National Symposium on Biological Invasions

Africa acting together against Biological Invasions




National Symposium on Biological Invasions

5 – 7 May 2021

Virtual Symposium

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National Symposium on Biological Invasions

'Africa acting together against Biological Invasions'

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Day 1 - Wednesday 5 May 2021		
09:00 - 09:05 (5 min)	Opening of online symposium - Martin Hill, Centre for Biological Control (CBC)	
09:05 - 09:15 (10 min)	Opening Address - Barbara Creecy: Minister of Forestry, Fisheries and the Environment	
09:15 - 09:20 (5 min)	Symposium logistics and housekeeping - Organising Committee	
Session 1a & 1b - Facilitators: Maanda Rambauli and Katelyn Faulkner		
09:20 - 09:25 (5 min)	Introduction to session 1a	**Transport and Introduction of Alien Species**
09:25 - 09:40 (15 min)	Eckehard (Ecki) Brockerhoff	**KEYNOTE:** Bridgehead effects in invasive insects and pathogens
09:40 - 09:45 (5 min)	*Questions to Keynote speaker*	
09:45 - 09: 55 (10 min)	Bernard Slippers	Interconnected global populations of Botryosphaeriales tree pathogens arising from anthropogenic spread
09:55 - 10:00 (5 min)	Cheyenne Theron	*Lecanosticta pharomachri*: a new and important pathogen of *Pinus* species propagated in the Southern Hemisphere
10:00 - 10:05 (5 min)	Kira Lynn*	Discovery of seven novel *Fusarium* species associated with two ambrosia beetle species in Indonesia and their global relevance as tree pests
10:05 - 10:20 (15 min)	Discussion on session 1a	
10:20 - 10:35 (15 min)	**TEA BREAK**	
10:35 - 10.40 (5 min)	Introduction to session 1b	**Transport and Introduction of Alien Species**
10:40 - 10.50 (10 min)	Katelyn Faulkner	The movement of alien species in Africa poses an important and increasing biosecurity threat
10:50 - 10.55 (5 min)	Josie South	Southern Hemisphere Fish Invasion Trends
10:55 - 11.05 (10 min)	Marcus Byrne	Traditional medicine as a route for importation of alien organisms
11:05 - 11.10 (5 min)	Emily Jones*	Invasiveness in terrestrial true ferns (Polypodiophyta): insights from an assessment of horticultural trade
11:10 - 11.15 (5 min)	Takalani Nelufule*	Native species with alien populations: the extent of the problem in South Africa
11:15 - 11.25 (10 min)	Samalesu Mayonde	A new invasive cactus, *Opuntia megapotamica* Arechav., discovered in South Africa
11:25 - 11.27 (2 min)	Minette Havenga*	**POSTER** - Population biology of the exotic foliar pathogen *Teratosphaeria destructans* in South Africa and South East Asia
11:27 - 11.29 (2 min)	Nobuhle Angeline Magubane*	**POSTER** - An assessment of *Tithonia tubaeformis* invasion along eSwatini-South Africa border
11:29 - 11:50 (21 min)	Discussion on session 1b	
11:50 - 14:00 (2 hr, 10 min)	**LUNCH BREAK**	

**student*

Session 2a & 2b - Facilitators: Sjirk Geerts and Lorraine Strathie		
14:00 - 14:05 (5 min)	Introduction to session 2a	**Establishment and Spread of Biological Invasions**
14:05 - 14:20 (15 min)	Colleen Downs	**KEYNOTE:** Evaluating the role of native bird and mammal species in the dispersal of alien invasive species: a southern African perspective
14:20 - 14:25 (5 min)	*Questions to Keynote Speaker*	
14:25 - 14:30 (5 min)	Nitin Kanle Satishchandra*	Climatic suitability and host preference of the emerging invader cycad aulacaspis scale insect in South Africa
14:30 - 14:35 (5 min)	Mesfin Gossa*	The value of botanical gardens to biosecurity and plant health research in South Africa
14:35 - 14:40 (5 min)	Joséphine Queffelec*	Factors influencing sex ratio in the invasive woodwasp *Sirex noctilio* in South Africa
14:40 - 14:45 (5 min)	Mlungele Nsikani	Eradicating alien plants before they become widespread invaders in South Africa: practical challenges and potential solutions
14:45 - 14:50 (5 min)	Michael Cheek*	Assessment of the invasions status of five introduced Melastomataceae taxa in South Africa
14:50 - 14:55 (5 min)	Tumelo Morapi*	Invasive potential and management of the genus *Leptospermum* (Myrtaceae) in South Africa
14:55 - 15:10 (15 min)	Discussion on session 2a	
15:10 - 15:30 (20 min)	**TEA BREAK**	
15:30 - 15.35 (5 min)	Introduction to session 2b	**Establishment and Spread of Biological Invasions**
15:35 - 15:45 (10 min)	Tumeka Mbobo*	Patterns of naturalisation, invasion, and impact differ between fleshy and dry-fruited species of Myrtaceae
15:45 - 15:55 (10 min)	Sage Wansell*	The invasion biology of *Pontederia cordata* L. (Pontederiaceae) in South Africa
15:55 - 16:00 (5 min)	Emma Sandenbergh*	Distribution, density and reproductive potential of *Iris pseudacorus* (yellow-flag) in South Africa
16:00 - 16:10 (10 min)	Felix Fru*	High diversity and clonality are the hallmarks of *Fusarium circinatum* invasion in South Africa.
16:10 - 16:20 (10 min)	Caitlin R. Gevers*	The distribution and prevalence of *Leptocybe invasa* (Hymenoptera: Eulophidae) and its associated community in South Africa.
16:20 - 16:25 (5 min)	Gudrun Dittrich-Schröder	Global diversity and introduction history of *Glycaspis brimblecombei* reflects a history of bridgeheads and distinct invasions
16:25 - 16:27 (2 min)	Reshnee Lalla	**POSTER** - Detection and initial assessment of a new cactus species in South Africa
16:27 - 16:29 (2 min)	Kanhaiya Shah*	**POSTER** - Does resource acquisition-allotment strategy facilitate *Hyptis suaveolens* (L.) Poit. invasion success in dry deciduous forests?
16:29 - 16:31 (2 min)	Lalatiana Randriamiharisoa	**POSTER** - Adaptation Strategy and use analysis of the urban environment of Antananarivo, Madagascar by Common mynas (*Acridotheres tristis*)
16:31 - 16:36 (5 min)	Chelsey Matthys*	Listing invasive alien species: Where have they gone (Introduction to workshop)
16:36 - 16:55 (19 min)	Discussion on session 2b	
16:55 - 17:15 (20 min)	**TEA BREAK**	
17:15 - 18:00 (45 min)	Chelsey Matthys, Sjirk Geerts and John Wilson	**WORKSHOP -** The development of a protocol for declaring alien species absent from South Africa.

Day 2 - Thursday 6 May 2021		
Session 3: Facilitators - Jolanda Roux and Phumudzo Tshikhudo		
10:00 - 10:05 (5 min)	Introduction to session 3	**Impact of Biological Invasions**
10:05 - 10.15 (10 min)	Sabrina Kumschick	A new IUCN Standard for classifying impacts of alien taxa
10:15 - 10.25 (10 min)	John Wilson	The Alien Species Risk Analysis Review Panel—what is ASRARP and how you can help
10:25 - 10.30 (5 min)	Claude Moshobane	The influence of invasive *Opuntia ficus-indica* on human livelihoods in Limpopo Province, South Africa
10:30 - 10.35 (5 min)	Fanelesibonge Hlabisa*	Ant diversity and assemblage composition in relation to the invader *Parthenium hysterophorus* and its biological control in South Africa
10:35 - 10.40 (5 min)	Lungile Khuzwayo	Detection and mapping of invasive alien plants in the Western Cape mountain catchments
10:40 - 10.45 (5 min)	Wilhelm de Beer	Current status of the Polyphagous Shot Hole Borer invasion in South Africa
10:45 - 10.50 (5 min)	Shawn Fell	The impact of Polyphagous Shot Hole Borer on Pecan trees in South Africa
10:50 - 10.55 (5 min)	Quadri Agbolade Anibaba*	Land-use is a more important predictor of native abundance and diversity than invasive *Tithonia diversifolia* – evidence from a typical tropical savannah landscape in Nigeria
10:55 - 11.00 (5 min)	Antonella Petruzzella	MadMacs: Mass development of aquatic macrophytes – causes and consequences of macrophyte removal for ecosystem structure, function, and services
11:00 - 11:20 (20 min)	Discussion on Session 3	
11:20 - 13:00 (1 hr 40 min)	**LUNCH BREAK**	
Session 4a & 4b: Facilitators - Mlungele (Mlu) Nsikani and Ryan Brudvig		
13:00 - 13:05 (5 min)	Introduction to session 4a	**Management of Biological Invasions: detection, eradication, and impact reduction**
13:05 - 13:10 (5 min)	*Session dedicated to memory of Olaf Weyl*	
13:10 - 13:20 (10 min)	Geethen Singh*	Detecting Aliens from Space
13:20 - 13:25 (5 min)	Nonkazi Mdidimba*	Detecting alien freshwater crayfish using eDNA in South Africa
13:25 - 13.30 (5 min)	Tainã Gonçalves Loureiro	Dropping plates to track aliens along the South African coast
13:30 - 13.40 (10 min)	David Kinsler*	Remote Sensing as a monitoring tool for Water Hyacinth (*Pontederia crassipes*) in the context of the biological control release programme at Hartbeespoort Dam
13:40 - 13:45 (5 min)	Robert Luke Jansen van Vuuren*	Molecular identification of fall army worm strains in laboratory reared cultures
13:45 - 13:50 (5 min)	Keletso Moilwe	Repeatable methods of classification for alien and native vegetation in Montane Grasslands
13:50 - 14:00 (10 min)	Grant Martin	Invasive Alien Plants Working Group for southern African mountains
14:00 - 14:15 (15 min)	Discussion on Session 4a	
14:15 - 14:21 (6 min)	Husqvarna	**Video Insert from Sponsor – Husqvarna**

14:21 - 14:23 (2 min)	Debbie Muir	**POSTER:** Integrated control of floating macrophytes: can biocontrol and aerial herbicide spraying at sub-lethal concentrations be effective?
14:23 - 14:25 (2 min)	Iram Mujahid Iqbal*	**POSTER:** Discrimination of Invasive species in Protected Areas of Pakistan using remote sensing
14:25- 14:27 (2 min)	Janneke Aylward	**POSTER:** Reproduction and gene evolution in a Eucalyptus stem canker pathogen
14:27 - 14:29 (2 min)	Prividelge Makunde*	**POSTER:** Host preference of *Spondyliapsis* cf. *plicatuloides* (Froggatt) (Hemiptera: Aphalaridae) in South Africa
14:29 - 14:31 (2 min)	Takudzwa Comfort Madzivanzira*	**POSTER:** Standardisation of Australian redclaw crayfish Cherax quadricarinatus sampling gear in Africa
14:31 - 14:33 (2 min)	Zukiswa Zulu*	**POSTER:** Assessing the extent of the overlap between biocontrol and chemical control interventions in KwaZulu-Natal
14:33 - 14:35 (2 min)	Takudzwa Comfort Madzivanzira*	**POSTER:** Potential ecological and socioeconomic impacts of invasive crayfish in Africa
14:35 - 15:15 (40 min)	**TEA BREAK**	
15:15 - 15:20 (5 min)	Introduction to session 4b	**Management of Biological Invasions: detection, eradication, and impact reduction**
15:20 - 15.30 (10 min)	Llewelyn Foxcroft	Alien species in South African National Parks: invasion, management and science
15:30 - 15.40 (10 min)	Nolwethu Tshali	Management of *Spartina alterniflora* in Great Brak Estuary, South Africa
15:40 - 15.45 (5 min)	Reley Ludolph	Diversity of biological invasion responsibilities for Biodiversity Officer in the Western Cape
15:45 - 15.55 (10 min)	Debbie Muir	Pesticide use in NRM programmes in South Africa: An emphasis on aquatic weeds and their control.
15:55 - 16:00 (5 min)	Zukiswa Zulu*	An assessment of the magnitude and costs of herbicide usage in managing invasive alien plants in South Africa
16:00 - 16.05 (5 min)	Jufter Musedeli	Does herbicide application affect the biocontrol agent *Zygogramma bicolorata* in the integrated management of *Parthenium hysterophorus* in South Africa?
16:05 - 16.15 (10 min)	Andrew Turner	A fresh look at biocontrol for pines
16:15 - 16.20 (5 min)	Fortune Ravhuanzwo*	Risk analysis of the invasive oriental fruit fly, *Bactrocera dorsalis* (Hendel) in South Africa.
16:20 - 16.35 (15 min)	Discussion on Session 4b	
16:35 - 16.45 (10 min)	**TEA BREAK**	
16:45 - 17:30 (45 min)	Tsungai Zengeya – SANBI	**WORKSHOP:** Indicators used to monitor biological invasions at a national level

Day 3 - Friday 7 May 2021		
Session 5: Facilitators - Guy Sutton		
09:00 - 09:05 (5 min)	Introduction to session 5a	**Management of Invasive Species: biological control**
09:05 - 09:10 (5 min)	*Session dedicated to memory of Stefan Neser*	
09:10 - 09:25 (15 min)	Harriet Hinz, CABI	**KEYNOTE -** Facts, challenges and opportunities of classical biological control of weeds
09:25 - 09:30 (5 min)	*Questions to Keynote speaker*	
09:30 - 09:35 (5 min)	Megan Reid*	Population genetics of invasive and native *Nymphaea mexicana* Zuccarini: taking the first steps to initiate a biological control programme in South Africa.
09:35 - 09:40 (5 min)	Blair Cowie	Managing *Prosopis*: renewed promise for biocontrol
09:40 - 09:45 (5 min)	Sivenathi Hatile*	The host specificity of *Trabutina mannipara* (Hemprich & Ehrenberg) (Homoptera: Coccoidea: Pseudococcidae): a potential biocontrol agent of invasive Tamarix taxa in South Africa.
09:45 - 09:50 (5 min)	Khethani Mawela	Potential of the leaf-mining moth, *Melanocinclis* sp., as a biocontrol agent for *Tithonia diversifolia* in South Africa
09:50 - 09:55 (5 min)	Lulama Madire	Preliminary study on the impact of a biocontrol agent, *Mada polluta* (Coleoptera: Coccinellidae), on *Tecoma stans* L. in East London, South Africa
09:55 - 10:05 (10 min)	Julie Coetzee	Where's the water hyacinth?
10:05 - 10:15 (10 min)	Lorraine Strathie	Tackling a global invader: Biological control of *Parthenium hysterophorus* in South Africa and its broader benefits
10:15 - 10:30 (15 min)	Discussion on Session 5a	Management of Invasive species: biological control
10:30 - 11:10 (40 min)	**TEA BREAK** with poster session 5a	**POSTER session** - see details on page 8
11:10 - 11:15 (5 min)	Introduction to session 5b	Management of Invasive species: biological control
11:15 - 11.20 (5 min)	Matthew Paper*	Chewers or phloem-feeders…who takes the biggest 'bite' out of water hyacinth under elevated CO_2
11:20 - 11:25 (5 min)	Rosali Smith*	The status of the submerged aquatic weed *Egeria densa* in South Africa
11:25 - 11:30 (5 min)	Pride Mudavanhu	Alien invasive acacia management: a biocontrol success story from South Africa
11:30 - 11:35 (5 min)	Naweji Katembo	Impact of biocontrol on the seed regenerative capacity of *Lantana camara* in South Africa
11:35 - 11:40 (5 min)	Zezethu Mnqeta*	Mass-rearing, releasing and monitoring of biological control agents on invasive alien cacti
11:40 - 11:50 (10 min)	Samuel Motitsoe	Invasive alien aquatic plants management: Ecosystem recovery and restoration
11:50 - 12:00 (10 min)	Costas Zachariades	Update to the catalogue of target weeds and their biological control agents in South Africa, and a new way to assess the outcome of biological control at a weed population level
12:00 - 12:15 (15 min)	Discussion on Session 5b	
12:15 - 12:35 (20 min)	IOBC ATRS - Regional Office	Symposium summary
12:35 - 12:40 (5 min)	Sebataolo Rahlao (SANBI)	Next Symposium - 2022
12:40 - 13:00 (20 min)	Closure of online symposium - Bernard Slippers, Forestry and Agricultural Biotechnology Institute (FABI)	
Symposium closes at 13:00		

