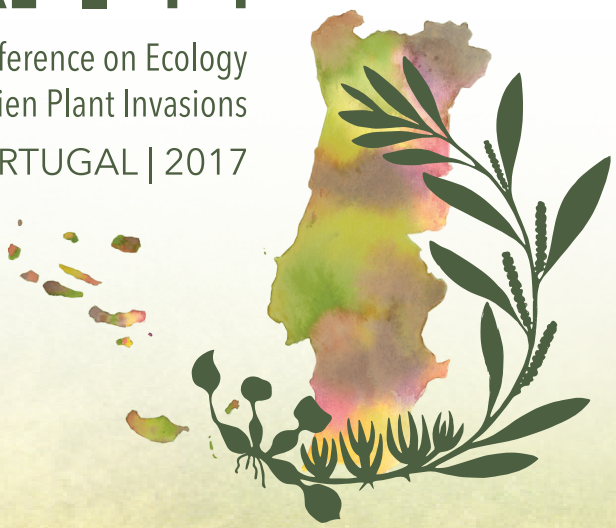
EMAPI 14

International Conference on Ecology
and Management of Alien Plant Invasions

PORTUGAL | 2017



PROGRAMME & BOOK OF ABSTRACTS

ECOLOGY AND MANAGEMENT OF ALIEN PLANT INVASIONS

Syntheses, challenges and new opportunities

Lisboa, Portugal

4th – 8th September 2017

EDITORS

CRISTINA MÁGUAS | CASPARUS CROUS | CATARINA COSTA

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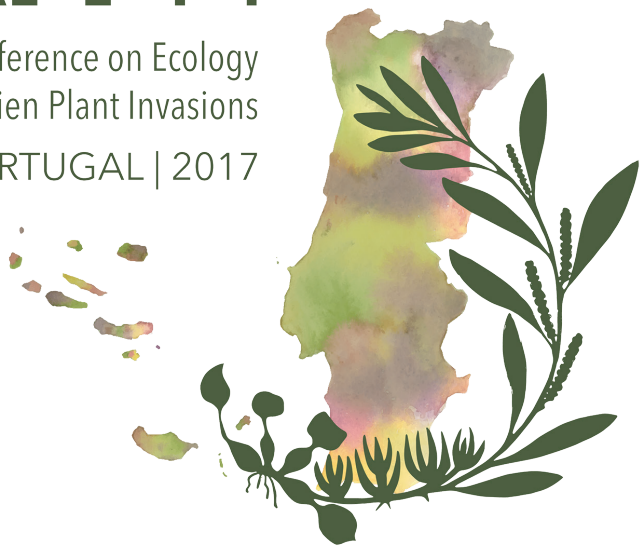

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cE3c centre for ecology, evolution and environmental changes

Ciências ULisboa

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Dear Colleagues and Friends, WELCOME to Lisbon!

We are delighted to have so many top senior and young researchers, as well as many other stakeholders in managing non-native plants, participating in EMAPI 2017. This conference will focus on the latest research and technical developments regarding the ecology and management of plant invasions, and will hopefully assist us all in forming and reforming future strategies to mitigate this truly global environmental issue.

There is currently a great interest in the control and eradication of non-native species in Portugal, an aim supported by the Portuguese research community as whole, including private land-users and governmental organizations. Hosting EMAPI in 2017 was thus a highly strategic project for our country. It is, therefore, an honor and privilege to host the 14th EMAPI Conference here. For this 14th edition, we particularly aim to synthesize the state-of-the-art of researching alien plant invasions, present novel and recurring challenges, and stimulate thought as to new or unexplored opportunities to tackle the management of non-native flora. Our great wish is that scientists, managers, and policy makers from around world will interact and explore ways to address the regional and global challenges presented by alien plant invasions.

The conference is organized with keynote lectures, oral communications, poster sessions, and symposia. But apart from the academic programme, there will also be awards, commercial exhibitions, and a social program which will include a dinner at an exclusive venue with traditional music from Lisboa.

My best wishes to all participants during the week's proceedings, but also for the coming years, working together in exchanging knowledge, nurturing friendships, establishing strong and efficient collaborations, and maintaining innovation in non-native plant ecology and management.

Enjoy Lisbon and enjoy Portugal!

Cristina Máguas and the Scientific/Organizing Committee

INTERNATIONAL SCIENTIFIC COMMITTEE

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PARTNERS AND SPONSORS

CENTRE FOR ECOLOGY, EVOLUTION AND ENVIRONMENTAL CHANGES (cE3c)

cE3c is a research unit under the administration of Fundação da Faculdade de Ciências da Universidade de Lisboa (FFCUL) focusing on research and technology transfer that addresses societal challenges in ecology, evolution and the environment–the three E's of the Centre's name. The main goals are:
i) to carry out basic and applied research on the ecological and evolutionary patterns and processes occurring in terrestrial ecosystems, at both the continental and insular scales; ii) to study the drivers and impacts of environmental changes and design effective responses to those impacts; iii) to collaborate with universities in undergraduate and post-graduate training activities; iv) to contribute to technical and scientific exchange at the national and international levels; v) to promote the diffusion of scientific results through publications and by organizing seminars and scientific meetings at national and international settings; vi) to participate with its expertise in community services.

CÂMARA MUNICIPAL DE ALMADA

Almada is located in the Lisbon's Metropolitan Area, in Portugal, in the southern bank of the Tagus estuary. Has a geographical area of 70 km2 and 174.000 inhabitants.
The Municipality of Almada is well aware that to achieve prosperity, quality of life, economic and social development, is essential to value its environmental quality and landscape, as vital elements to preserve natural resources, biodiversity and ecosystem services.
The Department for Environment, Climate, Energy and Mobility of Almada Municipality is a multidisciplinary department in charge of environmental management and planning at the city level, dealing with energy and mobility issues.
One of the priority areas of intervention has been the development of a Local Strategy for Climate Change, firstly aiming at reducing environmental impacts and carbon intensity of the city (mitigation), and secondly, increasing the resilience of its natural and building environments (adaptation).
In this framework, Almada has been developing a Green/Blue infrastructure, based on ecosystem services and natural resources preservation, where the Organic Community Allotment Gardens Network are distributed, integrate adaption in sectorial plans and in land use plans, develop ecological restoration projects in risk and degraded areas and Multi-adaptation projects that tackle different hazards and combine solutions for enhancing territorial resilience.

CÂMARA MUNICIPAL DO BARREIRO

The Municipality of Barreiro is the executive body of the municipality, directly elected by citizens registered in the respective area. It is responsible for promoting the development of the municipality through the planning, management and realization of investments in the different areas of its competence, such as urban planning and urban planning, education, social action, environment and basic sanitation, Sport, culture and civil protection, among others. To this end, it defines and executes policies aimed at defending the interests and meeting the needs of the local population, promoting the quality of life of its citizens.
As part of its strategy to conserve nature and biodiversity, in 2012 the Municipality created the Local Nature Reserve of Sapal do Rio Coina and Mata da Machada. One of the problems that affect the existing natural values are invasive species, namely acacias and weeping of the beach. The LIFE Biodiscoveries Project (LIFE13 BIO / PT / 000386) is now being developed, supported by the European Commission's LIFE Program, which aims to control invasive species through public participation.

TECNOMASS - SISTEMAS ANALITICOS, LDA

Tecnomass was formed in 1988 to represent Eurovector Spa Elemental Analysers in Portugal.
With over 20 years of experience in Mass Spectrometry, Tecnomass represented Micromass UK between 1999 and 2002, at which time Micromass were the market leader, Sercon Uk between 2008 and 2013 and now represent ISOPRIME Ltd., Elementar Group, who manufacture Isotope Ratio Mass Spectrometers.

SOCIEDADE PORTUGUESA DE ECOLOGIA - SPECO

The Portuguese Ecological Society is a scientific association.
Established in December 1995, SPECO crafted a suitable environment where ecologists can and should interact, reinforcing the ecological science in its interdisciplinary. We seek to be a dynamic scientific community, increasingly awaken and active on social issues. SPECO aims to reach all who use ecological science as a base to nature conservation and environmental management. Moreover, we develop scientific or technological activities in the fields of Ecology and sustainable development, fulfilling a long time void in the national scientific community, a meeting point among several different fields. Although young comparing with their fellow European associations, SPECO established from start a pool of ideas and lively discussions during conferences, workshops and debates that have been promoted or supported, and in the various initiatives that have been set up since the beginning. SPECO is a member of the European Ecological Federation, enrolled in National Record of the Nature Defence Organizations (APA), and has taken part in several meetings and conferences as an Environmental Non-Governmental Organization (ENGO).

SOCIEDADE PORTUGUESA DE BOTÂNICA

The Sociedade Portuguesa de Botânica is a non-profit association created in January 2009 and aimed at spreading botany and conservation of flora and habitats in Portugal.
Our objectives are: I) Promote the conservation of species of flora and their habitats; II) Disseminate and promote the technical and scientific knowledge of botany, flora and vegetation, particularly those present in the national territory; III) Promote the exchange of information and experience among botanists, professionals and amateurs, regardless of their training; IV) Centralize geographic, morphological, photographic and ecological information of the Portuguese and Mediterranean flora; V) Promote the application of scientific knowledge in the definition of habitat and species management measures; VI) To promote awareness actions on issues related to Portuguese flora and vegetation, in the components of biodiversity, conservation, ecology, habitats, among others and VII) Spread the taste for botany, flora and vegetation.
Throughout the year there are activities such as field trips, botany courses, training courses applied to ecology, seminars, among others. We invite you to visit our website, which will be the meeting portal for all interested parties.

INSTITUTO DE CONSERVAÇÃO DA NATUREZA E DAS FLORESTAS, I. P. – ICNF, I. P.

The Instituto da Conservação da Natureza e das Florestas, I. P. is a public institute integrated in the indirect administration of the Portuguese State, endowed with administrative, financial and own autonomy.
ICNF, I. P.'s mission is to propose, monitor and ensure the implementation of nature conservation and forest policies, aiming at the conservation, sustainable use, valorization, enjoyment and public recognition of the natural heritage, promoting the sustainable development of Forestry and associated resources, fostering the competitiveness of forest ranks, ensuring structural prevention in the framework of concerted planning and action in the field of forest protection and hunting and aquaculture resources of inland waters and other areas directly associated with forestry and forestry activities.

FULL PROGRAMME

SUNDAY 03 September

17:00 PARTICIPANTS RECEPTION & REGISTRATION @ OPEN SPACE

19:00 WELCOME DRINK @ OPEN SPACE

19:40 PARTICIPANTS RECEPTION & REGISTRATION @ OPEN SPACE

MONDAY 04 September

08:00 PARTICIPANTS RECEPTION & REGISTRATION

08:50 OPENING SESSION

09:00 PLENARY LECTURE @ MAIN ROOM

Session 1 *Current trends in invasive plant ecology*
Moderated by David Richardson

Petr Pyšek CAS, Czech Republic
Current trends in plant invasion research

09:50 COFFEE BREAK

10:20 PARALLEL SESSIONS

Session 1 *Current trends in invasive plant ecology*
Moderated by Daniel Montesinos @ MAIN ROOM

10:20 Franz Essl The GloNAF-initiative: new insights into the biogeography and macroecology of global plant species invasions

10:40 Ana Novoa When can we make generalizations in invasion science?

11:00 Jennifer L Bufford Signs of evolution? Examining fecundity and seed size of *Rumex* spp. across climates in the native and introduced range

11:20 Bruce Osborne Timing is still everything: early growth and development underpins the success of an alien perennial herb in a coastal grassland ecosystem

Session 2 *How to promote and benefit from the collaboration of citizens?*
Moderated by Cristina Máguas @ PARALLEL ROOM I

10:20 Ross Shackleton Engaging stakeholders and understanding drivers of local knowledge and perceptions of invasive species to improve understanding and management of biological invasions

10:40 Andrew Wannenburgh Achievements and challenges in South Africa's terrestrial invasive alien plant control programme

11:00 Madli Linder Recent outcomes of alien hogweeds control activities in Estonia

Session 3 *Risk assessment and implementation of prevention tools*
Moderator to be confirmed @ PARALLEL ROOM II

10:20 Oscar Cacho Allocating resources to manage invasive plant populations

10:40 Benno Augustinus Can we predict Impact from damage early in the season? The case of *Ophraella communa*, a potential biocontrol agent of *Ambrosia artemisiifolia*

11:00 Philip Hulme Integrating invasive species policies across ornamental horticulture supply-chains to prevent plant invasions

11:20 Jorge Capelo Incorporating vegetation science in adaptive management of forest stands invaded by wattles

11:50 POSTER SESSION

12:20 LUNCH

14:00 PLENARY LECTURE @ MAIN ROOM

Session 2 *How to promote and benefit from the collaboration of citizens?*
Moderated by Charlie Shackleton

Helen Roy CEH, England
Unravelling the ecology of biological invasions through citizen science

14:50 PARALLEL SESSIONS

Session 1 *Current trends in invasive plant ecology*
Moderated by Franz Essl @ MAIN ROOM

14:50 Jason Verbeek Can a common invader impact community diversity through the exchange of shared enemies?

15:10 S. Luke Flory Interactive effects of drought and plant invasion on longleaf pine communities

15:30 Christiane Werner Assessing the spatial impact of an N2-fixing plant invader across heterogeneous environments using a combined isotope - remote sensing approach

15:50 Daniel Montesinos Tautological assumptions about invasive traits: when non-invasive exotics present the same trait-shifts that invasives

Session 2 *How to promote and benefit from the collaboration of citizens?*
Moderated by Ross Shackleton @ PARALLEL ROOM I

14:50 Enrique López EEIKO: A multiplatform application for invasive alien plant species control

15:10 Eugenio Gervasini European Alien Species Information Network (EASIN): supporting scientific research & European policies

15:30 Jetske Vaas Participatory mapping of hotspots: where to keep the invaders out?

Session 4 *Modelling plant invasions: the role of climate, traits and socioeconomy*
Moderated by Andrew O´Reilly-Nugent @ PARALLEL ROOM II

14:50 Hana Skálová Distribution and competitors to *Ambrosia artemisiifolia* in the Czech Republic

15:10 Margherita Gioria Seed bank density and persistence as predictors of species invasiveness

15:30 Katarzyna Bzdęga Geostatistical modelling of seasonal variation of invasive plant species with the use of hyperspectral data

15:50 Konstantin Ochs Macrophyte control by managed flows using habitat suitability modelling

16:20 COFFEE BREAK

16:50 PRACTITIONERS CORNER @ MAIN ROOM
Henrique Pereira LIFEBiodiscoveries project

17:10 PARALLEL SYMPOSIA
Ross Shackleton *et al.* Factors driving people's knowledge and perceptions of invasive species @ PARALLEL ROOM I
Jorge Oliveira-Costa and Vânia Pivello The importance of phenotipic plasticity to invasiveness among plant communities @ PARALLEL ROOM II

18:10 Informal inspirational talks in the afternoon with a senior researcher,
David Richardson CIB, South Africa @ MAIN ROOM

TUESDAY 05 September

09:00 PLENARY LECTURE @ MAIN ROOM

Session 3 *Risk assessment and implementation of prevention tools*
Moderated by Montserrat Vilà

Pilar Castro Díez UAH, Spain
Impacts of non-native trees on multiple ecosystem services: a worldwide review

09:50 COFFEE BREAK

10:20 PARALLEL SESSIONS

Session 1 *Current trends in invasive plant ecology*
Moderated by Casparus Crous @ MAIN ROOM

10:20 Heinke Jäger Over 40 years of *Cinchona pubescens* invasion in Galapagos: coming to a natural end?

10:40 Andrea Westerband Functional trait responses of Hawaiian native and invasive plants across spatial scales and a precipitation gradient

11:00 Pedro M. Antunes Is mediation of plant invasion by soil biota context dependent?

11:20 Eva Maria Malecore Does heterospecific pollen interference increase resistance of native communities against alien plants?

Session 2 *How to promote and benefit from the collaboration of citizens?*
Moderated by Ana Novoa @ PARALLEL ROOM I

10:20 Luke Potgieter Public perceptions of urban plant invasions: an ecosystem service perspective

10:40 Silvia da Fatima Langa Socio-economic impact of water weeds in the Incomati River in Mozambique

11:00 Charlie Shackleton The role of invasive alien species in shaping local livelihoods and human well-being

Session 3 *Risk assessment and implementation of prevention tools*
Moderated by Robert Tanner @ PARALLEL ROOM II

10:20 Elizabete Marchante Are Botanic Gardens still actively dispersing invasive plant seeds

10:40 Max Wade Lessons to learn from plant species of EU concern in the assessment of future risk, prevention and management in the British and Irish Isles

11:00 David Galicia-Herbada A generic and high-resolution spatial assessment of the invasion risk in Spain

11:20 Patrícia Fernandes Forestry species and the risk of invasion to neighbouring ecosystems: *Pinus pinaster* and *Eucalyptus globulus*

11:40 CEF, Coimbra, Presenter name to be confirmed Is it possible to eradicate a plant invader? The case study of *Baccharis spicata* in Porto Metropolitan Area

11:50 POSTER SESSION

12:20 LUNCH

14:00 PLENARY LECTURE @ MAIN ROOM

Special session in *Plant invasions in an era of global environmental changes and future uncertainty*
Moderated by Helena Freitas

Harold Mooney Stanford University, USA
Why is it taking so long?

14:50 PARALLEL SESSIONS

Session 1 *Current trends in invasive plant ecology*
Moderated by Mari Cruz Diaz-Barradas @ MAIN ROOM

14:50 Lenka Moravcová Does seed persistence in the soil play a role in species invasiveness? Insights from burial experiments.

15:10 Angelica Lopez Phylogenetic niche conservatism in the spread of invasive grasses in Australia

15:30 Jesse Kalwij Reaching new heights: alien plant dynamics in a montane ecosystem

Session 3 *Risk assessment and implementation of prevention tools*
Moderated by Paul Maxwell Wade @ PARALLEL ROOM II

14:50 Robert Tanner Accommodating impacts on ecosystem service in risk analysis: the EPPO way.

15:10 Ayşe Yazlik Global assessment of alien plant impacts using the Environmental Impact Classification for Alien Taxa (EICAT)

15:30 Karen Castro The challenge of weed risk analysis for biofuel crops in Canada

15:50 Sabrina Kumschick Alien species classification according to their impact

Session 6 *The impact and consequences of biological invasions*
Moderated by Pedro M. Antunes @ PARALLEL ROOM I

14:50 Elisabeth Pötzelsberger Is tree-of-heaven really that invasive? – Origin and human caused distribution of tree-of-heaven in Eastern Austria

15:10 Jonatan Rodríguez Novel interactions between *Carpobrotus edulis* and invertebrate species in the native and non-native range

15:30 Ana Sofia Lino Vaz Effects of non-native tree species on cultural ecosystem services: An assessment approach with insights from the Iberian Peninsula

16:20 COFFEE BREAK

16:50 PRATICTIONERS CORNER @ MAIN ROOM
Miguel Ferreira A hands on approach to Invasive Species Control at the Azores islands

17:10 PARALLEL SYMPOSIA
Henrique Pereira *et al.* Plant invasion control in practice @ PARALLEL ROOM I
Florian Ulm *et al.* Risks and challenges on valorizing the use of IAS @ PARALLEL ROOM II
Richard Shaw, *et al.* Why so little biocontrol of plant invasions in Europe: what are the real issues? @ MAIN ROOM

18:10 ROUND TABLE @ MAIN ROOM
Speaking about Invasives with a native taste

WEDNESDAY 06 September

09:00 PLENARY LECTURE @ MAIN ROOM

Session 4 *Modelling plant invasions: the role of climate, traits and socioeconomy*
Moderated by Elizabete Marchante

Ingolf Kühn UFZ, Germany
Modelling plant invasions: the role of climate, traits and socioeconomy

09:50 COFFEE BREAK

10:20 PARALLEL SESSIONS

Session 1 *Current trends in invasive plant ecology*
Moderated by Luke Flory @ MAIN ROOM

10:20 Sarka Jahodova Molecular ecology of three invasive *Heracleum* species in Europe

10:40 Krystal A. Nunes Comparative impacts of aboveground and belowground enemies on an invasive thistle

11:00 Mari Cruz Diaz-Barradas Plant response to water stress of native and non-native *Oenothera drummondii* Hook. populations

11:20 Maria Cristina Morais Will drought stress promote invasion by *Hakea sericea* in Mediterranean-type ecosystems?

Session 4 *Modelling plant invasions: the role of climate, traits and socioeconomy*
Moderated by Jennifer Bufford @ PARALLEL ROOM II

10:20 Andrew O'Reilly-Nugent Functional distinctiveness in plant invasions

10:40 Bernd Lenzner Evolutionary history as driver of plant invasion success: the role of diversification rates

11:00 Tiffany Knight Functional and phylogenetic effects on abundance of native and alien species across spatial scales

11:20 Emily Haeuser Non-naturalized alien garden plants are more competitive against resident species under climate change

Session 5 *Biosecurity and management of alien plant invasions*
Moderator to be confirmed @ PARALLEL ROOM I

10:20 Philip Weyl The Nagoya Protocol: implications for classical biological control and the management of invasive plant species

10:40 Nkoliso Magona Australian Acacia species in South Africa: an assessment of introduction status and potential for eradication

11:00 Michaela Vítková Controversial *Robinia pseudoacacia* in Europe – a site-specific strategy for sustainable management

11:20 Rui Botelho Management of alien plant invasions in five priority habitats for conservation in the Azores: achievements and failures in 15-years of experience

11:50 POSTER SESSION

12:20 LUNCH

14:00 PLENARY LECTURE @ MAIN ROOM

Session 5 *Biosecurity and management of alien plant invasions*
Moderated by Hélia Marchante

John Wilson CIB/SANBI, South Africa
Monitoring and reporting on plant invasions at a country level

14:50 PARALLEL SESSIONS

Session 4 *Modelling plant invasions: the role of climate, traits and socioeconomy*
Moderated by Bernd Lenzner @ PARALLEL ROOM II

14:50 Daniel Chapman Improving invasive species distribution models using prior knowledge and casual occurrences

15:10 Montserrat Vilà Comparative patterns of plant invasions in the mediterranean biome

15:30 Lua Andrea Alves-Burgos Predicting plant Invasiveness using climatic niche traits: A framework for priorizing invasive plant control in Chile

15:50 Rakhi Palit Factors influencing naturalisation and invasion success in woody horticultural species

Session 5 *Biosecurity and management of alien plant invasions*
Moderated by Philip Weyl @ PARALLEL ROOM I

14:50 Suzanne Lommen Can novel methods control ragweed? Assessing long-term efficacy by experimentation and demographic modeling

15:10 Iain Paterson The more the merrier for *Pereskia aculeata* biocontrol? Perhaps not!

15:30 John Brock Established alien invasive trees and probable invader trees in Arizona, USA

15:50 Jan Sliva How far is Europe united in the fight alien plant invasions?

Session 6 *The impact and consequences of biological invasions*
Moderated by Manuela Giovanetti @ MAIN ROOM

14:50 Elizabeth Wandrag Partitioning of seedling microsites can facilitate invader establishment in native grasslands but limit their impact

15:10 Florian Ulm How *Acacia longifolia* engineers its soil: From hitchhiking nurse plants to disrupting N/P cycles

15:30 Mauricio Mantoani *Gunnera tinctoria* invasions in Ireland: impacts on greenhouse gas emissions and soil carbon and nitrogen and the effects of removal

16:20 COFFEE BREAK

16:50 PRACTITIONERS CORNER @ MAIN ROOM
Philip Hulme Biosecurity and the management of alien plant invasions in New Zealand

17:10 PARALLEL SYMPOSIA
Daniel S. Chapman, Rob Tanner *et al.* Distribution models to support and improve plant risk assessments: challenges, applications and new opportunities @ PARALLEL ROOM I
Pedro M. Antunes and Peter Kotanen Accounting for soil biota feedbacks in invasive plant management

20:30 CONGRESS DINNER @ Casa do Alentejo @ PARALLEL ROOM II

THURSDAY 07 September

09:00 PLENARY LECTURE @ MAIN ROOM

Session 6 *The impact and consequences of biological invasions*
Moderated by David LeMaitre

Ruben Heleno CFE, Portugal
On the road to a novel natural world: how alien species change the structure and function of ecological networks

09:50 COFFEE BREAK

10:20 PARALLEL SESSIONS

Session 5 *Biosecurity and management of alien plant invasions*
Moderated by John Hay @ PARALLEL ROOM I

10:20 Hélia Marchante First report of the establishment of the biocontrol agent *Trichilogaster acaciaelongifoliae* for control of invasive *Acacia longifolia* in Portugal

10:40 Michael Wohlwend Limiting the invasion of an exotic plant on an experimental prairie

11:00 Cristina Vieites-Blanco Testing the effectiveness of two biological control agents on the invasive plant *Carpobrotus edulis*

11:20 Peter Ferus Potential exchange of invasive plant propagules by trade

Session 6 *The impact and consequences of biological invasions*
Moderated by Casparus Crous @ MAIN ROOM

10:20 Iris Stiers The influence of invasive plant species cover on different biological communities in temperate ponds

10:40 Jan Čuda The impact of invasive herb *Impatiens glandulifera* on ecosystem functioning of the temperate forest is small and varies between years

11:00 Francisco López Núñez Four- trophic level food webs reveal the cascading impacts of an invasive plant targeted for biocontrol

11:20 Janet A. Morrison A dual challenge for suburban forests: abundant deer and non-native, invasive plants

Session 7 *Chasing invasive species with high technology*
Moderated by Artur Gil @ PARALLEL ROOM II

10:20 Hillary Cherry Using detection dogs to assist weed eradication in conservation areas: a case study of hawkweed (*Hieracium* L.) in Australia.

10:40 Rowan Sprague Seeing the wood for the trees: Why remote sensing imagery can detect but not predict alien conifer invasions

11:00 Barbara Tokarska-Guzik Which features of invasive alien plants are crucial for their mapping with airborne hyperspectral and ALS remote sensing data?

11:20 Ernesto José de Deus Google Street View potential for studying alien plant invasions

11:50 POSTER SESSION

12:20 LUNCH

14:00 PLENARY LECTURE @ MAIN ROOM

Session 7 *Chasing invasive species with high technology*
Moderated by Joana Vicente

Duccio Rocchini C3A, University of Trento, Italy
Estimating plant species invasions from space: the upmost ecological challenge

14:50 PARALLEL SESSIONS

Session 5 *Biosecurity and management of alien plant invasions*
Moderated by John Brock @ PARALLEL ROOM I

14:50 Springer Kaye How strong, stable relationships killed the drama and 10,000 plants

15:10 Bongani Mashele Updates on management and progress made towards eradication of *Pueraria montana* var. *lobata* (kudzu vine) in South Africa

15:30 John Du Vall Hay Management techniques for the control of *Melinis minutiflora* P. Beauv. (molasses grass): ten years of research on an invasive grass species in the Brazilian Cerrado

15:50 Michael Padmanaba Island of aliens: plant invasion in protected areas of Java, Indonesia

Session 6 *The impact and consequences of biological invasions*
Moderated by Rui Elias @ MAIN ROOM

14:50 Martin Hejda Impacts of invasive trees across different trophic levels: Is the difference between the invaded and native stands consistent for plants, nocturnal Lepidoptera and birds?

15:10 David Le Maitre Impacts of alien plant invasions on water resources and yields from the Western Cape Water Supply System (WCWSS)

15:30 Theo E. W. Linders Integrating socio-economic and ecological effects of *Prosopis*, a woody invasive alien species, for development of improved management strategies

Session 7 *Chasing invasive species with high technology*
Moderated by Barbara Tokarska-Guzik @ PARALLEL ROOM II

14:50 Josef Brůna The role of timing in plant invasion monitoring using UAV

15:10 André Große-Stoltenberg Field spectroscopy together with airborne LiDAR and hyperspectral remote sensing reveal occurrence and impact of the invasive ecosystem engineer *Acacia longifolia*

15:30 Nuno César de Sá Using Landsat Time Series to understand how management and disturbances influence the expansion of an invasive tree

15:50 Elizabeth Haber Predicting the spread of the invasive coral vine (*Antigonon leptopus* Hook & Arn.) using remote sensing and species distribution modeling

16:20 COFFEE BREAK

16:50 PARALLEL SYMPOSIA
Artur Gil New trends and challenges in remote sensing of invasive alien plants @ PARALLEL ROOM I
Elizabete Marchante and Hélia Marchante How to improve surveillance and (early) detection of invasive plants – may citizens be active collaborators? Challenges and opportunities @ PARALLEL ROOM II

17:50 "CLOSING" SESSION The best moments of EMAPI 2017...
And also concluding remarks @ MAIN ROOM

FRIDAY 08 September

08:00 – 09:00 FIELD TRIP Departure from the venue, Sana Lisboa Hotel

SYMPOSIA

MONDAY 17:10 @ PARALLEL ROOM I

Ross Shackleton
Centre for Invasion Biology at Stellenbosch University
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Factors driving people's knowledge and perceptions of invasive species

Organized by Ross Shackleton, Brett Bennett, Rodrigo Estevez, Anke Fisher, Christian Kull, Brendon Larson, Elizabete Marchante, Hélia Marchante, Ana Novoa, Luke Potgieter, Dave Richardson, Charlie Shackleton, Arne Witt and Sofia Vaz

Many invasive species have economic and intrinsic benefits but also induce a number of costs, and can result in conflicts of interest and hider control operations. Therefore, understanding knowledge and perceptions of people and different stakeholders is crucial with regards to managing invasive species. In the week prior to EMAPI a workshop will be held to investigate the primary factors that drive peoples knowledge and perceptions of invasive species globally and what that means for management. In this symposium we will briefly present the outcomes of the workshop and engage in further discussions on the topic with the aim of coming up with a unified set of factors or framework.

TUESDAY 17:10 @ PARALLEL ROOM I

Henrique Pereira dos Santos
Project LIFE Biodiscoveries, Barreiro Municipality, Portugal
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Plant invasion control in practice

The "Plant Invasion Control In Practice" symposium aims to brings to light experiences and results from several recent invasive plant species works and projects in Portugal. These species present a growing problem within nature and also society, therefore it is crucial that this topic is debated and information is shared in order to lessen their long-term effects.

We consider that it is crucial to promote practical cases, in which the experiments can be replicated in different contexts while being examples of good ecological practices, but also promoting unsuccessful cases. Exploring the pros and cons of several interventions can be helpful in the near future.

The aim is to present Projects with objective results in the field, which will be able to show different paths towards a common goal – the control of invasive species, more specifically, acacias.

Short communications presented:

1. Barreiro Municipality

LIFE BIODISCOVERIES PROJECT - INVASION SPECIES CONTROL THROUGH PUBLIC PARTICIPATION

2. Pedro Serafim Altri Florestal

A EXPERIÊNCIA DA PROPRIEDADE NOVA AUSTRÁLIA NO CONTROLO DE INVASORAS
This Company is one of the largest European producers of whitened Eucalyptus paper pulp. Altri made a change of land use from *Acacia* sp. invasion to Eucalyptus in a very rare large intervention to eradicate invasive species in 400 hectares.

3. Paulo Domingues QUERCUS

CABEÇO SANTO PROJECT
A nature conservation Project promoted by Quercus (national environmental NGO) aiming to control invasive species in an area of about 100ha in Águeda municipality.

4. Isabel Fagundes Sociedade Portuguesa para o Estudo das Aves (SPEA)

CONTROLO DE CHORÃO-DA-PRAIA NO PROJETO LIFE BERLENGAS
Berlengas LIFE Project aims to contribute for a sustainable management of the Special Protection Zone (ZPE) of the Berlengas (a small Portuguese archipelago) and the main goals are to preserve its habitats, endemic plant species and marine bird populations. The removal of ice plant is one the project's main actions.

