinal phenological patterns of IAS can provide valuable information to understand future range shifts. Despite their importance, empirical studies on the phenology of IAS across larger geographical scales are rare. This is mainly because phenological studies require frequent simultaneous observations. Thus, these studies are costly and hard to organize.

The use of freely available digital data has the potential to overcome these challenges and to provide unprecedented amounts of research data. However, little research has yet tracked the phenology of IAS using these approaches. We use iPhenology to observe the flowering and seed production of the invasive garden lupine (*Lupinus polyphyllus*) as a model species across its invaded range in Europe. To this end, we collected image-based observations of the species from the GBIF-database between 2019 and 2021. Overall, 3,500 unique observations were analyzed and classified according to their phenology. The dataset comprises images derived from species identification applications, the citizen science network iNaturalist, and national observation networks. We analyze spatio-temporal patterns and explore possible drivers of the garden lupine's phenology. We compare the results to expert observations throughout Europe and assess the suitability and limits of the approach for future applications.

**P36**

### **Fighting Alien Species Trans-border. A Citizen Science perspective**

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#### **Abstract**

Citizen Science has come a long way since the voluntary collection of specimens by naturalists in the 16th and 17th Century. Indeed, developments in information technology and recent trans-disciplinary collaborations have transformed the efforts of once solitary individuals into an environmental movement with the potential to address important international issues. One such collaborative project is Interreg's Italia-Malta's FAST project (Fighting Alien Species Trans-border) which aims to counteract the introduction, naturalisation and spread of invasive alien species which pose a threat to the ecology of several high nature value sites within Sicily and the Maltese archipelago. The choice of these islands is important for their trans-border role in the Mediterranean region.

Although there are numerous Citizen Science projects currently being undertaken globally, the FAST project is unique for the Maltese Islands in the sense of it being the first national BioBlitz organised on the Islands. The bioblitz will be targeting a Natura2000 site over four days. Participants will be receiving data-collection training for invasive species before joining the bioblitz. At the end of their participation, Citizen Scientists will be asked to fill a standardised international survey developed by European BioBlitz Network (DITOs Consortium 2019).

During this presentation talk we will be discussing the conservation impact of this rapid data collection of invasive species in a protected site as well as the motivations of the participants to continue volunteering as Citizen Scientists in the future.

## P37

### Should reproduction mode in knotweeds change the management approach?

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#### Abstract

Alien knotweeds (*Fallopia* spp. complex) are one of the most invasive species in Europe and cause serious problems in nature protection. Once established, they form vast stands and almost completely outcompete native species. Besides human-made habitats, knotweeds mainly occupy riparian vegetation where periodical disturbance occurs. Such habitats enable both generative and vegetative reproduction. Vegetative reproduction prevails in all knotweed taxa and the overwhelming majority of localities. However, there are several localities in Europe with high cytological and genetic variability, which suggests ongoing generative reproduction. In this study, we describe cytological and genotype variability (using Simple Sequence Repeats, SSRs) from localities in France, Germany, the Czech Republic, and Croatia. In addition, we studied the seed production of particular clone variants and seedling vitality. The localities differ in number of cytotypes and genotypes in particular taxa, as well as in seed production and germination of particular genotypes (octoploid seeds showed about 10% higher germination compared to hexaploids). At specific localities, which we assume as invasion hot spots, octoploid cytotypes of the hybrid *F. × bohémica* ( $2n = 88$ ) and high genotype variability of octoploids were found. In the Czech Republic, genotype variability was mainly found in hexaploid hybrids. Low variability was found in German and Croatian populations. In addition, seedlings of specific parental combinations reveal high fitness and vitality. Our results stress the importance of cytological and genotype variability observed in the field which is obviously the result of generative reproduction. Hybridisation, backcrossing, and polyploidization are therefore considered as important driving forces in the invasive process. We suggest the general approach to knotweed management should change based on the knowledge of generative mode of reproduction presence. The presence of hybrids increases the competitive and invasive ability of knotweeds, and native vegetation in such localities can be completely destroyed as was repeatedly described.

## P38

### Surveillance, inspection, ID tools and how it all comes together to control invasive alien plants

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#### Abstract

With the adoption of the EU Regulation on Invasive Alien Species (EU Regulation 1143/2014), National Governments were obliged to fulfil the requirements of prevention, early detection, eradication and control of species on the List of Union Concern. Border inspection, inspection of places of production, surveillance of internet trade and surveillance in the field by both land managers and citizen scientists all play their part. This inspection and surveillance work are supported by a knowledge infrastructure, comprising a range of ID tools and online databases.

<https://q-bankplants.eu/>

<https://qbank.eppo.int/plants/>

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### **Using genetic markers to study the naturalization of cultivated tree species – the case of *Eucalyptus globulus* Labill.**

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#### **Abstract**

Genetic markers can provide valuable insights into the regeneration and dispersal of plants. This approach can be particularly useful to study exotic cultivated species that are undergoing a process of naturalization. Here we present an overview of the use of genetic markers in invasion ecology, with a particular focus on *Eucalyptus globulus*, a fast-growth tree species native to Australasia. Plantations of *E. globulus* expanded exponentially in different world regions due to economic reasons, but there are increasing reports of plant escape and invasion, especially after wildfires. The ongoing WildGum II project is aimed at investigating the spatiotemporal dynamics of wild eucalypt populations (WEP) in Portugal, using genetic markers and remote sensing. Data and tissue samples for genetic analyses were collected from nearly 3,000 eucalypts distributed across 10 WEPs. Genetic markers were used to estimate genetic diversity, the mating patterns and the gene flow. Parentage analysis was used to assess offspring abundance, dispersal direction and distances, and the role of the parent-trees on the recruitment process. A study case of a massive post-fire plant recruitment that occurred in Central Portugal is presented. Genetic diversity of the post-fire cohort was much lower than in the seed-trees. One single seed-tree originated 52% of the offspring. Post-fire dispersal occurred southward in accordance with local post-fire winds. Maximum dispersal distance was 101 m and external pollen has travelled a minimum distance of 700 m. These results presented as an example, strongly support the multiple advantages in using genetic markers for studying the naturalization of cultivated tree species.

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P40

### **Developing a prioritization framework for the management of invasive species under climate change for the Flemish Waterways: drafting the priority species list**

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#### **Abstract**

Site managers need clear guidance to develop an efficient policy for the management of invasive species. However, financial resources are scarce, as well as the knowledge on which species present a priority. Hence, it is necessary to develop a clear framework tailored to the needs of the individual manager, in this case the Flemish Waterways.

The first step towards this management framework is the design of a list of priority species. The list needs to encompass both the currently present invasive species, but also species that might present a future risk. To this end, a compilation was made of all non-indigenous plants on Belgian territory, including all traded plant species and invasive species present in neighbouring countries. Each of the species was subject to a climate matching under different climate scenarios, to evaluate whether they could establish within Flanders under the concurrently present Köppen-Geiger climate zones. Resulting species were subsequently evaluated for both invasiveness and manageability. Relevant and available plant traits were noted from the plant trait database TRY and used as base for discussion in the final step, where relevance of each species was evaluated by an expert panel based on a predetermined set of possible impacts.

The resulting shortlist was used to draft a management guide, compiling general management guidelines but with emphasis on the specificities of each individual plant. The species list will also be implemented in an early warning system (EWS) built on existing data infrastructure (i.e. citizen science platform 'waarnemingen.be' or LIFE Riparias EWS). This will aid the Flemish Waterways to tackle new introductions as well as to allocate available resources efficiently.



## RELATIONSHIPS BETWEEN WEEDS AND INVASIVE ALIEN PLANTS (SPECIAL JOINT SESSION WITH EWRS)

### P41

#### Short-term effects of shoot cutting of an invasive perennial herb, *Asclepias syriaca*, on native vegetation composition of old fields

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#### Abstract

Understanding the impact of invasive plant species is important for elaborating more effective management. Common milkweed (*Asclepias syriaca* L.) is a perennial clonal herb, and one of the most widespread invasive plants in Hungary, mainly present in secondary grasslands.

We studied the impact of the invasion of *Asclepias syriaca* on basic soil properties and on native vegetation composition by comparing invaded and uninvaded areas and the effect of cutting treatment of *Asclepias* shoots in the sandy region of Kiskunság National Park, Hungary in 2019–2021.

In ten old-fields, we assigned four 4 × 4 m plots, from which three were invaded by *Asclepias*, and one was uninvaded. Invaded plots were treated by cutting (1) all of the *Asclepias* shoots, (2) half of the *Asclepias* shoots, (3) none of the shoots, and (4) the uninvaded reference plots remained untouched. The cutting of *Asclepias* shoots were conducted twice a year in the summer of 2019–2021. The cover of each vascular plant species and the number of *Asclepias* shoots were recorded in each plot before the first and after the second treatment per year. Soil was sampled before treatment.

Our result shows that the soil properties of the invaded and uninvaded plots were statistically not different. The three year short-term cutting treatment reduced the number of shoots and the cover of *Asclepias*. The cover of sand grassland specialist plants were higher in uninvaded than in invaded plots, and these covers did not change in response to the cutting treatments. Instead, the cover of neophyte plants increased after the cutting of *Asclepias* shoots.

We found that the invasion of *Asclepias* changed the native plants vegetation composition, but not the soil properties. We conclude that more time or additional seeding of native species is required for native plants recovery.

### P42

#### Alien plants in weed flora of olive orchards in the Köprübaşı District, Turkey

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#### Abstract

Olive is a foremost crop in the Köprübaşı District of the Manisa Province of Turkey. A face-to-face survey was carried out in 69 orchards to find out cultivation problems. The survey was focused mainly on weeds, weed control and applications that can affect weed biology and ecology. This presentation describes weed flora in olive orchards in the district and discusses common and problematic weeds in the context of native and non-native. 141 species were recorded according to producers' observations and field control by us. Online flora of Kew Herbarium (<https://powo.science.kew.org/>) was used to determine alien status of species. 31 species were determined aliens for Turkey. Producers considered *Cynodon dactylon* (in 57 orchards), *Sorghum halepense* (26), *Tribulus terrestris* (17), *Sisymbrium officinale* (12), and *Convolvulus arvensis* (12) as the most problematic species, which are all native species. Among alien species, *Chenopodium album* subsp. *album* (18), *Xanthium orientale* (17), *Portulaca edulis* (9), and *Erigeron bonariensis* (7) were mentioned as the most problematic ones. Currently, the most common and problematic species are native species. While olive orchards are mostly established in forest areas, it can be concluded that weedy species not regarding to origin can be problematic in disturbed areas.

## PAST, CURRENT AND FUTURE DRIVERS RESPONSIBLE FOR BIOLOGICAL INVASIONS

P43

### Invasion of tubenose gobies from Ponto-Caspian region to the Baltic Sea (and beyond)

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#### Abstract

Tubenose gobies (*Proterorhinus* spp.) are endemic Ponto-Caspian species, which have become widely invasive over the last few decades. The western tubenose goby (*Proterorhinus semilunaris* (Heckel)) is an invasive species in Europe and the Great Lakes in North America, the tubenose goby (*Proterorhinus marmoratus* (Pallas)) has been recognised in the Rybinsk reservoir and the Neva Bay in Russia. Information on the distribution and invasions of eastern tubenose goby (*Proterorhinus nasalis* (De Filippi)) has so far been scattered, caused particularly by uncertainties in the species identification and taxonomy (referred also as *P. semipellucidus*). In 2021, our molecular analysis revealed the existence of the Ponto-Caspian origin eastern tubenose goby in the Baltic Sea.

Species of Ponto-Caspian region (including the Black Sea, the Sea of Azov, the Caspian Sea) are known as exceptionally successful invaders into the Baltic Sea basin. Low species diversity, brackish water, eutrophication and closure of the ecosystem are only few drivers of the high invasion rate in the vulnerable Baltic Sea. Opening of the waterway canals, such as Rhine-Main-Danube or Volga-Don, has intensified shipping and therefore opened new possibilities for Ponto-Caspian species to disperse. By the year of 2016, 44% of the non-indigenous species, which inhabited the Baltic Sea, the Northern Sea and the Great Lakes were of Ponto-Caspian origin emphasizing the capacity, significance and riskiness of the biological invasions.