Poster sessions

Day 1 - Poster session 1b: Transport and Introduction of alien species		
Wednesday, 5 May	**Delegate**	**Poster Title**
11:25 - 11.27 (2 min)	Minette Havenga*	Population biology of the exotic foliar pathogen *Teratosphaeria destructans* in South Africa and South East Asia
11:27 - 11.29 (2 min)	Nobuhle Angeline Magubane*	An assessment of *Tithonia tubaeformis* invasion along eSwatini-South Africa border

Day 1 - Poster session 2b: Establishment and Spread of Biological Invasions		
Wednesday, 5 May	**Delegate**	**Poster Title**
16:25 - 16:27 (2 min)	Reshnee Lalla	Detection and initial assessment of a new cactus species in South Africa
16:27 - 16:29 (2 min)	Kanhaiya Shah*	Does resource acquisition-allotment strategy facilitate *Hyptis suaveolens* (L.) Poit. invasion success in dry deciduous forests?
16:29 - 16:31 (2 min)	Lalatiana Randriamiharisoa	Adaptation Strategy and use analysis of the urban environment of Antananarivo, Madagascar by Common mynas (*Acridotheres tristis*)

Day 2 - Poster session 4a: Management of Biological Invasions: detection, eradication, and impact reduction		
Thursday, 6 May	**Delegate**	**Poster Title**
14:21 - 14:23 (2 min)	Debbie Muir	Integrated control of floating macrophytes: can biocontrol and aerial herbicide spraying at sub-lethal concentrations be effective?
14:23 - 14:25 (2 min)	Iram Mujahid Iqbal*	Discrimination of Invasive species in Protected Areas of Pakistan using remote sensing
14:25 - 14:27 (2 min)	Janneke Aylward	Reproduction and gene evolution in a Eucalyptus stem canker pathogen
14:27 - 14:29 (2 min)	Prividelge Makunde*	Host preference of *Spondyliapsis* cf. *plicatuloides* (Froggatt) (Hemiptera: Aphalaridae) in South Africa
14:29 - 14:31 (2 min)	Takudzwa Comfort Madzivanzira*	Standardisation of Australian redclaw crayfish *Cherax quadricarinatus* sampling gear in Africa
14:31 - 14:33 (2 min)	Zukiswa Zulu*	Assessing the extent of the overlap between biocontrol and chemical control interventions in KwaZulu-Natal
14:33 - 14:35 (2 min)	Takudzwa Comfort Madzivanzira*	Potentia8l ecological and socioeconomic impacts of invasive crayfish in Africa

**student*

Day 3 - Poster session 5a: Management of Invasive species: biological control		
Friday, 7 May	**Delegate**	**Poster Title**
10:30 - 11:10 (40 min, 2 min each)	Daniel Rodgers*	Evaluating the suitability of a candidate biological control agent for *Sagittaria platyphylla* within South Africa
	Ekhona Zozo*	Is a new biocontrol agent required for the control of *Cylindropuntia pallida* (Cactaceae) in South Africa, or could the agents used for other *Cylindropuntia* weeds be utilised?
	Roy Caister*	Seasonal abundance of the seed-feeding weevil *Smicronyx lutulentus* on the invasive Parthenium weed in South Africa
	Thembelihle Mlokoti	The possible role of mortality in the underperformance of *Aristaea* (*Parectopa*) *thalassias* (Meyrick) as a biological control agent *of Leptospermum laevigatum* F. Muel.
	Siyasanga Tracy Mnciva*	Enhancement of *Megamelus scutellaris* Berg (Hemiptera: Delphacidae) by naturally occurring phytopathogens for biological control of water hyacinth
	Tamzin Griffith*	*Hypogeococcus* as a potential biological control agent for *Trichocereus spachianus*
	Ludzula Mukwevho	The effect of light intensity on the inflorescence production and efficacy of the bud nipping mite on *Lantana camara* L. (Verbenaceae)
	Silvia Langa	Status of aquatic weeds associated with biological control agents in the southern Mozambique rivers.
	Philip Ivey	Civil society, plant surveys and biological control researchers, working together!

**student*

Day 1 Abstracts
Session 1a

KEYNOTE:
Bridgehead effects in invasive insects and pathogens

Brockerhoff, E.[1]

[1]*Swiss Federal Institute for Forest, Snow and Landscape Research, WSL, Switzerland*

Many non-native species are more abundant in their invaded range than in their native range. This can be explained by favourable resource availability, reduced competition and escape from natural enemies in the invaded range. Consequently, such invasive populations can become the source of secondary invasions originating from the invaded range, propagating further invasions. This process of secondary invasions has been likened to the military term 'bridgehead' which enables invasion and further expansion on the other side of a river. Bridgehead effects are thought to be important drivers of pest and pathogen invasions and there is some evidence for this. Two types of evidence are important here: (i) border interception records of pest arrivals from native and non-native regions and (ii) population genetic studies. In this presentation I will review several case studies to discuss the relative importance of bridgehead effects and implications for pest management.

Interconnected global populations of Botryosphaeriales tree pathogens arising from anthropogenic spread

Slippers, B.[1], Nagel, J.[1] and Wingfield, M.J.[1]

[1]*Forestry and Agricultural Biotechnology Institute, University of Pretoria*

The rate of introduction and emergence of invasive tree pathogens continues to increase. This is despite the development of increasingly strict biosecurity measures during the course of the past two decades. Population genetics studies have shown that many of these pathogens have seemingly unstructured global populations. These population genetics patterns can be explained through repeated and persistent introductions over time. The scale and frequency of these introductions increases the threat that these invasions pose, for example through increasing rates of evolution of these pathogens and their potential to overcome host resistance and to adapt to varying environmental conditions. We have analyzed patterns emerging from population genetics studies on selected globally-distributed tree pathogens in the fungal order Botryosphaeriales. These patterns have made it possible to visualize a "worldwide web" of forest pathogens. The studies have also allowed us to consider mechanisms that facilitate the movement and establishment of these pathogens, in particular the relevance of latent infections in living plant material.

Lecanosticta pharomachri: a new and important pathogen of _Pinus_ species propagated in the Southern Hemisphere

Theron, C.A.[1], Marincowitz, S.[2], Rodas, C.A.[3], Wingfield, M.J.[2], Barnes, I.[2]

[1]Department of Plant and Soil Sciences, Forestry and Agricultural Biotechnology Institute, University of Pretoria
[2]Department of Biochemistry, Genetics and Microbiology, Forestry and Agricultural Biotechnology Institute, University of Pretoria
[3]Forestry Health Protection Programme, SmurfitKappa Colombia, Colombia

Brown spot needle blight (BSNB), caused by *Lecanosticta acicola*, is an infamous disease of *Pinus* spp. in the Northern Hemisphere, causing serious damage to native stands of these trees. The only known occurrence of this pathogen in the Southern Hemisphere is from Colombia where it was recorded in the early 1980s causing severe defoliation of *P. radiata* in plantations. Recent outbreaks resembling BSNB in plantations of Mesoamerican pines in Colombia raised concerns that *L. acicola* may have re-emerged. Analyses of DNA sequence and morphological data for isolates collected from these trees showed that the new outbreaks are caused by the recently described *Lecanosticta pharomachri*, which is distinct from, but closely related to *L. acicola*. This pathogen was first described (van der Nest et al. 2019) from native *Pinus* spp. in Central America and it is thus likely that *L. pharomachri* has been accidentally introduced into Colombia. This study also led to the first discovery of the sexual stage of *L. pharomachri* and successive sexual outcrossing in these populations could increase genetic diversity and promote the further spread and adaptive ability of this fungus to other pine hosts and climates. The appearance of *L. pharomachri* in Colombian plantations of non-native *Pinus* spp. places it on the list of important threats to South African forestry where various susceptible Pinus spp. are widely planted. Biosecurity regulations in South Africa must thus accommodate this new threat

Discovery of seven novel *Fusarium* species associated with two ambrosia beetle species in Indonesia and their global relevance as tree pests

Lynn, K.M.T.[1], Wingfield, M.J.[1], Durán, A.[2], Oliveira, L.S.S.[2], de Beer, Z.W.[1] and Barnes, I.[1]

[1]Department of Biochemistry, Genetics and Microbiology, Forestry and Agricultural Biotechnology Institute, University of Pretoria
[2]Plant Health Program, Research and Development, Asia Pacific Resources International Holdings Ltd., Indonesia

Ambrosia beetles (Curculionidae: Scolytinae and Platypodinae) are wood boring insects that cultivate and feed on fungal mutualists in the xylem of their plant hosts. Several ambrosia beetle species have emerged as important invasive pests globally, and the diseases with which they are associated threaten numerous tree species. An example is the accidental introduction of *Euwallacea fornicatus* into several countries, including South Africa. This has resulted in the emergence of Fusarium die-back on various economically important plant hosts. This study investigated two Fusarium-farming *Euwallacea* ambrosia beetle species that have emerged as pests in their native environment of Indonesia. The overall aim was to broaden knowledge regarding the diversity of this and other beetle-fungus mutualisms. Based on phylogenetic analysis, several novel haplotypes of *Euwallacea similis* and *Euwallacea perbrevis* were identified. Multigene phylogenetic analysis of their fungal mutualists revealed their non-specific relationship with seven novel *Fusarium* spp. residing in the *Fusarium solani* species complex (FSSC). The results confirmed that this symbiosis is promiscuous, suggesting that closely related beetle species can potentially swap fungal mutualists and thus result in new disease outbreaks. These results are globally relevant given that these insects are moving worldwide and thus require focussed quarantine strategies to avoid future accidental introductions.

Session 1b

The movement of alien species in Africa poses an important and increasing biosecurity threat

Faulkner, K.T. [1,2], Hurley, B.P. [3], Wilson, J.R. [1,4], Robertson, M.P.[5]

[1]*South African National Biodiversity Institute*
[2]*Centre for Invasion Biology, University of Pretoria*
[3]*Forestry and Agricultural Biotechnology Institute, University of Pretoria*
[4]*Centre for Invasion Biology, Stellenbosch University*
[5]*Centre for Invasion Biology, University of Pretoria*

Alien species are often introduced to Africa from other continents, and once introduced these species can easily spread between countries. Using data on alien birds and insect pests of eucalypts, we show that while introductions from other continents are important, the intra-African spread of alien species represents an important and possibly increasing threat to biosecurity. Predictions of future invasions made for 86 well-known invaders using species distribution models and socio-economic and biodiversity data, further highlight the threat posed to Africa by these invasions. Of the 542 invasions predicted for Africa, 46% could spread from the country in which the species first establishes into neighbouring countries where they would cause significant negative impacts. These invasions are unlikely to be prevented as most African countries have a low capacity to prevent introductions, and as in many instances the country of first establishment will have little incentive to do so as there will be no impact in that country. While these types of invasions occur in all regions where countries share land borders, their impacts are likely to be particularly severe in Africa. This challenge to biosecurity needs to be urgently addressed, especially in light of the commencement of free trade in Africa.

Southern Hemisphere Fish Invasion Trends

South,J.[1,2,3], Baigún,C.[4], Bragança, P.H.N.[1], Loureiro, T.G.[5], Madzivanzira, T.C.[5], Petruzella, A.[6], Vitule, J.R.S.[7], Weyl, O.L.F.[1,2,3]

[1]*South African Institute for* Aquatic *Biodiversity*
[2]*Centre for Invasion Biology, SAIAB*
[3]*Department of Ichthyology and Fisheries Science, Rhodes University*
[4]*Instituto de Investigación e Ingeniería Ambiental, Buenos Aires, Argentina*
[5]*Centre for Invasion Biology, Stellenbosch University*
[6]*Centre for Biological Control, Rhodes University*
[7]*Laboratório de Ecologia e Conservação (LEC), Departamento de Engenharia Ambiental, Setor de Tecnologia, Universidade Federal do Paraná, Brazil*

Freshwaters provide multitude ecosystem services which sustain human populations. We are undergoing a global freshwater biodiversity crisis, and this is being further exacerbated by invasive species. Many of these risks are disproportionately experienced by countries classed as the 'Global South', i.e. countries with developing economies. Paradoxically, the bulk of the knowledge base and research initiatives on aquatic invasions are generated in the 'Global North', and as a result, can ineffective or unfeasible when transplanted. We propose that by conceptualising and facilitating collaborative science across the southern hemisphere there is a unique opportunity to exploit similar geographical nature and nuanced socio-economic context with regards to advancing aquatic invasion ecology. Using three southern hemisphere countries as a starting point (South Africa, Brazil and Argentina) we examine patterns in lateral species donations across the respective continents and review which fish invaders are shared and suggest areas for future collaboration and hypothesis testing.

Traditional medicine as a route for importation of alien organisms

Byrne, M.J.[1,2], Williams, V.[1], and Burness, A.[1]

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The Global Compendium of Weeds lists 26,541 'weedy' plant species – of which 47% were introduced into new regions through the pathway of herbal medicine trade. South Africa is one of >130 countries to sign cooperation documents related to China's 'Belt and Road Initiative' (BRI). One aim of the BRI is to promote Traditional Chinese Medicine (TCM) in BRI countries and expand these markets. TCM practitioners are present in at least 27 African countries – including 3,500 in Côte d'Ivoire. There are 158 registered TCM practitioners in South Africa, and probably more unregistered. To investigate potential alien plant species introductions by TCM into South Africa, a catalogue detailing the TCM remedies sold by a South African franchise was analysed, to determine species and plant parts used. These were compared against their weed ranking in the Global Compendium. 128 plant taxa were recorded, mostly Compositae (13 spp.), followed by Apiaceae (9 spp). 20% of the species listed have a 'medium' to 'extreme' predicted global risk of becoming weeds. Urban migrant medicinal plant use and the allied international traditional medicine trade is an introduction pathway for alien, and potentially invasive, plants into South Africa that should be monitored as the BRI takes off.