THURSDAY 16:50 @ PARALLEL ROOM I

Artur Gil

cE3c, Azorean Biodiversity Group, Department of Biology, Faculty of Sciences and Technology, University of the Azores, Portugal
artur.jf.gil@uac.pt

New trends and challenges in remote sensing of invasive alien plants

This symposium aims at identifying, presenting and discussing some novel trends and challenges in satellite, airborne and UAV-based remote sensing of invasive alien plants. This 60 minutes' event will consist of three oral communications and a final debate/discussion (of 15 minutes each) among speakers and the attendants:

1. Duccio Rocchini Center Agriculture Food Environment, University of Trento, Italy
REMOTELY SENSING INVASIVES: OPEN TOOLS TO TRACK INVASIVE SPECIES FROM SPACE

2. André Große-Stoltenberg Institute of Landscape Ecology, University of Münster, Germany
EXPLORING THE SPATIAL DIMENSION OF *ACACIA LONGIFOLIA* N-ENRICHMENT BY MAPPING D15N DISTRIBUTION PATTERNS WITH THE SUPPORT OF LIDAR AIRBORNE REMOTE SENSING

3. Nuno César de Sá Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Portugal
MULTI-SEASONAL MONITORING OF ACACIA LONGIFOLIA THROUGH UAS: POTENTIAL FOR DETECTION OF A BIOCONTROL AGENT

4. Artur Gil (moderator) Ce3C, Azorean Biodiversity Group, Department of Biology, Faculty of Sciences and Technology, University of the Azores, Portugal
FINAL DISCUSSION AMONG SPEAKERS AND THE ATTENDANTS: NEW TRENDS AND CHALLENGES IN REMOTE SENSING OF INVASIVE ALIEN PLANTS

WEDNESDAY 17:10 @ PARALLEL ROOM I

Daniel S. Chapman
NERC Centre for Ecology & Hydrology, UK
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Distribution models to support and improve plant risk assessments: challenges, applications and new opportunities

Distribution models are well-established tools for predicting the current and future potential distributions of invasive alien plant species, yet until recently they have seldom been applied in risk assessments. The goal of this symposium is to discuss how distribution models can support and improve expert-led risk assessment for invasive alien plant species. First, we will outline how distribution models are currently feeding into the risk assessment process underlying recent the European Union Regulation on invasive alien species. This will stress the need for consistent approaches and communication of model outputs to expert risk assessors. Then we will discuss the most important methodological challenges posed by the types of plant species prioritized for risk assessment. These species are typically emerging as invaders in the risk assessment areas and have already established invasive distributions in other parts of the world. Therefore, their models require global scale modelling accounting for non-equilibrium distribution patterns, differences in the niche between native and invaded ranges, strongly biased recording patterns and model extrapolation. Finally, we will consider new opportunities, including the potential for more biologically-driven process-based dynamic modelling techniques to support and improve plant risk assessments. This symposium comprised:

1. Rob Tanner European and Mediterranean Plant Protection Organisation
THE CURRENT ROLE AND CHALLENGES OF MODELS IN PLANT RISK ASSESSMENTS

2. Daniel Chapman NERC Centre for Ecology & Hydrology, UK
SPECIES DISTRIBUTION MODELLING: APPLICATIONS IN PLANT RISK ASSESSMENTS

3. Joana Vicente (moderator) Universidade do Porto and University of Trás-os-Montes e Alto Douro, Portugal
ROUND-TABLE DISCUSSION BETWEEN THE ATTENDANTS

THURSDAY 16:50 @ PARALLEL ROOM II

Elizabete Marchante[1] and Hélia Marchante[2]

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2 - Escola Superior Agrária/Instituto Politécnico de Coimbra (ESAC/IPC) & Centre for Functional Ecology (CFE), Universidade de Coimbra, Portugal

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How to improve surveillance and (early) detection of invasive plants – may citizens be active collaborators? Challenges and opportunities

With this symposium we aim to discuss different approaches used to implement surveillance and (early) detection (and rapid response) of invasive alien plants, and evaluate advantages and disadvantages of such approaches. Additionally, we aim exploring how far citizen's participation (including e.g., use of geolocation Apps, volunteers, etc.) may be positive and discuss pros and cons of their active collaboration. In this context, the main objectives are: I) Learn from worldwide experiences on surveillance and (early) detection (including smartphone applications, monitoring schemes, etc.); II) Discuss pros and cons of using citizen science and volunteers for surveillance and early detection of invasive plants and III) List successful vs. unsuccessful experiments. This symposium comprised the following oral communications:

1. John Wilson South African National Biodiversity Institute (SANBI) and Centre for Invasion Biology (CIB), Stellenbosch University, South Africa
SOUTH AFRICAN EXPERIENCE IN SURVEILLANCE AND DETECTION OF INVASIVE PLANTS

2. Elizabete Marchante Centre for Functional Ecology (CFE), Universidade de Coimbra, Portugal
FIRST STEPS FOR AN (EARLY) DETECTION PROGRAM FOR INVASIVE PLANTS IN PORTUGAL

3. Hélia Marchante Escola Superior Agrária/Instituto Politécnico de Coimbra (ESAC/IPC) & Centre for Functional Ecology (CFE), Universidade de Coimbra, Portugal
CITIZEN SCIENCE COLLABORATION TO MAP INVASIVE PLANTS (AND NEW SPECIES WITH INVASIVE POTENTIAL) IN PORTUGAL – MAY SURVEILLANCE COUNT ON IT?

4. Jael Palhas Centre for Functional Ecology (CFE), Universidade de Coimbra, Portugal
HOW TO ENGAGE THE PUBLIC WITH (INVASIVE) PLANTS: CHALLENGES OF ENGAGEMENT AND SPECIES IDENTIFICATION
ROUND-TABLE DISCUSSION

TUESDAY 17:10 @ MAIN ROOM

Richard Shaw[1], Elizabete Marchante[2], Suzanne Lommen[3], Laura Verbrugge[4] and Hélia Marchante[5]

1 - Country Director CABI UK/ Regional Coordinator Invasives, UK, r.shaw@cabi.org;
2 - Centre for Functional Ecology, University of Coimbra, Portugal;
3 - University of Fribourg, Switzerland;
4. Radboud University, Netherlands;
5. Escola Superior Agrária de Coimbra & Centre for Functional Ecology, Portugal

Why so little biocontrol of plant invasions in Europe: what are the real issues?

Classical biological control of weeds/ invasive plants has been successfully applied in many continents in the past 150 years, but is a relatively 'novel' approach in Europe. Besides the apparent administrative complexity inherent to the many countries sharing the continent, and the absence of a harmonised regulation for the introduction of exotic beneficial natural enemies, there are other obstacles that have prevented, and are hampering implementation of biocontrol in Europe. We suspect the risk-adverse attitude of authorities and the lack of balanced knowledge of weed biocontrol benefits and risks to be important causes. Recent socio-political developments such as the loss of faith in the scientific community by the general public, and the recent EU regulation on invasive alien species more specifically, may only boost awareness of risks, but not of potential benefits of introducing exotic beneficials. Another cause may be the focus of the plant ecology research community being targeted at understanding plant invasions rather than their management.
We aim to further identify the obstacles for the implementation of biological control in Europe, and discuss different perspectives on biocontrol in a European context. We intend to come up with a list of practical guidance that could boost weed biocontrol in Europe. This symposium comprised the following oral communications, followed by a final discussion among the participants:

1. Dick Shaw aka Richard Shaw[1] and Suzanne Lommen[2] 1 - Country Director CABI UK and Regional Coordinator Invasives, UK; 2 - University of Fribourg, Switzerland
SOUTH AFRICAN EXPERIENCE IN SURVEILLANCE AND DETECTION OF INVASIVE PLANTS

2. Hélia Marchante Escola Superior Agrária de Coimbra & Centre for Functional Ecology, Portugal and Elizabete Marchante Centre for Functional Ecology, University of Coimbra, Portugal
OBSTACLES ENCOUNTERED IN THE 12 YEARS BEFORE INTRODUCING *TRICHILOGASTER ACACIAELONGIFOLIAE* IN PORTUGAL

3. Laura Verbrugge Radboud University, Netherlands
PUBLIC PERCEPTIONS OF BIOCONTROL

4. John Wilson South African National Biodiversity Institute (SANBI) and Centre for Invasion Biology (CIB), Stellenbosch
A VIEW FROM OUTSIDE EUROPE

MONDAY 17:10 @ PARALLEL ROOM II

Jorge Luis P. de Oliveira-Costa[1] and Vânia Regina Pivello[2]

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The importance of phenotipic plasticity to invasiveness among plant communities

The establishment of self-sustaining invasive plant communities is traditionally associated with environmental variables, although functional traits among species occupying similar indicate that sustainable invasive communities may also be mediated by intrinsic species attributes. Endemic to Australia, *Acacia* has spread to Mediterranean and Tropical regions virtually worldwide. Despite the impacts already reported elsewhere – biodiversity loss, altered forest successional trajectories, disrupted nutrient cycles, there has been a notable lack of studies addressing *Acacia* phenotypic plasticity among plant communities elsewhere in the world. Analysis on the plant phenotypic plasticity is fundamental to understand the potential invasiveness, and therefore, minimize ecological and economic impacts. In the literature, invasive plants are usually related to their high rates of nitrogen acquisition, and their abundance may be related to nitrogen-rich zones. Therefore, in this symposium we aimed to discuss about phenotypic plasticity among terrestrial plants, verifying a possible relationship between a phenotypic trait associated to resource acquisition traits to the invasiveness of Australian *Acacia* species by comparing it with coastal species between Mediterranean and Tropical regions. We present here some preliminary results of an ongoing research project that intends to extend to other countries the comparison between *Acacia* and native species ability to acquire nitrogen.

WEDNESDAY 17:10 @ PARALLEL ROOM II

Pedro M. Antunes[1] and Peter Kotanen[2]

1 - Department of Biology, Algoma University, Sault Ste. Marie, ON, Canada
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2 - Department of Biology, University of Toronto Mississauga, Mississauga, ON, Canada
peter.kotanen@utoronto.ca

Accounting for soil biota feedbacks in invasive plant management

There is increasing evidence that soil biota feedbacks affect plant community dynamics. Positive feedback (i.e., host-fitness-promoting soil rhizosphere communities) contributes to species dominance whereas negative feedback (i.e., host-fitness-reduction soil rhizosphere communities) allows for species co-existence. Hypothetically, the spatio-temporal dynamics between negative and positive feedbacks determine plant community composition. In addition, co-adaptive evolutionary mechanisms may determine these interactions but little is known about rhizosphere microbial diversity, including functional diversity. The introduction of exotic invasive species in native communities may disrupt long-established and locally adapted soil biota feedbacks. To what extend can this contribute towards invasion success is a matter of scientific enquiry. This symposium will start with a short presentation aimed at providing a background review on the topic including the most recent findings and state-of-the-art methodologies. This will be followed by a roundtable discussion with all participants focused on how soil feedback may be taken into consideration in exotic invasive plant management (from prevention to control and site restoration). It is expected that participants will contribute by pinpointing open questions and problems requiring evidence-based solutions. It is also expected that this symposium will lay the foundation for a manuscript on the topic.

TUESDAY 17:10 @ PARALLEL ROOM II

Florian Ulm[1], Rui Elias[2] and Miguel Prado[3]

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3 - Sousa Prado & Filhos – Agropecuária Ld
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Risks and challenges in valorizing the use of IPS

Many ecosystems worldwide are under increasing pressure from invasive plant species (IPS) and even though several international policies, guidelines, as well as eradication programs are in place, it seems that the further spread of IPS is difficult to prevent. While negative incentives, such as fines, can be useful to a certain extent, there is also the possibility for positive incentives, which involve the creation of an economically viable usage of IPS biomass. Thus, instead of seeing IPS solely as a burden, their usually high growth rates could be a valuable ecosystem service for the production of biofuels, wood pellets or soil amendment for agricultural use. However, in any of these cases, there should be strong regulations and well-designed guidelines in place to prevent further spread and misuse of IPS, as well as a safeguard to avert stakeholders from seeing IPS as a "cash crop". In this symposium, we would like to discuss potential usages and utilization strategies as well as potential regulatory measures that could allow usage of IPS with the ultimate goal of slow eradication or at least a decrease in IPS pressure on native vegetation.

1. Florian Ulm Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculdade de Ciências, Universidade de Lisboa, Portugal
QUANTIFYING IPS BIOMASS AND USING IPS COMPOST IN AN URBAN SETTING

2. Rui Elias
Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculdade de Ciências Agrárias e do Ambiente, Azores University, Portugal
VALORIZATION OF EXOTIC WOODLAND RESOURCES IN THE AZORES: THE CASE OF WIDESPREAD INVADER *PITTOSPORUM UNDULATUM*

3. Miguel Prado
Sousa Prado & Filhos – Agropecuária Lda.
HISTORICAL PERSPECTIVE AND CURRENT PROBLEMS ASSOCIATED WITH *ACACIA* SPP. INVASION IN THE ALENTEJO COASTAL REGION

PLENARY LECTURES

MONDAY 09:00 @ MAIN ROOM

S1 *Current trends in invasive plant ecology*

Current trends in plant invasion research

Petr Pyšek
Institute of Botany, The Czech Academy of Sciences, Průhonice & Faculty of Science, Charles University in Prague, Czech Republic

In this talk I will attempt to summarize the topics and issues that may potentially drive future research and management of alien plant invasions. Decades of studies on invasive species have yielded numerous milestones that were important for understanding the invasions, but recent decades have seen a marked shift in focus from topics addressing the mechanisms of invasions and underlying process towards more a complex perception of invasions, where the socioeconomic and social perspective on invasive species is recognized as increasingly important. Currently, these two facets are being increasingly integrated into invasive species paradigm. This was illustrated by a recent horizon scanning excercise of topics importance of that are likely to increase in the near and more distant future. However, there are two sides of novelty that can lead to opening new frontiers. One is represented by completely new attitudes made possible by emerging revolutionary technologies such as gene editing, while the other can be brought about by better use of existing tools and methodologies, such as global networks employing biogeographic approaches, recently built powerful global databases that allow a search for general principles, quantitative assessments of environmental and socioeconomic impacts using standardized tools, or stratified management of invaders.

MONDAY 14:00 @ MAIN ROOM

S2 How to promote and benefit from the collaboration of citizens?

Unravelling the ecology of biological invasions through citizen science

Helen Roy
Centre for Ecology & Hydrology, Wallingford, Oxfordshire, OX10 8EF, UK

Biological invasions are large-scale processes and cross-boundary collaborations, ensuring knowledge is shared between scientists, is essential to advance understanding and enable successful implementation of strategies to manage invasive non-native species. However, biological invasions are driven by humans and so involving people (beyond invasion biologists) in research is critical for informing horizon scanning and surveillance, and underpinning prevention, control and even the elimination of invasive non-native species. Here I provide an overview of the importance of citizen science in raising awareness of biological invasions while also enabling people to contribute to research for the benefit for society, science, and nature.

TUESDAY 09:00 @ MAIN ROOM

S3 *Risk assessment and implementation of prevention tools*

Impacts of non-native trees on multiple ecosystem services: A worldwide review

Castro-Díez, Pilar[1]; Godoy, Oscar[2]; Vaz, A. Sofia[3,4]; Alonso, Álvaro[1]; Aponte, Cristina[5]; Bayón, Álvaro[6]; Bellingham, Peter[7]; Cardoso Silva, Mateus[8]; Chiuffo, Mariana C.[9]; DiManno, Nicole[10]; Julian, Kahua[10]; Kandert, Susanne[10]; La Porta, Nicola[11,12]; Marchante, Hélia[13,21]; Maule, Hamish[7]; Mayfield, Margaret M.[14]; Metcalfe, Daniel[15]; Monteverdi, M. Cristina[16]; Núñez, Martín A.[9]; Ostertag, Rebecca[10]; Parker, Ingrid[17]; Peltzer, Duane[7]; Potgieter, Luke[18]; Raymundo, Maia[14]; Rayome, Donnie[10]; Reisman-Berman, Orna[19]; Richardson, David M.[18]; Roos, Ruben[20]; Saldaña, Asunción[1]; Shackleton, Ross[18]; Silva, Joaquim S.[21,22]; Torres, Agostina[9]; Trudgen, Melinda[23,24]; Urban, Josef[25,26]; van Loo, Marcela[27]; Vicente, Joana R.[3,28]; Vilà, Montserrat[6]; Ylioja, Tiina[29]; Zenni, Rafael[8]

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6 - Department of Integrative Ecology, Estación Biológica de Doñana (EBD-CSIC), E-41092 Sevilla, Spain;

7 - Landcare Research, PO Box 69040, Lincoln 7640, New Zealand;

8 - Setor de Ecologia, Departamento de Biologia, Universidade Federal de Lavras, Av. Central, s/n - Campus Universitário, Lavras - MG, 37200-000, Brazil;

9 - Grupo de Ecología de Invasiones, INIBIOMA, Universidad Nacional del Comahue, CONICET, Av. de Los Pioneros 2350 Bariloche, Río Negro, Argentina;

10 - University of Hawai'i at Hilo, Hilo, HI, 96720, USA;

11 - IASMA Research and Innovation Centre, Fondazione Edmund Mach, Via E. Mach 1, San Michele all'Adige 3801o, Trento, Italy;

12 - MOUNTFOR Project Centre, European Forest Institute, Via E. Mach 1, 38010 San Michele all'Adige, Trento, Italy;

13 - Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456,Coimbra, Portugal;

14 - The University of Queensland, School of Biological Sciences, Brisbane, QLD 4072, Australia;

15 - CSIRO Land and Water, Ecosciences Precinct, 41 Boggo Road, Dutton Park, Queensland 4102, Australia;

16 - Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Forestry Research Centre CREA-SEL, Viale Santa Margherita, 80 52100 Arezzo, Italy;

17 - Department of Ecology and Evolutionary Biology, University of California, 1156 High Street, Santa Cruz, CA 95064, USA

18 - Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Matieland 7602, South Africa

19 - French Associates Institute for Agriculture and Biotechnology of Drylands. Blaustein Institutes for Desert Research, Ben Gurion University of the Negev, Sede Boqer Campus 84990, Israel;

20 - NMBU - Norwegian University of Life Sciences, P.O. BOX 5003 Universitetstunet 3 Ås, Akershus NO-1432 Norway;

21 - Escola Superior Agrária, Instituto Politécnico de Coimbra, Bencanta, 3045-601, Coimbra, Portugal;

22 - Centre for Applied Ecology Prof. Baeta Neves (InBIO-CEABN), Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, PT1349-017 Lisboa, Portugal;

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24 - School of Biological Sciences, University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia;
25 - Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic, Zemědělská 1665/1, 613 00 Brno-sever, Czechia;
26 - Siberian Federal University, Krasnoyarsk, Svobodnyy pr., 79, Krasnoyarsk, Krasnoyarskiy kray, Russia, 660041;
27 - Department of Botany and Biodiversity Research, University of Vienna, Rennweg 14, 1030 Vienna, Austria;
28 - Laboratory of Applied Ecology, CITAB – Centre for the Research and Technology of Agro-Environment and Biological Sciences, University of Trás-os-Montes e Alto Douro, Vila Real, Portugal;
29 - Ecosystems and ecology, Natural Resources Institute Finland (Luke), PO Box 2, FI-00791 Helsinki, Finland.

Tree species contribute greatly to the ability of ecosystems to provide services that are critical for human well-being. Many non-native trees (NNT) have been planted worldwide e.g. for timber, fodder, erosion control, shade, and aesthetics; yet they also have undesired effects on related ecosystem services such as water supply, soil fertility or cultural heritage. These benefits and costs of NNT may accrue while they are still in plantations, or only after they have escaped to the wild as invaders. Objective assessment of the pros and cons of NNT relevant to multiple services is therefore needed to make informed management and conservation decisions. Here, we conducted a worldwide assessment of the effects of NNT's on the supply of multiple ecosystem services based on information published in scientific literature, in country-level economic/forestry reports, and in on-line social media. Following the Millennium Ecosystem Assessment, we covered supporting and regulating services (SRES), provisioning services (PES), and cultural services (CES). NNT contributed positively to several SRES, such as climate regulation, soil erosion control, and soil formation. Yet, they also negativelycontributed to fire regulation, with no trends found for water and pollution regulation, or pollination. At a global scale, native trees (NT) and NNT showed a similar contribution to PES related to timber production, but NNT provided slightly less unique non-timber products (e.g. pollen, honey, cork) than NT. Lastly, NNT contributed positively to CES related to aesthetics, cultural heritage, and tourist attraction, but negatively to people's leisure in nature and scientific interest. No trends were found for inspiration and pollen allergenicity. Overall, our results show disparate effects of NNT on multiple ecosystem services, leading to potential conflicts when managing these species. We provide worldwide information that can contribute to the management of such conflicts, taking into consideration the social variables and environmental characteristics of different countries. We stress that decisions on NNT management should rely on the simultaneous assessment of multiple ecosystem services.

WEDNESDAY 09:00 @ MAIN ROOM

S4 Modelling plant invasions: the role of climate, traits and socioeconomy

Modelling plant invasions: the role of climate, traits and socioeconomy

Ingolf Kühn

Helmholtz Centre for Environmental Research – UFZ, Germany

Models are increasingly used to infer both, (plant) species invasiveness and habitat invasibility. I will give a brief overview on different modelling approaches (mechanistic vs. phenomenological, with different methods for the latter) and some of the problems frequently encountered (e.g. phylogenetic or spatial non-independence, non-equilibrium, ignoring variability).

While for plant species, the wide-spread notion is that their biology is responsible for their invasiveness. Also, climate matching is a crucial pre-requisite. Nevertheless, recent analyses suggest that human action is even more important and might override biological, ecological or climatic factors.

This will directly translate into species distributions, covariates of invaded ranges and habitat invasibility. Here I will present and critically discuss different approaches. Many models are based on climatic variables. Still, given that most alien species are spreading and do not have filled their complete niche space, I question whether model based on incomplete ranges are valid. In addition, recent studies revealed the overall importance of of human action (again). I discuss the consequences of this and refer to other groups of parameters (e.g., land use, climate) for assessing the future distribution of alien species.

WEDNESDAY 14:00 @ MAIN ROOM

S5 Biosecurity and management of alien plant invasions

Monitoring and reporting on plant invasions at a country level

John R. Wilson

South African National Biodiversity Institute, Kirstenbosch Research Centre, South Africa
&
Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, South Africa

The impacts of biological invasions are increasing and are felt by all sectors of society. In some cases mitigation and control measures have reduced undesirable impacts, but often control has been ineffective or the problem has not even been recognised. A major challenge is to develop indicators that can be used to track the various aspects of the problem in ways that are practical, transparent, and allow assessments of the effectiveness of control interventions. In this talk I discuss on-going international efforts to develop indicators; present the results of a soon to be released report: "The status of biological invasions and their management in South Africa in 2017"; and examine the example of incursion response planning.

Three aspects of biological invasions need to be monitored—pathways, species, and areas. Significant progress has been made in developing categories for pathways; indicators for species (viz. alien species occurrence, species alien status, and alien species impact); and there are several proposals for indicators of how invaded particular areas are. When we tried to estimate these for South Africa, however, several problems were apparent. In particular, efforts to assess the effectiveness of control interventions are rarely in terms of outcomes, i.e. they do not feed-back to indicators of pathways, species, or areas. This link requires managers to be explicit about what they are trying to achieve, at what scale, and within which time-frames. For managers to effectively track progress, appropriate indicators and monitoring programmes are needed (e.g. eradographs for incursion response planning). The report on invasions in South Africa highlights major data gaps, but has been crucial in focusing effort on what needs to be done to improve management. Finally I discuss ways in which such reports can feed into predictions of future biological invasions, i.e. the size of a country's invasion debt and what can be done to reduce it.

THURSDAY 09:00 @ MAIN ROOM

S6 The impact and consequences of biological invasions

On the road to a novel natural world: how alien species change the structure and function of ecological networks

Ruben Heleno

Centre for Functional Ecology, University of Coimbra, Portugal

Anthropogenic activity is reshuffling species across the globe at unprecedented rates. Many such species rapidly escape human landscapes and become integrated within natural communities by interacting with native and other introduced species. However, while the individual impacts of biological invasions on native biodiversity have been frequently demonstrated, consistent changes on overall community structure remain resistant to generalizations. Here, I will use species interaction networks to show how the integration of alien plants, pollinators and seed dispersers have shaped the communities of the Galápagos, Azores, São Tomé and Principe, and mainland Portugal. Our results show that many introduced species can integrate and even replace native species with detectable, yet relatively small changes on overall network architecture. Nevertheless, native and introduced species play very different roles on these novel communities and therefore they are not functionally equivalent to the species they displace. Consequently, in addition to the direct depleting effects on biodiversity, alien plants and animals are changing trophic and mutualistic networks, disrupting important ecosystem functions and threatening ecosystem persistence.

THURSDAY 14:00 @ MAIN ROOM

S7 Chasing invasive species with high technology

Estimating plant species invasions from space: the upmost ecological challenge

Duccio Rocchini

Center Agriculture Food Environment, University of Trento, Italy

Anticipation has recently become a central topic in biollogical invasion science. Anticipatory methods are also crucial for developing effective management practices to deal with invasive species. Given the negative economic and ecological impact of invasive species, a rapid method for detection and prediction of their arrival and spread is critical to allow an effective early assessment of species invasion risk and impact. This talk focuses on recent efforts to model the distribution of invasive species using remote sensing, and to stimulate debate on the potential of remote sensing for monitoring and forecasting biological invasions.

TUESDAY 14:00 @ MAIN ROOM

Special session *Plant invasions in an era of global environmental changes and future uncertainty*

Why is it taking so long?

Harold Mooney

Senior Fellow, Emeritus - Stanford Woods Institute for the Environment; Paul S. Achilles Professor of Environmental Biology, USA

Although the whistle was blown decades ago about the threats of invasive species efforts to stem the growing tide of incursions the responses that have been made are not adequate to meet the challenges that society faces, now, and in the future. The drivers of the enhancement of the success of invasive species are increasing, with global changes, raising the bar of corrective action even higher. I discuss the past cumbersome and inadequate international efforts to meet the challenges and the role of the Intergovernmental Platform for Biodiversity and Ecosystem Services in moving forward.

ORAL COMMUNICATIONS

Session 1 *Current trends in invasive plant ecology*

MONDAY MORNING

When can we make generalizations in invasion science?

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Prevention is the most cost-efficient component of invasive species management strategies. To prevent the introduction of new invasive species, evidence-based criteria are needed for identifying potential invaders. Identifying traits and mechanisms associated with invasive success is, therefore, a fundamental challenge in invasion science.
Several approaches have been taken to achieve this goal, including in-depth studies of particular taxonomic or functional groups of organisms in different global contexts. This approach posits that the performance of introduced species in negotiating barriers along the introduction-naturalization-invasion continuum are best understood by studying the role of biotic, abiotic and human factors as drivers and mediators within closely-related groups of species. Examples of key groups that have been recently studied are Australian Acacia species (c. 1012 species), bamboos (Poaceae; subfamily Bambusoideae; c. 1400 species) and cacti (Cactaceae; c. 1800 species).
Reviews of the introduction and invasion ecology of these groups have yielded important generalizations, such as the roles of propagule pressure, native range size, growth traits and genome size in facilitating invasiveness. However, each group of species studied had a particular combination of interacting or unique factors that influenced their invasion success, making the transfer of insights gained from a particular group to another tenuous, and potentially misleading. This presentation discusses the value of having in-depth studies of certain groups of species from both a theoretical and a practical point of view to aid in understanding and managing future invasions.

TUESDAY MORNING

Functional trait responses of Hawaiian native and invasive plants across spatial scales and a precipitation gradient

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The mechanisms that determine how a non-native species becomes a dominant, invasive member of a plant community remain poorly understood. Previous studies examining the causes of invasion have focused on invader traits and community attributes (e.g. diversity) that promote resistance to invasion. However, more recent studies have attempted to predict invasiveness using phylogenetic relatedness and/or novelty of non-natives relative to natives, with contradictory results. We expand previous studies to encompass multiple spatial scales and a precipitation gradient. We collected functional trait data on native and non-native plants across the Hawaiian Islands. Studies on phylogenetic novelty of invasives are well suited to the Hawaiian Islands because native species exhibit strong phylogenetic relatedness due to geographic isolation. The data include leaf thickness, specific leaf area, chlorophyll content, maximum photosynthetic capacity, and stomatal conductance, among others.

The functional trait responses were highly variable among native and non-native species, and we found no uniform patterns in response to precipitation within either group, contrary to our expectations. For both native and non-native species, physiological responses were correlated with some but not all of the morphological traits, and these relationships were significantly influenced by precipitation levels. We also found that plant habit also significantly influenced functional trait responses. Lastly, changes in spatial scale significantly influenced the functional traits of our study species, highlighting the need for integration of spatial variation in studies of plant community dynamics and assembly processes. Our results suggest that within Hawaii, native and invasive species overlap in their functional traits, and that the degree of overlap changes with spatial scale and resource availability. Increasing drought associated with global climate change may therefore have mixed effects on the community composition of Hawaiian forests.

TUESDAY AFTERNOON

Phylogenetic niche conservatism in the spread of invasive grasses in Australia

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Species distribution models (SDMs) are widely used to predict the distribution of invasive species in new regions based on the environment they occupy in the native range, assuming species environmental niches are conserved across space. But niches may also be conserved through evolutionary time, such that species tend to occupy similar environmental niches to closely related taxa. If such phylogenetic niche conservatism occurs, then the distribution of an invasive species may be predictable from the environmental niche occupied by closely related native species in the new region. We tested this idea by comparing the environmental niches occupied by native and invasive grass species belonging to the same genus in Australia: phylogenetic niche conservatism would imply strong overlap in the environmental niches of native and invasive congeners. We quantified niche overlap for 15 grass genera that had at least four native and four invasive species in Australia using distributional data from herbarium collections coupled with SDMs that quantified the degree of overlap among species in environmental space. We found that the degree of niche conservatism varied among genera: in some genera, principally C3 grasses in the clade Pooideae, there was strong phylogenetic niche conservatism, such that the environmental space (and thus spatial distribution) of invasive species was highly predictable from that of native congeners. For other genera, specifically Setaria, Urochloa and Echinochloa, native and invasive congeners occupied very different environmental space. We discuss the implications of these findings for understanding the distribution of both native and invasive grasses.

MONDAY MORNING

Timing is still everything: early growth and development underpins the success of an alien perennial herb in a coastal grassland ecosystem

Bruce Osborne* [1,2], Margherita Gioria[1,2,3], Mauricio Mantoani[1,2] , Alberto Benavent Gonzalez[4] and Conor Sweeney[2,5]

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Whilst the characteristic(s) that contribute to successful alien plant invasions still remain enigmatic there has been an increasing interest in the possibility that phenological differences are a key feature, allowing introduced species to exploit periods when co-occuring species are largely inactive. Comparisons of the growth and development of the alien perennial herb Gunnera tinctoria, which is a successful invader of a number of grassland ecosystems in the West of Ireland and elsewhere, shows that established plants initiate growth at least one week prior to that of co-occurring species and this is followed by rapid leaf emergence and expansion, whilst young seedlings (1-2 years of age) initiate growth and leaf expansion even earlier. A consequence of rapid canopy development is the elimination of many species from the above ground vegetation, through their intolerance of shading, as well as the prevention of early recruitment. Early canopy development is facilitated through the existence of preformed structures including both leaves and inflorescences that are, unusually, a feature often associated with arctic, Antarctic or alpine plants, which are formed towards the end of the previous growing season, as well as by atmospheric N-fixation, which can support shoot growth when the availability of inorganic forms in the soil is low. Early growth is, however, a risky business, particularly during early seedling establishment, due to the likelihood of post emergence exposure to low temperatures and we show that this risk may have been reduced as a consequence of climate change related reductions in the start of the growing season by ~25 days in the last ~25 years. Whilst there is evidence that other plant invaders are also successful because they can initiate growth early in the year the generality of this feature as the defining feature of all plant invasions awaits more quantitative information.

MONDAY AFTERNOON

Assessing the spatial impact of an N2-fixing plant invader across heterogeneous environments using a combined isotope - remote sensing approach

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Exotic invasive plant species are known to substantially alter and potentially transform native ecosystems. However, quantifying the impact of such invaders on the surrounding plant community in the presence of environmental heterogeneity is challenging and accordingly, the spatial extent of influence – e.g. on nutrient cycling – is largely unknown. We used the composition of foliar nitrogen isotopes, δ15N, as a spatial tracer of N input and functional changes caused by the invasive N2-fixing *Acacia longifolia* (Andrews) Willd. in a nutrient-poor Portuguese dune ecosystem. Within the highly heterogeneous ecosystem, we modeled foliar δ15N of a native, non-fixing species, *Corema album* (L.) D. Don, along transects with increasing distance to *A. longifolia* by applying a generalized additive mixed model. As predictors, variables related to the presence of *A. longifolia* were used together with LiDAR (light detection and ranging) derived maps of vegetation cover, topographic wetness index, and a landform classification based on topographic position.
The model successfully predicted C. album δ15N (R2 = 0.62), allowing us to disentangle effects of *A. longifolia* from the background variation of the heterogeneous ecosystem. *Acacia longifolia* caused significant enrichment in a range of ca. 5–8 m surrounding its canopy, which indicated substantial N input originating from symbiotic N2-fixation by the invader. Moreover, patterns of N enrichment interacted with site topography.
Thus, spatially explicit models of functional tracers may serve to identify and map heterogeneity in ecological processes as well as to quantify and predict the spatial influence of invasive species. Linking remote sensing techniques with tracers of biological processes and interactions will advance our understanding of dynamic native-invader interactions across spatially structured heterogeneous systems from small to large spatial scales.

MONDAY AFTERNOON

Tautological assumptions about invasive traits: when non-invasive exotics present the same trait-shifts that invasives

Daniel Montesinos
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Introduced exotic species can rapidly adapt to conditions in non-native ranges, including changes in size and competitive ability, which result in different invasive success for each individual species. Increased competitive ability generally increases invasive success, but the role of plasticity of competitive effects and responses on invasive success is unclear. Additionally, little is known about the heritability of such changes, and on the importance of hypothetical reintroductions in the maintenance of locally adapted traits. To test for this, we experimentally produced cohorts of the invasive *Centaurea solstitialis*, and the non-invasive *C. calcitrapa* and *C. sulphurea*, of ancestry from either the native range in Spain, the invasive range in California, or (for the invasive *C. solstitialis* only) inter-regional hybrids from both ranges. We then quantitatively assessed traits from both regions and all species. Finally, we set up one-to-one competition experiments with the grass *Bromus hordeaceus*. Despite the many similarities in trait-shifts between invasive and non-invasive species, the invasive *C. solstitialis* was the only species presenting significantly larger competitive effects and responses in the non-native range of California, but also a significantly lower plasticity for this trait. This suggests that the specific combination of numerous trait-shifts in a specific place and time, more than one or two specific traits, are responsible for invasive success. It also challenges the conception that higher plasticity is always beneficial for invasiveness, since a less plastic competitive ability is providing *C. solstitialis* with a more consistent success.

