BOOK OF ABSTRACTS

IAVS 2023 AUSTRALIA

65th Annual Symposium of the International Association for Vegetation Science

The Future of Vegetation in the 22nd Century

3rd – 8th September 2023

Coffs Harbour, Australia

Fluvial vegetation affected by regulation provides gains and losses of Ecosystem Services

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Riparian and aquatic vegetation downstream of dams is predictably affected by the hydrological alteration of natural hydrographs by damming. Shifts in species composition and abundance affect the abiotic and biotic components of rivers, and a complex cascade of changes takes place affecting the provision of Ecosystem Services (ES). The present study addresses the gains or losses of ES under water management scenarios in two Portuguese rivers impaired by dams with diverse operation rules; a run-of-river dam and a storage reservoir. An integrative tool, RIVEAL-ES, based on Bayesian Belief Networks (BBN) was produced, combining drivers of change and ES values to enable decision-makers to quantify trade-offs associated with management options as well as to identify the most effective management targets aiming to increase ES. BBN provides intuitive graphical representations that allow users to deal with complex problems, including a prompt uncertainty assessment of different decision-making options. We modelled three categories of ES: Fluvial Ecological Integrity (Supporting), Carbon Storage (Regulation and Maintenance), and Socio-cultural values (Cultural ES). We show the effects of different scenarios in the Bayesian parent nodes, and the most likely response of communities (riparian plants, macrophytes, diatoms, macroinvertebrates) and associated ES. The BBN includes four main components: the disturbance component assumed to result mainly from changes in the hydrological regime and land use; the biotic component that estimates the response of biological indicators; the ecosystem response component that estimates changes in ecosystems; and the ES component that estimates changes on fluvial integrity, carbon stock and cultural services.

Diverse vegetation die-off events through time and across landscape gradients, Southwest USA

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This talk illustrates extensive vegetation dieback and forest die-off events in the mountainous landscapes of the Southwest USA (New Mexico, Arizona), with particular focus on my home landscapes in northern New Mexico. Multiple lines of evidence document that past severe droughts have caused substantial pulses of tree mortality in the Southwest (e.g. 1580s and 1950s). However, since 2000 the recent combination of protracted drought and ongoing global warming has caused historically unprecedented levels of diverse forest die-offs by amplifying interactive tree mortality processes, especially more extreme plant physiological stress and insect outbreaks (also more extreme wildfire, not addressed here). High levels of Southwest tree mortality have been observed across broad elevational and landscape gradients, from subalpine spruce-fir (*Picea-Abies*) forests above 3500 m elevation down through mixed-species forests of Douglas-fir (*Pseudotsuga*), aspen (*Populus*), and pine (*Pinus*) to the lowest woodlands of juniper (*Juniperus*) at 1500 m, and even riparian angiosperm trees along desiccated streams during peak drought episodes, along with substantial dieback and mortality of semi-arid woodland shrubs and grasses too. Spatial variability of within-species tree mortality patterns is described. Effective “Smokey Bear” suppression of the Southwest’s natural high-frequency surface fire regimes during the 20th century fostered “structural overshoot” of live biomass in densified conifer forests, contributing to the large regional magnitude of recent drought-induced “mortality overshoot”, sometimes particularly on more-productive mesic sites. Southwest tree mortality events have continued into 2023. Unprecedented hotter-drought extremes increasingly drive similar vegetation die-off events world-wide, fostering rapid reorganisation of ecosystem patterns and processes.

The global emergence of tipping-point drivers of ecosystem disruption & vegetation re-organisation

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Global patterns and trends of vegetation responses to ongoing warming and intensified climate extremes are addressed, highlighting the widespread emergence of novel tipping-point threshold risks and disruptive ecosystem changes to forests worldwide. Temperature- and moisture-related non-linearities and thresholds occur in numerous vital physical and biological processes of the Earth system (atmosphere, hydrosphere, cryosphere, and biosphere). Some climate-related thresholds directly affect vegetation growth, stress, natality, and mortality due to bio-physical process constraints on photosynthesis, transpiration/water transport, growing season length, etc., operating at plant, site, and landscape scales. Climate can trigger contagious non-linear vegetation disturbance processes such as high-severity wildfires, massive insect outbreaks, or desertification bare-soil thresholds. Modest directional changes in mean climate conditions cause large changes in the frequency and magnitude of extreme climate events that can exceed tipping-point thresholds, with implications for: vegetation 'structural overshoot' by growth during favorable conditions and associated 'mortality overshoot' with subsequent extreme stress episodes; typical growth benefits from elevated CO_2 vs. negative effects of extreme hotter-drought; patterns of global greening vs. global browning; challenges in vegetation modeling. Hotter-drought extremes are driving extensive tree mortality and forest die-offs in all major forest types world-wide by exceeding thresholds of physiological stress and by amplifying interactive disturbance processes; note the disproportionate vulnerability and importance of Earth's remaining 'historical forests', dominated by larger, older trees, with feedback implications for global carbon and water cycles. As global climate increasingly diverges from the documented range of variability, previously unseen tipping-point thresholds are being crossed and historically unprecedented ecosystem surprises are emerging, contributing to rapid re-organisation of vegetation patterns and processes. I close with thoughts on stewarding the world's vegetation into the 22nd century.

NSW vegetation and biodiversity data – design, develop, deliver, repeat

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New South Wales maintains a well-structured and integrated suite of vegetation data products to meet the current and evolving needs of government decision makers. A well-considered design and delivery approach ensures data is delivered to business systems through an open and transparent application programming interface that enables wider innovation and reuse across research, industry and government. This paper provides an overview of the structure and relationships between the primary data elements including vegetation plots, vegetation classification and mapping, plot-based vegetation condition benchmarks, estimates of vegetation clearing, and associations between vegetation type and threatened ecological communities and species. Development of this Integrated BioNet Vegetation Data (IBVD) product and approach has evolved over 17 years, and now involves an ongoing program of continuous improvement. To assist others wanting to undertake a similar, but possibly accelerated, journey key learnings are distilled into ten governance, product design and data value supply chain principles to help you on your way.

NSW State Vegetation Type Map (SVTM) undermines ecological fire management

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Reliable vegetation maps are crucial for managing biodiversity and bushfire risk. In New South Wales (NSW), recommended fire intervals vary by structural formation and include dry sclerophyll forests (DSF; fire every 7-30 years) and wet sclerophyll forests (WSF; 25-60 years). However, the recent NSW State Vegetation Type Map (SVTM) reclassifies extensive areas formerly mapped as DSF in regional maps, to WSF, effectively doubling the recommended interval between fires in these forests. To assess SVTM modelling accuracy, data from north coast BioNet Plots (5213) were compared to the diagnostic features of the NSW key to vegetation formations (tree height >30m, floristic indicators). SVTM mapping of WSF was found to be highly inaccurate, with 80.8% of corresponding plots not meeting the diagnostic canopy height threshold for WSF (>30m) and 24.8% of plots meeting neither canopy height nor floristic indicator criteria for WSF. Floristic indicators of dry sclerophyll forest were also widespread among plots misclassified to WSF, including in the understorey (50% of plots) and canopy trees (42%). Most plots misclassified to WSF were long-unburnt at the time of survey (73%), likely increasing the cover-abundance of WSF indicators (‘soft-leaved shrubs’) at the expense of DSF ‘grasses’ and ‘hard-leaved shrubs’. Vital attribute analysis indicates that most taxa on misclassified sites are sensitive to infrequent fire, highlighting potential consequences of extended fire intervals following misclassification. The observed misclassification of forests and the subsequent lengthening of recommended fire intervals is likely to promote ongoing fire exclusion and biodiversity decline in the region’s dry sclerophyll forests.

The impact of fire on a rainforest remnant dominated by *Nothofagus moorei* in north-eastern New South Wales

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The impact of fire on microthermal rainforests of eastern Australia is likely to find greatest expression in geographically isolated communities where environmental conditions are marginal for the persistence of characteristic species. The purpose of this study was to assess the impact of an extreme fire event on a small rainforest outlier dominated by *Nothofagus moorei*. Site conditions at this location suggested that attributes marginal for the persistence of some dominants included rainfall and related hygrometric conditions, fire frequency and substrate characteristics. Impacts of disturbance in relictual communities could be expected to provide insights into the prospects for these species elsewhere in their range, particularly in relation to traits contributing to resilience and species persistence. The contribution of outlier populations to regional gene pools highlights their significance, but there are challenges associated with conserving such remnants.

Spatial modelling of threats to Gondwana Rainforests of Australia World Heritage Areas in New South Wales, Australia

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The Gondwana Rainforests of Australia World Heritage property (Gondwana Rainforests) contains outstanding examples of major stages of the Earth's evolutionary history, ongoing geological and biological processes, and exceptional biological diversity. These World Heritage values are largely associated with its landforms, remnant rainforests and wet sclerophyll ecosystems. The most recent (2020) International Union for Conservation of Nature (IUCN) Conservation Outlook Assessment gave the property a "significant concern" rating. The assessment identified the impacts of climate change, changing fire regimes, and invasion by pest species and pathogens as being some of the main threatening processes. In this project we sourced available spatial data to model the likelihood of exposure of World Heritage values in New South Wales to threatening processes, including drought, fire, post-fire soil erosion, lantana (*Lantana camara*), phytophthora (*Phytophthora* spp.), myrtle rust (*Austropuccinia psidii*) and bell minor (*Manorina melanophrys*) associated dieback (BMAD). For fire impacts we extended the modelling to assess potential ecological impact by predicting the consequence of exposure to the 2019/2020 fires. We used the Multi-criteria Analysis Shell for Spatial Decision Support (MCAS-S) tool to collate the spatial data, build each of the models and generate area reports.

In this poster we report on the results of the modelling and demonstrate how MCAS-S was used to map areas with the highest level of exposure to each threat as well as cumulative impact from multiple threats, including repeated fire. This is the first time this spatial data has been collated into a MCAS-S datapack for the Gondwana Rainforests and made available to others to explore, use and improve.

Shrub cover and wild herbivores prevent plant invasions of Tasmanian alpine vegetation

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Alpine ecosystems are becoming more exposed to plant invasion due to a decrease in climatic severity and increased human disturbance. But is this pattern ubiquitous or are some alpine regions still resistant to plant invasions and if so why? To answer this question, we contrasted the alpine regions of Tasmania, where exotics appear rare, with those of the Australian mainland where exotics are widespread. Tasmanian species distribution data, experimental data from long-term grazing enclosures and observational data from roads have been used to determine the role of disturbance (remoteness, stock grazing and roads) and biotic factors (native plant competition and wild herbivory) on non-native plant occurrence. The distribution data showed that non-native plants are rare in the Tasmania alpine. They mainly occurred in regions that are currently, or were recently, grazed by stock. Non-native plants occurred sporadically in time and space in experimental grazing plots monitored for over thirty years, with the biggest outbreaks being where wild animal grazing was excluded. Roadside verges facilitated non-native plants which were almost always absent just 6 m from roads. These results indicated biotic resistance from the native alpine heath communities and herbivores and facilitation by roads and stock. Thus, the critical variables in explaining the marked difference between the Australian Alps and Tasmania in non-native plant invasion seemed to be the lack of both widespread high shrub cover and herbivorous animals on the mainland.

Monitoring model for spatiotemporal dynamics of Mongolian grassland based on multi-source remote sensing data

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Grassland is the basic means of production of a grassland husbandry economy. A good grassland ecological environment is a necessity for the development of grassland. Grassland condition is not only important economically, as it reflects the number of grazers rangeland can support, but also crucial ecologically, as it indicates the integrity of wildlife habitats. Even though studies have demonstrated the effectiveness of remote sensing in grassland monitoring, it is still a challenge to use remotely sensed data in mixed grasslands because the large proportion of dead material complicates analysis for indices that were not developed for heterogeneous landscapes, especially in conservation areas. In this study, biophysical and spectral data were collected in Mongolia and surrounding pastures. We collected data from 100-200 locations with 1-5 plots per location, including vegetation species, above-ground green biomass, and spectral measurement of vegetation using hand-held spectroradiometer (350-1050nm for 108 locations in 2020, 350-2500nm for 200 locations in 2021). Google Earth engine was the main platform for satellite data processing including pre-processing and cloud mask, index calculation, and variables were considered for each multispectral dataset using the original band reflectances and vegetation indices. The effect and relationship of spectral signature with variables selected parameters in the field as biomass, and vegetation canopy moisture were defined as prediction and coefficient of determination for the monitoring model. We analysed and obtained an effect of temporal, spectral, and spatial capacities of spectral data, which are related to biophysical parameters. The results aid understanding of the relationship between remote sensing data and ground truth data.

COCOS: effects of climatic extremes on ecosystem stability

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The frequency of extreme climatic events (ECE) is rapidly rising, as is their negative impact on natural systems and on our societies. ECE disrupt the stability of ecosystem functions, with unpredictable consequences for the provision of ecosystem services important for human welfare. Determining the capacity of ecosystems to resist (i.e., maintain their properties) and to recover (i.e., return to their functioning) after ECE is a pressing task. Equally important is to identify biodiversity-mediated mechanisms underpinning ecosystem response to ECE. Here, we present COCOS, a new project funded by the European Union, which will investigate both research aspects. Within COCOS, we will use extensive datasets on vegetation functions (e.g., plant biomass and cover) and on climatic parameters to assess the relationship between ecosystem stability, biodiversity and ECE at the global scale. From LOTVS, a worldwide collection of long-term vegetation time-series collected in permanent plots, we will obtain measures of resistance and recovery for different ecosystem types, and of plant community taxonomic and functional diversity. Using ERA5-Land climatic variables, we will compute indices of precipitation and temperature-related ECE, which we will then use to identify years in LOTVS time-series featuring anomalous climatic conditions. Focusing on those years, we will analyse the association between stability, biodiversity and ECE of varying intensity, which will allow generation of predictions of ecosystem-specific resistance and recovery. Research questions and the state of the art of COCOS will be presented, along with preliminary results on the analysis of the stability-ECE relationship.

How can consultants contribute to the conservation of vegetation and plant species?

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Ecological consultants are rapidly becoming some of the most important collectors of ecological knowledge, yet this knowledge is not always available to guide the management and conservation of vegetation and plant species. Consultants are often permitted to access restricted lands where few other ecologists have been, and for example collect critical data on how plants respond to disturbance or how they are distributed across the landscape. Surveys undertaken by consultants to document population size and habitat of threatened plant species, or to collect systematic data that contributes to defining a vegetation classification, are often critical in determining how those species and habitats are managed. This talk will outline six themes within which consultants have and can contribute to vegetation conservation, including (1) taxonomy (e.g. discovery and naming of new plant species), (2) classification (e.g. delineation of new vegetation communities), (3) regulation (e.g. how species and vegetation communities are best assessed and managed), (4) survey methods (e.g. new technology to improve survey outcomes), (5) threatened species ecology (e.g. necessary pollinating or dispersal vectors and networks), and (6) dissemination of data and interpretations (e.g. publication in the scientific literature). Given the large proportion of young ecology graduates that ultimately find themselves employed by consulting companies, harnessing their enthusiasm to contribute positively to vegetation conservation should be a priority.

Plant and soil fungal community responses to cultural burning

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Fire is a key driver of ecological dynamics in terrestrial ecosystems. Thus, understanding the effects of fire on ecosystem dynamics above and below ground is imperative, yet rarely attempted, to ecosystem management and the associated control of invasive plant species. Fire has been used for millennia by Traditional Owners for fuel reduction and flora regeneration. The aim of this project is to improve understanding of vegetation and soil fungal community responses to cultural burning on stock route reserves in the Balonne Shire Council area, south-western Queensland. The effects of cultural burning practices on invasive and native plant species and soil fungal communities were assessed across four paired sites (burnt/unburnt). Within each site, two burnt and two unburnt transects were established six months post burning. Each 30 m transect consisted of six 1 m^2 quadrats. A total of 48 soil samples were collected from vegetation survey quadrats at two of the four sites. Total mean plant species richness ranged from 4 to 9 per quadrat revealing site-specific variation. However, mean total species richness (7) was similar across all burnt vs unburnt sites. Invasive plant species across all sites included *Cenchrus ciliaris* (buffel grass), *Conyza albida* (fleabane), *Bryophyllum sp*. (mother of millions) and *Xanthium occidentale* (noogoora burr). Our preliminary results indicate that cultural burning has a negligible effect on driving the above-ground plant richness between burnt and unburnt plots at the quadrat level. However, whether these patterns are mirrored on a larger scale and in the below-ground soil fungal richness remains to be assessed.

Remote sensing as a tool for statewide vegetation monitoring

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Remote sensing is a powerful tool for vegetation monitoring, providing valuable insights into the nature, extent and dynamics of vegetation cover across New South Wales. Vegetation monitoring at a statewide level is essential for assessing and tracking the health, productivity, and biodiversity of ecosystems. Traditional ground-based methods are limited in their ability to capture information over large areas efficiently. Remote sensing techniques, on the other hand, offer a synoptic, repeatable, and cost-effective approach for acquiring data on vegetation characteristics at multiple scales. Ever improving availability of satellite-based sensors coupled with shorter return cycles, provide contemporary data that can be used to identify and map different vegetation types and monitor changes. Temporal monitoring of vegetation dynamics is crucial for understanding the impacts of climate change, land-use change, and disturbances on ecosystems. Remote sensing platforms offer the ability to capture repeated consistent observations over time, enabling the detection of changes in vegetation condition, such as deforestation, degradation, and regrowth. Time-series analysis of vegetation indices derived from satellite data allows for the quantification of vegetation productivity, phenological shifts, and disturbances, aiding in the development of effective land management strategies. The systematic integration of satellite-based data with aerial and ground-based measurements and modelling approaches has further enhanced the accuracy and reliability of the statewide vegetation monitoring and mapping programs. The application of remote sensing for vegetation monitoring in Australia has significantly advanced our understanding of ecosystem dynamics, land cover changes, and biodiversity conservation. It has facilitated the development of tools and techniques for mapping and monitoring vegetation at multiple scales, providing crucial information for environmental planning, natural resource management, and decision-making processes.

Management of eucalypt forests with declining canopy health in NSW State Forests

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Managing eucalypt forests with declining canopy health is an increasing challenge across all tenures in New South Wales. Chronic decline of eucalypts, usually called dieback, is widespread and increasing, as it is across Australia. There is considerable debate about the underlying causes and potential interventions. Observations of declining health and increasing pests, parasites and diseases, as well as changes in vegetation composition and structure with reduced occurrence of mild fire, point to a solution. Forestry Corporation of NSW has developed a Eucalypt Decline Management Plan to address this forest health issue. The management strategies employed focus on several key areas. Firstly, they aim to contribute to the understanding and control of eucalypt decline through research and collaboration. Secondly, guidance is provided on the assessment of eucalypt decline, facilitating accurate and consistent evaluations of the health of eucalypt forests. Additionally, the use of fire under appropriate conditions is promoted to enhance forest health, diversity, and resilience. Lastly, guidance is given on appropriate management actions to be taken when eucalypt decline is observed. By implementing these management strategies, forest managers can effectively address eucalypt decline. These approaches will help restore the ecosystem values of eucalypt forests and maintain the ecological, economic, and social benefits that these ecosystems provide.

How does the representation of species in nurseries impact restoration success?

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Ecological restoration through revegetation is predicted to be a powerful tool to promote the recovery of human impacted ecosystems. Revegetation projects typically rely on acquiring plants from nurseries. While most nurseries propagate species that are found in reference communities, we are uncertain if the range of species from nurseries represent the range of taxonomic diversity and the range of ecological functions of the reference communities. We examined plant species available for revegetation projects in eastern Australian sclerophyll forests in nurseries and compared this to reference communities in sclerophyll forests in national parks in the Sydney basin. We found that plants from nurseries had an over-representation of tall, fast-growing trees compared to species from reference communities. We also found that nursery plants tended to have higher seed mass, and lower capacity to resprout after fires. Next, we compared the range of species and functional representation of restored ecological communities with the reference national park communities. Restored communities were functionally different than the reference communities, with many of these differences the same as the differences between nursery and reference communities. Our results suggest that species available from nurseries can limit the success of ecological restoration, and these effects can be seen decades after restoration projects.

The Eurasian crane (*Grus grus*) as an ecosystem engineer in grasslands

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Large bird species such as cranes are involved in human-wildlife conflicts as they often forage in croplands. The Eurasian crane (*Grus grus*) is a large bird species protected across Europe which, thanks to conservation programs and its ability to utilise croplands for foraging, shows a strongly increasing population trend. This exaggerates the existing conflicts between crop farmers and cranes and is spilling over to natural habitats, where foraging by large flocks can lead to land degradation. No studies have evaluated the effects of foraging cranes on grasslands, despite the fact that these habitats provide important feeding grounds for cranes across their whole range. To fill this knowledge gap, we evaluated the ecosystem engineering effect of foraging Eurasian cranes on the vegetation of dry grasslands in Hungary. We used indicators of vegetation naturalness, forage quality, and floral resource provision to evaluate the ecosystem state from multiple aspects. We sampled 100 quadrats in disturbed patches and 100 in undisturbed grasslands in two seasons and two years. Cranes created distinct vegetation patches with different species composition from undisturbed areas. We identified important trade-offs between the positive and negative effects of the foraging activity of cranes on different structural and functional components of the ecosystems. The crane-disturbed early-successional patches increased plant diversity and floral resources but decreased the area of undisturbed grasslands. Although crane-disturbed patches could provide forage for livestock early in the season, the forage quality became poor later in the year. We highlight the importance of monitoring the landscape-level extent of the disturbed areas.

Low replicability assessing trait distribution patterns along a gradient using functional traits

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Ecological theories predict that assembly processes are driven by two deterministic forces: environmental filtering and limiting similarity. Their relative importance under different environmental conditions is still not completely obvious. Therefore, this paper explores the finding of a stress-dominance hypothesis in several sites and assesses whether trends along an environmental gradient are the same in similar places. We studied productivity gradients from open sand grasslands to meadows in three sites in Kiskunság, Hungary and in Deliblato Sands in Serbia. Each site was sampled using a 2×2 m plot size, resulting in 344 vegetation plots. The cover of species was estimated visually. Four trait values (height, seed mass, specific leaf area, and leaf size) were collected from field measurements and databases. The weighted median of interspecies distances in traits (a robust alternative to Rao's quadratic entropy) was used to determine functional diversity. The convergence and divergence of each trait in communities were evaluated by randomization tests, and effect sizes were calculated for each plot. We used hierarchical general additive models (HGAM) to determine whether the trend of effect sizes along the productivity gradient is the same in different sites. The HGAM approach indicated that traits follow global trends but are influenced by site-specific effects. The exception is seed mass, which did not show any trend. Both environmental filtering and limiting similarity exist in the communities, and a trait convergence to divergence shift pattern along a productivity gradient was observed. This research was supported by NKFIH (project numbers K124671, K138674).

Does climate matter for Australian natural vegetation?

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Australian vegetation has long been considered “different”, due to long biogeographic isolation and the old Gondwana substrate. In the 1980s John Beard challenged that climate alone could not predict Australian vegetation accurately, and he may be right. Presented here are results from the application, to Australia, of what may be the final version of a globally applicable climate-based model of natural vegetation, based on 40-plus years of improvements and fieldwork worldwide. Plant forms have been shown to be a convenient and useful way to overcome enormous numbers of taxa worldwide and to evaluate models. Results are presented as predicted vegetation stand types at sites (meteorological stations) and are compared with understood actual natural vegetation types. A map is attempted but is limited by availability of the necessary climatic pixel fields. Results (unknown at time of abstract submission) may show whether Beard was right.

Monitoring habitat restoration at landscape scale using cloud platform technology

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Measuring biodiversity loss due to habitat decline and fragmentation is challenging, particularly at landscape scale. Rural, coastal and urban communities have been restoring habitat since perhaps the mid 1970s, protecting and restoring ecological balance on private land, and in local public and natural places. Much restoration effort has focused on building community with environmental benefits, but significant environmental outcomes have also been achieved by public and corporate entities and private individuals. Thousands of locations across Australia have been transformed from degraded and disturbed landscapes into resemblances of natural areas, but data is poor. As governments and other investors become increasingly interested in measuring value and outcomes from investment, collecting and analysing data to quantify benefits has become more important. However current data recording is ad-hoc and non-standardised, making aggregation and analysis difficult. In 2021, the New South Wales Koala Strategy funded a habitat restoration program which called for comprehensive and standardised data recording across work sites and partnered with the Atlas of Living Australia (ALA) to utilise the BioCollect platform data collection infrastructure. Building on this initiative, over 45 groups are now using BioCollect to capture complex information about current and past restoration work. Standard templates were created for a range of activities including benchmarking assessments, site establishment, follow-up interventions and monitoring. BioCollect ensures data are structured around internationally recognised data standards. This presentation demonstrates how these data can be aggregated to provide a landscape level perspective on restoration outcomes.

Rapid decoupling of fern communities in northern Italy

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Climate change and anthropogenic land-use change are driving significant shifts of plant communities across the world. The ability of taxa to respond to changing local climatic conditions and disturbance regimes will likely drive changes in community composition over time. Seed-bearing taxa are likely more dispersal limited than spore dispersing taxa such as ferns, however, studying changes in fern communities is challenging as ferns occur sparsely compared to seed plants. To get around data paucity on ferns, we analysed a fern-presence dataset (c. 56,000 records) from northeastern Italy straddling between two biogeographic regions and spanning 32 years to (1) test drivers of fern communities, and (2) examine whether the distribution of fern taxa and the communities they form are changing over time. By grouping species presence in 328 10 km^2 quadrants across the region, we identified five broad fern communities sharing similar growing environmental conditions. Using spatial rasters of biogeographic regions, geology, and land use (Corine land-cover), we present evidence that fern communities in northeastern Italy are strongly influenced by geology and land use reflecting the distinct shift in biogeographic regions. We then compared the elevational distributions of fern taxa prior to and after 2006/2007 and identified patterns of rapid elevational shifts in fern taxa: some increasing or decreasing in elevation, others expanding and contracting their elevational range. These latter patterns appear to be a response to both increasing temperatures in the region but also to rapidly changing anthropogenic land use, thus suggesting that fern communities are decoupling across the alps.

Vegetation classification of the Juriesdam-Seekoeigat sections of Mountain Zebra National Park, South Africa

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The Nama Karoo biome is the second largest biome in South Africa and is located on the central plateau area of the country. It is dominated by dwarf shrubs and grasses on the valley bottom and plateaus, with medium-sized shrubs along the moderate to steep mountain slopes. This study identified, classified and mapped the plant communities of the Jurisdam-Seekoegat sections of the Mountain Zebra National Park. The study area was stratified into physiognomic-physiographic units using 1:50,000 stereo aerial photographs. A total of 44 sample plots (400 m^2) were placed in a randomly stratified manner within identified homogenous units. Plant species present in sample plots were recorded and allocated a modified Braun-Blanquet cover abundance scale value. The veld condition was determined using the Ecological Index Method. Plant community data was analysed using the JUICE software package while diversity of the different plant communities was determined using the Shannon-Wiener and Gini-Simpson Indices. A modified TWINSPAN classification was applied to the data and resulted in the identification of eight plant communities that can be grouped into six major communities. The different plant communities can all be related to topography and effect of previous land use. The rocky midslope vegetation had the highest species richness and diversity while areas least affected by heavy grazing had a higher veld condition score. The results also indicate the importance of restoring overgrazed veld, while it seems that heavily grazed areas will not recover without further human intervention.

Defining the world's formation types using the global vegetation database sPlot 4

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Defining vegetation formation types in vegetation databases is a challenge as physiognomic and structural attributes have to be translated into floristic or functional criteria. We here use the formation system of Faber-Langendoen et al. (2016) to define vegetation formations for vegetation plot records from the sPlot database. Our procedure involves several steps, starting with training datasets for which the formation is known, making use of 30,000 plots outside Europe in sPlot 4.0 and over 1.8 million within Europe, covering 28 different Faber-Langendoen formations. The formal description of these formations is done with the ESy expert system, based on set-theoretic concepts and formal logical operators using diagnostic species groups. In addition, we make use of structural (e.g. cover of the different life forms in the plots) or functional attributes (e.g. leaf size) and combine them with the floristic membership expressions in membership formulas. Using the training datasets as benchmarks, we use brute force approaches and the kappa statistics to find optimal threshold criteria for membership expressions, with respect to the number of species required from a diagnostic species group or for structural attributes. Simultaneously, different combinations of membership formulas are tested. Finally, these rules are applied to the whole sPlot database to predict formations for records for which the formation is unknown, and comparing the formations' predicted distribution across continents, climate zones and floristic realms. The continuous potential distribution of formations is then modelled using boosted regression trees and climate, soil and topographic heterogeneity as predictors.

Importance of voucher specimens to plant conservation

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There is a price for every action and every inaction. Lodging voucher specimens from fieldwork in a recognised herbarium is good practice. Still, this rarely happens in ecological surveys, whether for national parks services or for development applications. I explore this issue and suggest a model for good, sustainable practice that would aim at quality assurance, knowledge development, and a sounder basis for land management decisions that should lead to better outcomes for plant conservation.

Elevation-dependent patterns of snow-gum dieback in Australia's montane and subalpine forests.

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Subalpine forests face the synergistic threats of global warming and increased biotic attack yet the influence of variation in tree physiology on mortality is unclear. We hypothesised that increased vulnerability of subalpine snow-gums (*Eucalyptus pauciflora*) to wood-borer-mediated dieback at intermediate elevations may be associated with poorly-resolved differences in traits between montane and subalpine snow-gum subspecies. To better understand the variation between snow-gum subspecies and in response to elevation, we characterised variation in 20 structural and drought-related functional traits along a 1000 m elevation transect. We then tested associations between dieback, elevation, bark thickness and wood density in two subspecies in Kosciuszko National Park, New South Wales. We then surveyed associations between bark thickness and increased dieback severity among six snow-gum subspecies distributed across the Great Dividing Range. Of the 20 traits surveyed, 50% were similar between montane and subalpine snow-gum subspecies, 25% varied continuously with elevation and 25% differed between subspecies. Increased dieback severity across the montane-to-subalpine subspecies transition was correlated with lower bark thickness, whereas reduced dieback at the highest elevations was correlated with greater precipitation and lower temperatures. Similar associations between thinner bark and increased dieback severity were subsequently observed in four other snow-gum subspecies distributed throughout the Australian Alps. Identifying traits contributing to species' distribution limits and biotic agent vulnerability will be critical for predicting, monitoring, and possibly mitigating declines of subalpine forests under future climates. Our results suggest that subalpine snow-gum forests may face an increased risk of borer-mediated dieback under warmer, drier future climates.

Episodic vegetation change on a recent lava flow in British Columbia, Canada

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The Tseax Volcano in northwestern British Columbia erupted sometime in the 1700s, replacing temperate rain forest with a 26 km^2 lava plain. We questioned why current plant cover ranges from bare basalt and thick blankets of lichens and mosses to mature forest more than two centuries later. Plant cover by species was described in 174 4 x 4 m quadrats distributed randomly across 13 strata or arrayed in transects. Increment cores determined tree ages, nearby streamflow records were examined, surface fuels were monitored for moisture content, and dataloggers recorded air temperature and humidity in selected patches. Vegetation analysis revealed significant substrate effects and a pronounced legacy of recent disturbance events. A'a surfaces often support continuous cover of the cyanolichen *Stereocaulon paschale*, which can be replaced by the moss *Racomitrium lanuginosum* if undisturbed. Pahoehoe surfaces are less vegetated, except in cracks and collapsed lava tubes, which support several fern, shrub, and tree species. Vascular cover is negatively related to distance from lava flow edges, and exotic plant cover is primarily associated with roadsides. Wildfires have repeatedly reset succession, as the distinctive climate of the basaltic plain rapidly dries surface fuels, making them susceptible to ignition. Conversely, localised flooding and road dust have deposited silt that promoted establishment of trees and other vascular plants. As extreme weather supporting wildfires and floods increases, lava bed vegetation development will be set back in some places and accelerated elsewhere. This complexity challenges textbook descriptions of linear ecological succession and foretells an uncertain future in a changing climate.

Connecting biodiversity stewardship to benefits for the Australian farm biodiversity stewardship pilots

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A framework was developed to inform funding decisions in Commonwealth pilots of market mechanisms improving outcomes for biodiversity in Australia's agricultural landscapes. The framework is anchored in environmental accounts for ecosystem condition, assembled at the scale of natural resource management (NRM) regions, and essentially involves two parts: (1) Spatially explicit estimates of local ecosystem condition to support biodiversity (including consideration of connectivity), and (2) Models of outcomes for biodiversity persistence at regional and national scales integrating spatial data on ecosystem condition with the distribution of biodiversity components at regional and national scales. Project proposals included spatial information defining management areas, as well as information on their current condition and the level of management change landholders were proposing to undertake, which had to be consistent with published guidance. Potential benefits to biodiversity were evaluated by first estimating the likely change in local ecosystem condition each project could achieve within its management areas, including changes to connectivity, and then modelling the impact of that local condition change on outcomes for biodiversity at regional and national scales. The framework makes use of the decades of work that have yielded complex and valuable spatial information on biodiversity, and a collection of site-scale ecosystem condition metrics across Australian jurisdictions. Its design provides conceptual consistency in application to agricultural landscapes nationally, but its assembly for the twelve NRM regions involved in the pilot programs, two in each State, required differences in the details of how available information was used in each State and region.

A novel framework to generate global plant functional groups for ecological modelling

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Forecasting ecological communities' responses to biotic and abiotic constraints and environmental changes is one of the pivotal tasks of predictive ecology. However, the modelling of plant communities' dynamics in time and space is hampered by the sheer number of species in natural systems. A way to reduce the complexity is grouping species sharing similar ecological niches into functional groups or types. Often, the creation of functional groups is carried out for each case study ad-hoc in a non-systematic way, and using a small set of traits, limiting its transferability to other geographical areas or study systems. To provide functional groups that are not region-specific but valid for the entire world, we propose a framework that analyses a global functional trait database (TRY) and a plant-soil cooccurrence database to propose a generic plant functional group (PFG) taxonomy. Based on most relevant and measured functional traits, we designed a multi-step process that includes: i) data harmonisation and missing values imputation; ii) multi-trait species groups generation for each of the main ecological dimensions featured in ecological modelling of plants communities worldwide (i.e., dispersal, competition, demography, etc.) and iii) the combination of dimension-specific groups into comprehensive PFGs. In addition, to test whether our PFGs accurately summarise species functional variation, we validate our approach by assessing within and among groups homogeneity in the traits space. Our framework generates robust, data-driven PFGs with non-overlapping combinations of traits for each ecological dimension, also allowing for the integration of new species-trait data once it becomes available.

Ground truthing of IVC and HOTW mapping typologies using neotropical bird assemblages

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The Habitats of the World (HOTW) typology and mapping uses the International Vegetation Classification (IVC) Group level framework to build a mapping system based on bird assemblages with vegetation to better identify priority habitats for bird conservation. The HOTW system consists of 550 terrestrial habitats around the globe that broadly match the IVC Macrogroup mapping for most biomes but differ significantly in others. Fieldwork was undertaken in multiple biomes in South America to determine: A) if either mapping system correctly identified the habitat on the ground; B) what the bird assemblage was for each site; C) what habitat was predicted from the bird assemblage site results; and D) did the habitat at the site locations match the predicted habitat from the results of C). The results indicated (in contrast with North America) that the IVC and HOTW mapping in the neotropics both have significant resolution issues across most biomes in areas with significant relief. Even where resolution was not an issue (e.g. on extensive plateaus or alluvial basins) many examples of incorrect IVC habitat mapping exist. Correspondingly, the HOTW extrapolation from the IVC Groups was also incorrect. The results showed that bird assemblages were a more accurate indicator of habitat than either mapping scheme in most environments. One major exception was in mesic ruderal areas where bird assemblages could not accurately predict original or natural (potential) habitat. Problems with accuracy and resolution can be resolved by including bird indicator species in the algorithms used in vegetation mapping.

North America bird habitats: a new classification based on bird assemblages

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Animal habitats are formed by the combination of vegetation, climate, and geography classes used by those animals. Although each of these components has been thoroughly studied, until recently there has been no attempt to create a global classification of bird habitats. Such a classification could be helpful to biologists in understanding how animal groups occupy and use the landscape and identify habitats needing conservation to ensure that threatened animals continue to have places to live. We have developed a habitat classification system for North America (Habitats of the World or HOTW) based on both vegetation and indicator bird assemblages. The HOTW system accurately classifies habitats and provides a simplified, universal system that experienced and inexperienced ecologists and conservationists can easily use. The HOTW system identifies 144 primary and subtype habitats for birds in North America (including the Hawaiian Islands). Sixty-two are terrestrial primary habitats with distinct bird assemblages and 38 subtypes. Subtypes are local variations of the primary habitats, but harbour different bird assemblages. Each habitat was mapped as an aggregation of multiple International Vegetation Classification (IVC) Groups. The accessibility of the HOTW system has led to it being adopted by various conservation organisations (e.g., American Bird Conservancy and NatureServe) to identify the habitats with the highest threat assessment level and prioritise management practices from these.

Sampling of inaccessible areas in the Atlantic archipelagos using unmanned aerial vehicles

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Unmanned aerial vehicles, a.k.a. ‘drones,’ were used to obtain high-resolution georeferenced images of vegetation stretches in inaccessible areas in oceanic archipelagos. These include near vertical cliffs and rocky islets never directly observed by humans, many harbouring incompletely known flora and vegetation. We use the Desert Islands and cliffs in Madeira Island, eastern Atlantic, as case-studies to evaluate the accuracy of remote vegetation sampling. In one case, Salvage Islands, a set of terrain vegetation relevés is compared with the correspondent visual ‘plots’ in hi-res drone images. Statistical adherence of both data sets was trialled by Mantel tests. Moreover, in areas not accessible, i.e. those without terrain relevés as reference, we performed repeat reciprocal cross-Mantel-testing of several images/flights of the same area. Bootstrap sampling on a single flight image was also evaluated. Furthermore, detailed aspects of uncertainty in remote sampling, namely those pertaining to misidentification or non-visibility of plants or vegetation patches, are addressed by complementary comparisons of classifications and ordinations. Thus, we found the method to be accurate and reliable to survey sparse single-stratum vegetation of inaccessible areas.

Shields of green – riparian vegetation in embattled landscapes

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Riparian vegetation is the hero of human-dominated landscapes, both rural and urban, supporting a wide range of critical ecosystem services and representing a key priority for conservation and rehabilitation efforts globally. Riparian vegetation also plays a significant role in mitigating climate change risk for people and nature, including protection from extreme climatic events such as floods, droughts and extreme storms. Climate change, along with growing anthropocentric pressures, however, is increasing the intensity of these extreme events and altering the landscape and temporal context within which riparian vegetation functions. Consequently, conventional approaches to riparian vegetation management and restoration may no longer be the most effective. Here, I discuss how riparian vegetation is responding to accelerating intensification of pressures and threats, with a focus on recent extreme weather events. I explore the implications of observed and predicted changes for riparian ecosystem function and services as well as riparian management objectives and strategies. I present findings from a range of studies addressing key questions concerning the ecology, management and restoration of riparian vegetation across a range of landscapes with the aim of engendering a discussion on the potential for 'climate-ready' riparian restoration.