Invasiveness in terrestrial true ferns (Polypodiophyta): insights from an assessment of horticultural trade

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Ferns have a long history in horticulture and have been shown to have a high propensity towards invasion. Despite this, no studies have considered the role of trade as a driver of invasiveness in this plant group. We developed an inventory of traded terrestrial true ferns (Polypodiophyta) across 6 major trading countries using catalogues from on-ground and e-commerce nurseries. GLMs were used to determine which market and species traits influenced the probability of establishment success in the country of trade. The final model highlighted that various market traits do influence invasiveness in ferns with market presence, e-commerce, and the number of cultivars and variations significantly influencing establishment success. In addition, species traits such as native range and successful establishment elsewhere were also important predictors. We further identified families most popular in trade and found these families to coincide with those commonly suggested by horticulturalists, but also with families known to have contributed a significant portion of alien ferns in previous studies. Several species of concern were identified as having successfully invaded regions other than the country of trade as well as having a high market presence. This study emphasised the role of horticultural trade in invasion success in alien ferns and highlighted the value of early detection through screening horticultural catalogues.

Native species with alien populations: the extent of the problem in South Africa

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In legislation the nativity of a species is usually defined at a country-level, with alien species and native species treated differently for management purposes. However, there are often substantial within-country biogeographical barriers and so a taxon that is regarded as native at the country-level might still form alien populations at a local level. This phenomenon has not been well defined and has received little research attention in South Africa or globally. We defined the phenomenon whereby a native species has alien populations—referred to as native-alien populations; compiled a list of these populations in South Africa; and determined their pathways of dispersal. To collate records of native-alien populations and their pathways of dispersal in South Africa, we performed a literature search and made use of an online survey to obtain data from experts. The pathways of dispersal were classified using the Global Invasive Species Database scheme. We found a total of 198 native-alien populations across terrestrial, freshwater and marine realms, including 52 for invertebrates, 102 for vertebrates and 44 plants. We were able to assign pathways of dispersal for 89% of native alien populations. Native-alien populations are prevalent in South Africa and the pathways of dispersal vary across the taxa.

A new invasive cactus, *Opuntia megapotamica* Arechav., discovered in South Africa

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The most dominant and widespread invasive species in South Africa are from the Cactaceae. The socio-economic benefits of cacti in the agricultural and ornamental horticulture sectors are the main reason of their introduction in South Africa. About 35 of the estimated 400 introduced cacti species have already been listed as invaders under the NEM:BA regulations. The genus Opuntia contains almost half of the invasive cacti including the taxonomic challenging *Opunita engelmannii*. Three morphologically distinct lineages, notably *O. engelmannii* (Limpopo), (Northern Cape) and (Eastern Cape) are present in South Africa. These lineages differ in terms of their susceptibility to cochineal insects used for biocontrol. Efforts to distinguish the invasive *O. engelmannii* lineages using morphometric and sequence data of the intergenic trnL-F chloroplast region confirms the Eastern Cape lineage to be *O. megapotamica*. Our study is the first to confirm the presence of this invasive cacti, which was misidentified, in South Africa and offer an opportunity for a proper management plan of the invasive Opuntias.

POSTER

Population biology of the exotic foliar pathogen *Teratosphaeria destructans* in South Africa and South East Asia

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The aggressive leaf pathogen *Teratosphaeria destructans* causes widespread damage to Eucalyptus trees cultivated outside their native environment in South East Asia and South Africa. This study investigated the genetic diversity, recombination potential and global relatedness of seven *T. destructans* populations with the aim of identifying the source of the South African population. This was achieved by developing and applying mating type and microsatellite markers to a global collection of isolates. Genotypes generally separated according to the region sampled. This suggests that there have been independent sources of introduction, or alternatively that the pathogen has evolved in the introduced ranges over time. With the exception of the one from Malaysia, all populations, had low genotypic diversity and there were no signs of recombination. This highlights the strong influence of asexual reproduction in non-native populations. The Malaysian population had the highest recorded genotypic diversity, an even distribution of mating types and evidence of recombination, indicating the existence of a cryptic sexual cycle in this region. All investigated populations represented non-native introductions into the sampled areas but the origin of *T. destructans* remains unknown. The South African population was characterised by a single mating type and genotype and it is consequently unlikely to change rapidly. The microsatellite markers developed in this study can now be exploited as a rapid diagnostic tool to monitor for introductions of new genotypes into South Africa and elsewhere.

POSTER

An assessment of *Tithonia tubaeformis* invasion along eSwatini-South Africa border

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In South Africa there is substantial sums of money spent on efforts to eradicate and manage invasive alien species which have a negative impact on the environment and biodiversity. *Tithonia tubaeformis* is an alien species from Central and Northern Mexico currently invading Nkomazi Local Municipality, Mpumalanga and affecting the livelihoods of communities in Southern Africa. *Tithonia tubaeformis* produce in excess of 3000 fruits within a single growing season and produces fewer, larger and heavier seeds, ensuring vigorous seedling growth and longer survival in nutrient-poor environments. A risk analysis is indispensable therefore this study will focus on better understanding the current status, extent and predict potential distribution of *T. tubaeformis* in South Africa. This will be mainly achieved by conducting site and road side survey. For current distribution data will analyzed using Geographical Information System (GPS) and for predicting potential distribution a MaxEnt software will be used for data analysis.

Session 2a

KEYNOTE

Evaluating the role of native bird and mammal species in the dispersal of alien invasive species: a southern African perspective

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Alien invasive plant species are a major problem globally, threatening ecosystem functioning and biodiversity. Native bird and mammal species facilitate their spread through mutualistic relationships. Studies of seed dispersal and germination of alien invasive plants are important for effective management. The role of native bird and mammal species in the dispersal and germination of alien invasive species from a southern African perspective are summarised. For fleshy-fruited invasive plants, morphological traits (seed size, fruit size) and phenological traits (fruiting period length are important. For avian species, variation in their morphology (body size, gape width, bill length), abundance and habitat specificity are important. Avian species potentially dispersing invasive plants are typically generalist and relatively abundant species. Although relatively poorly documented, ungulate species' contribution, because of their large body size, large gut capacity, longer seed retention times and large home range sizes, shows them as potentially important seed vectors of alien invasive plants in southern Africa.

Climatic suitability and host preference of the emerging invader cycad aulacaspis scale insect in South Africa

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The cycad aulacspis scale, *Aulacaspis yasumatsui* (Hemiptera: Diaspididae) is an invasive alien pest first reported in South Africa in 2015. We predicted the potentially favorable regions for the establishment of the cycad aulacspis scale using CLIMEX. Our bio-climatic prediction model revealed that in South Africa, 93% of the winter rainfall areas, and 90% of the temperate, summer rainfall areas are suitable for *A. yasumatsui* and range expansion is thus expected. Encephalartos species which are endangered and endemic to Africa as *A. yasumatsui* has the potential to kill the cycads. Using age, stage, two-sex life table software we predicted which Encephalartos species are the most susceptible to *A. yasumatsui*. Our result suggests that to prevent further spread, close monitoring and strict quarantine measures should be implemented in areas where *A. yasumatsui* has not yet been recorded and susceptible cycad species are present. Legislation to prevent future introductions and a management plan to prevent further spread and assess eradication are urgent.

The value of botanical gardens to biosecurity and plant health research in South Africa

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South Africa is privileged to have many botanical gardens located across the country. These gardens accommodate diverse collections of exotic and native plant species, and provide a unique opportunity for biosecurity research. In 2016, a South African National Biodiversity Institute (SANBI)-funded project was initiated under the framework of the International Plant Sentinel Network (IPSN). The project aimed to improve surveillance and identification of new and emerging pest and pathogen risks, by monitoring plant health in botanical gardens in South Africa. Assessments of plant health were conducted in various gardens, and samples collected from damaged plant parts, soil and water. Where possible, collections were made in conjunction with garden staff, in order to build capacity and increase awareness regarding plant health issues. Micro-organisms and insects obtained from these samples were identified using morphological identification and DNA sequencing techniques. Many pest and pathogen problems were identified in the gardens, including first reports of alien species such as the Polyphagous Shot Hole Borer (PSHB), various aphids, scale insects and Phytophthora species. The results highlight the valuable contribution of botanical gardens to biosecurity and plant health research.

Factors influencing sex ratio in the invasive woodwasp *Sirex noctilio* in South Africa

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Sirex noctilio is an invasive woodwasp that economically impacts pine plantations in the Southern Hemisphere. Mating success and reproductive potential are important factors that influence invasiveness, population growth and economic impact. The establishment of *S. noctilio* in new areas is often characterized by highly male-biased sex ratios that later revert to those observed in the native range. In the summer rainfall regions of South Africa, this phenomenon was not observed, and the sex ratio remained highly male-biased for a decade after introduction. The aim of this study was to understand what caused the persistence of this biased sex ratio. We tested hypotheses related to female investment in male versus female offspring, mating success and the effect of genetic diversity on diploid male production due to complementary sex determination. We found that 39% of females did not mate and that the genetic diversity was low and led to diploid male production. Among the hypothesis considered, disproportionate female investment in male offspring had the most significant impact on sex ratio. This selective investment in sons could be due to the avoidance of inbreeding, or to a lack of adaptation to the environmental conditions of the summer rainfall regions of South Africa.

Eradicating alien plants before they become widespread invaders in South Africa: practical challenges and potential solutions

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There have been several attempts to eradicate alien plants before they become widespread invaders in South Africa dating back to the 1960s. Although local extirpation of species has been achieved in certain cases, the goal of successful eradication of a species from the country is yet to be realised. To address some of the challenges associated with the eradication of alien plants before they become widespread invaders, the Biological Invasions Unit of the South African National Biodiversity Institute was set-up in 2008 to oversee and prioritise eradication. However, the lack of successful eradication of any species indicates that there are challenges that remain unidentified and/or unaddressed. This study used an expert workshop to evaluate the practical challenges and potential solutions to eradicating alien plants before they become widespread invaders in South Africa. Results indicate that lack of consistent management, limited funding, and lack of accurate information to guide management attempts successfully are the main practical challenges to eradicating alien plants before they become widespread invaders. Improved coordination between different stakeholders working on eradication, better integration of research and management, and ensuring that eradication projects are consistent and long-term could lead to improved eradication outcomes.

Assessment of the invasion status of five introduced Melastomataceae taxa in South Africa

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The Melastomataceae contains well-known horticultural species as well as some species that are invasive particularly on Pacific and Indian Ocean islands. Three Pleroma species, a Heterocentron species and a Melastoma hybrid were found outside of cultivation in Durban, KwaZulu-Natal, South Africa in 2011. To get a more accurate understanding of their current distributions, we surveyed the wider Durban area and southwards to Port St. Johns in the Eastern Cape and included herbarium voucher information and distribution data from the Southern African Plant Invader Atlas. The populations of *H. subtriplinervium*, *P. granulosum* and *P. urvilleanum* are relatively static and seem to be casual garden escapes. Field observations suggest populations of *P. mutabile* and the Melastoma hybrid are expanding locally and have the potential to become more widely invasive in South Africa.

Invasive potential and management of the genus *Leptospermum* (Myrtaceae) in South Africa

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There are an estimated 14 species of *Leptospermum* in South Africa, which are native to Australasia. Two are listed under NEM:BA, four are naturalizing and a further estimated eight species are introduced. Some of the species in the genus are known for their essential oils and ornamental value. In this study, we aimed to identify whether the factors underlying invasion success recognized for model groups like pines, Australian acacias and Proteaceae apply to another less frequently invasive group of woody plants. The specific aims were to: develop a global inventory of leptospermums using online inventories and literature; secondly determine key traits facilitating naturalisation and invasiveness of the genus and whether they are similar or different to the findings from research on the model groups. Processes and impacts of invasion by *Leptospermum* are not well studied, although various species are introduced globally. Successful invasions into novel environments by introduced species involve complex interactions between physical and biological characteristics of the environment and species. Therefore, it is important to understand the factors of invasiveness of these plants to prevent future invasions and develop effective management mechanisms for those potentially invasive.
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Session 2b

Patterns of naturalisation, invasion, and impact differ between fleshy and dry-fruited species of Myrtaceae

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Different traits influence and subsequently determine the progression of alien plants along the invasion continuum. We explored these patterns using the family Myrtaceae. We found that: 1) more fleshy-fruited taxa have been introduced than dry-fruited taxa (235 vs. 168; 8.9% vs. 13%, respectively); 2) fleshy-fruited taxa have a lower rate of naturalisation (21 vs. 69; 11% vs. 92%); but 3) a much greater proportion of naturalised taxa have become invasive (86% vs. 35%). Our study showed that event-related factors and alien species traits are important correlates of fleshy-fruited invasions, whereas event-related factors seem more important in dry-fruited invasions. Both groups had similar impact mechanisms and magnitudes, though most fleshy-fruited impacts were recorded on islands. We discuss possible mechanisms to explain these differences.

Next, we investigate the status of alien fleshy-fruited Myrtaceae in South Africa by (1) determining which species are present, (2) exploring morphological and molecular techniques to distinguish taxa, (3) updating distribution maps, and (4) evaluating the biological invasion risks the taxa pose. This study contributes to the understanding of drivers of fleshy-fruited plant invasions and can be used to inform and guide management strategies.

The invasion biology of *Pontederia cordata* L. (Pontederiaceae) in South Africa

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Pontederia cordata L. (Pontederiaceae) is a Category 1b invasive macrophyte that has spread rapidly throughout South Africa (SA). *Pontederia cordata*, commonly named pickerelweed, is native to the Americas and is a congeneric of the harmful invader water hyacinth. Pickerelweed has caused detrimental environmental, agricultural and socio-economic impacts in SA and its management is imperative. Preliminary field surveys suggested that only one of three tristylous forms is invading SA without seeds, causing speculation that pickerelweed's incompatibility system may be preventing seed production. This study investigated the invasion ecology of pickerelweed in SA by determining its population genetics, pollination ecology and floral traits. Genetic analysis determined that invasive SA populations have low genetic diversity. This suggested that asexual reproduction may be occurring. Thereafter, floral traits and pollen grains were measured, revealing that only short-morphed plants exist in SA. Moreover, the presence of generalist insect visitors indicates the unlikelihood that seed production is prevented due to lack of pollinators. Lastly, pollination experiments were conducted to confirm the incompatibility system preventing seed production. No seeds were produced, and thus illegitimate short-morph pollination prevents seed production. Rhizomes are responsible for invasion and suggestions for management strategies and implications of these findings are also addressed.