P44

### A dedicated database for the analysis of the main drivers of the global distribution of the seed beetle *Stator limbatus* (Coleoptera: Chrysomelidae: Bruchinae)

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#### Abstract

*Stator limbatus* (Horn, 1873) (Coleoptera: Chrysomelidae: Bruchinae), a polyphagous seed beetle native to hot and dry areas of North, Central and South America, was first reported for Europe in 2021, in the islands of Sardinia (Italy) and Corsica (France), where it has established on some *Acacia* species. This beetle has the potential of becoming an invasive species in Europe in view of its biological traits, such as a high phenotypic plasticity, local adaptation to host species, and generalist habit. Interestingly, *S. limbatus* was reported in Europe on *Acacia mearnsii* and *Acacia saligna*, which are two well-known invasive trees outcompeting native vegetation in many areas of high conservation value. *Acacia saligna* is an invasive alien species of (European) Union concern (Reg. EU n. 1143/2014) quite widespread in the Mediterranean, while *A. mearnsii*, despite being a species commonly used in forestry at the global level, is less common in the Mediterranean region. Therefore, the potential spread of *S. limbatus* in the Mediterranean and in Europe, and consequently the potential impacts due to its spread, deserves further studies. With this aim, based on a systematic literature review and collection of information from key international experts on this beetle, we implemented a georeferenced database with worldwide records of *S. limbatus*, its host plants, data on local climate and habitat types, biological and biogeographical information on the hosts: native range, status in the recorded location (e.g., native, naturalized, exotic, invasive), and type of fruit, as well as available genetic information on the seed beetle and host species. The dedicated database will disentangle the main drivers affecting *S. limbatus* global distribution, and support spatial suitability models and risk evaluation.

## P45

### Are juvenile performance traits of tree species positively correlated to their invasiveness? Two case studies on maples and conifers

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#### Abstract

Determining the traits correlated with invasiveness in order to identify potentially invasive species remains a priority in invasion ecology. In trees, an important juvenile relative growth rate (RGR) and specific leaf area (SLA) under optimal conditions have been identified as performance traits promoting invasiveness. We tested the correlation between performance traits and a continuous quantification of invasiveness for two forest species groups: maples (*Aceraceae*) and conifers (*Pinaceae* and *Cupressaceae*). Eight maple species were grown indoor under non-limiting conditions during 8 weeks. Fifteen exotic coniferous species were grown for 10 weeks outdoor, under a shade sail, in southern Belgium. At several harvest times, SLA was measured and seedlings were dried to weigh the biomass and determine RGR. The global invasiveness was quantified using a combination of the number of regions and countries invaded in GBIF, and the number of citations and risk score in the Global Compendium of Weeds. For conifers, the local invasiveness in Belgian forests was also quantified as the density of regeneration observed in old arboreta. Phylogenetic effects were tested. For maples, as expected, we found a positive correlation between invasiveness and RGR, SLA, relative leaf production rate and height. For conifers however, RGR was not correlated to global and local invasiveness. Height of the seedlings was the only trait positively associated with global invasiveness, and species with higher SLA, height and number of leaves also had a higher local invasiveness in Belgium. We conclude that invasive maple species, mostly post-pioneer species, could benefit from an acquisitive strategy as already shown for other tree species. For conifers, the combination of traits promoting invasiveness might differ. Invasive conifers in forests might adopt a “sit-and-wait” strategy at the seedling stage.

## P46

### Copper uptake and impact in a native and invasive plant in riparian systems

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#### Abstract

*Fallopia japonica* is a major plant invader on a global scale and often becomes dominant in riparian areas. Anthropogenic pollution may differently affect this invasive species compared to native riparian plants. We focused on copper, a commonly used fungicide, making it relevant as a possible source of agricultural pollution. Our aim was to investigate the impact of copper pollution on the growth and copper uptake of *F. japonica* and a common native riparian species in Europe, *Urtica dioica*. Since *F. japonica* is known as a plant with high tolerance against heavy metals that can accumulate high amounts of heavy metals in roots and rhizomes, we hypothesised that growth of *F. japonica* would be less impacted by copper contamination compared to the native species and would also be able to take up more copper.

We tested this hypothesis in a mesocosm experiment using riparian soil with five levels of copper pollution based on background levels reported in literature ranging from 0 to 2,430 mg per kg of soil. We measured above- and belowground plant performance across the growing seasons and recorded the copper content of above- and belowground plant compartments as well as total and plant available soil copper content.

Increasing copper pollution negatively impacted both species across all growth parameters. However, copper pollution affected *U. dioica* at lower concentrations compared to *F. japonica*. The effect threshold for *U. dioica* was at 270 mg / kg while it was at 810 mg / kg for *F. japonica*. These results indicate that copper pollution introduced into riparian areas via streams may lead to facilitation of plant invasion by impacting the native species *U. dioica* which can often be found in habitats invaded by *F. japonica* more strongly than the invading plant, which could lead to higher damages to the ecosystem (such as biodiversity loss) overall.

**P47**

### **Evaluation of genetic diversity of *Phalaris arundinacea* populations growing in Lithuania**

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#### **Abstract**

Wetlands are part of a very complex and important terrestrial ecosystem. Invasive plant species pose a major threat to aquatic ecosystems. In the temperate zone, one of the most common species of macrophytes is the reed canary grass (*Phalaris arundinacea* L.). It naturally grows and is widespread in Lithuania, but in some areas of North America it occurs in uncharacteristic growing places. Numerous studies have been performed in the invasive range of *P. arundinacea*, although information on the viability of the species in its natural range, like Lithuania, is insufficient. So far, the genetic studies of *P. arundinacea* populations are particularly important, because the plant is used for the feed production, ornamental purposes, phytoremediation and biofuels. The objective of the study was to estimate genetic diversity of *P. arundinacea* by microsatellite markers. All alleles of Lithuanian populations of *P. arundinacea* were polymorphic. The average polymorphism among the studied population were nearly 30 %. The index of Nei's gene diversity was not very high. Selected for the study populations have bigger part of the genetic diversity within, rather than among populations. There was small statistically significant genetic differentiation among the population groups of *P. arundinacea* according to CORINE land cover and use classes, former nitrogen pollution of rivers, present state of the rivers. Bayesian clustering suggested that current individuals of *P. arundinacea* populations are admixtures of two (according to the largest  $\Delta K$ ) or four (according to the second largest  $\Delta K$ ) formerly distinct genetic groups. This study data complements the global knowledge of the genetic structure of *P. arundinacea* in the natural range of this plant and might be helpful to understand the invasion ways in some habitats and develop the destruction of this plant or to be applied in the selection process for new productive varieties.

**P48**

### **AFLP analysis of genetic diversity among Lithuanian populations of *Lythrum salicaria***

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#### **Abstract**

Nowadays the main focus is on the state of endangered species or invasive organisms, especially on riparian species. These plants are affected by a much stronger effect of anthropogenic factors. One of these species is *Lythrum salicaria*. It is a common wetland species with a widespread local distribution of the Northern Hemisphere. It is investigated along its invasive distribution range in North America, and natural areas of West Europe, but information about species in the Baltic States is missing. The aim of this study is focused on comparison of genetic diversity of Lithuanian populations of *L. salicaria* in relation to riparian environment characteristics. Fifteen populations were examined according to amplified fragment length polymorphism markers. Molecular parameters were related to the river basins, type of land cover and use according to CORINE, natural vs. regulated fragments of the rivers. Mantel test revealed significant correlation between genetic and geographic distance of populations. Genetic diversity within populations was higher than among populations. The Bayesian clustering revealed that populations are admixtures of two gene pools. This study indicates that Lithuanian populations of *L. salicaria* exist in rather different conditions of anthropogenic and other type impacts, and we have detected some traces of molecular signatures of this impact on genetic structure of *L. salicaria* populations. However, studies on the genetic variation of *L. salicaria* populations need to be further detailed in the future. The study was carried out within framework of national program titled under "Sustainability of agro-, forest and water ecosystems" (project No. SIT-02/2015).

**A study on the introduction of *Eucalyptus* s.l. in the Mediterranean**

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**Abstract**

Many non-native *Eucalyptus* s.l. species have been introduced in Mediterranean countries during the last decades. A few of the introduced species are very common and their invasion status is very well studied. On the other hand, very little information is currently available for most of the introduced species. The present research project started in 2020 aiming to draw the most comprehensive picture of the distribution and total number of introduced *Eucalyptus* s.l. species and lower taxa (including hybrids) in the Mediterranean countries

To do this, we retrieved all available information from the scientific and grey literature, *index semina*, horticultural and arboreta catalogues, herbarium data, field surveys, and from any other available and reliable source, including texts in local languages.

The preliminary results of this study paint a rather complex picture. We have found a high number of introduced *Eucalyptus* s.l. species in the Mediterranean, at different stages of the introduction-naturalisation-invasion continuum (i.e., from species that failed to establish populations in the wild, to highly invasive species). Also, the specific reasons for introduction and introduced areas have slightly changed in time, reflecting cultural and social changes, changes in forestry policies, and other historical aspects. The database that resulted from this study is expected to support further studies on the ecology of introduced *Eucalyptus* s.l. species and future risk assessments in the Mediterranean region.

## P50

### Simulating incursions to understand the influence of spatiotemporally dynamic environment and propagule pressure on establishment success

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#### Abstract

Understanding the determinants of invading alien species establishment success is pivotal in predicting incursions and developing effective early response strategies. Propagule pressure has been implicated as the primary factor determining establishment success and even as the “*null model of biological invasions*”. However, this premise has been highly contentious because of its deceptively simple concept (i.e., introducing more individuals increases establishment success) that dismisses other factors, such as the environment. Moreover, individuals’ dynamic behavioural responses to different and changing environments is a complex factor rarely considered. Using *virToad* – a hyper-realistic life-history simulator of the cane toad (*Rhinella marina*) for predicting spatiotemporal population dynamics and management outcomes (Pili et al. 2022), we simulated 18,000 incursion scenarios to understand the interacting effects of (i) propagule size (2–20 individuals), (ii) propagule number (1–3 introductions), (iii) spatial environment (different landscapes; airport vs. wharf), and (iv) temporal environment (changing daily rainfall; introduced between day 1–730) on establishment success. Running-window binomial regression models revealed that the importance of propagule size would significantly and substantially vary in different landscapes and fluctuate with changing environmental conditions – signifying changes in regimes and interaction among factors. Generally, propagule size swamps the effects of spatial and temporal environment when  $\geq 12$  individuals were introduced ( $\geq 75\%$  probability of establishment); however, this was undermined when individuals were introduced in separate events ( $>1$  propagule number). But in realistic scenarios (at most, propagule size = 3; propagule number = 3 per year), disregarding the effects of temporal and spatial changes in the environment led to false predictions of establishment success. Given the recent prominence of accidental transport and introduction of alien species – characterised by few individuals and infrequent introduction events, accounting for spatiotemporal differences and changes in the environment is requisite in assessing establishment success and predicting incursions for decision support.

#### Reference

Pili, A. N., Tingley, R., Chapple, D. G., & Schumaker, N. H. (2022). *virToad*: simulating the spatiotemporal population dynamics and management of a global invader. *Landscape Ecology*, 37, 2273–2292.

## P51

### Anthropogenic nurse effects on subarctic invasion

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#### Abstract

Invasive species represent a serious threat to many native ecosystems, but currently are nearly absent from arctic and subarctic Canada. The town of Churchill, Manitoba (58.76° N, 94.16° W), has an unusually high number of invasive species due to the presence of a grain port and railway that enable the transportation of invasives to this location, but few of these species have spread to the surrounding tundra. I am attempting to understand why one of these highly invasive species, common dandelion *Taraxacum officinale*, currently is restricted to town, focusing on an anthropogenic effect: the tendency of buildings to provide shelter and thus, allowing *T. officinale* to persist. To do this, I am comparing the common dandelion and a native species, *Taraxacum lacerum*, to test for buildings’ effects on their survival. This research will help in understanding what might limit an invasive’s distribution and thus, aiding conservation and management efforts. As climate change becomes an increasing concern, being able to understand and predict factors potentially affecting future invasions is increasingly important.