Chasing Fairy Bells: the role of consultants in plant conservation

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Ecological consultants often carry out important scientific work on plants and animals but are constrained in how they do this work. Projects are often dictated by client's needs and may be focused on assessing the extent of a population or on ways to manage it within legislative boundaries. It can be difficult to carry out and publish high quality research projects. From 2017 to now, Stringybark Ecological has worked in partnership with Local Land Services to research the rare shrub *Homoranthus darwinioides* (Fairy Bells) in the Hunter and Central West of New South Wales. Initial surveys to review the extent of the species and collect seeds for conservation seedbanking were expanded after severe bushfires in 2019 affected some populations. This provided an opportunity to learn about the species' response to fire and to monitor recovery after fire. The work has led to a better understanding of the threats to this species and how to manage them. This case study will discuss the findings of the study but will also focus on the funding and project management that allowed us as consultants to complete this work.

NSW Biodiversity Conservation Trust – supporting landholders to manage biodiversity

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The Biodiversity Conservation Trust (BCT) is managing over 2,200 Private Land Conservation agreements with landholders across more than 2 million hectares in New South Wales, Australia. These areas have many unique landscapes, threatened ecosystems, and habitats for threatened native plant and animal species that are now protected and being managed by private landholders for conservation. The private land conservation network across New South Wales is growing. Thousands of landholders now manage a patchwork of land under a range of agreement types. Placing land under an agreement, even on part of a property, is a big commitment. The BCT acknowledges this commitment, and through our Landholder Support Program we seek to support people in managing their conservation agreements and achieving their goals. The agreements we support are shaped according to specific sites and landscapes. Our local staff, who know and live in the region, support agreement holders in a variety of ways. We can provide practical advice on conservation management, help problem solve, source technical information on management and assist with monitoring ecological outcomes.

Dealing with client confidentiality while still advancing vegetation knowledge

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Ecological consultants are often confronted with a delicate situation – how to balance the knowledge of findings that could be significant to science, with the need to maintain client confidentiality on projects. Across Australia, in most situations, ecological consultants are paid to undertake work on projects by the client who has a vested interest in the outcome. For ecological studies undertaken to assess the impacts of a proposed development, sensitive data can be collected and not disclosed to the public or scientific audience for months or even several years after collection. Indeed, the licenses under which consultants operate normally only require an annual return (data upload). The ecological consultant is typically required to operate in accordance with legislation, regulation and policy, and sometimes within an explicit code of ethics or accreditation scheme. Even absent the latter, it is arguable that a code of ethics applies in any case, and it would be expected that anyone working in this field has an inherent duty of care towards the subject that they either love and/or earn an income from. This presentation will address these issues and consider the benefits to conservation planning and action, cumulative impact assessment and public knowledge arising from improved knowledge transferal, versus the challenges of doing such to client confidentiality and commercial opportunities.

What are plant community types and why do they matter for offsetting?

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In New South Wales (NSW), Australia's most populous state, statewide vegetation mapping of plant community yypes (PCTs) provides units of calculation for the assessment of biodiversity offsets in the Biodiversity Offsets Scheme. Assessments of biodiversity values hinge on the identification of PCTs, the primary surrogate for measuring loss and gains, with the ultimate purpose of achieving no-net-loss of biodiversity. The purpose of this talk is to summarise and describe how vegetation units and their ancillary data are used as surrogates for biodiversity values within the statutory requirements of the NSW regulatory framework and associated biodiversity credit market. This talk describes the challenges associated with using vegetation data as transactable units within a nature-based market and how NSW has adapted to such challenges.

Building and using vegetation information for regional scale biodiversity conservation

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New South Wales (along with Queensland) has been a hot spot of scientific and political interest in native vegetation management for several decades, against a backdrop of high biodiversity and strong impact pressures. This experience illustrates universal themes for global biodiversity conservation. Building a data-rich and integrated vegetation evidence base is costly and time consuming but is one of the best investments governments can make for biodiversity conservation management. The following are the stated aims of the current biodiversity legislation in New South Wales, but are likely to be similar globally:

- Conserve biodiversity at bioregional scales
- Maintain diversity and quality of ecosystems and enhance capacity to adapt to climate change
- Report on the status of biodiversity and effectiveness of conservation actions
- Assess the risk of collapse of ecological communities
- Slow the rate of biodiversity loss and conserve communities
- Guide prioritised and strategic investment in conservation
- Establish methods of assessing biodiversity impacts of developments and offset benefits
- Support public consultation and participation in decision making.

None of these can be fully achieved without comprehensive vegetation information systems. This means integrating different sources of analyses, drawing upon field data, modelling, statistical analysis and mapping. We need to be able to share our insights openly with a variety of audiences, some of whom will misunderstand it. We need to have information systems that are flexible for a variety of purposes, ranging from local decisions to international reporting, and to a changing future. We need to have systems and processes that enable us to capture, reuse and share data to continuously improve. We need to navigate political, financial and operational challenges to achieve this. These are challenges globally for native vegetation management.

Leaf phenology from a multi-scale analysis in seasonally dry tropical forests

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Understanding leaf phenology (LF) patterns and their main drivers is crucial for climate change studies. In dry tropical ecosystems, the spatiotemporal dynamics of LF from local to regional scales remain poorly understood. In this manner, integrating different remote sensors (e.g., orbital and near) to achieve better spatial and temporal coverages can provide a better understanding of ecological processes. This study aimed to analyse LF (I) drivers and (II) patterns based on orbital and near remote sensors in a seasonally dry tropical forest, located in northeast Brazil. We obtained 1-year data of environmental drivers, including rainfall, air temperature, and gross primary productivity (GPP), and 2-years data of Green Chromatic Coordinate index (GCC) as a proxy for LF from a PhenoCamera and two orbital sensors – OLI (Landsat-8) and MODIS (Terra/Aqua). To perform the analysis, we employed Pearson correlation, a Generalised additive mixed model and first-derivate to detect the start and end of growing seasons (SOS, EOS) on GCC. Our findings indicated that (I) GCC is significantly correlated with GPP ($r=0.93$, $p<0.001$) and shows a stronger association with cumulative rainfall ($r=0.53$, $p>0.05$) than air temperature ($r=0.40$, $p>0.05$). The comparison between (II) the three observational data of GCC showed significant correlations between PhenoCamera and OLI ($r=0.85$, $p<0.001$) and PhenoCamera and MODIS ($r=0.83$, $p<0.001$) exhibiting deciduous patterns, with a mean difference of 3 (±3) and 1 (±1) days in the SOS, and 2 (±4) and 13 (±13) days in the EOS, respectively. We conclude that upscale remote sensing approaches are promising for LF studies.

Role of systematic data collection and central databases in community classification

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Databases provide a linkage between the collectors of vegetation plot data, the researchers that identify vegetation units at the different levels of abstraction, and the end-users of a classification system. The development of a national vegetation classification for Australia will require such a database to warehouse the floristic, environmental and trait data being collected in plots across the country. The development of consistent data protocols for input into the database not only enhances the consistency of the products produced from it, but also the effectiveness of communication and outreach between the various groups. A functional database should be accessible to all users of vegetation data, who necessarily will have a range of ecological expertise. Effective communication between researchers and end-users will be needed to ensure a mutual understanding of the national classification system and its key concepts. What may seem obvious to the expert can often be unclear to the lay user of the outputs from a classification system. Australia also has multiple provincial jurisdictions, each with its own range of ecosystems, and varying classification histories and traditions. It is likely that databases for each jurisdiction will be needed and be inter-connected with the national database. A major challenge for the development of a national database network will be to develop consistent data protocols between the jurisdictions without being overly prescriptive and causing the loss of information. The requirements of a database must not take precedence over the requirements of ecological data collection and analysis.

Flowering sex ratios, growth¸ and spatial distribution pattern of a dioecious tree, *Podocarpus nakaii,* in a subtropical evergreen forest, Taiwan

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Podocarpus nakaii, a dioecious plant, is facing a very high risk of extinction in the wild. The International Union for Conservation of Nature (IUCN) reports that this species is classified at the "endangered" level. The sex ratio and spatial distribution pattern of different sexes are major components that affect the reproductive success and population persistence of dioecious plants. Flowering activity, sex expression, and spatial distributions of males and females of *Podocarpus nakaii*, were investigated in a subtropical forest, Taiwan. The sex ratio of 1,152 trees showed a significant female bias (1:0.58). As evidenced by diameter at breast height (DBH) data, smaller trees were significantly female biased, whereas larger trees showed no significant difference in sex expression, suggesting that females tend to be more precocious in sexual reproduction. For growth rate, male trees grew significantly larger than female trees. Point pattern analysis of the spatial distribution of reproductive trees showed that both males and female trees were aggregately distributed. The results of bivariate point pattern analysis showed males and females showed significant attraction in short distances of 0-10 m, no interaction at middle distances of 10-37 m, and repulsion at long distances of 37-50 m. These results suggest that no inter-sexual competitive interference was observed within short distances, which may be caused by the limited seed-dispersal range of this species.

Twenty-one year short-term stand dynamics of an evergreen forest in the Kaoshifo subtropical experimental forest, Taiwan

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In 1995, a 0.6 ha (300×20 m^2) permanent forest plot was established in the Kaohifo sub-tropical experimental forest, Taiwan. All individual trees with a diameter at breast height (DBH) ≧ 1 cm were mapped and recorded. The second, third and fourth censuses have been done in 2002, 2009 and 2016, respectively. In this study, we reveal the demographic pattern of recruitment, mortality, abundance, basal area and structure of size classes of DBH over the three census intervals. Over a period of 21 years, the first two census intervals showed increased basal area but decreased number of individuals. The third census interval showed a decrease in the number of individuals and slightly decreased basal area. It indicated that the forest gradually recovered from typhoon disturbance, the canopy remained closed, and the light resources under the forest became insufficient, which may have caused a decreased number of individuals. Species composition was almost the same except a few species with few individuals moved into or moved out of the plot. The rank of the top 10 dominant species changed slightly. Not all species had the same changing pattern because species responded to the fluctuation of the environment differently in the time series. The mortality rate decreased with the size class increment indicating that individual tree competition was the main mechanism controlling the mortality pattern. After these three censuses, we concluded that the Kaoshifo forest might be adapted to frequent typhoon influence. The forest remains stable in species composition, and DBH is shifting to larger size classes.

Harmonisation of woody biomass data from TERN ecosystem monitoring sites across Australia

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Large-scale, long-term monitoring of ecosystems can improve our understanding of how ecological processes vary over space and time. However, collating data sampled from multiple sites requires a centralised approach to standardise data at multiple scales. Over the past decade, vegetation data, including above-ground biomass, coarse woody debris, vegetation structure and leaf trait data, have been collected in sites operated by the Terrestrial Ecosystem Research Network (TERN) and CSIRO spanning 11 distinct vegetation types across Australia. Here we present the synthesis of the above-ground woody biomass dataset, derived for 38,000 individual plants across 387 species and 80 families. These data have been formatted using standardised variable names and units and aggregated at different levels such as stem, tree and site. We will show how these data are made FAIR (Findable, Accessible, Interoperable and Reusable) with standardised metadata with project and site information, protocols, and controlled vocabularies to describe assets. All data are openly accessible through the TERN Discovery Data Portal (https://portal.tern.org.au) and the newly created EcoPlots (https://ecoplots.tern.org.au) portal, allowing users to search and access to data based on different jurisdictions, data sources, feature types, parameters and temporal extent. While these datasets can be used to map and monitor changes in above-ground carbon storage across the 1 ha stand scales, the repeated measurements of individual trees over multiple time points at the majority of sites allows assessment of relative tree growth rates, mortality and species turnover over time at plant community or individual scales.

Ecological restoration for resilient cities: reimagining the urban nature in Delhi, India

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Urban forests are the source of essential ecosystem services that play an important role in maintaining the city's climate and contribute to biogeochemical cycles. Threatened by high fragmentation, rising pollution levels and constant inflow of invasive species, these can become living laboratories to study vegetation patterns in our rapidly changing world. In this paper, we are unravelling the vegetation ecology of Delhi Ridge Forests. A remnant of the Aravalli hills in northwestern India, these are the "green lungs" of Delhi. We identified three transition phases that drastically modified Delhi Ridge Forests in the last 100 years. What started as a citizen-led movement to conserve these forests is now a massive restoration project. Using plot-based surveys, we examined vegetation patterns with emphasis on species associations that could inform long-term management plans. We found a high richness of native plant species despite the dominance of invasive species. Some native species form positive associations with invasive species, while others form negative associations. This becomes clear from the multivariate analysis that reveals native-invasive cliques of three dominant invasive plants, i.e. *Prosopis juliflora*, *Lantana camara* and *Leucaena leucocephala*. This study demonstrates the existence of novel assemblages in the urban forests of Delhi. Restoration of Delhi Ridge Forests by removal of the dominant invasive species can lead to replacement by other invasives, with unforeseen impacts on the native species that are part of these native-invasive cliques. We suggest that restoration practitioners consider the novelty of urban vegetation before designing restoration plans to manage urban invasive species.

A new classification system for urban wetland vegetation

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Urban wetland vegetation, as a type of compound vegetation containing attributes of both wetland and urban ecosystems, carries several important functions (e.g., maintaining the ecological balance of cites and supplying cultural services), and has been a hotspot of vegetation research and protection. However, the classifications of vegetation based on natural wetland vegetation and urban artificial vegetation are not suitable for urban wetland vegetation, leading to problems in its management and maintenance. Therefore, we propose a new urban wetland vegetation classification system. It refers to the new generation Chinese vegetation classification system as well as classification of other wetland park vegetation, and innovatively integrates ecological characteristics, landscape attributes and functional requirements into the classification of vegetation groups. To verify the effectiveness of this new system, we undertook a trial in Guangzhou Haizhu National Wetland Park, a wetland on The List of Wetlands of International Importance and located in the mega city Guangzhou, China. The new system classifies the vegetation into 4 levels, comprising 144 associations, 70 alliances, 16 subformations and 3 formations. Cluster analysis of species from different communities displayed that the classification system performs well, especially in the classification of wetland aquatic vegetation and wetland agricultural vegetation. We hope that the new classification system will assist research and conservation of urban wetland vegetation.

Natura 2000 effectiveness at supporting native and priority plant species in the EU

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The Natura 2000 (N2K) protected-area network is the main tool for conserving biodiversity in the European Union (EU). Despite covering 18% of the area, its effectiveness at conserving plant biodiversity across countries and biogeographic regions remains uncertain. We provide a first estimate of the number and percentage of native and priority (according to EU directive) plant species within the N2K network. Using 1,223,017 plots from the European Vegetation Archive (EVA) we calculated the number and percentage of native and priority species: 1) in the data set, 2) within the N2K and 3) outside the N2K, both at the level of the entire EU, for each biogeographical region, country and combinations. To test for significant deviations from the overall pattern in the EU, we fitted generalised linear models (GLMs), regressing the percentage of species inside N2K against countries or biogeographical regions, accounting for sampling effort. We also tested whether protected areas host a higher-than-expected species richness given by means of species-area relationships. We demonstrate that the N2K network hosts more than 50% of the native vascular flora. Significant variations exist across countries and biogeographic regions, indicating that the N2K network is not equally effective across Europe. In contrast to native species, priority directive species were less represented inside N2K. Despite the limitations connected to the opportunistic data, we demonstrate that the N2K is effective but not sufficient to preserve the EU plant diversity. The enlargement of the N2K, scheduled by 2030, can provide a solution. We call for a design-based collection of plant diversity data to allow temporal monitoring of plant diversity across the EU.

Protecting or hiding: why not both? Strategies of woody plants against fire

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Species from fire-prone ecosystems usually rely on two key strategies to persist and survive fire: they either allocate more biomass below-ground or invest in protecting their above-ground inner tissues, both allowing them to resprout new branches after fire has consumed their biomass. Here we investigate: i) whether species can both escape by hiding buds below-ground and protect their above-ground structures instead of trading each strategy with one another, ii) how plants' post-fire responses are linked to these above- and below-ground strategies and, iii) how plants may persist by changing strategies depending on the vegetation type. We compared 24 Cerrado woody species, analysing their below-ground bud-bearing organs function (clonal spread or *in situ* persistence) in relation to their above-ground bark production, aerial bud protection, and their responses after fire. Species could display both above- (protecting) and below-ground (hiding) strategies. However, a clear division was found concerning how well species are protecting their aerial buds depending on their type of below-ground organs' specialisation: species spreading clonally better protected their above-ground stems and buds with thicker bark when compared to species persisting *in situ*. After fire, plants growing in woody savannas exposed to fires of low severity and frequency were more likely to resprout from above-ground buds, while in open savannas where fires are more intense and frequent, plants resprouted mostly from below-ground. These results show that Cerrado species can combine different fire-survival strategies capable of driving different post-fire responses depending on the fire regime, partly explaining woody community assembly across different savannas.

A special ecological island system - Danxia mountaintops

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Islands are a model system for studying species-area relationships, but the results are not fully applicable to terrestrial patches due to the absence of a surrounding adverse medium like water. We used the incompletely isolated mountaintops of the Danxia landform to reveal the species-area relationship in this high connectivity region. Danxia are characterised by flat tops and steep cliffs, forming semi-isolated independent hilltops. We investigated 20 hilltops, identified all the species and sampled the soil. The area and shape of the hilltops were obtained by unmanned aerial vehicle images, and the topographic complexity of the mountaintops were extracted from a Digital Elevation Model. Correlation analysis showed that the total species abundance and the richness of arbor species were significantly correlated with the area and shape of hilltops. With the exception of arbor, there was no correlation between other species and area, but there was a significant correlation with arbor richness. The results revealed that arbor richness dominated the diversity of other species, and was determined by area. We also explored the relationship between soil properties, microbial diversity and plant abundance in plant community construction through mixed linear model. This study provided guidance on diversity conservation and establishment of protected areas.

Assessment of different drought situations in alpine regions of Taiwan

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Climate change impacts encompass not only rising temperatures, but also alterations in hydrological conditions. In Taiwan, despite stable annual precipitation, there is a noticeable trend towards more pronounced dry and wet seasons. High-altitude regions present a challenging environment for plants due to factors such as low temperatures, strong winds, and poor soil nutrients. The extended dry season raises the likelihood of drought, intensifying the challenges faced by species in these high-altitude areas. Standardising hydrological conditions in high-altitude areas of Taiwan is crucial for evaluating environmental drought conditions. This study examined drought conditions from meteorological, ecological, and soil perspectives, applying the Standardised Precipitation Evapotranspiration Index (SPEI), Normalised Difference Vegetation Index (NDVI), and Soil Moisture Drought Index (SODI) as indicators. The data of this study were retrieved from satellite images, meteorological stations, and on-site soil moisture monitoring. Sampling plots were established in the three vegetation types in the alpine region of He-huan Mountain to monitor soil moisture and develop a relational model between SPEI, NDVI, and SODI. It is anticipated that lag effects and thresholds will be observed in these relationships. Furthermore, we aim to explore potential differences in water retention capacity between vegetation-covered areas and bare ground. This study aims to utilise easily accessible satellite data to accurately explain the hydrological condition and understand the hydroclimate of Taiwan, as well as its impact on high mountain vegetation in the future.

FloraVeg.EU – a new online database of European vegetation and flora

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FloraVeg.EU is a new online database providing basic information on European vegetation types, habitats and plant species. It provides public access to various datasets compiled within projects of the Vegetation Science Group at Masaryk University and the IAVS Working Group European Vegetation Survey. The database consists of three modules. (1) The *Species* module informs about characteristics of European vascular plant species, including ecological traits such as habitats and growth form, as well as leaf, flower, fruit, and seed traits. Additionally, it includes biogeographical and ecological information, environmental relationships, Ellenberg-type indicator values and disturbance indicator values, and relationships to vegetation and habitat types. (2) The *Vegetation* module includes the classes, orders and alliances according to the EuroVegChecklist, which are updated according to the decisions of the European Vegetation Classification Committee. Each of these vegetation types are characterised by country-based distribution maps and data on dominant life forms, phenology, soil properties, biogeographical features, successional status and degree of naturalness. A list of diagnostic species is also provided for each class. (3) The *Habitats* module includes terrestrial and freshwater habitats at the three highest hierarchical levels of the EUNIS classification. Each habitat is characterised by a brief description, a point-based distribution map, diagnostic, constant and dominant species, and a list of corresponding alliances. Individual species, vegetation types and habitats in these three modules are illustrated by >28,000 photographs. The *Download* section of FloraVeg.EU provides datasets in a spreadsheet format that can be used for further analyses.

The influence of winter fire on seedling recruitment in a heathy woodland

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Fire is an integral part of many landscapes globally. Fire seasonality is unique for each landscape and burning out of the historic fire season may have long-lasting impacts on vegetation. Climate change is creating hotter and drier conditions in fire-prone landscapes in Australia, and they are becoming more susceptible to catastrophic fires. To combat risk to people and property, land managers conduct prescribed burns, typically in autumn, to reduce fuel loads and decrease the intensity of bushfires. However, the window of opportunity to conduct prescribed burns safely is narrowing due to climate change. Therefore, conducting seasonal burns in cooler and wetter months is one potential option for land managers. We examined the effects of winter prescribed burns on seedling germination in a heathy woodland in southeast Australia where bushfires have historically burnt in summer. Vegetation and seedling surveys were conducted in spring 2022 at sites where prescribed burns were conducted in winter 2021. We classified sections at each of the sites into three treatments (burnt, patchy, unburnt). We found that the winter burns triggered germination for obligate seeding species, but at least six species were not present as seedlings and many species had a low abundance of seedlings. Prescribed burns in winter could be used as an effective tool to decrease the amount of fuel in the landscape, however the presence of some species could decline as a result. Further research is required into burning out of season and the effects on germination.

Can biodiversity assessment data contribute to vegetation classification and mapping programs?

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Broadscale vegetation classification and mapping are primary information resources used to assess biodiversity values in site-based impact assessment and land use change studies. In New South Wales, a large jurisdiction in eastern Australia, biodiversity conservation regulation mandates the collection of standardised vegetation survey data by private industry biodiversity assessment practitioners. In this talk, we examine the contribution data generated from these biodiversity assessment protocols have contributed to the development and ongoing improvements to the States vegetation classification and mapping information. We use the recent completion of a large plot-based vegetation classification in eastern New South Wales to investigate the contribution of private industry survey effort to both the development of the typology and the subsequent mapping. Only a small proportion of the accumulated plot data used for classification was sourced from private industry biodiversity assessment practitioners, but the data were frequently in areas not otherwise sampled. More importantly our findings overwhelmingly suggest that the results of private industry biodiversity assessments are rarely retained in the State government centralised biodiversity data repositories. This means that a potentially significant data resource is frequently overlooked and improvements to the classification and mapping may not be realised in those areas that are subject to highest development and land use pressures. We suggest improvements in data capture and data exchange procedures would significantly advance the contribution of private industry data to large scale vegetation classification and mapping efforts.

Comprehensive, ultra-high resolution forest models with terrestrial laser scanning: a continent-scale plot network

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The biodiversity and climate crises are the two greatest threats to stability on our planet. The majority of the Earth's species and their living biomass are found in the shade of trees, so adequately quantifying this vital realm is essential in order to gain the insights needed to face these challenges. We present a new approach to capturing the fundamental metrics to describe where this shade is, its extent, and which species - their volume, shape and mass - contribute to its elevation and support. We use terrestrial laser scanning (TLS) to generate comprehensive, geolocated and ultra-high resolution structural models of forests. ArborMeta has developed survey methodologies and custom point cloud processing software to capture and extract key metrics of woody biomass and biodiversity from TLS. We have established a network of hectare-sized plots in forest and woodland communities across the Australian continent, with data, analysis and modelling services to be accessible for monitoring, modelling, calibration and research purposes.

Garima Webrrd Jagun (Respect Fire Country): cultural burning and the role of Indigenous peoples in managing future Australia

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How does custodianship and reciprocity shape fire in cultural landscape? What can we learn for cultural fire? Country teaches us lore and provides all that we have, but this relationship needs to be reciprocal – we need to give back to and care for country. While country has a long time to create and recreate within evolving natural and cultural systems and will endure, many species including humans must adapt and evolve within these systems or will perish during disturbance and change. Now is the time for people to wake up from their own dream and learn to share in the dreaming of country. Many of our ancestors learnt to use fire to protect and heal country and now we must continue to do the same. Can all of us walk with Indigenous Australians on this journey, and can cultural fire play a role in reducing the threat of megafires under global warming?

Rapid urban greening using Miyawaki forests

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Miyawaki, or pocket, forests are becoming increasingly popular choices for urban greening and creation of biodiversity stepping-stones in our urban landscapes. The small size of Miyawaki forests enables them to be planted in any vacant pocket of land. As such, biodiversity havens can be created in corners of car parks, disused tennis courts or suburban back gardens. Native plant diversity in these forests and the fast rate of forest maturation enables rapid creation of habitat. This is an ideal option given the pressing need for climate change and biodiversity action, particularly in urban areas typically characterised by limited biodiversity. As part of a Miyawaki forest research and outreach program, seven Miyawaki forests have been planted to May 2023 in Perth and regional Western Australia. The survivorship and growth rate of plants is being recorded in these forests and compared with plantings using traditional methods for reforestation. Biodiversity and abundance of soil organisms in these forests and in nearby bushland have also been assessed using eDNA and soil respiration rates. Citizen scientist data, gathered by school children involved in the outreach program, have provided information on the organisms observed in the forests, as well as assessing a range of other forest attributes. Results indicate rapid growth of Miyawaki forests in the Australian context, and that these forests can be biodiversity havens and a valuable tool for bringing biodiversity into our cities.

NSW woody vegetation clearing monitoring and reporting

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The New South Wales (NSW) Department of Planning and Environment (DPE) has been capturing and reporting on annual woody vegetation change using remote sensing techniques since 2007, with data available from 1988 to present. Annual land clearing reporting and access to long term trends supports public debate on sustainability, development of environmental policy, and administration of existing vegetation legislation. The data created has been used in mapping and monitoring vegetation communities and native species habitats across NSW. Annual woody vegetation clearing data is captured using the Statewide Land and Tree Study, originally developed by the Queensland Department of Environment and Science with method refinement by the Joint Remote Sensing Research Program (JRSRP). DPE application and refinement of this program has included adapting the method from Landsat to SPOT and Sentinel imagery and combining it with non woody land clearing detection for annual reporting of all vegetation types. More recently, DPE has implemented a rapid vegetation clearing detection program using Sentinel imagery (developed by the JRSRP). This Early Change Monitoring program benefits from the rapid revisit time (approximately 5 days) to identify vegetation clearing and engage with landholders regarding potentially unauthorised clearing within weeks of its occurrence. This early intervention can minimise environmental impacts and reduce costs to both government and the individual.

Exclusion without encroachment: fire controls tropical savanna plant composition, diversity, and biomass independent of trees

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Theory regarding the fire-dependent nature of savannas tends to focus on how fire maintains herbaceous plant communities via control of trees. In this study we sought to determine if there are generalisable effects of fire on savanna communities that are not mediated by trees. At six sites in Brazil (N=6), spanning 5,200 km and encompassing large variations in vegetation types, edaphic conditions and climate, we sampled frequently burned (F) and fire-excluded (E) savannas (time since last fire ranging from 15 to 19 years), none of which had experienced forest expansion. In each site we set three transects with a total of 30 1 m^2 plots for sampling plant communities and 10 0.25 m^2 plots for biomass. Plant communities had significant shifts in composition due to fire exclusion. Fire promoted herbaceous plant diversity: local-scale species richness and within-site beta diversity were about 37% and 25% greater, respectively, in F versus E savannas. Fire-excluded savannas had a 2-fold greater biomass accumulation compared to F (mean 0.44 versus 0.77 kg/m^2), due to the dead biomass. Most (90%) of this accumulated fuel was attributable to grasses. As expected, shrub biomass was modestly (15%) higher due to fire exclusion, while contrary to our expectations we found no effect of fire exclusion on forb richness or biomass. In conclusion, our results reinforced that although edaphic factors, climate conditions, and tree-grass interactions influence aspects of tropical savanna plant communities, fire is clearly a key ecological driver that directly maintains herbaceous layer diversity.

sPlot 4.0: towards a truly global database for understanding vegetation spatiotemporal changes

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sPlot (v4.0) is the most comprehensive vegetation database in the world containing more than 2.5 million plot observations and 53 million species x observation records from 138 countries. To reduce the geographical distribution bias of the previous versions towards the Global North, we actively worked to promote the integration of researchers from underrepresented areas in this new release. Beside embracing more inclusive language during the call for contribution, we adapted our membership rules to better accommodate local cooperation agreements with databases with multiple contributors. We also improved the handling of missing spatial information by manually attributing coordinates (and associated uncertainty) based on the sampling locations provided by the contributors. In comparison to the previous release, the number of plots from the Global South increased by 41% (46,538 new plots summing up to a total of 158,151 plots). More importantly, the data was contributed mainly by local investigators: the number of custodians based in the Global South more than doubled (113% increase, 26 new contributors making up a total of 49). sPlot 4.0 is also a tool for investigating vegetation change due to new time-series data: it includes 264,246 observations of resurveyed plots from which one quarter (69,624 observations) comes from outside Europe. As a result, sPlot 4.0 opens great opportunities for global vegetation research by combining the macro and local scales: extensive geographical coverage with fine-grain data and on-ground insights from local researchers.

Does elevation influence thermal tolerance thresholds of alpine plants?

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In alpine environments, elevation functions as an extreme temperature gradient, along which alpine plants experience both extremes of heat and cold. Yet, few studies examine *both* upper and lower physiological thermal limits of alpine plants. Thermal tolerance is thought to reflect the ambient temperatures that plants experience. Thus, elevation gradients may explain intraspecific variation in thermal tolerance of alpine plants. We investigated heat and cold tolerance thresholds, using chlorophyll fluorometry, of ten alpine species growing *in situ* across three elevation gradients in the Australian alps. We collected genetic samples of each species to characterise population-level genetic differentiation across elevation. Local air and leaf temperatures of representative species were recorded during the field campaign. We found that cold tolerance thresholds decreased with increasing elevation, although the relationship was weak, while heat tolerance thresholds were not associated with elevation. Species was a consistent predictor of cold and heat tolerance. For all species, genetic differentiation was relatively low across target gradients showing no significant relationship between elevation and differentiation. We also observed decoupling of leaf temperature from air temperature, the extent of which varied among species at a single location. Without strong associations between elevation and thermal tolerance, our findings show that the thermal environment alpine plants experience and, in turn, its influence on thermal tolerance is more complex than elevation alone can predict. Furthermore, species-level variation in thermal tolerance and leaf temperature at a given elevation suggests microclimatic conditions may have a greater influence on alpine plant thermal tolerance than elevation.

Land-use patterns in mountain grasslands of Maramures and Bukovina regions (Carpathian Mountains)

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The Carpathian Mountains are renowned for their species-rich semi-natural grasslands, particularly in areas where traditional agriculture is maintained. In this study, we conducted investigations on grassland vegetation and management practices in eight Ukrainian and Romanian villages located in the Maramures and Bukovina regions. Our research aimed to address three main questions: i) Which regions and types of grasslands exhibit the highest plant diversity and how are they managed? ii) To what extent are historical (traditional) grassland management practices applied today? iii) Do political and ethnic affiliations impact recent land-use patterns and grassland phytodiversity? We randomly sampled six grassland parcels in each village and obtained information from farmers regarding recent and historical management practices. Romanian villages of Moldovița and Surdesti exhibited the highest plant diversity. Vascular plant richness was found to be highest in grazed meadows, while bryophyte richness was highest in pastures. Traditional land use was identified in most parcels studied in both Ukraine (78%) and Romania (80%). Despite substantial modifications to historical farming systems, practices such as spring and autumn grazing, manuring with farmyard dung, and application of hayseed for grassland regeneration are still being utilised. Most of these practices are widespread irrespective of political (Ukraine vs. Romania) and ethnic group (Hutsuls vs. Romanians) affiliations. Our study suggests that traditional farming practices play a crucial role in maintaining the phytodiversity of mountain grasslands in the central eastern Carpathians, and supporting local bio-cultural heritage would be vital in preserving this biodiversity for future generations. Financial support: APVV-0226, VEGA 02/0065/23, 09I03-03-V01-00018.

First robotic structural monitoring of EU forest habitats

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According to Directive 92/43/EEC of the European Council, each European Union country oversees periodic habitat monitoring in the Natura 2000 network. For the case of forest habitats this includes floristic and structural characterisation for the assessment of their functionality. This task is currently carried out only by trained human operators. The H2020 Project "Natural Intelligence for Robotic Monitoring of Habitats - NI " ("Research and Innovation boosting promising robotics applications") aims to develop quadruped robots able to move autonomously in the unstructured environment of forest habitats. We tested for the first time the efficiency and the accuracy of robotic structural monitoring compared with traditional field surveys inside selected stands of *Luzulo-Fagetum* beech forests (9110 Annex I Habitat). We measured tree diameter at breast height (DBH) on three circular plots of 200 m^2. At the completion of human monitoring, the robot scanned the same plots to create a 3D map using its Personal Laser Scanner. Individual tree locations and their DBHs were extracted from the derived point clouds and compared with field measurements. We obtained a tree detection rate of 98.15%. In terms of accuracy, the Root Mean Square Error of the DBH was between 11.25 and 5 cm, which is in line with literature. The regression model showed an R^2_{adj} of 0.69 ($p < 0.001$) between the measured and the extracted DBHs. In future, a human-robotic monitoring framework might represent an accurate support for those repetitive and time-consuming activities in habitat monitoring, offering a valuable benefit for biodiversity conservation.

The effects of clear-cutting on Mediterranean riparian plant diversity and composition

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Clear-cutting causes long-lasting changes in riparian biota of Mediterranean riparian forests. This work examined the patterns of modifications of riparian forests and studied their possible recovery from a clear-cutting event. A systematic vegetation survey of riparian forests was conducted along a Mediterranean river in central Italy. Plot placement was randomly stratified within 2 contiguous 20 m wide strips in 500 m long sectors. We classified clear-cutting events in plots by using an historical analysis of aerial photographs, categorizing them in three age classes: recent (< 10 years ago); intermediate (between 10 and 20 years ago); old or absent (> 20 years ago). We used ANOVA and PERMANOVA models to analyse the response of vegetation attributes to clear-cutting and strip position. Compared to old clear-cut areas, recent clear-cut areas showed a significant increase of alien species richness and abundance and a decrease of woody species richness. Significant compositional changes also occurred in areas with recent clear-cutting: nemoral species decreased and generalist, ruderal and alien species increased. Riparian forests of internal strips, rich in pioneer and hygrophilous species, are impacted by logging but seem to quickly recover thanks to their natural resilience to disturbances by flood. Contrarywise, clear-cutting events in the external strips did not affect any of the investigated vegetation attributes, possibly due to the effect of past anthropogenic disturbances and the dominance of *Robinia pseudoacacia*. Our results confirm the long-lasting effects on forest riparian communities of clear-cutting management practices, emphasising the fragility of Mediterranean river ecosystems.

Environmental heterogeneity driven plant diversity supports biodiversity conservation on small natural features

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Small natural features (SNFs), such as inselbergs, rocky outcrops and ancient burial mounds, can provide safe havens for plants of natural habitats in human-modified landscapes. SNFs with high topographical heterogeneity provide a unique opportunity for studying links between environmental heterogeneity (EH) and biodiversity. By studying steppic burial mounds covered with semi-natural dry grasslands, we evaluated the effect of EH components (topography, soil, microclimate) on plant biodiversity and vegetation composition. We designated 16 study sites in central and southern Europe, each containing mounds with five microsites (top, north-, east-, south- and west-facing slopes) and a plain grassland. We measured soil moisture, soil chemical properties, solar radiation, and microclimate, and recorded the cover of vascular plants. We found that topographical heterogeneity was associated with sharp differences in microclimate and soil properties. Besides the contrast between mild north-facing and harsh south-facing slopes, east- and west-facing slopes also sustained unique environmental combinations characterised by dynamic diurnal changes in air temperature and vapour pressure deficit. Various combinations of the EH components supported the formation of unique plant species compositions within the microsites, and the co-occurrence of species typical of contrasting habitat types within the small area of the mound. Steppe plants were typical of the mild microhabitats, while forest-steppe plants were typical of the harsh microhabitats. The largest species richness was present in the west-facing slopes characterised by large diurnal environmental changes. Our results suggest that SNFs with complex topography can harbour a high biodiversity and introduce a high level of EH to otherwise homogeneous plain landscapes.

The NSW State Vegetation Type Map (SVTM)

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The NSW State Vegetation Type Map (SVTM) represents the most complete and consistent information about the distribution of plant community types (PCTs) across New South Wales (NSW), benefitting landholders, planners, and local communities. Two types of PCT mapping are available: the SVTM extant map (showing distribution of types within the limits of present-day native vegetation cover); and the SVTM pre-clearing map (displaying the likely distribution of types prior to the loss of native vegetation cover). PCTs are the finest level of classification in the NSW vegetation classification hierarchy. They identify and describe recurring patterns of native plant species assemblages in relation to environmental conditions; that is, sets of species that commonly occur together in association with combinations of soil, temperature, moisture, and other factors. The NSW Department of Planning and Environment (DPE) has taken a systematic approach to mapping PCTs based on vegetation plot data. The SVTM methodology applies a hierarchical approach where groups of co-occurring species are successively delineated into smaller subsets at progressively finer spatial scales. Broad vegetation categories have been delineated using Aerial Photography Interpretation (API) and placed into Vegetation Photo Patterns (VPP) classes (e.g., wetlands, shrublands, rainforests). VPPs are based on the influence of large-scale environmental factors such as climate and geology. At finer levels, classification units become increasingly descriptive and are based on landform and topography (e.g., gullies, ridges, plateaus, depressions). PCTs were assigned at finer levels using machine learning and then checked by expert interpreters. The SVTM utilised the best available aerial (ADS40/80) and satellite (SPOT 5, SRTM, Landsat) imagery, a comprehensive collection of environmental variables, and existing vegetation mapping. It covers all of NSW and can be downloaded as a 5 m resolution raster. The SVTM was constructed from 100,000 vegetation plots, over 60 million polygons and 600 discrete species distribution models. All 800,000 square kilometres have been examined at between 1:10,000 and 1:15,000 by expert air photo interpreters. The SVTM represents the best available information on the extent of plant communities in NSW. It was designed to be easy to update as new information becomes available. The SVTM is readily accessible through the Sharing Environmental and Enabling Data (SEED) web portal and the mobile app Trees Near Me NSW.

Mapping the influence of seasonality in forb communities of the Cerrado

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Seasonality can affect the structure and composition of forb communities in tropical savannas. Forbs are affected by a well-defined contrast between dry and wet seasons, since some species may lose their above-ground biomass during the dry season, being present in the community only during wet seasons. Here, we used multivariate exploratory analysis (PCoA) to investigate changes in forb communities during seven years in the dry and wet seasons of open savannas of the Cerrado. Between 2016 and 2022, we compared three fire-excluded areas since 2011, sampling twice a year (in dry and wet season) in ten 1 m^2 subplots. Forb species were identified and had their cover estimated. We performed PCoA using cover data based on dissimilarity matrices (Bray-Curtis and Sorensen). Both PCoA analysis showed that forb communities differ between wet and dry seasons. Over time, the abundance of species in communities became less similar between dry and wet seasons. However, species composition did not differ. Our results suggest that in areas where fire is suppressed, the effect of seasonality on community composition increases over time, enhancing differences between abundance of species that already existed in wet and dry seasons.