TUESDAY MORNING

Does heterospecific pollen interference increase resistance of native communities against alien plants?

Eva Malecore, Mark van Kleunen, Mialy Razanajatovo

Heterospecific pollen interferences occur when a mix of heterospecific and conspecific pollen is deposited on a plant's stigma. This naturally occurs since pollinators may visit various plant species, thus transporting mixtures of pollen from different species. A recent meta-analysis found that alien heterospecific pollen donors have a more negative effect on seed production than native heterospecific pollen donors, thus aggravating the negative effects of aliens on natives. Furthermore, the more closely related the alien species to a native, the greater the negative effect. However, it is likely that also pollen from native species negatively affects the reproduction of aliens, increasing biotic resistance of native communities. To our knowledge, no study has tested this yet. In a greenhouse experiment, we assessed the effects of pollen from both aliens and natives on each other and on themselves, to test whether species status (alien/native) plays a role in heterospecific pollination. Furthermore, we looked at the role of phylogenetic distance between pollen donors and receptors. We used six native and six alien species, covering a broad range of phylogenetic distances. We created pollen mixtures using all 144 pairwise combinations between the 12 plant species, and applied them to the respective plant species. We had three main treatments on each species: (1) a pollen mixture of conspecific and heterospecific pollen from another species of the same status (2) a pollen mixture of conspecific and heterospecific pollen from a species from the other status, and (3) conspecific pollen (control). We are currently collecting data on seed set of the treated flowers, and will present the results at the conference. We expect that native heterospecific pollen donors have the smallest effects on other natives, and native and alien donors have the largest effects on aliens. The effect of heterospecific pollen receipt should increase with decreasing phylogenetic relatedness.

MONDAY MORNING

The GloNAF-initiative: new insights into the biogeography and macroecology of global plant species invasions

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Biological invasions have become a defining feature of global environmental change. However, until recently no comprehensive standardized global database of alien plant species distributions has been available.

Here, we present the Global Naturalized Alien Flora (GloNAF) initiative (https://glonaf.org/), which has become the most comprehensive resource for alien plant species distributions. GloNAF contains more than 13,168 plant species, corresponding to 3.9% of the extant global vascular flora, or approximately the size of the native European flora, that have become naturalized somewhere on the globe as a result of human activity (van Kleunen et al. 2015).

We will present key insights that have emerged from analyses of this database. In particular, we will highlight i) fundamental patterns of global alien plant species richness, ii) the temporal dynamics of historic alien plant species accumulation, iii) and show how environmental and anthropogenic pressures and biogeographic context interact in driving plant invasions.

Finally, we will provide an outlook on on-going analyses based on this global database, and we will outline avenues for further research.

Reference

van Kleunen M. et al. (2015) Global exchange and accumulation of non-native plants. Nature 525: 100–103.

TUESDAY MORNING

Over 40 years of *Cinchona pubescens* invasion in Galapagos: coming to a natural end?

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The long-term dynamics and impacts of plant invasions may be determined by interactions among pathogens, invasive plants and co-occurring native species. *Cinchona pubescens* (quinine, Rubiaceae) is one of the most invasive tree species in Galapagos, at one point covering an estimated 11.000 ha on the island of Santa Cruz where it displaced native species, changed the microclimate, and increased phosphorus concentrations in the soil. Over the last 10 years, however, a dramatic die-off of the species has been observed such that the current distribution is estimated to be only 1.400 ha. To accurately evaluate the decrease in *Cinchona* abundance and growth, we measured plant species composition in 1998, 2002, 2005 and 2016 in 14 randomly placed 20 m × 20 m plots established in the vegetation zone dominated by the endangered endemic shrub *Miconia* robinsoniana. Our results indicate that the *Cinchona* population in the plots decreased markedly over time, while cover of *Miconia* significantly increased. Thus, while the vegetation zone was co-dominated by *Cinchona* in 1998, *Miconia* is once again the dominant species. The cause of the sharp decline in the abundance and growth of *Cinchona* across multiple vegetation zones on Santa Cruz is presently unknown. However, it appears as though emerging pathogens have accumulated on *Cinchona* over time, a process which may have been fostered by high plant density at the peak of the invasion. Consequently, future research efforts will focus on using experimental manipulations of the host and pathogens in natural and controlled environments to identify pathogens and their effects on *Cinchona*. Results of this research will improve our understanding of the mechanisms underlying long-term outcomes of plant invasions.

MONDAY AFTERNOON

Can a common invader impact community diversity through the exchange of shared enemies?

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Alien plants can strongly alter ecosystem structure and diversity by displacing populations of native species. Typically, these biodiversity impacts are attributed to direct interactions such as interbreeding, allelopathy, andresource competition; however, indirect interactions with invaders also affect native communities. One such interactionis the exchange of shared predator, parasite, or pathogenic enemies. Upon invasion, alien plants often carry specialist enemies from their native range or acquire novel enemies in the invaded region. These enemies may spill over to attack cooccurring natives, particularly, to close relatives of the hosting invader. Despite this, the extent to which shared enemies affect native species is poorly understood. I am investigating exchange interactions between native plant species in Ontario, Canada, and a common invasive thistle, *Cirsium arvense*. To do this, I am testing how *C. arvense* affects the performance of native plant species through the exchange of soil pathogens and insect herbivores. Additionally, I examine whether relatedness affects native plants' susceptibility to competition by enemy exchange. Finally, I quantify how *C. arvense* affects its own performance through its associated enemy community, providing a comparison between the tolerance of *C. arvense* and native species. This study provides insight into why *C. arvense*is successful in outcompeting natives, investigates how native-invader relatedness affects the potential for invasion, and addresses how indirect competition can affect the diversity of invaded plant communities.

MONDAY MORNING

Signs of evolution? Examining fecundityandseed size of *Rumex* spp. across climates in the native and introduced range

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Rapid evolution of alien plants in their introduced range has the potential to significantly influence the dynamics of plant invasions, yet it remains poorly understood. A potential powerful but underexplored approach to identifying post introduction evolution is the examination of trait–environment relationships observed in the field for alien species in the native and invaded range. In their native range many plants demonstrate a gradient of traits across different climates, but any new trait gradients in the introduced range may or may not match those found in the native range. To evaluate evolution post-introduction, we conducted field surveys of three species of *Rumex* (Polygonaceae), *R. obtusifolius, R. crispus*, and *R. conglomeratus*, in both the native range (United Kingdom) and the introduced range (New Zealand). Populations were sampled in four regions in each range that encompassed a similar gradient in temperature and precipitation. These *Rumex* spp. are ideal to study evolution because they have been present in the introduced range for c. 150 years, have a short generation time, and have not been deliberately cultivated by humans for particular traits, which could obscure natural evolution post introduction. We compare the overall fecundity of these *Rumex* spp. between the introduced and native ranges and assess the effect of climate on seed size and fecundity in the native range with climate effects in the introduced range to test for post-introduction evolution in New Zealand. Subsequently, we partition variation in seed size within and among sixteen populations in the native and invaded range and attribute variation to environmental gradients in each range. Using these data we explore how both the mean and variance in trait values can shift following introduction and the extent to which native trait–environment relationships are maintained following introduction.

TUESDAY AFTERNOON

Reaching new heights: alien plant dynamics in a montane ecosystem

Jesse M. Kalwij*[a,b], Lisa-Maricia Schwarz[a], Sophia C. Turner[c], Lena Y. Watermann[a], & Alexandra Erfmeier[a,d]

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Alien plants can strongly alter ecosystem structure and diversity by displacing popula Montane ecosystems are increasingly recognized as being susceptible to alien invasions. Even relatively pristine mountainous ecosystems display rising numbers of alien species. For example, longitudinal observations showed that alien plant species are rapidly increasing their upper altitudinal distribution limits (Kalwij et al. 2008, Kalwij et al. 2015). However, it remained uncertain whether alien species are able to complete their life cycle, or whether their occurrence is merely the result of dispersal events originating from the species population core (i.e., where species can complete their life cycles). To address this question, we recorded the occurrence and life stages of all alien plants along an altitudinal gradient. These data allowed us to distinguish between the edge of the species' population core and periphery. Previous longitudinal observations comprised of the three highest altitudinal observations of all alien species in the verges of a road covering an altitudinal gradient of 1,500–3,200 m a.s.l. in the Drakensberg, South Africa. In 2016 and 2017, we expanded on this sampling protocol by adding the highest altitudinal observations of flowering and seed-producing alien plants. In addition, we determined the highest altitudinal seed viability in a climate chamber. We found 84 exotic plant species, 70 of which had seeds. For annuals, highest observed individuals were at significantly higher altitudes than flowering individuals, but there was no difference between flowering and seed-bearing plants, or highest seed viability. For perennials, we found no significant difference in altitude between any of the life cycle stages. These results show that most alien species can complete their life cycle at very high altitudes.
Altitudinal range shifts, triggered by climate change or facilitated by anthropogenic disturbance, could therefore lead to an increased impact of exotic species in montane ecosystems.

WEDNESDAY MORNING

Comparative impacts of aboveground and belowground enemies on an invasive thistle

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Most research examining how herbivores and pathogens affect invasive plant performance focuses on aboveground interactions, while the importance of the belowground biotic community on invader success remains poorly understood. Even less well explored is the issue of whether the relationship between these interactions may change across space, leading to regional variation in the performance of an invasive species.
To address these gaps in knowledge, the noxious weed *Cirsium arvense* (Canada thistle) was used as a study system. *C. arvense* was grown in three common gardens across 509 km of its invaded latitudinal range in Ontario, Canada. In each plot, *C. arvense* seedlings from all three locations were protected with above- and/or belowground exclosures in a fully factorial design. After two months, plant size was measured and the above- and belowground biomass were harvested, dried, and weighed in order to provide a measure of overall plant performance. Performance was greatest when both above- and belowground exclosures were applied and lowest when no exclosures were applied. When only one type of exclosure was applied, plants performed better with belowground exclosures than they did with aboveground exclosures. This pattern was consistent between common garden locations. The negative impact of belowground interactions on the performance of this invader suggests that plant-soil interactions may be at least as important a determinant of its performance and potential for future spread as aboveground interactions.

TUESDAY AFTERNOON

Does seed persistence in the soil play a role in species invasiveness? Insights from burial experiments

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Recent research indicate that seed persistence in the soil could be an important determinant of species' invasiveness. To assess its role in determining the invasiveness of alien species, we conducted a burial experiment testing differences in seed persistence between 28 invasive and 45 non-invasive species in the Czech Republic. The fraction of seeds was exhumed each year (spring 2014 – 2017), and the proportion of germinated or decayed seeds, and of non-germinated but viable seeds, were determined in each sample. This allowed us to assess seed persistence/viability after 1.5, 2.5 and 3.5 years of burial. Preliminary results suggest that invasive and non-invasive species differ in seed persistence. Seeds of all invasive species were viable to some percentage after 1.5 year of burial in the soil, while 16% of non-invasive species did not survive during this burial period. Moreover, the majority of invasive species showed a high seed survival percentage (survival category 75 - 100%), while only low percentage of non-invasive species were viable in this survival category. After 2.5 years of burial in the soil, the majority of invasive species showed a seed survival percentage ranging from 5 - 25%, while non-invasive species were distributed rather evenly among all other survival percentage categories, with only 5% species in highest survival category. Invasive species tend to persist longer in the soil and have thus potential to form larger seed banks then non-invasive species. The differences in seed persistence between two categories of alien plants after 3.5 years of burial will be presented and discussed.

WEDNESDAY MORNING

Plant response to water stress of native and non-native *Oenothera drummondii* Hook. populations

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Oenothera drummondii subsp. *drummondii* (Onagraceae) is a native species from coastal dunes of the Gulf of Mexico. It is short-lived perennial herb, about 50 cm in height, with a strong taproot. Nowadays this species has extended on several coastal dune areas in temperate zones, all over the world, and invasion have become a significant problem in some coastal areas.
We hypothesized that *O. drummondii* possess an extraordinary capacity of adaptation, through morphological and functional traits, to the conditions of the new habitat. This plasticity together with an extraordinary reproductive and growing capacity turn into an extremely dangerous species for local plant communities.
To test this hypothesis we have collected seeds from 4 different populations of *O. drummondii* (México native, Israel, North and South of Spain), in order to compare plant responses under a drought stress treatment. Seeds were germinated in the greenhouse of the University of Seville, where 20 plants per population grew under optimal conditions. After one year, we randomly selected 10 control and 10 stress plants in each population, and morphological and physiological traits were measured before and throughout the drought treatment, which lasted two months. After this period all plants were re-watered to evaluate the recover capacity. During the experiment we have weekly recorded the weight of all pots and measured photochemical efficiency, leaf gas exchange, RWC, LMA in 5 control and 5 stressed plants from each populations.
Plants originated from humid populations (México and North of Spain) have experienced a higher stress manifesting a negative carbon balance at the end of the treatment; while plants from Israel maintained an almost null and those from the South of Spain were able to undergo a positive carbon balance. All plants recovered well after re-watering.
We can conclude that *O. drummondii* manifested an extraordinary adaptation capacity to local environmental characteristics, and these traits remain when we grow plants from different biogeographical origins under the same conditions. This capacity might be the clue for its extraordinary invasive behavior.

WEDNESDAY MORNING

Will drought stress promote invasion by *Hakea sericea* in Mediterranean-type ecosystems?

Maria Cristina Morais, Berta Gonçalves, João Alexandre Cabral

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Hakea sericea is one of the most problematic invasive alien species established in Portugal, where occurs mainly in the northern and central parts of the country, associated with roads, natural habitats, forests, and disturbed areas, where it can form dense, impenetrable, and sometimes extended mono-specific stands largely favored by anthropogenic disturbances. This species possesses a large canopy-stored seed bank and an event like a deliberate cutting or a wildfire results in the release of abundant seeds, which can increase its abundance and impacts, threatening the success of management efforts. The reduced water availability anticipated in climate change scenarios for the Mediterranean region would inevitably affect its growth and performance and, consequently, its invasive potential. Understanding how this species will interact with climate change will be helpful in predicting *H. sericea* trends and impacts in Portugal, but the role of such factor on the invasiveness of *H. sericea* is poorly understood. Therefore, the main focus of this study is to examine the effects of drought conditions (continuously moist and intermittent drought) under two light intensities (representing forest gap and shade conditions) on the establishment of *H. sericea*. The survival, growth and physiological characteristics of seeds and seedlings of *H. sericea* (photosynthetic pigments, proline, soluble sugars and antioxidant enzymes) were investigated in a growth chamber experiment. The results will allow managers to anticipate the invasion potential, mitigate its effects, and to improve the restoration of the ecosystems invaded by *H. sericea*.

Keywords
silky hakea, climate change, drought, light availability, germination, growth, physiological traits

TUESDAY MORNING

Is mediation of plant invasion by soil biota context dependent?

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Centaurea stoebe (spotted knapweed) invasion is limited in the Pacific Northwest (PNW) compared to monodominant stands established in the grasslands of Montana (MT). One difference between PNW and MT is annual rainfall, which can influence plant competition via moisture-driven shifts in soil pathogens and mutualists. We asked if soil moisture influences the competitive ability of *C. stoebe*, whether this is mediated by plant-soil feedbacks (PSF), and what ecological mechanisms may be involved. We grew *C. stoebe* with or without the common native grass *Bromus marginatus*, in live or sterile soil collected from *C. stoebe* populations in PNW and MT. Soil volumetric water content was kept high (~30%) or low (~10%). We measured *C. stoebe* biomass, arbuscular mycorrhizal fungal (AMF) colonization, root lesions and assessed potential shifts in the whole fungal (ITS) and AMF (18S) community using MiSeq.
Centaurea stoebe was largest in sterile wet soil. Growth was reduced by the addition of soil biota in wet, but not dry soil. This shift from negative to neutral PSF in drier soils also occurred when *C. stoebe* was grown in competition. In contrast, *B. marginatus* exhibited negative PSF regardless of soil moisture. Thus, soil moisture influenced PSF differently for each plant, with consequences for *C. stoebe*'s competiveness. The data show that higher competitiveness of *C. stoebe* with decreasing soil moisture may be driven by AMF, rather than pathogens. AMF colonization was highest in competing *C. stoebe* in dry soils, whereas few lesions were observed. Additionally, the AMF to pathogen ratio (estimated from ITS-sequences) increased in dry soils only for *C. stoebe*. Our results confirm that *C. stoebe* competitiveness increases in the presence of AMF, and that differences in soil moisture may influence the abundance, composition and function of AMF, which may help explain why *C. stoebe* is invasive in drier regions.

MONDAY AFTERNOON

Interactive effects of drought and plant invasion on longleaf pine communities

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Climate change and biological invasions are two primary global environmental problems but little is known about how such abiotic and biotic drivers might interact to affect the structure and function of native communities. We used a multiple-year, factorial common garden experiment to test the independent and interactive effects of simulated drought (via rainout shelters) and invasion (by cogongrass, *Imperata cylindrica*) on longleaf pine communities and ecosystem functions. Cogongrass, a perennial, rhizomatous, C4 grass, is one of the most widespread and problematic invaders in the southeastern US. The drought treatment significantly reduced soil moisture across the growing season but this effect was partially mediated by the invader. Invaded, drought treated plots had higher soil moisture, lower temperature, and higher humidity than uninvaded plots. As a result, although the invader had strong independent effects on longleaf pine, cogongrass also facilitated tree survival under drought conditions early in the experiment. However, as the invasion progressed, pine trees that had not emerged above the invader canopy were much less likely to survive. Invasion significantly reduced the diversity and altered the composition of herbaceous plant communities, while the effect of the persistent drought treatment had relatively little effect, and only in uninvaded plots. Finally, there were strong negative effects of invasion on arthropod richness and abundance, especially among herbivores and predators, and the treatment effects varied significantly over time. Altogether, our research highlights the difficulty in predicting the ecological effects of interactions between climate change and plant invasions, and suggests that biotic factors such as invasions may have greater impacts than abiotic factors associated with climate change.

WEDNESDAY MORNING

Molecular ecology of three invasive *Heracleum* species in Europe

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Heracleum mantegazzianum, *H. persicum* and *H. sosnowskyi* are three invasive species of tall hogweeds in Europe. They were introduced to Europe in the 19th century as garden ornamentals (former two) and a fodder plant in the middle of the 20th century (the latter). To study population genetic structure and variation we used AFLP fingerprinting and employed a biogeographical sampling approach on three scales: (i) continental, covering 16 countries in Europe, (ii) regional, covering three regions (UK, Czech Republic and Swiss Alps), and (iii) local, consisting of one river system in England. For *H. mantegazzianum* sampling also covered approximately a third to a half of its distribution area in the native range (Caucasus). Samples from native area of *H. persicum* (Iran) and *H. sosnowskyi* (Caucasus and Transcaucasia) were also obtained. In total we analysed ~2000 individuals from 180 populations. Preliminary results for *H. mantegazzianum* revealed higher within-population variation and isolation by distance in native compared to invaded populations. UK shows higher among-population variation than Czech and Swiss regions, possibly due to more isolated populations in UK. On the local scale, weak population genetic structure was detected within particular rivers, but stronger differentiation among rivers of the same catchment. In the paper, the population genetics of the three species will be compared and discussed with focus on differences in introduction history, migration and population/metapopulation structure.

Session 2 *How to promote and benefit from the collaboration of citizens?*

MONDAY MORNING

Achievements and challenges in South Africa's terrestrial invasive alien plant control programme

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South Africa's environmental weed control programme, Working for Water, simultaneously promotes conservation and poverty relief through environmental weed control projects. We trace the programme's history and review the factors that led to its success. These included a sound scientific grounding, a clear demonstration that the weeds are a serious threat to vital and scarce water resources, and a unique opportunity presented by South Africa's transition to democratic government. The programme built on historical precedents for control, and was able to capitalise on a core of dedicated managers that delivered a good-news story, leading to increased funding. The programme has facilitated advances in biological control, raised levels of awareness, enacted legislation, and promoted research. However, it has only treated a relatively small proportion of the estimated invaded area, and assessments of progress towards ecosystem-scale outcomes cannot be made as they are not monitored. The need to operate in a bureaucratic environment, an emphasis on job creation and relative neglect of environmental goals, and high levels of political interference are significant obstacles to progress.

Keywords
Poverty relief, water conservation, biocontrol, legislation, research

TUESDAY MORNING

The role of invasive alien species in shaping local livelihoods and human well-being

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Invasive species are recognised drivers of social-ecological change. However, most research focuses on ecological impacts, whilst the role of invasive species in human well-being and livelihoods is less understood. Yet, understanding the benefits and costs of invasive species for livelihoods and human well-being is necessary for guiding policy and management. Here we present findings from a number of case studies and a recent literature review on the role of invasive species in livelihoods. Findings indicate that most species provide a variety of benefits for and costs to livelihoods. From the review, almost half (45 %) of species studied had both positive and negative effects on local livelihoods (e.g. *Prosopis* species), with 38 % inducing mainly costs (e.g. *Chromolaena odorata*) and 18 % producing mainly benefits (e.g. *Opuntia ficus-indica*). Common benefits included the provision of firewood, fodder, timber and food products (and income from trade in such) and to a lesser extent supporting and regulating services such as soil improvement and shade. Some also provided cultural services such as recreation and spiritual values. However, in some cases invasive species also undermine livelihoods and increase vulnerability through encroaching land and reducing access, decreasing provisioning services and reducing agricultural production, all of which can result in losses that increase vulnerability. Furthermore, some invasive species have negative implications for human health and safety and reduce cultural values. Economic impacts on livelihoods were highly variable between sites and cases. The mean cost induced by invasive species was US$ 532±894 per household per year in comparison to benefits of approximately US$ 226±244 per household per year. The implications of these findings will be considered along with future research needs on the topic of invasive species and livelihoods to fill in research gaps and better inform policy formulation and management in the future.

MONDAY AFTERNOON

EEIKO: a control of invasive alien flora species multi-platform application

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EEIKO has been designed to use not only with plants, with animals, fungi or microorganism too. In compliance with the recommendations of EC Regulation 1143/2014.
EEIKO is a Geographical Information Systems technology based web platform with two different interfaces:

- **Input interface:** to inform citizens and to create awareness of the issue, as well as to report the new location of invasive alien species. Based on citizen participation and expert verification on a crowdsourcing basis, this approach is a disruptive innovation in this ecological area of. The platform citizens can use free. After verification, the new locations will be seen on EEIKO website. This database can be shared with other biodiversity platforms.

- **Output interface:** this interface has been designed to use by environmental authority. It is used:
    - to carry out invasives alien species control projects,
    - keeping the atlas of invasive alien species up to date,
    - to prevention the invasion,
    - to follow the results of the control invasive actions included the following of the restoration of the damaged ecosystems,
    - to have an early detection notifications,
    - to determinate emergency measures and rapid eradication at an early stage of invasions,
    - to have a history with the action, atlas, and evolution of invasive species.
    - To do inquiries and multiple inquiries to obtain information to do reports.

- It possible to work in the control of IAS with the platform and the same time with different managers, and to share the information or the results. This is very useful to cooperation and coordination between Member States.
- The EU is already supporting EEIKO. This project has received funding from the Horizon 2020 Research and Innovation Programme under grant agreement N° 743453.

MONDAY AFTERNOON

European Alien Species Information Network (EASIN): supporting scientific research & European policies

Eugenio Gervasini, Konstantinos Tsiamis, Ana Cristina Cardoso

Sharing scientific information is crucial to address the growing threat of alien species (AS). The European Alien Species Information Network (EASIN), launched in 2012 by the European Commission, is an online platform facilitating the exploration of existing information on AS from distributed sources, supporting scientific assessments and the implementation of European policies on AS (e.g. EU Regulation 1143/2014). EASIN records more than 14,000 AS occurring in Europe, including all kinds of taxa and habitats. For each taxon listed, EASIN gathers information on taxonomy, year and country of first introduction in Europe, habitat, pathways, impact, synonyms and common names. EASIN also aggregates, integrates and harmonizes spatial occurrences of AS in Europe, from a partnership of global and European databases and literature. The quality of the EASIN data is ensured by an Editorial Board, composed of experts on different taxonomic groups and habitats, contributing to the continuous update and review of the EASIN Catalogue through a dedicated platform. All the information gathered in the EASIN is publicly available through a widget framework, providing free, easy to use and flexible web tools for tailored searching, analyzing and mapping, aiding scientists and policy makers in obtaining high quality information. These web tools follow internationally recognized standards and protocols, while ownership of the data remains with its source. The EASIN datasets have been used for pan-European assessments of pathways and gateways of alien invasions, to model scenarios for the spread of aquatic species (Elodea nuttallii) and recently for an updated inventory, distribution patterns and introduction trends of alien terrestrial plants in Europe (in preparation), contributing thus towards the fulfilment of the related targets of European policies. EASIN is also oriented to citizen science, and developed a Smartphone Application "Invasive Alien Species Europe" allowing citizens to report invasive alien species of Union Concern.

Keywords
alien species, EASIN, assessment of invasion traits, policy, citizen science

MONDAY AFTERNOON

Participatory mapping of hotspots: where to keep the invaders out?

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Invasive alien plant species (IAS) challenge the integrity of ecosystems, especially on islands. Caribbean islands make up one of the world's 25 global biodiversity hotspots, with about 60% of the region's 12,000 plant species being endemic. Utrecht University works in Saba and St. Eustatius to facilitate decision-making regarding the management of IAS, such as Coralita (*Antigonon leptopus*). Ample ecological research has been conducted on this vine, with little impact in terms of policy or management measures. Hence, we approach IAS from a social-ecological perspective, explicitly involving perspectives of different stakeholders such as beekeepers, farmers and garden owners. First, we aim to understand how Coral vine's effects on ecosystem services are experienced by them, employing Q methodology. Participants rate 48 statements based on 4 discursive claims regarding 12 landscape values on a normal distribution. Factor analysis will derive several discourses from this, which we take to designate stakeholder groups. Second, we employed participatory mapping by having participants choose 5 areas they would like to see free from the vine, overlaying this with maps on the presence of and habitat suitability for Coral vine. On the "hotspots" that appear like this, one could e.g. base zoning proposals. Having identified the different stakeholder groups and hotspot areas we aim to support decision-making on IAS management, by kick-starting dialogue among government, scientists, citizens and nature managers on the islands in a next research step.

TUESDAY MORNING

Public Perceptions of Urban Plant Invasions: An Ecosystem Service Perspective

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Cities are instrumental in the management and transfer of ecosystem services (ES), arising both within and beyond cities, to beneficiaries. Many alien plants were introduced to urban centres specifically to create, augment or restore ES, however, many of these species have subsequently spread beyond original plantings, often causing negative effects on existing ES or creating novel ecosystem disservices (EDS). With IAPs firmly embedded in many urban landscapes, perceptions of IAPs and the ES or EDS they provide inevitably varies between and within beneficiaries of different socio-economic groups. Consequently, identifying the relative importance of ES for different beneficiary groups and the role IAPs play in the provision or disruption of these services in urban areas is necessary for effective prioritisation of IAP management/control efforts.

Using the city of Cape Town as a case study, a series of social surveys will be conducted at multiple sites across the city to determine the public's perceptions of a subset of widespread IAPs and their capacity to provide ES and EDS when accounting for the location of beneficiaries.

We hypothesise that IAPs play a significant role in the provision of ES across the city with relatively few associated EDS. The perceptions of IAPs and the ES or EDS they provide will differ markedly along the cities' socioeconomic gradient - IAPs are frequently compatible with recreational interests (cultural services) in the more affluent areas of the city, while providing a suite of provisioning services in the poorer communities.

This study may challenge popular negative assumptions about IAPs and suggest that they can serve important functions both for local ecosystems and for human communities. It may also provide lessons on the tension between and within different environmental imaginaries informing invasive species management.

MONDAY MORNING

Recent outcomes of alien hogweeds control activities in Estonia

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Giant hogweed (*Heracleum mantegazzianum*) and Sosnowsky's hogweed (*Heracleum sosnowskyi*) are listed as invasive species likely to disrupt natural balance according to the regulation of the Minister of the Environment of Estonia. Sosnowsky's hogweed is also listed as the species of European Union concern in the annex of EU Regulation 1143/2014 on Invasive Alien Species.
As a result of long-term state-controlled eradication efforts (since 2005 and ongoing), the further widespread dispersal of alien hogweed colonies has stopped in Estonia. Annual surveys show that hundreds of colonies are counted as exterminated or fading by now.
Public awareness plays crucial role in alien species management efforts. In November 2016, a public opinion poll to ascertain the population's awareness of the non-native species, including, more specifically, the invasive species of hogweed was carried through in Estonia. The survey studied people's attitudes towards the control of alien species, willingness to participate in eradication of the introduced species of hogweed, evaluation of the state's management measures, and sufficiency of information. In total, 1045 people aged 15 to 74 were questioned face-to-face. The survey showed that the most significant contrast in alien species, including invasive hogweed species, awareness is among nationality. Native Estonians are more informed than non-native Estonians. The awareness rate is also higher if the respondent has a higher level of education and/or job position. People aged 50 to 74 are most interested and aware of alien species. Younger people show less interest and are less informed. The poll results show considerable awareness shortages among certain population groups and help to address the awareness raising efforts more effectively.

TUESDAY MORNING

Is it possible to eradicate a plant invader? The case study of *Baccharis spicata* in Porto Metropolitan Area

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Baccharis spicata, a species native to South America, was reported for the first time within European territory in 2015. A couple of naturalized populations were detected in the surroundings of Porto suspected of being unintentionally introduced with goods arriving through the harbor of Leixões. A recent risk assessment using two types of protocol was applied to this species after the detection, showing that it presents a high risk of invasion for Europe and therefore special attention should be paid by the Portuguese and European authorities (Verloove et al. 2016).
The challenge of eradicating *Baccharis spicata* after its early detection through a collaborative program emerged early in the process, combining resources of several research centers, municipalities and volunteer citizens. The focus of the eradication program includes: to detect and map the existing populations (in order to evaluate if eradication is still feasible or containment may be more adequate), to train technical and operational staff as well as volunteers to detect and control the species and at the same time organize control activities with volunteers.

The methods used, the first results of the project and also the challenges faced during the project implementation will be presented and discussed.

MONDAY MORNING

Engaging stakeholders and understanding drivers of local knowledge and perceptions of invasive species to improve understanding and management of biological invasions

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Engaging stakeholders and understanding local knowledge and perceptions of invasive species is extremely important to guide policy formulation and management implementation to reduce the negative effects of biological invasions on humans and the environment. Research in the social domain represents a growing body literature within invasion science, as we come to realise that this field of study is highly complex and transdisciplinary issue. Here we discuss findings from a recent review that assessed the role that stakeholder engagement has within the field of invasion science. We then go on to discuss a subset of this engagement methodology which encompass understanding stakeholder knowledge and perceptions. We draw on a number of recently published case studies and a synthesis paper that is in progress to highlight the importance of this topic. Specifically, we focus on the drivers of knowledge and perceptions and how they differ across different social-ecological settings and areas of the world and what this means for policy and management. We also identify gaps and make recommendations for future research on this topic in our concluding remarks.

TUESDAY MORNING

Socio-economic impact of water weeds in the Incomati River in Mozambique

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The proliferation of aquatic weeds in the Incomati Basin River in Mozambique could be associated with the agricultural developments of the Maragra and Chinavane sugar cane farmers. Ironically, it is the practices of some of these farms along the river that create the nutrients on which aquatic weeds thrive, and these farms that are most impacted by weed infestation. The main objective of this study is to evaluate the socio-economic impact of invasive aquatic plants in the Incomati Basin River and methods used to control them.
The survey and consultation on the impact of aquatic weeds in the Incomati Basin River indicates that the current presence of water hyacinth, *Eichhornia crassipes*, water lettuce, *Pistia stratiotes* and red water fern, *Azolla folicoloides* on the surface area of and along the Incomati River caused the prevailing socio-economic impacts, since the problems mentioned during the interview include economic loss, interference with irrigation, diseases, transport problems. These socio-economic impacts, albeit from one system, provide the justification to control these weeds

Keywords
Invasive, Aquatic weeds, socio-economic Impact, Incomati River

Session 3 *Risk assessment and implementation of prevention tools*

TUESDAY AFTERNOON

Global assessment of alien plant impacts using the Environmental Impact Classification for Alien Taxa (EICAT)

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Invasion ecology has traditionally focused on understanding which species invade, what is the role of habitats on invasion process and how to control these taxa. In the last decade, attention started to be paid to understanding the impacts of alien taxa, in order to provide management with science-based arguments for prioritizing and managing invasive species. The types of impacts of invasive species are very different, but the knowledge of which impacts are associated with individual invading species is still rather poor. One tool towards closing this gap is the Environmental Impact Classification for Alien Taxa (EICAT), developed to capture this variation by considering 12 different mechanisms, each evaluate in five different impact categories and three confidence score. The EICAT scheme has been recently adopted by IUCN as an official tool for assessment of the impacts of invasive species.

In this paper, we present the first results of scoring impacts of plants that are considered as the most invasive globally. We evaluated 80 species, based on more than 600 articles in the scientific literature assessing impacts; on average there were 10 studies per species. Preliminary results show that there are 32 species with impact classified as massive, with 25 studies covering impact through the competition and 17 through poisoning or toxicity. Massive impact on ecosystems we recorded in 11 studies.