P52

### Ship lay-ups and stoppages: biofouling and biosecurity

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#### Abstract

Extended vessel residence time in port or at anchor is recognized as a key factor in biofouling accumulation, viability and release of propagules, and subsequent invasion risk. Recent global shipping disruptions due to COVID-19, leading to thousands of ships either laid up (cruise vessels) or stopped (container and other cargo vessels), as well as short-term pulse events such as the blockage of the Suez Canal, altered or continue to alter the movement patterns of commercial ships and may increase worldwide invasions of marine non-indigenous species in coastal ecosystems. This large scale of disruptions across numerous geographic locations has been on-going for over two years. It is crucial to increase surveillance efforts targeting fouling biota over the next 5 years to detect new invasions in a timely manner. Critically, biosecurity measures ought to clearly anticipate the likelihood of recurring layup or stoppage events. Yet, at present, there is no international programme or proposition to evaluate, assess, address, or mitigate the potentially increased transport of species due to recently altered ship movement patterns. The current non-binding IMO Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (Biofouling Guidelines) do not address post lay-up/stoppage management. Urgently required is an explicit biofouling management response to long-term vessel residency events that incorporates (1) compulsory reporting of the results of independent inspections of fouling on stationary vessels, (2) clear protocols meeting international standards for the removal of fouling accumulations prior to voyage resummptions, and (3) required reporting of responses to these policies.

P53

### The invasive potential of *Spiraea tomentosa* L. as a result of seeds adaptation to hydrochory

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#### Abstract

*Spiraea tomentosa* (L.) is a shrub naturally occurring in North America. In Europe this species has been cultivated as an ornamental plant since the 18th century. Currently new spontaneous sites have been discovered in Denmark, Sweden, Norway, Belgium, Germany and Poland where in the latter its population is observed at natural and semi-natural plant communities in the western part of the country. In Poland most sites of this shrub are located in the Lower Silesian Wilderness (Polish: Bory Dolnośląskie), where its expansion triggered some relevant environmental changes and impediments to forestry. The shrub appears in high numbers in highly insolated forest communities, unmanaged meadows and peat bogs. Sites along dense network of drainage ditches and natural streams are especially numerous.

Plants dispersed along streams have some significant properties such as adaptation of the diaspores to hydrochory that facilitate the migration and colonization of new offshore communities. In order to determine the seed buoyancy and vitality after remaining in water, in 2012 mature seeds of *S. tomentosa* were gathered and after 30 days of cold stratification were placed in vessels filled with distilled water at a temperature of 4 °C. Subsequently, the number of floating seeds and the vitality of submerged and partially submerged seeds was defined. It was proven that *S. tomentosa* seeds retain their ability to sprout for approx. 3 years after partial submersion and more than a year after full submersion. About 80% of the diaspores float freely on the water surface for a minimum period of 30 months.

The seed dispersal and their prolonged germination after flooding are therefore conducive to rapid and massive migration of the *S. tomentosa*. It can also be a factor facilitating the colonization of new posts, within and outside the area occupied in the past.

## IMPACTS OF INVASIONS ON NATIVE SPECIES, COMMUNITIES AND ECOSYSTEMS

P54

### Assessment of toxicological effects of leaf litter extracts from non-native tree species on soil respiration and on the aquatic invertebrate *Potamopyrgus antipodarum*

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#### Abstract

Non-native trees (NNTs) have been introduced worldwide for the wide variety of services they provide. However, some non-native species may also exert negative effects on both terrestrial and aquatic ecosystems. Unfortunately, not all impacts have received the same attention. For example, nowadays there is information for few NNT species on the ecotoxicological effects of their leaf litter extracts on ecosystems. In addition, available studies tend to focus on communities and the information they provide is sometimes contradictory, showing both positive and negative effects of NNT leaf litter. Our goal is to better understand the ecotoxicological effects of non-native leaf litter on soil microbial respiration and on the survival and behavior of the aquatic snail *Potamopyrgus antipodarum*. To this end, we collected senescent leaves at their natural moment of abscission from several NNT species (both deciduous and evergreen). We prepared 5 concentrations (100%, 50%, 12.5%, 3.1%, and 0.75%) of leaf extracts of each species to evaluate their impacts on soil respiration, recorded through the CO<sub>2</sub> concentration. The toxicity of the three smallest concentrations of leaf litter extract on the mortality and behavior of *P. antipodarum* was measured. These results may help to improve the assessment of the risk of adverse effects of these non-native tree species.

P55

### Ecology and invasiveness of the genus *Cornus* L. in Lithuania

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#### Abstract

Plants of the genus *Cornus* (Cornaceae) are valued for their ornamental qualities and cultivated in many world regions. In Europe, four species of the genus are native, while one native species, *Cornus sanguinea*, occurs in Lithuania. In addition, there are five other species of the genus (*Cornus alba*, *Cornus alternifolia*, *Cornus amomum*, *Cornus mas* and *Cornus sericea*) and one subspecies (*Cornus sanguinea* subsp. *australis*) alien to Lithuania.

Investigations on *Cornus* in Lithuania were performed from 2018 to 2021. We studied *Cornus sanguinea* subsp. *sanguinea* and *C. sanguinea* subsp. *australis* reproductive traits (flowering and fruit set). We also conducted a study on the recruitment intensity of naturalised and native plants of the genus.

*Cornus alba* and *C. sericea* are the most widespread and invasive species in Lithuania. These species occur in contrasting habitats, from dry or mesic grasslands and forests to damp, occasionally flooded areas and frequently invade anthropogenic habitats. *Cornus sanguinea* subsp. *australis* is a relatively recent discovery in Lithuania and is spreading rapidly, with a high potential for invasiveness. *Cornus sanguinea* subsp. *australis* has been planted in railway and road shelterbelts and is now spreading to many natural and anthropogenic habitats. *Cornus alternifolia*, *Cornus amomum* and *Cornus mas* are rare casual alien species. As these species are being increasingly cultivated in plantations, their further spread and naturalisation in Lithuania are likely.

The results of the study showed that the alien *Cornus sanguinea* subsp. *australis* has significantly more flowers in the inflorescence and produces more fruit than the native *Cornus sanguinea* subsp. *sanguinea*. In Lithuania, *Cornus alba* and *Cornus sericea* flower and yield fruits twice a year. As birds disperse the fruits, they spread particularly rapidly and are highly invasive.



P56

### Potential impacts of invasive crayfish on native benthic fish: shelter use and agonistic behavior

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#### Abstract

Spinycheek crayfish *Orconectes limosus* and signal crayfish *Pacifastacus leniusulus* are successful North American invasive crayfish species now distributed throughout Europe. Both species compete with native benthic fish for shelter, and often occupy the shelters thereby displacing the fish. In a laboratory approach, we assessed competition for shelter and antagonistic interactions between these invasive crayfish species and the native benthic fish species, stone loach (*Barbatula barbatula*) and bullhead (*Cottus gobio*) to investigate the potential impact of invasive crayfish on native benthic fish. The presence of crayfish significantly affected the shelter use by both benthic fish species. Spinycheek crayfish and signal crayfish succeeded to gain control of the shelter and thereby displaced both fish species from their shelters. Invasive crayfish species showed remarkable combative interactions against both species of benthic fishes evidenced by the high number of aggressive and non-aggressive interactions. Our results highlight a pronounced dominance of invasive crayfish over benthic fish in terms of shelter competition and aggressive interactions under laboratory conditions, which might promote their exposure to predation.

P57

### Taxa with dual status in Latvia – an example on the genus *Rosa* L.

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#### Abstract

So far only few studies focused on taxa, which have dual status in Latvia – a particular country or region. Dual status means that the same species may be present as alien and native. Dual status of taxa can complicate the planning and implementation of invasive species management and, as a result, localities of some rare, native species can be affected or destroyed.

In Latvia, number of species and infraspecific taxa in genus *Rosa* and their status are still debatable. At least 18 *Rosa* species are known in wild flora of Latvia, and at least half of them must be recognized as alien. Many *Rosa* species are assumed as archeophytes in flora of Eastern Europe. However, due to the lack of argumentation *Rosa* species in Eastern Europe can be native instead. The aim of our study is to evaluate floral status, distribution patterns and specific habitats of each non-native *Rosa* species in Latvia. *Rosa* in different regions of Latvia, analyze floral status, distribution patterns and specific habitats of each *Rosa* species. We collected new distribution and taxonomical data of alien and native *Rosa* taxa from 2017 till 2021.

We concluded that from all alien *Rosa* species, at least two – *R. villosa* L. and *R. caesia* Fr. have a dual status in flora of Latvia. *Rosa villosa* (syn. *R. pomifera* Herm.) is well separable in two populations: *Rosa villosa* subsp. *villosa* plants known from Western Latvia and recognized as alien plant which grows only in anthropogenic habitats, whereas population from Eastern Latvia, known as *R. pomifera* subsp. *glandulosa* (Schmalh.) Šmite considered as natural.

*Rosa coriifolia* Fr. is questionably recognized as a synonym of *Rosa caesia* Sm. widely in scientific literature, but, at the same time *R. caesia* should be considered an alien in Latvia, but *R. coriifolia* – as native and protected species.

P58

### Impacts of the invasive *Carpobrotus* spp. on coastal habitats in a Mediterranean context: evidence from the Life project LETSGO GIGLIO on Giglio Island (Tuscan Archipelago)

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#### Abstract

*Carpobrotus acinaciformis* and *C. edulis* are well-known invasive alien plants native to South Africa, whose detrimental effects on native communities are widely documented in the mediterranean basin and that are largely managed in coastal ecosystems. Most literature on these species focuses on their impacts on habitats of sand coastal dunes, while the effect of *Carpobrotus* spp. invasion on other habitats such as rocky cliffs and coastal scrubs and garrigues is almost neglected. We present here a study case conducted in a small Mediterranean island where *Carpobrotus* spp. invaded three different natural habitats listed within the Habitat Directive 92/43/CEE (1240: Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp.; 1430: Halo-nitrophilous scrubs (*Pegano-Salsoletea*); 5320: Low formations of *Euphorbia* close to cliffs). We surveyed the presence and abundance of *Carpobrotus* spp. and of the native species on 44 permanent square plots of 2 × 2 m, in invaded and uninvaded areas, in each of the 3 habitats mentioned.

We found impacts on natural vegetation in all the habitats investigated, in terms of decrease of native species richness, diversity (expressed as Shannon index) and abundance (expressed as total percentage cover). Moreover, invaded communities showed a severe change in species composition with a strong homogenization of the flora present within the three habitats.

This survey represent the pre-intervention part of a long term monitoring foreseen in the project LETSGO GIGLIO "Less alien species in the Tuscan Archipelago: new actions to protect Giglio island habitats", a Life Natura project co-funded by the European Commission aimed at the restoration of the habitats of the Island of Giglio, also by means of the massive containment of *Carpobrotus* spp. in natural areas.

P59

### Alien and invasive species effect on the populations of the Baltic coastal endemic species *Linaria loeselii*

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#### Abstract

Alien and invasive species negatively impact ecosystems and are recognised as a significant contributor to the loss of native biodiversity worldwide. Endemic plant species, especially those adapted to grow in specific habitats most invaded by alien species, are particularly sensitive and vulnerable. *Linaria loeselii* (Plantaginaceae), an endemic of the south-eastern Baltic Sea, grows in dune habitats susceptible to invasion of alien plant species. Therefore, we aimed to determine the impact of alien plant species on *Linaria loeselii* populations.

In coastal dunes, which are the only habitats of *Linaria loeselii*, the impact of invasive plant species is expressed in several ways. The invasion of dune habitats by *Rosa rugosa* and *Cytisus scoparius* completely changes the habitat and the direction of vegetation succession. As a result, *Linaria loeselii* becomes extinct and cannot recover unless the invasive plants are entirely eradicated and habitat conditions are restored. *Gypsophila paniculata* competes with *Linaria loeselii* in the first stages of invasion, but after a certain period, it outcompetes and modifies its habitat. The increasingly spreading alien *Agropyron dasyanthum* has a similar effect on *Linaria loeselii*, but so far, its impact on the species is localised to the Curonian Spit. The impact of the annual *Corispermum pallasii* on adult *Linaria loeselii* is unclear, but they may inhibit its recruitment.