Soil temperature and microtopography shape plant community dynamics along altitudinal gradients

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The changes of plant communities' composition over time are significantly influenced by a combination of local micro-abiotic factors and broad abiotic conditions. In high mountains, where habitat includes a vertical dimension, differences in microclimate are expected to be particularly pronounced. Soil temperature can vary noticeably over short distances. Until now, the relationship between soil temperature and plant community dynamics remains understudied. In this work, we propose a new approach to test the direct effect of soil temperature variations on changes in plant distribution and community structure. We focused on 84 nested plots (ranging from 2.25 cm² to 4 m²) collected in the Apennines (Italy) along an elevational gradient. A total of three temporal surveys were carried out every five years from 2006 onwards. Soil temperature was measured hourly using 40 dataloggers buried 10 cm below the soil surface for one year. Soil temperature data were than processed to estimate the snow cover length, the number of growing days and growing degrees days. Variation in plant communities was estimated considering several indices. We used linear mixed models to investigate the effect of soil temperature related variables on the patterns of community composition variation. The main results reveal that plots with the longest period of snow cover and with low values of growing degrees days have the highest change in species composition and increase in species richness. These results underscore the importance of soil variables and provide evidence that cryophilic areas are the most vulnerable to climate change.

Systematic monitoring shows the success of nature conservation management of wet grasslands

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Wet grasslands, with their high biodiversity, are a focal habitat of nature conservation in northern Germany. Once covering large areas in the lowlands, they have suffered from drainage, eutrophication and land use intensification and today occur exclusively in managed nature reserves. However, even in protected sites many threatened species are declining because of fragmentation and the pressure from surrounding agriculture. About 20 years ago, the nature conservation authorities of Bremen, northern Germany, initiated systematic monitoring of the protected wet grassland reserves in the region. Based on the concept of "indicative species groups" (ISG), permanent plots were established in eight sites, including 23 "sub-sites" and 189 plots. These were regularly monitored with vegetation analyses, mostly in 3 to 4 year intervals. The statistical analysis paid special attention to the number and proportions of vascular plant species belonging to different ISG. Ordinations and similarity coefficients revealed that species compositions in the eight sites were highly stable. Species richness likewise was constant. The number and proportions of species typical of wet grasslands were high and had increased over time, whereas species of intensively managed grasslands and disturbance indicators had decreased. The number of species typical of mesotrophic grasslands was low and did not show a systematic change. Most IUCN Red List species surprisingly increased in frequency, in contrast to trends observed outside the nature reserves. We conclude that systematic monitoring is costly, but very instructive for evaluation of the success of local management.

Recovery and management of southeast Queensland lowland subtropical rainforest after fire

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Large components of the Gondwana Rainforests World Heritage Area in southeast Queensland were affected by fires in late 2019, damaging critically endangered lowland subtropical rainforest, opening-up forest canopies, and allowing weeds to become established. These areas provide habitat for many listed flora species and listed communities, such as critically endangered lowland subtropical rainforest. Post-fire, there was significant evidence of natural regeneration, including both resprouting (basal, stem and root) and germination from seed (from established soil seed banks). These regeneration strategies raised questions about the capacity of rainforest and wet sclerophyll flora to deal with fire events of varying intensity: (1) Which rainforest and wet sclerophyll flora are regenerating post fire? (2) What are the mechanisms used by rainforest and wet sclerophyll flora to regenerate post fire? (3) Will most regenerating species fall into the Pioneer or Early Secondary categories? (4) Are there strategies that need to be considered (such as supplementary planting) when restoring fire-affected rainforest and wet sclerophyll vegetation communities? After the fires in Lamington National Park, we assessed how rainforest and wet sclerophyll forest species responded to wildfire. Ninety-three percent of surveyed species resprouted, 5% regenerated from seed, and 2% were killed outright. Furthermore, almost 50% of those species resprouting are successionally advanced Mature Phase species, providing compelling evidence of rainforest diversity, recovery, and resilience post fire. Although slow growing, and without the lateral branching structure evident in Pioneer species, their presence provides valuable assurance that large numbers of particular rainforest species were not lost to fire.

Consultant contributions to research: research contributions to consulting

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Consultant ecologists have a wealth of field experience and practical knowledge of species and ecosystems, built through days, months and years of recurrent surveys. Consultants also have a lot of data and despite best intentions are often torn between client requests, legislative requirements, constrictive timeframes and sometimes, confidentiality constraints. Research ecologists often have specialist equipment and skills in data analysis, genetics, breeding systems or ecosystem interactions. Researchers also have a hunger for data, and a desire to use research for practical and applied outcomes. In this session we will explore worked case studies of how, and why, research can support consulting as well as how consultants can use their data and skills to facilitate targeted and relevant research.

A bird's eye view: how consultants see their role in plant conservation

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Ecological consultants are a diverse group and in some ways represent the 'boots on the ground' of vegetation science, performing the everyday work of identifying vegetation types, assessing the impacts of development, and monitoring for change. When working toward the goals of clients with limited time and funding, it can be challenging to pursue the ideals that attracted many of us to the industry. A survey was conducted to determine how consultants see their roles going forward, including the impact of their contribution in conserving plants, the changing role of consultants, their adaptation to improvements in technology, and opportunities for the future. The results provide an insight into the values, motivations, strengths and challenges experienced by consultants in Australia. This discussion will provide some perspective to help harness the unique position of consultants in the world of plant conservation.

Connections across space and time with examples from NSW, Australia

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Ecological connectivity presents as the new age for perceiving and assessing the condition of native vegetation across regions. It resonates with quantum physics and indigenous knowledge's focus on relationships, rather than focusing on independent objects such as individual plants or patches. Ecological connectivity is a central aspiration for broadscale connectivity conservation, such as for the Great Eastern Ranges initiative. It is often considered within conservation planning generally, and for assessing natural capital. Yet how well is connectivity integrated into conservation practice? Up to now at least, ecological connectivity has been too often an aspiration of conservation plans but has lacked a coherent theory to integrate it into broader conservation concerns. Attempts to integrate connectivity with habitat amount and condition have been met with accounting inconsistencies, which we refer to as the problem of *inequitable integration*. Are ecological relationships necessarily a separate consideration in ecology, that sit aside from more tangible phenomenon, or could they be central to what we understand and value most in the natural environment? We present connectivity-centred theory and modelling results from applications in New South Wales, Australia. Our modelling spans species- and ecosystem-level assessment. We model across space and across time to consider uncertain climate futures. We *equitably* integrate spatial and temporal relationships with the condition of vegetation at fine scales to produce metrics of biodiversity status and trends, forecasts, and spatial prioritisation for conservation action.

Mid-term effects of seed bed preparation and early grazing on a seed transfer experiment for grassland restoration

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Semi-natural mountain grasslands are species rich and provide many ecosystem services, such as biomass production and carbon sequestration. Habitat destruction is threatening these ecosystems, highlighting the need for restoration. Seed transfer is increasingly used for restoration, but the appropriate methods to prepare the transfer and to manage the grassland afterwards are still under debate. Our study aims to test the effects soil preparation by harrowing and livestock grazing have on the establishment of transferred species and community trajectories towards the reference system. In a previous study, first-year seedling counts showed a positive effect from soil preparation and a negative effect from grazing on the recruitment of transferred species. We asked whether these first-year results translate into significant effects on plant cover over the following three years. The transferred species cover increased whereas their richness remained unchanged. We found a weak positive effect of harrowing on total cover whereas grazing had no effect. Soil preparation had a positive effect on transferred target species cover. The negative effect of grazing on first year transferred species recruitment turned into a positive effect in the fourth year. This effect was only apparent in the harrowed plots, resulting in a significant grazing-by-harrowing interaction. The similarity of the plant community to the reference increased from the first to the fourth year and was stronger in grazed and harrowed plots. In conclusion, the results confirmed the positive effect of soil preparation on restoration by seed transfer and demonstrated that initial grazing exclusion is not needed in the mountain grasslands of our study area.

How does climate structure rainforest trees into communities across the Australian subtropics?

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In coming decades, Australia's subtropical rainforests face serious challenges associated with ongoing climate change. Existing spatial climate gradients present excellent opportunities to rapidly expand understanding of how plant strategies, viewed as ensembles of relevant functional traits, are 'filtered' into distinct assemblages by climate. In this study, we combined comprehensive community composition and functional trait data with climatic and biogeographic variables to explain how rainforest trees are structured into communities across the Australian subtropics. Detailed tree surveys were conducted in rainforest sites distributed over a regional climate gradient of moisture availability that spanned 600 to 3,000 mm rainfall yr^{-1}. For each recorded species, we measured seven morphological traits that captured species' hydraulic and light-utilisation strategies. Principal component analysis of the seven functional traits across the entire species pool highlighted two major strategies: hydraulic strategies (PC1) and leaf economics (PC2). Using joint species distribution models (JSDM), we found that species' hydraulic strategies explained their abundance trends along the regional moisture gradient remarkably well. Predictably, species with efficient hydraulics increased in abundance along the moisture gradient and those with safe hydraulics declined in abundance. Drought-deciduous species were the only exception – these species declined along the moisture gradient despite having extremely efficient hydraulics. Thus, the JSDM was able to explain how vastly different drought resistance strategies can have similar abundance trends along climate gradients. Interestingly, species' leaf economics explained their abundance trends along a gradient of soil clay content (unrelated to moisture availability). Species with faster leaf economics increased in abundance as clay content increased, while those with slow leaf economics had weak or neutral abundance trends along the same gradient. Overall, our results reveal the eco-physiological basis for how climate has structured rainforest tree assemblages across Queensland's entire subtropical region.

Advancing the International Vegetation Classification as a terrestrial ecosystem typology

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The goal of the International Vegetation Classification (IVC) is to fully describe the diversity of the Earth's terrestrial ecosystems. The conceptual basis for the classification emphasises the link between patterns of vegetation growth form, structure and floristics and ecological and biogeographic drivers at multiple scales, from global biomes to local plant communities. The IVC remains unique among global terrestrial ecosystem typologies in providing units at all scales, with lower and mid-level units based on field surveys, plots, and mapping, whereas global levels are based on expert-based, synthetic interpretations of ecological and vegetation patterns. However, the typology was limited by lack of context with respect to the full range of earth's ecosystems (including freshwater, marine, subterranean realms) and the limit of growth forms and structure to readily observable features, thereby excluding important functional traits. The release of the IUCN Global Ecosystem Typology (GET), which has a conceptually robust, scalable, and spatially explicit functional approach for all of earth's ecosystems, presents an opportunity to revisit the conceptual basis of the IVC. Here we briefly summarise the IVC approach, introduce the main features of the GET, and then propose revisions to the IVC that build on the strengths of GET for terrestrial ecosystems. The outcome is a stronger ecological conceptual foundation for the IVC, enhanced engagement of the scientific community in its ongoing development, and a more robust application of the IVC and GET typology in the terrestrial realm for management, conservation and restoration.

Exploring the ecological niches of nitrogen-fixing plants in Europe

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Nitrogen-fixing plants are notable for their ability to acquire atmospheric nitrogen through microbial symbiosis. This enables them to escape nitrogen deficiency, one of the principal limitations of plant growth. Nitrogen fixers are also crucial for the nitrogen cycle in terrestrial ecosystems and thus their productivity and functioning. Although recognised as a functional trait, nitrogen fixation has been relatively less considered in functional plant ecology compared to, for example, leaf economic spectrum traits. Systematic research on the association between nitrogen fixation and environmental gradients on a large scale is lacking so far. We investigated the habitat preferences and ecological niches of nitrogen fixers in relation to climatic gradients across Europe. Using a dataset of 1,100,421 vegetation plots from the most comprehensive database recently available, the European Vegetation Archive (EVA), we defined the niches (habitat suitability models), geographical ranges and preferred habitat types of the whole functional group and specific species. We used climatic variables deriving from high-resolution climate models (CHELSA Bioclim+, ENVIREM) based on the plot geographical coordinates and Ellenberg-like indicator values deriving from plot vegetation composition to complement the approach. We revealed strong habitat preferences for nitrogen fixers, which are differentiated based on their association with the two types of nitrogen-fixing bacteria, *Frankia* and rhizobia. We detected distinct geographical patterns, with rhizobia-Nitrogen fixers generally being more common in southern Europe and *Frankia*-Nitrogen fixers in the colder climates of northern Europe. We found dependencies for both groups on environmental and climatic factors like nutrient availability and annual rainfall.

Plastid genomes of *Weinmannia* (Cunoniaceae), an extant Gondwanan lineage

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Cunoniaceae is one of the plant families that were present in the rainforest of Gondwana during the Eocene. *Weinmannia* L. (Cunoniaceae) is a diverse genus of trees and shrubs that are prominent members of Andean forests, where they play an important ecological role in water regulation and carbon fixation, as dominant woody plants of these ecosystems. Our understanding of their phylogeny and biogeography has had important advances in the genomics era, including Angiosperm353, 2b-RAD, and plastid phylogenomic. A recent rapid diversification event (<10 Ma) has taken place in the South American Andes: a radiation gave place to ~90 species associated with mountains and cloud forests. Here we present the first assembly and annotation of *Weinmannia* chloroplast genomes, important new information for the family. We worked with a monophyletic group of six species occurring in Eastern Cordillera of Colombia, and three *Weinmannia* samples from Bolivia. Our results show that morphologically and ecologically different species originated in recent speciation events, and these have great similarities in their plastid genomes. Next steps in this research include the use of Plastid Genome Annotator and further phylogenetic analyses with the most variable sequences of the chloroplast genome.

How adaptation could reshape forest structure and traits in a +3deg world

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Increasing atmospheric CO_2 and increasing temperatures both promise to reshape global forests. In a +3deg world, high atmospheric CO_2 should lead to a greening of global ecosystems as photosynthesis becomes more efficient. On the other hand, temperature extremes may increase mortality events due to increased frequency of fire or drought.Combined, these two forces will alter the selective landscape of forests (i.e. the traits that are favoured through natural processes) leading to shifts in forest composition and structure. However, the eco-evolutionary consequences of such changes are currently poorly understood. Using a process-based stand model `plant`, we estimate the magnitude and direction of likely shifts in traits and forest structure under alternative climate change scenarios. We show how the additional leaf area associated with global greening enhances competition, thereby escalating competitive arms races for rapid growth and large size. By contrast, we find that increased mortality selects for shorter vegetation that matures earlier. Finally, we consider how this new vegetation might be assembled, whether that be from existing species, or through the evolution of new high CO_2 specialists.

Prescribed fires and wildfires have complimentary effects on the regeneration of tropical open savannas

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Although fire is an important driver in tropical open ecosystems, changes in fire regime can negatively affect plant communities. Fire exclusion leads to increases in fuel load, thus increasing fire risk and wildfire occurrences. Prescribed fires are used as a management tool in tropical savannas both to avoid wildfires and to maintain pyro-biodiversity. Wildfires are thus considered detrimental to biodiversity in comparison to prescribed fires. We evaluated the effects of wildfire (W) and prescribed fires (PF) at the end of the dry season in open savannas of the Cerrado. Before fires, we sampled vegetation (cover and height in 1 m^2 subplots, 10 subplots/plot, total of four plots/treatment) and biomass (8x0.25 m^2 samples per plot). Prescribed fires were performed in September (50x50 m plots) and a wildfire occurred one week after, burning neighboring plots. We resampled vegetation and biomass in the first rainy season after fires (January). Although no differences were observed in plant richness and cover of grasses, cover of shrubs and dead biomass tended to be higher in the PF treatment. However, forb and bare soil cover was higher at W plots. Given the widespread threat of invasive grasses, the higher amount of bare soil in W plots can be an opportunity for the establishment of such species. However, we show that forbs benefited from more severe/intense fires than shrubs and grasses and thus, a mosaic of different types of fire would be more advantageous in tropical savanna to maintain plant diversity and function.

Assessing morphological leaf traits, and hydraulic vulnerability in *Eucalyptus*-species across climatic gradients

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Species' adaption to increasing climate change-induced aridity is vital for their survival. However, few studies examine leaf vulnerability expression in *Eucalyptus* species from different climatic environments. We investigated Specific Leaf Area (SLA), Huber Value (HV), and leaf vulnerability (P50 = 50% loss of conductance) using psychrometers and cameras to capture real-time leaf embolisms in three *Eucalyptus* species from the field and arboretum to determine whether genetics, phenotypic plasticity, or their combination, were driving trait expression. For field-collected species, there was a significant difference between *E. polybractea* (dry) and *E. delegatensis* (wet) in all measured traits, whereas no difference was found between *E. delegatensis* and *E. obliqua* (mesic). Significant differences occurred in SLA ($p<0.05$) between field and arboretum trait expression for all three species. No significant difference between field and arboretum was observed for P50 in *E. obliqua* and HV in *E. delegatensis*, suggesting that phenotypic plasticity was not influencing P50 in *E. obliqua* and HV in *E. delegatensis*. The influence of species genetics was evaluated by comparing trait expression measured previously in the arboretum. No trait differences occurred among all three arboretum species for SLA and HV. However, there were significant differences in P50, with *E. obliqua* expressing the highest P50 (most vulnerable to embolism) and *E. polybractea* being the most embolism resistant. This suggests that SLA and HV are mainly determined by phenotypic plasticity, and P50 is determined through both genetics and phenotypic plasticity, though this is not uniform across the genus. The results are useful when determining which *Eucalyptus* species can adapt to future climate-change conditions.

One hundred years of vegetation changes in temperate mountain forests

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Global changes involve several factors such as climate warming, increased nitrogen deposition, and changes in land cover. Over the decades, researchers have made significant efforts to study the impact of environmental changes on forest ecosystems using permanent or quasi-permanent plots. Most studies, however, analyse vegetation changes over several decades. In this study, we took advantage of a unique opportunity to resurvey vegetation research conducted a hundred years ago in the Tatra Mountains (Poland, central Europe). The aim was to assess the impact of various global change factors on forest vegetation. To analyse the changes in species optima along the elevation gradient, we used the Huisman-Olff-Fresco models based on five different response curves. Mean indicator values by a group based on Ecological Indicator Values for Europe (EIVE) were used to characterise changes in plant niche dimensions and evaluated by one-way ANOVA with a modified permutation test. The results show significant changes in vegetation in the study area over the last century, with species showing different trends in changes in elevational optima, including upward, downward, or no trend. Species showing a downward shift were typical of the fertile lower-montane beech forest, while species typical of spruce forest growing on acid soils and occupying mainly higher-montane forest showed the opposite trend (upward shift). Overall, the detected patterns can be better explained by past land use and naturalization of forests through decades of protection than by climate change.

Do vegetation classification systems capture long-term changes?

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Developing “expert classifications” have served as a baseline to assess shifts in vegetation over time and have aided in the optimization of conservation and management efforts, albeit mostly at small geographic scales. Over the past couple of decades, there has been a push towards integrating the data from these studies into a classification that represents a broad geographic area (e.g. United States National Vegetation Classification (USNVC)). Given the effort that goes into their development, it is important that these large-scale classification systems are able to account for vegetation dynamics over the long term. Our objective is to quantitatively assess the robustness of the USNCV. Specifically, in a supervised classification methodology, we use clustering methods to test how well current USNVC units agree with numerical solutions and how well existing units represent new and increasingly different data points. For our analysis, we used three vegetation data sets that each span several decades: eastern deciduous forest in North Carolina (1977-2009), Chihuahua Desert Grassland in Texas (1981-2014), and montane and subalpine forests in Colorado (1972-2012). Cluster and USNVC groupings resulted in similar noise levels, indicating similar robustness of both approaches when presented with new data, and larger datasets with non-random sampling locations performed better than small data sets with random sampling locations (up to 76% noise). Our results indicate that the robustness of current classification systems should be assessed but needs to be carefully evaluated depending on the data on which a vegetation unit is based and how quickly vegetation dynamics occur.

(Re)making vegetation in the 22nd century: drivers of global vegetation composition in a rapidly changing biosphere

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Humankind is asking a lot of vegetation over the next century, and beyond. Vegetation is viewed as one of the primary ways in which we can draw down carbon dioxide from the atmosphere and increase the terrestrial carbon sink. This mitigation measure – alongside the carbon which can be sequestered in soils – is central to climate change action efforts globally. We also expect that the many services that vegetation provides to people will continue to be maintained. Within this expectation is also embedded the idea that vegetation will continue to provide habitat for broader biodiversity, including the increasing numbers of imperilled and threatened species across the world. Native vegetation that remains is expected to continue to regenerate under increasing levels of disturbance. We anticipate that plants will, under increased disturbance and changed climate regimes, be able to provide the raw materials for what is increasingly being termed 'nature repair' – the quest to restore, reafforest, or simply to 're-make' vegetation. Plant-based nature repair through practices such as tree-planting is seen as a panacea that connects aspirations for climate action, biodiversity stewardship and poverty alleviation, but this is a highly problematic solution when undertaken without integrity. Finally, vegetation is often at the centre of our approaches for undertaking the meaningful and overdue work of reconciliation with Indigenous people and decolonialising of research approaches. Yet, there are hard limits on the potential for vegetation to deliver on these human aspirations. These limits are set by both the biophysical environment and the biology of species and need to be factored into the framing of 'nature repair' and restoration goals to minimize the risk of over-promising and under-delivering. In this talk, I will critically examine our capacity to repair nature to meet the dual needs of carbon capture and biodiversity stewardship, and to protect against overexploitation and loss of plant species and the homogenisation of global vegetation.

NSW Biodiversity Conservation Trust – investing in private land conservation

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The Biodiversity Conservation Trust's (BCT's) purpose is partnering with landholders to enhance and conserve biodiversity across New South Wales, Australia. Our vision is for vibrant private land conservation areas protecting our unique and diverse plants and animals. We are managing over 2,200 Private Land Conservation agreements with landholders across more than 2 million hectares in New South Wales. These areas have many unique landscapes, threatened ecosystems and habitats for our threatened native plant and animal species that are now protected and being managed by private landholders for conservation. During this session we will share with you: (1) What is private land conservation in New South Wales and how it contributes to international and national targets for protected areas and global biodiversity protection and management; (2) The different types of mechanisms available through the BCT for landholders to protect and manage native vegetation and biodiversity on their property; (3) BCT's new four-year plan for *Investing in Private Land Conservation – NSW Biodiversity Conservation Trust Conservation Management Program 2023-2027* and the science underpinning the investment priorities.

Medicinal plants for metabolic and nutritional disorders among some local communities in Iran

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Medicinal plants have been used for centuries in Iran and remain highly interesting, but their uses are poorly documented. With urbanisation and out-migration, preserving this knowledge is crucial. This study aimed to document the use of medicinal plants for treating metabolic and nutritional disorders in Larestan, Gerash, and Lamerd counties of southern Iran. Rural communities have a significant understanding of plant use, but traditional plants face increased threat from climate change. A total of 200 informants from three tribes were interviewed in 27 local communities. Ethnobotanical data, including local names, parts used, preparation methods, side effects, and conservation status, were collected. The data were analysed using the ethnobotanyR package in R. Plant identification was confirmed by reference books. To identify novel medicinal uses, the results were compared to authentic written sources. A total of 50 plant species from 22 families were used to treat four disorders. The major growth form was herbs, with the predominant family being Lamiaceae. The most commonly used plant parts were leaves. The leading method of preparation was decoction. Approximately 74% of the plant materials were wild-sourced. *Citrullus colocynthis* (L.) Schrad. was the most cited medicinal plant (UR=98). The informant consensus factor (ICF) was highest for diabetes, followed by lipid disorder, dehydration, obesity, and weight loss. Fidelity levels varied from 7.14% to 100% for different plants. Recording the plant utilisation by indigenous people will support sustainable practices and facilitate pharmacological research.

Taking a functional approach: revising Australia's National Connectivity Index

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Well-connected habitat facilitates ecological processes, such as foraging, dispersal and migration. Yet, land-clearing and degradation have led to widespread loss and fragmentation of native vegetation, and are primary causes of global biodiversity decline. To guide better conservation decisions, reliable information is required on habitat connectivity and fragmentation across Australia. We present the newly revised National Connectivity Index (NCI 2.0) that couples remote-sensing based ecosystem condition data with landscape-scale ecological connectivity modelling. The index is calculated using the neighbourhood habitat area approach that applies principles from landscape ecology and metapopulation ecology to integrate ecosystem condition data with measures of functional connectivity. The primary spatial input is the 250 m resolution Habitat Condition Assessment System v2.1 (2001–2018) grid, which is used to estimate the condition-weighted connectivity of each cell to its surrounding neighbourhood. To account for biological processes operating across a range of ecological scales, functional connectivity is measured at six spatial scales (250 m–8,000 m). The revision of the National Connectivity Index provides the most up-to-date assessment of landscape-level habitat connectivity at a national scale. It is non-specific to individual species or habitat types, enabling it to represent Australia's biodiversity across biological scales and ecological systems, as required by a national indicator. The index can be used for reporting on status and trends in landscape connectivity, and alongside habitat extent and condition in biodiversity assessment and conservation planning.

NCI 2.0:
http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B0C034993-30A4-43D8-B9B2-7565A7B768D4%7D

Owl-mediated diploendozoochorous seed dispersal increases dispersal distance and supports seedling establishment

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Seed dispersal is an essential process contributing to the maintenance of plant populations. Zoochory is a widespread way of plant dispersal in every terrestrial ecosystem that can ensure the long-distance dispersal of seeds. Secondary seed dispersal (SSD) by far-ranging raptors is a special type of zoochory, which might have a major role in colonisation of new habitats. We used the barn owl (*Tyto alba*) as a model species to test the effectivity and seasonality of SSD in open semi-natural landscapes. We collected 582 pellets from six sites in east Hungary throughout one year. We identified prey items in the pellets and determined the viable seed content of the pellets by germination experiments. We found that herbivorous common vole (*Microtus arvalis*) was the most abundant prey item through which most of the seeds spread, but the highest number of viable seeds was found in a pellet with field mice (*Apodemus* sp.) remains only. Owls dispersed the seeds of generalist and disturbance-tolerant plants, indicating the habitat type where small mammals occur abundantly. In another experiment we tested the effect of the pellet material on the seedling survival and found that prey remains enhanced establishment of seedlings. Our study suggests that SSD by barn owl is an occasional but important event in long-distance seed dispersal. Since the studied owl species uses several habitat types and has larger mobility than rodents, the revealed dispersal mechanism can considerably increase seed dispersal distance and seed exchange between habitat types.

Monitoring vegetation with remote sensing: research and developments

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Monitoring of vegetation metrics across New South Wales (NSW) and Queensland (QLD) continues to evolve along with technological advances. This has seen a trend of higher spatial and temporal resolution remotely sensed datasets, improving the frequency of observations as well as the accuracy and repeatability of measurements. Notably, advances in ground based, UAV (unmanned aerial vehicle) and airborne LiDAR (Light Detection And Ranging) has improved our ability to monitor change in vegetation metrics. This includes estimates of foliage projective cover, tree density, stem volume and the vertical distribution of plant material. However, while the ground based and aerial LiDAR systems can provide detailed measurements of vegetation structure at a site and regional scale, there is a requirement for statewide mapping of the extent and change in vegetation cover extent at least annually to support policy decisions. The current mapping of statewide foliage projective cover (FPC) metrics in NSW is derived from Landsat and SPOT satellite optical imagery calibrated with site measurements that have greater error and repeatability issues than newer LiDAR techniques. The availability of suitable airborne laser scanner data over many areas in NSW and QLD has enabled the development of a new LiDAR calibrated Sentinel 2 FPC product which provides much more detail than the existing products. In this presentation, I will provide an update on current research activities and challenges encountered with the objective of improving statewide vegetation mapping products.

Five years of offsetting native vegetation: risks, uncertainties and challenges for no-net-loss

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New South Wales has one of the oldest and most comprehensive biodiversity offsets schemes in the world. The current version implements a process called the Biodiversity Assessment Method (BAM) to assess vegetation condition, development impacts and the biodiversity gains from offset activities. It is implemented via an online calculator (the "BAM-C") that uses data obtained from plot-based field assessment to calculate the credits required for development or the credits generated by offset actions. Here, we analyse 5 years of the BAM-C data between 2017-2023 comprising 1,737 development and offset assessments in various stages of completion. We examine how vegetation across New South Wales is potentially being impacted by development and offsetting, comparing the condition, area and types of vegetation involved in developments and offsets. Within the BAM, biodiversity gains can result from avoiding losses, management to encourage the likelihood of natural regeneration, and active restoration. Unlike many offset schemes, we find that there is heavy reliance on achieving no net loss through encouraging natural regeneration of moderate condition habitats via management of threats rather than avoiding losses by protecting high quality habitats. As development and offset credits are not explicitly linked in the BAM-C data, we conduct a simulation experiment to determine the effective offset-development area ratio distribution (i.e., the area offset per unit of development). We conclude by discussing the extent to which no net loss of biodiversity may be achieved, and the primary uncertainties determining this.

Utilising vegetation types for conservation planning, management and monitoring: a case study of bush heritage

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Conservation organisations face the daunting task of effectively managing and monitoring vast areas to preserve biodiversity and other important values. To address this challenge, Bush Heritage has implemented a systematic approach that leverages vegetation types as a fundamental driver for conservation planning and monitoring efforts. Here we present a case study that highlights the successful integration of vegetation types in Bush Heritage's adaptive management approach based on the Conservation Open Standards. Vegetation classifications serve as essential building blocks for understanding ecological patterns and functions, identifying priority areas, and implementing targeted conservation actions. It allows Bush Heritage to gain a comprehensive understanding of biodiversity, habitat quality, and ecological processes across their conservation estate. This information serves as a basis for developing tailored management plans that align with the specific needs and requirements of each vegetation type. Moreover, vegetation types play a crucial role in the monitoring and evaluation of conservation initiatives. Through regular and systematic monitoring of vegetation integrity, Bush Heritage assesses the effectiveness of its management interventions and adapts strategies as needed. By tracking changes in vegetation composition, structure, and function we can detect early warning signs of ecological degradation or successful recovery. New work is leveraging the IUCN Global Ecosystem Typology and use of conceptual models around ecosystem function to improve how we understand ecosystem functionality and identify effective indicators. Finally, we will discuss how the integration of vegetation types with conservation planning also enhances collaboration and knowledge sharing among various stakeholders.

Resilience through soil seedbanks in coastal freshwater wetlands of subtropical Australia

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Freshwater wetland ecosystems are important but understudied in coastal landscapes and will be significantly impacted by projected climate change. Soil seed banks provide insight into disturbance regimes, past vegetation and potential responses to projected changes. We investigated the role of soil seed banks in supporting vegetation resilience for coastal freshwater wetlands in southeast Queensland, Australia, and explore possible change pathways given the relationship between soil seed bank composition and the standing vegetation communities. We surveyed standing vegetation and assessed soil seed bank samples from 60 wooded coastal freshwater wetland sites through a germination experiment. Soil seed bank assemblages were dominated by forbs and sedges, but composition was variable throughout the study region. Latitudinal and land use (urban-rural) gradients explained some variation in soil seed bank composition. Soil moisture and groundwater dependence were also drivers of species distributions, particularly for freshwater wetland species. Similarity of soil seed banks to standing vegetation was low and species present in both extant and soil seed bank assemblages were commonly native wetland taxa. Our results suggest that projected climate changes could induce four scenarios for vegetation assemblage changes for southeast Queensland including: 1) expansion of weed communities, 2) expansion of saltmarsh communities, 3) maintenance and expansion of wetland/terrestrial species. However, a fourth scenario of transformation to an unvegetated open water zone is possible where changing conditions will reduce germination and regeneration for many species. These diverse vegetation futures highlight the vulnerability of coastal freshwater wetlands and the need for research and management interventions to maintain their biodiversity and ecosystem services.

Comparative analysis of factors influencing visitor numbers in 20 Estonian nature trails

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The popularity of nature tourism is increasing visitation to nature trails. Visitor numbers are affected by various factors that a trail´s infrastructure or natural environment offers. Therefore, it is relevant to know which factors are influencing visitor numbers in order to manage the trails more effectively. The purpose of our study was to make a quantitative comparison of which nature trails factors are best correlated with visitor numbers on 20 nature trails in Estonia. Data was collected between May and August 2019, and visitor numbers data were requested from the State Forest Management Center. A model of factors was constructed in two steps: first a correlation matrix comprising all factors, then a generalised linear model for comparing the relative effect of the factors. Significant correlations were found between visitor numbers and distance to the nearest county center, nearest possibility for catering, nearest bus stop, number of web and application visits, number of different surface types, number of toilets on the trail, trail species pool, and accessibility by car. Knowledge of those factors influencing nature trail visitor numbers is helping to create attractive visitor areas where the location of the infrastructure is well-considered. This can reduce or prevent problems caused by nature tourism in nature trails through more science-based managing. The importance of this study lies in the methodologically uniform assessment of both natural and anthropogenic factors influencing trail visitor numbers across a whole cultural area.

Miyawaki mini forests and community approaches to rapid urban greening

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The original Miyawaki Method was an approach to establishing mini forests in post-industrial landscapes. This approach has been developed and adapted for use by communities around the world in many different cultural contexts. Each of the different communities and community activists have adapted the method to suit their local objectives and conditions. Over the past decade, urban forests based on the Miyawaki concept have become increasingly popular in various cities around the world to help address diverse objectives including creating biodiverse ecosystem, capturing more carbon and in the context of the current climate change these are considered to be vital in tackling these issues. This paper considers and compares different approaches to implementing mini forests. Five case studies from Europe, India, Australia, and Japan were used to understand different community governance and implementation models such as public, private, community and partnerships, supported by literature, and the efficiency level of each discussed. There are some common lessons to be learned in establishing and adapting the Miyawaki Method for local contexts. Furthermore, the power and significance of the method has been deepened by its various cultural adaptations to local community contexts and environments. Additionally, it can be argued/ discussed that there is an increasing role of design of the mini forests to address pressing climatic and social challenges and to develop better community connections with nature in cities around the world.

Do niche shifts along climatic gradients depend on adaptation to soil conditions?

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Plant niches vary along spatial gradients and understanding the mechanisms behind this variation is crucial for predicting the effects of environmental change. In this study we test the hypothesis that the changes in edaphic niches of plant species along a macroclimatic gradient are dependent on the adaptations to soil conditions. We used GAMMs to model the effect of macroclimate on the pH and nutrient niches of forest plants based on 7,000 plots representing forests all over Sweden. Niche widths and optima were then calculated based on these models and analysed for trends along the climatic gradient. Data from GBIF were used to calculate climatic indicators for the species. These indicators, together with indicator values for climate and edaphic conditions, were used to test whether changes in species niches along the climatic gradients depend on adaptations to these conditions. We found that many species showed changes in niche widths while their optima did not change along the gradient. Out of the 44 species, the pH niche width of 18 species increased with increasing temperature, while the niche width of 19 species increased with decreasing temperature. These two groups did not differ in their indicator values of edaphic conditions while there were clear differences in several climatic indicators. The distributions of species with decreasing pH niche width towards a colder climate had, for example, higher mean temperatures than increasing species. The indicator values for soil conditions did not differ between the groups and there was thus no support for our hypothesis.

A possible new species of eucalypt – *Eucalyptus* sp. Bassendean

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Eucalyptus sp. Bassendean is a potential new species of eucalypt with limited distribution between Bundarra and Tingha in New South Wales and on land of significance to the local Mooki and Bassendean Aboriginal people. Field studies and spatial data have been used to determine the distribution, landscape context and ecological characteristics of the species, and samples and molecular analysis used to describe its morphology and phylogenetic classification. The intent of the study was to determine whether the eucalypt is a new species or a disjunct population of an existing species, to place the species in its local context, understand its ecology and to prepare a draft threatened species listing under the New South Wales *Biodiversity and Conservation Act 2016.*

Up, down, and around: where will alpine species go with climate change?

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Alpine species are at the edge of their upper distribution, with those species on the tops of mountain summits seemingly with nowhere to go under a warming climate. However, alpine environments are the product of their slope, aspect and relative elevation, which creates steep climatic gradients at small spatial scales, resulting in mosaics of thermal habitats. This may create refugia from changing climates. Due to this microclimatic complexity, course climate weather data is unable to predict the potential distribution of alpine species in a changing climate. In order to understand future alpine community assembly, we must account for microclimatic conditions and alpine species' spatial distribution at small spatial scales. Here, we aimed to characterise the extent to which meso-topography affects vegetation structure and composition, and the turnover of species on 14 alpine summits in Victoria over 18 years. Warmer aspects, those that experience high solar radiation and are sheltered from prevailing winds, favoured a higher cover of shrubs and facilitate more frequent immigration. By contrast, cooler aspects maintain a higher cover of alpine endemic species. These results show that topography may influence the persistence of alpine specialists at their range/altitudinal limits and the rate and direction of change and dynamics of thermophilisation.

Bringing the vulnerable alpine Baw Baw Berry into cultivation

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The Baw-Baw Berry, *Wittsteinia vacciniacea*, is a vulnerable evergreen trailing shrub dating back to ancient times before Gondwanaland separated. *Wittsteinia vacciniacea* is the only species of the genus to occur in Australia, and one of five genera in the family, Alseuosmiaceae. The Baw-Baw Berry is restricted to just a few mountainous populations within Victoria. The fragrant flowers are attractive pendent yellow-red bells, and the globose fruit a greenish-red berry with persistent attractive calyx lobes. It is the combination of the trailing habit and floral features that makes this species an ideal candidate for amenity horticulture. We collected plant material from four of the five known locations in Victoria and propagated it using +/- Clonex® gel and either peat plugs or a perlite/vermiculite mix +/- Clonex®. Greater root development was achieved using the peat plugs and Clonex® was not necessary to ensure root strike. Seed was collected from Mount Baw Baw, which supports the largest population. Preliminary work on fresh seed indicated high fill rate, determined by x-ray imagery, and a reasonable germination response at 20/15°C with a 12/12-hour photoperiod. We explored the germination niche using a thermogradient plate to determine the optimal temperature range. Select plants have been incorporated into the Royal Botanic Gardens Victoria Living Collection, as part of a broader ex situ conservation strategy. This species appears suitable to a range of horticultural scenarios so popularising this species may ensure its future survival beyond its current refugia.

Taxonomical and functional changes in dry grassland vegetation after 30 years

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Dry grasslands on porphyry outcrops in central Germany are part of the Natura 2000 habitat network and extremely rich in plant species. Yet they have suffered from increasingly frequent drought events, variation in grazing management and intensification of agricultural use of the surrounding landscape. To explore how plant diversity has changed in the last decades we resurveyed 120 plots and analysed taxonomic and functional changes (species richness, community composition, community-weighted mean traits) and related micro-topography and soil variables to changes observed between the vegetation surveys. On average, we found increased species richness with lower mean vegetation cover and considerable shifts in species composition, brought about by the increased number of therophytes. Trait composition shifted in flowering phenology, ecological status and reproduction type, benefitting early bloomers, generalists and seed dispersal, while locally restricted grassland specialists decreased. Changes at landscape scale were mainly related to habitat area, as community composition was less affected on larger outcrops. In contrast, local scale changes were more related to micro-topography and soil characteristics, pointing to the importance of micro-site conditions on mitigating large-scale impacts. Climate change has significantly affected the composition of grassland communities on porphyry outcrops in central Germany. While dispersal of species with certain characteristics seems to be promoted by the phenological shifts, the spread of rare characteristic grassland species seems to be impeded. This resulted in maintenance of plant diversity at local scale but declines at landscape scale. These findings highlight the importance of biodiversity change assessments at different spatial scales.