When scoring of plants is completed we believe that the results will allow to identify taxa that have different levels of environmental impact, facilitate comparisons of the levels of impact by alien taxa among regions and taxonomic groups, and predict potential future impacts of taxa in the target regions and elsewhere.

Keywords
impact, alien species, environmental impact, EICAT, impact mechanisms, management, impact categories

MONDAY MORNING

Can we predict impact from damage early in the season? The case of *Ophraella communa*, a potential biocontrol agent of *Ambrosia artemisiifolia*

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Ambrosia artemisiifolia, common ragweed, is a noxious Northern American plant that has become invasive in various continents, including Europe. In 2013, the leaf beetle *Ophraella communa*, which is used as a biological control agent in China, was detected in Northern Italy and Southern Switzerland. Most likely, it was introduced accidentally. Since its establishment, air-born pollen concentrations in the Milano area have dropped by approximately 80%, suggesting that *O. communa* has a significant impact on pollen production by common ragweed in Northern Italy. This impact is likely depending on the population densities of the multivoltine beetle.
In 2016, we studied the impact of *O. communa* on pollen and seed production of established individual common ragweed plants in a field experiment at four field sites in the Po plain. We specifically investigated the impact of *O. communa* on pollen and seed output and searched for predictors early in the season for impact on pollen and seed output.
We found that leaf damage remained low until the end of July, but then increased rapidly within 3 weeks to over 80% on average. High levels of *O. communa* damage on overall reduced pollen and seed production of common ragweed plants. This was due to both increased mortality of particularly smaller plants and a reduced reproductive output of surviving plants. Plant volume and leaf damage in June could be used as predictors of pollen and seed production at the end of the season. We discuss the influence of beetle demographics and abiotic factors on these findings.

TUESDAY MORNING

A generic and high-resolution spatial assessment of the invasion risk in Spain

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Biological invasions, being a well-recognized paradigm of global change, have been readily incorporated into the political agenda of many countries as a top-ranked environmental concern. Prevention has been distinguished as the most effective way to face this problem and there is no question that targeting areas and ecosystems at highest risk make preventive measures most efficient. However, risk assessments are usually undertaken on a species-specific basis, thus limiting their ability to make generalisations. Here, we present a simple model for assessing invasion risk that is independent of species and is based on a set of key determinants of the geographic pattern and level of invasion: 1) environmental similarity, calculated from bioclimatic data, 2) biodiversity similarity, approached from biogeographic variables, 3) propagule pressure, estimated from data on trade, tourism, immigration, population and terrestrial transport network, and 4) ecosystem disturbance, measured from land use and fire frequency. An assessment using this model is performed at 1 km2 resolution for the whole territory of Spain. The model identifies the geographic origin of the biological invasions that will likely affect terrestrial Spain in the next future and provides the most detailed generic spatial assessment of invasion risk within a country. Results are also compared with the present level of species invasion.

TUESDAY MORNING

Are Botanic Gardens still actively dispersing invasive plant seeds?

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The centuries-old practice of seed exchange among botanic gardens (BGs) is still an active endeavour, with hundreds of institutions worldwide participating in this network. *Indices Seminum* are crucial to increase plant collections at BGs, as well as sources of research material, but biological material circulation is not without perils. In fact, historically, BGs have been consciously, and unwittingly, involved in the introduction and acclimation of several species that are today naturalised or invasive in many parts of the world.
In the past few decades, a growing awareness of the problem and research on invasion biology has changed the perspective on this matter and BGs are on the forefront of research and society awareness on invasive plants and associated problems. In fact, the European Council and BGCI issued the European Code of Conduct for Botanic Gardens on Invasive Alien Species, in 2013. Most countries have legislated on invasive species, and the European Union issued the Regulation 1143/2014 on invasive species, valid from January 2015 onwards.
However, it is still not uncommon to find on *Indeces Seminum* species widely invasive, many of them subjected to international restrictions: water hyacinth (*Eichhornia crassipes*), tree of heaven (*Ailanthus altissima*), etc. In this context, we wanted to verify if the expected downward trend of invasive species on seed catalogues along time was a reality. For that, we selected a number of widespread invasive plant species and searched occurrences in *indices* from 1996 to 2016. Results will be presented and discussed.

MONDAY MORNING

Incorporating vegetation science in adaptive management of forest stands invaded by wattles

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Australian wattles, mostly *Acacia dealbata*, *A. longifolia* and *A. melanoxylon* have long invaded large stretches of Portuguese native and planted forest ranges. Either mixed stands where wattles co-dominate or have become dominant, are found throughout the Portuguese continental and island territories. Economic worthlessness, habitat loss of quality or collapse of the previous forest ecosystem follows invasion by wattles. Eradication efforts have been, for the most, of limited success. We devise a set of silvicultural models, i.e. protocols for the rational management of forest stands, thataim simultaneously at i) prevention of invasion, ii) attempting to reduce the presence of wattles in stands, ii) coping with wattles when eradication is not feasible while improving ecological and economical sustainability. The rationale of adaptive silvicultural models is based both on the knowledge of both populational features of invasives and of vegetation succession. Wattles are r-strategists producing large amounts of seeds and sprouts, germinating and growing earlier than native flora and are mostly prone to occupy first the gaps created by disturbance. In forest stands, disturbance issues either from i) natural or involuntary events: wildfire, tree mortality, pest attacks, gap dynamics, gravitational disturbance, etc.; or ii) management practices: logging, clear cuts, thinning, understory removal, tilling. Moreover, understory vegetation arises from the regional species pool assembling in plant communities with some degree of relation, in composition and structure, to those found in natural forest sucessions. We propose the active and rapid planting of such shrubs or small-trees in the gaps created along the management cycle of forest stands as to achieve coenotical saturation first with native flora and thus preventing opportunity to wattle invasion. Silvicultural models should encompass biogeographical specificities of vegetation, ecological and economical goals and realistic prospects of diminishing the degree of wattle invasion.

Keywords
Acacia, silviculture, gap dynamics, vegetation science

TUESDAY AFTERNOON

The challenge of weed risk analysis for biofuel crops in Canada

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Canada's renewable fuels strategy promotes the domestic production of biofuels. At present, the biofuel industry in Canada concentrates on first generation biofuels based on corn, wheat, canola and soy, while the development of second generation feedstocks such as those derived from lignocellulosic biomass is still in its infancy. However, interest in alternative feedstocks is increasing, as apparent by the growing number of requests to the Canadian Food Inspection Agency (CFIA), Canada's National Plant Protection Organization, for weed risk assessments on potential new, non-native biofuel species. A cautious approach to these species is warranted, due to the intent for large-scale cultivation coupled with the potential risk of invasion. In this presentation, I will provide an overview of the nascent biofuel industry in Canada, including new feedstocks of interest and the CFIA's approach to biofuel risk analysis. The multi-stage risk analysis process, based on guidelines developed by the International Plant Protection Convention, includes an initiation stage followed by pest risk assessment and development of risk management options. A recent risk analysis of *Arundo donax* provides an example and highlights some of the challenges of this approach. Interest in growing new feedstocks in Canada has also prompted the CFIA's initiation of a pre-approved list of low risk biofuel crops such as native species or non-native species with a low probability of invasiveness. The development of this list will follow a similar approach to one proposed recently in the United States, using risk assessment scores to rank species invasiveness, along with the addition of a climate-matching criterion to exclude species with a low establishment potential in Canadian climates.The aim is to promote a precautionary approach for feedstock selection by encouraging good species choices and preventing invasions while supporting innovation as the biofuel industry develops in Canada.

TUESDAY MORNING

Lessons to learn from plant species of EU concern in the assessment of future risk, prevention and management in the British and Irish Isles

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The list of species of EU concern (as per EU IAS Regulation 1143/2014) includes a number of plants that are not currently classed as invasive in the British and Irish Isles. In response to the EU IAS Regulation, an analysis is made of five of these species with the aim of determining what response should be mounted at a national level. In each case, the response must account for risk posed across the specified geographical area and, as a result of action/inaction, knock-on risk to the rest of Europe. The species are *Baccharis halimifolia*, *Parthenium hysterophorus*, *Cabomba caroliniana*, *Heracleum persicum* and *Heracleum sosnowskyi*. The investigation includes a detailed consideration of relevant biology and ecology, current distribution, pathway analyses, and a review of the risk assessments which led to these plants being listed as species of EU concern. Based on the evaluation, action is recommended on a species by species basis for each nation comprising the British and Irish Isles. Potential actions discussed include (i) surveillance recommendations including the potential for use of eDNA, (ii) practical methods of risk reduction, (iii) determining if rapid response protocols should be developed, (iv) identifying the most appropriate means of control, (v) evaluating how plant waste can be disposed of effectively and safely, and (vi) consideration of the need to develop mechanistic tools for large-scale risk assessment and management optimisation which account for pathways/interconnectivity. An analysis will be made of the findings for the above species in order to determine whether there are any trends between them and, if so, if these could be applied to other species across Europe currently on the list of species of EU concern, or to be added in the future.

MONDAY MORNING

Allocating resources to manage invasive plant populations

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Invasive alien plant managers have limited resources available to be allocated to different forms of prevention, surveillance, treatment, community engagement and research. For existing invasions that are being managed for eradication or containment, the underlying challenges can be addressed by developing a 'probability map' based on the best information available and improving it over time. Ideally, the map would show likelihood of weed presence in space based on habitat suitability, proximity to known invasions and other factors. This information would guide surveillance and treatment efforts. However, the 'probability map' could be as simple as a priority list of sites for monitoring and treatment. The ideal approach to use will depend on the budget, the size of the invasion and the resources available.
The optimal allocation of the budget among different activities depends on a number of factors, including the type of weed, the environment being invaded and the stage of the invasion. In the early stages, more funds may go towards targeted research to refine the probability map or to improve the surveillance and treatment methods. Once more is known about the invasion and the probability map is reliable, there is less need for research and a larger proportion of the budget would be allocated to surveillance and treatment.
In terms of temporal allocation, there is an important trade-off between total cost and duration of an eradication program. High surveillance effort early in the program is expensive but it results in higher probability of eradication and lower risk of containment failure.
In this paper we explain these principles and trade-offs, and present examples from existing weed eradication responses. We conclude by proposing ways of making these decision analysis principles more accessible to practitioners on the ground.

Keywords
surveillance, detection, eradication, decision analysis

TUESDAY MORNING

Forestry species and the risk of invasion to neighbouring ecosystems: *Pinus pinaster* and *Eucalyptus globulus*

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The expansion of forestry trees into habitats outside plantations is a relevant concern for managers and conservationists, and a relevant issue for biological invasion research. Among the most planted forest species worldwide, we can find Eucalyptus and Pinus species. Specifically, Portuguese planted forests are predominantly composed of two species, *Eucalyptus globulus* and *Pinus pinaster*. However, little is known about the regeneration and spread capacity of these species under different habitats and environmental conditions. Thus the overall goal of this study was to identify the spatial recruitment patterns of *P. pinaster* and *E. globulus* into habitats surrounding the plantations analysed according the specific objectives: (i) to determine the capacity of these species to colonize outside the planted areas, (ii) to evaluate their seedling establishment capacity under different ecological conditions, (iii) to identify those conditions that favor or hamper these species establishment, and (iv) to understand the main factors that drive natural establishment of these species.

These species presented very different recruitment characteristics, regarding the number of established seedlings and the distance of colonization, much higher for *P. pinaster*. Considering the seedling survival capacity, *E. globulus* displayed higher mortality rate during initial phase of seedling growth, when compared to *P. pinaster*. The better climate predictors explaining *E. globulus* recruitment were temperature seasonality and annual precipitation. *E. globulus* was more likely to be present in areas with low temperature seasonality and high annual precipitation. On the other hand, it was not clear how *P. pinaster* recruitment is affected by climatic conditions. Finally, site characteristics (such as habitat type, vegetation cover, and disturbance) were the most important group of variables influencing *P. pinaster* and *E. globulus*. Forest was the most resistant habitat to these species establishment. In the case of *E. globulus* also grasslands were very resistant to their establishment. In conclusion, the results that support this thesis suggest that the colonization outside plantation by *E. globulus* will likely be remarkably slow when compared to *P. pinaster*. Indeed, *E. globulus* limited expansion ability seems to be related with the combination of two characteristics: limited seed dispersal; and high seedlings mortality rate. In contrast, *P. pinaster* seedlings had high plasticity and drought resistance.

The findings presented here were crucial to understand the spatial pattern of *P. pinaster* and *E. globulus* natural recruitment, and the spread capacity of these important forestry species through their response in early colonization stages to environmental conditions, and can help to explain future shifts in these species distribution and natural establishment outside the planted areas.

Keywords
planted forest; tree invasions; natural regeneration; expansion capacity; Portugal.

MONDAY MORNING

Integrating invasive species policies across ornamental horticulture supply-chains to prevent plant invasions

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Ornamental horticulture is the primary pathway for invasive alien plant introductions. We critically appraise published evidence on the effectiveness of four policy instruments that tackle invasions along the horticulture supply-chain: pre-border import restrictions, post-border bans, industry codes of conduct, and consumer education. Effective pre-border interventions rely on rigorous risk assessment and high industry compliance. Post-border sales bans become progressively less effective when alien species become widespread in a region. A lack of independent performance evaluation and of public disclosure, limits the uptake and effectiveness of voluntary codes of conduct and discourages shifts in consumer preference away from invasive alien species. The examination of four major policy instruments targeting the ornamental industry supply-chain highlights

that while each has the potential to contribute to reducing the risk of plant invasions, none is sufficient on its own to stem the problem. However, integrating these policy instruments along the ornamental industry supply-chain would progressively reduce the risk more effectively. While the important role of government, industry and the public in stemming the threat from invasive alien plants is well recognised, there has been little guidance to date as to how actions appropriate for each stakeholder could be better coordinated and more complementary. We propose a clearer mechanism for integration but its delivery will require the development of closer partnerships between government, NGOs and industry, perhaps through a joint body that oversees the outcomes of independent weed-risk assessment, advances the effectiveness of codes of conduct, informs priorities for sales bans, endorses appropriate labelling, and promotes consumer education. Integration will require government-industry agreements to fund effective pre- and post-border weed-risk assessments that can be subsequently supported by widely adopted and verifiable industry codes of conduct. This will ensure customers make informed choices in the face of better targeted public education addressing plant invasions.

TUESDAY AFTERNOON

Accommodating impacts on ecosystem services in risk analysis: the EPPO way

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With the implementation of the EU Regulation (No. 1143/2014) on the prevention and management of the introduction and spread of IAS, a significant requirement for a species inclusion on the List of Union Concern is adverse impacts on ecosystem services. However, difficulties can arise when assessing impacts on ecosystem services in pest risk analysis as most studies are (1) biased to species which are widespread (and thus do not warrant a pest risk analysis), (2) have been conducted in other geographical regions (and thus are used as a proxy), or (3) are ambiguous to define due to short timeframes. Pest risk analysis is the technical and objective process of evaluating biological or other scientific and economic evidence to determine the level of invasion risk associated with a species. In this presentation, we will present the results from twelve risk analysis conducted on invasive alien plants under the LIFE funded project 'Mitigating the Threat of Invasive Alien Plants in the EU with Pest Risk Analysis to Support the Regulation EU (1143/2014)'. A new EPPO pest risk analysis for invasive plants has been designed to be compliant with the Regulation and it was decided at an early stage to score negative impacts on ecosystem services, biological diversity and socio-economic activities separately. Regardless of the small sample size, we had the opportunity to assess invasive plants with different life forms that originate from different continents and represent different track records of invasiveness.

TUESDAY AFTERNOON

Alien species classification according to their impact

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Alien species can cause a broad range of changes to the recipient ecosystems, and can affect people's livelihoods and health. Classifying alien species according to the magnitude of impact caused can inform management decisions and help to understand and mitigate negative effects. Novel standardised methods have recently been developed to serve this purpose. On the one hand, the Environmental Impact Classification for Alien Taxa (EICAT) includes impacts on native biodiversity and classifies alien taxa depending on the level of organisation affected in the recipient environment, ranging from impacts on individuals and populations to changes in the composition of communities. This scheme has been formally accepted by the IUCN as a tool to aid the conservation of biodiversity by assessing the threats posed by alien taxa; it can be used as such in concert with the Red List of threatened species.
In parallel, the Socio-economic Impact Classification for Alien Taxa (SEICAT) focusses on impacts caused on human well-being. Levels of impact focus on how alien taxa change what people are able to do, i.e. activities, ranging from impacts on individual persons to the disappearance of an activity from a region.
Both schemes assign impacts to one of five levels, from Minimal Concern to Massive based on semi-quantitative descriptions of scenarios; additionally they include categories for taxa which are Not Evaluated, have No Alien Population, or are Data Deficient. Both schemes rely on published evidence of impact, and they include a method for assigning uncertainty to classifications based on the quality of this data.
These schemes allow for the comparison of impacts between taxa and regions. We discuss their theoretical and practical applications for impact prediction, policy making and alien species management, and give examples of species already assessed.

Session 4 *Modelling plant invasions: the role of climate, traits and socioeconomy*

WEDNESDAY MORNING

Functional distinctiveness in plant invasions

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Invasive species can have large impacts on ecosystem structure, function and diversity but those impacts can vary widely depending on the traits of the invader and of the community being invaded. We demonstrate how a recently proposed framework of functional distinctiveness can explain differences in invader impacts between communities. This 'ecology of outliers' framework proposes that a few species can play unduly important roles within communities. Invasive species with traits that are already common in communities are functionally redundant and are unlikely to have major impacts. Instead, invaders with distinctive traits have greater impact, especially if they allow an invader to occupy a vacant niche and become abundant and dominant.

We apply this framework to observational and experimental data from invaded Australian grassy woodlands, collected over 7 years from 100 plots that were subject to various fencing and biomass removal treatments (i.e. simulated herbivory effects). Half of the plots were fenced, and biomass removal treatments carried out on a subset of fenced and open plots. As expected, the proportion of exotic invaders increased with increasing fertility and/or exclusion of major herbivores. Interestingly, some of the largest changes were driven by just one or two invaders. Examining species in terms of their functional traits, we see that these are species with distinctive traits that gave them a competitive edge when competing for light. When there are few limiting resources, the importance and intensity of competition increases and the number of available niches diminish. Under these conditions, subordinate species were excluded from the community leading to an overall decline in diversity.

We explore how the importance of functional traits in structuring communities can vary with environmental conditions, and discuss how they can be used to predict the impact of invasive species and conserve native species biodiversity.

WEDNESDAY MORNING

Evolutionary history as driver of plant invasion success: the role of diversification rates

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The introduction by humans and subsequent establishment of species in regions beyond their natural ranges has become a defining feature of global environmental change and biogeographic homogenization. However, naturalized plant species are not uniformly distributed across the phylogenetic lineages, with some families contributing disproportionally more to the global alien species pool and others less. Considering absolute species numbers, species-rich families (i.e. Poaceae, Asteraceae, Fabaceae, Brassicaceae) contribute most to regional alien species pools. However, family importance changes when the relative contribution to alien species pools is analysed (e.g. Papaveraceae). This indicates, that phylogenetically clustered characteristics such as species' traits, association with anthropogenic habitats, or the location and size of species ranges affects the global distribution of naturalized species.

At macroevolutionary scale, estimation of diversification rates show substantial differences between angiosperm plant families and over time within families. High diversification rates have been associated with high species richness in certain clades and very high extant species numbers correlate with the highest diversification rates in three clades: (i) higher monocots (Poales & Cyperales), (ii) core asterids (Apiales & Asterales) and (iii) core rosids (Fabales & Rosales).

Here, we take advantage of the two lately compiled datasets on the (i) phylogenetic history of angiosperm plant families and (ii) global naturalized and invasive alien plant species, to provide the first comprehensive analysis of the relationships between diversification rates and alien species establishment and invasion success worldwide.

WEDNESDAY AFTERNOON

Improving invasive species distribution models using prior knowledge and casual occurrences

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Species distribution modelling (SDM) is a well-established tool for predicting the potential distribution patterns of invasive non-native species. Specifically, SDMs aim to map the likelihood of establishment by a non-native species should it be introduced or disperse to each location in the modelled landscape. Global-scale SDMs for invasive species are typically developed using statistical algorithms that contrast the environmental conditions where the species' occurs with those at 'pseudo-absence' locations sampled from a background landscape, termed presence-background (PB) models. However, developing PB models for invasive non-native species is not trivial and modellers typically employ strategies to account for dispersal and sampling constraints on the distribution and to avoid extrapolation during global model projection. Here, we argue that there is flexibility to further adapt PB strategies for invasive species to make a more complete use of knowledge about the species' distribution and environmental requirements. We propose two simple and easily-implemented innovations that can be implemented with commonly-used modelling software: (1) increasing the realism of modelled responses by using prior biological knowledge to define highly unsuitable regions to include in the model background region; (2) helping the PB model to learn about where is unsuitable for establishment by using casual occurrences as 'absence' data. We test our approach by modelling the global potential distribution of Japanese hop (*Humulus scandens = H. japonicus*). We show that the proposed innovations improve predictions of its potential invasion in Europe, increase the realism of the modelled responses to climatic factors and reduce the need to extrapolate during projection to new regions.

WEDNESDAY MORNING

Non-naturalized alien garden plants are more competitive against resident species under climate change

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Through repeated introductions, frequent plantings and trait selection, alien garden plants are responsible for the majority of plant invasions. Nevertheless, only a small portion of horticulturally-introduced species escape to become invasive. For many, this is likely due to inadequate climatic suitability in their introduced ranges. Climate change, however, may reduce this barrier for many species. Few studies have experimentally explored how non-naturalized alien garden plants will respond to climate change, and those that have addressed only singular aspects of climate change. Here, we examined the performance of ten non-naturalized alien herbaceous garden plants in a greenhouse experiment under joint increasing temperature and reduced precipitation treatments consistent with climate projections for Konstanz, Germany. To account for potential indirect effects of climate change on non-naturalized alien colonization success, through effect on resident plants, we grew our study species in competition with local resident native and already-naturalized alien species. Reduced precipitation negatively affected both non-naturalized alien and competitor performance similarly, particularly at higher temperatures. However, regardless of precipitation treatment, non-naturalized aliens performed better against competitors when temperatures increased. Thus, even if absolute performance does not improve under projected future climates, non-naturalized aliens may still be able to establish by outcompeting resident species. Resident naturalized alien competitors performed better than native competitors across all treatments, suggesting that they may be more resistant to climate change than native species. Future climates are therefore likely to promote not only new invasions from frequently-planted alien species, but also an increasing predominance of already-naturalized aliens in the landscape.

MONDAY AFTERNOON

Distribution and competitors to *Ambrosia artemisiifolia* in the Czech Republic

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Ambrosia artemisiifolia, an annual plant native to North America, was unintentionally introduced to Europe in the 19th century. Because of its negative impact on human health, agriculture and biological diversity it is nowadays considered as one of the most dangerous European alien invaders. From the Czech Republic it is known since 1883, up to the 1990s it was recorded in about 80 localities, while about 300 localities in 164 grid cells are recorded up to now. The distribution is shaped mainly by the proportional area of industrial, commercial and transport units, further fine-tuned by factors related to human-related dispersal and climate, such as density of railway network and temperature, respectively. The prediction model indicated that many suitable grid cells are unoccupied and further spread is highly likely, supported by ongoing climatic changes and increasing propagule pressure due to the rapid increase in abundance of the species in a wider area of central Europe. As an annual, *A. artemisiifolia* is crucially dependent on the successful performance of juvenile plants. Seedling growth and development are influenced by temperature and nutrient levels. The seedlings grow in the range of temperatures 10 to 34 °C, the growth is faster under higher temperatures and greater nutrient supply, reaching maximum biomass at 30 °C. The temperature optimum is higher than that of some potential native competitors and this fact should be taken into account when choosing species for competitive mixtures developed to suppress *A. artemisiifolia*. *Bromus erectus*, *Lotus corniculatus* and partly also *Phleum pratense* were identified as the successful competitors in a competition experiment.

Keywords
plant invasions, seedlings, environment, temperature, salinity, nutrients, competition

MONDAY AFTERNOON

Geostatistical modelling of seasonal variation of invasive plant species with the use of hyperspectral data

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Maps of spatial plant species distributions are required for different aspects of environmental research, resource management, and conservation planning. They may also be applicable to monitoring and control of invasive species. This study aimed to determine the relationship between selected aspects of seasonal variability (e.g. cover andthe life-cycle stages, co-dominants) for *Heracleum sosnowskyi* and *Fallopia* spp. using geostatistical methods supplemented by field data set and hyperspectral imaging.
Fitting semivariogram models (ordinary kriging and cokriging) was tested by the cross-validation (CV), which resulted in an accurate predicted coverage models for analyzing species. In order to verify the correctness of the conducted modeling, the following errors were calculated: mean error (ME) and root mean squared standardized error (RMSSE). The cross-validation for *H. sosnowskyi* indicated the following errors: ME=0.08, RMSSE=2.53 (ordinary kriging), and ME=0.07, RMSSE=1.04 (ordinary cokriging) respectively. In case of *Fallopia* spp. the CV showed ME=0.09 and RMSSE=1.6. Hence, the exact coverage models for taxa were obtained. These errors values indicate to well-conducted estimation. ME with a value close to 0 informs about small differences between the value measured and the value estimated, while RMSSE indicates a slight underestimation of the variables in the grid interpolation. The results showed that the substantial amount of sampling points can increase the accuracy of the maps. However, an additional variable (e.g. hyperspectral image) revealed the most of details on them.
Using geostatistical tools allows the visualisation of species distribution and cover in local scale, and their accuracy depends on number of variables and sampling points.
Research has been carried out under the Biostrateg Programme of the Polish National Centre for Research and Development (NCBiR), project No. DZP/BIOSTRATEG-II/390/2015: The innovative approach supporting monitoring of non-forest Natura 2000 habitats, using remote sensing methods (HabitARS).

MONDAY AFTERNOON

Macrophyte control by managed flows using habitat suitability modelling

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Mediterranean rivers from intensive agricultural watersheds usually display an outgrowth of macrophytes notably by alien species due to high concentrations of nutrients in the water runoff and low flows resulting from water abstraction for irrigation. Standard mechanical and chemical control is used to mitigate problems associated with the plant biomass, mainly an increased flood risk. However, such control measures are cost and labor intensive and do not show long-term efficiency. Although the high sensitivity of aquatic vegetation to instream hydraulic conditions is well known, management approaches based on flow regulation are still poorly explored.

The aim of our study was therefor to apply physical habitat simulation techniques to model the shifts in habitat suitability for macrophytes under different flow scenarios in the Sorraia river in central Portugal and to test whether such an approach can be used to regulate the area for establishment of invasive species.

We analyzed the habitat utilization regarding the physical parameters flow velocity, water depth and substrate of the four most important aquatic species, including the invasive alien *Myriophyllum aquaticum*. The field work was performed during the lowest discharge period of the year to assess the minimum hydraulic conditions allowing for aquatic vegetation establishment and subsistence. We then proceeded to model the potential habitat availability for different flow conditions based on the site-specific habitat suitability index for each physical parameter and species, using the two-dimensional hydraulic model River2D.

Our results show that the distribution of aquatic vegetation is primarily a function of the different hydraulic conditions found in the river. Using site specific preference curves and a 2d hydraulic model it was possible to determine minimum annual flows that could prevent the excessive growth and channel encroachment caused by aquatic vegetation. Specifically, managed flows could allow for the control of the invasive *Myriophyllum aquaticum*.

WEDNESDAY AFTERNOON

Predicting plant invasiveness using climatic niche traits: a framework for priorizing invasive plant control in Chile

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Climatic niche traits have been increasingly used to predict invasiveness; their use is based on the assumption that niche requirements properly integrate and reflect plant performance. Currently, they can be easily assessed, given the amount of global environmental information and the recent technologies that allow massive data processing. In this study, we evaluated the relationship between invasiveness and climatic niche traits such as niche breadth and niche position for a set of 49 exotic species in Chile.

Plant invasiveness was estimated using potential distribution area obtained from global species distribution models. Data occurrences were obtained worldwide and correlated with climatic data using MAXENT. The projected potential area of species in Chile ranged from 88,411 km^2 (*Atriplex numularia*) to 738,702 km^2 (*Cirsium vulgare*), with an average of 509,320 km^2. We detected a significant positive relationship between potential distribution and thermal niche breadth and a significant negative relationship with thermal niche position. The additive model, including those two traits, explained 55% of the variation in potential area.

Besides contributing to the ecological understanding what traits best explain invasiveness, this study gives an accessible tool to managers, helping prioritization of actions in order to prevent establishment of new exotic plants or eradicate the most invasive plants at regional scales.

MONDAY AFTERNOON

Seed bank density and persistence as predictors of species invasiveness

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Soil seed banks can play a key role in plant invasions, acting as sources of propagules and genetic diversity, and promoting the persistence of a species in a community even under unfavorable environmental conditions. To assess the role of seed bank traits and related species strategies in determining species invasiveness, we used a database comprising data from natural seed banks for 2700 species, including 687 invasive species, in 14526 records. Specifically, we tested whether (1) invasive and non-invasive congeneric species differ in seed bank type (transient vs. persistent) and density, in their native and non-native distribution range, and, (2) for invasive species only, whether these traits differ in their native and non-native distribution range. Preliminary results indicate that the characteristics of the seed bank of invasive congeners did not differ significantly from those of non-invasive congeners, either in their native or non-native range, although these patterns were strongly species- and genus-specific and habitat-dependent. Interestingly, invasive woody species formed a consistently denser seed bank in their non-native than native range, while such differences were not significant for other growth forms. Perennial grasses showed a significantly higher probability of forming a persistent seed bank in their non-native range, possibly associated with higher disturbance levels in the introduced range, while the opposite was found for annual herbs. Overall, there is little evidence that species that become invasive are pre-adapted to the novel conditions encountered in their introduced range with respect to seed bank traits and that persistent and/or large seed banks are a requirement for the spread of naturalized alien species. The fact that invasive and naturalized but non-invasive species share similar seed bank strategies suggests that these strategies play an important role in the initial phase of establishment but not in the invasion phase.

WEDNESDAY AFTERNOON

Comparative patterns of plant invasions in the mediterranean biome

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We compared the patterns of alien plant invasions in the world's five mediterranean-climate regions (MCRs). We expected landscape age and disturbance history to have bearing on levels of invasion. We assembled a database on naturalized alien plant taxa occurring in natural and semi-natural terrestrial habitats of all five regions (specifically Spain, Italy, Greece and Cyprus from the Mediterranean Basin, California, central Chile, the Cape Region of South Africa and Southwestern - SW Australia). We used multivariate (hierarchical clustering and NMDS ordination) trait and habitat analysis to compare characteristics of regions, taxa and habitats across the mediterranean biome. Our database included 1627 naturalized species with an overall low taxonomic similarity among the five MCRs. Herbaceous perennials were the most frequent taxa, with SW Australia exhibiting both the highest numbers of naturalized species and the highest taxonomic similarity (homogenization) among habitats, and the Mediterranean Basin the lowest. Low stress and highly disturbed habitats had the highest frequency of invasion and homogenization in all regions, and high natural stress habitats the lowest, while taxonomic similarity was higher among different habitats in each region than among regions. Our analysis is the first to describe patterns of species characteristics and habitat vulnerability for a single biome. We have shown that a broad niche (i.e. more than one habitat) is typical of naturalized plant species, regardless of their geographical area of origin, leading to potential for high homogenization within each region. Habitats of the Mediterranean Basin are apparently the most resistant to plant invasion, possibly because their landscapes are generally of relatively recent origin, but with a more gradual exposure to human intervention over a longer period.

WEDNESDAY AFTERNOON

Factors influencing naturalisation and invasion success in woody horticultural species

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Worldwide many invasive plant species are garden escapees. While weed risk assessment can reduce the number of new plant introductions with weedy potential, this does not address the issue of the large number of non-native plant species already present in many regions, the majority of which are horticultural species. Variables that might influence whether an introduced species successfully naturalises and becomes invasive include planting effort, residence time, species traits and taxonomic attributes.
We evaluated the importance of these variables on plant naturalisation using data on the horticultural woody species introduced to Canberra, Australia. Canberra provides a unique opportunity for this evaluation because it was a planned city with extensive horticultural plantings originating from government nurseries, meaning there are excellent records documenting planting effort from the time the city was established. We accounted for the direct effects of variables on naturalisation and invasion success by fitting univariate and multivariate models, and for indirect effects using path analysis in a Bayesian framework. Species more likely to naturalise were those with greater planting effort, longer residence time, small seeds and those with dispersal mechanisms linked to wind and animal dispersal. Cold hardy and tall plants were also more likely to naturalise but cold hardiness and height mostly affected naturalisation success indirectly via planting effort. Species belonging to the families Poaceae, Leguminosae, Apocynaceae and Rosaceae had a higher probability of naturalisation than other families. Among the above mentioned factors, only planting effort and plant family were significantly associated with naturalised plants spreading to become invasive. These findings will be used to build a quantitative risk assessment model that will allow us to predict woody garden species that pose the greatest risk of becoming invasive in the future and can assist in detection and management of new incursions.