The preservation of a viable population of the endemic *Linaria loeselii* in the coastal dunes of the Baltic Sea must be ensured by continuous control and eradication of alien and invasive species, which is an integral part of habitat protection.

## P60

### Associated fauna of *Sabellaria alveolata* reefs in the Mediterranean Sea, an unexpectedly high number of NIS

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#### Abstract

The honeycomb-worm *Sabellaria alveolata* is a gregarious polychaete that occurs in mesolittoral/upper infralittoral temperate habitats, building biogenic structures of different shape, often coalescing into reefs, up to one meter in height and several tens square meters in extension. The reefs create complex microhabitats and stabilize the sediments, and due to their pivotal role in the coastal zone, they are protected by the European Habitats Directive. Due to the introduction of non-indigenous species (NIS), together with increasing anthropization and habitat degradation, the associated fauna of *Sabellaria*-reefs is often studied to assess the health of the reef. With this study, we aimed to determine the reef-inhabiting fauna of three Sicilian *Sabellaria* populations recently described, coupling taxonomic and molecular approaches. Our results revealed the presence of several known invaders like the amphipod *Grandidierella japonica* and the isopod *Paranthura japonica* but also different matches with sequences from North and South America present in public databases. The occurrence of NIS in natural habitats suggests stability of the populations also because ovigerous females were found. Our work shows the importance of the implementation of barcoding in faunistic studies to better represent the local and regional biodiversity. Moreover, the impact of these species on *Sabellaria*-reefs has yet to be assessed. Therefore, it must be considered that, since many NIS tubicolous have been found, they may have a negative effect on the health of these important habitats.

## P61

### How can we measure the impact of invasive plants on large herbivores in an African savanna?

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#### Abstract

Protected areas play an important role as refuges from invasive species and their impacts on biodiversity. However, very few protected areas worldwide are completely free of alien species, and many of them suffer various impacts at the species and community levels. Kruger National Park is one of the largest nature reserves in Africa, representing a typical savanna ecosystem where rivers play a key role in animal survival. Several plant species are invasive in riparian areas in the park (*Parthenium hysterophorus*, *Xanthium strumarium* and *Datura* sp. div.), but their impact on large herbivore communities is still unknown. Here we will explore in the field whether and how much these alien plants are utilized as a food source by herbivores. Approximately 60 sites invaded by these three species have been selected along several rivers throughout the park in March 2022, where the impact on vegetation and soil will be recorded. In a subset of sites, camera traps will be placed to monitor plots dominated by the invasive species as well as adjacent uninvaded areas with native dominants to compare the utilization of invaded and non-invaded riparian habitats by the large herbivores. This data on animal feeding behaviour will be completed by direct recording of the contribution of each invasive species to the animal diet. We will collect dung of several common herbivore species (e.g. elephant, impala, waterbuck, rhino) and use DNA meta-barcoding to find out whether the herbivores consume the alien plants and how large a contribution to their diet the three target invasive species make. This knowledge of the real utilization of invasive plants by herbivores is an essential first step for assessing the impacts of plant invasions on other trophic levels in savanna ecosystems.

**P62**

### **Distribution of non-indigenous crayfish species in Estonia and their threat to noble crayfish (*Astacus astacus* L.) populations**

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#### **Abstract**

Until 2008, Estonia was one of the last countries in Europe where non-indigenous crayfish species (NICS) were not recorded. Today, three alien crayfish species have been detected in Estonia and threaten the native noble crayfish (*Astacus astacus*) populations. The first specimen of signal crayfish (*Pacifastacus leniusculus*) was caught during the monitoring of noble crayfish in North Estonia in 2008 and now it is found in five different water bodies across the country. The first sighting of spiny-cheek crayfish (*Faxonius limosus*) was registered in 2017 in the pre-estuary of the Pärnu River, which flows into the Baltic Sea. Its population continues to expand upstream and to the other tributaries of the Pärnu River. In the same year, the marbled crayfish (*Procambarus virginalis*) population was detected in the outflow channel of the cooling system of the Balti Power Plant, which enters into the Narva reservoir. Today, marbled crayfish have been found in several locations in the Narva watershed. The dispersal pattern of NICS indicates that these populations are the result of illegal human-assisted introductions. This study gives an overview of the status and distribution of NICS, their influence on noble crayfish populations, and eradication plans in Estonia.

Keywords: signal crayfish, *Pacifastacus leniusculus*, spiny-cheek crayfish, *Faxonius limosus*, marbled crayfish, *Procambarus virginalis*, eradication, NICS

**P63**

### **Controlling an invasive native plant does not compromise species richness or functional diversity of wet grasslands**

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#### **Abstract**

Invasive plants are significant causes of ecosystems degradation, and they challenge ecological restoration and sustainable management. Although native to Central Europe, the poisonous hemi-cryptophyte *Jacobaea aquatica* became invasive in pre-alpine wet grasslands due to management changes in recent decades. This markedly reduced the ecosystem services of these grasslands. Thus, we tested plant community-based methods to control the abundance of this invasive native plant. As *J. aquatica* mainly occurs in species-rich grasslands, our aim was to identify management methods that do not compromise the conservation value of the resident communities. We monitored 20 independent sites across the pre-alpine Allgäu region in southern Germany, which varied in productivity and management intensity. Overall, we assessed effects of management intensity on the abundance of *J. aquatica*, and on functional diversity and species richness of the resident communities. At all productivity levels, abundance of *J. aquatica* declined with lower management intensity, whereas changes in community composition and species richness were less pronounced. However, management plans should also consider the productivity of invaded sites. Overall, our findings suggest that a moderately-reduced management allows the control of *J. aquatica* without compromising the plant diversity of the resident community. Therefore, intermediate management intensity is recommended to control the invasive native *J. aquatica*.

## P64

### **Uncertainty in assessing the impacts of alien species: application to the International Union for the Conservation of Nature's framework**

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#### **Abstract**

Alien species can have various impacts to the recipient biodiversity within the ecosystems they invade. The magnitude of these impacts can vary greatly across invasion scenarios and can be measured, and reported, in vastly different ways. As such, making meaningful comparisons to improve future predictions and aid management actions has been difficult. Thus, the development of a tool to standardise impacts across taxonomic groups and geographical regions was a welcomed addition to the invasion science toolbox. In 2020, the International Union for the Conservation of Nature (IUCN) formally adopted the Environmental Impact Classification of Alien Taxa (EICAT) framework. The framework provides a standardised system to classify the documented impacts of alien species into one of five semi-quantitative categories, based on specific criteria related to the level in which the alien species affects native species (i.e. from individuals to populations). This allows comparison of impacts across taxonomic groups and invasion scenarios even when impact data has been collected in different contexts with different methods. However, assessments must be conducted with consistency to ensure comparing species based on their impact scores is scientifically robust. Although the EICAT scheme accommodates uncertainty by assigning confidence scores to each impact assessment, improved application of these scores is necessitated for more meaningful interpretations of assessments at the species-level. Here, using a global assessment of alien ants, we discuss the common pitfalls assessors encounter when conducting EICAT assessments and demonstrate how these are causing the misinterpretation of impact categories.

## P65

### **Morphological features of haemocytes during early stages of injury in crayfish**

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#### **Abstract**

The clotting system is a highly complex and diverse process and not only varies among different groups of organisms but even within species in crustaceans. Studies focusing on ultrastructure features of the coagulation process in decapod crustaceans are scarce. The ultrastructure features of the coagulation process of the marbled crayfish were examined using the transmission electron microscopy technique. Segments of limb were cut and immersed in the fixative after amputation at different time points to observe the ultrastructural changes in haemocytes and tissue during coagulation. Shortly after limb amputation, the haemolymph coagulated at the wound site to prevent fluid loss using the material of granules released from these haemocytes to form the clot. In addition, all haemocytes were functionally active immune cells capable of phagocytosis. After the amputation of limbs, the muscle tissue in the wounded part started to degenerate. Interestingly, we observed a massive influx of haemocytes to the wound site, and the degenerated muscles and other tissues were avidly taken up by these phagocytic cells. In conclusion, we illustrated the ultrastructural changes in degranulating and phagocytosing hemocytes during the early stages of the injury and coagulation.

Keywords: clotting, haemocytes, innate immunity, decapods

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## NOVEL ECOSYSTEMS IN THE ANTHROPOCENE

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### Novel forest ecosystems in the Ramsar sites of the Southern Pannonian Plain

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#### Abstract

A long history of human induced land-use changes has resulted in the endangerment of Europe's natural forests. Since the invasibility of habitat increases with the increase of its humidity, riparian areas are also sensitive to invasions. Riparian forest ecosystems of the Ramsar sites of the Southern Pannonian Plain contain established and widespread new combination of species that arise through the inadvertent introduction of invasive plant species. Research was conducted in six Ramsar sites, on the territory of the northern part of Serbia (the southeastern part of Central Europe). Selected protected wetlands were researched in detail over a five-year period (2011–2015). This study revealed a significant presence of invasive tree species of varying degrees of invasiveness. Sampling of vegetation data where the presence of invasive tree taxa was determined was done according to the Braun-Blanquet methodology. The analyzed matrix of dominant invasive tree species contained 178 relevés and 287 taxa. Five groups of forest stands were separated by numerical analyzes. The concept of dominant and diagnostic species was used to give informal names to the new isolated groups of stands: *Bromus sterilis* – *Robinia pseudoacacia* comm., *Prunus cerasifera* – *Ailanthus altissima* comm., *Vitis acerifolia* – *Acer negundo* comm., *Iris graminea* – *Fraxinus pennsylvanica* comm. and the last with the dominance of planted clonal woody species *Rubus caesius* – *Populus euramericana* comm. New separated groups with the dominance of invasive tree species could be considered as new plant communities with the potential of changes in ecosystem functioning of forests. Highly established invasive tree stands prevent the re-establishment of pre-existing species assemblages. Degradation of native forest communities mostly arose from intensive forest management and/or human activities in the close vicinity of protected areas. It would be difficult that native forest communities return to their previous state spontaneously, hence another appropriate management approach needs to be considered.

## BIOLOGICAL INVASIONS AND CLIMATE CHANGE

P67

### Protecting terrestrial communities from climate change – invasion synergies on South Georgia Island

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#### Abstract

The effects of climate change are already marked on South Georgia Island, with rapid glacial retreat. In parallel, the island continues to harbour non-native invasive plants and invertebrates, posing a threat to native ecosystems, with some species now so widespread that eradication is impossible.

Our project is assessing the vulnerability of South Georgia's unique terrestrial ecosystems to invasive plants and invertebrates that may benefit from climate change.

To do so, we are:

- 1) Recording colonisation of recently deglaciated areas by non-native species.
- 2) Identifying 'winning' and 'losing' native and non-native plants under simulated warming.
- 3) Mapping invasive carabid beetle and native invertebrate distribution and abundance.
- 4) Identifying high-risk potential future invaders from the Falkland Islands.

This research is generating information that will directly help conservation management on South Georgia in a warming climate.

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### Stress conditions prolong the maternal care and juvenile development in marbled crayfish (*Procambarus virginalis* Lyko, 2017)

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#### Abstract

Marbled crayfish are one of the most threatening invaders in the freshwaters worldwide. It is the only obligatory parthenogenetic crayfish species known to date. The high level of adaptability and frequent reproduction contributes to the successful and fast establishment in the new environments. As it matures very fast and can reproduce several times per year, juvenile recruitment occurs in different seasons during the year. Hence, the incubation and early postembryonal development are challenging for both mother and juveniles due to various abiotic and biotic conditions. Our study aimed to describe the effect of harsh environmental conditions on mother-offspring interactions and the duration of maternal care. Mothers with attached juveniles in the 3rd developmental stage (the first independent stage with still close affinity to mother) were exposed to different conditions: 1) control with the normal water level, aeration and feeding, 2) low water conditions with feeding, 3) low water conditions with food deficiency, and 4) low water conditions with food deficiency, and the effect of an intruder (red swamp male) for 90 days. Individuals were observed once during the day for the attachment of juveniles, the number of free juveniles, moulting events in females and shelter acquisition. Juveniles were weekly measured to check their developmental stage. The results obtained indicate that stress conditions (starvation and intruder effect) prolong the maternal care (attachment phase), therefore delaying females' moulting and slowing down juvenile development. Therefore, marbled crayfish females showed the capability to manage maternal behaviour in accordance with concrete conditions and provide a safe harbour for offspring for a longer time to increase their chances of survival in varying abiotic and biotic circumstances.