Extraction of vegetation structure metrics using LiDAR

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The ability to capture LiDAR data from a range of platforms including airborne, unmanned aerial vehicles (UAV), and terrestrial systems has advanced significantly over the last few years. The integration of multiple sources of LiDAR data has enabled the development of both advanced visualisation techniques as well as the extraction of high precision vegetation structural metrics. The ability to calculate plant stem metrics across all heights in a vegetation patch allows the creation of unique profiles for different vegetation types, along with precise metrics from specific heights in the under, mid and over storey. Complementary segmentation of point clouds into individual plant canopies facilitates the extraction of metrics for individual plants, such as canopy volume and openness, height and general canopy dimensions. Recent advances in the use of LiDAR to capture, visualise and extract vegetation structural metrics are presented.

Warming-induced changes in subalpine grassland botanical composition have ecosystem-level consequences

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The subalpine grasslands of south-eastern Australia are species-rich plant communities that support large and diverse faunal assemblages totally dependent upon their continuation. These grassy subalpine ecosystems have great economic as well as ecological value and are vital aesthetic components of the high-country habitat. What is perhaps less widely recognised is that these systems are important contributors to our economic prosperity because of their role in capturing, storing, filtering and releasing vast quantities of water. This role in the hydrological cycle is strongly dependent upon the peaty nature of the soil underlying highland grasslands. These peaty soils are threatened by climate change and land management practices, endangering these ecosystems themselves but also having enormous ramifications for ecosystems, settlements and industries downstream and downhill. Our experimental research from Tasmania over the past decade has revealed that warming by 2°C alters botanical composition in these grasslands, increasing grass cover at the expense of the hyper-diverse forb community. We have also found that the same warming treatment increases the liberation of carbon dioxide from the peaty soil in these grasslands. In this talk, I will provide evidence that this acceleration of carbon efflux from these grasslands is due to the combination of direct and indirect effects related to the changes in plant community composition. Thus, changes in plant community composition have the potential to exacerbate climate-induced changes in key ecosystem processes in this system.

Great Eastern Ranges initiative and ‘the art of connecting’

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It is now well established in science, policy and global biodiversity targets that the challenges facing nature conservation and other natural resource management demands ecosystem restoration at scales that extend beyond traditional scales of practice. Making progress toward achieving meaningful results requires interventions that transcend unnecessary barriers of land tenure, and that aggregate across entire landforms and regions. Such efforts involve a voluntary mix of opportunistic and intentional actions performed by various actors within the context of higher-level goals. Failure to ensure adequate coordination within and amongst contributors risks the potential for effort that falls short of, or are mismatched with, what is needed for a coherent and meaningful result. The Great Eastern Ranges (GER) initiative was created as a direct response to reverse the impact of habitat destruction and loss of connectivity from habitat degradation and fragmentation, and to build resilience to climate change by bringing people together to reconnect our natural world – putting people at the heart of the solution and recognising that active management is required. GER uses a connectivity conservation approach to the challenge, engaging local landholders and other community members in place-based, grassroots-driven efforts across land tenures and boundaries that meet their local needs and priorities. Along with similar initiatives elsewhere in Australia, such as Gondwana Link in Western Australia, GER can clearly demonstrate how collaborative, cross-tenure connectivity conservation is uniquely able to leverage established relationships, communications channels and practitioner networks of member organisations, enabling the practical and applied translation of national restoration targets into tangible results.

Seed germination strategies in fire-prone sub-alpine flora

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Australia's south-eastern sub-alpine regions were severely impacted by the 2019/2020 bushfires, including Namadgi National Park in the Australian Capital Territory and adjacent alpine National Parks in New South Wales and Victoria. Some of the plant species most affected by the fires occupy seemingly narrow ranges and/or are poorly known, generating interest in their conservation and ecology. In particular, knowledge of the post-fire recruitment potential of sub-alpine species is lacking. A full factorial experiment investigated seed germination response to fire cues (smoke chemicals), post-fire disturbance (light/dark) and gibberellic acid (GA_3) of nine species collected from southeast Australian sub-alpine communities: *Damperia fusca* (Goodeniaceae), *Epacris petrophila* (Ericaceae), *Leptospermum namadgiense* (Myrtaceae), *Trachymene composita* (Araliaceae), *Viola improcera* (Violaceae), *Celmisia* sp. *pulchella* and *Olearia* sp. *rhizomatica* (Asteraceae) and *Leionema lamprophyllum* subsp. *obovatum* and *Phebalium squamulosum* subsp. *ozothamnoides* (Rutaceae). Seed viability was estimated using the tetrazolium chloride staining test. Imbibition tests ruled out physical dormancy among all species. Species that achieved low germination when compared to viability, required more than 30 days to complete germination, and/or responded to GA_3 were diagnosed with physiological dormancy. Rudimentary embryos were seen in freshly dispersed *T. composita* seeds and further investigations into morphological dormancy were carried out. Germination response to smoke chemicals and light/dark varied among species and germination strategies in fire-prone sub-alpine regions are discussed.

35 years in private conservation: monitoring changes seen and threats encountered

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Within New South Wales, private conservation is often a partnership with government through partial or in-perpetuity agreements. These agreements provide landholders with the backing of government expertise and a level of assurance that lands may be protected in the future. This comes with government oversight, burdens and expectations. This talk presents one individual's perspective of the benefits and issues in trying to protect native systems based on 35 years of managing, researching and monitoring private reserves across a diverse range of systems within Australia. Impacts including human, introduced species and natural disturbances can change the trajectory of vegetation in ways often unpredicted. Our understanding of natural change in diversity and vegetation type can be hampered by our limited understanding of systems and a too rigid adherence to guidelines and benchmarks.

Biomass, structure, and species composition along a 2,500-m elevation gradient in Japan

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Elevational change in forest structure, species diversity and composition have long been examined for predicting the response of forest ecosystem structure and function to global warming. For the elevational gradient in the humid tropics, canopy height and above-ground biomass decrease linearly with increasing elevation (decreasing temperature). On the other hand, for the latitudinal gradient in the temperate zone such as Japan, canopy height and above-ground biomass do not dramatically decrease from warm to cool temperate, and to boreal forests. This is because the life-form of the dominant tree species changes from evergreen to deciduous broad-leaved, and to evergreen coniferous from low to high latitudes. The negative effects of lower temperature and shortened growing season on forest structure are compensated by this life-form shift to species adapted to such severe climate. A similar structural change may be observed along an elevational gradient in the temperate zone, but it has rarely been examined specifically using a relatively large (e.g. 1 ha in area) permanent plot for measuring ecosystem structure and function. Elevational change in biomass, structure, carbon pool, species diversity and composition along a 2,500 m elevation gradient were examined by using five 1 ha plots established at 150, 500, 1,100, 2,100, 2,650 m from warm to cool temperate, and to subalpine forests in central Japan. As expected, biomass and other structural variables did not dramatically decrease with increasing elevation. I also report the nonlinear change in biomass allocation, carbon pool, and species diversity along the elevational gradient.

The Dynamics of Australian VEgetation (DAVE) - project overview and progress

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Increasing atmospheric CO_2 concentrations and associated changes in climate are inducing profound alterations to global biomes. Predicting the extent of these alterations requires a mechanistic modelling approach that can simulate the complex relationships between eco-physiological and demographic processes driving ecosystem function and species composition. Dynamic Global Vegetation Models (DGVMs) have been developed for this purpose. While significant advances have been made in state-of-the-art DGVMs, their ability to accurately capture the dynamics of Australian vegetation, including carbon and water fluxes, growth and mortality rates, and vegetation structure remains limited. Here we present the Dynamics of Australian VEgetation (DAVE) project, which aims to use recent knowledge on biogeochemical, eco-physiological, hydrological and demographic processes to modify the LPJ-GUESS dynamic vegetation model for Australia. We will provide an overview of the project and present recent progress and efforts in model development. This includes characterising, defining, and parameterizing a unique set of Australian Plant Functional Types (PFTs) and formulating ecosystem processes missing from many global DGVMs but key to the dynamics of vegetation in Australia (e.g., nitrogen fixation, resprouting following fire etc.). Additionally, we will present results from preliminary model simulations, which are forced with historical climate reanalysis data as well as future climate and carbon emission scenarios. By using comprehensive data for model parameterisation and evaluation, we anticipate that DAVE will improve our ability to predict how Australian vegetation will respond to changing climate conditions.

Global coordinated study on plant diversity changes on nature trails

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Recreational activities and the tourism sector are globally becoming more popular. Although people's interest in nature tends to be rather positive, it can also have harmful effects on te biodiversity and vegetation as the extent and frequency of disturbances grow. Nature trails are basically linear corridors of disturbances. By bringing visitors to fragile and protected areas, as well as constructing and maintaining trails, there is an impact on the surrounding environment including changes in biodiversity, endangered species and species composition due to alien species and other disturbances. There have been plenty of studies concerning tourism impacts on natural areas; however, these have typically focused on local scale (e.g. studying single trails) and flagship species, meaning that the methodologies are incomparable, and the data is often based on estimations done on a relative scale. Therefore, we have very limited knowledge of how this affects nature, and what are the effects in different regions, habitats or trail types. Here we present the rationale for the methodological approach, and call for a coordinated global effort – GetDiv – for collecting comparable and comprehensive data of diverse aspects of nature trails on a local, regional and global scale, with the focus on plant diversity. We carried out a pilot study in Estonia on 32 nature trails and present here these preliminary results.

Landscape genomics for climate adaptation in *Eucalyptus* foundation species to survive dieback

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Forests have been heavily disturbed by land use change and are becoming increasingly maladapted to the changing climate. In Australia, eucalypt woodlands are suffering from widespread dieback events that are both driven and exacerbated by worsening droughts. Current strategies for forest restoration and management include selective breeding, assisted migration and assisted gene flow. However, these approaches are largely uninformed by knowledge of specific climate adaptive polygenic variation. Landscape genomics is an emerging field that investigates the influence of environmental gradients on genomic variation in populations. Here, landscape genomics was applied to the woodland eucalypt sister species *Eucalyptus melliodora* and *E. sideroxylon*, both important foundation species in the box gum grassy woodland endangered ecological communities of Eastern Australia. By assembling new reference genomes, scanning millions of SNPs across hundreds of trees using GWAS, we identified 564 SNPs that were associated with temperature and precipitation in both species. We demonstrate that these SNPs can then be used in models to accurately predict the optimal local climate of trees, enabling forest restoration managers to select seedstock based on their genetic suitability to the changing environment. Similar studies are under way for *E. viminalis*, and *E paucifora* currently suffering dieback.

Lessons from the past: historical grassland management in the Carpathian Mountains

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Historical grassland management practices can be revealed through the examination of historical materials in libraries and archives, or by observing still-existing ancient systems in areas where traditional practices are preserved. In our research on the application of grazing in the management of hay meadows, we conducted a comprehensive literature review. Additionally, we carried out a field survey in 36 villages of the Carpathian Mountains across 8 different countries. We identified seven parallel farming systems that existed in the Carpathian Mountains prior to agricultural intensification and found that grazing of hay meadows was a regular practice in each of them. Spring, autumn, and occasionally summer grazing, along with corralling and manuring of hay meadows, were integral parts of these systems, adapted to the seasonal movement of dairy farms across various agroecosystems. Recent trends indicate that hay meadows are predominantly grazed in the Eastern, Southern, and Apuseni Carpathians, with minimal grazing observed in the Western Carpathians. The decline of grazing in hay meadows is strongly correlated with a decrease in livestock numbers and modifications to farming systems during collectivization. Spring grazing is often associated with sheep breeding and steeper slopes, while autumn grazing is linked to hay meadows that receive manure and have a higher frequency of mowing. Grazing of hay meadows has numerous positive impacts on grassland biodiversity and can be considered a promising tool in current grassland conservation and restoration efforts.

Drought accelerates local extinction and erodes mountain plant community stability

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Warming of mountain regions is projected to be three times faster than the global average. Few studies have reported species loss in mountain plant communities, and even fewer have explored mechanisms facilitating the colonization by novel species. Despite this apparent high resistance to climate change, mountain communities are likely generating an “extinction debt”. Following five years of exposure to downslope climates, we tracked translocated plant-soil communities and their novel competitor interactions at the trailing range edge of mountain plant communities. We found increasing species turnover under two warming scenarios with time. Gradual extinction of native species was followed by the colonization of novel species after a severe drought year in the third year of exposure. The mechanism facilitating novel species colonization in mountain communities was not competitive pressure but a direct environmental filter. We show a time lag between the extinction of native species and the colonization by novel species which can be explained by interacting climate stressors, here warming and drought, pushing communities to a certain threshold increasing their susceptibility to colonization. Destabilised and thinned communities provided a window of opportunity for novel species to enter. Our study provides experimental evidence of the payment of extinction debt in mountain plant communities revealing abrupt threshold dynamics in a long thought inert system.

KIWA – Artificial intelligence for early detection of forest fires

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Globally, forests are under transition. Novel disturbance regimes are emerging, with high uncertainty for future successional trajectories. The consequences for biodiversity and carbon budgets are widely unclear. There are clear limits to modelling approaches since the changes expected, e.g. changing fire regimes in central European forests, are unprecedented with no comparable historical events. In addition, societies and economies are not yet well prepared. KIWA ("Artificial intelligence for early detection of forest fires") will use advanced technologies such as high-performance unmanned aerial vehicles (UAVs) to identify and assess potential forest fire risks. Artificial intelligence algorithms will be applied to large amounts of data collected from satellites and drones, among other climate and weather data sources, to diagnose patterns and trends. This will enable us to exploit big data from various sources and support feasible and prompt risk assessment for early prevention and action. Via an Open Urban Data Platform, data will be evaluated in real time and transmitted to a specialised application for relevant agencies to localise forest fires as precisely as possible at an early stage and to make them effectively controllable with appropriate measures. The solution developed in KIWA will enable institutions such as fire departments, disaster management teams, counties or cities to be more resilient in the face of increasing forest fire risks in the context of the climatic changes of our time. After being successfully tested, the KIWA approach is aimed for application across various forest ecosystems, biomes and continents.

Dispersal limitation versus environmental filtering in regional alpine metacommunities of NW Spain

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Empirical research, including reciprocal transplanting, has largely demonstrated that dispersal limitation occurs in plant communities, explaining why many species from a regional species pool are lacking in suitable niches. In alpine habitats, it has been suggested that spatial scale and distance are key factors for understanding plant distributions, but few studies have evaluated the role of dispersal vs. environmental filtering in whole regions with a complete vegetation sampling. We hypothesised that alpine metacommunities occurring in the same habitat type are mainly influenced by dispersal limitation at the regional scale, as an effect of metacommunity processes linked to mass effects and neutral theory, rather than species sorting and patch-dynamics. We tested this hypothesis in two alpine habitat types (calcareous and siliceous bedrocks across temperate and oro-mediterranean climates) in the Cantabrian mountains (NW Spain). Despite habitat-based differences in geographic extent, the two metacommunities showed similar properties in coherence, turnover and boundary clumping. In the two habitat types, geographic predictors were more informative than climatic and topographic variables using Redundancy Analysis (RDA) and Generalised Dissimilarity Models (GDM). The effect of dispersal limitation was stronger when the area under study increased, even if topo-climatic variation also gained importance in larger areas. These results suggest that dispersal limitation influences the diversity of alpine communities even in relatively small alpine regions. Using additional data for specific subregions and species subsets, we further assess the possible impact of non-measured factors (seed traits, soil chemistry) and a dark-diversity approach on the observed patterns.

Plant species' elevation range shifts reflect complex landscape dynamics in the Andes of northern Patagonia

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Accelerated climate change is causing shifts in species geographical distribution. In mountain areas, numerous studies have detected an upward shift in plant species due to rising temperatures. However, this phenomenon remains untested in the temperate forests and scrublands of northern Patagonia. We assessed changes in plant elevation ranges in temperate mountainous forests and scrublands over the last five decades. We compared elevational distribution of species between two different periods, focusing on both the maximum and minimum range limit. We obtained current species occurrence data by surveying 141 vegetation plots (500-1,600 m above sea level) between 2021 and 2023. These current ranges were then compared to the period from 1960 to 1980, using historical phytosociological data. Our findings reveal distinct patterns in both direction and magnitude for different species, species groups and vegetation units. Generalist species and shrubland resprouters exhibit an upward shift and an expansion of their distribution range along the elevation gradient. In contrast, most of the mesic and dry forest species are either experiencing a downward shift or remain static at both edges. Additionally, ranges of species characteristic of subalpine forests are contracting towards the treeline. We show that the altitudinal distribution of plant species has changed in the last decades. However, these observed distributional changes cannot be solely attributed to the direct effect of warming. Instead, they arise from complex interactions between land-use dynamics, fire disturbance, and possibly other changes induced by both human activities and climate.

Regeneration potential of urban forest remnants in a subtropical landscape: the role of propagule banks

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Urbanisation represents a major challenge for vegetation assemblages largely due to the various stressors associated with fragmentation. In this study, we investigated the impacts of urbanisation on vegetation assemblages in 20 remnant forest patches in the heavily urbanised region of Greater Brisbane in Queensland, Australia. Our goal was to understand the resilience and regeneration potential of these forests through the analyses of three propagule bank sources: aerial, litter, and soil. We found that each bank type had a distinct composition, suggesting that each contributes uniquely to forest regeneration and resilience. We also observed that all surveyed forests were affected by edge effects. As propagule bank assemblages did not mirror extant communities, changes in vegetation communities can be expected unless new management and mitigation strategies are adopted to prevent propagule entry via forest edges. Our findings highlight the urgent need for conservation efforts to ensure the long-term viability of urban remnant forests.

Relationships between the functional composition and climate regulation processes across European habitats

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Nature-based solutions to protect, manage and restore natural ecosystems are urgently needed to mitigate the climate and biodiversity crises, two of the biggest threats in the 21st century. Terrestrial ecosystems affect the climate from local to global scales via reflection of solar irradiation, evaporative cooling or carbon sequestration. The functioning of terrestrial ecosystems is largely determined by the traits of the dominant plant species. However, although it is known that plant communities differ in their climate regulation processes, little is known on how plant traits affect these regulation processes, both within and across different habitat types. To bridge this gap, we related the community-weighted mean values of 20 plant traits to the proportion of reflected solar irradiation, evapotranspiration and net primary productivity across 51,498 vegetation plots, classified into ten types of forest, shrubland and grassland habitats. Using linear and random forest models, we found that climate explained between 6.4% and 77.1% of variation in climate regulation processes. After accounting for the effects of climate and habitat type, the functional composition of plant communities was still significantly related to the climate-adjusted proportion of reflected solar irradiation (with an average of 9% explained variation), evapotranspiration (2.9%) and net primary productivity (6.4%). The strongest relationships were found in forest habitats, although the strength and direction of individual relationships were strongly dependent on the type of habitat analysed. We conclude that considering the functional composition of plant communities within habitats can help inform nature-based solutions to climate and the biodiversity crisis.

Gondwanan world heritage rainforests in a continental and global context

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Rainforests have a deep evolutionary history in Australia and are highly valued. The 'Gondwana Rainforests of Australia' World Heritage Area (WHA) is one of six Australian WHAs that recognise rainforest values. A new continental synthesis of Australian rainforests is timely, given that major fires of 2019/2020 renewed awareness of their increasingly marginal persistence under a changing climate and that there has been a steady accumulation of data and understanding of rainforest ecology over recent decades. Here, we present the first part of a continental synthesis focussing on subtropical and temperate mainland Australia. A new floristic classification identified 30 rainforest ecosystem types across the region using a dataset of 3,818 samples including 2,554 species, from which summary descriptions of characteristic species and other properties were generated for each type. The classification, linked to the IUCN Global Ecosystem Typology, was based on a graph-theoretic approach that overcomes some limitations of traditional central-tendency methods. We mapped the distribution of each ecosystem type using remote sensing and environmental models trained by the sample data. We generated six different maps from variations in the methodological protocol to represent the plausible range in uncertainty for distributions of the rainforest types. We used the maps and descriptions to ask how well different types of rainforest ecosystems are represented in: i) the World Heritage estate; ii) the broader protected area network; and iii) national and state listings of threatened ecosystems (aka ecological communities). New listings are currently underway to fill gaps revealed by the analysis of 2019/2020 fires.

Miyawaki urban mini-forests - growth rate and species performance

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In the tropics, the Miyawaki Method is suitable for fast recovery of forest stands, combining knowledge about the natural species composition, regeneration dynamics and ecological preferences of tree species along succession gradients. We assessed the recovery of tree species in restoration plots planted in Kenya between 3 and 7 years after establishment in an urban landscape at the University of Nairobi. We assumed the growth to be quasi-constant initially, described by a linear regression model which was also applied to wood-volume growth. Based on average slopes in the growth models per species, height growth ranged from 0.1 m y^{-1} in *Craibia brownii* to 1.33 m y^{-1} in *Cordia africana*. Growth in diameter at breast height was highly dependent on the species and the local conditions in regeneration plots; the maximum values reached range from 1.96 cm y^{-1} for *Olea capensis* to 15.6 cm y^{-1} for *Cordia africana.* The wood-volume growth exhibited big differences, with the plots planted in 2014 and 2013 having growth rates over 1 mm^3 d^{-1}. This study is important in rehabilitation programs where species composition of natural forest vegetation is used to select tree species in restoration plantings. It also provides a good choice of species for mixed urban environments which are able to store huge volumes of carbon due to fast growth and therefore to sequester the high carbon emissions of urban areas.

Simulating an acute heatwave with warm nights in a sub-alpine grassland

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An often-overlooked aspect of heatwaves is the concomitant elevated night-time temperatures, compounding heat stress experienced during the day. An acute heatwave is short, and consequently some of the most commonly assessed morphological functional traits will not exhibit impacts within the duration of the event. However, impacts on leaf chemistry underlying short-term acclimation can respond within seconds to minutes and therefore are a promising avenue to assess effects of an acute heatwave. We simulated an in situ acute heatwave on a sub-alpine grassland, investigating the effects of elevated day and night time temperatures by measuring the activity and health of photosynthetic machinery and a range of leaf spectral indices indicative of defensive and damage responses. We conducted the experiment in situ to assess species responses in a setting that encompasses the natural range of abiotic and biotic stimuli. Early indications suggest that heatwave treatments had no significant impact on photosynthetic health. We detected differences in photosynthetic activity (as indicated by stomatal conductance) among species but not treatments. Preliminary assessment of leaf chemical changes indicate treatment effects were small, though flavanol spectral indices, important in a number of signalling and stress related roles, were up-regulated across the experiment (though not in response to temperature). Further leaf chemistry analyses using metabolomics will be used to detect and quantify delicate shifts in secondary metabolites. The results of these studies will have relevance to understanding community level impacts of increasingly common heatwaves projected in the future.

Genomic footprints of hybridisation, introgression and adaptation of feathergrasses in the face of climate change

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Global climate changes strongly impact wild species' biology, influencing shifts in their distribution or phenology. One of the potential effects of climate change is increased hybridization risk by expanding ranges or flowering times of closely related species. Gene flow between species could be a primary source to widen genetic diversity and in consequence, can facilitate evolutionary rescue. On the other hand, it may also lead to the extinction of parental species, through the production of hybrid swarms and lead to genetic erosion. Understanding the role of hybridisation and introgression in the evolution of species is crucial for preserving biodiversity. Thus, the first step should be quantifying the amount of shared diversity between genetic pools of species potentially threatened by such changes. Given the trends in climate change, the steppe species which are already exposed to extreme droughts may be threatened by future climate change. Thus, we decided to take a closer look at feathergrasses (genus *Stipa*) which are important components of steppes. Based on ecological niche models, morphological features as well as over 5-7 thousand of DArT derived SNPs we prove that the ecological niches and geographical distribution of studied species partially overlap which allows for both hybridisation and introgression events. However, interbreeding between species, occurred only in specific parts of the distribution ranges and particular individuals. This is a premise for further research on the adaptive potential of hybridization and introgression of steppe species.

The research was supported by the National Science Centre, Poland (project no. 2020/39/D/NZ8/02307).

Origins and assembly of the Australian Rainforests: protecting deep-time World Heritage values

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The Southern Hemisphere plant-fossil record shows the global scale range shifts of Paleo-Antarctic rainforest lineages (PARLs) in response to tectonic movements and climate change through time. The PARLs represent living plant lineages with fossil records in the mid-high latitude paleo-forests of the Cretaceous and Paleogene Southern Hemisphere. Some of the PARL genera remaining in Australia include: *Agathis*, *Nothofagus, Tasmannia, Orites, Ceratopetalum, Caldcluvia / Ackama, Wilkiea, Doryphora, Daphnandra, Eucryphia, Elaeocarpus, Austrobuxus, Ripogonum* and *Akania*. The Australian vegetation was shaped by the Eocene (ca. 40 Ma) final breakup of the supercontinent Gondwana, resulting in the oceanic separations of Antarctica, Australia and South America; and the subsequent collision of the Australian and Southeast Asian plates starting in the late Oligocene (ca. 26 mya). In Australia's few remaining warm-cool-wet, sub-montane to montane tropical and subtropical forests, PARLs can be the most abundant lineages and often represent the nominated outstanding universal values (OUV) of World Heritage areas. Conservation management to secure a future for these deep time moist forest survivor lineages in the face of increasing climate extremes including drought and seasonal dryness will require interpretation of the past from the fossil record, an improved understanding of how the traits that contribute to resilience worked to secure persistence, and how within and between species genetic diversity is structured across species full contemporary distributions, and environmental variables. This is the science that is capable of providing the knowledge and tools to protect WH Rainforest OUV against the combination of hostile selection pressures, and limited landscape opportunities.

Assessment of extreme climate events and impact on alpine vegetation in Taiwan

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Under current climatic situations, the frequency of droughts and extreme heat events have been increasing, threatening the species diversity and endemism of alpine vegetation. Taiwan is in a humid subtropical monsoon climate region, with an average annual precipitation of over 2000 mm. With low temperatures and abundant annual rainfall, it is unthinkable that drought events could occur in the alpine region of Taiwan. However, previous studies have suggested that water imbalance events might have occurred in Taiwan between 2015 and 2019, leading to thermophilic and xerophilic alpine vegetation. However, the general lack of alpine weather stations makes it difficult to determine whether a drought did occur. Therefore, this study attempted to detect the timing and duration of extreme climatic events by the Standardised Precipitation-Evapotranspiration Index (SPEI) and Temperature Index (TI). Furthermore, the Enhancement Vegetation Index (EVI) was employed to investigate the trend in alpine vegetation on 15 monitored summits during extreme climatic events. The results showed a significant positive correlation between the annual average SPEI, temperature, and EVI values. Marked wet and dry seasonal differences exist in the alpine regions of Taiwan, and the lack of precipitation in spring and summer might cause drought in the coming year. Meanwhile, extreme temperature events between 2016-2022 could increase EVI, but the following extreme drought in 2019 might cause a sudden drop in EVI and reasonable shrinkage of vegetation. Those results suggested that extreme heating and temporal uneven precipitation could still cause drought and seriously affect alpine vegetation even in humid climates.

Assessing the diversity and conservation status of forest habitat types (Natura 2000)

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Europe's Natura 2000 is the largest coordinated network of protected areas in the world, and the priority Habitat Types (HT) within it are of the highest conservation importance. However, they often occur in smaller areas, and there is no reliable information on their conservation status. Among them is the HT of *Tilio-Acerion* forests of slopes, screes and ravines, which was studied in a Natura 2000 site in eastern Slovenia, Europe. The studied site is characterised by a matrix of European beech (*Fagus sylvatica*) forests with rather small, fragmented areas covered by *Tilio-Acerion* forests. As a more detailed approach is required for conservation purposes, different habitat subtypes within this HT were mapped and studied on i) cooler, moist forest sites, generally dominated by sycamore maple (*Acer pseudoplatanus*), sub-alliance *Lunario-Acerenion*, and ii) warmer, drier screes in forests, generally dominated by limes (*Tilia* sp.), sub-alliance *Tilio-Acerenion*. Our research objective was to investigate the site heterogeneity, species diversity and conservation status of *Tilio-Acerion* forest and its subtypes. Information from the field mapping and vegetation survey was complemented by LiDAR data. The results show that habitat subtypes differ significantly in terms of species composition, forest stand characteristics, topography and relief, and the various threats they experience (e.g., fragmentation, tree mortality, game browsing). This study provides baseline information for setting more realistic conservation management targets for priority forest HT. Due to the specificities of each habitat subtype, conservation measures should be targeted at the Natura 2000 habitat subtype level.

Climate gradients drive grassland plant diversity across spatial scales

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Temperate grasslands are among the richest ecosystems in plant species at small grain sizes but most are degraded by land use. Understanding what governs grassland plant diversity remains limited to studies of a single grain size, even though strong evidence exists that the biodiversity changes and their drivers may strongly depend on the scale of the study plots. This hinders our ability to translate results from local scale experiments to larger scales that are relevant to policy and management. To bridge this gap, we analysed the comprehensive data collected across various grassland habitats in Ukraine with a standardised sampling methodology (https://edgg.org) at 191 plots. Each plot includes seven subplots of different grain sizes with two replicates (n=2,674 subplots in total): 1 cm²; 10 cm², 100 cm ², 1000 cm ², 1 m², 10 m² and 100 m². The smaller subplots were nested within the larger sublots. Our analysis revealed that climate variables were the strongest drivers of plant diversity across spatial scales. Specifically, annual precipitation and temperature (mean and annual range) collectively shaped plant diversity across grain sizes. Intermediate levels of precipitation were associated with the highest alpha and gamma diversity. Betta diversity had weak positive response to climate variables, suggesting that the impact of climate was consistent across different spatial scales. Prioritizing climate drivers in grassland policy and management is crucial, especially in the context of global change, as altered precipitation and temperature levels could lead to significant changes in plant diversity across different spatial scales.

How plant biodiversity affects ecosystem functioning along a natural stress gradient

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To date, our understanding of the Biodiversity-Ecosystem Function (BEF) relationship is mainly the result of manipulative experiments testing the role of species richness but neglecting other diversity facets, such as the above-/below-ground community functional structure. However, dealing with the ongoing biodiversity loss while conserving ecosystem functions and services requires a deeper comprehension of the BEF relationship, including multiple diversity facets and addressing the environmental context. To this scope, taking advantage of the remarkable gradient of stress characterising Mediterranean coastal dune ecosystems, we aim to analyse 1) the relative influence of above-/below-ground functional traits on multiple EFs; 2) whether functional traits operate through a mechanism of functional complementarity among species (i.e. functional diversity) or selection of dominant traits that maximize EFs, commonly measured as the community weighted mean of trait values; and finally 3) the influence of the environment on the BEF relationship. We collected data from 110 herbaceous plots distributed along a sea-inland environmental gradient in Central Italy, conducting a floristic survey to quantify diversity and measuring several ecosystem function indicators related to productivity, decomposition, water regulation, soil carbon stocks, nutrient cycling, and, ultimately, multi-functionality. We applied mixed-effect models to disentangle the BEF relationship and the modulating role of the environment. Results highlight that biodiversity mainly operates through dominant traits and that a trade-off of a fast above-ground strategy and slow below-ground strategy maximizes EFs. However, the stress gradient reduces the ability of biodiversity to buffer ecosystem functions, emphasising the influence of the environmental context on ecosystem function and service provision.

Environmental controls of rainforest floristics: climate change implications for the Gondwana Rainforests

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The Gondwana Rainforests of Australia World Heritage Area (GRAWHA) protects a time capsule of Australia's past climate, flora and fauna. Home to numerous endemic lineages persistent since the Eocene, the GRAWHA incorporates important mesic refugia for niche-conserved taxa, including climate relics. However, climate projections and long-term monitoring studies suggest that these remnants of Gondwana, and their relatively stable environments, will likely be transformed by the impacts of climate change. Concern for the future of the GRAWHA was highlighted in the 2020 International Union for Conservation of Nature (IUCN) Conservation Outlook Assessment, which for the first time elevated the property's conservation assessment to 'Significant concern', largely due to the impact of unprecedented, extensive bushfires in 2019/2020. This study summarises the findings of a 20-year modelling and monitoring study of the climate, floristics, and structure of subtropical and temperate rainforests across the Tweed Caldera section of the GRAWHA. The implications of a rising cloud cap, increasing moisture stress and increased bushfire risk for the long-term survival of the Gondwana Rainforests are explored in detail. The utility of long-term monitoring studies and bespoke climate modelling in informing conservation management and adaptation planning for the Gondwana Rainforests is also demonstrated. This work improves our understanding of the resilience of the Gondwana Rainforests in the face of climate change and presents management recommendations to support its ongoing role as a refuge.

Guiding through between-community functional dissimilarity measures

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One of the effective tools to study the variation between communities is the use of pairwise dissimilarity indices. Besides species as variables, the involvement of trait information provides valuable insights into the functioning of ecosystems. In recent years, a variety of indices have been proposed to quantify functional dissimilarity between communities. These indices follow different approaches to account for between-species similarities in calculating community dissimilarity, yet they all have been proposed as straightforward tools. In this paper, we review the trait-based dissimilarity indices available in the literature and identify the most important conceptual and technical properties that differentiate among them, and that must be considered before their application. We identify two primary aspects that need to be considered before choosing a functional dissimilarity index. The first is the way communities are represented in the trait space. The three main types of representations are the typical values, the discrete sets using the combination of species×sites and species×trait matrices, and the hypervolumes. The second decision required is the concept of which dissimilarity to follow, including two options: distances and disagreements. We use the above scheme to discuss the available functional dissimilarity indices and evaluate their relations to each other, their capabilities, and accessibility.

Testing the main and interaction effects of invasive herbs on resident plant diversity

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Invasions of alien plants are known to reduce the diversity and functioning of resident communities. Even though the spread of multiple invasive species in the same community is relatively common, the interaction between their effects gained attention relatively recently. *Asclepias syriaca*, and *Solidago* species (incl. *S. gigantea* and *S. canadensis*) are high-concern invasive herbs on Hungarian sandy old-fields. In this study, we examined how their cover is related to taxonomical and functional diversity of the resident plant communities, also accounting for the interaction effect between *Asclepias* and *Solidago*. We sampled vascular plant composition and percentage cover in 80 plots of 4 sq-m on four old-field sites. We assembled trait data for canopy height, seed mass, specific leaf area, bud bank and vegetative spread for all species. We modelled species richness, community completeness, community weighted mean for each trait separately, and Rao's quadratic entropy for each trait and all combined as functions of *Asclepias* cover, *Solidago* cover and their interaction term. *Solidago* cover had a negative main effect on species richness and community completeness, while *Asclepias* had no significant effect. Both invasive species had a weak effect on functional composition and diversity. The interaction effect was never significant. *Solidago* cover decreased resident plant diversity; however, the filtering effect of *Solidago* cannot be explained by the traits involved in the analysis. Interaction between *Asclepias* and *Solidago* cover has no significant effect.

A biome approach to plot-based vegetation classification in northern Australia

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Australia's vegetation types are unique with 85% of the Australian flora endemic to the continent, similarly so for the vegetation types they occupy. Australia has a long history of applying varying classification schemes across different jurisdictions which are enshrined in state legislation; however, these are not comparable across jurisdictional boundaries. The National Vegetation Information System is a heavily weighted structural classification system at its higher levels, rather than a floristic classification. To demonstrate a cross jurisdictional approach, we present a floristic plot-based classification of the Australian tropical savanna biome using a composite of vegetation plot-based data sourced from the Queensland, Northern Territory and Western Australia governments, the Terrestrial Ecosystem Research Network, and non-government organisations. We place Australia's vegetation types into an international context, using the International Vegetation Classification and IUCN Global Ecosystem Typology. We use presence / absence data from 50,000 plots to derive a preliminary list of macro groups. This floristic-based classification does not replace existing classification systems but adds value by putting floristics into existing structurally dominant classification schemes. This method can be applied across other major biomes in Australia to develop a continental list of macro groups that can be cross walked to existing classification systems.

Effects of grazer species, season and intensity on a Mongolian Plateau steppe

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Effects of three herbivore species, four grazing seasons and three grazing intensity levels on a *Stipa grandis* and *Leymus chinensis* dominated steppe vegetation were investigated using a 6-year grazing experiment in the Xilingol region of Inner Mongolia, China. The results showed that cattle, sheep and goat had different preferences of plant species, and grazing by these herbivores at moderate grazing intensity drove the divergent changes in species composition of vegetation. Grazing in different seasons at moderate intensity affects plant community structure and production mainly through altering the seasonal pattern of plants standing dead and litter, and by changing plant nutrient resorption and remobilisation; autumn grazing had the biggest adverse effect on plant community structure and production, while winter and early spring grazing benefited plant growth. Grazing intensity and precipitation jointly shaped the compensatory growth and ANPP of the grassland, with the highest ANPP occurring at relatively high grazing intensity under high precipitation. Our results provide insights into the vegetation dynamics under different grazing regimes and imply that livestock composition can be used as a mean to manage vegetation dynamics; that is, winter and early spring grazing is better than complete animal exclusion for grassland health, and an adaptive management based on residual vegetation height is efficient for coping with the large inter-annual variation in climate and vegetation production in this semi-arid steppe region.

Abiotic and biotic factors drive forest demographic trade-offs in the Qinghai-Tibet Plateau

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The trade-offs in forest demographic processes that are vital to forest productivity are influenced by climate context, functional traits, and forest structure. The combination of these factors that drives forest demography trade-offs remain poorly understood, especially in the Qinghai-Tibet Plateau. This study collected forest demography data in 1399 permanent forest plots containing 125 species and 103,773 individual trees, from 1979 to 2017 in the Qinghai-Tibet Plateau. We aimed to explore patterns of forest demography and evaluate whether functional traits, forest structure and climate-dependent covariates affected demography following forest recovery from felling. We found that overall Growth Rates (GR) and Recruitment Rates (RR) decreased significantly over time, and RR increased with GR and Mortality Rates (MR). Stand age, trees density, Specific Leaf Area (SLA) and Wood Density (WD) were important factors regulating forest demography. Moreover, forest demography responses to functional traits, and changes in these responses with time, were related to forest stand age, tree density and climatic conditions. Generally, recruitment and growth of these species (which had higher SLA) were higher and faster with climate gradients. High tree density limited GR and RR of acquisitive species, but MR didn't increase. With the increase of stand age, the MR of species with high WD were lower than acquisitive species, which keep the forest ecosystem stable in the late stages of succession. This study highlights the importance of functional trait - stand structure/climate interactions in determining forest demography and contributes to knowledge of regional forest demography trade-offs in the Qinghai-Tibet Plateau.

Is flower diversity an objective predictor of ecosystem service quality?

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Agri-environmental policies implement biodiversity-based solutions to reverse the degradation of ecosystem services. This two-year field experiment challenges the solely biodiversity oriented policy, by assessing the ecosystem service quality along the artificially formed diversity gradient of melliferous flower areas. Indeed, the high diversity of flowers resulted in longer and more abundant flowering periods than monocultures. However, the foraging activity of bees (both honeybees and bumble bees) was the greatest in monocultures and in the low diversity treatment, while the high-diversity mixture had the lowest attraction effect. The forage activity was also suppressed by the diversity around the co-dominant melliferous species. The study showed that, in particular, the sole indicator of flower diversity is not sufficient to explain service provision quality if the intensity of the service is the main aim. In the light of these results, it is suggested that the biodiversity-oriented policy might require revisions.