Distribution, density and reproductive potential of *Iris pseudacorus* (yellow-flag) in South Africa

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Iris pseudacorus (yellow-flag) is a category 1a invasive plant in South Africa (NEMBA 2004), occurring in 8 of our 9 provinces. We aimed to determine the current distribution, density and reproductive potential of this European weed which is threatening South Africa's wetlands. The presence of yellow-flag iris has been confirmed at 50 out of 71 reported sites, with the most severe invasions occurring in South Africa's temperate and subtropical regions. High levels of variation in the density and reproductive output of yellow-flag iris have been recorded between invaded sites. Seed production in South African yellow-flag iris populations appears to be higher than that in its native range, with high levels of seed viability reported by Jaca & Mkhize (2015), and a mean germination rate of 83.33 % recorded in this study. Invaded sites occurring in regions with high mean annual temperatures and precipitation tend to have greater densities than those in cooler, drier regions, and may prove more susceptible to further iris invasions in the future. While I. pseudacorus populations are currently being managed both mechanically and chemically, the larger and more dense populations may prove more challenging to control in this way. As such, options for the biological control of yellow-flag iris are currently being investigated in collaboration with European partners.

High diversity and clonality are the hallmarks of *Fusarium circinatum* invasion in South Africa.

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Pitch canker on plantation grown Pinus species, caused by the fungal pathogen *Fusarium circinatum*, first appeared in the western and southern Cape regions of South Africa. But outbreaks have recently been reported from the major plantation growing regions of KwaZulu-Natal and Limpopo in the eastern, summer rainfall region of the country. To shed light on the population biology of *F. circinatum* in this region of South Africa, we used microsatellite markers and mating-type assays to study a collection of 296 isolates from different nursery and plantation sites. Sixty-eight genotypes were identified, with one occurring across the region, on all host and symptom types. Overall, individual pitch canker outbreaks appeared to be associated with relatively small numbers of dominant genotypes, which were widespread across the region. Opposite mating-type individuals occurred in most of the populations, although linkage disequilibrium analysis showed that *F. circinatum* reproduces asexually in this region; an indication of clonal populations. The results confirm previous findings that *F. circinatum* in South Africa originates from multiple different introductions and that highly aggressive clones are driving its spread in the country. This is characteristic of invasive pathogens and should be an important consideration for current and future pine disease management strategies.

The distribution and prevalence of *Leptocybe invasa* (Hymenoptera: Eulophidae) and its associated community in South Africa

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The gall wasp, *Leptocybe invasa*, is native to Australia and induces bump-like galls on various species of Eucalyptus. Since 2000, it has been detected outside its native range, with two genetically distinct lineages. Lineage A has been reported worldwide, whereas Lineage B has a more limited distribution in Asia and Africa. Gall wasps have intricate communities consisting of the gall former, parasitoids and inquilines. We investigated the distribution and prevalence of the *L. invasa* lineages, and the hymenopteran species associated with *L. invasa* in South Africa. The species investigated included the parasitoid wasp, *Selitrichodes neseri*, a biological control agent released in 2012 and three other hymenopteran species found to emerge from *L. invasa* galls, namely *Quadrastichus mendeli*, a known parasitoid of *L. invasa*, *Megastigmus zebrinus* and *M*. *pretorianensis*. Galled Eucalyptus material was collected at infested sites across South Africa, and emerging adults collected and identified. Morphology and restriction enzymes were used to differentiate between the various species and lineages. The results indicated that L. invasa lineage A has spread throughout South Africa while lineage B has a more limited distribution. The Leptocybe lineages were found to co-occur on individual trees increasing the chances of admixture. *Selitrichodes neseri*, *M*. *zebrinus* and *M*. *pretorianensis* were present throughout South Africa.

Global diversity and introduction history of *Glycaspis brimblecombei* reflects a history of bridgeheads and distinct invasions

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Glycaspis brimblecombei is an invasive insect pest of Eucalyptus spp. that has spread rapidly around the world since its first report in California in 1998. The pest now occurs on at least four continents where Eucalyptus is grown as a non-native plantation species. To characterise global routes of invasion for this insect, we characterised the sequences of a portion of the Cytochrome Oxidase 1 (COI) gene from 105 individuals from the invasive and native range, including from Australia, Brazil, Chile, La Reunion, Mauritius, South Africa and the USA. In addition, we developed 13 polymorphic microsatellite markers, of which we used 11 to characterise the diversity in the same 105 specimens. Our results suggest that there have been two independent migrations out of Australia, which is also assumed to be the origin. The first introduction was likely into the USA, from where it appears to have spread to South America and eventually to South Africa. A second introduction appears to have occurred on the islands of Mauritius and La Reunion. These findings highlight the threat of bridgehead populations to accelerate pest invasions in Eucalyptus, even if those populations are on widespread non-commercial populations of Eucalyptus (as in California), as well as the apparently common pattern of multiple introductions.

POSTER

Detection and initial assessment of a new cactus species in South Africa

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Brasiliopuntia brasiliensis, one of the tallest members of the Cactaceae family (<9m) native to South America, was recently detected in northern KwaZulu-Natal (KZN), South Africa. Due to surveys and awareness efforts, two more populations were detected in KZN and Limpopo. From engagements with the Cactus Working Group (CWG), it is possible that *B. brasiliensis* could be more widespread in South Africa. Commonly called the "Brazilian Prickly Pear," this species has an erect trunk and is armed with red to brown long spines. Its growth form coupled with dual reproduction modes, makes it a strong competitor and a threat to native forest species by reducing habitat availability and accessibility. Initial assessments of the KZN populations indicate a population size of less than 1000 individual plants and clumps. Flowering and fruiting individuals were observed. Initial attempts of manual control by the landowners did not seem to be effective, and it is likely that animals have been facilitating the spread of this species into new areas at the site. The next steps in this project are to extirpate the known infestations, create more awareness to detect other populations, produce an accurate distribution map for South Africa, and complete a weed risk analysis that will potentially inform the regulation of *B. brasiliensis* in the country.

POSTER

Does resource acquisition-allotment strategy facilitate *Hyptis suaveolens* (L.) Poit. invasion success in dry deciduous forests?

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Hyptis suaveolens (L.) is a prominent invader across tropical areas of Africa and Asia. Superior performance and dispersal benefits favour its expansion. Field study revealed that the abundance of resident native species decreased drastically with the increase of *H. suaveolens* dominance in sunlit areas of dry deciduous forests of India. To understand this, common garden and growth chamber experiments were setup under high light (PPFD, 941.13 µmol m-2s-1) and low light (PPFD, 201.81 µmol m-2s-1) conditions to study trait performance and resource acquisition-allotment of *H. suaveolens* seedlings. High light individuals performed significantly better in terms of various plant functional traits. Significant high plasticity is suggestive of trait modulation ability in wide range of light environments. Resource acquisition-allocation strategy of *H. suaveolens* facilitates its expansion in disturbed well-lit habitats. In low light environments, *H. suaveolens* individuals maintain self-sustaining populations through substandard performance and act as 'sleeping individuals'. In the event of increased light availability, these shade dwelling 'sleeping individuals' outperform native species through high resource acquisition in short span of time, leading to their decline. Insights from the current research will assist in the management of problematic invasives like *Hyptis suaveolens* and *Echium plantagineum* (another highly plastic invader) in African subcontinent.

POSTER

Adaptation Strategy and use analysis of the urban environment of Antananarivo, Madagascar by Common mynas (*Acridotheres tristis*)

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Acridotheres tristis is among the 100 worst invasive species in the world and has been introduced in Madagascar. The spread of this species could have an impact on Madagascar's biodiversity. A. tristis has been well studied in its native country but few studies have focused on this species in Madagascar while it is spreading fast throughout the island. The objective is to understand the species 'adaptive strategies based on the breeding ecology, population evolution, the areas uses, and its interaction with bird species. Three sample sites were studied and choose by presence of the roost of the species. Scan sampling method and transect were used. *A. tristis* breeds twice a year in Antananarivo. Abundance was estimated to 7,9 ind / ha and a roosting site were about 6196 individuals and it is increasing twice by year. Five bird species are interacted frequently with *A. tristis* near its nest and three other species in the roost. Cohabitation between the species is generally observed, but competition was sometimes observed for access to nesting and roosting sites. *A. tristis* adapts and has thus easily colonized Antananarivo because the associated ecological characteristics are completed and even that the species is continuously increasing today.

Listing invasive alien species: Where have they gone (Introduction to workshop)

Matthys, C.[1], Geerts, S.[1] and Wilson, J.R.[2,3]

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Lists and inventories of invasive alien species are important for an accurate account of how many alien species are present in a country. In South Africa, considerable effort has been made to improve the accuracy of alien plant lists and inventories. Lists of alien species should ideally be based on field observations with a physical specimen that is curated in a collection and whose identity has been confirmed both morphologically and through molecular methods. However, this is often not achieved, and there are numerous errors in such lists. Such errors can inflate species numbers, create confusion, and lead to wasted management effort. This study aims to address this issue by creating a framework to guide the process of listing an alien species as present or absent within a country. The framework that will be designed is intended to be followed by any entity tasked with responding to a concern raised about the presence or absence of an alien species within a country. This framework will be refined via the proposed expert workshop and then applied to a case study species, namely *Calluna vulgaris*, that is listed under the National Environmental Management: Biodiversity Act (Act No. 10 of 2004): Alien and Invasive Species Regulations as alien plants and has been reported as present in the country but their presence has not been formally recorded and confirmed.

WORKSHOP - The development of a protocol for declaring alien species absent from South Africa.

Matthys, C.[1], Geerts, S.[1] and Wilson, J.R.[2,3]

[1]*Cape Peninsula University of Technology*
[2]*South African National Biodiversity Institute*
[3]*Centre for Invasion Biology, Stellenbosch University*

Purpose

Why is this workshop happening? This workshop will be conducted to obtain expert input to improve and refine a preliminary framework on declaring an alien species absent from South Africa.

What will the total duration of the workshop be? 45 minutes without any breaks as it is an online discussion.

Participants

Who is going to be there? Researchers, academics, managers and practitioners from various organizations who are working on invasive alien species
What is their role in the workshop? Provide informed/ experienced input and opinions on the preliminary framework.

Products

What are the expected outputs of the session? An audio recording of the session. Feedback and input from participants

Process

What is the agenda?

- Introduction and short presentation by the facilitators (Chelsey Matthys, Prof Sjirk Geerts and Prof John Wilson) that summarizes the literature review on the topic and introduce the preliminary framework (10 mins).
- Participative discussion on the following: (1) the current protocol for listing invasive species; (2) observed cases of species that are listen but were never recorded in the country or are no longer present in the country; (3) possible reasons why a species may/should be listed but not present in the country; (4) pros and cons of listing an alien species that is not present in the country; and (5) management approaches for updating invasive species lists.
- Closing comments and thank you/acknowledgements

Day 2 Abstracts

Session 3

A new IUCN Standard for classifying impacts of alien taxa

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[1]*Centre for Invasion Biology, Stellenbosch University*
[2]*South African National Biodiversity Institute*

In 2020, the Environmental Impact Classification for Alien Taxa (EICAT) was launched as an IUCN Standard. The aim of EICAT is to give environmental managers, scientists and the general public a better understanding of the magnitude of impacts caused by alien taxa. This can feed into policy making and aid the prioritisation of their management.

The development of EICAT started in 2013 at a workshop aiming to gain a better understanding of impacts caused by alien taxa. After the initial publication in a scientific journal, further guidelines were developed, which were heavily based on the Red List of Threatened Species. EICAT has since been applied to classify the environmental impacts of aliens from a range of taxonomic groups.

For a protocol to be accepted as a standard by IUCN, it has to go through a global participation process involving NGOs, governments, and many other institutions. Feedback received in this process was highly supportive, and included suggestions for modifications to improve the method. Incorporating these improvements has resulted in the final IUCN EICAT Categories and Criteria.

This success story shows the value of bringing scientists together to collaborate on protocols for improving policy making and management at a global scale.

The Alien Species Risk Analysis Review Panel—what is ASRARP and how you can help

Wilson, J.R.[1,2], Kumschick, S.[1,2] and Nsikani, M.[1]; on behalf of ASRARP

[1]*South African National Biodiversity Institute*
[2]*Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University*

The National Environmental Management: Biodiversity Act, Alien and Invasive Species Lists were the culmination of years of expert and stakeholder consultation and review. However, there are inconsistencies in the lists and several issues that affect how they are implemented in practice. To address such issues, the Department of Forestry, Fisheries and the Environment asked the South African National Biodiversity Institute to establish an independent scientific advisory panel. The panel (ASRARP):

1. reviews applications to import alien species;
2. reviews risk analyses on alien species; and
3. provides scientific advice on other issues pertaining to the risk of biological invasions.

In this talk we discuss the significant progress ASRARP has made with all these functions and highlight how some of the broader issues identified with the lists might be addressed. While ASRARP is not a decision-making body (a government body is being established to do this), it is an important part of ensuring the changes to the regulatory lists are science-informed, credible, and implementable. Please get involved by attending risk analysis training courses, helping completing risk analyses using the framework outlined at https://zenodo.org/record/4017196, review risk analyses as part of working group or as external experts, and get involved with ASRARP itself.

The influence of *Opuntia ficus-indica* on human livelihoods in Limpopo Province, South Africa

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In South Africa, the National Environmental Management: Biodiversity Act (NEM:BA) Alien and invasive species regulations list the *Opuntia ficus-indica* as a category 1b invasive species requiring control, However, the *O. ficus-indica* fruits may be used for human consumption. The purpose of the present study was to investigate the socio-economic impacts of *O. ficus-indica* to roadside traders in Limpopo province. To achieve the aim of the study, a convenient sampling of roadside traders with prickly pear was carried out late 2019 and early 2020 along the roads R71, R81, N1. In total, 71 roadside traders were interviewed, the majority of whom were males (45, 62.5%). A multiple hierarchical regression analysis was used to analyse the data. The gross seasonal income ranged between (266.66 and 400 USD), and the highest amount generated by an individual was (933.33 USD). Results indicated a positive relationship between the lengths of time the seller has been selling *O. ficus-indica*. and the gross income per season, $r = 0.386$, $n = 72$, $p < 0.001$." We conclude that, *O. ficus-indica* contributes positively to the economic and food security of the rural communities in Limpopo province.

Ant diversity and assemblage composition in relation to the invader *Parthenium hysterophorus* and its biological control in South Africa

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[1]Agricultural Research Council, Plant Health and Protection

Parthenium hysterophorus (Asteraceae; famine weed) is a severe invader in about 50 countries. It degrades ecosystems, leading to biodiversity and ecosystem service losses. However, little is documented of the impacts of *P. hysterophorus* on invertebrate communities. The composition and abundance of ant assemblages was studied in relation to the occurrence of *P. hysterophorus* and its biological control agent, the stem-boring weevil *Listronotus setosipennis* (Coleoptera: Curculionidae), in South Africa. Pitfall traps were used to collect and identify ant species in invaded and uninvaded sites, and where *L. setosipennis* was present, to investigate whether the composition and abundance of ant assemblages was altered by the occurrence of the plant or weevil. Furthermore, the behaviour of arthropods on *P. hysterophorus* plants was studied to evaluate potential predator-biological control agent interactions. Ant abundance was highest in areas with *P. hysterophorus* and established *L. setosipennis* populations, and lowest in uninvaded sites. Generalist and subterranean predatory ants were more common when *L. setosipennis* was present. In contrast, specialist predatory ants were more abundant in uninvaded sites. It is important to investigate changes in native communities in relation to plant invasion, as well as to understand the role of predation in the success of biological control.