Keywords
Garden escapees, woody species, planting effort, residence time, species traits, Bayesian framework, path analysis

WEDNESDAY MORNING

Functional and phylogenetic effects on abundance of native and alien species across spatial scales

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Biological invasions of ecosystems by non-native species cause ecological and economic problems worldwide. Although many studies have tried to understand the mechanisms (e.g., biotic resistance, environmental filtering) that allow certain plant species to succeed in a new range, studies have shown variable support for different mechanisms and it therefore remains difficult to obtain a general understanding of patterns and mechanisms and predict potential future invasions. Possible factors contributing to the differences among studies are differences in vegetation, environmental conditions, and spatial scale. Here, we bring together data from 7 studies, each with data on different spatial scales, to evaluate if we can predict plant invasion patterns from functional and phylogenetic indices across studies and spatial scales. Specifically, we ask 1) how differences in traits and similarity influence the relative abundance of native and alien species at different spatial scales, and 2) what determines differences in results among studies.
We expect that 1) at fine spatial scales, non-native species that are dissimilar to the native community (i.e. niche complementarity) and have acquisitive trait values (i.e. competitive advantage) would be most abundant. At broad spatial scales, non-native species that are similar to the native community and have trait values that are well-suited to the environment would be most abundant (i.e. pre-adaptation). Furthermore, we expect that 2) at high resource availability, species with acquisitive trait values would outcompete other species, and hence competitive advantage would be more important than niche differences. All relationships would be similar for native and alien species. We test these predictions using a unique combination of data from 7 studies from different ecosystems.

Session 5 *Biosecurity and management of alien plant invasions*

THURSDAY AFTERNOON

Updates on management and progress made towards eradication of *Pueraria montana* var. *lobata* (kudzu vine) in South Africa

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The leguminous *Pueraria montana* var. *lobata* (kudzu vine) is ranked as one of the worst invaders in the world. It has a substantial and persistent root-stock from which it can quickly grow and smother native vegetation and forestry plantations. In this study we determine the distribution of P. montana in South Africa, assess the threats it poses, investigate what is limiting its current distribution, determine the effectiveness of current management activities, and provide recommendations for national management strategies. Kudzu vine was introduced to South Africa the 1930s from Argentina, but fortunately only to one farm. Currently there are 9 populations and the total area occupied is 74 ha (condensed ha). These populations have been subject to sporadic control operations in the past, which likely slowed down its spread. Given the threat it poses to South Africa and Africa more generally, a major investment in the control is warranted. Since 2013 we have been intensively controlling root stocks in an attempt to extirpate small populations, and have drastically reduced populations. In cases where root-stocks are large, or occur in sensitive riverine habitat, longer term control will be needed, with strict regulations need to be enforced to prevent spread. Finally it is vitally important that this species is not promoted for use in other African countries.

THURSDAY MORNING

Testing the effectiveness of two biological control agents on the invasive plant *Carpobrotus edulis*

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Carpobrotus edulis (L.) N.E. Br. is a South African succulent plant which invades temperate coastal areas around the world, modifying the abiotic environment and affecting composition, diversity and dynamic of plant communities in different coastal habitats. Current control efforts to eradicate *Carpobrotus* sp. (i.e. physical and chemical) usually lack effectiveness and/or are aggressive to native plants.
However, biological control has not been tried for this species until now. In a 6-months greenhouse experiment, two potential agents of control – the scale insect *Pulvinariella mesembryanthemi* (Vallot) (a highly specific insect feeding on the plant) and the fungus *Sclerotinia sclerotiorum* (Lib.) de Bary (a generalist pathogen native in Europe) – were tested to check their effects on four native (South African) and four invasive (Iberian) populations on different ecophysiological parameters.
Five plants of each population were individually potted in a peat-sand (1:1) mixture and assigned randomly to one of four treatments (control, fungus-inoculated, insectinfested and fungus and insect-infested). Chlorophyll fluorescence and spectral reflectance parameters, as well as plant mortality, were recorded every month.
Plants inoculated with the fungus showed significantly less photochemical efficiency and chlorophyll content than control and insect-infestated plants respectively, while plants infested with *P. mesembryanthemi* showed lower fluorescence yield and lower survival than control plants. The combination of both agents led to a higher chlorophyll degradation and to a lower survival than control plants. The normalized difference vegetation index that correlates empirically with photosynthetic activity was population-dependent. Nevertheless, there was not a clear pattern of higher sensitivity of native or invasive plants of *C. edulis* to each control agent or to the combination of both agents. Both agents seem to be able to affect negatively to the invasive plant, although more time may be needed in order to provoke serious damage on them or, on the contrary, to achieve their recovery.

THURSDAY MORNING

First report of the establishment of the biocontrol agent *Trichilogaster acaciaelongifoliae* for control of invasive *Acacia longifolia* in Portugal

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Acacia longifolia is one of the most widespread invasive plants in coastal areas of Portugal where it disrupts the composition and function of natural plant and insect communities as well as microorganisms in the soil. Although biological control is frequently considered a sustainable and environmentally compatible method of pest control (insect pests and weeds) and has been used extensively around the world for over a century, the intentional introduction of natural enemies to control invasive plants has only recently been considered for use in Europe Union Member States. The Australian bud-galling wasp, *Trichilogaster acaciaelongifoliae*, reduces seed production of *A. longifolia* and has been successfully used as a biological control agent in South Africa for more than 30 years. After a long period of host specificity testing and risk assessment, release permits were issued by Portuguese and European Union authorities and, in late 2015, *T. acaciaelongifoliae* was released into eight selected sites along the Portuguese coast. During 2016, post-release monitoring detected 56 galls at four of the release sites, and in at least two sites second generation galls were noticeable in early 2017. Further releases were made in late 2016 and monitoring of the insects will continue. Although the number of galls detected are currently low, it is noteworthy that after only one release campaign, and considering the major challenge of crossing hemispheres and the adverse field conditions during the release (mostly windy and cold), *T. acaciaelongifoliae* is starting to establish in Portugal, the first time in the northern hemisphere. It is also encouraging that the wasps have already synchronized their phenology to match the northern hemisphere seasons. In addition to the analysis of the release process and first results, studies being developed for wide-scale monitoring, including interaction networks and remote sensing will be discussed.

WEDNESDAY AFTERNOON

The more the merrier for *Pereskia aculeata* biocontrol? Perhaps not!

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Pereskia aculeata is a primitive creeping cactus that is a serious environmental weed in South Africa. Two biological control agents have been released against *P. aculeata*, the first in 1991 and the second in 2014. The first agent released, *Phenrica guerini* (Chrysomelidae), was considered ineffective but recent evaluations have indicated that it is providing some level of control at a limited number of sites in the country. The second agent, *Catorhintha schaffneri* (Coreidae), has not been established for long enough to determine how effective it will be, but preliminary data suggest that it will be more damaging than *P. guerini*. Interaction studies conducted on potted plants under greenhouse conditions indicate that there is an antagonistic relationship between the two agents and that *C. schaffneri* alone is more effective than either *P. guerini* alone, or both agents in combination. These data suggest that *C. schaffneri* should be the focus of future mass-rearing and release efforts; and that releases of *C. schaffneri* should not be made at sites where *P. guerini* is already established. Further post-release assessments are required to determine whether *C. schaffneri* will reduce *P. aculeata* densities below the damage threshold or whether a third agent will be required. This study emphasises the importance of considering the interactions between biological control agents prior to release. More emphasis should also be placed on selection of the most effective agent during the early stages of biological control programmes because once an ineffective agent is established it could reduce the efficacy of future agents which may have controlled the target invasive alien plant.

WEDNESDAY AFTERNOON

How far is Europe united in the fight alien plant invasions?

Jan Sliva, Alberto Cozzi & Bent Jepsen
NEEMO EEIG

The EU Regulation no. 1143/2014 on invasive alien species (IAS) entered into force in January 2015. While focusing on prevention, early detection and rapid eradication, and management, it aims at addressing the problem of IAS in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize the human health or economic impacts. The Regulation is centred on a list of IAS of Union concern, which currently contains only 14 plants. Numerous alien plant species that significantly affect biodiversity in entire biogeographic regions (e.g. *Asclepias syriaca, Reynoutria japonica* or *Impatiens glandulifera*) are not yet included.
The European Commission is supporting actions on IAS through several financing instruments among which, the LIFE program has an outstanding importance in respect of the management of both the species of Union concern, and all the rest of non-listed species that endanger biodiversity. Between 1992 and 2013, a total of 265 LIFE projects included measures dealing with IAS, out of them 178 and 15 projects targeted terrestrial and aquatic plants, respectively.
Large amount of valuable knowledge has been collected through the LIFE programme for the management of IAS, even before the EU Regulation was developed and enforced. However, the experience gained from LIFE realisations shows differences between regulations of individual Member States and/or within countries on regional level that may handicap the optimal transfer and application of best practice methods. So it may happen that some administrations still prefer outdated and inefficient approaches. We suggest the development of a suitable platform that would provide updated information on best practice and recommendations on the Union level to make the most of such experiences. This contribution shows examples of existing differences. Possible ways for a better capitalisation of the existing knowledge and experience are suggested and discussed.

WEDNESDAY AFTERNOON

Established alien invasive trees and probable invader trees in Arizona, USA.

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Four alien trees have established in Arizona wildlands, often in riparian habitats. These trees include: *Ailanthus altissima* (tree-of-heaven), *Elaeagnus angustifolia* (Russian olive), *Tamarix ramosissima* (salt cedar) and *Ulmus pumila* (Siberian elm). *Tamarix ramosissima* and *A. altissima* can be found over most of the state, while *E. angustifolia* and *U. pumila* are in cooler landscapes of northern Arizona. Ecological characteristics of these species will be described. These trees invade sites with more soil moisture compared upland areas and especially compete with native riparian vegetation. In dense stands, the alien trees lower biodiversity, alter stream flow and watershed yield. Mechanical and/or chemical treatments are used to manage these woody plants. Biological control using (*Diorhabda* sp.), a leaf eating beetle, was released for *T.ramosissima* control by the US Department of Agriculture in 2002. The results are interesting. Six alien trees, mostly confined to urban/residential sites in the Phoenix area displaying invasive behavior. These species include: *Acacia stenophylla* (shoestring acacia), *A. saligna* (Australian golden wattle), *A. farnesiana* (sweet acacia), *Leucaena leucocephala* (lead tree), *Rhus lancea* (African sumac) and *Ulmus parvifolia* (Chinese elm). Some of these species are observed at considerable distances outside of the urban/residential areas, indicating their invasive nature.

THURSDAY AFTERNOON

Management techniques for the control of *Melinis minutiflora* P. Beauv. (molasses grass): ten years of research on an invasive grass species in the Brazilian Cerrado

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Exotic species invasions are considered to be a major threat to the preservation of biodiversity and in the National Park of Brasilia, *Melinis minutiflora* (molasses grass) is present in over 10% of the area. In this long-term study we compared two treatments for control of molasses grass 1) a single burn and 2) integrated management (a single burn + herbicide sprays + manual removal). The aerial biomass of molasses grass in the experimental area initially represented ca. 55% (55.0 ± 17.42%) of the total aerial biomass of the ground layer. A single burn was not sufficient to control molasses grass, and it attained its pre-treatment values of biomass after two years, ca. 4.2 t/ha. The integrated management reduced and maintained its biomass at less than 1% of its original value after two years and this level was maintained throughout the study, proving to be a promising strategy for the environmental recovery of areas invaded by molasses grass in the Cerrado. The floristic richness of the ground layer in the different treatments ranged from 260 to 329 species/400 m2 at and generally increased over the study period in all treatments. Based on our experience, we can estimate that a team of three workers would need approximately 8 hours near the end of the rainy season and prior to flowering to maintain one hectare free of molasses grass. However, because of the great recolonization potential of molasses grass long-term monitoring and targeting of re-establishment outbreaks with immediate intervention are needed to maintain biological diversity of the native vegetation.

THURSDAY AFTERNOON

Island of aliens: plant invasion in protected areas of Java, Indonesia

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Inhabited by 145 million people, Java Island in Indonesia is currently the most populous island in the world. Java has long period of human interference which was responsible for dramatic natural vegetation change and landscape modification. However, the island contains the remaining biodiversity in small protected areas in a 'sea' of settlement, intensive agriculture, and massive infrastructure construction. We established 403 (10 x 5) m plots along trails in eight national parks varied from lowland to mountain and from wet rainforest to dry savanna. Forty four data loggers were set up to record temperature and humidity and 35 soil samples were collected for chemical analysis. Principal component analysis was applied to describe species composition across the parks, in addition to generalized linear mixed model to elucidate environmental factors affecting number and abundance of invasive plants in each park. We found 67 alien plants. *Lantana camara* and *Chromolaena odorata* spread in all park, while *Clidemia hirta* was absent in the two driest parks. *Elephantopus scaber*, *Hyptis capitata*, and *Passiflora foetida* were in all lowland parks but none of the mountain parks. In contrast, *Ageratina riparia* and *Austroeupatorium inulaefolium* were in all mountain parks but none of the lowland parks. Thirty three species occurred in only one park, including *Acacia nilotica* which now covers more than 60 km^2 of the Baluran National Park after 40 years since the first planting. Canopy cover and altitude significantly affected abundance of invasive plants, where parks with the highest canopy density and were isolated at opposite ends of the island were the least invaded. History of plant introduction appeared to be another important factor determining which species occurred in which park. Lessons from Java are likely to be an ideal case study for biological invasions into protected areas on a continental island in Asian tropics.

THURSDAY MORNING

Limiting the invasion of an exotic plant on an experimental prairie

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Ecologists, conservationists and land-managers have long been fighting on the frontier of alien plant invasion. Despite these efforts, invasive plant species are an increasing problem for ecosystems and economies around the world. Aggressive invaders can make ecosystem restorations particularly difficult. Some invasive species alter the community assembly process, leading to undesirable outcomes for community composition in restoration projects. In North American prairie restorations, the aggressively invading legume, *Lespedeza cuneata*, is difficult to manage with traditional methods once it becomes dominant, leading to the need for new research to determine how to curb its invasion during the community assembly process.

We conducted an experiment running since 2009 to determine the separate and interactive roles of community assembly, nutrients, and invasion timing on the abundance of *L. cuneata*. We manipulated (i) the timing of the seeding for species groups (grasses – forbs) in order to test whether grass-dominated communities resisted invasion better, (ii) nutrients in order to test whether the invasive legume gains a competitive advantage in nutrient-poor soils through its nitrogen fixation and (iii) timing of *L. cuneata* invasion to determine if established communities could better resist invasion. We demonstrate that each treatment significantly reduced the cover of *L. cuneata*.

This success has several implications: First, it highlights the importance of establishing competitive native species to suppress invasive species. Second, nutrient addition was successful at reducing invader cover, suggesting alternative means of controlling invasive legumes. Third and most important, our results show that continuous invasion control in early years of restoration can promote success of the native community. Excluding much lower covers of exotic invaders, other structural changes in the community indicate these methods of restoration seem to have lasting effects on prairie plant community assembly processes.

Keywords
Invasion, *Lespedeza cuneata*, prairie, invasion timing, community assembly, nutrient addition, *sericea lespedeza*

WEDNESDAY MORNING

Controversial *Robinia pseudoacacia* in Europe – a site-specific strategy for sustainable management

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Robinia pseudoacacia (black locust) was one of the first North American trees introduced into Europe. As a result of long-term cultivation and invasion, it has become a part of the landscape, nature, culture and economics. The same properties that make *Robinia* attractive for cultivation, i.e. nitrogen fixation, wide habitat tolerance, fast growth and vigorous vegetative propagation, are the source of problems in nature conservation and environmental management. Positive economic (timber, biomass, honey, firewood, erosion control etc.) but negative environmental impacts result in conflicts of interest among different groups of stakeholders when management priorities are to be decided. Such conflicts are often viewed only in a local context, therefore the current management varies locally according to national legislation, preferring either socio-economic benefits or biodiversity impacts. *Robinia* is not been included on the recent list of IAS of EU concern, although it is ranked among the top 26 plants in Europe with highest negative impact. Removing *Robinia* from the list could compromise the ability to control it where it is necessary. On the other hand, *Robinia* grows in habitats ranging from urban to forest to natural grassland and in some cases it can have a positive environmental effect, e.g. in intensively used agricultural landscapes. Therefore, stratified management that takes into account habitat, species' local ability to spread, as well as economic, cultural and biodiversity aspects is the preferrable approach, tolerating *Robinia* in selected areas and eradicating it from naturally valuable habitats. We introduce practical decision framework for sustainable *Robinia* management in Europe. Based on rigorous cost-benefit analysis and identification of potential conflicts, management practices ranging from tolerance to slow conversion by succession and rapid eradication are suggested. The decision scheme is linked to categorization of stands with *Robinia* into eight groups.

WEDNESDAY MORNING

Australian *Acacia* species in South Africa: an assessment of introduction status and potential for eradication.

Nkoliso Magona, David M. Richardson, Johannes J. Le Roux, Kanyisa Jama, Philip Weyl, Suzaan Kritzinger-Klopper, John R. U. Wilson

Australian *Acacia* species (wattles) are widespread and abundant invaders in many parts of the world, and have caused substantial impacts on biodiversity and ecosystem services. South Africa is a hotspot for invasions by wattles, but the last detailed inventory of the group in South Africa was based on data collated forty years ago. In this project, we aimed to determine: 1) how many wattles have been introduced to South Africa; 2) which species are still present; 3) the introduction status of species that are present; and 4) whether it is possible to eradicate taxa with restricted distributions. All herbaria in South Africa with specimens of wattles were visited and locality records were compared with records from the literature, databases, and expert knowledge. For taxonomically uncertain taxa we employed DNA barcoding approaches. Field surveys were conducted to confirm the presence at previously known localities and they were categorized according to the Blackburn Scheme. We found evidence that 114 species of wattle had been introduced to South Africa, of which 50 are still present. Seventeen of these species are invasive (16 are category E, one is D2); 8 have naturalised (C3); and 25 are present but not yet known to successfully reproduce (C1). It is clear that systematic re-evaluations of historical records of the type conducted here is crucial if the status of even well studied groups of alien taxa is to be accurately determined. Finally we report on on-going efforts to manage the 8 naturalised species.

Keywords
Australian acacias, herbaria, invasive species, management plan, tree invasions

THURSDAY MORNING

Potential exchange of invasive plant propagules by trade

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Recent research activities concerning the role of trade in alien plant spreading deal usually with database data on species richness and do not answer the question what amount of their propagules can be transported from one to another country. On example of bilateral trade exchange between Slovakia and Romania, our study as first tries to quantify potential export/import of invasive plant propagules from/to any country, both as a part of consignment as well as attached on the way (stowaway), defines trends in terrestrial good shipment and highlights white places in this area of knowledge.

Taking into account spreading characteristics and habitat preferences of 30 most dangerous invasive plant species, statistical data on commodity exchange between these two countries for period 2006 -2010 combined with transport mean usage as well as normative for commodity purities, we found that mostly exported from Slovakia were: *Amaranthus* sp., *Galinsoga* sp., *Kochia scoparia* and *Sorghum halepense*. Depending on export extent, Romania could receive from 1.3 to 289.4 t of each. On the other hand, from Romania much more species (*Amaranthus* sp., *Artemisia annua*, *Conyza canadensis*, *Cuscuta campestris*, *Datura stramonium*, *Erigeron annuus*, *Galinsoga* sp., *Iva xanthiifolia*, *Kochia scoparia*, *Lycium barbarum*, *Sorghum halepense*, *Veronica persica* and *Xanthium orientale* subsp. *italicum*) could be exported to Slovakia but in much lower extent (from 0.2 to 37.2 t). Export of cereals could play the most important role in the invasive plant exchange. From the transport means, road transport was ever more preferred.

WEDNESDAY MORNING

The Nagoya Protocol: implications for classical biological control and the management of invasive plant species

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The Nagoya Protocol is a supplementary agreement to the Convention on Biological Diversity (CBD) with the aim to provide a legal framework for the *Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization* (ABS). The Protocol entered into force on 12 October 2014 and has been ratified by 96 countries as of 29 March 2017. "Utilisation of genetic resources" is defined as "to conduct research and development on the genetic and/or biochemical composition of genetic resources". This therefore impacts our work when searching for, collecting and studying natural enemies in their native range, as potential biological control agents for invasive weeds. Some countries, for example most of Europe, are not restricting access to genetic resources. However, in other countries the situation has proven more complicated. Despite some regional efforts each country is likely to implement the Nagoya Protocol in different ways thus complicating legal access and use of genetic resources. Our presentation aims to give an overview of the issues arising for classical biological control through the Nagoya Protocol and the recent steps we took to try and find pragmatic solutions. We emphasize the growing importance to exercise due diligence when it comes to ABS to guarantee that classical biological control remains a viable tool for invasive plant management.

WEDNESDAY MORNING

Management of alien plant invasions in five priority habitats for conservation in the Azores: achievements and failures in 15-years of experience

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The mountainous eastern part of São Miguel island, Azores Archipelago, Portugal, holds priority habitats for conservation (Council Directive 92/43/EEC) such as endemic Juniper forests (code 9560), Macaronesian laurel forests (code 9360), endemic Macaronesian heaths (code 4050), active raised bogs (code 7110) and bog woodlands (code 91D0) among other important natural habitats of the Azores. Moreover, the single population of the endemic Azores bullfinch (*Pyrrhula murina*), one of Europe's most endangered birds, is restricted to this area which is largely threatened by alien plant invasions. These reasons encouraged Sociedade Portuguesa para o Estudo das Aves (BirdLife partner in Portugal) to implement sustainable management measures for the conservation of the rare Azores bullfinch and the preservation of endangered priority habitats, and supported the application to European funding by this non-governmental organization since 2003. Direct actions for the recovery of natural habitats have been carried out mainly by controlling invasive alien plants and planting native species grown in a nursery built specifically for habitat restoration purposes. On the course of three LIFE projects, invasive alien plants have been removed from almost 500 ha of natural habitats in remote mountainous areas. Several innovative mechanical and chemical methods have been tested for the control of several alien species (*Pittosporum undulatum*, *Acacia melanoxylon*, *Clethra arborea*, *Hedychium gardnerianum*, *Hydrangea macrophylla*, *Gunnera tinctoria*, *Cyathea cooperi*, *Dicksonia antarctica*) and techniques have adapted according to the monitoring of intervention areas. Successful (and unsuccessful) protocols will be presented in this communication so that they could be replicated in invaded ecosystems worldwide.

THURSDAY AFTERNOON

How strong, stable relationships killed the drama and 10,000 plants

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Strong, stable funding for post-border management of invasive species is critical to ensure that new and sparsely established pest species do not create permanent, costly impacts to agriculture and conservation areas. Early Detection and Rapid Response capacity in Hawaii is largely tax-payer funded, and is affected simultaneously at the local, state, and federal level by strong shifts in the U.S. economy, such as the 2007 economic recession. During the past five years, for example, the Hawaii Invasive Species Council has received relatively strong and consistent funding, when compared to the previous five years (though at no point have funds been sufficient to meet statewide need). During this same time period, the Big Island Invasive Species Committee (BIISC) had adopted an Early Detection and Rapid Response (EDRR) approach to invasive species management. Six target species were selected in 2008 to demonstrate the potential for eradicating species newly established on the island of Hawaii. In this presentation, we will examine progress made toward eradication of each species between the recession years of 2008 – 2012, and during the economic recovery from 2013-present. We discuss effective mapping for systematic eradication of species, and the expansion of partnerships and science advocacy in the political sphere as factors contributing to the recovery of ISC programs. An encouraging picture emerges, for those optimistic about the economic future of Hawaii and the U.S..

WEDNESDAY AFTERNOON

Can novel methods control ragweed? Assessing long-term efficacy by experimentation and demographic modeling

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Populations of the North American common ragweed (*Ambrosia artemisiifolia*) have invaded most other continents. In the past decades the species has dramatically spread in Europe, adversely affecting human health and crop production. Traditional control methods (herbicides, mechanical damage) are insufficient to reduce populations in the long term and are inapplicable in many habitat types.

Here, we examine the long-term efficacy of some novel control methods. One method is classical biological control with the exotic *Ophraella communa*, a leaf beetle that has colonized ragweed populations south of the Alps after accidental introduction into Europe. It has already proven successful in controlling ragweed in China and Australia, but it is unclear how it will perform under European conditions. Another method concerns mowing regimes specifically targeted to reduce ragweed pollen and seed production.

We experimentally tested how application of these methods over 3-7 consecutive years affected quantities and traits of ragweed plants and seeds of common ragweed field populations in Europe. We subsequently incorporated the established effects into Integral Projection Models to investigate how they would affect the long-term growth rates of ragweed populations. Projections of our models suggest that the beetle reduces these growth rates below replacement level, also under stochastic environmental conditions. We used life table response experiments to identify which underlying demographic processes are responsible for these effects. Projections of the mowing effect into different backgrounds representing different European environmental conditions indicate which mowing regime is most successful in each of these backgrounds. We will discuss the implications of these results for the potential of using these novel methods in Europe, and the resulting benefits for human health.

Session 6 *The impact and consequences of biological invasions*

TUESDAY AFTERNOON

Effects of non-native tree species on cultural ecosystem services: an assessment approachwith insights from the Iberian Peninsula

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Limitations in the assessment of cultural ecosystem services (CES) through objective and quantifiable approaches have constrained our knowledge of how global changemay affect human well-being. Here, we address this caveat by evaluating the effects of non-native tree species (NNT) on multiple CES, including recreationand ecotourism, aesthetics, inspiration, and cultural heritage. We propose an indicator-based approach, based on the systematic screening of photographic, internet and catalogue information systems,and respectivemeta-analysis through the odds ratio. We test our approach in the Iberian Peninsula, to assess the effects of NNTon CES,and on pollen allergenicity as a related ecosystem disservice. We further assess land cover and management, socio-economic and climatic determinantsofthe variation in the effects of NNT on CES across Portuguese and Spanish administrative regions. Overall, the effects of NNT differed across CES. NNT contributed more to aesthetic and cultural heritage CES than expected by chance. For recreation and ecotourism, we observed an opposed situation, with official tourism entities showing preference for NNT, but with tourist users exhibiting preference for NT. No trends were found for inspiration and pollen allergenicity. The effects of NNT on CES also varied with social (e.g., economy, tourism, unemployment) and climatic (e.g., temperature, precipitation) determinants, and depended on the amount of forest and protected areas across Portuguese and Spanish regions. Our approach is a step forward to quantifyCES with special emphasis on non-native species effects, allowing reproducibility for worldwide assessments and to support decision-making.

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THURSDAY AFTERNOON

Impacts of alien plant invasions on water resources and yields from the Western Cape Water Supply System (WCWSS)

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A key motivation for managing invasive alien plant (IAP) species is their impacts on stream-flows, which, for the RSA as a whole, are comparable to forest plantations at about 970 m3/ha/a or 1 444 million m3/a (2.9% of naturalised mean annual runoff). We modelled the impacts on yields from the WCWSS under three scenarios: current invasions; by 2045 under ""No Management""; and under "effective" control.

Streamflow reductions (SFRs) by invasions were simulated using the Pitman model, with taxon-specific mean annual and low-flow SFR factors for dryland (upland) invasions and crop factors for riparian invasions, to generate stochastic flow sequences for the WCWSS model for the three scenarios. The 98% assured total system yields were ±580 million m3/a, compared with ±542 under existing invasions and ±450 with "No Management". Ongoing invasions could result in a total annual reduction equivalent to the capacity of the Berg River Dam. This finding confirms that IAP-related SFRs can be significant. Invasions are already having a significant impact on water production by South Africa's water source areas and are projected to increase. These are losses the country cannot afford so invasion control measures are essential, not optional.

TUESDAY AFTERNOON

Is tree-of-heaven really that invasive? – Origin and human caused distribution of tree-of-heaven in Eastern Austria

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Tree-of-heaven (*Ailanthus altissima* Mill. Swingle) is considered as one of the most noxious, most invasive tree species. Since its first reported introduction in Europe in the 18th century, tree-of-heaven has spread throughout whole Europe except for the far North. According to historical reports, tree-of-heaven was first introduced in Paris in the 1740s and then in other large cities. Because of its aesthetic value, its tolerance against air and soil pollution and resistance to herbivory it was planted in cities, along roads and in parks. After the destructions of World War II and with increasing climate change it is considered to have started its massive spread from urban areas to rural sites and riparian and open forests. In Austria, tree-of-heaven today is widely distributed in the warmer, eastern areas of the country. This has caused increasing concern among ecologists and forest managers, who are fighting this tree with different costly mechanical and chemical methods. What is rarely considered in the discussion about the invasiveness of tree-of-heaven are the few literature records on intentional plantings of tree-of-heaven such as in shelterbelts or for soil stabilisation. An investigation of the genetic differentiation of tree-of-heaven stands in Eastern Austria based on molecular markers and a survey among forest managers suggest that the spread of tree-of-heaven was heavily supported by humans since the 19th century. The current wide-spread distribution of tree-of-heaven therefore must not only be attributed to its high reproductive success, but has been strongly shaped by numerous plantations. In some cases, the progeny of only a single tree were used for such plantations.

WEDNESDAY AFTERNOON

Partitioning of seedling microsites can facilitate invader establishment in native grasslands but limit their impact

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Exotic plant species may invade new locations because they colonise microsites that are not used by native species (they occupy a different niche), or because they outcompete native species for shared microsites (they are a superior competitor). This distinction is important because under the first scenario even widespread invaders should have little impact on native species, while under the second scenario invaders could exclude native species. We describe a model that estimates the degree to which two species overlap and compete for establishment microsites using data from seed addition experiments, allowing us to quantify niche and competitive differences among species. We hypothesised that the relative importance of niche and competitive differences will vary along resource gradients. A greater number of favourable microsites may occur under high resource conditions, leading to microsite competition among species, while under low resource conditions species may be restricted to specific microsites that match their particular requirements, leading to niche differentiation.
We tested these ideas by adding seeds of six common grassland species, three native and three invasive, to cleared plots at different densities on their own, and in pairwise combinations. We created an experimental resource gradient by adding nutrients to some plots. We show that individuals of the same species compete strongly for microsite occupancy but rarely compete with other species. Rather, species partition microsites regardless of resource availability. An exception was the native species *Chloris truncata*, which dominated plots and reduced microsite availability for both native and invasive species under all resource conditions when moisture was not limiting. Our results suggest that partitioning of establishment microsites may be common and allow exotic species to readily invade disturbed grasslands and coexist with native species. Competition for microsites, leading to competitive exclusion, may occur only when certain species encounter conditions particularly favourable for their establishment.

WEDNESDAY AFTERNOON

How *Acacia longifolia* engineers its soil: From hitchhiking nurse plants to disrupting N/P cycles

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Mediterranean basin ecosystems are under increasing pressure from invasive species, which are a global change driver interacting with other threats to ecosystem functioning, such as alterations of nitrogen (N) and phosphorus (P) cycles. Many Mediterranean soils are highly oligotrophic and N and P co-limited, which makes ecosystem-engineering species especially problematic, as they can change the medium to long term soil functioning, with detrimental effects on the native vegetation. Woody legumes, such as the Australian *Acacia* spp., are prolific invasive species in the Portuguese dunes and can be considered ecosystem engineers, fundamentally changing the ecosystem they invade, increasing soil organic matter levels, changing soil nutrient cycles and creating monospecific stands that fully replace the native vegetation.

Many of the aboveground changes occurring in this process are well known and are related to the high growth rates of this species, resulting in abundant litter and root production. However, it remains elusive how *Acacia* plants establish themselves in oligotrophic systems before they can start to create large amounts of biomass. Also, while *Acacia* spp. introduce large amounts of carbon (C) and N into the ecosystems they invade along time, little is known about the fate of other crucial macronutrients, such as P. Lastly, while litter and root mass have been suggested as major sources of belowground biomass input, the rhizosphere as an interface between plant and soil has rarely been addressed.

Here, we address these questions using *Acacia longifolia* as a model plant. We show how *A. longifolia* manipulates soil organic matter pools even before litter production starts to introduce organic matter. Also, we explore the complex relationships between N and P in biomass production and how *A. longifolia* exploits its phenotypic plasticity and nutrient use efficiency in order to outperform local plants and ultimately fully invade the affected ecosystem.

THURSDAY MORNING

Four- trophic level food webs reveal the cascading impacts of an invasive plant targeted forbiocontrol

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Biological invasions are a major threat to biodiversity and as such understanding their impacts is a priority. Ecological networks provide a valuable tool to explore such impacts at the community level, and are particularly insightful for biocontrol programs, including the potential for their seldom evaluated indirect non-target effects. *Acacia longifolia* is among the most widespread invasive species in Portugal, and has been recently targeted for biocontrol by a highly specific gall-wasp. We used a replicated network approach to: (1) identify the mechanisms by which direct and indirect impacts of *A. longifolia* can cascade from plants to gallers and their parasitoids and inquilines; (2) disentangle the interaction networks between plants, gallers, parasitoids and inquilines before the biocontrol; and (3) explore the potential for indirect interactions among gallers, including those established with the biocontrol agent, via apparent competition. During 15-months, we collected a total of 219 plants and 31737 galls from native plants and identified 49 galler-, 65 parasitoid- and 87 inquiline-species. No galls were found on any of the 16 alien plant species. Invasion by *A. longifolia* simplified alarmingly the plant communities, with bottom-up effects, namely decreasing overall gall biomass, and richness, abundance and biomass of gallers, their parasitoids, and inquilines. Correspondingly, we detected a significant decline in the interaction richness between plants and galls. The invasion tended to increase overall interaction evenness by promoting the local extinction of native host-plants of gall species. However, highly idiosyncratic responses hindered the detection of further consistent changes in network topology. Predictions of indirect effects of the biocontrol agent on native gallers via apparent competition ranged from negligible to highly significant. Such scenarios are incredibly hard to predict, but even if there are risks of indirect effects it is critical to weigh them carefully against the consequences of inaction and invasive species spread.