Patterns of intra/interspecific trait variation of trees along a fog gradient in Taiwan

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In sub-tropical montane cloud forest (SMCF), fog plays a unique ecological role directly affecting plant growth. It creates an environment with reduced temperature and solar radiation, higher humidity, and limited nutrient availability. We used the functional-trait approach to clarify which of these ecological factors is more important for the selection of woody species into the forest community. In the northern part of Taiwan (eastern Asia), we surveyed woody species in 27 plots (20 × 20 m), distributed in nine localities along a fog frequency gradient (elevation around 2000 m above sea level). Up to three individuals of each species in each plot were collected to measure leaf thickness, chlorophyll content, specific leaf area (SLA), leaf dry matter content (LDMC), equivalent water thickness, and wood density. We calculated the fixed, site-specific, and intraspecific community-weighted mean (CWM) of each trait. We used simple linear regression with restricted permutation to test the relationship of CWMs to annual fog frequency (while accounting for other environmental factors). Interestingly, we found that while on an intraspecific trait level, SLA is negatively related to fog frequency, on an interspecific trait level the SLA-fog relationship is positive (though only marginally significant). We hypothesise that on an intraspecific trait level, fog selects individuals of the same species that are more resource conservative (with relatively lower SLA), while on an interspecific trait level, fog selects species that are more shade tolerant (with relatively higher SLA). Our study provides evidence that along a fog gradient, selections on intra- and inter-specific trait levels are driven by different underlying variables.

Vegetation of Dongsha Island

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Dongsha Island is located approximately 400 km southwest of Taiwan in the South China Sea, mainly formed by the accumulation of biological debris such as coral and shellfish, and lacks a soil layer. Previous surveys have identified the vegetation types of Dongsha Island as predominantly tropical shrublands, a subtype of the tropical coastal forest. As tropical island ecosystems are often unstable and vulnerable to disturbance, this study aimed to understand the environment changes of Dongsha Island using a comparative vegetation analysis. A comprehensive island-wide vegetation survey was conducted to classify the vegetation types, and applied multivariate analysis was used to explore the relationship between plants and environmental factors. The woody plant communities were classified into four types: I. *Guettarda speciosa* type, II. *Scaevola taccada* type, III. *Suriana maritima* type and IV. *Pandanus odorifer* type. Herbaceous plant communities were classified into two dominant types: V. *Sesuvium portulacastrum* type and VI. *Ipomoea pes-caprae* subsp. *brasiliensis* - *Bidens pilosa* var. *radiata* type. Compared to the historical studies, there were only minor changes observed in the vegetation of Dongsha Island. The composition of woody species in plots showed no significant changes but there was an observed tendency to expand. However, the *Sesuvium portulacastrum* grassland may have decreased due to the expansion of *Avicennia marina*. The dominant area of *Ipomoea pes-caprae* subsp. *brasiliensis* - *Bidens pilosa* var. *radiata* type is easily disturbed by human activities. The expansion of invasive herbaceous species on the island is harmful to native plants, and it is necessary continually to monitor their influence.

A decade long flowering phenology survey in an alpine subtropical island

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Flowering phenology can profoundly impact various aspects of plant ecology, including pollination, fruit development, seed dispersal, and population establishment, thus influencing the functioning of the ecosystem. Given the vulnerability of alpine ecosystems to climate change, many studies have investigated the effects of warming on the flowering phenology of alpine plants. However, long-term, on-site monitoring of plant phenology has been lacking in Taiwan (21.83–25.33° N, 120.00–122.00° E) due to the low accessibility of high mountain areas in this subtropical island. To address this gap, we collected ten years of data from Mt. Xue Glacial Cirque (3,587-3,886 m above sea level), which is particularly representative of the region. From 2012 to 2021, monthly surveys revealed 128 species of flowering plants from 80 genera in 34 families, with Compositae and Gramineae as the dominant families and an endemic rate of 60.16%. Of these, 15 species were above the Near Threatened (NT) level according to the IUCN Red List, including *Arabis gemmifera*, *Draba sekiyana*, and *Potentilla tugitakensis*, all endangered. Furthermore, we classified some of the 76 species recorded for over three years into early and late flowering types. We found that the early flowering type was more sensitive to environmental changes and would flower earlier with warming. Our study allows us to compare the flowering phenology characteristics of subtropical alpine plants with those of other regions with long-time series data in mid-to-high latitudes.

Factors shaping functional and evolutionary patterns of fern communities in cloud forests

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Elucidating the mechanisms by which traits aggregate into communities gives us an edge in predicting how trait patterns might change in dynamic ecosystems. This study combines approaches considering eco-evolutionary processes to understand trait-environment interactions and species coexistence. Fog is a prevailing environmental phenomenon driving narrowly the distribution of cloud forests in Taiwan, but how fog affects plant functional trait distribution is still unclear. We investigated the effects of the environment on leaf traits and assessed phylogenetic and trait dispersion patterns and their link with environmental and taxonomic components across fern assemblages. Across twenty-four 400 m^2 plots, established along a gradient of fog frequency while controlling for confounders, we measured seven leaf traits for epiphytic and terrestrial ferns on an individual-level basis, and quantified local environmental conditions. We then related individual-level mean trait values and their community-level trait and phylogenetic dispersion to fog frequency and other factors. We discovered that fog significantly reduced specific leaf area (SLA) in both types of fern community, while leaf area increased with increasing fog, but only in terrestrial ferns. Except for SLA, all traits exhibited phylogenetic signal. In terms of local abiotic factors, there were no patterns of phylogenetic relatedness or functional diversity associated with fog alone, but community functional diversity and phylogenetic relatedness converged with increases in heat load in epiphytic fern communities. Rich assemblages of terrestrial ferns were phylogenetically over dispersed. In summary, several factors interact in cloud forests to specifically alter the functional and evolutionary patterns of both epiphytic and terrestrial fern communities.

Coastal dwarf forest, a new phytosociological unit evidenced by transect data from China

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Dwarfing of plants under coastal environmental stress is a common phenomenon, but coastal dwarf forest constituting a new vegetation unit remains to be determined. This study aimed to reveal the non-recognised dwarf forest formations of the coast and provide evidence to resolve the dispute. Using a three-year transect survey of coastal forests in China conducted from May to August in 2021-2023，this study obtained a data set containing 43 coastal dwarf forest samples and 44 typical forest samples. Data analysis showed that coastal dwarf forest presented a strong uniqueness in terms of geographical distribution, habitat characteristics, community structure, individual functional traits, formation mechanism and growth model. Our study argues that coastal dwarf forest is a stable, post-successional ecosystem which lies outside of the current vegetation classification system. This study provides a new insight for the classification of coastal vegetation, and also provides a new reference for coastal vegetation management.

Analysis of environmental causes of historical forest fires in Taiwan

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As climate change increases the frequency of drought, forest fires are also becoming more frequent and extensive. Analysing forest dynamics can help identify the impact range of forest fires and monitor post-fire vegetation recovery using the Normalised Difference Vegetation Index (NDVI). The NDVI is highly correlated with important ecological variables such as the Leaf Area Index (LAI) and biomass, enabling estimation of fuel accumulation in forests. To identify the key environmental factors influencing high-mountain forest fires in Taiwan, we calculated the NDVI using Landsat satellite images combined with historical fire events in the area. We have also estimated the amount of fuel accumulation at historical fire sites using the NDVI, and assessed pre-fire environmental conditions, fuel moisture, and other relevant factors using regional weather stations and interpolated ERA-5 climate data. Our results revealed fire severity is likely to be positively correlated with the amount of accumulated fuel in areas with frequent human activity, highly dry environments and fuel moisture conditions. Identifying these key factors can enhance our comprehension of the forest fire drivers and help inform more effective prevention and management strategies.

The biogeographical regions of the world in relation to the terrestrial biomes

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The description of biogeographic territories has been the task of a series of botanists throughout the last 200 years, and their proposals have been very diverse according to the state of knowledge of the world's flora during that period. We consider that such territorial descriptions provide a useful tool to understand and document the spatial patterns of the plants' distribution in large scale according to their ecological requirements and their evolutionary history. We attempt here to provide an update of the biogeographic kingdoms and regions of the world by introducing the new floristic and vegetation information, as well as several regional approaches that have been produced in the last 38 years after the historical maps by Takhtajan and Good. The upper biogeographic ranks, kingdom and region, are explained with the attributes they have to fulfill in terms of their floristic content and evolutionary background. Recently, a new approach for a classification system of large scale terrestrial biotic units of the Earth, based on vegetation and shaped by bioclimatic characteristics, has been proposed. These biotic units, mostly those at the level of biomes and sub-biomes, are also used to characterise the regions and particularly to define the limits between the neighboring units. There are six kingdoms and 42 regions recognised for the entire planet and a map of them is provided.

Measuring landscape capacity to support climate migration in New South Wales, Australia

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Up to a fifth of remaining species-level plant diversity in New South Wales (NSW), Australia is predicted to be lost to chronic climate change stressors by 2070, potentially matching losses from past habitat degradation. Some loss is inevitable due to historical emissions with irreversible climate driven loss already likely. However, NSW ecosystems can avoid the worst climate change impacts if adaptive capacity is strengthened and supported by active management. Adaptive capacity lies in physiological tolerances, local system resilience, and landscapes supporting climate migration. Beyond in situ adaptation and where landscapes facilitate, climate migration provides opportunities for species and ecosystems to shift in response to declining bioclimatic suitability. We present the Spatial Resilience Index, a repeatable measure of landscape capacity to support climate migration in response to bioclimatic shifts. Spatial Resilience adapts the Bioclimatic Ecosystem Resilience Index, a 2022 Kunming-Montreal Framework indicator, for adoption as a NSW indicator of landscape capacity to retain biodiversity under climate change. The index measures how well present-day biodiversity is connected to bio-climatically suitable places under future climate, accounting for the velocity of change and how habitat loss and fragmentation impede migration. Spatial Resilience in NSW is tested under plausible climate futures as a function of habitat condition and spatial configuration offering an objective means of monitoring change in capacity over time. This analysis highlights where landscapes can support climate migration and where active management will be needed. Results vary markedly depending on the interplay between climate change velocity, landscape heterogeneity, and anthropogenic disturbance.

Climate-change adaptation applications of an ecosystem classification in western North America

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The Bio-geoclimatic Ecosystem Classification (BEC) system is a framework that uses the classification of mature vegetation communities to identify and delineate ecologically equivalent climatic regions and site conditions. The composite vegetation-site-climate units of this system are readily applicable for modelling the effects of changing climate on vegetation at both a regional and stand level. Mapped bioclimatic units, down-scaled climate surface variables, and machine-learning are used to create a model of current bioclimates. The future distribution of these bioclimate envelopes is then predicted from 90 global climate model-scenarios projecting climate data. The effects of climate change are translated to site-level impacts by matching the relative edaphic position of ecosystem types, and the potential impacts to vegetation are inferred by comparing the differences between the current potential vegetation to equivalent sites in future projected bioclimatic units. Climate change adaptation applications using this forecasting approach have been developed to identify climate refugia and assess conservation area networks, to match species and populations to appropriate sites for assisted migration, and to identify regions and sites where indigenous medicinal plants or whole vegetation communities are most susceptible to climate change stresses.

Cost-efficient mapping of forest ecosystems using machine learning

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Ecosystem maps are an important tool for managing natural landscapes. Existing Ecosystem Mapping (EM) approaches, which use expert models or air photo interpretation, are confounded by subjectivity, poor updateability and require expensive independent field verification to assess map accuracy. A data-driven, machine learning approach to EM has the potential to address these limitations; however, the high cost of training data acquisition has limited its application in practice. We outline a scalable, cost-efficient sample design that places line-intercept transects using cost-constrained conditioned Latin hypercube sampling of ecologically relevant landscape-level predictors. Our hierarchical sample design provides spatially distinct units for 1) training data, in the construction of machine-learning ecosystem models, and 2) appropriately scaled experimental units for map accuracy statistical evaluation. Additionally, we propose a variety of novel accuracy metrics which include proportion representation, spatial explicit accuracy, fuzzy class membership and spatial misregistration, thus accommodating the varying applications for EM. We demonstrate our method in a 50 000-ha area of low boreal forest in British Columbia, Canada, in which we sample, build, and evaluate a stand-level EM. We use a Random Forests learner with predictor covariates derived from LiDAR and Sentinel 2 satellite imagery. We found machine-learning models trained with data from as few as 30 transects, representing 3-4 two-person crew-days of effort, generate a stand-level forest EM with 80%(+/-10%) agreement on map unit proportions and 75% +/- 10% spatial accuracy where training sets are optimally balanced. The ‘PEMr’ R-statistics package consolidates the tools of this protocol.

A new plot-based vegetation classification approach for eastern NSW

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The reliance on a master typology of native plant assemblages to support biodiversity conservation objectives is common to many jurisdictions internationally. In New South Wales (NSW), Australia, changes to state biodiversity laws have extended the role of vegetation classification in land management and land use decisions. Plant community types (PCTs), the finest level in the NSW vegetation classification hierarchy, are used as a basis for assessing and determining biodiversity values and for underpinning the calculation of credit values in a market-based trading scheme. The weak performance of an existing PCT typology in providing a consistent and objective identification of types led to a revision of the NSW classification approach, commencing in eastern NSW. In this talk we describe a bottom-up approach used to identify a revised set of PCTs for eastern NSW from analyses of approximately 50,000 standard vegetation survey plots. Multivariate techniques were used to identify floristic and environmental patterns, commencing with a mixture modelling approach to partition the dataset into regions of common probability profile. We evaluated a suite of contemporary clustering algorithms before adopting k-means clustering to explore finer patterns at a consistent classification scale within each defined region. Draft types were reviewed against multiple factors using a standardised workflow to produce final revised PCTs. Approximately 1,100 revised PCTs have been identified for eastern NSW. Floristic, environmental and spatial attributes of PCTs are defined by member plots and explicit plot membership is now stored in the online BioNet database. A new online tool allows quantitative metrics to be used to objectively assess new plots against PCTs. We argue that the revised classification is a major advance, resulting in reduced complexity and uncertainty for users, improved access to primary data, and enhanced functionality for other applications including mapping.

Assisting the migration of dispersal limited rainforest species to predicted climate refugia

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Previous climate change events have resulted in global mass extinctions. Modelling of climate impacts to the Gondwanan Rainforest of the Tweed Caldera in northeast New South Wales have predicted reductions in species abundance and contraction in suitable habitat. One method to mitigate these impacts is assisted migration, a tool widely discussed in conservation ecology since the early 2000's. National Parks and Wildlife Service of New South Wales are partnering with numerous organisations and experts to develop and implement conservation strategies to improve in-situ genetic diversity and assist the migration of dispersal limited rainforest species, to predicted climate refugia. Species with current and planned actions include *Elaeocarpus sedentarius* (Minyon Quandong), *Eidothea hardeniana* (Nightcap Oak), *Diploglottis campbellii* (Small-leaved Tamarind) and *Endiandra floydii* (Crystal Creek Walnut). The aim of these translocations is to increase the adaptive capacity of existing populations and to establish genetically diverse, self-sustaining populations for the most at-risk species. The new populations will be representative of wild sites and provide insurance against predicted losses associated with climate impacts.

Gradient of desiccation tolerance in a lichen symbiont system

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Stress responses and consequent community shifts of obligatory symbiotic organisms such as lichens are poorly predictable due to their mutualistic dependency on partners viability and adaptability. The lichen *Ramalina farinacea* is known to partner with different photosynthesizing symbionts from the genus *Trebouxia* (Chlorophyta) with diverging physiological performances in stress conditions. We tested the desiccation tolerance of *Ramalina farinacea* and its algal symbionts from three different locations in Europe; Tenerife (Spain), Valencia (Spain) and Estonia. Specimens' photosynthetic characteristics as well as stress-related Volatile Organic Compounds (VOCs) were recorded in real-time *in vitro* stress events. By comparing symbiotic organism desiccation stress responses to the stress tolerance of its potential partners adapted to different precipitation regimes, we aim to identify associations in this symbiotic system with risk to higher damage in extreme drought events.

Dynamic stability of *Phytophthora cinnamomi* infection in Dharawal National Park, Australia

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Phytophthora cinnamomi is an introduced soil-borne pathogen that infects plant roots and causes population decline in susceptible native species. Infection by *P. cinnamomi* is listed as a key threatening process under Commonwealth and New South Wales (NSW) biodiversity legislation. Widespread vegetation loss appears less evident in NSW than other southern states, but the difficulty of *Phytophthora* detection means that dieback symptoms may remain unattributed to a causal agent. In 2022, we revisited sites from a 2014 *P. cinnamomi* incidence survey conducted in Dharawal National Park, south of Sydney. An earlier survey in 2008 had sampled separately in Dharawal National Park and other conservation reserves in southern Sydney. We found that *Phytophthora cinnamomi* infection rates were dynamically stable over the 14-year timeframe; however, infection was spatially and temporally variable among sites. Proximity to roads and waterways appeared to increase the likelihood of site infection. We found a mismatch between visual assessment of disease and laboratory assay of soil samples at a site: visual assessment could not substitute laboratory analysis, nor (by extension) facilitate remote sensing of invasion fronts. While the infection threat may be stable in Dharawal National Park, slow-turnover susceptible plant species may require targeted *Phytophthora cinnamomi* control. Our findings will contribute to an eastern NSW risk map and inform further conservation actions such as trail closure or maintenance and visitor management mitigation measures.

Flowering and fruiting patterns in the Lamington subtropical rainforest

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Lamington and Border Ranges National Parks protect the largest area of subtropical rainforest (complex notophyll vine forest) in eastern Australia and a key component of the Gondwana Rainforests of Australia World Heritage Area. This study is located on part of a 1.94 ha permanent plot (the O'Reilly's plot) established by J H Connell and colleagues c. 2 km north of O'Reilly's Guest House (Green Mountains) in Lamington National Park in 1964. The plot occurs at 920 m altitude on soils derived from Cainozoic basalts and contains both warm and cool subtropical elements. In 1998 we commenced recording flowering and fruiting activity of a range of tree species, comprising 10 canopy species and 10 subcanopy or understorey species. Five individuals of each species were surveyed monthly using binoculars to examine their crowns and searching for fallen buds/flowers/fruit. Other species were added opportunistically, while several individuals in the original sample had to be replaced due to mortalities. During the first 15 years of this study, all species flowered at least once. Some species demonstrated a clear annual reproduction flowering every year, while others flowered less frequently (termed supra-annual). Examples are presented as figures. Three anomalously high peaks in flowering (number of species in bud or flower) were evident over the monitoring period. These were August–October 2003, August 2006 and September–October 2009 where 9 (45%), 10 (50%) and 9 (45%) species were recorded in flower or bud respectively. Two of these events coincided directly with fully-fledged El Niño episodes. Flowering appeared to decline following El Niño episodes and remained depressed during La Niña events; this has been particularly evident during the past two years (i.e. 2021–2022).

Predicting vegetation integrity: from structure and composition to quality and quantity

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The forthcoming post-2020 Global Biodiversity Framework aims to achieve a 15% net gain in the area, connectivity and integrity of natural systems by 2050. Here we focus on integrity using the summed plant foliage cover and native species richness of 6 plant functional groups compared to their empirically defined biodiversity benchmark. We extrapolate the spatial patterns in foliage cover and species richness to predict where different plant functional groups are above or below benchmark. We use the log of the response ratio (LRR) to reflect the proportional change to assess the integrity of vegetation relative to a numerical benchmark. We use ensembles of artificial neural networks to build spatially-explicit, continuous, landscape-scale models of foliage cover and native species richness to assess locations where plant functional groups meet or exceed biodiversity benchmarks. These models of vegetation cover LRR performed well (R^2 0.79 – 0.88), whereas models of the vegetation richness LRR were more variable (R^2 0.57 – 0.80). Across our study area (11.5 million ha) we predicted that 1% met or exceeded the cover benchmarks and 0.1% met or exceeded richness benchmarks, indicating that much of the landscape is modified. Maps of vegetation integrity can provide important information to complement assessments of area and connectivity. Our results highlight that to achieve net gains in the area, connectivity and integrity of ecosystems will require significant investment in restoration.

Reshaping how we collect and analyse ordinal data – from past to future practices

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Of the staggering 23 million records within the global sPlot 2.1 vegetation database, approximately 66% contain plant cover-abundance estimated on an ordinal scale. Ordinal plant cover data often need to be transformed into a continuous form (0%–100%), especially when scrutinising summed foliage cover of multiple species. Traditional approaches to transforming ordinal data (for example taking the midpoint of the cover-abundance class), assumes the data are symmetrically distributed. However, skewed abundance patterns are ubiquitous in plant community ecology. Using a modelling solution, we account for the underlying right-skewed distribution of plant cover estimates. We illustrate our method using a case study from New South Wales, Australia (95 812 observations accessed through BioNet Atlas database); compare the model-derived estimates to other commonly used transformations and validate our model using an independent dataset from West Virginia, USA (51 497 observations accessed through the VegBank database). We tailored different transformation values for six different growth forms – trees, shrubs, grasses (and grass-like), forbs, ferns and the 'remaining others'. We show that different plant growth forms require different transformation values. We found that previous approaches overestimated cover, especially of smaller growth forms such as forbs and grasses. By applying a tailored transformation to growth forms, we were able to curtail the overestimation of summed foliage cover. Considering the substantial and ongoing effort to amass new and archival records of plant species from around the globe, these results make a significant contribution to advance analyses and exploration of the ecological attributes of vegetation plot data.

Distribution and genetic diversity of Madeira Island (Portugal) endemic *Geranium maderense* (Geraniaceae)

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Madeira archipelago (760 km^2) is part of the Macaronesia region within the north-east Atlantic, 795 km south-west of mainland Portugal. It comprises the volcanic islands of Madeira, Porto Santo, and Desertas, and harbours close to 180 endemic plant taxa. In Macaronesia, three genera of Geraniaceae (35 taxa) occur: *Geranium* L., *Erodium* L. and *Pelargonium* L. (all neophytes). *Geranium* is a cosmopolite genus, being highly diverse in the mountains around the Mediterranean Basin, Caucasus and Himalayas. In relation to Macaronesia, native taxa occur only in Madeira and Canary archipelagos, including the Canary Islands endemic *Geranium reuteri* and the Madeira Island endemics *G. maderense*, *G. palmatum* and *G. yeoi*. *Geranium maderense* is a perennial, monocarpic herb, up to 200 cm tall, with persistent leaf petioles, producing very showy inflorescences. Although widely cultivated (Madeira and elsewhere), it is a very rare plant in the wild only found, so far, in two localities associated with maritime cliffs, and is classified as a Critically Endangered species (International Union for Conservation of Nature (IUCN)) and a protected species according to the EC habitats directive (Annex *B-II, IV) and Bern Convention (Annex I). Here we present new data on the distribution of *G. maderense*, including 3 new populations detected through Unmanned aerial vehicles (drone) technology, and the first data on genetic diversity (based on the Inter Simple Sequence Repeat method). Results support a clear inter-population diversity pattern, with a clear correlation between geographic and genetic distances.

Genetic diversity of the Madeira Island (Portugal) endemic *Pittosporum coriaceum* (Pittosporaceae)

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The genus *Pittosporum* Banks ex Gaertn. includes approximately 200 species of paleotropical distribution, ranging from Australasia, Oceania, Eastern Asia and the Arabian Peninsula to some parts of Africa (e.g., Ethiopia, South Africa). *Pittosporum coriaceum* Dryand. ex Aiton, is a Madeira Island endemic, representing the sole Pittosporaceae in Europe and Macaronesia. *Pittosporum coriaceum* is a 5 – 14 m tall evergreen tree, with smooth light-grey bark; leathery, glabrous, ovate to oblong-ovate leaves; flowers are small, white-yellowish, and strong-scented; fruits are ovoid apiculate woody capsules, up to two centimetres, dark-brown when ripe. The ecological optimum of *P. coriaceum* lies within the zonal belt of the stink-laurel (*Ocotea foetens*) evergreen temperate forest, often in steep inaccessible rock walls and outcrops. *Pittosporum coriaceum* genetic diversity was obtained through Inter Simple Sequence Repeat in 104 individuals taken from 14 wild populations and 5 garden collections. Considering the low genetic diversity, the species' floral and reproductive biology, we discuss our results envisaging both *in situ* and *ex situ* conservation of *P. coriaceum*, stressing the importance of ancient garden live collections, namely those of the Monte Palace Tropical Garden (Funchal, Madeira).

Conservation of species-rich semi-natural grasslands in Europe: hay management for biogas production

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In Europe, the state of preservation of semi-natural grassland communities is deteriorating due to their improper use, which frequently arises from the problem of grassland biomass management. To solve this problem, new methods of using hay should be sought. Species-rich meadow biomass can be used as a substrate for the production of biogas generated in the anaerobic digestion process. Many species-rich semi-natural grasslands in Europe such as mesic, seasonally wet and wet grasslands require regular mowing and have not yet been fully studied in terms of bioenergy potential. This review summarises the current state of the art techniques and presents future perspectives and problems related to the possibilities of harvesting biomass from different types of grassland that can potentially be a source of substrate for biogas production. The main factors related to the biology of meadow plants influencing their biogas potential are also discussed. Managing grassland biomass as a substrate used in agricultural biogas plants may have a positive impact on the conservation of semi-natural meadow communities. However, the inadequate and intensive use of grasslands may cause problems in securing meadow habitats and their biodiversity. The integration of biogas production with the conservation of valuable semi-natural habitats requires an appropriate and well-thought-out approach. Sustainable and extensive use of this type of plant community will allow us to obtain biomass, maintain the appropriate conservation status of grasslands, and preserve their high biodiversity.

Threats and solutions to safeguard the vegetation of South Pacific islands

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Despite their small area (ca. 100,000 km² excluding Papua New Guinea, or 0.08% of global land area), the tropical islands of the Pacific Ocean harbour a high number of endemic plants (e.g. more than 4,000 tree species or 8% of the world's total). Three of the 36 global biodiversity hotspots are Pacific tropical island countries and territories. This unique plant diversity is threatened by increasing human pressures and disturbance, mainly deforestation, overexploitation, invasive plants and animals, urbanization and climate change, particularly in coastal areas. According to the IUCN Red Lists, more than 30% of South Pacific island plant species are threatened, but the native vascular flora has not been fully assessed so this is an underestimate. Research priorities are a complete species inventory and assessment of current distribution and conservation status, and improved understanding of forest structure, dynamics and ecosystem services. Management priorities include more protected areas, development of integrated controls of invasive species, and habitat restoration and plant reintroduction experiments. Socio-cultural aspects should be integrated into these programs because of the diversity and complexity of local and traditional knowledge and practices, land tenure systems, and governance modes. Islands are extraordinary social-ecological model systems and natural laboratories to study vulnerability, resilience and adaptability of ecosystems and societies to local and global change. However, a key limiting factor to an effective, integrated approach to plant conservation in the South Pacific islands remains the small number of local biologists and conservationists. Thus, education, training and local capacity building are a high priority.

Estimating mean annual rainfall in southeast Australia from pollen assemblage data

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Palynologists analyse fossil pollen assemblages to reconstruct temporal changes in plant communities and infer past patterns of environmental change. To quantify the estimation of environmental variables, the relationship between pollen assemblages and environmental conditions must be understood. An array of 31 pollen trap sites was established in 1970-1975 along a 1400 km transect from Lake Eyre in South Australia to Waldron's Swamp near the New South Wales coast. Mean annual rainfall, calculated using BIOCLIM, ranged from 122 mm in the arid inland to 1073 mm near the coast. Pollen samples were collected periodically from each trap over varying durations (minimum=3 years, median=6.8 years, maximum=9.9 years). Samples were prepared using standard techniques and pollen types were identified and counted on microscope slides. We modelled aggregate influx rates of 35 pollen taxa against mean annual rainfall using generalised linear models with quasi-Poisson errors and log link. Sites were weighted by trapping duration. Jack-knife estimates of rainfall and 95% confidence limits were calculated for each site using a maximum quasi-likelihood approach. Root-mean-squared prediction error was 103 mm. These preliminary results suggest that it will be feasible to refine the modelling approach to provide reasonably accurate estimates of past rainfall from fossilized pollen assemblages in lake sediments and peat cores. Next steps include improving the taxonomic resolution of pollen types, potentially leading to a more powerful estimation model, further testing of prediction accuracy using other modern pollen assemblage data, and application of the model to fossil pollen data to reconstruct palaeorainfall patterns in southeast Australia.

Queensland's Spatial BioCondition Framework: statewide predictions of vegetation condition for biodiversity

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Accurately mapping the condition of native vegetation over large areas is important for applications related to biodiversity offsetting, natural capital accounting, vegetation management policies and conservation planning. Assessments of vegetation condition for biodiversity have to date mainly been limited to site-based approaches. Many jurisdictions have well-established site-based condition assessment frameworks. These frameworks use a suite of compositional, structural, and functional attributes of vegetation as surrogates for biodiversity and compare sites to a reference derived from relatively undisturbed 'best-on-offer' sites within the same ecosystem type. In this work, we moved from a site-based to a statewide product, specific to requirements of the Queensland Government, by undertaking a modelling and mapping approach using remote sensing. As predictors we used Sentinel-2 derived green and bare fractional cover temporal statistics, phenology metrics and the minimum foliage projective cover (2017-2019). Our final gradient boost regression tree model used 8 predictor variables, 17,000+ training points and had an R^2 = 0.73 (estimated using 25% of points exclusively for testing). The standard deviation of the green cover fraction was the most important variable influencing predicted vegetation condition. Assessment with 235 field validation points, collected by stratified random sampling, for the Southeast Queensland and Brigalow Belt bioregions, showed good agreement (R^2 = 0.68, and MAE = 12.91). Challenges remain in predicting in more dynamic non-woody ecosystems and in understanding the influence of the different variables in the prediction. Nonetheless, this work demonstrates a systematic and repeatable method to assess vegetation condition for biodiversity at scales suitable for state level applications.

How does a combination of climate and canopy cover changes affect understory vegetation

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Understanding forest understorey community response to environmental change, including management actions, is vital given the understorey's importance for biodiversity conservation and ecosystem functioning. The Natural World Heritage Hyrcanian temperate forests (Iran) provide an ideal template for furnishing an appreciation of how management actions can mitigate undesired climate change effects, due to the forests' broad environmental gradients, isolation from colonisation sources and varied light environments. We used records of 95 understorey plant species from 512 plots to model their probability of occurrence as a function of contemporary climate, soil variables, and canopy cover. For 65 species with good predictive accuracy, we then projected two climate scenarios in the context of either increasing or decreasing canopy cover, to assess whether overstorey management could mitigate or aggravate climate change effects. Climate variables were the most important predictors for the distribution of all species. Climate change was projected to negatively affect future probabilities of occurrence. However, management, here represented by canopy cover change, is predicted to modify this trajectory for some species groups. Models predict increases in light-adapted and generalist forbs with reduced canopy cover, while graminoids and ferns still decline. Increased canopy cover is projected to buffer an otherwise significant decreasing response of cold-adapted species to climate change. However, increasing canopy cover is not projected to buffer the predicted negative impact of climate change on shade-adapted forest specialists. Except for forest specialists which require other conservation measures, canopy-cover management may help prevent the climate-change induced loss of some important groups for biodiversity conservation.

The climatic niches of endemic *Cleome* (Cleomaceae) in the Irano-Turanian realm

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Rare and endemic species are considered to be vulnerable to environmental changes, due to their restricted and unique ecological requirements. Thus, assessing the effect of environmental variables on geographic distributions of these taxa is necessary to define their conservation status. Considering the ecological importance and rarity of *Cleome*, as well as the presence of some endangered taxa in the Irano-Turanian realm, one of the main centres of endemism, species distribution models are useful to assess the effect of future climate change on *Cleome* species, and to assign their conservation status based on International Union for Conservation of Nature (IUCN) criteria. Current potential habitats of rare and endemic *Cleome* in the Irano-Turanian area (*C. khorassanica*, *C. foliolosa*, *C. heratensis*, *C. turkmena*, *C. rostrata, C. coluteoides* and *C. ariana*) were assessed using six algorithms and both climate and edaphic variables and projected under future conditions by using two SSPs under five general circulation models. Our results showed that both bioclimatic and edaphic variables affect the distribution of the studied taxa. Most of the current potential habitats are located in the desertic regions. Geographically, species distribution models revealed that suitable habitats tend to shrink and shift downward. In addition, the conservation ratings showed a high risk of decline in the most taxa (NT-EN range). These results can be used to determine high-priority regions in the Irano-Turanian realm for conservation purposes of threatened *Cleome*.

Assessing vegetation condition under Conservation Agreements managed by the Biodiversity Conservation Trust

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The Biodiversity Conservation Trust (BCT) currently manages 2,302 private land conservation agreements with landholders over 2.3 million hectares across New South Wales, Australia. From the outset, the BCT has focussed on delivering an evidence-based approach to plan, assess and monitor ecological outcomes. To achieve this, the BCT has developed an Ecological Monitoring Module (EMM) to enable detailed evaluation of management effectiveness, test assumptions about biodiversity gain, and inform adaptive improvement at the site and program scales. A central component of the EMM is an assessment of vegetation condition within each proposed conservation agreement. Vegetation condition is assessed using the Biodiversity Assessment Method measure of Vegetation Integrity (VI). Vegetation integrity is assessed against composition, structure and function benchmarks to derive a score for unique Vegetation Units. These vegetation units are defined by Bioregion, Keith vegetation class, condition state, and management regimes. Vegetation condition benchmarks describe the reference state to which sites are compared to score their site-scale biodiversity values and set goals for management or restoration. To be eligible for a Conservation Agreement a pre-set vegetation condition threshold must be met. In this presentation we will provide an overview of our vegetation assessment methods.

Queensland regional ecosystem framework

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The state of Queensland covers 1.73 million square kilometres, which is five times the size of Germany. It encompasses a wide variety of landscapes across temperate, wet and dry tropics, and semi-arid to arid climatic zones. The Queensland government has a long history of vegetation survey and mapping dating back to 1946 with multi-disciplinary land system surveys, and then systematic vegetation surveys across Queensland since 1971. The survey and vegetation mapping up to this time used standard classifications based on structure, floristics and environment. The Queensland government developed the unique regional ecosystem (RE) framework in the 1990s drawing on the historical land system mapping. The government has developed a consistent, seamless and robust 1:100 000 scale RE coverage of Queensland. Regional ecosystems have the mandatory inclusion of environmental variables as a structural element in the classification hierarchy. Thirteen bioregions and 12 land zones provide higher level grouping of vegetation which reflect climatic and environmental attributes. The RE framework has been primarily expert-based but with the collection of data from over 18 000 standardised plots, the opportunity to use quantitative techniques for identifying and evaluating plant associations will validate and refine the RE concepts. In 2021, 80% of Queensland was remnant vegetation, and this allowed robust preclearing and biennially updated remnant RE coverages to be produced. This system produces detailed statistics and mapping for each RE, and informs legislation and policy at local, state and national levels, underpinning decisions that have wide-ranging implications for biodiversity, government programs and people's livelihoods.

Plants response to estuarine constraints: a study of controlled salinity and inundation

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Estuarine wetlands span a wide array of environmental constraints. As ecosystems at the interface between marine and terrestrial environments, salinity and inundation are among the most important factors impacting growth performances and plant community composition. Vegetation is under high stress in areas where both gradients meet at their high point (close to the river and/or low altitude, resulting in frequent inundations from the tide, and close to the sea, where water salinity is at its highest due to the mixing of fresh water and salt water) and plant communities are shaped by the harsh environmental conditions. In the current context of climate change, a rise in sea water levels will displace salinity and inundation gradients in estuaries and their associated wetlands. This will significantly change the physical and chemical parameters of the soil types and impact the plant communities within estuarine ecosystems. We therefore set out to determine the effect of the modification of water salinity and submergence frequency on plant productivity in a pot experiment in controlled conditions. Five individuals of three species (*Alopecurus geniculatus*, *Festuca arundinacea* and *Holcus lanatus*) of estuarine wetlands were exposed to three saltwater concentrations and three inundation frequencies. Growth and biomass production of each individual were assessed non-destructively through photography weekly for 3 months. Leaf traits (SLA, LDMC and chlorophyll content) were also measured during the experiment. We will present the design of this experimental setup, the photography tool developed especially for this study, as well as the results.

Vegetation community composition and strategies along environmental gradients in an anthropised estuary

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The tidal marshes in the nature reserve of the Seine Estuary in northern France have been shaped by long-lasting and extensive human activities. In this anthropised setting, we have studied the vegetation communities along gradients of disturbance (inundation and salinity), under different land use types (grazing and mowing) and tidal regimes (tidal restriction and tidal influence) in the – often overlooked – oligohaline marshes of the estuary. Our aim was to identify and hierarchise the instrumental factors behind the characteristic patch dynamics of the vegetation communities along these gradients, and to foresee possible trajectories of the communities in a context of climate change and rising seawater levels. Canonical Correspondence Analysis between vegetation and soil surveys revealed that topography, soil pH, conductivity and organic carbon explained most of the differences between vegetation communities, followed by exchangeable cation availability. Community-weighted means applied to functional trait data from the TRY-database and our vegetation surveys have provided evidence for acquisition- and conservation-based strategies at the community level. This method also revealed the stress- and perturbation gradients of our study sites, through Grime's CSR strategies. The stress gradient was negatively correlated to topography and acquisition strategy, while disturbance and conservation gradients could mostly be explained by land use. We also found that the local hydrodynamic conditions of each site were responsible for significant shifts in community assemblages. Finally, we measured significantly longer disturbance gradients on the tidally restricted sites, implying larger ecotones. Tidal restriction may therefore be an appealing decision-making tool for ecological conservation and agricultural practices.

Understanding the importance of cold – and heat – tolerance in mountain plant species

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Temperatures are rising and the thermal regimes of our ecosystems are changing rapidly, becoming warmer and more variable. In the mountains, a reduction in snow cover is expected to bring greater risk of extreme cold events and a general warming trend to lead to more frequent extreme heat and drought events. Many of us are actively researching the impacts of these changes by examining temperature and warming effects on a wide variety of organisms, and yet important questions remain around what determines thermal tolerance or the thermal limits of a species distribution? Are they the same thing? And how best to measure or predict them? To assess the integrated response of organisms and communities to changing thermal regimes requires systems level perspectives that draw together impacts at different scales – e.g., cell vs organ vs organism within a species, or plant vs pollinator vs pathogen at community scales. I will present work our collaborators and I have been doing to better understand thermal tolerance of alpine plants: what drives it, and to explore how best to assess it, at seed, seedling, leaf, and whole plant scales.