Detection and mapping of invasive alien plants in the Western Cape mountain catchments

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The Fynbos Biome is South Africa's most invaded terrestrial region in terms of the prominence of woody invasive alien plants. A modern feature of the Fynbos Biome is the widespread occurrence of dense stands of these trees and shrubs. These invasions reduce stream flow, threaten biodiversity and cause catastrophic fires. Managing these invasions is one of the greatest natural resource management challenges in the region and requires reliable and frequently updated information on the extent, expansion or retraction of the distribution and density of problem species. Remote sensing has been proposed and widely used as a tool for detection and monitoring, generating data on plant species distributions over time that is more cost and time-effective, and less labour-intensive than field-based monitoring. The objectives of this study include the generation of a repeatable classification of the extent of invasion by alien trees in selected mountain catchments of the Cape Floristic Region using high resolution multispectral imagery over multiple years, estimation of the rate of expansion of alien tree invasions in the study areas as well as estimating the impacts on stream flow in the Western Cape mountain catchments through hydrological modelling.

Current status of the Polyphagous Shot Hole Borer invasion in South Africa

de Beer, Z.W.[1]

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The Polyphagous Shot Hole Borer (PSHB) is a recent invader in South Africa. Together with its fungal symbiont *Fusarium euwallaceae*, this beetle can rapidly kill susceptible host trees. Since its initial detection in South Africa, PSHB has spread rapidly and it is now well established across the country. The PSHB affects a wide range of trees across various landscapes, with urban forests being especially vulnerable. Economic sectors, including the avocado and plantation forestry industries, and natural ecosystems are also threatened. The apparent ease of anthropogenically-mediated long-distance dispersal, the broad range of trees in which the beetle and fungus can establish, and the cross-sectoral nature of this invasion have presented many challenges with regard to effective management and control. We present an update on the current status of the PSHB invasion in South Africa, including an updated distribution map and list of confirmed host plants. We also discuss ongoing research efforts, and the need for a coordinated response inclusive of all stakeholders, and underpinned by up-to-date scientific knowledge.

The impact of Polyphagous shot hole borer on Pecan trees in South Africa

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The South African pecan nut industry is an ever-growing industry, with more than 580 000 new tree plantings and 16 000 tons of nuts exported in 2018. The introduction of the invasive ambrosia beetle, *Euwallaceae fornicatus* or Polyphagous shot hole borer (PSHB), and its symbiotic fungi poses a risk to the pecan trees in SA. The main concern is the fungal symbiont, *Fusarium euwallaceae*, as it is known to cause Fusarium dieback, that in some cases can cause tree mortality. During a geographical survey of the area we determined the possible epicentre of the PSHB outbreak, where we found 46 English Oak trees on the Agricultural high school grounds infested with reproducing PSHB. Based on these findings we aim to determine the spread and seasonality of PSHB in the Jan Kempdorp area, Northern Cape, using Quercivorol baited black panel traps. The traps are monitored for a year, after which the English Oak trees will be removed and possible changes in population size observed afterwards. The results of the experiments will give us some insight into what impact PSHB will have on the pecan trees as well as the industry.

Land-use is a more important predictor of native abundance and diversity than invasive *Tithonia diversifolia* – evidence from a typical tropical savannah landscape in Nigeria

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Invasive alien species (IAS) and land-use are major threats to the native plant community. However, studies on IAS and potential ecological impact in the context of land-use are limited in sub-Sahara Africa. Using a set of 45 plots in Jos metropolis in central Nigeria, we assessed the abundance of invasive *Tithonia diversifolia* (Hemls.) A. Gray, and its relationship with abundance and diversity of native plant species in land-use types. Abundance of *T. diversifolia* was the highest in farmland compared to riparian and roadside land-use types. Also, the abundance and diversity of native species were lowest in farmland, compared to the roadside and riparian plant communities, with higher *T. diversifolia* abundance. We show that while *T. diversifolia* has a low impact on native species, land-use type is an important predictor of native abundance and diversity. Although *T. diversifolia* have benefitted from the disturbances across land-use types, we found a very weak negative estimate of *T. diversifolia* effe`11ct on native species. These results consolidate existing evidence that land-use transformation in sub-Sahara Africa provides opportunities for alien plant invasion and native species decline. Thus, for management, it is important to preserve our landscape which will result in a synergy of conservation effort - both reducing *T. diversifolia* abundance and allowing native plant abundance and diversity to thrive

MadMacs: Mass development of aquatic macrophytes – causes and consequences of macrophyte removal for ecosystem structure, function, and services

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MadMacs is an international collaborative project which aims to determine the causes of mass development of macrophytes, and to study the direct and indirect consequences of their removal on ecosystem functions and services across five countries including South Africa. Mass development of macrophytes in rivers and lakes is a worldwide problem, and substantial resources are spent annually on their removal. Although macrophyte mass developments have known negative effects, well-developed macrophyte stands also have many benefits including providing shelter and nursery habitat for many organisms (= affecting biodiversity), as well as nutrient and carbon retention (= purification of water). However, these are often poorly known to the public or to water managers. Despite efforts to control water hyacinth, it remains South Africa's most problematic weed. Hartebeespoort Dam currently is a hotspot of water hyacinth invasion. We quantified the effect of water hyacinth presence/removal on structural and functional diversity and abundance of periphyton, macroinvertebrates and fish, as well as water chemistry measurements, fluxes of CO_2, CH_4 and N_2O, sedimentation rates. Measurements were made at both the control and impact site, before removal of water hyacinth, and one week after removal, in a BACI design. Our results help to guide rational knowledge-based plant management decisions.

Session 4a

Detecting Aliens from Space

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The effective management of Invasive Aquatic Alien Plant invasions necessitates a large-scale monitoring programme. We utilise Earth Observation (EO) data, the processing capabilities of Google Earth Engine (GEE) and the discriminatory abilities of automated image processing techniques and machine learning to map water, aquatic vegetation and water hyacinth across South Africa. Using these tools water hyacinth was mapped with an accuracy of 0.80-0.93 depending on the metric used. It was estimated to cover 417.74 km2 across South Africa in 2013. In addition, the developed GEE application allows users to monitor aquatic vegetation cover dynamics for a water system of interest up to a 2–3-day frequency. We highlight the drawbacks and directions for future development that take advantage of the synergies between GEE, EO and machine learning.

Detecting alien freshwater crayfish using eDNA in South Africa

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[3]*South African National Biodiversity Institute*

Environmental DNA (eDNA) has proven to be an efficient biodiversity monitoring technique in comparison with the conventional, physical biomonitoring techniques. eDNA is sensitive, cost-effective and presents a higher detectability of cryptic and elusive species like the freshwater crayfishes. It relies on obtaining the DNA released by organisms into the environment via feces, mucous, gametes, skin, hair, and carcasses, and detected in cellular or extracellular form by amplifying it with primers targeting the taxonomic spectrum of interest. Africa, has no indigenous freshwater crayfish species, and yet four crayfish species have been recorded in South Africa, namely; *Cherax cainii* Austin 2002, *Cherax destructor* Clark 1936, *Cherax quandricarinatus* (von Martens 1868) and *Procambarus clarkii* (Girard 1852).This study will assess the ability of eDNA to detect crayfishes in South African freshwater systems, using species-specific primers to detect the presence of the two wild-ranging alien invasive crayfishes in South Africa; *C. quandricarinatus* and *P. clarkii*. Extensive survey for *C. quandricarinatus* by Nunes et al. 2017 in KZN, Mpumalanga and Swaziland will provide the foundational basis for our comparison of the conventional vs eDNA biomonitoring techniques. Recently, *P. clarkii* has been recorded for the first time in the Free State province and seems to spreading. Methods of sampling, eDNA extraction, amplification and sequencing will be discussed.

Dropping plates to track aliens along the South African coast

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Long-term surveillance programs enable the early identification of alien species, the tracking of spread, the quantification of ecological changes and an assessment of the effectiveness of management and policy interventions. Fouling species can cause ecological impacts as many alien species tend to become dominant in invaded communities. Economic losses are also associated with fouling due to accumulation on vessel hulls, port infrastructure and the disruption of aquaculture activities. In South Africa, 42% of the marine alien species are fouling organism, highlighting the need to establish a standardised long-term surveillance program along the coast. Such a program will facilitate early detection of new incursions and enable temporal and spatial comparisons that can inform management actions. Accordingly, this study tested a monitoring approach to detect fouling biota using open and caged PVC plates. We demonstrate that this method is simple to implement, effective at detecting target species and yet cost-effective. It could be implemented in harbours, marinas or associated with aquaculture operations to offer extensive monitoring coverage around the South African coastline.

Remote Sensing as a monitoring tool for Water Hyacinth (*Pontederia crassipes*) in the context of the biological control release programme at Hartbeespoort Dam

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Recent mass releases of the biological control agent, *Megamelus scutellaris*, by the Centre for Biological Control (CBC) on Hartbeespoort Dam and other nearby impoundments have seen significant declines in water hyacinth (Pontederia crassipes) populations. Monitoring and recording these events are challenging with in-field methods. Therefore, Remote Sensing (RS) was used to measure and quantify the change in extent and relative health of the plants at a population-wide scale. With the cloud-computing resources of Google Earth Engine (GEE), hundreds of optical (Sentinel-2) and radar (Sentinel-1) satellite images were analysed for each dam, producing an accurate cover estimation (std error: ~2.9%) time-series, at a high temporal frequency of 2-5 days, from 2016 to present. This quantified, for example, the collapse of water hyacinth on Hartbeespoort Dam over the 2019/20 summer period, where the extent dropped from >40% to <5%. The RS methods presented here are potentially scalable and thus present promising, collaborative opportunities to create a regional monitoring tool for invasive macrophyte species.

Molecular identification of fall army worm strains in laboratory reared cultures

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The fall armyworm, *Spodoptera frugiperda*, is a lepidopteran pest, which invaded and established itself in Africa over the past four years. This pest is divided into two strains, the corn and the rice strain, differing primarily in host preference. Distinguishing between these strains has been performed in many studies solely by using the mitochondrial cytochrome oxidase (COI) gene, which is maternally inherited. This method however, may not be sufficient in Africa as it has been shown that inter-strain hybrids make up a large portion of the pest's population. The triose phosphate (Tpi) gene, a nuclear gene, is able to confirm hybridisation in male specimens. A laboratory culture reared from insects collected in Africa could have a mix of strains and therefore the genetic composition could change due to hybridization. This is problematic if experiments such as feeding assays are repeated as the biological responses may change over time. In our study we reared two fall armyworm cultures. Sequencing using both molecular markers to identified inter-strain hybrids in both cultures. Further screening after 4 generations of breeding resulted in constant discordance between the markers. Screening a culture frequently using both molecular markers could explain inconsistencies between experiments and verify inter-stain hybridisation.

Repeatable methods of classification for alien and native vegetation in Montane Grasslands

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[2] Fynbos Node, South African Environmental Observation Network (SAEON)

Strategic water sources areas supply South Africa with 50% of its surface water, while only 13% of these crucial areas are protected. Alien plant invasions occurring in strategic water source areas threaten the country's water security. The Grassland biome is particularly vulnerable to alien plant invasion due to the prevalence of commercial plantations of Pines and Eucalyptus in mesic areas. Remote sensing offers a cost-effective solution to accurately produce maps of alien plant abundance, enabling managers to improve the effectiveness of alien plant control methods and monitoring of impacts. Free and/or open source software (R, QGIS and Google Earth Engine) and free high-resolution data from the Sentinel 2 satellite data were used to detect, classify and map alien plant invasions for a large portion of the Mpumalanga/Limpopo sector of the Great Escarpment. The Blyde River catchment part of the Mpumalanga Drakensberg strategic water source area in Mpumalanga province is severely invaded by a range of species, in particular Eucalyptus, Wattles and Pines. We produced this Sentinel 2 based land cover map for 2019, but building our approach using free and open source programs and public data, allows the rapid and cost-free reproduction of land cover and alien plant invasion maps for subsequent years. Change detection over the years 1990 till 2020 will be done to assess the extent of invasion within the area, and repercussions for biodiversity and water.

Invasive Alien Plants Working Group for southern African mountains

Martin, G.D.[1]

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The mountains of southern Africa support critically important ecosystem services – notably water production - and are exceptionally rich in floral and faunal biodiversity and endemics. However, these mountains are marginalised regions and are under threat from detrimental land-uses, unsustainable use of natural resources, climate change, poor governance and invasive alien plants (IAP). Invasive alien plants in particular pose a substantial and continuously increasing problem in driving ecosystem changes, often with dire results. Owing to the different climate, altitude and relief found in these mountains they support a unique suite of IAPs compared to their surrounding landscapes, and because of the steep slopes and dangerous terrain conventional methods of research and management are inappropriate. This working group seeks to increase collaboration among researchers and conservation managers to facilitate best management and research practices for IAPs on southern African mountains, with the ultimate goal of reducing their spread and impacts.

POSTER

Integrated control of floating macrophytes: can biocontrol and aerial herbicide spraying at sub-lethal concentrations be effective?

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Floating macrophytes such as *Eichhornia crassipes* or water hyacinth is an aggressive invader on the majority of our water bodies in South Africa, most notably, our water supply dams such as Roodeplaat dam that also provides recreational activities to a large number of stakeholders around the dam. The water hyacinth on the dam exponentially increased in volume and biomass during the COVID-19 lockdown period due t the inability for the normal functions or management to commence on the dam. Biocontrol was implemented on the dam in early 2009 but efforts were scaled up in 2019 and 2020 to try and get the agents established. A NWA section 21 (c) permit was requested through DWS after a risk assessment was done by DEFF for a sub-lethal spray to compliment the biocontrol releases and boost the agents establishment and effectiveness. The Section 21 (c) and General authorization was approved and DEFF received the permit to apply the sub-lethal aerial application in December 2020. the infestation at that stage was around 70% and has reduced to around 10% in 2 months due to the successful integration of biocontrol and sub-lethal strip spraying of a GBH that does not contain polyethoxylated tallow amine. This was a case study for DEFF to look towards a new strategist on how to control floating macrophytes in the country with minimal pesticide impacts and pesticide residue build-ups in the ecosystem and minimal effects on aquatic systems to mitigate resultant algal blooms.