THURSDAY MORNING

The influence of invasive plant species cover on different biological communities in temperate ponds

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More than one-third of alien freshwater organisms are known to cause an ecological impact, but there is still a knowledge gap on how impacts are related to alien plant abundance. We investigated the association between cover of three aquatic invasive species *Hydrocotyle ranunculoides*, *Ludwigia grandiflora* and *Myriophyllum aquaticum* and abundance and diversity of different functional groups such as native plants, phytoplankton, zooplankton and pollinator activity. We sampled the different communities of 18-32 ponds in Belgium concurrently with various local environmental variables including cover of the invasive species. Our results demonstrated a strong negative association between cover of the invasive species and cover of the resident native vegetation because these invaders usurp a large amount of space throughout the water column. Impacts proliferated to other trophic levels as we found that the cover of the three species was negatively correlated with zooplankton density. The dense interwoven mats created an adverse environment for especially macrophyte-associated genera. Invasive species cover did not have a significant influence on phytoplankton biovolume. Our results on pollinator services showed that the presence of a high abundance of *L. grandiflora* facilitated pollinator visits to native *Lythrum salicaria* but this was not translated in increased seed set. Interspecific pollen transfer, using fluorescent dye, was investigated for *L. salicaria* and Alisma plantago-aquatica in presence and absence of *L. grandiflora*.Conspecific pollen loads remained high for *L. salicaria* in presence of *L. grandiflora* while the reverse was true for *A. plantago-aquatica*. This research adds to the general understanding of patterns of impact of invasive species since it has brought insight that impacts not only occur within the same trophic level but can cascade throughout an aquatic ecosystem and affect multiple biological communities. It also shows the importance of incorporating invasive species cover when studying impacts of invasive species.

THURSDAY MORNING

The impact of invasive herb *Impatiens glandulifera* on ecosystem functioning of the temperate forest is small and varies between years

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We studied impact of an invasive annual herb *Impatiens glandulifera* (Balsaminaceae) in a woodland community. The species is widespread along watercourses, where its impact has already been studied, but recently it is spreading further from the river courses into the adjacent forests. We focused on the complex impact of *I. glandulifera* on plant-soil feedback and functioning of the forest ecosystem. We set up a field experiment with three treatments: plots invaded by *I. glandulifera*, removal plots within the invaded site and spatially separated uninvaded plots that served as reference plots. We recorded > 40 variables over three years: soil characteristics including micronutrients, litter layer properties and enzymatic activity in litter, and species composition and richness of the herb layer.We demonstrate that *I. glandulifera* does not dramatically change soil and litter characteristics and has no effect on enzymatic activity and plant species richness of invaded community. We detected differences in floristic composition over time among invaded, uninvaded and invader-removed plots with supposedly negative effect of invader on light-demanding species. This suggests that the effects of *I. glandulifera* are mostly caused by shading other species in the invaded plant community. Finally, differences among uninvaded, invader-removal and invaded plots rarely remained significant during all three years of the study. This points to how misleading the evaluation of impacts can be if based on only one season.

THURSDAY MORNING

A dual challenge for suburban forests: abundant deer and non-native,invasive plants

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Suburbanization of the landscape causes fragmentation of natural areas that support most of a suburban region's biodiversity. In much of the eastern United States, small parcels of temperate deciduous forest are embedded in a matrix of human-dominated land uses. Such forests face a dual challenge: invasion by many European and Asian plant species and white-tailed deer at very high densities (due to a lack of predators/ hunting). These forests are depauperate in native plant abundance and/or diversity. Is this due to over-browsing by deer, competition from invasive plants, or their combination? I established a well-replicated factorial field experiment with all combinations of novel introductions of the European plant *Alliaria petiolata*, the Asian plant *Microstegium vimineum*, both, or neither, with exclusion or presence of deer (via exclosures), in six suburban forests in New Jersey, USA (224 4x4 m plots). Initial establishment of *Alliaria* was much lower than *Microstegium* (0-188 vs. 13-605 plants/plot) and was especially low in plots where *Microstegium* cover was greatest, indicating that co-invading plants can influence each other's invasion success. *Microstegium* cover was highly variable among years and forests, but established best in the more depauperate forests (higher deer pressure). In the spring flora, percent cover of native herbaceous plants increased with protection from deer in the more depauperate forests, but was unaffected by *Microstegium*, while woody plant cover in those forests increased with deer protection and decreased with *Microstegium*. In the fall flora, herbaceous native cover was much lower and had little response to either treatment, but native woody plants mirrored the spring woody flora's response. Non-native woody juveniles (all shrubs) did not respond to either treatment in either season. These results suggest that both high deer pressure and a new non-native plant invasion can cause native plant decline, while not affecting the resident non-native plant community.

TUESDAY AFTERNOON

Novel interactions between *Carpobrotus edulis* and invertebrate species in the native and non-nativerange

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The long history of intentional and unintentional introductions of alien species around the world has favoured the establishment of novel interactions between exotic and native organisms. An example is the interaction between native herbivores and Invasive Alien Plants (IAPs). It is widely assumed that many IAPs could accumulate natural native enemies in the introduced ranges, especially when it comes to long-term invasion processes. *Carpobrotus edulis* (L.) N.E. Br.invades a wide range of Mediterranean coastalecosystems threatening biodiversity. We have discovered somenovel interactions between native herbivores and invasive *C. edulis* in its introduced range. Here we analyse the abundance, species richness and evenness of native herbivores feeding on *C. edulis* in its native (five populations in South Africa, from September to December 2016) and in non-native range (five populations in Spain and three in California, from March to May 2016). We established 10 random quadrants per population to assess the interactions of native herbivores with *C. edulis*, and used 10 yellow sticky traps per population to compare invertebrates'groups only in South Africa and Spain. Our results showed that abundance, species richness and evenness of invertebrates were higher in South Africa than in the non-nativerange. Moreover, in the non-native range most of interactions are with generalist invertebrates, while in South Africa most of the interactions are with specialised herbivores. However, native spittlebugs, snails and exotic specialised herbivores – as *Pulvinariella mesembryanthemi* (Vallot, 1829) – were found feeding on *C. edulis* in native and non-native areas. Overall, our findings suggest IAPs can gain natural enemies in the non-native range in a relative short period (100 years). We conclude that *C. edulis* produces impacts in the invertebrates' community structure in the non-native range, affecting local ecological networks. Additionally, native invertebrates take advantage of *C. edulis* as a new food source and habitat.

THURSDAY AFTERNOON

Impacts of invasive trees across different trophic levels: Is the difference between the invaded and native stands consistent for plants, nocturnal Lepidoptera and birds?

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Invasions by alien trees represent a significant conservation problem, as trees often function as ecosystem engineers, creating the environment for other species. Therefore, complex impacts of invasive trees can be presumed. We compared 19 one-hectare plots invaded by a North-American invader to Europe, *Robinia pseudacacia* (black locust), with 20 plots dominated by native trees. Further, we compared stands with the exotic *Pinus nigra* with the stands of the native *Pinus sylvestris*. We sampled plants as producers, nocturnal Lepidoptera (moths) as herbivores and birds as predators. The differences in species richness were tested using marginal models and the composition of species and their basic ecological characteristics was compared using the ordination models. Possible cascading effects of the invasive trees, studied across the three trophic levels, were explored by the path analysis.

With the exception of birds in the stands of *Robinia pseudacacia*, similar richness of the remaining focal groups of species was detected in the stands dominated by native and alien trees, but the species composition and their ecological characteristics differed. For example, in Robinia-invaded stands, nitrophilous, hemerophilous and hemeroby-tolerant plants were more represented, but also plants preferring the continental climate and demanding less moisture. Concerning moths, the stands of *Robinia pseudacacia* hosted more feeding specialists, species of open habitats and with fast life cycle. Similarly to moths, the invaded stands hosted more birds with fast life cycle and associated with open habitats, however, the invaded stands hosted more habitat generalists. Our results show that the impacts of invasive trees need not necessarily manifest in terms of differences in species richness, so a detailed approach is necessary to reveal the impacts on the composition of species and on the proportional representation of species with particular ecological characteristics.

WEDNESDAY AFTERNOON

Gunnera tinctoria invasions in Ireland: impacts on greenhouse gas emissions and soil carbon and nitrogen and the effects of removal

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Recent evidence indicates that plant invaders can alter soil attributes and increase greenhouse gas emissions. To assess the impacts of *Gunnera tinctoria* Molina (Mirb.) invasions on greenhouse gas emissions and on soil carbon and nitrogen, comparisons were made with uninvaded grasslands and invaded areas subjected to mechanical removal and herbicide application on Achill Island, Ireland. Invaded areas had a significantly higher total soil carbon concentration (TOC) in the top soil layer (5-10 cm) (average of 14.02 %) compared to uninvaded areas (average of 10.12 %), but only during winter. No differences were found among the other soil layers (20-25 cm and 50-55 cm) during winter and no differences were found for any soil layer examined during the summer. This suggests a seasonal input of near-surface carbon that is lost from the system. In addition, despite the absence of any significant differences in total nitrogen, invaded plots had a higher nitrate concentration (average of 13.87 mg N/kg soil) than uninvaded grasslands (average of 5.13 mg N/kg soil) at the end of the growing season. Invaded plots also exhibited higher pH values (>7) than uninvaded plots (~6) during most of the growing period. Whilst there were no differences in CO_2 or CH_4 emissions amongst the treatments, invaded areas had over an order of magnitude higher N_2O emissions (average of 2,052 µg N_2O m^{-2} h^{-1}) compared to uninvaded grasslands (average of 124,3 µg N_2O m^{-2} h^{-1}). However, after removal, there were no differences in N_2O emissions among the different treatments. This indicates that G. tinctoria invasions may have a minor impact on soil carbon and nitrogen, whilst having a major impact on nitrogen-transforming reactions in these ecosystems that lead to enhanced N_2O emissions.

THURSDAY AFTERNOON

Integrating socio-economic and ecological effects of *Prosopis*, a woody invasive alien species, for development of improved management strategies

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Woody invasive alien species (IAS) are complex socio-ecological problems as they can influence both the invaded ecosystems and human well-being. Hence, a multidisciplinary approach is required to identify management solutions that optimize benefits from both an ecological and a socio-economic point of view.

We assessed how the ecological and socio-economic effects of *Prosopis juliflora s.l.* change with increasing cover of this invasive tree in Eastern Africa. *Prosopis* had been deliberately introduced because it can provide services to the rural people, including charcoal production as a result of woody biomass production. However, it also causes serious negative effects, such as reduced livestock numbers due to lower fodder availability and accessibility. We hypothesized that the net effect of *Prosopis* is positive at low cover levels and becomes negative when cover increases, that socio-economic effects plateau and that ecological effects continue to increase with increasing *Prosopis* cover. Ten administrative areas each in Baringo, Kenya (sub-locations), and Afar, Ethiopia (kebeles) were selected along a *Prosopis* cover gradient. In each area, socio-economic variables were collected through household interviews and ecological variables in plots with varying *Prosopis* cover. The results were up-scaled to the administrative area and compared to the *Prosopis* cover in each area, which were derived from satellite images. The relationships between *Prosopis* cover and socio-economic and ecological measurements were analysed separately and compared using generalised linear models.

Here we present first results of this study, which will help identifying the cover levels at which the net and individual effects are most beneficial to both people and the environment and will be used to inform decision makers about the consequences of *Prosopis* management. Management options for *Prosopis* may differ depending on whether priority is given to particular effects of the species, land use form and the stage of invasion.

Session 7 *Chasing invasive species with high technology*

THURSDAY AFTERNOON

Field spectroscopy together with airborne LiDAR and hyperspectral remote sensing reveal occurrence and impact of the invasive ecosystem engineer *Acacia longifolia*

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Invasive ecosystem engineers or transformer species are known to have a high impact on ecosystem functioning. Especially dissimilarity regarding leaf nitrogen content at community level predicts very well the impact of invaders on N-cycling. Impact together with occurrence are Essential Biodiversity Variables (EBVs) for invasion monitoring.
Here, local impacts of a model invader, the N2-fixing shrub *Acacia longifolia* (Andrews) Willd.,on nutrient and water cycling in nutrient-poor Mediterranean dune ecosystems have been shown at plot level. However, there is a gap of knowledge on leaf trait dissimilarity at community level as well as on cover and impact at landscape scale of *A. longifolia*.
We sampled leaf biochemical (e.g. N content) and field spectral data of 18 species including two invasive acacias in a heterogeneous Mediterranean dune ecosystem in SW Portugal protected under the NATURA2000 directive. In addition, we acquired airborne LiDAR and hyperspectral data for the site, and collected ground reference data on species' occurrence in the stabilized dunes.
Our results showedthat *A. longifolia* was dissimilar from native species of the same growth formespecially regarding leaf N-content. We could predict the varying biochemistry using sensor-based field hyperspectral data, which indicated the potential for further upscaling. In addition, we quantified the cover of *A. longifolia* at site level joining airborne hyperspectral and LiDAR data.
Finally, we conclude from the analysis of the airborne hyperspectral data that *A. longifolia* is transforming the open and closed dune scrub to a forest-type ecosystem which differs in terms of a strong biomass signal from native forest ecosystems at the site.
Thus, our sensor-based approach identifies the invader as a high impact species, and contributes to the use ofEBVs for invasion monitoring as it delivers occurrence data and assesses the impact on ecosystem structure and functioning at landscape scale.

THURSDAY MORNING

Which features of invasive alien plants are crucial for their mapping with airborne hyperspectral and ALS remote sensing data?

Barbara Tokarska-Guzik, Dominik Kopeć, Katarzyna Bzdęga, Anna Halladin-Dąbrowska, Andrzej Pasierbiński, Beata Woziwoda, Sylwia Szporak-Wasilewska, Jacek Jóźwiak, Gabriela Kuc, Anna Jarocińska, Adriana Marcinkowska-Ochtyra, Anita Sabat, Łukasz Sławik

The fast and effective detection and mapping of invasive alien plants at different spatial scales is becoming increasingly important for their management. The application of hyperspectral and ALS remote sensing data is a method complementary to traditional field surveys, which additionally allows coverage of large areas.
In the present study we test selected features of a few species differing in terms of life history against various classification methods, including Mixture Tuned Matched Filtering, Spectral Angle Mapper, Random Forest and Support Vector Machines. Six species were marked out for examination: two annuals *Echinocystis lobata* and *Erigeron annuus*, two perennial herbs: *Heracleum sosnowskyi* and *Solidago* spp. and two woody plants: *Spirea tomentosa* and *Padus serotina*.
The study aims at answering the following questions: (i) which features are most useful in the identification of individual species, including at early invasion stages? (ii) which method of classification is most effective? (iii) is it possible to select set of feature and a method which would be recommended as optimal?
Simultaneously with the acquisition of airborne data, on-ground botanical reference data were obtained three times during the growing season with the purpose of assessing the species detection possibilities and identifying species characteristics, among others: percentage cover, growth stage, and additionally coexisting species and type of land use.
The best species identification results were obtained for *H. sosnowskyi* and *P. serotina* with a classification accuracy exceeding 90% and *E. lobata*, which along with *Solidago* spp. and *S. tomentosa* gave classification accuracy result between 70-85%. Among the plant features that contributed to the best classification results were percentage cover and growth stage.

Research has been carried out under the Biostrateg Programme of the Polish National Centre for Research and Development (NCBiR), project DZP/BIOSTRATEG-II/390/2015: *The innovative approach supporting monitoring of non-forest Natura 2000 habitats, using remote sensing methods* (HABITars).

THURSDAY AFTERNOON

Predicting the spread of the invasive coral vine (*Antigonon leptopus* Hook & Arn.) using remote sensing and species distribution modeling

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The spread of invasive plant species often outpaces the capacity to manage the invasions. Remote sensing can be used to map the distribution of invasive plant species at a snapshot in time, but it is difficult to predict the future distribution without incorporating the habitat preferences of the invasive species. Habitat suitability modeling is predictive, but often suffers from an insufficient number of training points. In this study we combine vegetation classification models based on remotely sensed imagery with habitat suitability models to predict the potential distribution of an invasive vine, *Antigonon leptopus* (Polygonaceae), on two neighboring Caribbean islands, St. Eustatius and Saba. A Support Vector Machines (SVM) classification was produced for two WorldView-2 images of St. Eustatius (images acquired on 8 February 2011 and 24 August 2014) to produce maps of presence/absence of the vine. Pixels from the SVM classifications where *A. leptopus* was present in both years were used as the dependent variable in the species distribution model for St. Eustatius. The independent variables tested for the species distribution model were slope, elevation, soil hardness, soil moisture, drainage area, distance to nearest building, and distance to nearest road. The results suggest that the potential for *A. leptopus* invasion can be readily assessed for other islands in the Lesser Antilles. We illustrate this potential for the neighboring island of Saba, revealing that the expansion of *A. leptopus* may approach that of St. Eustatius if no preventive actions are taken.

THURSDAY MORNING

Google Street View potential for studying alien plant invasions

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Roads and roadsides have an important role in the establishment and spread of alien invasive plants. Car surveys have been used worldwide to investigate alien plant invasions along roads, allowing covering large areas faster and with fewer resources than on-foot surveys. Still, considerable resources and budget are needed. Recently, a few ecological studies have used Google Street View (GSV) as a remote sensing tool, particularly in the detection of alien invasive plants along roads, proving to be a cost-effective alternative method to car surveys. GSV is a free-access web technology featured in Google Maps and Google Earth which allows users to conduct virtual travels along roads using geo-referenced panoramic photographs regularly taken at short intervals by high-resolution cameras placed on the roof of a moving car.
In this work the GSV technology is presented, addressing its worldwide coverage, the main technical features and sharing some examples in ecology where it has been applied. The efficiency of GSV at plant detection, its advantages and handicaps, are discussed based on a recent study where the performances of car and GSV surveys are compared. Some other undergoing studies using GSV to investigate alien plant invasions are shared, presenting original approaches to exploit the capacities of GSV in this ecological field. Different alien invasive plants are presented as potential targets for GSV surveys. We forecast that GSV will be increasingly used in the study of alien plant invasions.

THURSDAY MORNING

Using detection dogs to assist weed eradication in conservation areas: a case study of hawkweed (*Hieracium* L.) in Australia.

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Eradication is widely recognised as a highly cost-effective management objective at the early stages of weed invasions. However, timely interventions that allow successful eradications can be challenging and resource intensive, and management techniques may not always be available. New technologies may be needed to overcome issues related specifically to the target weed or the invasion area. For example, characteristics of the target species and the invaded environment can impact on the ability to delimit the infestation or to detect every plant within the infestation, both of which are critical for eradication. In New South Wales, Australia, we are attempting eradication of mouse ear hawkweed (*H. pilosella* L.) and orange hawkweed (*H. aurantiacum* L.) primarily from subalpine conservation areas. Invaded plant communities include tussock grasslands and heathlands, where hawkweed plants can easily 'hide' among the dense vegetation. In addition, small nonflowering hawkweed rosettes can be difficult for humans to distinguish visually. Thus, the use of traditional human surveillance requires extensive time and resource allocation. To improve detection speed and accuracy, we are using scent detection dogs to complement human surveillance. Over a two year period, two spaniels were trained to distinguish hawkweeds from other plants and successfully detect hawkweeds in field environments. We are now working to incorporate the use of these 'weed eradication detector dogs' into the eradication program in a cost-effective and efficient manner. This presentation outlines: i) dog training procedures and field trials, including challenges related to biosecurity and presenting the correct target scent to the dogs; ii) factors contributing to dog detection ability, including weather, terrain, and handler skills and ability; iii) the unexpected benefits of extensive media interest; and iv) the costs, benefits and challenges of implementing detector dog surveillance to improve weed eradication efforts.

THURDAY AFTERNOON

The role of timing in plant invasion monitoring using UAV

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The rapid spread of invasive plants makes their management increasingly difficult. Remote sensing offers methods for fast and efficient monitoring, but the optimal methodologies for each species remain largely undefined. We present fast, repeatable and a cost-efficient computer-assisted method of detection for two noxious herbaceous plant invaders in Central Europe, with markedly different phenological, structural and spectral characteristics. Namely giant hogweed (*Heracleum mantegazzianum*), a species with very distinct flowering phase, and less visually distinct knotweeds (*Fallopia japonica*, *F. sachalinensis* and their hybrid *F.* × *bohemica*). We have assessed the effects of spectral and spatial resolution as well asacquisition time for successful recognition using imagery from purposely-designed unmanned aerial vehicle (UAV), VHR satellite and aerial color orthophotos. The demands for both spatial and spectral resolution depend largely on the target plant species. Monitoring during the species most distinct phenological phase (flowering for giant hogweed and senescence for knotweeds) resulted in high accuracy even with lower spectral resolution of our low-cost UAV. We demonstrate that proper timing can compensate the lower spectral resolution tosome extent. The results of our study serve as a basis for identifying priority areas for management, targeted at localities with the greatest risk of invasive species' spread and, once eradicated, to monitor its potential to return over time. The best mapping strategy should reflect morphological and structural features of the target plant and use appropriate spatial, spectral and temporal resolution. The UAV enables flexible data acquisition for required timeperiods at low cost and is well suited for targeted monitoring; while satellite imagery provides the best solution for larger areas. Nonetheless, users must be aware of their limits.

THURSDAY AFTERNOON

Using Landsat Time Series to understand how management and disturbances influence the expansion of an invasive tree

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Invasive plant management is both challenging and expensive and as such strategic and well informed decisions may contribute for a more effective management. Remote sensing time series can inform decision-making, improving management strategies. *Acacia longifolia* is one of the most widespread invasive plants in Portuguese coastal areas. We used this species to test a new approach to assess how different management practices and disturbances may influence invasive plants' distribution.

The Mann-Kendall statistical test was applied to a 15-year time series (2000-2015) of Landsat TM/ETM+ derived NDVI to detect statistically significant vegetation trends. These maps were interpreted together with a land-cover map derived from a combined rule-based and supervised classification of a Landsat OLI image from November 27th 2013; this interpretation was then complemented with information about management practices and disturbances allowing to identify the processes influencing the current distribution of *A. longifolia*.

The overall accuracy of the classification was 0.785 (Kappa 0.753) and *A. longifolia* was detected in 9% (8691 ha) of the study area. Of the nine processes of land cover change identified, "vegetation cover intensification" and "vegetation recovery after removal" were the main drivers of expansion. Pine forests were vulnerable to invasion but offered resistance to conversion into *A. longifolia* monospecific stands, while herbaceous and shrub habitats seemed less resistant to invasion. Some interventions aiming to control *A. longifolia* were shown to aggravate the invasion. This approach facilitates monitoring the invasion and allows managers to allocate resources to areas where management may be most effective.

Full Citation

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THURSDAY MORNING

Seeing the wood for the trees: why remote sensing imagery can detect but not predict alien conifer invasions

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Invasive conifer trees pose a daunting threat to biodiversity and native ecosystem functions as well as a massive challenge to land managers to control their spread. Because a sole reproducing tree is capable of spreading thousands of seeds by wind, managers need to know the locations of individual trees, particularly those which are reproducing. Existing monitoring techniques such as surveys on foot and by manned aircraft are both expensive and time-consuming. Worse, they cannot guarantee high-precision for pinpointing the locations of invading individuals. Satellite remote sensing imagery data has been promoted as a more accurate and time-saving solution to monitoring issues. While recent technological advances such as LiDAR have enabled remote sensing data to detect invading trees with high accuracy, these technologies are still expensive and require a high degree of expertise to process. Using free, accessible aerial and satellite imagery data of pine invasions in New Zealand, we examined how useful low-cost remote sensing imagery is for determining point locations of invading conifer trees and whether it really is a solution to existing management and monitoring issues. While most studies using remote sensing of tree invasions simply assess the likelihood of detection, we conducted ground-truthing fieldwork to determine detection probabilities across age classes, sizes, and densities of surrounding individuals. We found that most trees under one meter in canopy diameter were not detected except in open areas. Generally, the number of adult trees was underestimated in high and mid density areas, meaning that the predicted number of reproducing trees in an invasion was often underestimated by between 15 and 30%. While remote sensing is a valuable tool for detecting large, isolated trees, its detection limitations and tendency to underestimate the true number of trees suggests that the method is best for identifying sites for more detailed, ground-based surveys.

PRACTITIONERS CORNER

MONDAY 16:50 @ MAIN ROOM

LIFEBiodiscoveries project

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Beginning on July 1st of 2014, Project Life Biodiscoveries is financed by the Community Program LIFE+, and has as an objective to promote the public participation as a mean to control and remove invasive species in the Local Natural Reserve (RNL) of Mata da Machada e Sapal do Rio Coina, located at Barreiro Municipality. The target species are acacias (7 species present) and ice plant, which initially occupied respectively 44 and 26 hectares, in a total area of 380 hectares of the RNL. The population target includes individuals – alone or integrated in formal groups -, families, retired citizens groups, companies, school community and associations, which take part in the Project, either in regular or sporadic activities, by adopting work plots. So far 59.8 hectars of the Local Naural Reserve have been adopted by volunteers and 117,8ha have been assigned to the field work team, comprised of inmates from the Estabelecimento Prisional of Montijo, as a result of a signed protocol between this prison establishment and Barreiro's City Hall. Of the initial 44 and 26 hectars invaded, after 2,5 years of LIFE project, they have been reduced to 29,42 and 3.85 hectars respectively. So far, 3101 volunteers have been involved in the project, 22 public awareness and dissemination activities have been conducted, and 621 people have participated in those activities.

TUESDAY 16:50 @ MAIN ROOM

A hands on approach to invasive species control at the Azores islands

Miguel Gomes Caetano Ferreira
Terceira's Natural Park - Azores Regional Directorate for Environment

The Azores archipelago is composed by 9 islands, dispersed wide across 500 Km in the North Atlantic. Located 1500 Km from the Portuguese Mainland and 1700Km from Newfoundland- Canada. Several of the islands still preserve remnants of its native *Macaronesian Laurissilva Forests*, with about 60 species of endemic plants. Terceira is the island with the biggest area of native forest. Fertile volcanic soils combined with temperate oceanic climate, high humidity and mean annual temperature of 17,5ºC make a perfect setting for many exotic plant species from different climatic zones to proliferate. That is why across the Azores islands exotic invasive species are a huge threat to the *Laurissilva* and its endemic species.
Most of the invaders were brought from different parts of the world during the 17 and 1800's to be part of the aristocrats romantic gardens. Many escaped into nature and have been proliferating since, while others are very recent introductions. The most common invasive species include: *Pittosporum undulatum*, *Acacia melanoxylon*, *Solanum mauritianum*, *Clethra arborea*, *Rubus ulmifolius*, *Hedychium gardnerianum*, *Hydrangea macrophylla*, *Phytolacca americana*, *Lantana camara*, *Ulex europaeus*, *Leycesteria Formosa* and *Gunnera tinctoria*.
The Azores Environmental Directorate has been taking into action several interventions across the islands targeting invasive species at protected sites, where different invasive species represent a threat to the existing ecosystems. This removal of exotic invasive species has been carried out with different techniques depending on species, development, population size and location. Mechanical, chemical and combined methods of the invasive species eradication are to be described.

WEDNESDAY 16:50 @ MAIN ROOM

Biosecurity and the management of alien plant invasions in New Zealand

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In New Zealand, over half of the flora is comprised of naturalised alien plants and this level of invasion has considerable economic and ecological consequences. For example, invasive alien plants threaten one third of all New Zealand nationally threatened plant species and would degrade the conservation estate corresponding to a loss of native biodiversity equivalent to $1.3 billion. For this reason, New Zealand has implemented a range of policy initiatives to combat alien plants that act at various stages from the border to natural environments. New Zealand implements a white-list of permitted species and breaches of this legislation are dealt with severely, particularly where individuals attempt to smuggle live plant material into the country. This has even led to prosecutions against botanical gardens. However, the government also works closely with the horticulture industry through the National Plant Pest Accord to remove potentially invasive plants from sale. For species outside of cultivation, the National Interest Pest Response (NIPR) programme aims to eradicate selected established invasive alien plants from New Zealand. Species were selected because of their potential to have a significant impact on economic, environmental, social and cultural values. However, incursion response is not restricted to species listed in the NIPR. New Zealand maintains a register of "unwanted organisms" which are capable of causing unwanted harm to any natural and physical resources or human health. Although government has no obligation to act against an unwanted organism in certain cases an incursion of an unwanted organisms results in an eradication campaign. Finally, for widespread species there are national programmes to eradicate species from conservation sites using chemical methods or biological control. Examples of each of this programmes will highlight their strengths and weaknesses and the lessons that can be learned by other countries as they develop their own alien plant legislation.

POSTERS

Session 1 *Current trends in invasive plant ecology*

P1

The dominant invasive alien plants in the riparian areas of Serbia

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River margin ecosystems have proven to be particularly prone to alien plant invasions. Research has shown that river corridors are important in promoting the dispersal of invasive species, as they enable the long-distance dispersal of propagules, while also providing suitable habitats for the subsequent colonization. Knowing the importance of riparian areas for the spread of invasive plant species, and given the fact that no similar research has been done thus far in Serbia, the aim of our research was to analyze the importance of rivers and canals in our country for the spread of invasive plants and establish which are the most dominant invaders in these zones.

Field research was conducted during the summer-autumn period of four consecutive years (2013-2016). The total number of field sites chosen for this study was 230, located along the course of 37 rivers and seven major canals of the Danube-Tisa-Danube hydrosystem (Vojvodina Province). The field sites were chosen based on the high incidence of invasive alien plants (e.g. cover, abundance), and comprised of 100 m long transects.

The records collected have shown the presence of 29 invasive alien species recognized by the National list of invasive plants of Serbia. Of the species registered, five can be highlighted as dominant, based on their number of records. *Xanthium strumarium*, the most documented, was present in 65% of field sites (along 95% of rivers), *Echinochloa crus-galli* and *Amorpha fruticosa* in 46% of field sites (76% and 70% of rivers, respectively), *Robinia pseudoacacia* in 44% (95% of rivers) and *Conyza canadensis* in 42% of field sites (76% of rivers). Their cover ranged from <5% of the area of the transect up to 100% in certain field sites for *Xanthium strumarium*, *Amorpha fruticosa* and *Robinia pseudoacacia*, 80% for *Echinochloa crus-galli* and 70% for *Conyza canadensis*.

Keywords
invasive alien plant, riparian area, river, canal, Serbia

Acknowledgments
The authors acknowledge the support of the Ministry of Education, Science and Technological Development of the Republic of Serbia (Projects No. TR 31018 and III 43002).

P2

Invasion potential of the higher ploidy level geo-cytotype, *Solidago gigantea* to the native, Hungarian flora

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The influence that chromosome number has on exotic plant invasions is a well-known phenomenon. A growing number of papers suggest that higher ploidy levels may influence the invasion potential of a species. *Solidago gigantea* is a rhizomatous, perennial herb native to North America and invasive in Europe and Asia. In its native range, di-, tetra- and hexaploid cytotypes are present, while in the invasive European range only the tetraploid cytotype is present.

We researched if North American *Solidago gigantea* hexaploids present a greater invasion potential to native European plant communities than the already established *S. gigantea* tetraploids. First, we collected vegetation data from the native North American and invasive European ranges to measure their influence on their respective plant communities. Then, we planted hexaploid (from Montana) and tetraploid (from Hungary) individuals into a common garden in Hungary to compare behavioral differences between the two geo-cytotypes. In addition, we performed a microsatellite fragment length analyses on these individuals to evaluate genetic differences between them.

Our field experiment provided evidence that the hexaploids exert less adverse effects to their own plant communities than the tetraploids. Our common garden experiment also showed that the North American tetraploids outperformed the European tetraploids in every measured parameter. Our genetic analysis revealed a genetic separation between the geo-cytotypes we investigated.

Our results show that the investigated geo-cytotypes play different roles in their respective plant communities. Additionally, the results of the common garden experiment suggest a stronger invasion potential of the European tetraploid geo-cytotype due to increased performance. However, the introduction of North American hexaploids should be prevented due to the risk of genetic hybridization between these geo-cytotypes.

P3

Can an invasive species change the carbon dioxide sink capacity of an estuary?

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Spartina densiflora Brong. is an invasive species, coming from South America, that invades marshes and estuaries of the south Atlantic coast of the Iberian peninsula. This species has C_4 metabolism and shows a high level of ecophysiological adaptation to saline environments with high temperatures and radiation. In the marshes of the southwest of the Iberian peninsula this species occurs from the low zone of the marshes, with high incidence on the tides, until the limit of the high tides equinoctial means. *Spartina densiflora* developes a high biomass, occupying the niche of an important set of species of the succession of marshes, like *Spartina maritima*, *Sarcocornia perennis*, *Halimione portulacoides* and *Arthrocnenum macrostachyum*. The carbon dioxide sequestration values of *Spartina densiflora*, as a natural sink, are higher than some of the species that replaces at certain topographic gradient locations. The impact of the invasion over the natural species composition may alters the behavior of this ecosystem as a natural CO_2 sink. Its incidence in the succession of the marshes of the southwest zone of Spain and Portugal is very high, being able to modify the sense of the succession through the successional mechanism of inhibition. In the light of the Paris Summit's (COP21, 2015) conclusions, where natural carbon sinks are a desirable route to combat this global change, it is appropriate to study the current situation of this invasive species in the Atlantic estuaries of Spain and Portugal and its role in relation to carbon dioxide sink modification.