Prolonged drought has wide-ranging effects on ecosystem structure and function

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It is well established that observed and projected climate changes, including shifts in rainfall regimes and more severe droughts, will have substantial effects on Earth's ecosystems. The effects are predicted to be particularly large in ecosystems that are considered water limited, e.g. drylands. This is important given that drylands comprise one-third of Earth's terrestrial surface area and support over two billion people. I will present findings of current research focussing on how altered rainfall impacts plant community dynamics. The talk centres on research from a long-term experimental framework, where the effects of altered rainfall regimes (+65% and -65% relative to ambient) have been assessed at six sites in arid and semi-arid Australia since 2016, coinciding with a significant natural drought event (2017-2019). The prolonged drought had detrimental effects on plant standing biomass and below-ground communities, with cascading effects on soil carbon and nutrient pools and fluxes, with less evidence of treatment effects likely due to the severe conditions. Microbial biomass was surprisingly resistant to the rainfall treatments but strong effects on potential exo-enzyme activity and litter decomposition indicates significant changes in ecosystem functioning. I will provide examples of associated work that illustrate the broader effects of altered rainfall regimes, including shifts in plant-soil biotic interactions, that can affect vegetation dynamics. Rainfall variability including prolonged drought can thus have wide-ranging impacts on ecosystem structure and function, highlighting the importance of understanding and monitoring the impacts of global change.

Evolutionary response of cold-adapted chasmophytes to climatic oscillations in the Mountains of Central Asia

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Past climatic oscillations are the main driving force of evolutionary changes in alpine species. The evolutionary species' response to paleoclimatic oscillations is crucial in forecasting their future response in the face of climate warming. Our aim was to explore the effect of climatic fluctuations on the evolutionary history, demography, and distribution of high-mountain plants (*Campanula, Sergia*, *Stipa*) associated with rocky habitats within Central Asia. Tertiary isolation of the Central Asian mountain ranges led to the geographic disjunction of species between Tian-Shan and Pamir-Alai mountains, whereas subsequent Quaternary isolation into subregions led to further intraspecific genetic differentiation. The relatively small genetic admixture among populations indicates rather rare historical events of connectivity. In response to Holocene warming, chasmophyts experienced a substantial decline in effective population size. Currently, their occurrence is highly influenced by precipitation in the coldest and driest quarters. The wider realised ecological niche of the Tian-Shanian taxa allows them to better adapt to global warming and potentially extend their ranges in the future, while Pamiro-Alaian taxa, with its narrower niche, are more susceptible to environmental changes and are potentially at risk of extinction. Our results highlight a general principle that glacial-interglacial cycles and contemporary island-like habitats distribution shape genomic variation of high-mountain species, making a significant contribution to the formation of biodiversity hotspots. The results also underline the urgent need for conservation action in alpine regions and preservation of the natural heritage of this still underexplored biodiversity hotspot.

The studies were supported by National Science Center, Poland (project no. 2018/29/B/NZ9/00313).

Priority areas for conserving Greater Gliders in Queensland, Australia

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The southern and central greater glider (*Petauroides volans*) is a nationally listed endangered species in Australia, dependent on mature native forests for critical habitat resources, including tree hollows. This study aims to map and evaluate patches of potential high-quality (core) habitat and corridors for the greater glider in Queensland. Using remotely sensed metrics, we mapped ten ranked classes of relative forest maturity within greater glider habitat at a 30 m resolution. The results showed that 35% (4.943M ha) of habitat was found in more mature classes (classes 7-9), representing vital limiting habitat resources such as tree hollows. The mean patch size above a 1.6 ha threshold was 122 ha, with most patches (71%) being ≤10 ha. Notably, we identified 14 patches ≥100,000 ha, indicating larger contiguous habitat areas. The distribution of more mature habitat was as follows: freehold and leasehold lands held 63.4%, multiple-use public forests 21.4%, and nature conservation areas 12.8%. Approximately half of the potential habitat was located on formally recognised Indigenous lands, with various categories of Indigenous ownership, management, and special rights. To conserve the greater glider, it is imperative to protect mature forest patches and establish functional movement corridors. These findings underscore the significance of preserving habitats to ensure the survival of this nationally listed threatened species. Our research provides essential insights for policymakers, conservationists, and land managers, aiding targeted efforts for the sustainable conservation of the greater glider in Queensland, Australia.

Influence of personality, psychological and physical state on vegetation sampling quality

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Censuses of species in vegetation plots have inherent errors related to the individual characteristics of the researcher. Their consequences in further vegetation analyses can be of considerable importance. Our research addresses aspects related to the quality of the surveys performed by botanists by testing the accuracy in proper plant identification and assessing species richness. The study considered the influence of age, gender, work experience, personality type, the need for cognitive closure, positive and negative mood, fatigue and the stress stimulus - time pressure. The data collected made it possible to indicate personal and personality traits that are important in assessing species richness, provide correct names in different types of grassland communities (*Bromion erecti*, *Arrhenatherion elatioris*, *Molinion caeruleae*) and to create a profile of the best performing researcher. The results of the study (on 77 persons, including 30 professional botanists) indicate that the most important factors affecting the botanist's perception include age, gender, work experience, stress, need for cognitive closure, agreeableness, conscientiousness, intellect, emotional stability, negative mood and fatigue. The best researchers are women who are around 45-50 years old, well-rested, not too intelligent with a relatively high level of cognitive closure, emotionally stable, extroverted, agreeable, conscientious, able to handle stress well and think positively. The Hirsh index and the number of citations were of little importance.

Acknowledgements: This research was supported by the National Science Centre, Poland, grant no. 2019/35/B/NZ8/03358.

Leaf functional traits are important for the formation of alpine plant communities

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The comparison of mean functional trait values of organisms within a community with those for random samples from the local biota allows us to estimate the importance of those traits for the formation of community composition. We focused on two associated questions: 1) how species from a given community differ by mean values of traits from random samples (with the same number of species) of the local flora; 2) how much mean values of traits of community species differ from Community Weighted Means (CWM). We studied leaf functional traits and the contribution of Grime's CSR-strategies scores in eight in the Caucasus. Most of the studied traits had significantly different values for random samples, means and CWMs. Leaves of plants in alpine lichen heaths, *Festuca varia* grasslands, snowbed communities and subalpine fen were smaller than in random sets, with an opposite pattern for a tall herb community. Specific leaf area was lower than random for plants in alpine lichen heath, *Festuca varia*, *Calamagrostis* and *Bromus variegatus* grasslands and subalpine fen, but higher for snowbeds and the tall herb community. The results obtained confirm the delimiting role of the S strategy for the establishment of communities in habitats with a low snow cover and for dominance there (alpine heaths, *Festuca varia* grasslands). Stress-tolerators prevailed in all the communities, except in the tall herb community where competitors were the most abundant.

Observed and dark diversity of alien plants across the world

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Biological invasion is a major threat to ecosystems worldwide. To facilitate mitigation of this problem, conservation authorities should anticipate new potential invasions before they occur. Here, we identified ecologically suitable but currently absent sets of alien plant species —alien plant dark diversity— in 367 regions across the Earth. The probability that an absent species composes the alien dark diversity in a region was estimated by using co-occurrence patterns and past invasion records of >346,000 species. Global distribution of alien-observed and dark diversity sizes differed considerably. In contrast to trends in alien observed diversity, alien dark diversity was higher in smaller, naturally species-poor, and unproductive dry regions. While both alien observed and dark diversity were unimodally related to temperature, dark diversity peaked at warmer values. Urbanization was the only gradient where alien observed and dark diversities similarly increased, probably due to the higher availability of suitable human-modified habitats. While alien observed diversity increased with economic wealth (GDP), the alien dark diversity decreased, highlighting the importance of the alien species dispersal, which is enhanced by intense trade volumes and human movement. Combining alien dark diversity size with GDP and urbanization projected for 2050, we show that about a quarter of the globe should face highest risk of future invasions. Lists of the most suitable dark diversity species in regions had large overlaps, which would lead to further biotic homogenization. Alien dark diversity allows us to assess forthcoming invasion risks, enabling preparation ahead of time for mitigating adverse effects of biological invasions.

Observed and dark diversity jointly reveal status and trend of plant communities

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Assessment of the status and trends in biodiversity is complex since different regions and ecosystem types vary naturally due to contrasting biogeographic and evolutionary history. The importance of large-scale processes has been widely acknowledged but rarely directly incorporated into diversity studies. Dark diversity offers an operational link across scales by embracing species from a region which can reach a local site, tolerate local conditions, but are still absent. Within the global research network DarkDivNet, we estimated plant dark diversity in >100 regions. Observed and dark diversities constitute a site-specific species pool, an ecologically filtered subset from the regional species list. The proportion of observed diversity from the species pool characterises the completeness of the local plant community. At a local scale (vegetation plot 10x10 m), just a quarter of the species pool is present, and the rest are in dark diversity, which together still makes up just half of the regional species list. Within a region, one-third of the variation of local diversity originates from the species pool size and two-thirds from completeness. Between regions, about half of the variation in local diversity is due to variation in regional richness, one-third is from community completeness, and the remaining is from ecological filtering. In contrast to other diversity metrics, community completeness showed a relatively strong relationship with environmental and anthropogenic gradients (R2=0.35), decreasing with precipitation, soil acidity, change in precipitation regime since the last glaciation, and recent human pressure. Overall, dark diversity considerably improves our understanding of biodiversity in plant communities worldwide.

Impacts of wildfire and short-term recovery in temperate rainforests of northern NSW

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World-wide attention focused on the wildfire impacts and recovery potential of temperate rainforest after 8.6% of internationally significant assemblages in northern New South Wales burnt in 2019/2020. Some plots in a long-term network experienced fire for the first time since 1956, allowing fire response assessments in relation to tree species, size and regeneration mode. Post-fire surveys were combined with litter and fuel accumulation experiments, weather observations and experimental burning to determine when rainforest was likely to ignite and carry fire. Rainforests ignited once fuel moisture was <15%. Most fires were of low–moderate intensity and restricted to the ground–shrub layer with occasional small-tree canopy scorch. Spotting from surrounding sclerophyll vegetation ignited small fires of <0.1 ha, while fires entering rainforest travelled <100 m. Tree mortality was 20–30% and increased with fire severity. Most burnt trees coppiced basally. Seedling regeneration was infrequent due to lack of seed banks. Coppicing was more abundant where fire severity was low. Large trees were more likely to ignite due to basal accumulation of wood and fuel compared to smaller trees. Low fuel biomass and flammability, lack of continuous ground-to-canopy fuels, and strong post-fire coppicing afford temperate rainforest some resilience to one to two fires per century. However, the susceptibility of canopy-dominant trees to basal wounding and collapse is a concern due to their longevity and age, their role in maintaining the rainforest microclimate, and their importance to diverse epiphytic bryophytes. The next generation of bushfire risk management plans are implementing new methods of quantifying risk to environmental assets such as rainforests.

Molecular ecology of New England Tablelands bioregion OCBIL-endemic shrub populations

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Old Climatically Buffered Landscapes (OCBILs) often exist as terrestrial island outcrops that are isolated in a larger landscape matrix. Flora species confined to OCBILs have a high incidence of endemicity and rarity, with an unknown susceptibility to rapid climate change. Shrubs are a significant component of OCBIL vegetation. Certain shrub species do not have seed distribution mechanisms and are pollinated by insect species with limited ranges that may only be active amongst the one OCBIL terrestrial island. Relatively small distances may be sufficient to be allopatric if pollen or seeds are not transferred between detached outcrops populations. However, these shrub species have been able to persist in small and perhaps genetically disjunct populations. This contrasts with general conservation biology strategies for preservation, which aim for large and genetically connected populations to maximise adaptive potential from increased and mobile genetic diversity. A systematic review of molecular ecology papers on OCBIL species, that measured population structure, migration rates and identified pollinators, indicated that invertebrate only pollinated species had highly structured populations with low gene migration rates. Adaptive potential was not studied directly in any of these papers. We will conduct molecular ecology and pollinator studies on several OCBIL shrub species in the New England Tablelands bioregion, to quantify genetic diversity and gene migration within and between OCBIL shrub populations, as possibly proxies to indicate the adaptive potential. Low genetic diversity and no gene flow would indicate the persistence of OCBIL species in small populations may be compromised by rapid climate change.

Allelopathy effects of invasive *Solidago* species on native grassland plant species

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Numerous studies have reported allelopathic effects of *Solidago gigantea* and *S. canadensis*. However, the results are inconsistent, and in the majority of experiments crops or vegetables were used as the tested species. *Solidago* spp. originating from North America are among the most widespread invasive plants in Central Europe. Knowledge about the resistance of grassland species used in habitat restoration against the allelopathic effects of *Solidago* species is important for successful restoration of habitat. This experiment was focused on the effect of water-based extracts from *S. canadensis* and *S. gigantea* on the germination and initial growth of seedlings of 13 common grassland species native to Europe. The novelty of this study lies in the analysis of the impact of particular parts of *Solidago* spp. (roots, rhizomes, stems, leaves, flowers) and testing on numerous common grassland species in *in-vitro* bioassay. Our results showed that the above-ground parts of *Solidago* had a significant stronger negative effect on seed germination and initial seedlings growth of tested species than below-ground parts. The grassland species differed in susceptibility to *Solidago* allelopathy, with the most resistant species being *Schedonorus pratensis, Lolium perenne*, *Trifolium pratense*, *Daucus carota* and *Leucanhemum vulgare*. The results show that before land reclamation, the above-ground parts of *Solidago*, including fallen leaves, should be removed during habitat restoration to reduce the allelopathic effect and the effects of roots and rhizomes seem to be of secondary importance. This knowledge can help in establishing successful and cost-effective methods for grassland restoration in areas invaded by *Solidago* species.

PEMr: An R package to develop cost-effective, accurate and repeatable ecosystem maps

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Accurate ecosystem maps are critical for practitioners to make informed landscape management decisions. We developed a cost-effective, machine-learning based Predictive Ecosystem Mapping (PEM) methodology that produces high accuracy stand-level maps. We consolidated our methodology into an R package (PEMr) to ensure reproducibility and allow application by the wider natural resource community. PEMr provides a comprehensive workflow to enable users to efficiently develop ecosystem maps along with various measures of map quality and uncertainty. The PEMr package consists of four sub-packages, 1) PEMprepr: to download and prepare spatial datasets, 2) PEMsamplr: to prepare sample plans for field collection and consolidate field data, 3) PEMmodelr: to build and assess machine learning models using various ecologically specific accuracy statistics, and 4) PEMmapr: to generate predicted ecosystem raster and vector maps. The package is open-source and hosted on Github. Whilst PEMr provides a specific process for ecosystem mapping, the inclusion of novel or repurposed methods from other scientific fields, enables its broader application in the areas of sample design, novel accuracy metrics, and testing model transferability. The package is optimised for processing large datasets (~4,000,000ha) and is written within a semi-flexible framework, to accommodate varying mapping objectives. Furthermore, the PEMr package contains several tests to estimate the completeness of field sampling (per map unit and by environmental multivariable space). These results can guide future targeted field sampling efforts and are essential in applying and understanding the limits of generated maps.

Biodiversity monitoring from above: linking spectral to local plant diversity

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Biodiversity monitoring is constrained by cost- and labour-intensive field sampling methods. Increasing evidence suggests that remotely sensed Spectral Diversity (SD) is linked to plant diversity. However, studies testing such a relationship reported conflicting findings, especially in challenging ecosystems such as grasslands. With the advances in aerial sensors, it is theoretically possible to capture the direct link between the spectral information at the canopy level and plant species characteristics. Yet, to use SD for biodiversity monitoring, a thorough investigation of the key factors (e.g., metrics applied, spatial resolution) and conditions under which such a relationship exists is necessary. Thus, this study aims to assess the applicability of SD for plant diversity monitoring at the local scale by testing eight different SD metrics while considering spatial resolution effects. Functional and taxonomic diversity were calculated based on data collected in 161 1.5 × 1.5 m experimental mesic grassland communities. Spectral information was collected using an unmanned aerial vehicle borne sensor measuring reflectance across six bands in the visible and near-infrared range at ~2 cm spatial resolution. Our results show that the relationship is significant and positive only when SD is calculated using categorical metrics. Despite the observed significance, the variance explained by the models had very low values, with no evident differences when resampling spectral data to coarser pixel sizes. Such findings suggest that new insights into the possible confounding effects on the SD~plant diversity in grassland communities are needed to use SD for monitoring purposes.

Environmental drivers and trends for plant turnover in the Global Alpine

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A mere 3% of the Earth's land surface is covered by alpine ecosystems, yet their contribution to mountain biodiversity and ecosystem services is unparalleled. These ecosystems are also particularly sensitive to global change and already experience rapid upslope migrations and species turnover. In this study, we aim to explore plant species turnover in the Global Alpine at present and under future climate change scenarios. For 27 main alpine regions, we performed General Dissimilarity Models (GDMs) on 11.867 sPlot vegetation data and 69 topo-environmental factors. The models assessed mean species turnover rates and identified their main drivers in every alpine region. Finally, we used predictions of the previously selected factors according to four climate change scenarios, to project species turnover for 2030, 2040 and 2050. Overall, Oceanian and African regions had the smallest turnover rates, while Andean and Himalayan regions had the highest. These results highlight the importance of environmental heterogeneity along sharp altitudinal gradients on species turnover. Despite drivers varying chiefly between regions, we observed stronger representation of seasonality factors in temperate regions and productivity factors in (sub-)tropical ones. Moreover, future predictions confirmed the high sensitivity of tropical alpine regions to climate change. Our results shed new light on the spatial patterns and future temporal trends of plant turnover in the Global Alpine and provide useful evidence to anticipate climate change impacts in these unique regions.

Alpine vegetation and climate change: insights from 50 years of research

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Alpine ecosystems contain relatively high levels of plant biodiversity and endemism, providing a range of ecosystem services, although occupying less than 3% of terrestrial land. They are among the most at risk ecosystems from warming, with changes in climatic conditions already documented in many regions. Insights into the current academic literature on climate change and alpine vegetation was attained using a bibliometric approach based on metadata from 3,143 publications identified from systematic searches of Scopus and Web of Science. Most of the research is in the broad areas of ecology, environmental sciences, and plant sciences, and nearly entirely in English. Although research extended back to 1978, there was a rapid increase from 2016 on, likely reflecting greater awareness of changes and risks from warming, but also more research from Chinese institutions, and about the Tibetan Plateau. Compared to actual area, there was less information about South America, Asia from North America, but proportionally more research from Ocean and Africa, in part reflecting their small alpine areas, and from Europe, reflecting a larger research effort. Much of the research examined grasslands, montane forests and meadows and treeline ecotones, with less focus on heathlands, arid, wetlands, snowbeds, subnivean vegetation and fellfields. Key references underlying the literature included IPCC reports, and Körner's 2003 book on alpine plant life. More research is required, including harnessing remote sensing and AI to assess current impacts and model future scenarios including increases in extreme climatic events, and a greater focus on South America, Canada and Russia.

Recreational trails facilitating weeds: insights from the Australian Alps and Andes

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Alpine ecosystems have high levels of plant biodiversity but are often threatened by biological invasions as well as other factors such as climate change. This talk summaries research projects in the Australian Alps and Andes that assess the role of tourism and recreation including trails in facilitating the spread of environmental weeds. In both regions similar types of non-native plants, mostly of European origin, benefit from the construction and use of recreation trails including increasing networks of formal (official) and informal (user created) trails in otherwise remote alpine areas. With the promotion of tourism and recreation in many alpine regions, there is increased potential for the unintentional dispersal of seed by hikers and others, with seed from hundreds of species recorded attaching to hikers clothing. Disturbance including from trampling damage to vegetation on and adjacent to trails can then favour the establishment of non-native species with ruderal functional traits over local alpine species that may have more stress related traits. Some non-native plants can then spread away from trails becoming significant environmental weeds in otherwise natural ecosystems. Unfortunately, increased tourism, diversification of recreational activities, combined with climate change and other factors are likely to further favour the spread of environmental weeds in these regions. Strategies including cleaning clothing and equipment of seed, closing inappropriately located (informal) trails and then restoring vegetation, better design and location of formal trails and control of environmental weeds that are already established can help reduce biological invasions in these regions of high conservation value.

Grazing management as a tool for the conservation of grassland ecosystems in South America

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Grassland ecosystems across South America have a long evolutionary history influenced by large grazers. However, the 10,000-year window without large herbivores between their extinction, by the end of the Pleistocene, and the introduction of domesticated cattle in the 17th century may not have substantially altered the regional pool of grassland species. After the Pleistocene, evidence from southeastern South America shows increased paleofires likely due to climate change, human activity, and the lack of large grazers. During this time, fire played the role of a large herbivore in mesic ecosystems, maintaining selective pressure for grazing adaptation characteristics such as rapid regrowth after biomass loss. However, grazing and fire may have differentially selected for other plant traits. In Brazil, while fire has been accepted for the management of grasslands in protected areas, grazing with domestic cattle for the same purpose has been taboo. In this contribution, we present evidence from surveys and long-term grazing management experiments in southern Brazil's grasslands indicating that grazing management is a key tool for generating fine-grain heterogeneity. We also discuss the potential adoption of adaptive grazing management options in protected areas.

Understanding long-term responses of grassland communities to changing rainfall regimes

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Climate models predict shifts in the seasonality, frequency and amount of rainfall that will result in more extreme climate conditions, including longer, more severe droughts. Such shifts in rainfall regimes will likely alter plant communities via direct effects on physiology and growth, and via indirect effects such as shifts in species interactions and altered rates of nutrient cycling. To explore the effects of altered rainfall regimes on the composition and functioning of grassland communities, I established a field scale rainfall manipulation experiment in Western Sydney with two overarching aims: 1) to quantify the impacts of rainfall extremes on the plant community and key ecosystem processes, and 2) to establish the relative importance of changes in the timing versus the amount of rainfall for ecosystem function. Rainfall shelters were used to exclude ambient precipitation, with water reapplied to achieve five rainfall regimes: 1) ambient, 2) 50% reduction, 3) 50% increase, 4) reduced frequency (single application of total ambient rain amount, applied in full once every 3 weeks) and 5) summer drought (12-14 weeks of full rainfall removal). There were clear impacts of rainfall treatments on the productivity, diversity and composition of the plant community, with notable shifts in the ratio of C3:C4 grasses. Reduced rainfall frequency generally had less impact on above-ground plant performance than reductions in rainfall amount, and the biggest effects were seen in response to summer-long drought. Treatment effects sizes varied across the 10 years of the experiment, which included both extreme wet and extreme dry years.

Grassland plant responses to cultural fire in Dja Dja Wurrung country

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Temperate grasslands in southern Australia have been decimated since colonization of Australia, and the few remaining remnants are mostly degraded and fragmented. The disruption of First Nations fire management and the introduction of stock grazing had dramatic and rapid effects on grasslands. Recently, cultural fire has been re-introduced into grasslands to restore both biodiversity and Indigenous connection to country. This provides a rare opportunity to examine if the return of cultural burning can restore plant diversity in ecosystems in which traditional management has been disrupted for >100 years. We explored plant community responses to cultural fire in three grassland sites on Dja Dja Wurrung country in central Victoria. Quadrats were established in burnt and adjacent unburnt plots soon after the fires. Pre-fire fuel loads were collected in all sites, and temperature loggers were used in two sites to estimate soil temperatures during the burns. Data was collected on resources (light availability and soil moisture) soon after fire and again in spring. Floristic monitoring was conducted in each quadrat in spring when most species were identifiable. Resources (soil moisture and light) and structural variables (openness, biomass) differed in burnt and unburnt plots through time. However, native species richness did not differ between burnt and unburnt plots. Exotic species richness increased in burnt plots the second spring post-fire. The lack of native plant responses to the re-introduction of a single fire suggests ecosystems are relatively stable and fire-dependent species (or grazing-sensitive species) may be lost, requiring active restoration through seed addition.

Plant selection of soil microbial communities depends on plant traits and phylogeny

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Plants select microbial species from surrounding soil communities through several mechanisms that include above-ground (shade, temperature) and below-ground (moisture, nutrients) changes in addition to root and leaf litter but, above all, through roots exudates. This process allows plants to select microbial species that best fit their interests. We looked at the effects of plant traits in a group of phylogenetically related species on the composition and structure of soil microbial communities. We selected eight *Arenaria* (Caryophyllaceae) species spreading along the Andalusia region of Spain, all belonging to the same section, *Plinthine*. We expected that phylogenetically close plant species would share more microbial species than distantly related species, as they have similar morphological and physiological traits. We found that the different plant species form different microbial communities under their canopy, attracting or repelling species from the surrounding environment to a different degree. Contrary to our expectations, preliminary results with *Arenaria* sp suggest this selection might be more dependent on plant traits than on phylogenetic relatedness.

Native plants and weeds share a diverse group of flower visitors

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In most systems, plant species coexist simultaneously and share floral visitors. Sharing floral visitors could increase pollinator populations, as an increase in the number of visits often correlates with a greater probability of fertilization. However, some flower visitors are inefficient pollinators and transfer foreign pollen from other plant species. Understanding which pollinators are shared with which plant species is important because some taxa can impact or improve the success of others. We observed flower-visiting insects to native and weedy plant species within five coastal forest reserves between Moonee Beach and Valla Beach in the Coffs Harbour region of New South Wales. Preliminary results indicate that over a 3-month flowering period, approximately 800 individual insects (and 6 spiders) visited 21 native and weedy plant species with bees, flies and beetles being the dominant flower-visitors. Some plants were visited by many flower visitors (up to 15 insect taxa) and others were only visited by a few. Understanding the interactions between native plants and introduced species may inform the management of key threatening processes impacting native plant species.

Ephemeral dune ecosystems, Manawatū coast, New Zealand - thirty years of beach-watching

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The Manawatū coast, on the western lower North Island, New Zealand, hosts one of the most dynamic parabolic dunefields in the world. This presentation reviews what we have learned about these dune ecosystems over the last 30+ years, and where that leaves us for a future of research, management, and climate change mitigation. During the last century, the dunes have changed from mobile sand-sheets to more static parabolics with associated transitory wetlands, to more stable landforms. Over this time the dunes' flora has changed from sporadic sand-binders and sand-plain specialists, to dominance by dune-builders surrounding wetland vegetation, to being vegetated largely by invasive alien species. Research has focussed on documenting these changes, and on understanding their drivers, particularly with respect to disturbance episodes and coastal dynamism. Various management interventions over the years have attempted to alter various unsatisfactory situations, with equally varied levels of success. Overall, the general preparedness of land-managers for future stressors is non-existent to poor, and the future of the coastal ecosystems remains in doubt. More mysterious is the nature of the past (pre-human) ecosystems along this coast, and their floristics. Some plant species are rare, and others apparently do not form coherent communities, which obscures management or restoration goals. The beach remains very watchable after more than thirty years.

Safeguarding the Gondwana World Heritage Rainforests for the future: prospects and challenges

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The Gondwana Rainforests of Australia is a serial World Heritage Area (WHA) of 41 separate reserves, totalling 370 000 ha in area and spanning 4° of latitude across New South Wales and Queensland along the Great Dividing Range and Pacific coast. The listing recognises the wide range of rainforest plant and animal lineages and communities with ancient origins in Gondwana, many of which are restricted largely or entirely to the property. The Outstanding Universal Value (OUV) of the WHA is imperilled by diverse threats, some of which are detailed in the papers in this session. Global warming and greater climatic extremes and megafires are predicted to exceed the specific subtropical and temperate climatic envelopes and largely fire-free regime that have allowed these remnants to persist for tens of millions of years and have already resulted in extinction of significant local populations. Invasive predators, weeds and pathogens and their interaction with changing climate and fire present further risks. In recognition of these threats, the property's International Union for Conservation of Nature (IUCN) Conservation Outlook Assessment rating was elevated to 'Significant Concern' in 2020, meaning significant additional conservation measures are required to preserve the OUV over the medium to long term. Solutions to some threats have already been initiated for specific taxa and include captive breeding and reintroduction programs, plant ex situ conservation initiatives and translocations, and managed fire for habitat maintenance and hazard reduction. However, governance arrangements will need to expand to resource the whole-of-property coordination of priorities, monitoring of key concerns, and implementation of integrated solutions.

Temporal stabilising effects of species richness and seed arrangement on grassland productivity

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The extent to which individuals experience inter- and intraspecific interactions through their spatial arrangements within diverse plant communities, whether because of confounding effects of species richness or direct changes in species patch sizes on their neighbourhood relationships, could affect grassland productivity and its stability at community scales. Elucidating the ways in which neighbourhood effects and species richness contribute to such community responses has important implications for how practitioners establish grasslands to meet forage production and conservation goals. We assessed the effects of altering plant species richness and seed arrangements on productivity and its temporal stability in developing grasslands seeded with a suite of globally common forage species. Communities seeded with more species and those with their seeds arranged into smaller conspecific patches produced more biomass and were more temporally stable than those seeded with fewer species and larger conspecific patches. The effect of manipulating species arrangements is attributable to greater neighbourhood scale interspecific interactions and stronger complementary effects. Furthermore, seeding species into conspecific patches resulted in communities that were 34% more productive, that were just as temporally stable, and that had similar diversity effects as those seeded with a species mixture, as is common in grassland reconstruction efforts. In comparison with conventional mixed-seeding methods, seeding grasslands with high species richness and small, single-species patches may promote grassland reconstruction. Our study highlights the importance of regulating intraspecific interactions and suggests that efforts to reevaluate methods used to establish forage and conservation grasslands could result in greater productivity and stability.

How to grow a Mulga: benchmarking characteristics of Mulga stands across Australia

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Mulga (*Acacia aneura*) dominates in the Australian arid environment. The species is known to vary in morphology from small shrubs to tall trees forming forests. As such a widespread species through the arid regions, Mulga is of commercial interest for carbon farming, as well as cattle and sheep fodder. While it has high commercial interest, our understanding of Mulga biology is patchy. Papers capture various traits; however, depending on where the data was collected, these traits can vary widely. In order to establish a deeper understanding of Mulga and establish clear benchmarks for expected behaviour in process-based models, we compiled available trait findings from the literature and combined this with new field data to define typical metrics for Mulga stands. Recorded metrics include aspects of stand structure (biomass, density, size), the allometry of individuals (height, crown volume, basal area) and traits. We consider the upper and lower limits of traits, the feasible relationship between traits and how the 'average' Mulga grows. This allowed us to have a stronger picture of what we know and don't know about Mulga. Benchmarking Mulga provides a baseline for modelling how Mulga grows today and how that might change as climate changes. We acknowledge the Traditional Owners on whose land my research was undertaken - Wongaibon, Barungji, Wadigali and Eora nations.

Temporal dynamics and assembly patterns of the Gondwanan rainforests, and implications for conservation

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The processes leading to the establishment and persistence of plant assemblages, intended as the processes by which species from regional pools merge and interact to form local communities, are of great interest to ecologists and evolutionary biologists. Understanding what drives the distribution of biodiversity is particularly relevant in the context of continuing anthropogenic impacts on natural systems, the developing climate crisis and current extinction rates. In previous research we consolidated our understanding of some of the processes impacting on the evolutionary and assembly patterns that we observe in current Gondwanan rainforest communities. Current distributional and assembly patterns have been impacted by the intensifying habitat disturbances of the Quaternary, which facilitated highly dynamic processes and differential responses from rainforest lineages with different histories and functional competences. Such processes leave landscape-level genetic signatures of distributional changes that can validate current interpretations and guide improved management strategies. We are currently finalising a macro-genomic study using an innovative multispecies genetic, functional, and environmental, dataset that aims to define the origins of current rainforest assemblages by investigating the relative contribution of current vs historical selective filters and dynamic process. We are discovering that co-distributed species don't necessarily embody similar histories or respond to the same drivers. Similarly, we confirm that the distribution of evolutionary potential is not evenly distributed across extant rainforest vegetation. From a biodiversity conservation viewpoint this suggests that different strategies can be considered for the management of different species (e.g., historically fragmented vs recently expanded) and different areas (e.g., refugia vs expansion corridors).

Stakeholder perspective on the use of active restoration in biodiversity offsets

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Despite its controversial nature, biodiversity offsetting is increasingly used as a policy tool for counterbalancing the biodiversity impacts of urban and infrastructure development. It aims to do so by compensating for biodiversity loss in one area with the generation of equivalent gains elsewhere. Ecological restoration, which encompasses a range of approaches from passive to active forms, is one of the methods that can be used to generate biodiversity gains. However, many uncertainties are associated with ecological restoration, notably its more active forms, and there are diverse perspectives on whether it can achieve sufficient gains to counterbalance losses. In this study, we present the perspectives of stakeholders involved in the Biodiversity Offsets Scheme and the restoration industry in New South Wales on, firstly, whether active restoration 'should' be used to achieve biodiversity gains, and secondly, whether active restoration 'can' be used in offset schemes. In the latter case we focus on stakeholders' views on the technical feasibility of using active restoration to achieve biodiversity gains. We also discuss ways in which the design and governance of offset schemes could facilitate the use of active restoration in a way that increases stakeholders' confidence in their ability to generate biodiversity gains. This study contributes to knowledge by shedding light on the perspectives of stakeholders involved in biodiversity offsets and restoration on the use of active restoration in offsetting. Additionally, it provides new insights on the specific challenges of using active restoration in the context of offsetting.

Succession and interannual variability in the herb-layer composition of European beech forests

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Understanding how vegetation changes after natural disturbance is crucial to assess the impacts of silvicultural activities on forest biodiversity. After the fall of a large beech tree, I resurveyed the herb-layer vegetation yearly between 2012 and 2022 in a beech forest in the Apennines (Central Italy). I established nine 25 m^2 permanent vegetation plots: three in the ~400 m^2 canopy gap, three at its margin, and three in the forest interior. Ten years after the treefall, ingrowth was almost absent and lateral expansion by neighbouring trees was insufficient to close the gap. Canopy openness in the gap plots decreased from 29% to 21%. The herb-layer in the canopy gap underwent a sevenfold increase in total cover and a twofold increase in species richness. Helical graphs show that this increase was sustained for the first seven years before slowing down. Plots at the forest margin and interior, contrastingly, did not show clear successional changes in herb-layer cover and richness. Interannual compositional variability, however, was high: both the nestedness and turnover components of year-to-year beta diversity were higher in forest interior than in the canopy gap. These results suggest that the herb-layer is more dynamic than previously thought. Not only does it reacts quickly and sustainedly to canopy openings, but it varies markedly from year to year even where light conditions are stable. These results stress the importance of disentangling interannual variability and succession when studying vegetation changes in forests and suggest many species might remain undetected when vegetation is sampled only once.

Restoring a Mediterranean grassland by sowing and reinstalling the original stone cover

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The pseudo-steppe of La-Crau is an old-growth grassland located in southeastern France that has been degraded by intensive agricultural activities over the last 50 years. They have led to changes in plant communities, soil and fauna that are still measurable decades after the abandonment of former cultivation. In 2001, we thus reinstated the stones that covered 50% of the ground before cultivation. In 2003, we sowed the structuring perennial grass, *Brachypodium retusum*, in a crossed experimental design. In 2021, we analysed the physicochemical composition of soil, litter and forage, we studied plant communities by sampling vegetation and the persistent seed bank, and we sampled above and below ground arthropods. Our results show that stone cover restoration had a positive effect on soil pH, bringing it closer to that of the original grassland, and on the abundance of non-target species abundance in the seed bank. On treatments where *B. retusum* was initially sown, the seed bank of annual species was significantly lower, and the flora more mesophilic than in the reference grassland. Finally, the biomass and litter mass of *B. retusum* were higher than in the treatments where there was no initial sowing. Regarding the mesofauna, acari were positively influenced by the restoration of the stone cover, while collembola were in lower abundance in treatments with *B. retusum*. Spiders and isopods were also in lower abundances where *B. retusum* was initially sown. Coleoptera abundances showed no significant difference between treatments and were lower than those observed in the grassland.

Using local and nature-based solutions to restore Mediterranean grassland ecosystems

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In the face of global changes and the sixth biodiversity extinction crisis, ecological restoration has been recognised as an indispensable complement to the conservation of species and habitats. Restoration interventions must be based on the use of species and ecological processes rather than on civil engineering. In southeastern France, the dry grassland of the Crau plain is an ecosystem that has been severely degraded over the past 50 years by intensive agricultural activities and quarrying. Success of spontaneous restoration of this grassland is hampered by limited seed dispersal and poor establishment of structural perennial species. Given the low resilience of the plant community in this ecosystem, active introduction of propagules from local, non-degraded communities is then necessary. We therefore tested different types of seedlings (a locally sourced commercial mixture; hay flower harvested from the steppe; ants seeds from refuse piles) in order to understand the mechanisms favoring recruitment and establishment of seedlings of typical steppe target species. This experiment was carried out *in-situ* in five experimental sites: the non-degraded steppe ecosystem and four degraded sites: two sites exploited by an alluvial quarry with a backfill of inert materials and either (1) the topsoil of the steppe, or (2) the soil of an intensive orchard; and two former orchards with either (3) normal plowing (15cm), or (4) deep plowing (25cm). The three seed types were also sown *ex-situ* in greenhouse under optimal conditions with soil from the five experimental sites and a control soil.

The Miyawaki method as an educational tool in Italian schools: a proposal

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The Akira Miyawaki reforestation method is a sophisticated, ecologically sound approach for environmental restoration. Originally developed in Japan and countries with heavy rainfall, it has been adapted by us to a Mediterranean climate through modifications such as: choice of plant species, selected not only in the terminal or late successional stages but also in the medio-successional stages of the forest succession; use of local soil added with compost and biofertilizers instead of soil brought in from outside; different types of mulching. While high planting costs make it less competitive compared to traditional techniques, the Miyawaki method has produced notable results in Italy and proven valuable for environmental education among children and young people. In fact, in addition to teaching the rudiments of dendrology, it is suitable for illustrating the concepts of ecological succession, adaptation and cooperation also with reference to the social and behavioural sphere. In Italy, the method has led to the creation of micro-forests in schools and to the establishment of the Tiny Forest Italia association, which uses the Miyawaki method to teach natural sciences. Micro-forests consequently become the subject of discussion between teachers and students who explore potential changes to the basic method. Interesting prospects for development and research are already emerging, both for the numerous urban forestation programs promoted in Italy in recent years, and for forest landscape restoration projects over vast areas where the Miyawaki tiny forests can play their role of starting groups for a progressive expansion of the forest cover.

Species gains and losses along temperature gradients

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Natural vegetation is increasingly being modified by global change. With climate zones moving poleward, it is interesting to know how rapidly species are gained and lost when travelling along temperature gradients. However, our knowledge is weak regarding how vegetation responds to global change, especially to increasing temperatures of plus 2°C and beyond. Using two case studies, this talk will show how natural vegetation changes along temperature gradients as well as discusses whether species functional traits facilitate movement poleward. The first case study will describe how rapidly plant species are gained and lost when travelling along temperature gradients across Australia and discusses whether current day spatial patterns can form baseline predictions for future warming scenarios. The second case study will discuss which species may be best adapted to bridge distances on the mainland under warming climate using insights gained from plant species occurrences in an island system in Western Australia. Arising out of these case studies, future research possibilities are outlined for addressing the impact of global change on vegetation dynamics across spatial and temporal scales.