POSTER

Discrimination of Invasive species in Protected Areas of Pakistan using Remote sensing

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Globally, biological invasions are considered as one of the major contributing factors for the loss of indigenous biological diversity. Remote sensing plays an important role in the unbiased detection of invasive weeds to support precision weed management. The main objective of study was to use hyperspectral remote sensing to discriminate and map the invasive species in two Protected Areas, in Punjab Pakistan. Spectral measurements were collected from the field using ASD field spectroradiometer and discrimination between plant species was evaluated statistically using spectral indices as well as wavelength spectra. Results showed that there were significant differences ($p<0.05$) in reflectance between the spectral indices of the most plant species of the forests. However, red edge parameters showed the highest potential ($p<0.001$) to discriminate between pairs of plant species. With leaf spectral signatures, the mean reflectance between all plant species was significantly different ($p<0.05$) at 562 (75%) wavelength bands. Overall, concluded that it is possible to identify invasive weeds, through remote sensing for their early detection and long-term monitoring that ultimately help in the management.

POSTER

Reproduction and gene evolution in a Eucalyptus stem canker pathogen

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The fungal genus *Teratosphaeria* is best-known as a group of aggressive Eucalyptus leaf pathogens. Two devastating stem canker pathogens, however, also reside in this genus, and one (*T. zuluensis*) was first discovered in South Africa. Only the asexual state of *T. zuluensis* is known, but it has been suggested that some populations produce genetically unique offspring. We assessed this possibility by investigating the distribution of mating-type (MAT) idiomorphs in previously characterised *T. zuluensis* populations. We also predicted and functionally annotated genes in its genome sequence and compared its gene content to that of the stem canker pathogen *T. gauchensis* and *Teratosphaeria* leaf pathogens. We found that a single mating type dominated *T. zuluensis* populations in Asia and southern Africa, suggesting that sexual reproduction is not a primary component of the *T. zuluensis* lifecycle in diseased Eucalyptus plantations. The stem canker pathogens had an expansion of unique gene families in comparison to the leaf pathogens, especially with regards to genes involved in the biosynthesis of secondary metabolites. Unique carbohydrate and amino acid metabolism gene families in the stem and leaf pathogens, respectively, could provide clues to the substrate specificity of each group. Overall, the results provide a broad view of reproduction and gene evolution in *T. zuluensis*, representing a step towards a more comprehensive understanding of the biology of this invasive tree pathogen.

POSTER

Host preference of *Spondyliapsis* cf. *plicatuloides* (Froggatt) (Hemiptera: Aphalaridae) in South Africa

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Spondyliapsis cf. *plicatuloides* and *Glycaspis brimblecombei* are invasive eucalypt psyllid pests native to Australia, and first reported in South Africa in 2014 and 2012, respectively. There are clear differences between species and hybrids of Eucalyptus regarding to the preference of the psyllids. The objective of this study was to identify the constitutive physical and chemical characteristics underlying these host preferences. A total of six preferred hosts and six non-preferred hosts were selected. The essential oils and phenolic compounds were extracted from leaves of each eucalypt species, and their chemical composition determined through GC-MS. A significant correlation was found between the preferences and the concentrations of Isoamyl 3-methylbutyrate, Neophytadiene, trans-(-)-Pinocarveol and α-pinene. Moreover, five polar compounds: 2-O-(2-(4-hydroxyphenyl)-ethyl)-d-β-glucopyranose, 5TMS, Alizarin, 2TMS derivative, Glyceryl-glycoside, 6TMS derivative, Scyllo-Inositol, 6TMS derivative, Stearic acid, TMS derivative were absent in Spondyliaspis' two preferred hosts. Compound 2-O-(2-(4-hydroxyphenyl)-ethyl)-d-β-glucopyranose, 5TMS was also not detected in E. camaldulensis, a host of both psyllids. All the physical parameters assessed in relation to level of infestation did not show any correlation with either preference or non-preference. These results provide important information for developing management strategies based on planting resistant or non-preferred hosts.

POSTER

Standardisation of Australian redclaw crayfish *Cherax quadricarinatus* sampling gear in Africa

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Freshwater crayfish are damaging invaders across southern Africa, however, monitoring techniques and efforts are disparate across the region as different sampling methods have been used. To develop a standard method for assessing Australian redclaw crayfish *Cherax quadricarinatus* abundance, a survey was conducted to assess for differences in detection probability (Pcapture) and catch per unit effort (CPUE) in Lake Kariba. Two sampling approaches were compared: opera traps baited with cooked maize meal historically used in crayfish surveys in Zimbabwe and promar traps baited with dry dog food that have been used for assessments in South Africa, Swaziland and Zambia. Baits were compared in the Barotse floodplain in Zambia using the promar trap. Pcapture and CPUE were significantly lower for opera traps baited with cooked maize meal compared to the promar traps baited with dry dog food. The Pcapture and CPUE for promar traps baited with dog food was significantly higher than for maize meal baited traps. Due to higher CPUE we consider the promar trap baited with dog food approach as the better method for determining crayfish population abundance and suggest that comparisons of abundance take this into consideration by applying conversion factors if different methods are applied.

POSTER

Assessing the extent of the overlap between biocontrol and chemical control interventions in KwaZulu-Natal

Zulu, Z.[1]

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KZN is one of the provinces with a rich diversity of invasive alien plant species in South Africa. Biological control and chemical control are one of the widely used methods to manage IAPs in the province by different role players. However, the possible overlap in these biocontrol and chemical control interventions has not been scrutinized.

The geographical locations of the current DEFF clearing project and biocontrol agent locations were mapped together in order to visualize if there are any possible overlaps in these two interventions for the 2019-2020 financial year. The results have shown that there is an overlap between these two interventions. However, this overlap is not as high as originally suspected. Although the detected overlap of interventions is low, there is a need to use a system that will enable biological control sites to be protected from clearing. There is also a need of geographical information system that can be accessible to all role-players so that when they plan their interventions they can be able to see which interventions are implemented in different areas. This will ensure that we avoid duplication of interventions where necessary, help to save limited resources, and also help to identify crucial areas that lack IAPs management interventions.

POSTER

Potential ecological and socioeconomic impacts of invasive crayfish in Africa

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Quantifying impacts of invasive species is crucial for management and policy making. Two freshwater crayfish, *Cherax quadricarinatus* and *Procambarus clarkii* have established naturalised populations in African countries. Concerns are being raised on their impacts on native biodiversity as documented in other continents and there is very little evidence from Africa. To fill this literature gap, lab experiments were used to determine ecological and socioeconomic impacts conferred by the crayfish species relative to a functionally analogue native crab on two static different resources. Consumption rates were derived for tilapia fish and pondweed under different temperatures with maximum feeding rate used to infer impact. Scavenging on dead fish was used as proxies for fish catches in artisanal gillnet fisheries whereas pondweed represents ecologically important macrophytes. Damage by *C. quadricarinatus* on fish was significantly higher than the other two decapods whilst *P. clarkii* had a significantly higher consumption of macrophytes than the other two decapods at all temperatures. This study further combined fisheries data to estimate the potential monetary losses that are due to catch spoilage by *C. quadricarinatus* in Kafue Flats. We show that there is a potential for fisheries damage of up to 1500 t/year (≡ US$2 million). These impacts are of high concern, and warrant efforts focus on population reduction and preventing further spread.

Session 4b

Alien species in South African National Parks: invasion, management and science

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South Africa National Parks (SANParks) are responsible for the management of 19 protected areas, many of which are widely recognised internationally and have a long history of conservation management (>120 years). They have, however, not been spared from the pervasive nature of alien species invasions. SANParks' alien species lists included 752 alien plants and 117 animals in 2017. Over the last few decades, much effort and resources have been placed on the management of invasive alien plants, with varying levels of success. For example, since 2000 the Working for Water/Biodiversity Social Programmes spent an estimated R590 million on alien plant control. The work presented here will provide an update on the status of invasions in SANParks and elucidate different management strategies currently in place. These will include species specific management programmes like those for *Opuntia stricta*, *Parthenium hysterophorus* and aquatic weeds in Kruger National Park. The characteristics of successful programmes will be highlighted and future challenges described. Potential opportunities for shared learning across Africa will also be explored, as well as current research programmes in SANParks and latent knowledge gaps, to help focus future research to improve management efficacy.

Management of *Spartina alterniflora* in Great Brak Estuary, South Africa

Tshali, N.[1]

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Spartina alterniflora commonly known as smooth cordgrass, is a highly aggressive invasive species native to the Atlantic and Gulf Coasts of North America. *Spartina alterniflora* can significantly alter both the physical structure and biological composition of invaded areas; its superior competitive abilities allow *S. alterniflora* to replace native plant species and negatively affect other organisms. In South Africa, *S. alterniflora* was recorded in 2004 in Great Brak Estuary, Western Cape and the arrival mechanism to this site it is still unknown. By 2011 the infested area was approximately 1.2 ha. Due to the potential environmental impact that *S. alterniflora* represents to the country, this species was listed as "Category 1a" under the South African legislation and therefore targeted for extirpation. Management to control this species started in 2011; foliar application of glyphosate combined with imazapyr was more effective than mechanical removal by hand. Here, we report on intensive management progress towards the extirpation of this species made by considerably reducing the infested area and the number of *S. alterniflora* plants. The total area affected by the invasive grass in November 2015 was 10 m^2 compared with the total area cover of 10,221 m^2 recorded in 2011.The regeneration of native species has also been observed.

Diversity of biological invasion responsibilities for Biodiversity Officer in the Western Cape

Ludoph,R.[1], and Muir, D.[1]

[1]*Department of Forestry, Fisheries & Environment*

Department Environment, forestry and fisheries; Natural Resource Management Programme is responsible for the Biodiversity implementation in different region of which the Western Cape; Biodiversity officer responsible for the implementation is based in the regional office in Bellville. Management of the contract -, Financial - as well as project documentation capturing.

Service providers in the Western Cape are as follows:

- Cape nature; Projects; Biological control implementation of collections, releases and monitoring teams in Robertson-, Stellenbosch- and George area. Alien fish in Cedar berg and Goukama nature reserve
- Advanced Environmental Corporation: Implementing feral pig's eradication and alien fauna conservation.
- City of Cape Town: Implementing projects; guttural toads, Mallard ducks, Aquatics, Early Detection Rapid response, House crows, waterweeds mass-rearing and Ecosystem restoration.
- Projects successes reported:
- *Pontedeira crassipes* total eradication of plants with integrated control methods; Biological control and chemical control. The plants have been nonexistent for the last 5 years at the Geelhoutboom site in the Outeniqua area.
- *Salvinia molesta* site at the Worcester dam has not shown any invasions for the last three years after integrated control using Biological control agents and chemical control.
- Feral pigs seems like the most of the infestations are eradicated and pictures of the process service provider used to catch.

Pesticide use in NRM programmes in South Africa: An emphasis on aquatic weeds and their control

Muir, D.[1]

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The Department of Environmental Affairs: NRM is responsible for the management of Environmental Programmes under the National Environmental Management: Biodiversity Act (NEM: BA) and Invasive Alien Species (AIS) regulations updated in July 2018 for the control of IAS. The programmes implemented under NRM encompass various IAS projects amounting to R1.6 billion with projects such as invasive plants, invasive animals, and biological control and aquatic weeds. The main methods of control uses pesticides to control these IAS which then requires compliance to various international contentions on pesticides such as safe use, storage and handling and disposal of obsolete stocks and empty containers. National pesticide legislation and the Departmental Pesticide Policy is also discussed with the emphasis on aquatic weed pesticides. The departmental Pesticide Policy has been amended to take a precautionary and substitution approach with regards to pesticides of high risk and their exposure and toxicity. The use of certain highly hazardous pesticides (HHP's) have been removed from the departmental Pesticide Policy to mitigate the risk to the environment and human health. Glyphosate and its co-formulants with regards to terrestrial applications has been removed and discussions are in process to find substitutions for glyphosates for aquatic applications although polyethoxylated tallow amine glyphosates have already been banned as of June 2017 in line with Act 36 of 1947.

An assessment of the magnitude and costs of herbicide usage in managing invasive alien plants in South Africa

Zulu, Z.[1]

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The management of invasive alien plants (IAPs) relies heavily on the use of herbicides. There are numerous organizations that are involved in the chemical control of IAPs in the country. However, herbicide usage data are rarely shared between organizations. Therefore, little is known about the overall scale of herbicide usage and their cost implications in the country because there is no national tracking system for herbicide usage in nature conservation.

This is an ongoing study that aims to quantify the magnitude of quantities and costs of herbicides in the country by consolidating herbicide usage records from different role-players that are making a valuable contribution in the management of IAPs. The data that is being consolidated include the types of herbicides used, the quantities, and the costs of herbicides used since the inception of the working for water program. Preliminary data obtained from DEFF WIMS database in KZN showed that the use of herbicides for the management of IAPs has increased both in quantities as well as costs over the years. The three most commonly used groups of herbicides were determined as imazapyr, followed by triclopyr, then picloram. Data collection for the rest of the country is still ongoing. The interactions that we have had with invasive species managers from different organizations have indicated that there is a great need for us to improve on record-keeping for herbicide usage in the management of IAPs in the country.

Does herbicide application affect the biocontrol agent Zygogramma bicolorata in the integrated management of *Parthenium hysterophorus* in South Africa?

Musedeli, J.[1], Strathie, L.[1] and Goodall, J.[1]

[1]*Agricultural Research Council, Plant Health and Protection*

The integration of biological and chemical control methods is advocated to manage the invasive weed *Parthenium hysterophorus* (Asteraceae), but may be complicated if herbicide application affects the biological control agents in use. Glasshouse experiments investigated the effects of a herbicide commonly used in chemical control operations on *P. hysterophorus* in South Africa, on the introduced leaf-feeding beetle *Zygogramma bicolorata*. Foliar application of Picloram 240 g/L at the recommended 0.5% concentration was applied to potted *P. hysterophorus* plants and allowed to dry, before plants were exposed weekly to the beetles in caged choice and no-choice tests, for up to nine weeks in a replicated study. In no-choice tests, oviposition was significantly lower on treated plants than on untreated plants. Adult feeding did not differ between treatments. Egg hatching was lower and adult mortality was higher on treated plants than on untreated plants. Adult location on plants or cage surfaces also differed between treatments. Similarly, in choice tests, oviposition was significantly higher on untreated plants, and adult feeding did not differ between treatments. Again, adult mortality was higher and egg hatching was lower on treated plants than on untreated plants. The integration of biological and chemical control methods on *P. hysterophorus* requires considered management for optimal efficacy.

A fresh look at biocontrol for pines

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The Western Cape Province has a massive problem with invasive pine species and their effects on water and biodiversity. Existing control methods are insufficient to solve the problem. Biocontrol is frequently a key component of integrated pest management and an argument is made for reconsidering biocontrol for pines in the fynbos biome. Biocontrol for pines has long been contentious (due to the perceived risk of pine pitch canker) and limited research work has been conducted to fully explore the potential of this approach. It is concluded that biocontrol for pines should be re-examined in a framework of relative risk assessment and that we should not let this urgent and important task stall any longer

Risk analysis of the invasive oriental fruit fly, *Bactrocera dorsalis* (Hendel) in South Africa

Ravhuanzwo, F.[1] and Moshobane, M.C.[1]

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The oriental fruit fly, *Bactrocera dorsalis* is a highly invasive fruit pest, native to Asia. Bactrocera dorsalis was likely introduced to South Africa primarily as contaminants of imported fresh fruits. To date, *Bactrocera dorsalis* has been detected in several provinces in South Africa but risk posed by this species has not been assessed for South Africa. Here, using the Risk Analysis for Alien Taxa framework, we assess the potential invasiveness, impact likelihood, and management options for *Bactrocera dorsalis*. Notably, we found a high risk score for *Bactrocera dorsalis*. In summary, our results indicated that *Bactrocera dorsalis* is likely to pose a high risk of being invasive in all provinces, especially where there are fruit farms. The outcomes of this study provides biodiversity managers and decision makers with management directions for prevention of further entry and avoiding the risks posed by Bactrocera *dorsalis*, with special emphasis on surveillance of risk prone areas. This study also supports the listing of *Bactrocera dorsalis* as a Category 1a species in the National Environmental Management: Biodiversity Act for Alien and Invasive Species list.