Keywords: crayfish, stress, maternal care, juvenile development

P69

## Quantifying carbon storage and sequestration patterns by native and non-native forests in Spain

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### Abstract

Many administrations have launched large-scale tree plantation programs to mitigate the impacts of climate change and enhance ecosystem services, such as water purification, soil protection, timber production, and recreation. These programs may target native tree species, but also productive non-native trees, which can become invasive. Given that non-native trees usually grow faster and have different strategies to assimilate carbon than native species, non-native tree introductions may have profound impacts on carbon sink capacity of forested lands and carbon cycle. The objective of this study is to quantify and compare the carbon sequestration capacity of native and non-native forests in Spain under different eco-regions (i.e., Spanish regions of provenance delineated with the divisive method), using the Spanish Forest Inventory (SFI) database. We will evaluate spatial patterns of carbon storage (within SFIs) and temporal carbon sequestration (among consecutive SFIs) across native and non-native forests, considering main forest types. Forest types have been defined based on their dominant species.

We extracted tree height and diameter at breast height (DBH) from the selected SFI plots, using the second (1986–1996), third (1997–2007), and fourth (2008–2017) SFI datasets. Then we used allometric equations to calculate tree biomass and stored carbon within each SFI plot. Carbon storage and sequestration were compared between native and non-native forest types, after accounting for the effect of forest structure (e.g., tree density and basal area), forest management (e.g., tree cutting and soil management), and climatic and edaphic variables. We estimated carbon storage and sequestration across eco-regions and time, and found that non-native forests stored more carbon than native forests in environments with higher water availability and lower climate seasonality, but not in hotter and drier environments. However, the identity of a forest (forest type) was more important than its origin (native vs. non-native) for carbon storage and sequestration.

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## Extreme weather events can have complex and temporally dynamic effects on invasive plant populations and communities

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### Abstract

Whilst it is often assumed that invasive plant species may benefit more from climate change than native species there is limited evidence to support this, particularly the way they respond to extreme weather events, which are predicted to increase significantly with global warming. To assess this we took advantage of an unusual extreme weather event, called Storm Emma or the 'Beast from the East', which was characterized by low temperature extremes and snowfall in Ireland in late February/early March 2018 at the beginning of the growing season, to examine its impact on a long standing population of mature plants of the invader, *Gunnera tinctoria*. The extreme weather event resulted in a disproportionately greater impact on mature populations of the introduced species *G. tinctoria* compared to the resident species. Storm Emma reduced the total leaf area of the invader by 11-fold, significantly delayed canopy development and reduced shoot biomass by > 85% and resulting in a four-fold increase in the number of resident species regenerating in invaded areas. In contrast, it had little impact on the dominant native species, *Juncus effusus*, which was largely unaffected by the extreme weather event. The extreme weather event also resulted in a detrimental impact on the reproductive capacity of mature plants, with the number of inflorescence's declining by more than 50%, although it had a much smaller effect on seedling growth. Although mature *G. tinctoria* plants were severely affected, canopy cover was within 10% of the original values and there was a complete recovery of the number of inflorescence's, one year after the extreme event. These results indicate that extreme weather events may not always benefit introduced species and can have complex time-dependent effects on plant invasions and invaded communities, with an impact that is likely to depend on the developmental stage of the plants.



## P71

### Energy reserves of alien gammarids in the Daugava River (Latvia) in 2019–2020

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#### Abstract

The Ponto-Caspian *Gammarus varsoviensis* and *Pontogammarus robustoides* are dominant gammarids in the Daugava River. The gammarids in the Daugava River and the Pļaviņas Reservoir were studied in 2019 and 2020 at 4 sites. The energy reserves (glycogen and lipids) are the main energy storage compounds in metabolism and can characterize beneficial traits of alien species invasion. The aim of the study was to characterize the seasonal variations in the lipids and glycogen in alien gammarids in the Daugava River. Organisms were sampled monthly over a 2-year period from April to September in a depth up to 0.5 m using a hand net with a mouth opening of 25 × 25 cm (500 µm). Simultaneously, water physico-chemical parameters were measured. The content of energy reserves was analysed in single individuals. Results revealed seasonal differences in biochemical composition, as well as differences between years, species, and females, females with eggs and males. The largest proportion of the stored energy was formed by lipids and it was significant between years. Mean lipids and glycogen concentrations were higher in 2019 than in 2020 as well as in females than in males in both species. Stored energy reached a peak in spring, and early summer but was depleted in late summer, coinciding with the reproductive period and environmental conditions.

This research was supported by the DU Research Project No. 14-95/2022/16 “Environmental assessment of the Daugava River by analyzing energy reserves of alien amphipod *Gammarus varsoviensis*”.

## P72

### Contradictory effect of climate change on American and European populations of *Impatiens capensis* Meerb. – is this herb a global threat?

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#### Abstract

The present study is the first-ever attempt to generate information on the potential present and future distribution of *Impatiens capensis* (orange balsam) under various climate change scenarios. Moreover, the differences in bioclimatic preferences of native and non-native populations were evaluated.

A database of *I. capensis* localities was compiled based on the public database GBIF, herbarium specimens (UNA, AUA, AMAL, UWAL, TROY, JSU, SAMF, GA, NC, LSU), and a field survey in Poland. The initial dataset was verified, and each record was assigned to one of two groups – native (3,664 records) or non-native (750 records). The analyses involved bioclimatic variables in 2.5 arc-minutes of interpolated climate surface downloaded from WorldClim v. 2.1. MaxEnt version 3.3.2 was used to conduct the ecological niche modelling based on presence-only observations of *I. capensis*. Distribution models created for “present time” showed slightly broader potential geographical ranges of both native and invasive populations of orange balsam. On the other hand, some areas (e.g. NW Poland, SW Finland), settled by the species, are far outside the modeled climate niche, which indicates a much greater adaptation potential of *I. capensis*. In addition, the models have shown that climate change will shift the native range of orange balsam to the north and the range of its European populations to the northwest. Moreover, while the coverage of niches suitable for *I. capensis* in America will extend due to global warming, the European populations will face 31–95% habitat loss.

## Microclimate measurements as a baseline for a global study of plant invasions in cold environments

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### Abstract

Biodiversity of cold regions, both in high latitudes and altitudes, is increasingly threatened by anthropogenic factors such as climate change and biological invasions. In the presented study, we combine experimental and observational approaches to study the synergistic effects of both processes on species redistributions. We aim at predicting biological invasions under the conditions of future climatic and land-use changes to develop sound mitigation and management measures in these areas. This will be achieved by studying distributional shifts of selected alien and native expansive plant species along altitudinal and latitudinal gradients, their tolerance limits, and ecological niches.

The study is performed in cold environments worldwide, using 50 selected study sites in polar and alpine regions. To explore the effect of climate on species movements from lowland to mountains, within each site plots were established at three altitudes along one road or hiking trail leading across the elevation gradient. In addition, to study the effect of land use and human pressure, each latitudinal site contains one pair of permanent plots located at the roadside and in the undisturbed vegetation further from the road, giving six plots per site in total.

We study the patterns in soil temperatures and humidity over years and soil nutrient availability over vegetation season in connection with vegetation composition. A subset of most frequent alien and native expansive vascular plants are used as model species in chamber experiments to study their plasticity and reaction to different temperature regimes.

This SEED-ASICS project is a part of the ongoing global project ASICS (ASsessing and mitigating the effects of climate change and biological Invasions on the spatial redistribution of biodiversity in Cold environments; <https://www.coldregioninvasives.com/>) supported within BiodivERSA in 2021-2024 (TAČR SS70010001). We gratefully acknowledge the immense effort and time that numerous SEED-ASICS partners contribute to the collection of field data.

## Does habitat type influence the performance of the invasive *Carpobrotus edulis*?

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### Abstract

Invasive alien species represent a serious problem for coastal ecosystems, which are subject to numerous threats and disturbances that jeopardize biodiversity conservation. Among the most problematic species colonizing different habitats along the coast of the Iberian Peninsula is *Carpobrotus edulis* (L.) N.E.Br., a succulent plant from South Africa.

This study explored if the biological and physicochemical characteristics of four coastal habitat types: sand dunes, cliffs, disturbed areas and mixed forests, influence the photosynthetic efficiency and growth of *C. edulis*. Sampling points were distributed along the northwestern coast of Spain and Portugal, comprising the four habitats. The samples were processed both in the field and in the laboratory using biometric, physiological and biochemical measurements.

*Carpobrotus edulis* presented longer ramets length in coastal mixed forests and a higher weight in cliffs. This is probably a result of the need to find better light quality in areas of moderate shade and the maintenance of scarce water resources available on the cliffs.

*Carpobrotus edulis* can acclimate to these different coastal habitats, maintaining its performance and showing a wide phenotypic plasticity in each one of them. We found that this species can cope with different types of abiotic stress like high light intensity, typical of cliffs and dunes. In addition, its photosynthetic efficiency is also not harmed by the different conditions of each habitat.

## P75

### Does *Carpobrotus edulis* carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) stable isotopes composition change under different habitats?

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#### Abstract

*Carpobrotus edulis* (L.) N.E.Br. is one of the most problematic invasive species worldwide and represents a severe threat to biodiversity in coastal areas. In the northwestern Iberian Peninsula, it invades different coastal habitats, including cliffs, dunes, mixed forests and disturbed areas.

Here, we assessed the tolerance and phenotypic plasticity of *C. edulis* to different abiotic stress conditions in these four coastal habitats using stable isotopes and plant biometrics. In each location, we selected five individuals of *C. edulis* and measured morphological traits and carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) stable isotope ratios.

Our results indicated that dry weight and leaf carbon content (%C) were higher in cliffs and lower in mixed forests, comparing these with the other two habitats. In contrast, leaf water content was higher in mixed forests and lower in cliffs. These results suggest that plants growing on cliffs presented protective structures for avoiding losing water due to high radiation exposure and substrate shortages typical of these habitats. Leaf nitrogen content (%N) was highest in forests, and this might be due to the presence of another invasive species, *Acacia longifolia*, which contributes to the soil N through symbiotic organisms. Differences in  $\delta^{15}\text{N}$  showed the use of different N sources in each habitat. Values are higher in disturbed areas with greater human activity and lower in forests. Comparing with the rest of the studied habitats, intrinsic Water Use Efficiency (iWUE) and  $\delta^{13}\text{C}$  were higher on cliffs and dunes. Higher  $\delta^{13}\text{C}$  values and increased iWUE are indicators of adaptation to unfavorable conditions such as drought or salinity.

Our experiment showed that *C. edulis* has a high tolerance to the ecophysiology stresses imposed by the coastal habitats. This, with the ability to acclimate physiologically and morphologically to different environmental conditions, may allow *C. edulis* to cope with stressful climatic conditions.

## P76

### What factors have led to the lightning spread of *Erechtites hieraciifolius* northwards?

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#### Abstract

*Erechtites hieraciifolius* (L.) Raf. ex DC. (Asteraceae) is native to the eastern regions of North America and Central and South America. In Europe, Asia and Australia, the species is alien. The species was first recorded in Lithuania in August 2020, in Varėna district, Margionys village.

The surveys carried out in 2020 and 2021 show that *Erechtites hieraciifolius* is spreading at lightning speed in a northerly direction. By 2022, the species had been recorded in more than 50 localities, and the area of occupancy in the country was more than 16,000 km<sup>2</sup> (approximately 25% of the country's territory). *Erechtites hieraciifolius* was most frequently found in woodland clearings and lakeshores and was rarely recorded in wet meadows and roadsides. Single individuals of the species were found in most places, distributed over a large area. Only in a few localities in southern Lithuania did *Erechtites hieraciifolius* form relatively dense groups. This suggests that the seeds of this species were introduced into Lithuania very recently and arrived in all or most of the sites around the same time.