P4

Reproductive system and floral morphs distribution of *Oxalis pes-caprae* in Algeria

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Oxalis pes-caprae is a geophyte native to South Africa. This species is widespread and invasive in the Mediterranean basin where it reproduces asexually by bulbils. The high competitive ability of *O. pes-caprae* has often been reported. In its native area, this species is heterostylous with trimorphic flowers and a self- and intramorph incompatibility system. In this study, we examined the morph proportions and the reproductive system of populations from Algeria. Pollen germination, pollen tube growth and seed set were analysed after self and cross pollinations. The results are discussed in relation to the evolution of the reproductive systems and the dynamic of the invasion process.

Keywords
Oxalis pes-caprae; morphs; incompatibility system; invasive plants

P5

Invasive plants in southern Portugal: a biogeographical approach

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Invasive species are one of the main threats to biodiversity worldwide and are responsible for several negative impacts at ecological, economic and ecosystem services level. Although complementarity between vegetation series dynamics and invasive plants ecology can be very useful to address ecological restoration and to prevent invasions, these two fields are seldom studied together. In this work we explored the relationship between invasive plants distribution and terrestrial plant communities of Southern Portugal aiming to analyze how the invasive ability of a species can vary with the biogeographical territories and which ecological conditions can favor the invasion by a certain alien plant. Fieldwork was conducted in 60 1 Km^2 sampling plots in the south of Tagus river region (Portugal), and a correspondence was made between nine selected invasive plants (*Acacia dealbata*, *A. longifolia*, *A. pycnantha*, *A. saligna*, *Ailanthus altissima*, *Arundo donax*, *Cortaderia selloana*, *Hakea sericea*, *Opuntia ficus-indica*) and the vegetation series and the biogegraphic units. The Andalusian-Lusitanian Coastal province was the most invaded biogeographic unit and revealed the dominance of *A. dealbata*, *A. longifolia* and *O. ficus-indica* in the cork oak psammophilous series (*Aro neglecti-Querco suberis* S.); *A. longifolia* dominated in the maritime turbinate juniper series (*Osyrio quadripartitae-Junipero turbinatae* S.) and *A. dealbata* and *A. donax* in the ash groves potential (Ranunculo ficariae-Fraxino angustifoliae S.). Based on these results, we suggest native plants that can be used in revegetation actions, working as a natural barrier, and discuss implications for prioritization and management of alien and invasive species in this region.

Keywords
Invasive Plants, biogeography, sinphytosociology, invasion ecology

P6

Too many flowers for few pollinators: a preliminary assessment of ambophyly in the invasive *Acacia longifolia* in Portugal.

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A. longifolia is an Australian species, showing a massive yellow flowering at the end of the winter. Notwithstanding it is entomophilous, its flowering occurs, in invaded areas, in a period unsuitable for insect activity. Then, to what extent do insects contribute to seed set? For the first time, the possible contribution of wind was assessed. *A. longifolia*, in fact, presents many floral traits usually pointed out for anemophilous species: abundant staminate small-sized flowers, lacking a fully developed corolla, flowers grouped into an inflorescence, and small pollen grains.

We a) surveyed flowering plants to spot insects active on them; b) carried on focal observations of bees visiting the inflorescences; and c) carried on exclusion experiments to detect the relative contribution of insects and wind to seed set. During the survey, we actually recorded a low abundance of insects, mainly honey bees: they were present on the 36.2 % of 174 plants. However, focal observations confirmed honey bees to be potentially good pollinators, transferring pollen when visiting the inflorescences and when visiting the extrafloral nectaries. The exclusion experiments corroborated the need of pollen vector for seed set. Our data emphasized an interesting trend with the wind as an active contributor, and insect contribution still being more robust than that of wind.

This work acknowledges the known entomophily of the species, notwithstanding time of flowering. Anyway it also underlines a previously neglected contribution to acacias seed set: that of wind. *A. longifolia* may be addressing to multiple vectors, biotic and abiotic, for its sexual reproduction. Ambophyly is predicted to enhance pollen transfer especially when pollinators are lacking for different reasons; in the case of the windy coasts of Portugal, this vector may have boosted its genetic variability and ability to colonise new environments. Further studies should be carried on to better understand the extent of wind contribution to acacias pollination.

P7

Are there invasive plants with intermediate characteristics or hybrids?

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Diagnostics of alien species can be difficult because of possible hybridization with native or other closely related alien taxa. According to traditional diagnostic characteristics, it's not always possible to distinguish a new ecological race arising during microevolution and a hybrid that may be more aggressive than parental alien taxa. The aim of our research is the verification of their hybrid nature using traditional morphological, experimental (by growing the seedlings of presupposed hybrids and their parents in the experimental plots for the detection of some the characteristics inheritance) and molecular genetic (ISSR-PCR) methods.

We researched several taxa in the Southern and Eastern Europe and in the Middle Russia. Hybridogenic origin of "*Bidens*×*garumnae*" (in sensu V.Papchenkov) isn't confirmed and this taxon should be considered as a complex of micro species of *B.tripartita*. We have established that the beggartick observed in Eastern Europe as "Bidens connata" isn't a North American alien species *B.connata* Muehl. ex Willd., but a complex of hybrids and back-crosses of invasive *B. frondosa* with native *B.cernua* arising in the secondary distribution range. This taxon is described as B. decipiens Warnst. in 1895, a herbarium type was being stored in Edinburgh [E]. Alien goldenrods form hybrids with native *Solidago virgaurea* L. in Europe. Generation F_2 growing in the experimental plots showed the stability of diagnostic macro- and micromorphological features of hybrids *S.*×*niederederi* Khek (= *S.canadensis* L. × *S.virgaurea*) and *S.*×*snarsksii* Gudžinskas & Žalneravičius (= *S.gigantea* Ait. × *S.virgaurea*). ISSR-PCR method confirmed the hybridogenic origin of these plants. As for *Erigeron* sect. *Conyza* (Less.) Baill., in Italy we found individuals defined as *Conyza*×*rouyana* Sennen. However, preliminary studies (using the PCR-ISSR method) didn't confirm their hybridogenic origin, and we plan to continue the studies, since according to all micro and macro morphological features, these plants are uniquely hybrids.

P8

Can mycorrhizal – plant mutualistic interactions increase the invasiveness of exotic species?

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The symbiotic relation between plants and mycorrhizal fungi has been touted as a potential factor to explain invasiveness. We tested if plant dependence on the mycorrhizal symbiosis affects invasiveness. For that, we recorded exotic plant invasiveness data in North America (NA) from the NatureServe repository (www.natureserve.org) and combined it with the mycorrhizal status of species from literature. Additionally, we tested whether the mycorrhizal status in high invasive plants of NA and South America (SA) differ each other. We found that for the whole exotic NA plants, facultative are more invasive than obligate mutualists, suggesting that mycorrhizal dependence a functional trait is fundamental in determining invasiveness. Additionally, we found that invasive plants are significantly more likely to be facultative rather than obligate or non-mycorrhizal mutualists in NA while in SA they are more likely to be obligate mycorrhizal. It is possible that a high proportion of species in SA invade tropical zones where the mycorrhizal association in soils poor in nutrients, is necessary. Further analysis is essential to prove these explanations.

P9

Living on the edge: greater dispersal ability and faster germination times towards range edges of invasive plant

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Novel evolutionary conditions experienced in the introduced compared to the native range is often cited as a key process to help explain the success of invasive plants. A significant assumption of this view is that species remain static and that evolutionary processes in the introduced range are relatively unimportant. However, biological invasions are a dynamic process and as a species expands in its range it is likely to experience novel conditions that may lead to different evolutionary trajectories from populations at the initial point of introduction, facilitating further range expansion. For example, during range expansion, individuals with greater dispersal and colonisation ability will be selected for towards range edges due to greater fitness benefits afforded by lower conspecific density. For plants however, seeds with greater dispersal ability often have poorer colonisation ability (lower germination success and slower growth), which may hinder further range expansion. We tested the hypothesis that selection for greater dispersal ability may lead to reduced colonisation ability towards range edges of invasive plants. We assessed dispersal ability (wing loading ratio: seed mass/wing area), germination success and growth related traits (height and leaf number) for multiple populations of a coastal invasive plant (*Gladiolus gueinzii* Kunze) along its entire introduced distribution in eastern Australia. We found significantly greater dispersal ability towards the range edges of *G. gueinzii* which was mediated by a decrease in seed mass. However, this was not associated with a decrease in the probability of germination or decreases in growth. In fact, seeds from range edge populations had a significantly faster time to germination. Our results show that shifts towards greater dispersal ability does not have an associated negative affect on colonisation ability for *G. gueinzii* and may be a key factor in promoting further range expansion in this invasive species.

Keywords
Range expansion, dispersal ability, colonisation ability, seed traits, introduced range

P10

"Is there a genetic variability of the invasive species *Acacia longifolia*?"

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Acacia longifolia is an Australian species considered one of the most aggressive invaders worldwide. An important aspect associated with its invasive mechanism is the ability to change phenological timings according to the environmental conditions, in particular the temperature. Since this species' introduction in Portugal by the forestry services in the late 19th century, its occupied area has been spreading yearly with severe impacts in ecology and economy.

In this study, our main objective was to understand if there were different populations of *A. longifolia* in Portugal under different climatic and forest density conditions. We used two types of molecular markers – Inter-simple sequence repeats (ISSRs) and microsatellites (SSRs) – to infer genetic diversity and perform the computation of descriptive population parameters. Samples were collected from three locations of the Portuguese coast: Osso da Baleia, Pinheiro da Cruz and Vila Nova de Milfontes. In the later, samples were collected from three different sites to better understand the genetic patterns on a smaller scale. ISSR analysis showed that all sampled locations show similar levels of genetic diversity but low genetic differentiation. Samples tended to cluster according to geographical location. Microsatellite analysis showed that samples from all locations have rare alleles but these vary in frequency, with Osso da Baleia showing the highest percentage and Pinheiro da Cruz the lowest. Samples from the three different sites in Vila Nova de Milfontes showed very low genetic differentiation and similar intermediate frequencies of rare alleles.

Considering our results, we conclude that there are no genetically differentiated populations in Portugal, despite the difference in environmental conditions. Therefore, we hypothesize that the strong phenological differences reported in previous studies are consequence of this species' capacity for acclimation and not due entirely to adaptation. Further molecular analyses are in course to expand the study to Spanish and South African populations.

Keywords
Acacia longifolia, molecular markers, genetic diversity, genetic differentiation, acclimation.

Acknowledgments
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P11

Potential and real seed production of *Cytisus scoparius* in native and invasive populations

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Cytisus scoparius (L.) Link (Fabaceae) is native to Europe, ranging within an area bounded by the Azores, Spain and Portugal in the south-west, north to the British Isles, east to southern Sweden and the west-central Ukraine and south to northern and central Italy. In other areas of Europe, *C. scoparius* is considered as alien species. This species has become invasive in Australia, North and South America, Africa.

In Lithuania, *C. scoparius* was introduced at the end of the 19th century. Fast spread, naturalization and invasion of *C. scoparius* started in the second half of the 20th century, when it was recommended for cultivation in fire protection belts of forests and as fodder plant for game animals. Currently, *C. scoparius* has been included into the list of legally recognized invasive species of Lithuania.

The study on potential and real seed production of *C. scoparius* was performed in 2016, in 14 populations in Lithuania (invasive range), Germany and Luxembourg (native range). In each population, the pods were sampled from 50 individuals and two pods were taken for analysis. A total of 100 normally developed pods from a population were analysed. The length and width of pods were measured with a caliper, then each pod was opened, and the number of ovules and developed seeds were counted.

Statistically significant differences in the pod length and width were revealed both among populations in the native and invasive ranges. The length of pods in the studied populations was less variable feature compared to the variations in pod width. The number of ovules in a pod was slightly higher in the native range; however, the number of developed seeds depended on the type of habitat rather than on the geographical origin of population.

Session 2 *How to promote and benefit from the collaboration of citizens?*

P12

Mapping alien plant species in Terceira Island (Azores): a collaborative effort between researchers and citizens

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The introduction of alien species into a territory is one of the main threats to native biodiversity conservation. This fact is usually magnified on small oceanic islands due to general lower native diversity, taxonomic disharmony, greater proportion of changed habitats and the high number of already intentionally introduced species in the past.
In 2015, the Azorean Biodiversity Group started an outreach project to map alien plant species on Terceira Island (Azores). The activity involves a collaborative work among researchers, grant holders, students and volunteer citizens. The activity mainly consists of a fieldwork journey through different areas, following the INVASORAS' project protocol to assess the presence of alien species. The data collected is validated by experts and uploaded into the INVASORAS (http://invasoras.pt) and Azores Bioportal (http://azoresbioportal.uac.pt/) websites.
Our contribution to the INVASORAS' project includes 352 new records of invasive plants for Terceira Island, corresponding to 21 species that occur on seven different habitats. *Pittosportum undulatum* Vent. represents almost 25% of all records, followed by *Arundo donax* L. and *Tradescantium fluminensis* Velloso each representing approximately 11% of the invasive plant species spotted.
This outreach project is relevant to enhance our understanding on plant species invasions on oceanic islands and particularly on the distribution of common alien species, which are not the main target of most research studies. Finally, this project highlights the importance of collaboration between researchers and citizens as a tool to involve the local populations in the conservation of native and endemic biodiversity.

P13

Capacity building and promoting citizen collaboration to prevent ornamental plant introduction into two National Parks close to Monterrey City.

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Gardens containing ornamental invasive plant species are a special threat to National Parks in their proximity, this is true for the Parque Ecológico Chipinque, and even more so if they are located inside the parks as it is the case for the Cumbres de Monterrey National Park. Both protected areas are situated close to the city of Monterrey, Nuevo Leon, Mexico. Parque Ecológico Chipinque in the direct neighborhood with gardens has been infested with common ivy (*Hedera helix*), a vine from Europe, thunder (*Ligustrum lucidum*) a decorative tree native to China and the golden rain tree (*Koelreuteria paniculata*) native to East Asia. The seeds of the last two species are dispersed by birds and water therefore rapidly expanding to natural areas adjacent to the gardens. The Cumbres de Monterrey National Park counts about 3000 inhabitants living inside the park area having ornamental plants in their gardens, which among other reasons has led to invasions of giant reed (*Arundo donax*), thunder (*Ligustrum lucidum*), Mother of Millions (*Kalanchoe houghtonii*), a very aggressive hybrid between *K. delagolensis* and *K. daigremontiana*, displacing among others Agave victoriae-reginae, an endemic species, golden rain tree (*Koelreuteria paniculata*) and tree tobacco (*Nicotiana glauca*). In order to counteract the spreading and ensure the success of the control efforts activities have been implemented, supported by the project "Enhancing Mexico's capacity to manage of invasive alien species (IAS) by implementing the National IAS Strategy" funded by the Global Environment Facility (GEF), implemented by UNDP and coordinated by CONABIO and CONANP. For instance, the National Park personal is working with environmental education experts to build awareness in local communities and visitors, collaborating with city officials in reforestation efforts using local native plants and convince ornamental plant producers to abstain from selling high risk species and replace them with native flora.

Keywords
national parks, collaboration, environmental education, citizen science

Session 3 *Risk assessment and implementation of prevention tools*

P14

Can restoration actions favour invasive species?

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Invasive species find favorable conditions for growth and propagation in recently created, disturbed sites, where they may outcompete the desirable native or local species.
SECIL-Outão quarry, located in Arrábida Natural Park (south of Lisbon, Portugal), is currently operating and undertaking restoration actions. Due to the presence of some invasive species in the surrounding areas and heavy earthwork and intense movement of vehicles at the quarry, it seemed important to detect and monitor the occurrence of such species in the revegetated (restored) areas. So, our objectives were: a) to obtain a general description of their occurrence in the post-exploited quarry areas and their surroundings, and b) to determine the causes or sources of such occurrences. For these purposes, we surveyed the presence, abundance and size of invasive species in these areas.
Overall, the results revealed the presence of 13 invasive species, the most significant ones being *Arundo donax*, *Acacia* spp., *Carpobrotus edulis* and *Ricinus communis*. *Arundo donax* and Acacia spp. were "scattered" throughout the quarry area while the other species tended to concentrate in certain sites. Adding to the natural dissemination of propagules from plants established within the quarry area, dispersal of seeds produced by the many adult specimens present in the industrial zone and surrounding roads might have been greatly enhanced by heavy machinery and vehicles moving around (e.g. seeds attached to wheels). Moreover, the former use of *A. donax* stalks to support plantations might have contributed to the dissemination of this invasive species in older revegetated areas. The use of local substrate is expected to avoid the introduction of external propagules, but this advantage was reduced by relatively long storage in the open air, which allowed the establishment of such propagules and the development of new propagule sources within the quarry.
This study reinforced the idea that restoration actions must be adequately monitored for the presence of invasive species, particularly when disturbances (such as quarry exploitation or substrate laying for revegetation) are frequent and/or intense. Moreover, it suggests some changes in restoration practices in order to reduce invasive species propagation and to foster their early control.

P15

Modelling of selected invasive alien species spreading in Sites of Community Importance – comparison of several modelling approaches

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Most of Sites of Community Importance (SCI) in the Czech Republic are threatened by gradual expansion of invasive alien species. This study detects selected SCIs level of IAS expansion as a base for future spread modelling. All 23 SCIs, variable in size and protected habitat character, were mapped to collect presence/absence data on selected IAS higher plants (*Fallopia* spp. (Knotweed), *Solidago* spp. (Goldenrod), *Impatiens glandulifera* (Himalayan Balsam) and *Heracleum mantegazzianum* (Giant Hogweed)). SCIs' areas and their surroundings were divided into five protection zones, graded by importance of present habitats for nature conservation to the categories: SCIs core area, broader SCIs core area, semi-natural habitats, anthropogenically affected habitats, habitats degraded by human activities. The modelling was based on totally 3 222 localities of IAS and the data of environmental variables in square grid 30 × 30 m. As environmental variables digital elevation model and derived data (slope and exposition), Natura 2000 habitat layer and distance from spreading vectors (roads, railways, water streams) were used. The predictions of the IASs' spreading was modelled on local scale and targeted to the spread inside of SCIs and into protection zones employing R software, biomod2 package.
Based on a pilot testing we selected Generalized Additive Models (GAM), Gradient Boosting Models (GBM) and Maximum Entropy Models (MAXENT) for final modelling in reference to combination of statistic and visual evaluation methods. The goal of the study was to estimate the best modeling approach for specific species spread in particular SCIs. The main problem to face is low percentage cover of IASs – about 0.5%-0.05% SCIs' area and high level of absence data. We calibrated models to recognize this matter of fact during the modelling. The models show the maximum possible spread of IASs under the contemporary conditions and will serve for targeted IAS management of the protected areas.

P16

Digging history of forest tree introductions in the island of Sardinia (Italy)

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Innumerable tree and woody species have been transported by humans around the world, including the Mediterranean islands, for a variety of practical and cultural uses. To produce a comprehensive list, investigate the pathways and dates of introduction of alien trees and their invasive status in the island of Sardinia (Italy), we examined all the available literature and historical documents and records with a special focus on those which have been introduced for forestry purposes and land reclamation in the last 200 years. We also visited a sample of the introduction sites to evaluate the status of the alien trees and classify species according to the stage they reached along the introduction–naturalization–invasion continuum, that describes how species proceed in the invasion process by overcoming geographical, environmental and biotic barriers. Many introduced alien tree species have been planted on very small experimental plot in a very limited number of sites and have never shown any sign of naturalisation in Sardinia. On the contrary, a significant number of species is casual, naturalised or even invasive with relevant negative impacts on biodiversity and ecosystem services, such as many *Acacia* species. In addition, forest and landscaping activities have also promoted the introduction of alien genotypes of native trees, due to the lack of local forest reproductive material.

P17

Setting priorities for monitoring and mapping of alien species: approaches for efficient actions

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Management of biological invasions requires cooperation of researchers, policy makers, local landowners and managers, stakeholders and workers in nature protection. The transfer of knowledge gained from scientific research to applied aspects is therefore a key assumption for the management to be successful. The precise knowledge of invading species' long-term population trends, their distributions and impacts they pose is obligatory condition for prioritization of management action, explaining eradication campaigns to the public, and adopting right decisions in nature conservation and other sectors most affected by invasions like agriculture, forestry or fishery.

Here we propose a scheme for monitoring and mapping of alien species. We present a cross-taxon classification system serving as a basis for national IAS strategy mapping that takes into account the differences in species life histories, assessment of their impacts as well as specific recording methods relevant to various groups of alien species.

As a result we propose to divide alien organisms into the following groups: terrestrial invertebrates; subterranean invertebrates; crayfish and crabs; molluscs; spontaneously spreading fish; released fish; amphibians and reptiles; birds; game mammals; other mammals; aquatic macrophytes; terrestrial plants with significant, regularly recorded negative impact; terrestrial plants with low, only occasionally recorded impact; and plants defined by habitat (ornamental plantings outside urban areas and biofuel plantations).

For each group there is a recommended list of methods used for recording leading to different priorities of recording. For example, for most of the groups the monitoring can be divided into large-scale less intense vs. detailed targeted monitoring, applied at a priori identified localities. In the scheme we also include the sharing of information from phytosanitary or veterinary agencies. Our approach can be used for prioritization of the recording IAS at national level and should lead to better management coordination and use of available funds.

P18

How threatened are protected areas of Natura 2000 network by invasive alien plant species? The case study of Sites of Community Importance in the Czech Republic

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Invasive alien species (IAS) pose a threat to protected areas established to protect high-level biodiversity habitats. There is an urgent need of the IAS spread prevention particularly in localities of biodiversity conservation as the human induced pressure to landscape is constantly increasing. This study is focused on analysis of selected IAS occurrences inside and in the close surroundings (1 km buffer zone) of chosen Sites of Community Importance (SCIs), Natura 2000 network elements. All 23 SCIs, variable in size and protected habitat character, were mapped to collect presence/absence data on selected IAS higher plants. SCIs' areas and their surroundings were divided into five protection zones, presenting habitats graded by their importance for nature conservation to the categories: SCIs core area (A), broader SCIs core area (B), semi-natural habitats (C), anthropogenically affected habitats (D), habitats degraded by human activities (E). The results show that, in spite of the high number of particular IAS localities (3 222 in total) within all the mapped area, the Natura 2000 habitats (zone A, B) are invaded at a low level - less than 0.5 % of their total area. The IAS localities were found predominantly in the border areas of the SCIs and their direct surroundings (zones C, D). The occurrence of IAS in protected areas and in their proximity is interconnected with specific human activities, such as logging or undefined borders of urban areas - transition zone of gardens to open landscape in the SCIs' proximity. Water courses and roads are important factors for IAS spread. Generalization about species distribution in the studied SCIs is impossible as the studied protected areas vary in the presence and abundance of mapped species. The results show that individual approach to management of particular SCIs is necessary to adopt for Natura 2000 habitats protection.

P19

Survival, population dynamics and invasive potential of species in perennial plantations

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Ornamental plants represent an important source of alien, and potentially invasive species. They form an important component of human environment, because they are grown in a broad spectrum of habitats such as home gardens, public spaces, open land (e.g. in belts along roads), floriculture plantations as well as specialized garden collections. Recently so-called "perennial beds" are becming increasingly popular that do not need any special maintenance following plantation. Which species are capable of survival in perennial plantation over a long term can provide us with information about naturalization/invasion process. In this study, we focused on ornamental plants mainly from North America and the Mediterannean region grown in perennial beds in mixtures with native species of the Czech flora. We studied how the species composition changed, what was the dynamics of individual species, and it was related to species traits (SLA, height). Twenty large and species diverse beds were established in 2006–2010 and revisited in 2016. The results show that the survival of individual species was context dependent, mainly depending on the initial species composition. A general principle seems to be that in the great majority of beds one or two species increased their abundance at the expense of others. These dominants were mainly aliens such as e.g. *Aquilegia canadensis*, *Centranthus ruber* or *Lychnis coronaria*. These species spread also into other plantations where they have not been originally planted. Other species that increased their abundance over the 10 years are e.g. *Aster dumosus* and *Verbascum nigrum*. By contrast, *Cerinthe major*, *Dalea purpurea*, *Gaillardia aristata* or *Monarda punctata* were present in the initial species pool, but dissapear.

P20

Caryopsis and embryo characteristics of *Spartina densiflora* Brongn. in relation to different localities and habitats in a tidal salt marsh of the Gulf of Cádiz

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This work analyses the size of the caryopsis and embryo, the viability and the seed dormancy of the invasive species *Spartina densiflora* in seven localities of the Odiel Marshes Natural Park (Huelva), and in different habitats (low, middle and high marshes, salt pans and non tidal marshes).

The results show significant differences between the mean size of the caryopsis from different localities and between those coming from different habitats, showing an overall mean value of 4.81±0.40 mm, while the smaller length the caryopsis coming from low tidal marshes (4.60±0.43 mm) and the larger ones from non tidal marshes (5.05±0.29 mm).

The embryo size shows a similar pattern with significant differences between different localities and between the different habitats analyzed, with an overall mean value of 4.28±0.44 mm, and being the size of the embryos that comes from the low tidal marshes population significantly smaller (4.01±0.53 mm).

The mean viability of the seeds is 71.9±17.8 %, with significant differences between the different localities and between the different habitats studied, with significantly higher values in high marshes (81.0±14.6 %) and in middle marshes populations (79.8±12.7%). The percentage of seeds with dormancy does not show significant differences neither between localities nor between different habitats, reaching in all the cases values around 13%.

Finally, the relationship between caryopsis and embryo size and the different responses of the seeds to the germination conditions (non-viable, dormant, and germinated) was analyzed, showing no differences in the size of caryopsis, however the embryo of non-viable seeds was significantly lower (4.22±0.47 mm) than those of dormant (4.32±0.54 mm) and those of germinated seeds (4.30±0.40 mm).

P21

An educational tool for explaining problems with an invasive plant (*Ambrosia artemisiifolia* L.) to children

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Common ragweed (*Ambrosia artemisiifolia* L.) is a North American native that was introduced to Europe and has become invasive and problematic in many countries. It causes troubles in agriculture where it is an important weed and causes serious allergies (pollinoses) in many people. Raising awareness among the general public is indispensable for controlling this plant (Chauvel and Martinez, 2013). The ragweeds Observatory has put together the educational tool Captain Allergo to help young people to know more about common ragweed.
Exchanges between teachers and researchers led to the realization of a tool associating playing and sciences and comprising a super hero, four rotating roll-ups (vertical posters) and three floor mats with basic information on common ragweed. The children complete their workbooks and then Captain Allergo recalls two fundamental messages in a video: people have to protect themselves from the pollen and uproot the plant prior to pollen production. Since 2015, 1400 children attended this activity. The trainings offered to teachers and activity leaders made it possible for them to be introduced to that invasive species and to discover the different stages of the animated sequence.
The Captain Allergo animated sequence was well received. The main concepts and messages seem to have been understood and the tool has met with great success among young people and managers. Today, our aim is to diffuse the animated sequence over the whole country to raise awareness among both children and parents. The character Captain Allergo could even be adapted so as to suit other plant species.

Funding and partners
The kit was funded by the French Ministry of Health, Inra and the ARS (Regional Health Agency) Burgundy. The GIP-FTLV (life-long education) has conceived the educational content of the kit and manages its diffusion through the Canopé network; the Ligue de l'Enseignement de Côte-d'Or organization and the Observatory of ragweeds provide activity leaders with training.

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Keywords
Captain Allergo, *Ambrosia artemisiifolia*, Science to children

P22

Commercially used alien plant species that could pose ecological risk in Croatia

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Prevention of introduction of alien species is generally considered more desirable and cost-effective than population control and eradication measures and should be prioritised. The main act related to the introduction of alien species into the nature and their possible impact on biodiversity in Croatia is Nature Protection Act (Official Gazette No. 80/2013). It prescribes a preventive measure that bans import, placing on the market, breeding/cultivation and introduction into the nature of alien species that pose ecological risk and are potentially invasive. This preventive measure includes prescreening and risk assessment if necessary. After prescreening process in Croatian Agency for the Environment and Nature the competent Ministry issues permits for alien species with low ecological risk or demands additional risk assessment if ecological risk can not be excluded.
In this work we present and analyse a list of terrestrial and aquatic plant species requested for commercial use for which ecological risk could not have been excluded and for which permits were not issued. Among them there are only three species (*Miscanthus* × *giganteus* J.M.Greef, Deuter ex Hodk., Renvoize, *Panicum virgatum* L. and *Paulownia tomentosa* Steud.) for which the risk assessments have been submitted.

Session 4 *Modelling plant invasions: the role of climate, traits and socioeconomy*

P23

Modelling hot spots areas for the invasive alien plant *Elodea nuttallii* in the EU

Bart Steen

Elodea nuttallii is an invasive plant species widely distributed in many of the freshwater habitats of Europe. The species is under discussion to be included in the list of invasive alien species (IAS) of Union concern of the European Union (EU) Regulation on IAS. In the present paper we aim to research the species' potential distribution across the EU, in order to provide a scientific basis for preventing further introductions. To this end we have generated a model-based habitat suitability map of *E. nuttallii* in the EU, showing areas where the plant is most likely to establish and persist overtime. The program MaxEnt has been used for implementing the map, taking into account environmental information about the species and the most updated geographically referenced occurrence data. The R package ENMeval and extraction of occurrence data at two spatial scales were used to compensate for sampling bias and model overfitting. Our results suggest that most of the suitable areas of the EU for the establishment of *E. nuttallii* are already occupied by the species. Still, there are many non-infested areas across the EU, but considering E. nuttallii rapid spread and the highly connected waterbodies in Europe, it is highly likely that these areas will be invaded in the near future. Among these, several areas coincide with Natura 2000 sites. We suggest that these areas should receive conservation priority, and early warning and rapid response mechanisms should be locally developed against new introductions of the species.

P24

Seasonal development of *Echinocystis lobata* under climatic extremes

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Most of well-known invasive plant species were widely spreading on the border between 19th and 20th century. Climate warming onward stimulates the invasion process. As a result new aggressive aliens appear, threatening the biodiversity of natural ecosystems. Example as such is recently occurring spread of wild cucumber (*Echinocystis lobata* (Michx.) Torr. et A. Gray.) within significant part of Europe including Lithuania. Climate change interferes with ordinary plant life. According to the World Meteorological Organization, the years 2011-2015 have been the warmest five-year period. Nowadays it becomes more and more important to evaluate patterns of the plant dynamics and thus to detect aberrations. So seasonal variation of invasive species has become a major research object of the modern phenology. For evaluation of growth dynamics four locations with *Echinocystis lobata* populations were selected in Lithuania (study was funded by Lithuanian Research Council, Project No. SIT-02/2015). Records of morphological and gravimetric parameters revealed huge potential of aboveground expansion: one individual of 1.3 kg mass was able to develop around 1000 seeds, for their dissemination extending stems in the distance, up to 242 m.Within drought in July 2015, growing in the most humid place the only population has survived. The seeds which before July were burried under the water of the river started to germinate providing possibility for species to survive. Hereby, among the reasons of successfull spread of annual *Echinocystis lobata*, sequestration of seeds are playing important role in the extreme conditions of environment.

P25

Latitudinal and altitudinal patterns of exotic plant species diversity in Macaronesian archipelagos

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Located at the North-eastern Atlantic Ocean at different belts of latitude, the archipelagos of Azores and Cabo Verde are a good model to explore the role of exogenous factors, particularly the physiography and the climate, in the dispersal success of introduced plant species. Both archipelagos were colonized in the 15th century by the Portuguese settlers and the flora is mainly composed of exotic species (about 60% of the total flora), threatening the native diversity within the hotspot area of the Macaronesian archipelagos. The nine islands that compose each archipelago present a wide range of altitudes (0 to 2351 m, in Azores and 0 to 2829 m, in Cabo Verde), with the corresponding altitudinal climatic gradient. Moreover, these archipelagos display different climatic regimes (temperate, in Azores vs tropical, in Cabo Verde). In this study, we aim to understand how climatic factors influence the invasive potential of plant taxa, both at genera and species level, considering their biogeographical origin. Additionally, endogenous factors, such as life history traits, are used to understand which species traits play a key role in the naturalization success of exotic flora in Azores and Cape Verde Islands.

P26

The differences in the invasiveness of some alien plant species between continental and coastal part of Croatia

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Croatia is small but heterogeneous country with different pedo-climatic conditions in their parts. In the continental region climate is, excluding mountain region, moderate continental and in the coastal region Mediterranean and sub-Mediterranean. The aim of the investigation was to explore presence, prevalence and level of aggressiveness of some invasive alien plants between continental and coastal part of Croatia. *Amorpha fruticosa* L., *Reynoutria japonica* Houtt. and *Solidago gigantea* (Ait.) are widespread and very aggressive in continental and weakly present in coastal part of Croatia. *Ambrosia artemisiifolia* L. is very common and aggressive weed on agricultural lands of continental region of Croatia, especially on its eastern part. It is much less present and aggressive in coastal part but seems like the species is in mild expansion in Mediterranean part of Croatia. *Ailanthus altissima* (Mill.) Swingle is present in every Croatian county but greater aggressiveness shows in the coastal region including islands.