WORKSHOP: Indicators used to monitor biological invasions at a national level

Zengeya, T.

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Biological invasions are a major threat to South Africa's biodiversity, economy, and sustainable development. The South African government has implemented legislation to deal with biological invasions and has invested substantially in biosecurity and control measures to prevent biological invasions and mitigate their impacts.

The report "**The Status of Biological Invasions and their Management in South Africa"** is part of South Africa's commitment to alleviating these impacts. It is a comprehensive national-scale assessment with contributions from various experts across several institutions in academia, government, and civic society. The report is unique in the world in focussing specifically on biological invasions and is an important part of South Africa's global leading position on the issue (the government invests over 1 billion ZAR a year to deal with the problem).

The report is based around a suite of 20 indicators that provide details on: 1) how alien species are introduced and move around the country; 2) the status and impacts of 1880 alien species, of which 776 are invasive; 3) the degree to which sites are invaded and impacted; and 4) the effectiveness of the full range of interventions that South Africa has used to address the problem. The report provides valuable insights into how South Africa can reduce the negative impacts of biological invasions on ecosystems, the economy, and people while retaining the benefits alien species provide where this is possible and desirable. It collates foundational information essential for researchers of the topic and provides an assessment of interventions that is vital for policy makers and managers.

The purpose of this workshop is to:

- Outline the process used to draft the National Status Report
- Introduce the indicators (trends, current status, and outlook)
- Highlight data that needs updating
- Identify key gaps and plans to fill the gaps
- Highlight key events such as the planned special issue on alien species check lists for South Africa, and
- To discuss how participants can help with information required for the next report

Day 3 Abstracts

Session 5a

KEYNOTE: Facts, challenges and opportunities of classical biological control of weeds

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Classical biological control of invasive plants has been conducted since over 100 years and has had some spectacular successes with cost-benefit ratios of up to 1:4000. About 27% of released agents contributed to the complete control of the respective target weed, at least locally, and about 66% of weed targets experienced some level of control, often depending on region and/or habitat. One of the challenges in weed biocontrol is to predict the likely level of impact agents will achieve, which is important to make informed funding and management decisions. A recent prioritization scheme developed for South Africa will be presented.

Determining the environmental safety of agents prior to release is another important aspect. A recent global review indicated that the percentage of intentionally released weed biocontrol agents causing nontarget attack has steadily decreased from the early days of weed biocontrol to now. Only three cases have been recorded worldwide (< 1%), where released agents have the potential to negatively impact nontarget plants at the population level. It is expected that this trend continuous with further recent advances in testing procedures and stricter regulations.

Overall, classical biological control is a safe and potentially very effective method to help mitigate the negative impacts of exotic invasive plants.

Population genetics of invasive and native *Nymphaea mexicana* Zuccarini: taking the first steps to initiate a biological control programme in South Africa.

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Nymphaea mexicana Zuccarini (Nympheaceae) (Mexican waterlily) is a rooted floating-leaved aquatic plant native to southern USA and Mexico that has become a problematic invasive alien plant in South Africa. Biological control is considered a desirable management strategy for the plant in South Africa. A good understanding of the genetic structure of invasive populations has been useful in other biological control programmes because taxonomic uncertainty about the target plant can result in natural enemies that are not adapted to the invasive populations being considered as potential agents. For *N. mexicana*, hybrids exist in the wild and horticultural trade, but identification is difficult, so understanding the genetic structure of populations is required to ensure that potential agents are collected off plants similar to invasive populations in South Africa. ISSR (inter-simple sequence repeats) analysis was used to determine whether invasive *N. mexicana* populations from South Africa were genetically similar to native range populations from USA or whether they were hybrids. Results from these analyses were matched with the morphotypes of each population based on petal colour, shape, and size. The genotypes suggested by the ISSR analyses corroborated the presence of both hybrid and pure forms of *N. mexicana* in South Africa, and this information can be used to facilitate the next stages of biological control of this species.

Managing Prosopis: renewed promise for biocontrol

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Mesquite trees (*Prosopis* spp.) are known to be one of South Africa's most widespread and damaging invasive plants. Despite biocontrol offering the only cost-effective solution to managing *Prosopis* spp. in the long-term, until recently the programme has been limited to the use of seed-feeding agents, namely the weevils *Algarobius prosopis* and *Neltumius arizonensis*, given the perceived benefits offered by the trees. Although Prosopis trees offer benefits in terms of shade, fuelwood, fodder and timber, recent research has highlighted the overwhelmingly negative ecological impacts of Prosopis spp., prompting renewed endeavors toward improving biocontrol. These recent biocontrol efforts have included (i) the planned mass rearing and release of A. prosopis to further reduce *Prosopis* spp. seed set and spread, (ii) the importation, assessment of new candidates, namely the seed-feeding weevil *Coelocephalapion gandolfoi* and the stem-defoliating moth *Evippe* sp. which has been released, and (iii) native range surveys, in collaboration with research groups in the United States and Argentina, to effectively identify new and damaging potential agents for use against Prosopis spp. in South Africa. Overall, the renewal of South African biocontrol efforts against Mesquite is promising and hopes to reduce the invasive range and ecological impacts posed by the trees in the future.

The host specificity of *Trabutina mannipara* (Hemprich & Ehrenberg) (Homoptera: Coccoidea: Pseudococcidae): a potential biocontrol agent of invasive Tamarix taxa in South Africa.

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Tamarix (Tamaricaceae), a phreatophyte genus from the Old World, is a tenacious competitor which has invaded North America, Australia, and South Africa amongst other countries. Biological control of invasive Tamarix taxa in South Africa is complicated by the indigenous *T. usneoides*, which is phylogenetically distant from the invasive *T. chinensis* and *T. ramosissima*. This suggests the possibility of finding a host specific biological control agent. *Trabutina mannipara* underwent laboratory-based host specificity trials. During no-choice testing, the scale insect showed no difference in host range selection as there was no significant difference in the settling and developmental rate on all Tamarix taxa tested. These undesirable non-target effects on the indigenous species led us to reject *T. mannipara* as a potential biological control agent of invasive Tamarix taxa. We examined the possibility of secondary metabolites being a factor in the feeding choice of *T. mannipara*, and no significant difference in the bark tannin levels was found between the above Tamarix taxa. Further investigation of plant secondary metabolites, used for defense against insect herbivory, may assist in the selection of biological control agents against invasive Tamarix in South Africa.

Potential of the leaf-mining moth, *Melanocinclis* sp., as a biocontrol agent for *Tithonia diversifolia* in South Africa

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The leaf-mining moth, *Melanocinclis* sp. (Cosmopterigidae), a candidate biocontrol agent collected from Mexico, was subjected to host specificity tests in quarantine to assess its safety as biocontrol agent of *Tithonia diversifolia*. Of the 26 plant species within the family Asteraceae, including 25 varieties of the cultivated sunflower (*Helianthus annuus*), the moth attacked and developed successfully on *T. diversifolia*, *Xanthium strumarium*, *H. tuberosus* and two *H. annuus* varieties (Agsun 8251 and Agsun 5109) during no-choice tests. However, survival to adulthood was lower on *X. strumarium*, *H. tuberosus* and *H. annuus* than on *T. diversifolia*. Also, feeding damage was minimal on the three non-target plant species compared to that on *T. diversifolia*. During multi-choice tests involving *T. diversifolia*, *T. rotundifolia*, *H. tuberosus* and 18 varieties of sunflower, the moth only attacked *T. diversifolia* and *T. rotundifolia*, with more adults emerging from the former. Results of the no-choice and multi-choice tests strongly suggest that the moth is safe for release as biocontrol agent of *T. diversifolia* and is highly unlikely to pose a threat to the cultivated sunflower varieties.

Preliminary study on the impact of a biocontrol agent, *Mada polluta* (Coleoptera: Coccinellidae), on *Tecoma stans* L. in East London, South Africa

Madire, L.G.[1]

[1]*Agricultural Research Council - Plant Health and Protection*

A leaf-feeding lady beetle *Mada polluta* Mulsant (Coleoptera: Coccinellidae), originally from Mexico, was initially released near East London in November 2016. Releases of 200 to 400 *M. polluta* adults were conducted at seven *Tecoma stans* L. (Bignoniaceae) sites. In February 2018, *M. polluta* was found to have established at three of the seven sites, and the populations of this agent have been growing since then. From 2020 to 2021, a study was conducted to assess the effect of *M. polluta* on plant damage, fruit production and dispersal rate of the *M. polluta* from the release points. The sampling was conducted on 80cm branches of *T. stans* in February on annual basis. The assessments were conducted at the three established sites, namely; the Old Transkei Road, Pearl Road, and Selbornian. The preliminary results show that the lady beetle has dispersed at the average rate of 1.25 km over a period of 48 months, translating to 0.31 km per year. The reduction in leaf density ranged from 75 to 99%, leaf damage from 38 to 88% and fruit production from 97.80 to 98.42% at all sites from year 2020 to 2021. According to field observations, both seedlings and mature trees were attacked by the beetle. Although *M. polluta* is a slow disperser, the beetle is exerting considerable herbivore pressure on T. stans which is likely to reduce the invasiveness of the invader.

Where's the water hyacinth?

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Hypertrophic, Highveld dams have historically been plagued with water hyacinth. Management interventions on these systems have included manual, mechanical, chemical and biological control, but these have largely been uncoordinated and unintegrated, resulting in variable degrees of control. In 2018, the delphacid hopper, *Megamelus scutellaris* was released at Hartbeespoort Dam, and following an inundative release approach over the next two years, the water hyacinth infestation reduced from more than 50% cover to less than 2% cover by July 2020. However, following germination from seeds in Spring of 2020, the water hyacinth infestation returned to almost the same level as 2018, but following rapid build-up of control agent populations, the infestation has decreased again to below 10%. Similarly, infestations at Roodeplaat Dam and Bospoort Dam are fluctuating in cover, following patterns observed at Hartbeespoort. Here we discuss possible reasons for these patterns, and the role of biological control in what may be the country's most dramatic reduction in water hyacinth.

Tackling a global invader: Biological control of *Parthenium hysterophorus* in South Africa and its broader benefits

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Parthenium hysterophorus (Asteraceae), an annual shrub native to Central and South America, is notorious due to its widespread invasion in about 50 countries. Monospecific stands of the weed cause substantial crop yield losses, decrease available grazing for animal production, reduce biodiversity, and harm human and animal health due to allergenic properties. A biological control programme has evaluated and introduced a leaf pathogen and three insect agents on *P. hysterophorus* in South Africa, supplementing another leaf pathogen already present. Despite considerable damage to vegetative and reproductive outputs under certain conditions, agent establishment and impact has varied and ranges from poor to considerable but localised, or to widespread. Various influential factors have been studied. Biological control provides a sustainable management solution for *P. hysterophorus*. However, despite some successes, it has not yet reached its full potential in South Africa. Concerted implementation efforts for approved agents, and their considered integration into management operations, as well as the inclusion of complementary agents that can disperse readily and tolerate local conditions, are still required. Nevertheless, these efforts have benefitted other countries, although even broader adoption on the continent is still necessary. The status and recommendations of this biological control programme are discussed and are relevant to the international arena.

POSTER

The tuber-feeding weevil *Listronotus frontalis* as a candidate biological control agent for the invasive semi-aquatic plant *Sagittaria platyphylla* within South Africa

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Sagittaria platyphylla is an invasive, aquatic macrophyte of South African freshwater systems. This invasive plant has proved difficult to manage due to its varied growth forms and reproductive strategies such as below ground tubers. The tuber feeding weevil *Listronotus frontalis* has been identified as a candidate biological control agent for the invasive species. The aims of this study were two-fold; to firstly determine the importance of tubers to *S. platyphylla* populations growing in South Africa, and secondly, to determine the biology and suitability of *L. frontalis* as a candidate biological control agent. The study showed tubers are abundant and continuously produced through ought South Africa, despite seasonal and habitat differences. *Listronotus frontalis* was shown to have short developmental time (42.67 ± 1.39 days from egg to ovipositing adult) and high levels of fecundity. The accumulated damage by larvae on the below ground tubers remains inconclusive. However, the adult weevils inflicted high levels of damage on aboveground *S. platyphylla* structures suggesting if shown to be host-specific the insect may prove to be a useful biological control agent, which may assist in the long-term management of *S. platyphylla*.

POSTER

Biological control of *Cylindropuntia pallida*

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Cylindropuntia pallida is an invasive alien cactus in South Africa. The aim of this project was to develop a biocontrol agent that would control *C. pallida* in South Africa. This was achieved by assessing the impact of two *D. tomentosus* biotypes being used in South Africa to control *Cylindropuntia fulgida* var. *mamillata* and *Cylindropuntia imbricata*. The fitness indices (FI) and damage parameters on the plants, of both biotypes, were compared. The potential impact of the biotypes' hybridization on biological control were also assessed in case of sympatric association of the infestations. The FI for *D. tomentosus* 'Cholla' and *D. tomentosus* 'Imbricata' on *C. pallida* were 0.27 and 0.02, respectively. A FI > 1 means the cochineal thrived on their hosts, while one < 1 but > 0 means they survived. Our results mean that the 'Cholla' biotype had relatively short developmental times, high survival of crawlers and highly fecund females, on *C. pallida*. Given our results we deem the 'Cholla' biotype the most effective, of the two, for release on *C. pallida* in South Africa.

POSTER

Seasonal abundance and impact of the seed-feeding weevil *Smicronyx lutulentus* on the invasive Parthenium weed in South Africa

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Smicronyx lutulentus (Coleoptera: Curculionidae), a tiny seed-feeding weevil, is one of the four insect and fungal agents deliberately released in South Africa to control the noxious, aggressive weed *Parthenium hysterophorus* (Asteraceae). A single larva of the weevil feeds within a developing seed, destroying it and thus reducing the number of viable seeds per capitulum. From November 2019 to November 2020, we evaluated the seasonal dynamics of the weevil in the field, to gain insight into its abundance and efficacy, and to investigate the influence of climatic variables on its performance. Flowering plants within ten randomly placed quadrats were sampled at monthly intervals at three established sites each in Mpumalanga and KwaZulu-Natal provinces. Vegetation was assessed and counts of all life stages of *S. lutulentus* were recorded in field and through floral dissections. The presence of a single larva often caused abortion of adjacent seeds within the capitulum. Adult presence and abundance varied among sites, and altered seasonally, with the weevil more common in the warmer months and absent during winter. Preliminary findings are discussed in the context of the status of the weevil as a biocontrol agent of *P. hysterophorus* in South Africa.