Having assessed the diversity of occupied habitats and possible dispersal vectors, we rejected the assumption that *Erechtites hieraciifolius* could have been introduced with logging machinery. Instead, it is most likely that the seeds of this plant reached Lithuania with warm and dry air masses from the southern regions of Europe (Poland, Hungary, Ukraine or other countries). There is, therefore, a high probability that the species could spread further north into the Baltic States, i.e. Latvia and Estonia, and possibly even further north into Finland.

**P77**

### **Potential trophic impacts and competition among invasive alien crayfishes in North America under current and future water temperatures**

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#### **Abstract**

In North America, freshwater ecosystems are losing species at rates 3–5 times higher than those of terrestrial and coastal marine fauna. Novel predators are a key driver in these dramatic changes in community composition and ecosystem function. This study is looking at resource competition between the red swamp crayfish (*Procambarus clarkii*) from the southern USA and the parthenogenetic marbled crayfish (*Procambarus virginalis*) that have yet to emerge via the pet trade in the Great Lakes–St. Lawrence River system in Canada. This study is measuring the functional response of the two species to animal, plant and mixed diets at different temperatures to understand the competitive interactions and impacts they will have in both present and future invasions. This study will present the preliminary results of this work, and present what the results are showing so far on the risks these invasive crayfishes pose to the Great Lakes.

**P78**

### **Nerve regeneration in crayfish**

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#### **Abstract**

Some species ranging from protozoans to mammals can regenerate their organs after an amputation or injury. Crayfish, as the representative of Decapoda, the most diverse order of crustaceans, exhibits substantial abilities for regeneration. Especially the clonal marbled crayfish (*Procambarus virginalis*) poses an excellent model for understanding arthropod regeneration. Antennae in crayfish are essential for gaining tactile information for sensing the local topography, localizing food and communicating with conspecifics. Therefore, the antennae are sensory organs full of nerve networks, making them a good candidate for the study of nerve regeneration. Crayfish haemolymph contains immune cells which can turn into stem cells and participate in the nerve regeneration in the nerve regeneration crayfish. Therefore, we focused on the potential roles of immune cells in the regeneration of antennae at the ultrastructural level using transmission electron microscopy. Our observations showed that immune cells could form new nerves and provide essential organelles such as mitochondria and Golgi apparatus, which are necessary for the functioning of neurones. In conclusion, we reported morphological changes in immune cells as stem cells during nerve regeneration in crayfish.

Keywords: nerve, regeneration, marbled crayfish, morphology

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## BIOTIC INTERACTIONS IN INVADED COMMUNITIES AND ECOSYSTEMS, INCL. INTERACTIONS BETWEEN INVADERS

P79

### Testing if mechanical control of *Carpobrotus edulis* is more effective than a specialized natural enemy

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#### Abstract

*Carpobrotus edulis* (L.) N.E.Br. is one of the most problematic invasive species worldwide. This succulent and clonal plant native to South Africa is frequently found in coastal areas and dune systems, where it drastically affects the biodiversity and the functioning of these ecosystems. Nowadays, diverse management strategies that focus on mechanical and chemical control have been implemented. However, applying these control strategies to remove *C. edulis* may cause indirect adverse effects. For instance, new propagules could be spreading and native species could be damaged. Consequently, to avoid spreading and re-rooting plant fragments, their physiological activity should be reduced. Here, we evaluated the plant regeneration capacity after applying mechanical control, (i) by placing the plant material on different ground surfaces (on sand, on stones and rooted) and (ii) by combining this with the exotic scale *Pulvinariella mesembryanthemi* (Vallot, 1829), a specialist hemipteran that feeds on plants of the genus *Carpobrotus* and other related species of the family Aizoaceae. Therefore, we measured how the ground surface and the herbivory affected the physiological activity of the plant ( $\phi II$ ,  $\phi NO$  and  $\phi NPQ$ ), its survival and re-rooting, biometric measurements (e.g., total dry weight or leaf length), shoot and root nutrient composition (e.g., N or Mg) and biochemical measurements (total phenols and tannins). The results showed that placing *C. edulis* over an inert ground surface like stones after its uprooting favours its death. Furthermore, *P. mesembryanthemi* highly affected the *C. edulis* studied parameters regardless of the ground surface type and seriously reduced plant biomass and photosynthetic activity. Its attack stimulated the plant defence mechanisms and accelerated the decomposition of *C. edulis*. We conclude that direct inoculation with *P. mesembryanthemi* or even the combination of placing the plant over an inert ground surface while it is under attack by herbivores could improve management strategies for *C. edulis*.

## Comparing the effect of herbivory and simulated herbivory on the growth and physiological activity of *Carpobrotus edulis* in shallow soils

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### Abstract

*Carpobrotus edulis* (L.) N.E.Br. is a South African mat-forming succulent plant that was deliberately disseminated for sand and dune stabilization in many Mediterranean-climate coastal areas, becoming a problematic invader. This invasive plant can compete and displace many native plants, modifying the characteristics of invaded habitats by altering many biotic interactions and soil physicochemical characteristics, among others. Here, we examined how insect herbivores and simulated herbivory affected plant responses in shallow soils. Therefore, this study aimed to determine the role of multiple stimuli associated with herbivory (insect damage or simulated puncture) and soil depths (i.e., simulating sand dunes or cliffs) on the growth and physiological activity of *C. edulis*. We selected a total of 60 *C. edulis* plants, half of which were grown in deep sandy soils and half in shallow sandy soils. First, plants were acclimatized for 11 months and then subjected to herbivory treatments. For each soil depth, ten *C. edulis* plants were randomly selected and inoculated with the black bean aphid *Aphis fabae* (Scopoli, 1763), ten others were punctured, and ten were left untreated as the controls. Our results showed that punctured plants in shallow soils had less photosynthetic efficiency of photosystem II, which it is not fully compensated by an increase in leaf electron flux and NPQ kinetics. However, potted plants simulating deep sandy soils did not significantly reduce their photosynthetic efficiency, with an increase in NPQ acting to protect the photosystem. Biometric parameters showed no significant differences between treatments, except for root fresh weight and shoot dry weight, where we found the highest values in plants subjected to puncture. Based on our findings, we can conclude that aphids do not alter the photosynthetic yield of *C. edulis* and the puncture mimics the effect of aphids in the absence of other stresses as shallow soil.

## P81

### Experimentally testing the different invasive potential of distinct lineages of *Dikerogammarus villosus*

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#### Abstract

*Dikerogammarus villosus* (Sovinsky, 1894) is a Ponto-Caspian amphipod rapidly expanding in European freshwaters and posing a threat to biodiversity. This species is spreading in Europe through two main corridors (southern and central) from two genetically and geographically separate sources: the Danube delta and the Dnieper delta. The two lineages present in Polish rivers: western in the Oder and eastern in the Vistula, are genetically distinct. There is a possibility that these lineages differ also in invasive potential. The goal of our study is to test if individuals from separate lineages show differences in spread ability and food preference (the factors that may be accounted for invasive potential). We used elongated aquariums divided into compartments with removable glass barriers to test the spread ability. After the introduction of 10 individuals from each lineage (20 in total), we removed the barriers and inserted them again after 22 h. Our results showed higher mobility of the Oder lineage. The food preference experiment is performed along the year. After 24 h of starvation, we introduce specimens from two populations per lineage to small pots and offered them three food types separately: leaves of *Salix alba*, frozen fish, alive larvae of Chironomidae and a mixture of all of them. After 24 h, we preserve specimens in ethanol 96% and measure the remaining food's weight to estimate the consumption of each type. The first results seem to point at a higher voracity of the Oder's populations. The results of both experiments suggest a general higher invasive potential of the individuals from west lineage. Future morphometric and molecular studies might further investigate these differences to help predict possible environmental consequences of this species spreading from two different routes.

## P82

### Behavioural response of the invasive amphipod *Gmelinoides fasciatus* in presence of predators on various bottom substrates

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#### Abstract

Invasive amphipod *Gmelinoides fasciatus* has established itself in numerous large lakes in Eurasia and in the process has displaced the native amphipod, *Gammarus lacustris*. The exact mechanism behind its invasion success is unclear and remains an important topic for invasion ecology. Three laboratory experiments were executed to determine if superior predator avoidance could be an important factor contributing to the invasion of *G. fasciatus*. Our results indicate that on gravel and sand substrate *G. fasciatus* exhibited superior digging behaviour to avoid predation by fishes (perch, roach), unlike its native counterpart. In addition to this, the behavioural response of *G. fasciatus* indicated a more substantial reduction in activity than *G. lacustris* when in the presence of predatory fish kairomones. However, the presence of kairomones had little effect on digging behaviour. *G. fasciatus* consistently demonstrated superior predator avoidance behaviour over the native *G. lacustris*, suggesting that this mechanism might play an important role in the invasion success of *G. fasciatus*.



## NON-NATIVE PESTS AND PATHOGENS. PESTS AND PATHOGENS SPREAD BY INVASIVE ALIEN SPECIES

P83

### Bacterial diseases on woody plants in Norway – a threat to natural environments?

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#### Abstract

In Norwegian orchards and landscaping areas, several bacterial diseases have been detected on woody plants during the last two decades. However, this issue has never been of concern for trees and scrubs in managed forests and natural environments. This may change since the ever-increasing import of plants may bring in new bacterial pathogens or more aggressive strains of species already present. In 2019, *Lonsdalea quercina*, a bacterium that has caused serious disease on several oak species (*Quercus* spp.) in USA and Spain, was found on an oak (*Q. robur*) imported to Oslo. The tree died, but fortunately there were no oaks in close vicinity. Thus, spread of the bacterium has seemingly been avoided. Fireblight, caused by the bacterium *Erwinia amylovora*, has been present in Norway since 1985 on plants in the family Rosaceae, especially on *Coroneaster* spp. In 2020, the first attack by *E. amylovora* was found in a commercial apple orchard in western Norway. Given the right climatic conditions, *E. amylovora* may spread to mountain ash (*Sorbus aucuparia*), a very common native tree species. As mountain ash, goat willow (*Salix capreum*) is not of commercial interest in forestry, but it is an important species from an ecological view. Goat willow in several locations in southern Norway are currently dying from attacks by *Pseudomonas syringae*. A specific variety, *P. syringae* pv. *aesculi*, has damaged several horse chestnut (*Aesculus hippocastanum*) trees in landscaping areas, but thus far not spread to horse chestnut established in natural environments. Although not causing mortality, leaf spots and/or shoot dieback by *P. syringa* has been found on elm (*Ulmus glabra*), birch (*Betula pubescens*), mountain ash, and several horticultural trees and scrubs. We are concerned about the future impact the import of plant material may pose as vectors for new bacteria, not the least *Xylella fastidiosa*.

## P84

### Several potentially pathogenic oomycetes isolated from diseased eelgrass in Norway

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#### Abstract

Seagrass meadows have diminished worldwide, among them species within eelgrass (*Zostera* spp.). Seagrasses are considered the rainforest of the oceans due to carbon capturing and the ecological role they play as cradles for marine species. Explanations for the decline of eelgrass in Norway include, amongst others, physical destructions from construction work along shorelines and polluted run-off from agricultural areas. However, we have obtained several oomycetes from diseased eelgrass and suspect the decline is partly associated with pathogens. From leaf spots and blotches we have isolated *Halophytophthora avicenniae* and a *Halophytophthora* sp., and from necrotic roots *Phytophthora gemini*, *P. chesapeakeensis*, and *P. inundata*. Our findings correspond well with reports from the Netherlands (e.g. Man in 't Veld et al. 2019). Thus, these microorganisms are seemingly well established in the North Sea Region. Several *Halophytophthora* spp. are also reported from marine and brackish-water in Portugal (Maia et al. 2022). Given the aggressiveness by oomycetes, particularly *Phytophthora* spp., on terrestrial plants, these organisms may also cause severe problems for eelgrass, but pathogenicity tests are required before firmly concluding. The coming season, we will further investigate diseases on eelgrass in connection with attempts to establish new eelgrass meadows in the Oslofjord.