P27

Ecological niche shifts across continents in aquatic plants native to South America and invasive elsewhere

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Niche shifts conservatism between the native and invaded ranges of invasive aquatic plants has been challenged. Most studies address terrestrial species, due to the lack of freshwater-specific environmental information at sufficiently fine spatial resolution. On the assumption that niche is conserved during the invasion process, we investigated the extent to which niches of aquatic plants are conserved comparing their native niches in South America with invaded niches in Africa, Australia, Europe and North America. The estimated niche for the native region was projected onto each invaded region to generate potential distributions there. Freshwater-specific climate and environmental variables were collected from a standardized 1km grid. Species occurrences were obtained from different world-databases with the Spocc R package. We used PCA-env analyses to assess the similarity between niches with the ecospat R package. Niche dynamics analysis was performed using three approximations to compare invaded niches with native niche: 1) niche overlap (D); 2) niche equivalence and 3) the niche similarity. Additionally, we indentified niche zones within the environmental space by overlapping the native and invasive niches: unfilled; overlap and expansion. While the overlap values measured the proportion of niche conserved, the expansion values estimated the proportion niche expanded. We found, that when analog climate niches are compared between species distribution ranges, some are conserved, while others expand their ranges. Our results are useful to demonstrate that while occupied subsets of its original native niche, in some continents its niche shifted. These findings can be used to identify areas at risk of recently introduction of neophytes, and develop future monitoring programs for aquatic ecosystems, prioritizing control efforts, which enables the effective use of ecological niche models to forecast aquatic invasion in other geographic regions.

P28

Evaluating model performance Maximum Entropy (MaxEnt) and Bayesian Networks (BayNeRD) for delineation potential distribution of invasive Prosopis in Turkana, Kenya

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Prosopis spp., woody plant species originating from Central and South America, were introduced globally to provide fuelwood and combat desertification in arid and semi-arid environments. The species is well adapted to thrive in dry and dessert climates through its extensive rooting system, increasing its drought tolerance. Running trials with a selection of subspecies has triggered a hybridization process, resulting in *Prosopis* becoming an aggressive invasive species. In Kenya several studies have been carried out to map its current distribution and the consensus is that the species is already well established throughout the country. This research aims to model the potential distribution of *Prosopis* in Turkana, Kenya while testing Maximum Entropy (MaxEnt), and Bayesian Networks (BayNeRD) for modelling suitable habitat. The modelling is based on previously mapped *Prosopis* distribution at 10m spatial resolution using Sentinel-2 satellite data. Regarding MaxEnt modelling, we tested a set of predictors including: i) distance from rivers and build up areas (HydroSHEDS and GUF); ii) soil type, lithology and landform (SOTER); iii) elevation, slope and aspect (Aster GDEM); iv) precipitation (CHIRPS and TAMSAT), and v) bioclimatic variables (WorldClim). We trained the models by using a number of presence points collected throughout field campaigns. Validation of the results is based on a k-fold cross-validation and comparison to *Prosopis* map products. Results indicate that the *Prosopis* invasion is likely still in an early stage and has the potential to colonize many suitable habitats within the study area. The models signify that distance to water, lithology, soil type, landform and slope are contributing foremost to its potential distribution. We hope that these results inspire stakeholders to take prompt actions to prevent *Prosopis* gaining a foothold in these suitable habitats.

Session 5 *Biosecurity and management of alien plant invasions*

P29

Determinants of the level of invasion in Kiskunság Region, Hungary

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Alien plant species are not evenly distributed in the landscape. In this study, we analyzed which factors determine the actual level of neophyte invasion in a landscape with heterogeneous land-use and which habitats are the most infected. Since neophyte species with different life-forms can respond differently to the factors determining the invasion, species groups of annual, herbaceous perennial and woody neophytes were also analyzed separately.
The study was conducted within the field site network of the Kiskun-LTER program (Hungary), in 16 sites of 5-by-5 km. Present and past land-use, landscape composition and environmental variables were included as factors with a potential impact on the level of invasion.
The most important factor determining invasion level was present habitat type, followed by the past habitat type of the location and landscape context. Tree plantations, agricultural habitats and recently abandoned agricultural habitats had the highest level of invasion. As expected, annual neophytes were most abundant in agricultural habitats, while perennial herbaceous neophytes were most abundant in old-fields and plantations, and woody neophytes in tree plantations. Past agricultural land-use was reflected in the higher levels of invasion of annuals and perennials, and past forestry practice resulted in higher levels of invasion of woody neophytes. In a landscape with a higher proportion of tree plantations, not only the tree plantations, but primary woodland patches also showed higher levels of invasion by woody neophyte species.
Our results indicate the importance of present and past land-use in plant invasion and suggest that tree plantations are hot-spots of plant invasion and threaten the remnants of semi-natural vegetation.

P30

Planned activities on management of tree of heaven (*Ailanthus altissima* (Mill.) Swingle, simaroubaceae) in Croatia

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Out of around 60 invasive alien plant species in Croatia, tree of heaven (*Ailanthus altissima* (Mill.) Swingle, Simaroubaceae) is considered to be one of the most invasive and one of the most widely distributed. It was introduced to Croatia as ornamental plant and it is still used for that purpose. It is widely distributed in the Mediterrannean part of Croatia, but it is also present in the continental part.
Due to its fast spread and negative impacts, tree of heaven has already drawn attention of local authorities and general public. There have been some local initiatives to raise awareness and educate general public about its invasiveness, as well as to record its presence. On the national level there are different activities planned in the near future in order to try to effectively manage its populations. Therefore, recommended methodology for its control and eradication was prepared and pilot project is planned to remove tree of heaven from selected localities in protected areas using this recommended methodology. Furthermore, to manage and control spread of this species on agricultural land, eradication measures for alien plant species have been integrated in Croatian Rural Development Programme for the period 2014-2020 (Measure 4). Along with other species, tree of heaven will be proposed for eradication in the Ordinance for this measure.

P31

Local roots or flower power? Perceptions of non-native plants and planting preferences in Landscape Architecture in the Netherlands and New Zealand

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Trade in ornamental plants is the major pathway for the introduction of non-native plants worldwide. While most studies on plant invasions address plant traits, trade volumes, or impact assessments, little is known about the values and norms which inform choices in planting strategies. Landscape architects can be influential in determining planting fashion and the type or scale of plant use across a region. Yet to date, how this sector views non-native plants or the threat they might pose to natural systems has not been quantified. We undertook a survey of landscape architecture students to elicit perceptions of non-native plants and their impacts. Data were collected at the School of Landscape Architecture (Lincoln University), the first and longest running landscape architecture programme in New Zealand, and the Dutch School of Landscape Architecture, which includes five (applied) universities that offer study programmes in garden design or landscape architecture. The objectives of this study were to compare landscape architecture students in the Netherlands and New Zealand regarding their perceptions of nature, preferences for plant characteristics, and perceived benefits and risks associated with non-native plants. In addition, semi-structured interviews were held with members of teaching staff in each school to gain insights into school curricula and staff views on the relevance of this topic for students of landscape architecture. The results from this study highlight differences in understandings about non-native plants in different cultural and geographical settings. Moreover, the findings increase our understanding of the social values related to this topic and inform preventive measures aimed at reducing the likelihood of introduction and spread of invasive plants.

P32

Adaptive management of an emerging aquatic plant invader in South Africa: Man meets Machine

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Hydrocleys nymphoides, an aquatic plant invader native to South America is currently limited to one naturalized dam population in South Africa, detected in 2009. By 2013, 30% of the dam was covered by the species. Here we report on our management interventions. To delimit the species and prevent spread into other areas, up- and down-stream surveys of the known population were conducted in 2013-2014, as well as waterbodies within a 20km radius. Various awareness-raising efforts were regularly undertaken over a 7 year period since detection, but these revealed no new populations, as did the surveys. To actively manage the known population, manual removal was conducted by a team of six suitably qualified people from a boat. Collected plant material was transported by boat and offloaded on the bank to dry out. This was done for approximately three months per year, from 2013-2016. Despite being labor intensive, and the immediate visible reduction in infestation size, this methodology resulted in roots being left in the soil and rapid seasonal regeneration. In January 2017, an amphibious dredging machine was used to aid manual operations. Equipped with different gadgets, this machine was able to dig into the substrate and dislodge roots, scoop and rake material to the bank, where it was collected by the team and spread out to facilitate decomposition. In 15 days, the machine removed 360,000kg of plant material at a cost of less than 100 000 ZAR. We will continue to explore this option in the future management of this species, and we anticipate that our management efforts taken during this early stage of its invasion, which have been preventative, consistent, effective and adaptive, will facilitate eradication of this species from the country.

Keywords
Hydrocleys nymphoides, aquatic invasive plant, invasive species management.

P33

Community consequences of introducing a biological control agent to the UK for the invasive weed, *Impatiens glandulifera*

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Invasive weeds are a growing problem in the UK and globally. They dominate habitats, reduce biodiversity, disrupt ecosystem services, and are difficult and costly to control. Introduced to the UK in 1839 from the foothills of the Himalayas, *Impatiens glandulifera* Royle (Himalayan balsam) is now the most commonly occurring non-native weed in riparian systems in England and Wales. As an annual, the plants die back in winter and leave riverbanks at risk of erosion. However, control using herbicides is restricted due to its proximity to watercourses. A pathogen of *I. glandulifera*, the rust fungus *Puccinia komarovii* var. *glanduliferae*, was introduced as a biological control agent against *I. glandulifera* in the UK, after 8 years of research and safety testing. This is the first release of its kind in Europe, and it is currently being trialled at field sites across the country. This research aims to determine how *Puccinia komarovii* var. *glanduliferae* a) affects the target weed and its interactions with native communities of fungi, invertebrates and plants, and b) be used to promote the restoration of these fragile riparian habitats.

P34

Evaluation of possible use of biological control agents as a tool in limiting the spread of invasive plant species of economic interest for Romania

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Evaluation of impact of the main invasive alien plant species in Romania is the major objective of botanists and plant ecologists by the risk analysis procedures even at regional, local distribution or at national level. This studies will be the minimal necessary databases for establishment of an early prevention alert system and implementing this system into a coherent management program for IAS control.
The paper try to establish some criteria for risk analysis of some alien invasive plant species and to bring new information about the use of some biological agents of control (especially insect species from Coleoptera order) in the biological control of alien invasive plant in some important natural or semi natural habitats from Romania.
The results obtained were related to the taxonomically identification and description of some new insect species or local species adapted to attack some main IAS plant species from different region from Romania.

Session 6 *The impact and consequences of biological invasions*

P35

Woody and herbaceous present different answers to biological invasion and anthropogenic activities

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Considering the increasing ecosystems change due to biological invasion and anthropogenic activities, our aim was to test the effect of biological invasions, disturbance and landscape use in woody and herbaceous communities of tropical sandy-savanna named *Mussununga*.
We sampled 13 patches using between 10 to 15 plots (10 x 10 m) with one subplot (2 x 2m) within each *Mussununga* patch., Woody communities with ≥3.2 cm of diameter at soil height were sampled in the plots, while in the subplots all other plants were sampled using cover-abundance approach. We used a generalized mixed model to test the native community diversity and structure over *Acacia* variables (presence, abundance and basal area), disturbance (four levels: *Eucalyptus*, fire, *Eucalyptus*+fire and none) and landscape use (three levels: *Eucalyptus*, forest, *Eucalyptus*+forest) using lmer package in the software R.
We recorded 5539 individuals, 90 species, 74 genera and 40 families. Abundance, height and basal area of native species were negatively related with *Acacia* presence. However, basal area of *Acacia* affected positively the abundance and basal area of native plants as well as abundance of *Acacia* interfered positively in Pielou index. Proportion of dead plants was related with *Acacia* presence and its abundance. Richness and abundance in the woody sampling were affected by disturbance. In the cover-abundance sampling, richness and abundance were affected by landscape.
The ambiguity between *Acacia* presence and *Acacia* abundance/basal area could be explained because the *Acacia* species demands a large amount of light and therefore invades patches with less woody vegetation. The resilience of savanna ecosystem and the exclusion of dominant grasses could explain the positive effect of *Eucalyptus* plantation in the native richness and abundance.
Invasion and disturbance changes tend to affect more the woody community than the herbaceous community.

P36

Water and nitrogen as important factors for root nodules development in *Acacia longifolia*

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Acacia longifolia is an exotic leguminous specie that establishes symbiotic associations with a consortium of nitrogen-fixing bacteria, resulting in a great adaptive advantage and allowing *acacia*s to disperse into poor soils. These bacteria, mainly belonging to the *Rhizobiaceae* family, grow inside root nodules, where fixation occurs. Considering that water and nitrogen are determinant factors in plants' growth, we wanted to study how they could influence nodule development. To perform this study, 4-5 cm long seedlings of A. longifolia were collected in the field, transplanted into sandy soil and maintained in a greenhouse for 45 days. These plants were subjected to four different treatments, including absence of nitrogen vs watering with a nutritive nitrogen solution, and water availability vs drought. Preliminary results showed that under normal water availability, more nodules were formed compared to those developed under water deficiency conditions. Considering that nitrogen fixation varies accordingly to nitrogen availability in soil, it was hypothesized that in the presence of nitrogen, plants would develop less quantity of nodules. Results show that under water stress, more nodules are formed in the absence of nitrogen in comparison to nitrogen availability under drought conditions, however when water was not limited the same difference was not observed. Macroscopic studies revealed differences in colour, dimension and shape among nodules subjected to the different conditions. Scanning electron microscopy (SEM) revealed a higher quantity of bacteria present in nodules under normal water conditions in comparison to the quantity of bacteria found in nodules subjected to water deficiency. These results suggest that water plays a decisive role in nodule growth and its distribution along *Acacia* roots.

Keywords
Acacia longifolia, nodules, water deficiency, nitrogen, Rhizobium, microscopy.

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P37

Horizon Scanning for Invasive Alien Species in Overseas Territories in Cyprus

Jodey Peyton

Invasive alien species (IAS) are considered one of the greatest threats to biodiversity. Horizon scanning, the systematic examination of future potential threats and opportunities, resulting in prioritization of IAS threats is an essential component of IAS management. In this talk we present the results of a horizon scanning exercise undertaken in Cyprus. The authors are currently undertaking a Defra Darwin Initiative project looking at the impacts of non-native species on native flora and fauna within the Sovereign Base Areas (SBAs) of Cyprus. The SBAs represent an intriguing context in which to assess impacts of non-native species not least because of the military movements but there is also relevance to linking to the wider Cypriot environment given the nature of the border between the SBAs and Cyprus. We used collaborative consensus methods to prioritise non-native species likely to arrive, establish and impact on biodiversity and ecosystems in the next ten years. We also assessed the likelihood of species having impacts on human health. We highlight the top 20 non-native species considered likely to arrive, establish and be of threat to biodiversity and human health in the terrestrial, freshwater and marine environments in Cyprus and suggest future steps in risk assessment and management plans to minimise impacts of any new arrivals

P38

Acacia ecology on brazilian dune systems - first data on the ecology of australian *Acacia longifolia* (fabaceae) across coastal dunes of Florianopolis, Santa Catarina, south Brazil

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In 2008 *Acacia longifolia* (Andrews) Willd., a coastal shrub native from Australia, was found in the Florianopolis Island, an south brazilian coastal area well knowns for its conservation values and ecological vulnerability. Since then, the surface covered by *Acacia longifolia* has increased extensively forming thick mats, which can eliminate the local species and threats seriously the coastal systems in this place. This communication shows some preliminary results about the research project on the *Acacia* sp. in the Florianopolis Island, supported by University of São Paulo.

The Nitrogen concentrations (N) in the shoot and in the soil layer in approximately a five-years-old stand of two Australian species (*Acacia longifolia* and *Acacia podalyriifolia*) and in a Brazilian specie (*Dodonaea viscosa*), as also the soil contents (texture, organic matter, pH, field capacity, density), were evaluated in the Florianopolis Island, Santa Catarina State, South Brazil. Was collected single samples of leaves and soils in aleatory areas of forest understory. The two Australian species presented high nutrient accumulation efficiency concentrating 30 mg/g nitrogen average: 30.545 mg/g by *A. longifolia* and 29.745 mg/g by *A. podalyriifolia*. The Brazilian specie just accumulated 20.810 mg/g of nitrogen in the shoot. In the soil layer there was only accumulation of 0.149 mg/g N, and was found 85%, 10% and 2% of matter level (respectively sand, fine particles and organic matter). The soil pH and soil density estimated was 5.5% and 1.5 g/ml, respectively. The field capacity measured for the forest understory area was 25-30% (under 72 hours time analysis). The high accumulation of nitrogen and the soil conditions may represent an advantage to Australian species as nutrient supply for invasion success, or a disadvantage to Brazilian species with biodiversity loss in areas subject to frequent invasion.

P39

Jekyll and Hyde of plant invasions: Central-European chateau parks as local refugia of plant diversity as well as sources of invasive plants

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Chateau parks are traditional sources of new alien plants recruiting from introductions of ornamentals. However, it started to be recognized recently, that parks can be also threatened by many invasive plants. The objective of our project is to rigorously assess the role of chateau parks in the process of invasion. We study parks as sources of new neophytes and as an environment providing protection for already present alien species.
The presented data are based on preliminary survey in 25 parks from the whole Czech Republic, located in urban areas, chateaus, palace gardens and countryside parks, in various landscape and socio-economic contexts. The patterns of alien plant occurrences can differ significantly within the same park depending on its spatial arrangements and functions, from intensively managed parts to extensive meadows and forests; these habitats are considered. Our primary aim is to contribute, by identifying problematic invasive species, towards maintenance of the historical and cultural value of the parks, including native flora and vegetation.
Our preliminary results show that (i) the number of escaping invaders and their population sizes are not high as we expected; (ii) the parks are threatened by many invasive plants arriving from surrounding urban landscapes; and (iii) many parks are refugia for threatened native species and vegetation types.

P40

Facilitation and dilution: how biodiversity regulates forest pest invasions

Q. Guo, K. Potter, S. Fei, A.M. Liebhold, J. Wen, K. Riitters

Community ecology theory predicts that high species in a host community would imply high disease diversity because of the availability of specialized niches. However, if the overall diversity of entire hosting community (i.e., hosts plus non-hosts) is very high, on average, the abundance (both density and biomass) of each host becomes inevitably low. We hypothesize that, because the lowered host abundance would not be able to support many pest species, very high host community diversity would help reduce pest richness. Our comprehensive analysis of data from 130,210 forest plots within 3109 counties with 66 pests on trees (51 insects and 15 pathogens) across the conterminous United States consistently supports this hypothesis; that is, when tress species richness in the host community is low, there is a positive richness relationship between host-community tree diversity and pest richness (through the "facilitation effect"), but when tree richness becomes very high, the pest richness is reduced, possibly because the abundance of many host species becomes too low to support many pest specialists with sustainable populations. Although pest richness is also affected by physical and social factors, we detected the unique role of biodiversity in facilitating and resisting pest invasions. This new finding helps explain the present patterns and needs to be considered in projections of future invasions and in management. Further details on the underlying mechanisms remain to be tested, preferably through field and lab experiments.

Session 7 *Chasing invasive species with high technology*

P41

Remote sensing of *Acacia longifolia* impact on ecosystem structure and functioning

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Acacia longifolia is an N-fixing invasive ecosystem engineer in Mediterranean dune ecosystems. Its local impact on ecosystem structure and functioning is well understood, but novel methods are required for an assessment at larger scales. Here, we address three objectives from leaf to landscape scale using remote sensing:
1) Does leaf trait dissimilarity between *A. longifolia* and native species reveal high impact on N cycling? 2) Can *A. longifolia*'s impact on N cycling be modelled at stand level in a spatially explicit way? 3) How can *A. longifolia*'s modifications of ecosystem structure and functioning be mapped at the landscape scale?
First, leaf traits of *A. longifolia* are clearly distinct from native species especially regarding leaf N content indicating high impact on N cycling. The dissimilarity can be predicted using hyperspectral data, which shows potential for mapping[1].
Second, the spatial extent of the N-fixation by *A. longifolia* can be modeled by changes in foliar δ15N, a functional tracer for N-fixation, of the non-fixing, native shrub Corema album, with distance to the invader and airborne LiDAR derived spatial heterogeneity as important variables[3]
Third, *A. longifolia* can be detected at landscape level by airborne hyperspectral and LiDAR data fusion. Moreover, invader induced modifications of productivity (GPP) can be mapped even at early stages of invasion[2].

1. Große-Stoltenberg A, Hellmann C, Oldeland J, Thiele J, Werner C (accepted with minor revision): Leaf trait dissimilarity distinguishes an invasive engineer in the hyperspectral/ biochemical trait space. Journal of Vegetation Science.

2. Große-Stoltenberg A, Werner C, Thiele J, Hellmann C, Oldeland J (submitted). Early detection of GPP-related regime shifts after plant invasion based on remote sensing.

3. Hellmann C, Große-Stoltenberg A, Thiele J, Oldeland J, Werner C (2017): Heterogeneous environments shape invader impacts: integrating environmental, structural and functional effects using isoscapes and remote sensing. Scientific Reports 7: 4118

P42

Monitoring and management of populations of four invasive alien plants along the French national road network

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French Ministry in charge of the Environment has the purpose to map, in a comprehensive and harmonized manner, the current distribution, in 2017 and 2018, of four invasive alien plants, located into the « green dependencies » along the national road network. These occurrence data will enable national authority and its local services to obtain an overview of the invasions, in order to define management objectives for the populations, with the aim of mitigating their adverse impacts, particularly on road safety and public health.
The four selected species of national concern are *Ambrosia artemisiifolia*, *Heracleum mantegazzianum*, *Ailanthus altissima* and the genus *Reynoutria*. To localize and characterize populations for their subsequent differentiated management, a field protocol, with seven criteria to collect for each population, has been developed. It requires the use of a speed-reduced vehicle and possibly of a high-resolution camera, in order to survey all populations in a few weeks along around 12.000 kilometers of national road network. The combination of the values of the survey criteria and the resulting map will provide the management objective for each population, using a decision-making tool to define three categories: populations to eradicate, to contain or without intervention.
This work, based on the complementary collaboration of scientific and operational staff of two state structures, reflects the challenge of implementing a common, original, effective and feasible national method, and the need for flexibility, due to territorial variations of budgets, tools, skills and availibilities between organizations. Tests and trainings will be conducted this summer during the initialization stage.
This program is a concrete case of « active surveillance » (specific, dedicated and organized inventory of invasive alien plants) for the following-up of widely spread terrestrial species, in the context of the obligation of the establishment of a national surveillance system, for the application of the European Regulation on invasive alien species and the associated National Strategy.

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Using and assessing Rapideye high-resolution multispectral satellite imagery for vegetation mapping in Madeira Island (Portugal)

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Madeira Island constitutes a biodiversity hotspot due to its high number of endemic/native plant species. This biodiversity is constantly threaten by natural hazards, ineffective land planning and management policies and also alien invasive plants spread (e.g. Acacia spp. – especially in degraded, abandoned and/or burnt areas). Consistent, reliable and periodical vegetation mapping is therefore crucial for supporting nature conservation policies in this island. We developed and assessed a methodological framework aiming to produce a Rapideye-based (high-resolution multispectral satellite imagery) vegetation map for Madeira island. Pixel and object-based Maximum Likelihood supervised classifications were applied to eight initial datasets stacking Rapideye multispectral bands from December 2009 (winter) and August 2011 (summer) and three derived vegetation indices: the classic NDVI, the already tested reNDVI and a newly tested NDVIre, respectively, in order to test the full potential of the Rapideye red-edge band for vegetation studies. The classification scheme to be used was categorized in three levels for a total of 7 first level (more generalized) classes, 12 second level classes and 26 third level (more detailed) classes. A total of 1244 ground truth points have been collected for the December 2009 dataset and a total of 1341 ground truth points have been collected for the August 2011 dataset. The random stratification procedure for the August 2011 datasets left respectively 931 points for classification and 410 points for accuracy assessment. This same procedure for the December 2009 datasets left respectively 851 points for classification and 393 points for accuracy assessment. The best results were obtained by applying the object-based approach to the Rapideye dataset of August 2011 including the Red Edge-NDVI band (best Kappa coefficient: 0.754) or the NDVI band (best Overall Accuracy: 74.77%). These methodological approaches applied to Rapideye imagery were confirmed as cost-effective procedures for mapping and monitoring vegetation in Madeira Island.

P44

Photo-oxidative stress and photoprotective markers to assess invasion success in Mediterranean-type ecosystems

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Photosynthesis fuels live on earth. However, plants may be exposed to excess energy in chloroplasts, which may limit their success in natural habitats. The whole plethora of photoprotective mechanisms contribute to prevent photo-oxidative stress and photoinhibitory damage, with some mechanisms being universal (i.e., present in all photosynthetic organisms). Invasive species are known to show high vigor, performing better than coexistent species under the same environmental conditions. A meta-analysis was conducted to explore photoprotective mechanisms activated by invasive and coexistent native species in Mediterranean-type ecosystems. We show that measurements of the carotenoids per chlorophyll (Car/Chl) ratio may be an excellent tool to assess invasion success in Mediterranean-type ecosystems. Different techniques for measurements, including spectroradiometry, spectrophotometry and high performance liquid chromatography were compared. It is concluded that spectroradiometric measurements of the Car/Chl is a reliable, unexpensive and easy technique, with high-scale applicability, to assess invasion success in Mediterranean-type ecosystems. Spatiotemporal limitations should be carefully considered for an efficient use of this technique in early detection and management of invasive species.

P45

Multi-seasonal monitoring of *Acacia longifolia* through UAS: potential for detection of a biocontrol agent

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Invasive Alien Species (IAS) are responsible for an estimated 12 Billion euros per year in costs of controlling and repairing the ecosystems just in the European Union alone. Providing efficient and low cost solutions for monitoring is vital to ensure the success and sustainability of IAS management.

Acacia longifolia is one of the most widespread invasive plants in the Portuguese coast, characterized by rapid growth and prolific seed production. Recently, to assist in controlling *A. longifolia* spread, the *Trichilogaster acaciaelongifoliae* wasp was introduced and became the first biocontrol agent used for this purpose in Continental Europe. This agent is expected to disrupt the seed production by galling in the flowering buds.

Unmanned Aerial Systems (UAS) can provide an ideal low-cost, highly customizable solution for very high resolution mapping of invasive alien plants (IAP). UAS also provide very high resolution canopy height models and allow to extract/predict various structural parameters, thus providing previously unachievable data for management.This research presents the first assessment of using UAS for *A. longifolia* detection throughout different seasons and also to determine vegetation characteristics such as height and crown parameters. It also provides information on how continuous monitoring of *A. longifolia* flowering can be used to monitor the establishment of *T. acaciaelongifoliae*.

To test the usability of UAS for monitoring *A. longifolia*, two areas with biocontrol and three without, with approximate 3.5 hectares were selected in the Portuguese coast. UAS data was acquired in the various seasons between 2017/2018 to test the detection of *A. longifolia* under different phenological states. We tested pixel and object-based classifications and report on the achievements of each approach.Using image processing techniques we extracted *A. longifolia* vegetation structure and compared these results with those from field measurements.

Session 5 *Biosecurity and management of alien plant invasions*

MODIFIED ABSTRACT

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Here to stay. Novel perspectives in sustainable and valuable uses for invasive alien plants (IAPs)

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Future management of invasive alien plants (IAPs) is a challenging task for the next decades as climatic conditions and land use intensification forecast an increase in undesirable invasions. The emerging assumption that IAPs eradication seems often unrealistic provides a new scenario in which novel approaches emerge relevant. In this context, a growing and remarkable line of applied research is currently looking for different solutions related to sustainable and integrated use/management of IAPs. Instead of adopting unidirectional attitudes, considering IAPs as environmental problems that should be eliminated, the unfeasible eradication of some IAPs lead us to develop multidisciplinary approaches. Together with the classic control methods, strategies such as educational programs concerning IAPs, the elaboration of legislative frameworks, or their inclusion in programs for agronomical or industrial purposes to limit the spread of already established populations are currently being developed.

Here, we summarize and highlight recent studies related to different uses of the *Acacia* genus, mainly focusing on agronomical purposes as a cost-effective and integrative way to manage *A. dealbata*, *A. longifolia*, *A. melanoxylon* and valorise their residues. Green manures, mulches or composted material from these species have been tested for the amelioration of soil nutrient content, crop growth and the control of crop-accompanying weeds. Composted material from acacias was particularly adequate for soil improvement and also as horticultural substrate component. In addition, plant material of *Acacia* showed a slight phytotoxic effect on the emergence and short-term growth of crop accompanying weeds. At the same time, the bioactivity of plant residues did not negatively affect crop yield favouring its possible use as novel tools in agronomy.

Our approach, mainly focused on the *Acacia* genus, might be extended to other IAPs that present similar invasive traits. Far from being a complete solution, presented approaches align with the Bioeconomy Strategy, CAP (Common Agricultural Policy) guidelines, and organic and sustainable agriculture principles. However, to be successful, these actions should be implemented and maintained within a context of participation between administrations and local communities.

SOCIAL PROGRAMME

FIELD TRIPS

On Friday morning (between 08:00 and 09:00) we will departure from the venue of EMAPI, the Sana Lisboa Hotel, to explore three different locations - Arrábida and Tróia, Sintra and Mata Naciona da Machada.

Arrábida Natural Park and Tróia Península

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2 - Sociedade Portuguesa de Botânica
3 - Parque Natural da Serra da Arrábida

In this field trip we will look at some of the major community types encountered in Arrábida due to different abiotic factors and time since fire. South of Lisbon, crossing the bridge over the Tagus River, we will reach the "Setúbal Peninsula", where lays, in the southern border of the peninsula, the Arrábida Chain, an elongated mountain where is located the Serra da Arrábida Natural Park. The Arrábida Chain is a distinct geomorphologic unit, clearly detached from the surrounding areas, and here most of the area presents skeletal soils and in some areas dark humic soils and "terra rossa" can accumulate. We will stop in Cabo Espichel, with its typical limestone mediterranean vegetation mosaic of maquis, low shrublands and fallows, that is among the most diverse in the whole country. After, we travel to JASPE, our second stop, to enjoy a fabulous view! The lunch will take place in Setúbal city, near the river Sado (13:30-14:30), and around 15:00 we will cross the river Sado by ferry-boat to the sandy territory of Peninsula de Tróia, where we will continue our observation of the Natural Vegetation.

Mata Nacional da Machada, Projecto LIFE Biodiscoveries (LIFE13 BIO/PT/000386)

Henrique Pereira dos Santos1 and Andreia Pereira[1]
1 - Barreiro Municipality and LIFE European Commission DG Environment

The LIFE Biodiscoveries Project is promoted by the Municipality of Barreiro, with the participation of the LIFE Program of the European Commission. The Project aims to control invasive species, namely acacia and ice-plant through public participation. The central idea is that individuals, in the family, through companies, schools or associations, can "adopt" fields and be responsible for controlling the invaders in these specific areas of land. The intervention area is located in the Local Nature Reserve of Barreiro, integrating the Mata da Machada and Sapal do Rio Coina.
The project is roughly halfway through, and at this time, it is easy to observe the work in the field, with the ice-plant practically controlled and with an effective reduction in the acacia area. We consider that it will be very pertinent, under EMAPI 14, to visit the project area and to be able to observe concrete results in-situ and to try out the techniques used.

Sintra

Hélia Marchante[1] and Elizabete Marchante[2]
1 - Escola Superior Agrária/Instituto Politécnico de Coimbra (ESAC/IPC) & Centre for Functional Ecology (CFE), Universidade de Coimbra, Portugal
2 - Centre for Functional Ecology (CFE), Universidade de Coimbra, Portugal

The field trip will include scenic views in Natural Park of Sintra-Cascais, with a short stop to observation of both native and invasive species and technical visit to an area under long term control of invasive plants vs. an area invaded (mainly Acacia spp.). We will also be able to enjoy a cultural visit to the Cultural Landscape of Sintra including Parque and Palácio de Monserrate, and a "free visit" to Sintra Village at the end of the day to enjoy local flavours.

CONFERENCE DINNER

20:30

Lisbon is renowned in the world for many reasons, including the good food!

We decided to organize the EMAPI 2017 Conference Dinner in a typical and historical restaurant in Lisbon: "Casa do Alentejo".
The "Casa do Alentejo" or "Alverca Palace" was granted the classification of "Public Interest Building", assuring that you will have the right ambience for our dinner. The restaurant is located at Rua das Porta de Santo Antão, right in the centre of Lisbon's "Baixa". Possibly built in the late seventeenth century, the building where today is installed the "Casa do Alentejo" has undergone profound changes in the early twentieth century. From its earliest history its known that belonged to an aristocratic family – the Paes Amaral (Viscounts of Alverca) – from whom adopted the name and the title of Paes do Amaral Palace or Palace Alverca. In 1932 it was leased to the Alentejo Guild, later called – Casa do Alentejo – becoming the headquarters of the Region Alentejo Association. In 1981 it was acquired from the descendants of Paes de Amaral family, becaming heritage of all Alentejo.
This restaurant has played an important role for Culture and Associations, in particularly between Lisbon and the southern regions of Portugal, Alentejo and Setúbal, promoting and preserving the culture of Alentejo.
Along the dinner, with a menu that integrates the flavors, smells and tastes of the traditional Portuguese gastronomy and wine, we will also have the possibility to "taste" traditional Portuguese music...!

AUTHOR INDEX