POSTER

The possible role of mortality in the underperformance of *Aristaea* (*Parectopa*) *thalassias* (Meyrick) as a biological control agent *of Leptospermum laevigatum* F. Muel.

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Biological control of *Leptospermum laevigatum* has been implemented since the 1980s using *Aristaea thalassias* with limited success to date. A study was carried out over 32 months to investigate factors which may be contributing to the low efficacy of the moth, and larval mortality factors due to parasitism, predation, overcrowding and season were considered. The developmental biology of the moth, which was unknown was also studied. The results demonstrated that the moth is abundant in the field and the rapid development of immature stage permits several generations a year. Although parasitism and overcrowding was low, mortality was ± 50% for all of the immature stages. Despite this, the moth was still abundant in the field suggesting that mortality was not the sole reason for low efficacy of this agent. Factors such as plant compensation, leaf quality as well as adult mortality may have contributed to survival and efficacy of *A. thalassias* as a biological control agent against *L. laevigatum*. While findings from this study have given insights into the survival and population dynamics of *A. thalassias* on *L. laevigatum* in South Africa, the evidence presented in this study could not explain the low field efficacy of the agent

POSTER

Enhancement of *Megamelus scutellaris* Berg (Hemiptera: Delphacidae) by naturally occurring phytopathogens for biological control of *Pontederia crassipes* (C. Mart) Solms (Pontederiaceae) in South Africa

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Megamelus scutellaris, the water hyacinth planthopper, has the potential to introduce phytopathogens when feeding on the plant. Because the effectiveness of biocontrol by the hopper could be enhanced by the presence of pathogens, we investigated the effects of interactions between *M. scutellaris* and naturally occurring phytophagous fungi from different *Pontederia crassipes* infested water bodies in South Africa, on the level of biocontrol. As part of the investigations, a total of 42 fungal isolates, in five different genera were isolated and identified. Amongst these fungal isolates, *Alternaria* sp., *Epicoccum* sp. and *Fusarium* sp. were the most frequently encountered fungi. Three *Fusarium* species were most virulent species to *P. crassipes* plants. A disease incidence of the damaged plants was significantly higher in *Fusarium incarnatum*, *Fusarium oxysporum*, and *Fusarium equiseti* with 68%, 63% and 54% damage, respectively. The combined effect of *F. incarnatum* and *M. scutellaris* showed the enhanced plant damage of 87%. The study has established virulent phytopathogens which have synergistic impacts and enhanced biocontrol potential when integrated with *M. scutellaris* to combat the invasive *P. crassipes.*

POSTER

The potential of *Hypogeococcus* (Pseudococcidae) as a biological control agent against torch cactus, *Trichocereus spachianus* (Cactaceae), in South Africa.

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Trichocereus spachianus is becoming an increasing concern as an invasive alien plant in South Africa, particularly in the dry savannah and Karoo biomes. Infestations decrease grazing area for both indigenous wildlife and livestock with mechanical removal not usually a viable option as it is challenging and expensive. Biological control is considered a promising management option because close relatives of *T. spachianus* have been effectively controlled by *Hypogeococcus* sp.. Surveys in 2019 were conducted in Argentina, where *T. spachianus* is considered an indigenous species, to search for potential agents, focusing on *Hypogeococcus* species. *Trichocereus spachianus* was described from species in cultivation, and although it is considered indigenous to Argentina, no wild populations of the plant have been recorded and none were encountered during field surveys. Thus, *Hypogeococcus* species were collected from various other cactus species and imported into South Africa for further testing. The host specificity and the efficacy on South African *T. spachianus* will be tested for each of the *Hypogeococcus* entities. Any found suitably specific and damaging, will be considered for release. Due to the increasing concern of *T. spachianus* as an invasive species, it is imperative to find an efficient and sustainable control option to limit its spread.

POSTER

The intensity of light on the inflorescence production and efficacy of the bud attacking mite on *Lantana camara* L. (Verbenaceae)

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Lantana camara is amongst the top-ranked invasive alien plants globally and continues to threaten biological organisms under diverse environments irrespective of the biocontrol efforts. Counts of inflorescences and galls were recorded on haphazardly selected 163 LP variety of *L. camara* invading the eucalyptus shaded, partly shaded and full-sun habitats at the highveld and lowveld regions of Mpumalanga. Greater than 85% of plants were sampled at each of the three microclimates, but the plants without developed inflorescence buds were recorded at the shaded microenvironments only. Furthermore, the inflorescence production per branch ranged between 4.8 and 2.9 at the lowveld, whilst a range of 4.8 to 1.9 was recorded at the highveld. The number of branches with inflorescences declined by up to 1.4 and 2.5 folds, hence, inflorescences per ranch declined by up to 1.7 and 2.5 folds at the lowveld and highveld, respectively. Of the plants with inflorescence buds, the gall occurrences, percentage branches galled and inflorescence galled per branch gradually declined with the intensity of light, thus, galling was lower at shaded compared to partly shaded and full-sun plots. Lastly, the number of seeds produced by plants invading three different microclimates did not differ significantly. Thus, although the inflorescence production is higher at full-sun, the number of seeds produced by the *A. lantanae* attacked buds does not significantly differ from that produced by the shaded plant.

POSTER

Status of Aquatic weeds associated with Biological control agents in the southern Mozambique rivers.

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Aquatic ecosystem in Mozambique are prone to invasion by several invasive alien aquatic weeds, that pose severe threat to human health and water flow, but the status of existing and introduced biological control agents effective against these plants is unknown. This study was aimed to identify biological control agents for water hyacinth, water lettuce, red water fern and giant salvinia and evaluate their impact in the rivers of southern Mozambique. Ten samples for water hyacinth and 100 samples for water lettuce, red water fern and giant salvinia were taken and inspections were done during in dry and wet seasons. It was observed that two arthropods fed on water-hyacinth plants, namely *Neochetina eichhorniae* and *N. bruchi*, the weevil *Neohydronomus affinis* was found at a very low density, too low to effectively control *Pistia stratiotes*; Water red fern found in the study area was *Azolla cristata* and not *A. filiculoides*; it was difficult to find *Stenopelnus rufinasus* on *Azolla* spp. and no *Cyrtobagous salviniae* was found on giant salvinia. This study serves as a baseline of biological control of aquatic weeds in Mozambique rivers and should be added to over time. It is recommended that t????

POSTER

Civil society, plant surveys and biological control researchers, working together!

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South Africa has over a century of safe and effective use of biological control to target certain invasive plants. The disconnected distribution of populations of certain invasive plant species and fluctuations in plant densities require the rearing, collection and dispersal of biological control agents to effect management. Since January 1994, biological control researchers have relied heavily on the Southern African Plant Invader Atlas and its author Lesley Henderson to provide accurate data on the distribution of invasive species. Lesley undertook the last collections of data for the atlas in 2017 and then handed the atlas over to the South African National Biodiversity Institute. In this paper, we explore how the Botanical Society of South Africa with its large membership base could fill the data gap left by the discontinuation of the atlas project. The Botanical Society has many active, botanically aware and technically proficient (iNaturalist skills) members nationwide. These members are keen to contribute to conservation of the natural areas they care about and could gather data on invasive species, which researchers can use to focus dispersal of the correct biological control agent.

Session 5b

Chewers or phloem-feeders…who takes the biggest 'bite' out of water hyacinth under elevated CO_2

Paper, M.[1]

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The advent of climate change, elevated CO_2 (eCO_2) and rising temperatures will have far-reaching effects on plant-insect interactions, yet we do not fully understand its implications on biological control programmes. We look at the response of the world's worst aquatic weed, Pontederia crassipes, to predicted eCO_2 conditions of 800 ppm and how it affects the feeding response of two biological control agents representing different feeding guilds, the chewing *Cornops aquaticum* Brüner (Orthoptera: Acrididae) and the phloem-feeding *Megamelus scutellaris* Berg (Hemiptera: Delphacidae). The photosynthetic rate and plant growth parameters of *P. crassipes* acclimated to elevated CO_2 conditions gaining very little CO_2 fertilization effect at eutrophic water levels. The chewing herbivory of *C. aquaticum* was consistent across CO_2 conditions, while *M. scutellaris* feeding increased substantially and was largely due to the significant increase in adult population density, 85% greater under eCO_2 conditions. These results indicate that plant-insect interactions that underpin biological control programmes for *P. crassipes* may still be successful under future predicted CO_2 conditions. Biological control programmes will need to adjust the focus away from the charismatic chewing insect herbivores and onto the often-neglected phloem-feeding biological control agents due to their potentially overwhelming response to elevated CO_2.

The status of the submerged aquatic weed *Egeria densa* in South Africa

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Managing freshwater systems in the Anthropocene have proven more complex. In South Africa, eutrophication and exotic species propagule dispersal have contributed to secondary invasions following the management of floating aquatic weeds. One of these secondary invaders is the submerged aquatic weed, *Egeria densa* Planch. (Hydrocharitaceae) or Brazilian waterweed. It is an "oxygenator" plant with a simple anatomy, making it a favourable plant for aquariums and school programmes. *Egeria densa* can easily be spread through plant fragments, and through it vegetative growth mode, can quickly form dense monoculture stands in rivers and dams. It is currently the most widely distributed submerged aquatic weed in South Africa. In 2018, the leaf-mining fly, *Hydrellia egeriae* Rodrigues (Diptera: Ephydridae) was released against *E. densa* in South Africa. This was the first biological control agent released against *E. densa* in the world, and also the first agent released against a submerged aquatic weed in South Africa. This paper will provide an update on the status of *E. densa* in South Africa, as well as results from post-release surveys on its biological control agent up until 2020. Challenges and future plans are discussed.

Alien invasive acacia management: a biocontrol success story from South Africa

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The last review investigating the role biocontrol for the management of *Acacia longifolia* and *A. pycnantha* was published by Impson et al. (2011). It was reported that both species are under excellent biological control following introduction in the 1980s of two *Trichilogaster* bud-galling wasps as well as two *Melanterius* seed-feeding weevils on both weeds. The report indicated that both species no longer rank among the topmost important invasive weeds, are no longer a threat to natural habitats and are no longer expanding their geographical range. The research focus during the present review period (2011-2020) endeavoured to validate findings from previous reviews as well as gain a better understanding of the seed dynamics of these weeds viz investigating annual seed rain in different climatic regions of the country where the infestations exist and seed banks. Running parallel to this, were studies investigating insect damage levels. Here we present an evaluation of the current biocontrol management plan, elucidate on whether the investment in the strategy has been worthwhile and if there is a need to update it. Overall, the studies aimed to evaluate whether the long-term presence of biological control is reflected in reduced reproductive capacity of these species.

Impact of biocontrol on the seed regenerative capacity of *Lantana camara* in South Africa

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This study measured, for the first time, the combined impact of biocontrol agents on the seed regenerative capacity of *Lantana camara* L. (Verbenaceae), i.e. seed production, seed-rain, soil seedbank, and seedling density, in an inland area of South Africa. The study was conducted on ten plots (20 x 50 m each) along part of the Sabie River catchment. Using insecticidal exclusion, comparisons were made between exclusion (insecticide treated) and biocontrol (untreated) plants over a three year period. Lantana seed production was slightly lower in biocontrol (5831 ± 844 seeds) compared to exclusion plants (6718 ± 1571 seeds), seed-rain density was significantly lower in biocontrol (1080 ± 122 seeds m-2) compared to exclusion plants (1419 ± 154 seeds m-2). Seed germination was lower in biocontrol (98 ± 41 seeds m-2) compared to exclusion plants (116 ± 38 seeds m-2). Seedling density was higher in biocontrol (36 ± 14 seedlings m-2) compared to exclusion plants (32 ± 11 seedlings m-2). Adult plants appeared to suppress their own seedlings. This study showed that the seed regenerative capacity of lantana is slightly but noticeably reduced by the current suite of biocontrol agents.

Mass-rearing, releasing and monitoring of biological control agents on invasive alien cacti

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Invasive alien cacti have negative impacts on indigenous biodiversity and agricultural productivity in South Africa. Biological control is a management option that can be implemented to minimize the negative impacts posed by invasive alien cacti. The Rhodes University Centre for Biological Control mass-rears biological control agents that are released against these problematic plants throughout South Africa on the request of land-users. The impact of these biocontrol agents is quantified through long-term monitoring and questionnaire surveys. The results indicate that at most release sites, there was a decline in cactus densities after releases of biocontrol agents. Most land-users who participated in the survey perceived biocontrol as a successful and safe method that they would recommend to other land-users. Biological control of invasive alien cacti is effective when mass-rearing and releasing are implemented properly.

Invasive alien aquatic plants management: Ecosystem recovery and restoration

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Invasive alien aquatic plant (IAAP) species have severe ecological and socio-economic impacts on freshwater systems in southern Africa and beyond. The application of biological control against floating IAAP species have significantly improved freshwater socio-economic returns, however ecological benefits remain poorly understood. This includes ecosystem biodiversity recovery and ecosystem structure and functions dynamics that will aid in restoration of previously invaded systems. This study quantifies ecosystem recovery following mechanical and biological control of *Salvinia molesta*. A combination of mesocosm (Before/After, Control/Impact) and field (Before/After) experiments were employed, to test; (i) changes in water quality, (ii) shifts in phytoplankton, periphyton and aquatic macroinvertebrate assemblages, and (iii) shifts in trophic interactions before and after *S. molesta* management. Mechanical removal and biological control of *S. molesta* did bring about ecological recovery and ecosystem re-organisation, however mechanical removal proved unsustainable, by allowing secondary invasion through multiple stable states. This presentation will discuss ecological dynamics before and after *S. molesta* management using both mesocosm and field evidence and highlight possible recovery/restoration trajectories and implications for previously IAAP invaded ecosystems.

Update to the catalogue of target weeds and their biological control agents in South Africa, and a new way to assess the outcome of biological control at a weed population level

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The maintenance of a catalogue of biological control agents released on target weeds, whether they have established permanent populations on their host in the field, and the amount of damage they inflict on the host, is essential when assessing, the effectiveness of biological control in suppressing weeds in South Africa. I discuss updates to this catalogue since it was published 10 years ago. At present, 129 species of biological control agents have been released, and 90 established, on 68 target weeds. We have changed the way in which we assess the outcome of biological control on a per-weed basis, from basing it on the need for other control methods, to scoring several parameters which affect the populations of the target weed, viz. density, biomass, area and rate of spread. Because biological control agents take several years to reach populations and distributions which reflect their ultimate effectiveness, we only considered 54 weed species. I present our results here. This is a dynamic process, which will include more weed species over time, and as more biological control agents are released. Although the outcomes-based assessment does not deliver a single metric of control for each weed species, it is more nuanced and accurate.

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