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## P85

### Global trade of non-native insects: a pathway for the introduction of pathogens?

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#### Abstract

The growing market demand for insects has led to a substantial increase in the number of insect farms. These farms often rear non-native species, which could favor the introduction of potential pathogens that may threaten native insect diversity. Many authors have warned of the global decline of insects, but only a few studies have explored the role of invasive pathogens in the loss of insects. Here, we synthesize relevant information from scientific papers about the spread of pathogens from commercial non-native species to indigenous insect species. Historically, many insects, such as honeybees, crickets and silkworms, have been used for commercial purposes. The use of insects can increase economic profits for agriculture, livestock and fish producers. Based on the literature, we identified five main commercial uses for non-native species: animal feed, biological control applications, human consumption, pollination services and recreational activities. However, insect farming, and its trade, has become one of the main sources of emerging infectious diseases since co-introduced pathogens from domesticated individuals can spread to wild populations. Insect pathogens correspond generally to various groups of microorganisms such as bacteria, fungi, microsporidia, and viruses. Understanding how species interact with pathogens is vital in predicting the ecological impacts of invasive alien insects on native insect diversity. We conclude that due to the increasing demand by consumers for insects as commercial products, it is necessary to monitor and regulate the trade of insect species and, particularly, the movements of non-native species across international borders.

# EFFECTIVENESS OF PAST AND CURRENT CONTROL MEASURES AND NATIVE COMMUNITIES RESTORATION EFFORTS

**P86**

## **Management towards the eradication of *Pennisetum setaceum* from the island of Gozo**

Stephen Mifsud

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### **Abstract**

*Pennisetum setaceum* has become a serious invasive species in many coastal areas and islands situated in the southern parts of Europe, including the Canary Islands, Madeira, Sardegna, Sicily and the Maltese Islands. It soon became an invasive alien species of EU concern when the European Commission, by implementing Regulation 2017/1263, obliged member states to manage and restrict the spread of the species. In a short time from its first introduction in the Maltese Islands (around the year 2007), the species had escaped considerably both in mainland Malta and in Gozo – the second-largest island of the Maltese archipelago with a surface area of 67 km<sup>2</sup>. It first escaped in urban areas and later spread in some rural communities, including Natura 2000 sites. In 2017, the EcoGozo Directorate within the Ministry of Gozo embarked on a mission to control and possibly eradicate this alien grass from Gozo. With restricted personnel and budget but a wise strategy, about 90% of the *Pennisetum* population recorded in at least 65 locations has been eradicated within five years of operation. Several simple strategies have been adapted, which have resulted in the desired accomplishment. This presentation gives a brief account of how this was achieved and what strategies have been used, namely Citizen Science and media technology for mapping, persistent monitoring, public involvement, and site-specific solutions for removing the plants from the various habitats in Gozo. Repeated interventions allowed us to reach some observations on how to prevent regrowth and that was instrumental in preventing the spread of plants and seeds. Some NGOs, local councils, and the Environment Resource Authority have also played helpful roles in this success story, which still does not have a jovial end because the ecology and surviving adaptations of *Pennisetum setaceum* are enormous.

**P87**

## **All or nothing – Estonia's experience in *Heracleum* IAS eradication**

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### **Abstract**

In Estonia, Sosnowsky's hogweed (*Heracleum sosnowskyi*) is a heritage from Soviet Union. It was grown in the fields for silage and was left spreading when USSR collapsed. In 2003, Estonia decided to launch eradication project due to the threat to biodiversity and human health. The project started in two counties where the plants were dug up. In 2005, an eradication plan was compiled and state needed to turn its focus on the whole hogweeds population – entire Estonia.

Good management plan needs accurate basic data – where and how much hogweed we have. By 2010 ca 1,300 hectares of hogweed was collected as MapInfo layer and eradicated. By 2022, there is ca 3200 ha of hogweed colonies in database (ca 100 ha new areas per year).

Eradicators are found through public procurement and for example in 2021 the cost was 387,457 euros in total (whole Estonia, state budget). Eradicators have to follow exact guidelines and dates. The main method has been treating hogweed plants with glyphosate based herbicides. The amount of colonies where the plants are dug up is increasing – water protection zones, ecological farmlands, low-density colonies, etc. For example in 2022 ca 1,300 ha have been treated with herbicides, ca 900 ha with shovels.

Since the seedbank is vital up to 10 years in the soil, the eradication has to be consistent. By now we consider that 620 ha has been cleaned from hogweeds but every year we find some places where hogweeds have regrown.

Whole-state eradication project is more than 30 contracts every year. It needs constant work with rising public awareness (social media, advertising), actions against spreading (co-operation with road administration, obligations in agriculture), special care on the borders and restricted areas (Russian border, military areas), quick action in case of new sites and flexible approach to the eradication methods.

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### Burn or uproot? Testing approaches to the management of a native invasive herbaceous plant in a semiarid Indian grassland

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#### Abstract

Grassland and savanna ecosystems harbor high plant biodiversity and provide critical ecosystem services. Fires are natural to these ecosystems, however, positive feedbacks known as the grass-fire cycle can result in high dominance of fire-tolerant, non-palatable C<sub>4</sub> grasses. Returning these grass-dominated systems back to a state in which they contain more even and more diverse plant communities that offer palatable biomass to herbivores might not be accomplished by simply excluding fire from the system. Experimentally removing dominant grass has been shown to result in increase in the ground cover of annual herbs and modify species composition and change fire regimes with its high fuel load where it is introduced. It is not fully understood whether dominant native plant species have a stronger impact on species richness.

To determine how fire and the presence of the genus *Cymbopogon* (a dominant C<sub>4</sub> grass) affect the abundance and diversity of other herbaceous plants in the system, we conducted an experiment in the Eastern Ghats, India. To examine the effects of fire and grass presence on the plant community, 53 sites were placed into three experimental treatments: (1) *Cymbopogon* present fire absent (CPFA), (2) *Cymbopogon* absent fire absent (CAFA), and (3) *Cymbopogon* present fire present (CPFP- Control treatment). We manually uprooted *Cymbopogon* and created clearings to prevent fire where ever required.

CAFA treatment resulted in lower herbaceous biomass overall, but more palatable biomass. CAFA treatment increased species richness on a regional scale ( $\beta$ ) but not on the local scale ( $\alpha$ ). CAFA also increased species evenness on a regional scale ( $\beta$ ).

According to our results removal of non-palatable C<sub>4</sub> had a beneficial effect on improving diversity and increasing biomass of native fodder species, and that proper management of grasslands on tropical mesic savanna are important based on scientific knowledge.

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### Towards the elimination of the invasive hogweeds in Estonia – obstacles affecting the success

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#### Abstract

Invasive hogweed management (*Heracleum sosnowskyi* mainly) has been carried out across the whole country since 2005 in Estonia, however, we haven't been able to get rid of it. To study the reasons hindering the success, we analyzed the Estonian hogweed database (2006–2020, held by Environmental Board) and interviewed the eradication contractors. The area of the hogweed colonies has increased continuously since 2006, however, during the last five years the trend has been slowing down. We predict that the area of the colonies will continue to increase in coming years. Interestingly, hogweed has also tended to spread into forest clear-cuts (recognized by remote sensing data) in recent years. Management duration is affected by the area of the colony, management continuity, and the amount of different contractors employed during the eradication period. The area of colonies eradicated each year is three times smaller than the area of newly discovered ones. Eradication time is three years longer in bigger colonies compared to the smaller ones. Colonies with five or more eradicators over the management period extend the eradication period by four years. Viability of the hogweeds has been weakened in many colonies that cannot be counted as eliminated though. That is one reason why the total area of the eradicated colonies has not increased to balance out newly discovered colonies yet. Additional monitoring is needed to more specifically assess the eradication efficiency. Public procurement system is inflexible and demotivating for contractors. Motivation is low to use time and labor consuming digging method with the price determined by the procurement, to eradicate expanded colonies or those discovered in current year (for what they have responsibility by the contract), and to continue the work done with poor quality by someone else in previous years. Lowest payment limits for public procurement contracts should be imposed.

# ENGAGING THE PUBLIC AND STAKEHOLDERS – FROM LANDOWNERS TO SCIENTISTS, PRACTITIONERS AND DECISION MAKERS AND BACK

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## Invasive raccoons in Germany: Cute or nasty? Perceptions of different stakeholders and regions

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### Abstract

Raccoons (*Procyon lotor*) introduced from North America continue to spread in Germany and Europe. Their first introductions date back to the 1930s when they were released in Hessen and escaped from fur farms in Brandenburg. We investigated to which degree stakeholders in Germany differ in their perception of this charismatic and at the same time invasive species. For this purpose, we combined three types of approaches: stakeholder interviews, stakeholder surveys, and newspaper analysis. The newspaper analysis covered articles published between 2010 and 2021, and showed a divided pattern with regional differences: while articles in Bavaria were rather positive, featuring raccoons as “cute” and “entertaining”, articles published in e.g. Berlin or Hessen were not only higher in number but also showed more diverse perceptions and its impacts. We observed strong differences in online surveys of eleven different stakeholder groups: animal protection and raccoon owners denied their impacts on ecosystems, whereas other stakeholders did not; there was also disagreement about hunting as a management method. Last, semi-structured interviews with 22 experts from four German states (Berlin, Bavaria, Saxony, Hessen) in the fields of administration, animal welfare, nature conservation, and hunting were conducted in late 2021. They showed that in regions where raccoons are common, a greater diversity of impacts as well as measures is known than in regions where raccoons are less present. While in Hessen and Berlin, the focus is on management for coexistence (e.g. raccoons-safe garbage cans, avoiding house entrances), in Bavaria hunting is focused. In contrast, hunting is said to be counterproductive, and proposals to capture animals, sterilise and release those, are more frequently applied. For a low-conflict coexistence, humans need to be educated about the presence of raccoons and how to deal with this species, especially in regions where they will spread in the future.

## Risk assessment protocol to target management measures of IAS of Union concern in Finland

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### Abstract

EU member states are required to make management plans for the invasive alien species of Union concern. In Finland, a specific protocol has been developed for the risk assessment to target the management measures cost-effectively. The protocol is consisted of the evaluation of distribution, propagule pressure, means of spread and pathways and impact. Based on the evaluation, a recommendation for the required management measures is given.

Management recommendations given by the risk assessment protocol include four categories: 1) established species – immediate control measures, 2) pets, ornamental and aquarium species found in Finland – civic education on prohibition of import, reproduction and release, 3) species found occasionally in Finland / species not found in Finland but potential for success – eradication of species 4) species with low spreading risk – surveillance of distribution.

All of the species included in the species list of union concern were evaluated. On the 66 species evaluated, majority of the species (31 species; 47%) belonged to the category 4, i.e., low spreading risk species. The other categories were more evenly distributed (category 1: 9 species; 13.6%, category 2: 16 species; 24.2%, category 3: 10 species; 15.2%). The species belonging to first category are Himalayan balsam (*Impatiens glandulifera*), Heracleum species (*Heracleum mantegazzianum*, *H. persicum*, *H. sosnowskyi*), yellow skunk cabbage (*Lysichiton americanus*), raccoon dog (*Nyctereutes procyonoides*), muskrat (*Ondatra zibethicus*), pumkingseed (*Lepomis gibbosus*) and signal grayfish (*Pacifastacus leniusculus*).

For the species belonging to the first category, various management measures are recommended. These include for instance the eradication of yellow skunk cabbage and *Heracleum* species from Finland, cost-effective control of Himalayan balsam with prioritization to protected areas, effective hunting of raccoon dog especially in habitats that are important for birds, enforcing of the restrictions, and education on the risks and restrictions regarding invasive alien species as well as the explanations for these restrictions.

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## **Implementation of invasive alien species legislation in the Czech Republic**

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### **Abstract**

The Czech Republic is within Europe among areas with relatively high diversity of plant and animal species, and natural habitats. There is a detailed information about the invasive alien species status, invaded habitats or IAS impacts. There were recorded 1,454 alien taxa in the national flora including 61 invasive plants and 595 alien taxa in the national fauna, consisting of 113 invasive animal ones. Lists of alien plants and animals will be revised and updated in 2022.