Celtic pig impact on the understory of an Atlantic oak forest

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The silvopastoral systems oak forest-pig race Celta in the Northwest of the Iberian Peninsula have demonstrated their economic and environmental importance. The introduction of animals causes an impact on the vegetation; however, to understand its impacts an experiment was established with the objective of determining impacts on vegetation cover and floristic composition of the understory before the entry of cattle and after one and two grazing cycles with three stocking rates. The trial was undertaken in a typical Atlantic oak forest, with other accompanying species such as pines, eucalyptus and chestnut trees. The experimental design consisted of establishing three blocks, with three plots per block, corresponding to the three levels of stocking rate tested: control without the presence of cattle, low stocking rate with 4 pigs•ha-1, and high stocking rate with 8 pigs•ha-1. In each plot, between 13 and 20 sampling areas of 1.5 m radius were installed around each intersection of a 20x20 m grid. A proportional reduction to the stocking rate was observed in the total number of species and in the understory cover. This reduction was greater in the second year of grazing, coinciding with the largest rooted area. The Shannon, D (1-Simpson) and Pielou indices decreased with time and stocking rate, while the Jost index increased. Some considerations regarding the management and conservation of plant diversity of these systems are provided.

Lord's designs are inscrutable: The peculiar relationship between *Centaurea ultreiae* and *Eucalyptus*

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Centaurea ultreiae Silva-Pando is an edaphoendemic plant from north-western Spain that grows within an area of 30 km^2 on gabbros and related rocks. It has been included in the International Union for Conservation of Nature (IUCN) Category for Spain: CR B1+2a,b(i,ii,iii,v) (Rodríguez Oubiña, 2003) and later incorporated into the Galician Catalog of Threatened Plants in the "endangered" category. In 2003, a total population of 6821 foliar shoots were estimated with a relatively good state of conservation. It has been considered that the cultivation of *Eucalyptus* and the construction of new roads and tracks may harm the species. Since 2020, field surveys have been carried out to check the status of the population and carry out a new census of it. In addition, monitoring plots of 10 x 10 m^2 have been installed, along with transect sampling and two plots of 15,000 and 14,000 m^2. The data obtained and its relationship with the rocky substratum, soil characteristics and habitat and type of cover are presented, showing that the plants grow exclusively on gabbros or similar rocks, in non-waterlogged soils, but with a certain moisture content, even in summer. Floristic composition is related to the type of soil and tree cover, and a large increase in the number of ramets has been observed. The relationship between the populations of *Centaurea ultreiae* and *Eucalyptus* plantations are emphasised. Some considerations on the actions of protection and conservation of the species are provided.

Vegetation management in NSW State Forests

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Vegetation management within the State Forests of New South Wales (NSW) is key to the sustainability of the forests. Since the late 1990s, Regional Forest Agreements and Integrated Forestry Operations Approvals have regulated State Forests from the extent of land set aside as reserves and being available for timber harvesting to the survey, monitoring and threatened species protection requirements. Revision of these regulations in 2018 has led to the Coastal Integrated Forestry Operations Approval with modern mechanisms designed and implemented for the management of vegetation in NSW State Forests. These mechanisms include formal reserves, averaging approximately 40% of the State Forest estate, surveys, protection exclusion zones for individual records, protection of mature individuals, flora species management plans, flora road management plans, and collaboration with and support for a range of external researchers and monitoring.

A new vegetation classification of a global biodiversity hotspot

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This study constructed a new vegetation classification in the global biodiversity hotspot of south-western Australia. The Swan Coastal Plain is a Mediterranean-type ecosystem that extends over a million hectares and forms part of this hotspot of biodiversity and endemism. The Swan Coastal Plain includes a range of priority and threatened ecological communities. We compiled and curated data from 2390 floristic plots over the extent of the study area, then analysed these as part of a new classification for the Swan Coastal Plain bioregion. Our project is focussed on Banksia Woodlands of the Swan Coastal Plain, which is listed at a federal level as a Threatened Ecological Community. This presentation will focus on the analysis techniques used, the broad results of the new classification and applications for decision-making.

Monitoring of non woody vegetation change in NSW

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Since the commencement of the Local Land Services (LLS) Act 2013 on the 25 August 2017 the Science, Economics and Insights in the New South Wales (NSW) Department of Planning and Environment (DPE) has been capturing non woody clearing events, identifying the removal of grasses, small shrubs and groundcover across NSW from their previously relatively undisturbed state since 1990. This non woody landcover disturbance (NWD) method is applied statewide and combined with the Statewide Land and Tree Study (SLATS) woody clearing data to report on landcover change for NSW annually. The NWD method draws upon: (1) high resolution satellite imagery sources such as Sentinel-2 from the European Space Agency and commercially available imagery from SPOT (Airbus Defence and Space) and Planet; (2) high resolution aerial imagery including circa 1990 aerial photography scanned and rectified by NSW DPE; (3) time series analysis of Landsat imagery (NASA and the USGS) to detect seasonal patterns of spectral changes from 1990. Non woody clearing events are captured over a calendar year, using the same start and end date Sentinel-2 Imagery as SLATS to enable consistent landcover change reporting. Some of the challenges associated with detecting non woody clearing events is that landcover change is implemented over extended periods of time and the management interventions can vary across different geographical locations and landscape type. The frequent repeat coverage of satellite imagery such as Sentinel 2 and Planet, has enhanced the ability of the team to detect the sequence of management interventions over time to confidently detect non woody clearing events.

Land-use richness can predict urban spontaneous plant richness at finer spatial

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It is widely accepted that biodiversity is influenced by habitat diversity per unit area. Urban spontaneous plants, that are not intentionally propagated by humans and do not belong to the remnants of the natural habitats, not only occur in green spaces but are also distributed in diverse microhabitats in impervious surface areas. Here, we surveyed spontaneous plant composition and land uses (12 types) in 321 0.25 ha sampling sites on the Chongming District islands, Shanghai, to determine the role of land-uses richness in explaining species richness. We applied linear regressions to examine the relationships between species richness and land-uses richness and quantified the importance of impervious surface coverage and land-uses richness using the Random Forest (RF) method. All these analyses were conducted for spatial scales from 0.25 to 5 ha in 0.25 ha increments. We found an overall positive relationship between species richness and land-uses richness, and the RF model predicted approximately 50% of the species richness variation at the smallest spatial scale. However, the positive relationship weakened with spatial scale increase, and a rapid decline in explanatory power occurred for all predictor variables in the RF model. In addition to impervious surface coverage, both the vegetated and non-vegetated land-uses richness contributed substantially to the prediction of species richness at finer spatial scales. The findings clarify how land-use diversity, both in green spaces and impervious surface areas, affects urban spontaneous plants richness and should be considered in urban biodiversity conservation planning at the neighbourhood scale.

Trade of potting substrates as a largely overlooked way of long-distance dispersal

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Humanity spreads numerous species, but the intentionally dispersed plants are often accompanied by other plant species dispersed accidentally. The global horticultural trade can disperse large quantities of propagules, yet has rarely been studied from an ecological point of view. To start filling this knowledge gap, we studied the viable seed content of potting substrates to answer the following questions: (i) At what density and diversity do substrates contain seeds? (ii) Does the composition of the substrates affect their seed content? and (iii) Do the dispersed species share traits and characteristics? We detected 438 seedlings of 66 taxa and found that 1 litre of substrate contains 13.27 seeds of 6.24 species on average. The seed content of the substrates varied highly and substrates containing manure contained considerably more species and seeds than substrates without manure, indicating that this pathway is an interplay between endozoochory and accidental human-vectored dispersal. Species that germinated from the substrate samples had higher specific leaf area and smaller, more persistent seeds than the regional flora, traits which facilitate endozoochorous dispersal. Our findings demonstrate that potting substrates can disperse large numbers of seeds of a wide range of species over large distances. In conclusion, this process constitutes Long-Distance Dispersal (LDD) in almost every case; thus, it can have significant and complex effects on plant populations and communities. However, as this dispersal pathway is largely understudied as a type of LDD, its ecological and conservational consequences are unknown.

VegTrends: assessing long-term trends in European vegetation and evaluating protected areas effectiveness

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Many terrestrial habitats across the globe are currently assessed as "threatened", and the extent to which existing protected areas effectively safeguard biodiversity is debated. With many ecosystem services depending on plants, reliable estimates of long-term vegetation change are needed as a benchmark for future monitoring and reporting, as well as to plan and undertake effective conservation measures. We hereby present VegTrends, a new EU-funded project aimed at: i) providing a multi-habitat and multi-faceted assessment of temporal vegetation changes across plant communities and species; and ii) evaluating the effectiveness of protected areas in conserving European habitats. Building on an unprecedented number of previously disconnected datasets now included in the ReSurveyEurope database, VegTrends will allow production of the first comprehensive and representative report of temporal trends in the vegetation of European open habitats accounting for the effects of protection status (Natura2000 + Emerald Network). As well as assessing compositional shifts and quantifying changes in taxonomic, functional and phylogenetic diversity metrics, we will analyse trends in biological variables defining changes in conservation status (e.g. richness and cover of habitat specialist, threatened and alien species) and investigate whether they differ based on protection status. Moreover, we will identify driving mechanisms (turnover vs nestedness, gain vs loss) and test for the exceptionality of observed changes. This will allow pinpointing habitats and species that underwent the strongest changes, with important implications for habitat conservation.

Uncertainty of outcomes for in-perpetuity agreements

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Managing a biodiversity site in perpetuity leads to a lot of questions – not the least of which is: What am I wanting from the ecological communities I am managing? The concept of a climax community, while very desirable, may also not be the best community for the biodiversity under management. I am a participant in the New South Wales Biodiversity Offsets Scheme, which relies upon a landholder land manager to undertake the management of the ecology to create more habitat (or better habitat where the property is largely already vegetated) for entities for which they are providing the biodiversity offset. As the impacts are generally permanent, so too must the offset be. However, does this mean that the offset acquired in 2023 must forever be for that community and species habitat? In terms of climate change affecting the seral stages of vegetation we are working largely in a vacuum. We can presume how certain entities are likely to respond, but need to consider if these are also keystone or engineer species. Considering the total offset too needs to be undertaken is the thought that, if the development site had continued to be unaffected, would it have trended as the managed community is also trending under the application of management, or would it have remained largely static or even undergone a continuing decline through factors such as weed invasion, loss of fire management practices and/or other factors that will change the structure and composition of the vegetation over time?

The distribution and evolution of flower size across the eucalypts

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The diversity of vertebrate pollinators in Australia, particularly songbirds, is often attributed to the ubiquity of eucalypt (*Eucalyptus*, *Corymbia* and *Angophora*) trees in Australian ecosystems. Eucalypt flowers produce copious nectar which feeds a diverse range of animal pollinators and as a group are highly diverse with over 850 species. While most eucalypt flowers are relatively small, some eucalypt flowers can be very large (up to 10cm across), and it is thought that large eucalypt flowers are bird pollination specialists, while smaller eucalypt flowers are pollinated by a mix of insects, birds and mammals. Our study characterises the patterns of eucalypt flower size distribution and evolution. We predict that flower colour has co-evolved with flower size in eucalypts, with larger flowers also brightly coloured to attract bird pollinators. Given bird pollination often improves gene flow between small, isolated populations we also predict that larger flowers have evolved more frequently in range-restricted eucalypts. We combine data on eucalypt traits from an online flora (EUCLID), range size data from specimen geolocations and a recent molecular phylogeny of the eucalypts. Using models of correlated evolution, we show that large, colourful eucalypt flowers have evolved more frequently in southwest than southeast Australia, and larger flowers occur in eucalypts with smaller ranges in the southwest but not the southeast. This will give us insight into the potential drivers of flower size evolution, and the distribution of vertebrate pollination across the Australian continent.

Disentangling native and alien plant diversity in Brazilian grassy ecosystems

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Biological invasions are one the main causes of biodiversity change, with impacts also on ecosystem services. To know the mechanisms behind biological invasions is not only important to understand the process of biological invasion as such, but also to be able to predict which species present a risk to be invasive in the future. Here we aimed to determine the level of invasion of natural grasslands in Southern Brazil, as well as the drivers of variation in native and alien plant species. We used data from plant communities sampled in 108 plots distributed in 12 sites of 25 km^2 each in *Campos Sulinos* grasslands. At each plot, the presence and cover of all native and alien plants were obtained. We registered 756 plant species, of which 43 have non-native origin. Alien species were recorded in all sampling sites. First results revealed that our areas have a low level of invasion, with alien species representing from 0.76 to 9% of the site total species richness and 0.1 to 8% of vegetation cover. Despite the low occurrence of alien species, the presence of grasses *Eragrostis plana* and *Cynodon dactylon* is problematic, due to the high invasiveness potential of these species in highly conserved areas. Vegetation data from other Brazilian ecosystems are available and are being incorporated into analysis, as are the environmental and anthropogenic drivers.

Advancements in vegetation mapping: exploring the accuracy and efficiency of 3D API

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Traditionally, vegetation mapping across Australia has relied on expert Aerial Photographic Interpretation (API) analysts using stereo pairs of geo-rectified colour print photos. However, with the evolution of technology in the 2000s, including advancements in imagery capture, software, and hardware, there has been a transition to very fine-scale digital stereo (3D) API. In this presentation, I focus on the use of high-resolution imagery (50cm pixels) which has been captured across most of New South Wales. On-screen digitizing is performed at a fine scale using ArcGIS in conjunction with specific 3D software. By combining stereo imagery with datasets such as digital elevation and surface models (DEM and DSM), soils and geology, and field survey data, vegetation boundaries can be accurately defined. Compared to traditional methods, experienced analysts using 3D API achieve a level of accuracy that was previously unattainable. The 3D perspective enables the identification of individual tree species, canopy height, midstory structure, as well as grassy and shrubby understoreys. Moreover, landscape position, elevation, and topographical features greatly assist in the precise delineation of vegetation community boundaries. Despite these benefits, the adoption of 3D mapping techniques by botanists and spatial ecologists remains limited. Through a series of real-world case studies, I will discuss the accuracy and efficiency of 3D API in comparison to other current techniques. I will highlight the substantial value that this mapping approach provides. Additionally, I will explore the challenges and barriers to entry, as well as the key factors influencing mapping decisions in New South Wales.

Importance of accurate assessments of biodiversity offset properties

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Biodiversity offsets are increasingly becoming an important mechanism for mitigating the impacts of development on biodiversity. The success of offsets depends on accurate assessment of properties, including the quality, quantity, and spatial configuration of vegetation and threatened species habitat. In this presentation, I will discuss the importance of accurate assessments of offset properties and how biodiversity can be appropriately valued. I will explore some of the greatest challenges to the successful establishment of biodiversity offsets including collection of adequate baseline data, mapping, use of suitable metrics to determine current habitat quality, expected gains under management, assessing restoration potential and land availability. I will examine the key factors that influence the effectiveness of biodiversity offsets, including the quality and types of vegetation and habitat present and the ability of an offset property to provide similar ecological functions to land being impacted. I will explore various metrics used to determine offset ratios, and how offsets can result in no net loss to biodiversity. I will discuss spatial configuration including the need for offsets to be near development sites to provide the required biodiversity gains. The cost-effective delivery of offsets is challenging, particularly in market-based systems, however there are significant opportunities for landholders to receive ongoing management payments to improve biodiversity values into the future. By understanding the key requirements to the delivery of accurate assessments of biodiversity offset properties, combined with management of risks, we can develop more effective offsets that deliver positive outcomes for the environment.

Post fire assessment of the Gondwana Rainforests of Australia World Heritage Area

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The bushfire season of 2019/2020 was the most extreme and widespread experienced in New South Wales (NSW). The unprecedented fire season was triggered by an intense prolonged drought, with the most significant increase in severe fire weather days since recording commenced. The fire raged through precious landscapes that had not been burned in living memory and were thought to be largely protected from wildfire. The Gondwana Rainforests of Australia World Heritage Area are home to outstanding examples that represent major stages of the Earth's evolutionary history, ongoing geological and biological processes, and biological diversity. Plant and animal lineages and communities with ancient origins in Gondwana can be found within the Gondwana rainforests, many of which are largely or entirely restricted to it. This presentation details the impacts of the 2019/2020 bushfire season in the rainforest within the Gondwana World Heritage Area in NSW, with a particular focus on Oxley Wild Rivers National Park. I used a variety of methods to understand the extent, severity, threat and regeneration of rainforests including aerial surveys, field surveys, drone surveys, and spatial analysis to compare and contrast the impacts of the 2019/2020 bushfire season on rainforest. My surveys have been undertaken over multiple years post fire and seek to inform management actions to assist the recovery of the rainforests within the World Heritage Area. There are considerable challenges for the long-term management and recovery of rainforest including significant time spans and projected climatic changes including increasing temperatures and more extreme weather events.

Along the river: taxonomic, functional and genetic diversity patterns of riparian plants

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Riparian zones along rivers are shaped by multiple factors, including hydrologic disturbances, dendritic structure, and downstream-biased dispersal. The longitudinal (upstream-downstream) gradient is frequently used in biodiversity studies, and multiple ecological theories related to the gradient have been developed. Some of these are related to the continuous change of physical properties (channel width, light availability, accumulation to erosion ratio); others focus on the role of hydrologic disturbances (changing frequency and intensity along the gradient) or concentrate on the prevalence of unidirectional dispersal (which causes the accumulation of diversity downstream). We used a multi-aspect approach to investigate patterns of taxonomic, functional, and genetic diversity of riparian vegetation along the longitudinal gradient. The study extent includes the collection of data in well-preserved watersheds in southern Poland and the meta-analysis of data from the literature. In the experimental part, taxonomic diversity showed unimodal patterns of increased diversity in mid-reaches. The investigation of functional diversity patterns showed a continuous transition of plant strategies along the gradient, reflecting the change in light availability and soil conditions rather than levels of hydrological disturbance. At the genetic level, we found evidence that within-species diversity is affected by unidirectional dispersal only for species adapted to hydrochory, without alternative dispersal strategies (particularly zoochory). Additionally, the population genetic patterns depend not only on the species traits, but also on the environment (habitat fragmentation). Our study emphasises that in such complex structures as riparian vegetation, the use of multiple facets of diversity leads to a deeper understanding of the underlying processes.

The importance of rare and subordinate species for ecosystem services in grasslands

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One of the most important ecosystem services of grasslands is the production of biomass. In addition, grasslands support a large diversity of plant species. It has long been recognised that grassland communities consist of a few common species and many rare ones. According to the mass-ratio hypothesis, ecosystem properties are primarily determined by the dominant species. Yet, little is known about how rare (in terms of frequency) and subordinate (in terms of dominance) species contribute to overall biomass production. We hypothesised that even if a single, infrequent and subordinate species is rather meaningless relative to overall biomass production, the combined contribution of such species is significant. Based on species-specific biomass data from semi-natural grasslands in Central Europe (Poland and Czechia), we demonstrated high inequality in biomass among co-occurring plant species. On average, half of the total biomass production was dependent on common and dominant species. High biomass inequality was due to five grass species, which constituted on average about 49% of the total biomass. Worth noting is that a total of 165 species were recorded in biomass samples, and that the biomass inequality decreased with increasing functional diversity (Rao's index). Infrequent and non-dominant species were the core of the diversity seen in the studied grasslands and made up a significant portion of the total biomass. We postulate that the maintenance of species diversity in grasslands should be prioritized in nature conservation policies to ensure the sustainability of grasslands ecosystem services.

Vegetation databases underestimate species richness at the landscape scale

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Mapping of Species Richness (SR) patterns is pivotal for biogeography and nature conservation. Vegetation plot databases serve as a relatively new source of information for SR examination including modelling. However, they inherit the methodological background of data collection which could bias the SR estimation at a landscape scale. Such a bias can be substantial but is rarely evaluated. Here, we directly compared SR estimates between two different data sources: (1) a vegetation-plot database, the Polish Vegetation Database (PVD), and (2) a species distribution atlas, the Atlas of Distribution of Vascular Plants in Poland (ATPOL). Analysed was an area ca 32,000 km^2 using data from 117,328 vegetation plots (PVD) and SR estimated for 3,280 10 x 10 km squares (ATPOL). The results show that the SR documented by the PVD is significantly lower than that recorded by the ATPOL, but still significantly increased total SR estimation at a landscape scale. The PVD SR increased as more plots and vegetation classes were sampled. However, even in the best sampling areas (more than 300 vegetation plots and 15 vegetation types sampled per 10 x 10 km square), the PVD SR was still significantly lower than that in the ATPOL. Assessed values for the species accumulation curves suggested high sampling completeness in the PVD, but the real bias was still substantial, and no correlation was found between PVD bias and species accumulation curve values. In general, the PVD significantly underestimated SR at a landscape level, yet it augmented information stored in the ATPOL.

Conspectus of the vegetation types of Tajikistan and adjacent areas (Middle Asia)

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Tajikistan and the entire Middle Asia are one of the most diverse regions on Earth, with high endemism of vascular plants and remarkable diversity of habitats and plant communities. In this work, we present the first syntaxonomic classification of vegetation in Middle Asia using a floristic-sociological approach. The classification was carried out on 5,887 relevés from the Vegetation of Middle Asia database (GIVD: AS-00-003) supplemented by data from other countries (e.g. from Iran). The dataset containing relevés collected between the years 2006 and 2022 in different vegetation types with the use of the Braun-Blanquet method and was subjected to hierarchical classification. We report 473 associations, subassociations and rank plant communities classified to 42 classes, 47 orders, and 80 alliances. We propose seven new classes: Irano-Turanian open woodlands in warm, subtropical, semi-arid to sub-humid climate (*Pistacietea khinjuki-verae*), eastern Irano-Turanian subalpine forb steppes (*Eremogono griffithii-Nepetea podostachys*), mesic grasslands of the alpine belt of the Middle and Central Asia (*Festucetea alaico-krylovianae*), sclerophyllous scrub vegetation of the large rock ledges, screes and badlands of the Irano-Turanian Region (*Ephedretea intermedio-equisetinae*), dry and thermophilous steppes of montane and subalpine belt of Middle Asia (*Artemisio persicae-Stipetea drobovii*), chasmophytic vegetation in colline and montane belts of Irano-Turanian Region (*Carici koshewnikowii-Asperuletea oppositifoliae*) and scree vegetation of montane and subalpine belts of Irano-Turanian Region (*Trichodesmo incani-Pachypterygietea brevipes*). This is the outcome of 17 years of vegetation survey in Middle Asia using a modern phytosociological approach. Studies in neighbouring countries are needed to complete the comprehensive vegetation classification.

Short-term response of functional diversity under extreme climate events on grasslands

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Global warming and extreme climate events, which are strongly linked to climate change, can affect plant functioning, biodiversity and ecosystem processes. Here, we aim to identify the changes in the functional structure of grassland communities in response to extreme climatic events (extreme precipitation and increased temperatures) after two years of experimentation. Heavy rains were simulated by additional irrigation, while increased temperatures were provided by open-top chambers. We used a trait-based approach, quantifying variations in four functional traits (seed mass, plant height, leaf dry matter content and specific leaf area) at the community level (community weighted means, CWM) and the functional diversity (functional richness, FRic; evenness, FEve, and divergence, FDiv). We checked the influence of applied factors on all recorded species as well as on graminoids and forbs separately, and the two most abundant families: *Poaceae* and *Cyperaceae*. Our results showed that simulated extreme climate events did not influence any functional diversity component and CWMs in whole communities. However, we found a significant increase in FDiv on irrigated and FEve on warmed plots within a group of graminoids. This may suggest that increased water availability may result in decreased stability of species composition, and increased temperature may lower the dominance rate among graminoids. In addition, increased irrigation favours the abundance of small-seed grasses, and increased temperature promotes more resource-acquisitive grasses at the expense of the forbs. Our research suggests that the short-term response of the grassland community to climate change of different plant groups may be masked within the whole community.

Acknowledgements: This research was supported by the National Science Centre, Poland, grant no. 2019/35/B/NZ8/03358.

The role of species interactions on alpine vegetation communities under climate change

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Climate change has already caused significant impacts on species survival worldwide. High altitude ecosystems are particularly vulnerable and sensitive compared to lower altitudes, making them early indicators of climate change impacts on vegetation. Previous research on vegetation dynamics in high mountain ecosystems primarily emphasised the impact of climatic factors or meteorological events on plant community composition, with only a limited number of studies addressing species interactions in the context of climate change. However, species interactions may play important roles in driving vegetation changes. To examine these interactions, this study utilised 600 high-mountain grassland relevés in Taiwan as a foundation to explore species relationships, and applied this knowledge to plant community monitoring data follow the standard procedure of the GLORIA (Global Observation Research Initiative in Alpine Environment) project from 2008 to 2022 to further investigate vegetation changes. Our results showed that the expansion of the dominant species, *Yushania niitakayamensis*, may lead to the reduction or disappearance of some negatively associated species in plots. Under the influence of drought effects, shrub species like *Rhododendron pseudochrysanthum* and *Juniperus squamata* may exhibit a sheltering effect, thereby maintaining species diversity. This study implies that a more comprehensive understanding of species functional groups and interactions is necessary to better comprehend the specific impacts of climate change on plant communities.

Large-scale disturbance and browsing by ungulates shaping the natural regeneration process

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My hypothesis was that large-scale natural disturbances allow young trees to escape the browsing pressure of ungulate herbivores. The study was conducted in two national parks in southern Poland; one of them characterised by small-scale gap dynamics, and the other affected over the last decade by intense- large scale disturbances. I analysed browsing intensity in 30 belt transects running from dense forest to canopy gaps in each of the study areas. I measured the saplings and recorded the diameter and height of each browsed shoot. Along with that, I conducted measurements of canopy openness along the transects. I then calculated the index of Browsing Intensity (BI) and the local canopy openness (LL) for each sapling. I compared the distribution of BI and LL indices among tree species and between study areas, and analysed the relationship between BI and canopy openness. In the disturbed area, mean values of LL were consistently higher compared to undisturbed area, while the BI index in most cases was significantly lower. The relationship between LL and BI was inconsistent, varying both between areas and among species. I conclude that the effect of canopy gaps on the recruitment of palatable tree species is only detectable at larger spatial scales. When canopy gaps are large and many, the pressure of ungulate herbivores is diluted and even the palatable tree species can regenerate successfully. When the gaps are relatively few, even the largest ones are not likely to enhance the natural regeneration of trees that are preferred by herbivores.

Hotspots and coldspots of plant species richness in Poland

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Human impact in the Anthropocene caused unprecedented biodiversity loss. Plant invasions, species range shifts, and extinctions create an urgency to document the flora. Comprehensive syntheses of information about richness of individual plant groups (e.g. native, neophytes, high conservation value) underlie scientific examinations, conservation, and activities to improve awareness of plants. Moreover, vascular plants' species richness can predict multi-taxon species richness and helps in site selection for conservation of numerous other groups of organisms. However, inventorying the biodiversity requires significant resources. Unfortunately, there is so-called plant blindness, where plants are poorly detected compared to animals. As a result, plant conservation initiatives lag behind and receive less funding than animal conservation projects. Harmonised vegetation and floristic databases, storing millions of records, can help in species richness inventories. Here, we used new data to identify hotspots and coldspots of different plant species groups in Poland, Central Europe. We investigated the relationships between the species richness of selected groups and the current system of nature conservation areas in Poland to find out whether the locations of these areas are matched with the conservation value assessed from plant species richness mapping. We observed a high correlation in richness of different groups of species, including correlation between native and neophyte richness. The results highlight that the current conservation area system needs to be enlarged and properly protected from invasions of neophytes. We also found a discrepancy between urbanization and agriculture on one hand, and plant hotspots on the other.

Environmental and socio-economic drivers of plant species richness in Poland

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Knowledge on spatial patterns of vascular plant species diversity and its drivers is the main issue of interest for conservation biology and ecology, as it forms the basis of our understanding of ecosystem processes and nature conservation planning. Here, we present results from modelling of plant species richness in Poland, Central Europe, ca 32,000 km^2. Species richness comes from a data set encompassing 2,137 vascular plant species in 2,866 10 x 10 km grid squares. The average values and diversity of environmental and socio-economic factors were derived from publicly accessible data sets. The applied computational algorithms (boosted regression trees and random forests), reveal the likely drivers of species richness and modelling of the effect of particular drivers. Among the most important drivers were average values of: farms size in a particular landscape; human population density; clay, potassium (K), and calcium carbonate ($CaCO_3$) content in soil; temperature; and topography roughness. Usually, these variables were constantly selected as crucial, regardless of the modelling approach applied. We did not find that environmental variability was among the main correlates of species richness. Instead, an increase of soil resource availability (K, $CaCO_3$, and clay content) increased richness of native species and high conservation value species. Strikingly was the negative correlation between the richness of plant species and the increased size of the farms, observed even in the case of neophytes. The modelled relationship confirms that, to a particular degree, the native and high conservation value species richness increases with human population density.

GIS-derived environmental variables supplements vegetation data stored in databases

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Vegetation plots databases (VPD) comprise a huge amount of vegetation records with spatial localisation accurately measured with Global Navigation Satellite Systems. Unfortunately, these data rarely are accompanied by field-measured environmental characteristics such as e.g. soil properties and moisture. This results in the VPD not being used to test hypotheses on the effects of environmental variables on species composition and/or richness. The environmental conditions can be assessed through bioindication (e.g Ellenberg's indicators values), but such assessments cannot be used for hypothesis testing due to circular reasoning (vegetation characteristics explained employing vegetation characteristics). However, in species distribution modelling studies the information on species occurrences is typically supplemented by environmental data derived from maps and databases, using geographic information systems (GIS). We applied a similar approach for testing hypothesis regarding species composition and species richness drivers in semi-natural grasslands, at large spatial extent (~20,000 km^2). Data from a VPD (700 vegetation plots) were supplemented by environmental and socio-economic variables derived from maps and environmental databases. Calculated in this way environmental characteristics were following results of bioindication. The data, used as explanatory variables in models, well explain both species composition and richness. Particularly in ordination, the GIS-derived environmental data were able to explain a large fraction of variance in species composition. The approach proposed here is promising, and allows for better exploitation for the potential of VPD to for test ecological hypotheses. Moreover, relevant environmental and socio-economic data are freely available, which reduces the cost of such research.

Observed and dark functional diversity in the DarkDivNet research network

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Dark diversity (i.e. absent part of the species pool) has successfully been used to shed light on taxonomic species richness patterns, but considering also the functional dark diversity (i.e. absent part of the functional species pool) allows us to distinguish community assembly processes and predict impacts on ecosystem functioning. The global research collaboration network DarkDivNet has collected standardised vegetation and trait data from >100 study regions across the world. In each 10 km radius region, collaborators sampled 30-90 10x10 m plots. In each plot (>4500), vegetative height and leaf size were measured for one individual of all recorded vascular plant species (>8500 species in total), and dark diversity was estimated using species co-occurrences in neighboring plots. We then used the measured traits to position observed and dark diversity species into the global spectrum of plant form and function (estimated using data from TRY trait database) and compared observed and dark functional diversity. We found that DarkDivNet data covers nearly 90% of the global functional spectrum. Considered together, functional diversity and average trait values differed between observed and dark diversity. Species in the observed communities generally had higher functional richness than dark diversity, and included taller species with 'slower' leaves (i.e. low N content, low SLA). In most regions, observed species have filled available functional space and species in dark diversity are functionally redundant. The trait values imply that competitive traits govern community assembly. Coordinated global sampling allows comparisons of functional observed and dark diversity in different regions across the world.

Assessing transformation of plant communities using a systematic ecological framework

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A unifying framework is presented for tracking the outcomes of land management practices and regimes on the condition components of plant communities. Assessments focus on a soil-landscape map unit. The framework is based on 22 indicators hierarchically organised into ten functional, structural and compositional criteria. Changes in the values of criteria and indicators over time represent the plant community's responses. This involves a two-step process. First, develop a systematic and comprehensive site-based chronology of land management practices and regimes over time. Second, fully integrate relevant data and information on the responses of the plant community into the chronology of practices and management regimes. How, and to what degree, management practices and management regimes have deliberately and inadvertently effected the key ecological criteria including their maintenance, losses and gains over time are presented graphically. Results are peer reviewed by local subject specialists. Data and information on the outcomes of actions include direct measures of field-based attributes, estimates of attributes derived from expert elicitation, environmental histories, interviews with skilled subject specials and relevant metrics derived from multi-spatial and multi-temporal remote sensing datasets. Provided a competent ecologist has access to key resources, a preliminary assessment can be completed in three days. Each indicator is scored separately using a metric 0-1, relative to the indicator's reference state. This framework has been widely applied across major climate zones in Australia and has included diverse production and conservation land uses. Examples are provided including plant community resilience, possible system trajectories and future management options.

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

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Human activities that cause global change have several effects on the biomes of Earth, such as land fragmentation, deforestation, pollution, anthropisation of natural landscapes, and alterations in the functioning of ecological systems. Remote sensing is an important tool for assessing ecosystem changes because it allows the collection of long time series of data that can be used to assess land cover and vegetation state of a chosen area. In this study, we used beta diversity metrics such as Jaccard, Sorensen, and Rao indices to produce a map that shows the variation of spatial heterogeneity over time. The moving window technique was used. Each chunk was considered as a plot and the pixels as species, and the selected metric was calculated for every image of the time series. This approach enabled us to calculate a value of beta diversity for every pixel, providing information about the variation of spatial heterogeneity over time. We chose Italy as the study area to test this workflow, specifically retrieving two time series from the year 1990 to the year 2018: 1) land cover maps from Corine Land Cover; 2) NDVI maps calculated from Landsat collections 5 and 7 images. Jaccard, Sorensen, and Rao indices were computed for the Corine Land Cover images, while only the Rao index was computed for the NDVI images. The resulting maps are intuitive, easy to interpret, and provide information about both the spatial pattern and the change in time of land cover and vegetation biomass.

Queensland's Statewide Landcover and Trees Study (SLATS)

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Accurate monitoring and inventory of changes to global stocks of woody vegetation are fundamental for sustainable natural resource management and environmental protection and restoration. In Queensland, Australia, the Queensland Government's Statewide Landcover and Trees Study (SLATS) has been monitoring woody vegetation change due to land clearing since the mid-1990's using satellite imagery from systematic long-term earth-observing satellite missions and field data. The study was initiated to accurately document what were at the time some of the highest rates of clearing in the developed world. Since then, SLATS data has informed major policy and legislative changes for vegetation management and conservation planning in Queensland. In recent years, the study's methodology has been significantly revised to provide more comprehensive data and information and leverage contemporary technologies and science. This has included: the development of a detailed, statewide woody extent baseline for monitoring and annual accounting; transitioning from Landsat to Sentinel-2 satellite imagery as the basis for change monitoring and annual updating of the woody extent baseline due to losses (i.e. clearing) and gains (i.e. regrowth); and, developing approaches for monitoring vegetation age and density to better inform what vegetation exists, is being cleared, regrowing, or maturing. The revised SLATS continues to support existing policies in Queensland, and importantly, provides accurate data at appropriate scales to inform emerging policy requirements such as targeted biodiversity policy (e.g. koala policy and offsets), natural capital markets, and greenhouse gas emissions inventory.

Accumulated soil seed bank of the invasive sand dropseed forms a challenge for its suppression

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Global warming, elevated atmospheric CO_2 concentrations, and increased likeliness of extreme drought and wildfires in many regions will benefit C4 grass species with an effective dispersal strategy. i) We explored the effect of a C4 invasive perennial grass, *Sporobolus cryptandrus* encroachment on the composition of soil seed banks in dry sand grasslands in Central Europe. We also aimed to: ii) quantify the vertical distribution of the seed bank, and iii) to explore the density of the soil seed bank of the invasive species. We used five mass-localities of the species; in each site a 1-ha-sized sampling area, in each sampling area, 1 m^2-sized plots were sampled along an increasing cover of the species. More than 19,000 seedlings emerged from the soil samples, and of these more than 15,000 were the seedlings of *Sporobolus*. Besides *Sporobolus* seeds, we found in total 87 other species, which of 30 species with the highest number of viable seeds accounted for more than the 90% of total seed bank density. The density and diversity of seed banks was highly affected by site, but these figures were not affected by the increasing *Sporobolus* cover. We found also that the increasing *Sporobolus* cover resulted in an increased proportion of *Sporobolus* within the seed bank, and this occurred even in plots with no *Sporobolus* cover. We assume that the recent arid period over the last year will facilitate a further rapid spread of the species.

Community assembly and the classical diversity measuring paradigm

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The classical paradigm of measuring diversity is based on the following assumptions: (1) There are no hidden species in the sample and/or they are negligible from the point of view of the study; (2) the assemblages are spatially homogeneous; and (3) the assemblages are infinitely large (in their spatial extension). This means that the classical diversity measuring paradigm is pattern-blind; i.e., it ignores the effect of pattern on diversity measures. A recent theory of community assembly is based on the concept of dark diversity. We stress that the Dark Diversity Paradigm is beyond the classical paradigm. Recently the measuring of beta diversity is also an increasingly popular topic. This means that the spatial aspect of diversity is emphasised in ecological studies, which emphasises the vital aspects of species assemblages, and also the dark diversity theory. There are numerous published statistical methods estimating the number of unseen species. We also review these techniques from the point of view of the estimation of dark diversity.

How do plant functional traits optimising growth rates shift along aridity gradients?

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At the scale of a whole plant, functional traits can influence height growth rates (a measure of individual fitness) in a given environment by mediating the rate of photosynthesis, respiration and turnover as well as the relative allocation of net primary production to different tissues. However, while the theoretical relationship between traits, whole-plant growth rates and the environment has been explored in the context of light availability, little is known about how traits influence whole-plant growth rates across aridity gradients. In this study, we expand the trait-growth theoretical framework by pairing it with a stomatal conductance model to analyse how the optimum value of five key traits: leaf mass per area, Huber value, wood density, sapwood-specific conductivity and $V_{c,max25}$, responds to variation in soil moisture availability and vapour pressure deficit. In general, our results provide a mechanistic explanation for the empirical observation that emergent trait distributions shift from resource-acquisitive to resource-conservative strategies as conditions become increasingly dry. In addition, we provide a mechanistic explanation for empirically-observed declines in apparent $V_{c,max25}$ with increasing drought stress. Finally, we propose testable hypotheses regarding the shift in optimal trait values with plant ontogeny. Understanding the processes which cause some plant functional strategies to be more successful than others under different aridity regimes will advance our ability to predict how the distribution of species and ecosystems will shift in response to a changing climate.

Consultant contributions to conservation: the perspectives of a consultant

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Within the New South Wales planning and conservation framework, ecological consultants undertake a large quantity of vegetation surveys for a variety of purposes. These surveys can yield important data relating to the ecology and management of threatened flora species and vegetation communities. The publication of this data can better inform the planning system and contribute to conservation efforts. In this presentation, the potential contributions of data regularly collected by ecological consultants to conservation is highlighted through case studies. Specifically, case studies involving targeted threatened species surveys, threatened species monitoring, and translocation plans are presented. Examples of publications based upon these standard survey techniques are outlined and the actual contributions of these publications are discussed. Finally, the potential contributions resulting from emerging consultant datasets, including those associated with the relatively recently introduced Biodiversity Offsets Scheme, are considered.