Long tradition in IAS research has resulted in good knowledge of alien species and invasion patterns in the country. Scientific institutions, governmental bodies and other stakeholders participate in collaborative projects aimed at IAS, e.g. one of the biggest projects – DivLand – Centre for Landscape and Biodiversity (2021–2026), project Prevention of *Procyon lotor* spreading in the Doupovské hory Hills (2019–2024) or One Nature project (2019–2026). Many other activities on smaller scale are carried out by NGOs, regional authorities or protected area administrations.

The Czech Republic has recently adopted new legislation on IAS, and has been fully implementing the EU Regulation 1143/2014, which brings many changes and policy updates. The Ministry of the Environment is the national competent authority responsible for relations with the European Commission on the topic, coordinates various activities and issues the permits and dispensations. Monitoring and mapping IAS are coordinated by the Nature Conservation Agency (habitat mapping, citizen science application, etc.) as well as the control and management policy. Together with stakeholders, the former Ministry and Agency cooperate in management measures for widespread IAS from the Union list (e.g., *Heracleum mantegazzianum* and *Ailanthus altissima*, *Myocastor coypus* and *Pseudorasbora parva*). It is clear, that, common effort of all stakeholders is the only way to reduce new introductions, spreading existing alien species and the negative impact of IAS on biodiversity.

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## **Participative preparation of guidelines for invasive alien species management for construction sites and public infrastructure maintenance in Slovenia**

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### **Abstract**

Invasive alien species (IAS) are considered one of the greatest threats to biodiversity and associated ecosystem services. Managing pathways of unintentional introduction and spread of IAS is critical to prevent their introduction and spread to new sites. Important pathways (CBD categories) for many IAS include machinery/equipment, vehicles, transportation of habitat material and natural dispersal. One way to control these pathways is through guidelines for construction sites and public infrastructure maintenance that propose effective measures to control or prevent the unintentional introduction and spread of IAS. There are many methods for cleaning machinery, equipment, and vehicles and for organizing the construction site to prevent the spread of IAS. The natural spread of IAS along infrastructure objects can also be reduced through adapted methods for maintaining these areas. Other measures include cleaning machinery, appropriate timing and frequency of grass cutting, proper disposal of biomass, etc. However, introducing new methods and adapting existing ones costs time and money. Therefore, the Institute of the Republic of Slovenia for Nature Conservation (IRSNC) decided to prepare the guidelines in a participatory manner in close cooperation with the state water and infrastructure agencies and various contractors for infrastructure construction and maintenance. The IRSNC has organized workshops and meetings with smaller groups to harmonize methods that are effective and easy for contractors to use. Initial field tests have been conducted. Promotion in various areas of construction and maintenance of infrastructure such as roads, railways, waterways, pipelines, and power lines will take some time, but is necessary if we are to transform best practices into common practice.

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## **Polyphenols and antiradical activity of invasive plants**

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### **Abstract**

Invasive plant species have numerous negative ecological and economic impacts, and they are one of the major threats to biological diversity in World. Reducing the negative impacts and controlling expansion of invasive species is crucial, but also produced plant biomass can be used to obtain a set of valuable products with high added value. Bioeconomy approaches of biomass processing have only partial influence to preventing the spread of invasive plant species, but produced products can promote economic development. Roots, leaves, stems, flowers and seeds of invasive species contain various phytochemicals – polyphenols, alkaloids, tannins, sterols, monounsaturated fatty acids, and some of extracted compounds have antiradical, antiviral and antimicrobial activities. Therefore, the main objective of this study was to evaluate polyphenols and antiradical activity in three invasive plant species found in Latvia (*Lupinus polyphyllus*, *Impatiens glandulifera*, *Echinocystis lobata*). Polyphenols are major plant secondary metabolites and can be defined as active substances which can be widely used. Analyzed plants and their selected parts contain polyphenols in noticeably different amount. Total polyphenols varies from 24.85 (gallic acid eq./100 g) in roots of *Lupinus polyphyllus* to 2.58 in fruit of *Echinocystis lobata*. In such more easily collectable biomass part as leaves also can be found polyphenols: *Impatiens glandulifera* – 16.75; *Lupinus polyphyllus* – 11.89; *Echinocystis lobata* – 3.06 (gallic acid eq./100 g). The highest antiradical activity was found in the extracts of the stem and roots of *Impatiens glandulifera*. Moreover, also other parts of *Impatiens glandulifera* have higher potential than other studied plants.

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## **Stakeholders' views on the global guidelines for the sustainable use of non-native trees**

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### **Abstract**

Non-native tree species may have a wide range of benefits, from climate-change mitigation to timber production. For these reasons, non-native trees are widely introduced and planted, providing significant socioeconomic benefits. However, some of the traits that make non-native trees desirable are also associated with invasion potential (e.g., fast growth rate, high seed production and high seedling survival) and the capacity to generate negative impacts (e.g., effective root systems can access and deplete underground water-sources). A growing number of non-native tree species have spread from plantations and become invasive, and they now cause a wide range of negative environmental and socioeconomic impacts. In Europe, almost 80% of the tree species in plantation forests are non-native. Aiming to encourage European national authorities to prevent and mitigate the impacts of invasive non-native trees, the Council of Europe endorsed a Code of Conduct on Invasive Alien Trees. This Code of Conduct was recently expanded in a set of Global Guidelines for a sustainable Use of Non-Native Trees (GG-NNTs). To assess the feasibility of these guidelines and the likelihood of being endorsed by different stakeholders, we identified regional, national and international stakeholders who are affected by non-native trees or who influence the use, regulation and management of non-native trees, and asked them to answer a survey designed to explore their attitudes towards the GG-NNTs. Overall, we identified 753 relevant stakeholder institutions and obtained a 35% response rate. Here, we present the results and assess whether there is a need to adjust the GG-NNTs in response to the comments received. We argue that such consultation is vital if the GG-NNTs are to be feasible, appropriate, and accommodate stakeholder concerns.



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## **From Blue Iguanas to Blue Vervain: engaging a community in protecting biodiversity in the Caribbean**

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### **Abstract**

Isolated islands with a high degree of endemism are known to be at particular risk of biological invasions. Many such islands have suffered from colonial policies that resulted in the introductions of invasive species. The From Blue Iguanas to Blue Vervain project is part of an environmental science programme with the aim of “Acknowledging legacies of race, social injustice and exclusion to inform the future”. The project is led by the UK Centre for Hydrology & Ecology and has partners of the National Trusts for the Cayman Islands and Montserrat in the Caribbean, the UK Overseas Territories Conservation Forum, Leeds Museums and Galleries and Meise Botanic Garden.

Small islands, such as Montserrat and the Cayman Islands, with small populations and limited resources, can lack the capacity to assess the risks and impacts of introduced species, let alone manage them. Part of this project will build capacity and community engagement on invasive species in the islands. The project is also connecting the island communities to data on their biodiversity from museums and herbaria in the UK and across the world. As well as addressing invasive species and records of species and recorders, the project is working with knowledgeable local people on Montserrat, through oral histories, to understand the ways in which colonialism has shaped the perceptions of young people on Montserrat’s medicinal plants, known culturally as “weeds and bush”.

Our project connects island stakeholders, including policy makers, scientists, teachers, wildlife managers and the public, but also museums, herbaria, academics, government and NGOs from the UK and further afield. It takes a community to protect biodiversity from invasive species and this project provides a platform through which the UK Overseas Territories can connect with resources from the UK and the world; decolonising collections to help conserve their unique biodiversity.

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### Could *Lagocephalus sceleratus* be used for the production of fishmeal? Fishers' perceptions and willingness to participate

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#### Abstract

*Lagocephalus sceleratus* (Gmelin, 1789) is well acknowledged as one of the worst invasive marine alien species, due to its toxicity, making it unfit for human consumption, and its effects on the environment and ecosystem services. In the frame of LagoMEAL project funded by the EP Fisheries (MIS: 5067491) that aims to explore the potential use of *Lagocephalus* in fishmeals, a questionnaire-based survey was conducted. Aim was to document fishers' perceptions (a) on the species' impacts on the environment and fisheries, (b) and willingness to participate in a systematic exploitation of the species for fishmeal production. The survey was conducted by face-to-face interviews of fishers operating in Crete and the Dodecanese islands, where the species is more abundant. The questionnaire comprised of questions regarding effects of *Lagocephalus* on fishing activity (e.g. damages, cost) and the environment, and willingness to participate in a targeted exploitation. Overall, 167 interviews were conducted. The vast majority of fishers reported a decreasing income, attributed among others to *Lagocephalus*. The average estimated costs due to damages caused by the species on the fishing gears is 5,200 € (median: 3,500 €) – without including loss of income due to catch and day-work losses, cost of baits. It is noteworthy that fishers have observed effects, through predation, of *Lagocephalus* on highly commercial species and especially cephalopods. With respect to their willingness to exploit the species, the vast majority was keen on target-fish it, and would do so for an average price of 4.20 €/kg (median: 3.50 €/kg), and were willing to use and construct special gears. Moreover, they would like to be compensated for gear losses, due to *Lagocephalus*. The work presented here is a valuable input for estimating the viability of the project and the alternative use of a discarded fish, and essential for future socio-economic assessments.

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## Economic costs of invasive species facilitated by canals and the Ponto-Caspianization of the European freshwater aquatic fauna

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### Abstract

Canals are indispensable economic infrastructures but also important pathways for the spread of aquatic invasive alien species (IAS). Albeit the impacts of canal-facilitated IAS being well-known, there is no quantification of the reported economic costs of these species. Here, we used InvaCost, a recently collated database of the monetary impacts of IAS, to identify the costs of species whose introduction and spread have been linked to three major canal systems: European Inland Canals, the Suez Canal and the Panama Canal. While we identified a high number of IAS that have spread across these systems (European Inland Canals: n = 34; Suez Canal: n = 411; Panama Canal: n = 98), monetary costs were reported only for a few species in countries adjacent to each canal. A total of \$33.6 million in costs have been reported from two species linked to European Inland Canals and \$8.6 million were inferred by three species linked to the Suez Canal, but no recorded costs were identified for species facilitated by the Panama Canal. To further investigate the effects of canalization on IAS spread, we collated 265 European macroinvertebrate time series containing records of 29 Ponto-Caspian species from 11 European countries. We found that the number of Ponto-Caspian IAS decreased with increasing distance to the Ponto-Caspian basin, while increasing over time. Furthermore, we found that the interval between occurring Ponto-Caspian species decreased with increasing number of Ponto-Caspian species, underlining facilitation processes. These trends were accompanied by a growing similarity in the faunal composition of sites, suggesting a progressing faunal homogenization of European freshwater courses. As a result, we highlight the pervasive lack of information on the impacts of invaders that are facilitated by anthropogenically-created corridors, while concomitantly emphasizing the complex spatio-temporal nature of invasions across canals.

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## Economic cost of invasions: is France special?

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### Abstract

While the ecological and evolutionary consequences of invasive alien species are receiving increasing attention, their economic impacts still remain understudied. In our study, we aimed at providing a general overview of the monetary losses (damages caused by) and expenditures (management of) associated with invasive alien species (IAS) in France. We compiled and standardized economic costs from systematic literature searches, complemented by both opportunistic and targeted data collection through contacting experts, into a worldwide database called InvaCost. In this database, each cost value is detailed with over 64 descriptors about the invasive species, the cost, the study and the reference. We demonstrate how the total economic costs caused by IAS in France is massive. We establish which are the costliest among different regions and different activity sectors. Damage costs were nearly eight times higher than management expenditure. Insects, in particular mosquitoes (*Aedes albopictus* and *Ae. aegypti*) and non-graminoid terrestrial flowering and aquatic plants (*Ambrosia artemisiifolia*, *Ludwigia* sp. and *Lagarosiphon major*) totaled the highest economic costs. Even if the costs of biological invasions in France are impressive, comparisons with other European countries highlight similar – or even higher – economic impacts. Since the total, accumulated cost represents a massive underestimation, we also present a simple extrapolation method to estimate the cost of some IAS so far unstudied. We encourage to use our approach for similar studies in countries for which no such synthesis exists yet.

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