Deriving broad vegetation types from plot data: a southeast Australian case study

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Vascular plant assemblages offer some of the most accessible and useful insights into ecosystem structure and function. Objective, quantitative methods of classification are widely used to derive lower-level units in a vegetation hierarchy; however, higher-level classes are usually derived either: i) by using aggregation protocols to group plot-based types; or ii) from the top down using structural and physiognomic features. Both methods yield broad types which reflect ecological properties, but they are once removed from the raw data and exposed to subjective biases. There are clearly advantages in deriving broad classes from the plot data, however this is rarely attempted because the integration of non-hierarchical solutions of different scales is problematic, whereas hierarchical methods do not scale well to large datasets. Graph theory is an alternative framework for modelling the structure of vegetation data and is theoretically better-suited to continuous data because: i) it is not reliant on assumptions of central-tendency; ii) it clusters samples more consistently with their nearest neighbours than a centroid-based approach; and iii) it permits the quantification of noise (outliers) in absolute terms rather than as a function of any particular attribution of samples to types. We illustrate the efficacy of graph theory in the derivation of a sub-formational level classification (15 types) using a large regional dataset of 7,541 samples located in south-east Australia. We employ gradient analyses to characterise relationships between types and contrast our plot-based typification with an alternative type-based classification derived by aggregation of lower-level types.

How can plot-based vegetation classifications support statutory applications for ecosystem conservation?

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Vegetation classifications underpin a variety of ecosystem-level regulatory applications via listing statements which codify the characteristics of the ecosystem and identify instances where regulatory protocols and conservation actions are triggered. Statutory definitions should be more robust to new information when they are supported by plot-based classifications because they facilitate a degree of objectivity in the formulation of definitions and because key properties of an ecosystem are quantifiable directly from the data. However, clustering solutions are notoriously unstable with new data. This is problematic for statutory applications, which require certainty and robustness to new information. We investigated the sensitivity of key ecosystem properties (composition, habitat, distribution) derived from plot data to changes in the allocation of samples to type member-sets using statutory listings of two critically endangered ecological communities under New South Wales legislation. The listings were based on clustered plot data which were subsequently reformulated in a new iteration of the classification. We quantified the degree to which: i) interpretations of the habitats (niches) of the communities varied over five iterations of the classification; ii) models of their geographic distribution are sensitive to the attribution of samples to types; and iii) samples originally attributed to the ecological communities in the listing process are proximal to the centroids of those clusters nominally attributed to the listed ecosystems in the latest iteration. We conclude that clustering is invaluable for the erection of robust ecosystem types. However, plot data are of limited utility in statutory applications because ecosystem properties are highly sensitive to sample-to-type attributions.

Impact of extreme rainfall events on the tropical forest biomass in the Western Ghats region of Kerala

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Tropical Forests are critical reservoirs of carbon and are crucial in regulating the global and regional climate. Along with climate change-related drivers such as forest fires and drought, extreme rainfall events also contribute to aggravating tropical forest degradation. A significant portion of the Western Ghats biodiversity hotspot in Kerala (India), is enduring destruction due to landslides, debris flow, and massive soil erosion caused by extreme rainfall events in the monsoon season. About 101 destructive landslide events occurred in Kerala's western Ghats mountainous region causing vast canopy cover loss during the monsoon period. The present study aims at analysing the IMDAA climate reanalysis hourly rainfall data for identifying the extreme rainfall events that occurred in 2018, 2019, and 2020, and attempts to estimate the forest area loss using dNDVI and AGB loss using ESA climate change initiative biomass data. Nelliyampathy Forest Reserve and Ranni Forest division had suffered significant primary forest loss. Further, a Random Forest classifier is used to model the forest canopy height and AGB density using GEDI footprint-level forest canopy height measurements, GEDI L4B, Sentinel-1, and Sentinel -2 data. Biomass loss is much more prominent in the northern part of the Western Ghats, especially in Nelliyampathy, Kottiyoor, and Nilambur forest divisions. Tropical evergreen forests with tree heightS ranging from 11-45 m are lost in the deforestation caused by extreme rainfall events. Forest canopy height and AGB density are crucial to assess ecosystem response to climate change, forest degradation, deforestation, and to quantifying the carbon emissions caused by them.

Botanists and their clothes: human-vectored seed dispersal in Central-European landscapes

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Human-Vectored Dispersal (HVD) is considered an effective long-distance seed dispersal type that can establish biological connections between otherwise isolated areas. Due to the increasing population number and mobility of mankind, our role in the dispersal of other organisms is expected to increase globally. In our field experiment, we assessed various mechanisms that can affect the efficiency of HVD, such as habitat types visited, time spent outdoors, types of activities, clothing types, the species pool, and the plant trait spectrum of visited habitats. During the 39 sampling occasions, we studied the outdoor activities of 88 volunteers in three Central-European countries. At the start of each field visit, we gave a new pair of socks to volunteers and at the end of the visit we collected the propagules attached on and in their socks and shoes. We analysed 251 samples, divided to 2008 sub-samples in total. We found that field biologists dispersed more seeds and species than hikers, and men dispersed more than women. Most seeds and species were dispersed when grassland habitats were visited. Cloth and shoe types had a significant effect on dispersal effectiveness. More than half of the seeds were firmly attached to clothes and shoes suggesting that these might disperse for a long distance. Interestingly, not only species with morphological adaptations for epizoochory were dispersed, but also those with adaptations for anemochory and endozoochory. As most dispersed diaspores belonged to disturbance-tolerant and weed species, it is crucial to apply prevention measures when visiting protected areas.

Nature at home: a project bringing grassland plants to urban gardens

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Urban gardens are often decorated with non-native plant species, which can act as potential starting points of plant invasions. Using native plants instead of non-native ones can be a suitable tool for decreasing the risks of future invasions, and to use species that are adapted to the regional soil and climatic conditions. Prioritizing native plants can also be a powerful tool in environmental education. In our project, we created a selection of seeds of native flowering plants and offered them to people for decorating their gardens. People could choose seeds of five species from a set of 25 species native to Hungary that are characteristic of natural grasslands or extensively managed fields. In a questionnaire survey, we asked the participants about their preferences and the reasons for choosing a certain set of species. We studied the trait spectrum of the most popular species which can help in designing native seed mixtures. The pilot year of the study (2022) showed that people were open to participate in this research and they were happy to use native plants in their gardens. Participants preferred plants with colorful and large flowers, with pink or lilac petals, and those that are medicinal herbs. We hope that our project can increase social awareness and raise the profile of native plants as important components of urban biodiversity. We aim to provide recommendations for a set of native plants that can successfully establish in gardens and offer an attractive alternative to non-native species.

Karroid islands in a sea of grasses, Free State Province, South Africa

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Grasslands with their high biodiversity and various ecosystem services are threatened by agriculture, industrialisation, urbanisation and forestry. These threats will intensify in the face of climate change. It is therefore important that we understand and describe grassland ecology to provide information on how to maintain the balance between sustainable production and diversity. Grasslands in the Free State contains islands of karroid vegetation, which are severely fragmented and affected by habitat loss. The Bloemfontein Karroid Shrubland, endemic to the province, occurs on dolerite sheets with shallow, coarse textured soils, poor infiltration and high runoff and evaporation resulting in physiological drought within a high rainfall area. This research investigated the refining of the coarser scale mapping of Mucina and Rutherford (2006) and that proposed by du Preez (2017). This enabled us to determine the threat status and protection level of the vegetation type as well as implement various management strategies. The Braun Blanquet cover abundance scale was used to complete a visual estimation of vegetation cover in 227 plots of 16 m^2. Classification was done in JUICE using a modified TWINSPAN and refined using Braun-Blanquet procedures. Preliminary results indicated different plant communities on different terrain units which all conform to the broader classification of Mucina & Rutherford (2006). Indications are also that the current maps need to be extended and new areas included.

Effects of climate change on the early life-history stages of alpine plants

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Early life-history stages of plants are considered highly vulnerable to climate change and crucial for species persistence. In this study, we conducted a two-factorial field manipulative experiment to investigate the responses of (i) seed maturation, (ii) seed germination and (iii) seedling establishment of ten Australian alpine species to a future warmer and drier climate and post-fire conditions. Warmer and drier conditions were created using modified open-top chambers, while post-fire conditions were simulated by burning small patches of vegetation and adding smoke water. To assess the effects of our treatments on the different life stages, we: (i) collected seeds from plants inside the chambers and compared their mass, size, viability and cotyledon size with seeds from control plots; (ii) buried seeds from the studied species inside mesh bags and monitored their monthly germination; and (iii) planted seedlings of the studied species and measured their monthly growth and survival. Overall, we found negative and neutral effects of the treatments on the studied life stages, and: (i) seeds from plants inside the chambers were significantly lighter and smaller in almost all species; (ii) the final proportion of germination was negatively affected by warmer and drier conditions and germination timing changed, and we did not detect any effect of post-fire treatment on seed germination; and (iii) seedling survival and growth were strongly affected by post-fire conditions, with most planted seedlings not surviving. Finally, we discuss the potential implications of our findings and their significance to future plant recruitment in alpine areas.

Mountains as model environments to test plant responses to climate extremes

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Mountain environments are characterised as highly heterogeneous with diverse topography-driven habitats, which are home to an equally diverse array of plant communities and endemic species. Of all the threats to mountain ecosystems, climate warming and reduced snowpack represent some of the key drivers of change. Earlier spring snowmelt, exposure to frosts, drier summers, extreme heat, longer growing seasons and an increased fire frequency not only have implications for plant growth, development and regeneration, but can lead to changes in community composition and species distributions. As plant ecologists, tasked with trying to understand 'why plants grow where they do', we can utilise the vast array of 'experiments by nature' across natural gradients in mountain landscapes and strengthen these with a powerful combination of *in-situ* and *ex-situ* experimental manipulations, to unravel the processes that underpin plant life in the mountains. We can then use this information to predict how mountain landscapes will fare in future decades in the forecasted snow-free future. In this presentation, I will showcase some recent and some longer-term explorations into how high mountain plants respond to extreme environmental drivers, and how a combination of approaches and methodologies can reveal the hidden mechanisms behind these responses and subsequent plant community change in these model environments.

Thermal tolerance and acclimation of alpine plants to water stress under a field-based experimentally induced heat wave

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Alpine plants in Australia are increasingly exposed to heatwaves, yet the level of plant tolerance to heatwaves remains unclear. We sought to determine whether alpine plants might shift their heat and cold tolerance, and how their internal water relations would be affected under a prolonged heat treatment. Using a field-based manipulative experiment, provided by the Australian Mountain Research Facility, we actively heated chambers to simulate a heat wave and tracked the response of six alpine plant species that were exposed to six days of a heat wave treatment (4°C above the ambient temperature) compared to the same species in control plots. On average, all heat-stressed plants exhibited 0.9°C increase in their tolerance to heat compared to untreated controls (LT50 $P<0.001$). The effect of the heat wave on plant cold tolerance was less clear. The increase in heat tolerance was accompanied by a significant loss of relative water content (7.6%, $P<0.001$) and a significant reduction of internal water potential (2,81 bars, $P<0.001$), as well as a reduction in soil moisture (by 2.8%, $P<0.001$). The reported increase in heat tolerance in heat-stressed alpine plants confirms their ability to acclimatise rapidly. This rapid acclimation is critical for plants to improve their survival under future environmental extremes and implies complex physiological adjustments at the plant tissue level.

The interactive effect of extreme precipitation, nutrients, and grazing on grassland vegetation

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Grasslands cover nearly 40% of Earth's terrestrial surface, account for one third of terrestrial primary productivity, and play an essential role in global food supply. Despite this, grasslands are often understudied and undervalued for biodiversity conservation. Water, nutrients, and herbivory are key drivers of grassland diversity and productivity. Thus, global climate change, coupled with nutrient deposition, and grazing practices in grasslands, could expose vegetation to conditions beyond their adaptive capacity. There is therefore a need to consider the effect of multiple factors simultaneously when studying how grasslands will respond to global change. We examined the interactive effects, through experimental manipulations, of extreme drought and extreme rainfall, nutrient addition, and grazing by cattle on the diversity and above-ground net primary productivity (ANPP) of a productive grassland near Narrabri, northwest New South Wales. We present a structural equation model describing the direct and indirect (through soil and plant nutrients, light availability, and community composition) effects of extreme precipitation, nutrient addition, and grazing on vegetation diversity and productivity. We predict that water will be a primary driver of ANPP, and that the effect of nutrient addition and grazing on ANPP will depend on water availability. We also predict that biomass accumulation under elevated water and nutrients will increase competition for light and reduce diversity through competitive exclusion, but the removal of biomass through grazing could mediate this. This unique combination of treatments provides a more realistic insight into the mechanisms altering native grasslands in an era of rapid global change.

Engineering effect of alpine shrubs: giant ecological slalom through snowdrifts and shrubs

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Worldwide, interactive effects of changes in climate and in land-use have triggered woody shrubs to encroach and expand into grass-dominated areas across many ecosystems. There is evidence from alpine ecosystems indicating that recent climate warming and a switch from pastoral land-use has led to an overall increase in shrub abundance and dominance across many of these landscapes. As a result, alpine shrubs are encroaching into otherwise non-shrubby communities, such as alpine herbfields and grasslands. Encroaching alpine shrubs may interact with winter processes through their structural traits such as plant height, volume, Leaf Area Index and their orientation towards the wind. These traits can have an engineering effect on how they accumulate snow that in turn may affect the composition of plant species immediately adjacent to them. We investigated how the properties of snow (depth, density, duration) and plant composition on the leeward and windward side of Australian alpine shrubs might interact with their structural traits. There was a significant interactive effect of orientation and plant height on snow depth, with plants on the leeward side accumulating on average 0.2 cm more snow for every cm-unit of target shrub height compared to the windward side. There was no difference in snow density, nor in snow days. There were also no significant differences between the leeward and windward side of target shrubs in the species composition of adjacent vegetation; however, there was a significantly different composition in open grassy sites nearby.

Vegetation management & ecological restoration for well-being: the Forestias Project, Samut Prakarn, Thailand

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The Forestias Project is a town planning initiative for the Enchanted Community District in the Forest of Samut Prakarn, Thailand. Ultimately, people will be able to live with nature for their personal well-being. The Project occupies an area of 63.68 ha, on flat, saline clay soil. Pre-survey showed existing vegetation dominated by *Typha angustifolia*, plus other weeds and grasses. The results of the study can be summarised as follows: (i) the Project was planted on an area of 77,360 sq.m., using 271,901 individual seedlings and an estimated 300 species (including native, ornamental and fruit species); (ii) the growth rate was measured only once, in March 2023, with an average total height of 2.91m, 4.41 m and 4.62 m in zones 1, 2 and 3 respectively, and an average DBH of 2.41 m, 4.22 m, and 5.04 cm in the 3 zones, respectively; (iii) animal biodiversity increased from a pre-survey of 83 species to 104 species at present; (iv) particulate matter with a diameter less than 2.5 microns (PM 2.5) averaged 52 mg/m^3, as opposed to 62 mg/m^3 outside the Project (standard is 50 mg/m^3); and (v) approximately 35,000 persons visited the site during August 2020-December 2022. It was concluded that: (i) the growth rate and development of planted trees were satisfactory; (ii) some species provided fruits for birds, leading to increased biodiversity; (iii) forest and green areas can reduce by PM 2.5 particulate matter, regulating temperature, increasing soil organism, etc; and (iv) the Project also provided environmental education, which can be modified for people and land development business, etc.

Are Australian montane subtropical rainforests cloud forests?

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I show that montane subtropical rainforests in eastern Australia meet the international definition of cloud forests and that they have been overlooked due to their subtropical latitudes even though two areas of cloud forest in South America at similar latitudes are listed in the International Union for Conservation of Nature (IUCN) cloud forest database. Structurally, climatically and floristically similar forests in far northern Queensland are recognised as cloud forests but those in southern Queensland and northern New South Wales are not due to classification with cool temperate rainforests, and/or a lack of cloud forest inclusion in the classification systems in this area. Additionally, the leading global cloud forest experts recognise a lower montane cloud forest (an upland Subtropical Rainforest at 1,000 m altitude at Gambubal) in a review of climatic data on cloud forests, which is within subtropical Australia at one site. Despite international recognition, subtropical cloud forests have not been widely recognised by local researchers and the broader community. I use available spatial datasets to map the distribution of similar lower montane cloud forests and cloudier and higher altitude rainforests in subtropical Australia that should be recognised as montane cloud forests in the Upper, Elfin and possibly Subalpine sub-classifications of Brunjzeel. The identification of cloud forests in this area will enhance the current understanding of their high value for biodiversity conservation, as refugia from climate change and disproportionate importance to hydrology through additional cloud water harvesting exceeding rainfall, including increased water supply for human use.

Vegetation classification for northwestern Arctic Alaska using an EcoVeg approach

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The USNVC is the standard for vegetation classification in the US and is part of the broader IVC. Recent work on the USNVC in Alaska established macrogroups, groups and alliances. Here we incorporate tussock tundra and low and tall willow (*Salix*) groups and alliances for northwestern Arctic Alaska into the IVC and USNVC classification. The study area encompasses the Seward Peninsula, the western Brooks Range, and the northwestern foothills and Arctic coastal plain of Alaska. We used pre-existing relevé plot data from northwestern Arctic Alaska to prepare a draft association classification. The draft classification was subject to peer review and subsequently refined. We fit the tussock tundra and low and tall willow associations into the USNVC using NMDS and GAMs to evaluate the patterns of environmental gradients against the ordination axis scores. We identified eight tussock tundra and 37 low and tall willow associations. The associations fit in two classes, two subclasses, two formations, two divisions, three macrogroups, four groups, and 13 alliances. Many of the tussock tundra and low and tall willow associations fit seamlessly within the USNVC, while some alliances had yet to be defined, and we have proposed new alliances here. In still other cases, we proposed a new group and recommend broadening the concept of an existing group using a data-driven approach. Since not all available data from Arctic Alaska were used in this study, we suggest continuing with a more comprehensive analysis to fulfill the gap at the alliance and association levels for Arctic Alaska.

The AusTraits plant trait database and workflow

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AusTraits is an open-source, harmonised database of Australian plant trait data. First released in 2021, AusTraits is establishing itself as the key resource for trait data on Australian plants, with data distributed through multiple portals including Zenodo, the Atlas of Living Australia, and the Austraits R package. AusTraits includes some data for nearly all of Australia's 26,000+ plant species and ~500 traits, with near-complete datasets for plant growth form, life history, and woodiness. Here we present an overview of a suite of resources developed as part of the AusTraits project that we envision will accelerate plant trait research worldwide. At its core, AusTraits is committed to the FAIR Data Principles (Findable, Accessible, Interoperable, and Reusable), to ensure data and the trait database workflow are readily discoverable and available for reuse. AusTraits is a rare example of a database that has both significant data (1.3 million entries, from more than 300 unique datasets), effectively captures all metadata associated with an ecological study, and adheres to a fully mapped ontology. All traits included in AusTraits are documented in the AusTraits Plant Dictionary (APD), a comprehensive vocabulary that includes trait descriptions, keywords, references, and links to other trait databases, allowing straightforward, consistent interpretation of trait data within AusTraits and the reuse of trait definitions by other researchers. The transparent R-based workflow that compiles AusTraits has been packaged as a standalone R package, traits.build, allowing researchers to build additional trait databases for other taxonomic groups or traits.

Vegetation under climate warming: four things we need to understand better

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Climate warming by 3°C or more is very possible over the next century, in association with further rises in atmospheric CO_2, poleward shifts in zonal rainfall patterns, increased incidence of extreme events, and large changes in land use. What is needed to forecast likely changes in natural vegetation? One strand is predicting trait values, such as for leaf mass per area and seed mass, from first principles. Some ecologically important traits are predicted quite well from the physical environment, but other traits vary widely among coexisting species, and are thought to be the outcome of competition among coexisting strategies. A second strand is to include potential future states into state-and-transition modeling for major vegetation types. For Australian rainforests and tall eucalypt forests, this should be twinned with a vital attributes scheme for the functional types seen as distinguishing different rainforest classes. Third, we can ask how much floristic difference is to be expected between vegetation patches 3°C or more apart. Fourth, we need to understand better how the geographical boundaries of species are determined, since clearly not all are hard physiological limits. Transplant-beyond-boundary experiments are now being done for us, by moving climate zones relative to species rather than by moving species relative to climate. To learn efficiently from these wide-area natural experiments we need field manipulation of factors. For a species to extend its distribution poleward, will it accomplish this without intervention, or will assisted dispersal be sufficient, or will suppression of competitors or changed fire regime also be needed?

Population genetics and regenerative strategies of a threatened alpine forb, *Celmisia sericophylla*

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Alpine ecosystems are experiencing increasing temperatures, earlier snowmelt, and extreme water deficits in summer. The rapid hydrological changes that are taking place in alpine environments are a major threat to plants that require stable water sources to survive. *Celmisia sericophylla* (Silky Snow Daisy) is a threatened alpine hydrophyte at risk of decline from changing hydrological regimes, with a highly restricted and patchy distribution in the Victorian Alps, Australia. Like many alpine and hydrophytic plants, *C. sericophylla* is clonal, a strategy that often stems from exposure to high levels of abiotic stress. Vegetative regeneration can be beneficial by allowing for population maintenance in situations where conditions are less favourable to seed production and seedling establishment, but as a primary mode of reproduction it also poses the potential risk of limited adaptive potential and introduces challenges to conservation efforts. Our understanding of the trade-offs between clonal reproduction and sexual reproduction in alpine environments is limited, and there have been very few studies that attempt to explain within-species variability in seed traits or what leads to these differences. In this study we will examine the genetic population structure and breeding system of a specialised clonal plant of ~150 clonal patches across its known range, and how this relates to patterns in propagule dispersal and recruitment. The work presents a unique opportunity to untangle the relationships between population genetics and regenerative traits, providing important information to guide the conservation of *C. sericophylla* and other threatened species with similar population structure and ecology.

Tree growth responses to ecological thinning in River Red Gum floodplain forests

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River Red Gum forests in New South Wales were logged for 150 years prior to the gazettal of Murray Valley National Park in 2010. Harvesting created high density stands of small trees. Increased competition for resources, combined with reduced water availability, slowed tree growth preventing the re-establishment of large habitat trees. Ecological thinning seeks to accelerate the growth of large trees by reducing competition through selective tree removal. A trial was undertaken to examine the effect of ecological thinning on trees of different sizes and under various conditions of water availability to determine its potential to aid restoration of River Red Gum forests under conservation management. Small trees were experimentally removed from plots within dense stands and diameter growth rates of retained trees were monitored annually for five years. Study sites were stratified by long-term water availability, and short-term water availability was represented by river flow rates within monitoring periods. Responses to thinning varied with tree size and water availability. Thinning increased the growth of small trees (<600 mm diameter at breast height), particularly in drier sites during wet years. However, thinning significantly decreased the growth rates of larger trees relative to un-thinned controls in wetter sites. These findings suggest that ecological thinning may be of limited use in accelerating development of large trees in these forests.

Remote sensing of fire in NSW

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The 'Black Summer' 20192020 Australian bushfires instigated a significant response from land managers and researchers in both government and university institutions to understand the precursors, immediate impacts, and predicted recovery potential across the vast fire ground. As such, a focus of fire science within NSW Government is on improving our ecological knowledge, and our statewide vegetation monitoring and reporting systems to help us better prepare for more extreme fire seasons in the future. Leveraging the increased availability of international satellite imagery capture missions and new computing technologies, the NSW Government Environment and Heritage Group's Remote Sensing of Fire Program has developed routine monitoring and reporting of fire extent and severity mapping (FESM), with 7 consecutive years of statewide coverage now mapped and publicly available. The program has also developed a new remote sensing approach to assess post-fire recovery of vegetation cover in forests, with observational monitoring across the 2019/2020 fireground completed for the third year since the fires. These data have been extensively used in decision support by fire and land managers in government and to develop measurable and reportable fire metrics, which aim to facilitate the maintenance of ecosystem resilience. Here, we provide a look at the science behind these remote sensing monitoring approaches and summarise the many and varied applications of the data across local, regional and statewide scales.

Managing fire and successional habitat at the sclerophyll forest / rainforest boundary for endangered eastern bristlebirds

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The eastern bristlebird (*Dasyornis brachypterus*) is a Gondwanan songbird and part of the Outstanding Universal Values of the Gondwana Rainforests of Australia World Heritage Area (WHA). The northern population of this nationally endangered species meets the International Union for Conservation of Nature (IUCN) criteria for being 'Critically Endangered' and is dependent on one of the less obvious, though vitally important, features of the WHA – grassy open forests and woodlands with adjacent rainforest gullies. An 80% decline in the northern population since monitoring began in the 1980s is largely attributed to habitat loss and inappropriate fire, particularly too infrequent fire. Coordinated cross-border and cross-tenure management of grassy sclerophyll habitat is a critical action for recovery of the northern population of eastern bristlebird, with weed control and prescribed burning at 2-6-year intervals essential tools for restoring and maintaining networks of grassy open forests/woodlands that bristlebirds depend on. These actions were taking place prior to the 2019/2020 bushfires and are ongoing, within challenging topographic, climatic and resource conditions. Consistent, multi-year, adaptive and site-specific management of successional habitat has proven successful in increasing wild recruitment of bristlebirds in some areas, building capacity for supplementary releases of captive-bred eastern bristlebirds to support recovery of the northern population.

Using satellite imagery to detect and map ephemeral wetlands

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Ephemeral wetlands are naturally uncommon in many parts of the world. In New Zealand, they have declined markedly in extent and condition, resulting in a Critically Endangered designation. We developed a technique to detect and map these wetlands using high resolution, ~weekly imagery from the Sentinel 2 satellite. For training and testing, we used shape files of ephemeral wetlands in two areas of the eastern South Island. We identified spectral bands and associated indices indicative of ephemeral wetlands using transects extending from mapped wetlands into surrounding vegetation. Based on seasonal pattern strength, and sensitivity to periodic inundation, as opposed to vegetation seasonality, we selected the Normalised Difference Snow Index (NDSI) as the best indicator. We then developed a pixel-based predictive algorithm using the amplitude and strength of the seasonal signal of NDSI. The algorithm was effective at specific locations but did not reliably detect the full set of 70 ephemeral wetlands in a 6 × 9 km test area. We then tested a machine-learning classification approach that combined models of seasonal change in multiple spectral indices. This model accurately defined 67 of the 70 wetlands. That no single spectral band or index was universally predictive likely reflects that ephemeral wetlands vary in reflectance owing to their depth, substrate, drying stage, and surrounding vegetation. Conservation applications of this technique include a) identification and mapping of ephemeral wetlands and other seasonally inundated ecosystems; b) detecting changes in hydroperiods in response to threats (climate change, afforestation) or management; and c) supporting site-based monitoring.

Conservation priorities across European ecosystems prone to climate warming, weather extremes and disturbances

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Climate change is rapidly altering the planet. Novel effects are currently arising worldwide, from melting ice in the Arctic via burning bushfires in Australia to droughted forests in Europe. Assessing the role of disturbance dynamics for biodiversity and ecosystem functioning, and for wilderness protection and landscape management, is crucial in the light of unknown futures. We conducted a meta-analysis across all ecosystem types in temperate Germany - from lowland coastal, through semi-natural mountainous to high elevation alpine - to assess the sensitivity of local biodiversity to severe weather events, shifting climate and altered disturbance regimes. The Federal Agency for Nature Conservation lists 700 ecosystem types, all of which are prone to different natural or anthropogenic disturbance regimes and show different sensitivity or resistance to climate change and other global change factors. For each of these numerous ecosystem types, we have compiled and evaluated the relevant stabilising dynamics versus altering processes which maintain or threaten current biota. An essential part of our analysis is understanding the impact of these dynamic processes on current biodiversity and ecosystem functioning and forecasting thresholds of transitions to future alternative states. The goal is to develop a universally applicable ‘ecosystem sensitivity’ key, which is able to forecast ecosystem vulnerability or resilience to changing climate. This will allow us to develop climate-smart management plans for maintaining ecosystem integrity and high levels of biodiversity - especially when either implemented at an early stage of restoration or managed for transition towards novel ecosystems.

Summarising emerging insights of two global mountain research initiatives (MIREN and GLORIA)

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We summarise insights from MIREN and GLORIA: MIREN, i.e., “Climate change and other global change drivers threaten plant diversity in mountains worldwide. A widely documented response to such environmental modifications is for plant species to change their elevational ranges. Here, we present a standardised protocol developed by the Mountain Invasion Research Network (MIREN) to systematically quantify global patterns of native and non-native species distributions along elevation gradients and shifts arising from interactive effects of climate change and human disturbance.” (Haider et al. 2022). GLORIA, i.e., “Global-scale approaches to monitor climate and biotic change in high mountains … have found that species from lower elevations are colonizing habitats on mountain summits at an accelerating pace, with five times faster rates than half a century ago. Further, repeated in situ surveys in permanent plots showed a widespread transformation of alpine plant community assemblages toward more warmth-demanding and/or less cold-adapted species. Concurrently to widespread increases in overall species richness, high-elevation plant species have declined in abundance and frequency. Strongly cold-adapted plant species may directly suffer from warmer and longer growing seasons through weak abilities to adjust respiration rates to warmer conditions. Combined effects of warming and decreasing water availability will amplify detrimental effects of climatic stresses on alpine biota. Many of the dwarf and slow-growing species, however, will be affected when taller and faster-growing species from lower elevations invade and prosper with warming in alpine environments and, thus, threaten to outcompete locally established species.” (Pauli & Hallo 2019)

Introduced species lose their enemies more often than their friends

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Many studies of biological invasions focus on enemy release – plants' escape from negative interactions (e.g., herbivores, pathogens, predators) in the introduced range. However, relatively few studies consider the potential for introduced species to shed their mutualists (e.g., pollinators, seed dispersers, mycorrhizae) when they move to a new range. We tested the missed mutualist hypothesis by observing plant-pollinator interactions over ~120 hours for 10 target species in nine sites across their native and introduced ranges. We found that plant species were being visited by 2.6 times more pollinators with 1.8 times greater richness in their native range than in their introduced range. For seven of our target species, the community composition of visiting pollinators also differed between ranges. However, the effect of missed mutualisms seems to be lower than the effect of enemy release. When compared across species, enemy release, a common mechanism explaining invasion success, was found to occur at twice the magnitude than that of missing pollinator mutualisms. Understanding both the positive and negative consequences of introduction to a new range can help us to predict and manage future invasion events more accurately.

The study of vegetation classification in the south of Central Range, Taiwan

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The aim of this study was to define vegetation units according to the Braun-Blanquet system in the Southern Central Mountain of Taiwan based on plot data from the National Vegetation Database and field samples. The main environmental factors associated with the distribution of recognisable community types were evaluated, and different approaches to vegetation classification were compared. A total of 1892 species belonging to 810 genera and 179 families were recorded, including 306 rare species. The vegetation units included five class 13 associations and 26 associations identified by cluster analysis. The vegetation units on the western side of the study area were located at a higher altitude and experienced significant vegetation compression. The variation in vegetation distribution by elevation gradient in these regions was mainly influenced by winter precipitation and average January temperature. Conversely, the distinct association type observed on the eastern side of the study area can be attributed to the year-round northeast monsoon. This meteorological phenomenon results in relatively low temperatures and humidity, as well as strong wind gusts, and contributes to the compression of the elevation range within each forest. In particular, the area of monsoon deciduous vegetation is confined to the western part of the low mountain ranges.

Restoration of warm-temperate evergreen broad-leaved forests and temperate deciduous forests at shopping malls in the Japanese Archipelago: CO_2 sequestration and biodiversity

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Urban environmental forests have been created throughout Japan using local seedlings since the 1970s. The concept is known as the “Miyawaki method” as it was promoted by Dr. Akira Miyawaki, professor of Yokohama National University. In this planting method, the soil is plowed sufficiently to create a mound with good aeration and drainage. Various kinds of tree seedlings cultivated in containers with a height of about 50 cm are planted at a density of 2 to 3 per square metre. Through natural planting, competition, and thinning, an optimal forest can then be formed efficiently. The plantation is easy for children and adults to be involved in, as young seedlings are used. It is widely adopted by governmental organisations, corporations, and private associations. Planted species are those of the natural potential vegetation of the site. Typical species in major metropolitan areas in Japan are evergreen broad-leaved trees such as *Castanopsis sieboldii, Machilus thunbergii* and *Quercus glauca*. ESPEC MIC Corp. has been working on the Miyawaki method since its foundation in 1988, focusing on cultivation, planting-site construction, studies of periphery plants, supply of local seedlings, support of the cultivation process and events, along with follow-up maintenance work and visualization of the ecological functions of those created forests. We present the results of a string of surveys we have been conducting on carbon sequestration and birds in municipal forests in the “Aeon Furusato no Morizukuri” project, a representative example of reforestation in metropolitan areas in Japan, since 2009.

The effects of nutrient addition on productivity in response to drought

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Drought can reduce grassland productivity by impeding plant species' ability to take up water and photosynthesize. Nutrient addition often stimulates biomass production by alleviating resource limitations, but nutrient uptake depends on soil water availability. Thus, these two global change factors interact, with experimentally eutrophied grasslands showing higher sensitivity to naturally occurring meteorological droughts. However, to date most studies have investigated these two factors in isolation. The few studies testing for interaction between drought and nutrients are site-level experiments that have reported either synergistic, antagonistic or additive responses of productivity. Therefore, we lack a comprehensive understanding of whether there is a general trend in productivity responses to these two major global change drivers or whether responses depend on the abiotic and biotic conditions. Moreover, the abiotic and biotic conditions under which nutrient addition modifies grassland drought responses remain difficult to identify as naturally occurring droughts vary widely in extent, severity, and duration. NPKD-Net is a globally distributed experiment simulating 1 in 1000-year droughts and heavy eutrophication distributed across 25 sites in eight countries around the world.

Effect of modern and historical landscape composition on soil fungal diversity in agricultural landscapes

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Landscape complexity has been found to be positively correlated to biodiversity in agricultural landscapes. Furthermore, complex landscapes with remanent patches can host more beneficial species which improve ecosystem functioning and services. However, the relationship between soil microbial biodiversity and current and past landscape composition has not been widely explored. To fill this gap, we conducted spatially intensive sampling of three agricultural fields in Estonia. The fields and their surrounding landscape have been recorded on maps since the turn of the 19th to 20th century, depicting the management succession from forested and seminatural areas to arable fields. We sampled these fields in a 100 m grid comprising 100 soil samples. Soil total fungal diversity and arbuscular mycorrhizal fungal diversity were determined by DNA metabarcoding, supplemented by soil physical and chemical properties measurements. Historical landscape complexity was measured by digitising the distribution of forests and other natural areas in available historical maps. Our results indicate that while soil properties account for most soil fungal variation, historic late 19th century landscape configuration is more strongly related to modern-day fungal distribution than the current landscape. While management and modern anthropogenic pressures can be useful in assessing regional and macroecological species distributions, historical legacies could be persistent and affect these assessments locally.

Cloud forest vegetation along fog frequency gradient in Taiwan: diversity and environment

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Fog represents a peculiar ecological factor, influencing vegetation in multiple ways: increased air humidity, decreased light availability and air temperature, and reduced decomposition rates and nutrient availability. In the Vegetation Ecology Lab at the National Taiwan University, we surveyed natural forest vegetation along a fog frequency gradient in Taiwan to better understand which of the proposed effects is the most relevant and why. Here I use data about forest vegetation and environment specifically collected on vertical (along elevation) and horizontal (along fog frequency) transects. I aim to describe the ecological optima of woody and fern species along the fog frequency gradient and test them using Ellenberg-type indicator values for fog frequency. I also focus on patterns of species diversity along the fog gradient for different plant life forms, namely woody species, lianas and terrestrial and epiphytic ferns. And finally, I use environmental data collected within our study sites to describe the ecological characteristics of the fog frequency gradient. These include long-term microclimatic monitoring in our permanents sites, data from a standard weather station established close to our 1-ha forest dynamics plot, soil temperature-and-moisture measurements using TMS loggers, tea-bag decomposition experiment to quantify decomposition rate and stabilisation index, and also measurements from Plant Root Simulator probes for in situ quantification of soil ion content. I demonstrate that studying the ecological effects of a less well-known environmental factor such as fog is challenging but can be achieved by creating a mosaic of relatively simple observations and sensibly connecting them.

Mapping tree species abundance in China's subtropical and tropical forests

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The non-random distributions of tree species over large scales are very common. Yet, the underlying drivers of species relative abundance in local and regional communities are far from clear to date. Here, we compiled a large vegetation dataset consisting of 9,431 forest plots for relative abundance of 775 tree species in subtropical and tropical regions of China. We used machine learning algorithms to map the relative abundance of these species, identify their environmental determinants, and detect the hotspots of species dominance. We found that temperature seasonality was the most important filter controlling species abundance. Soil pH mainly impacted abundance of species in the eastern region, especially evergreen broad-leaved species, while high habitat heterogeneity sheltered populations of many coniferous and deciduous broad-leaved trees in the western region. Species relative abundance was mainly clustered in several hotspots of both southwestern and southeastern China.

Vegetation diversity and peculiarity of the Danxia landscape

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Significant small-scale vegetation differentiation and independent ecological processes are found in the Danxia landform. Danxia is a geomorphic type where the basic feature of the terrain is flat hilltops and steep cliffs. Many peaks are steep on all sides, forming independent isolated peaks and cliff-enclosed gullies. Under the influence of this unique landform, numerous unique niches of different scales have been formed, thus giving rise to special ecological differentiation. The size of isolated peaks determines the number of plant taxa coexisting and the number of tree species. The thickness of the soil layer at the hilltop is thin, from the center to the edge. The annular pattern of soil layers results in the annular distribution pattern of vegetation: the center is trees; the periphery is small trees and shrubs; and the edge of the hilltop is xerophytic small shrubs and herbaceous ground cover. The microclimate of high temperatures and high humidity in the gully leads to an increase of 10% for tropical plants above those in the same latitude, with woody vines, tabular roots, strangulation, stem flowers, epiphytes and so on typical of tropical rainforest vegetation also present in the subtropical vegetation. Small-scale vegetation differentiation indicates that vegetation is as sensitive to environmental adaptation as species, and the same vegetation is not equivalent after scaling down.

Evaluating the impact of biodiversity offsetting on native vegetation

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Biodiversity offsetting is a globally influential policy mechanism for reconciling trade-offs between development and biodiversity loss. However, there is little robust evidence of its effectiveness. I evaluated the outcomes of a jurisdictional offsetting policy (Victoria, Australia). Offsets under Victoria's Native Vegetation Framework (2002–2013) aimed to prevent loss and degradation of remnant vegetation and generate gains in vegetation extent and quality. I categorised offsets into those with near-complete baseline woody vegetation cover ("avoided loss", 2702 ha) and with incomplete cover ("regeneration", 501 ha), and evaluated impacts on woody vegetation extent from 2008 to 2018. I used two approaches to estimate the counterfactual. First, I used statistical matching on biophysical covariates: a common approach in conservation impact evaluation, but which risks ignoring potentially important psychosocial confounders. Second, I compared changes in offsets with changes in sites that were not offsets for the study duration but were later enrolled as offsets, to partially account for self-selection bias (where landholders enrolling land may have shared characteristics affecting how they manage land). Matching on biophysical covariates, I estimated that regeneration offsets increased woody vegetation extent by 1.9%–3.6%/year more than non-offset sites (138–180 ha from 2008 to 2018) but this effect weakened with the second approach (0.3%–1.9%/year more than non-offset sites; 19–97 ha from 2008 to 2018) and disappeared when a single outlier land parcel was removed. Neither approach detected any impact of avoided loss offsets. I cannot conclusively demonstrate whether the policy goal of 'net gain' (NG) was achieved because of data limitations. However, given evidence that the majority of increases in woody vegetation extent were not additional (would have happened without the scheme), a NG outcome seems unlikely. The results highlight the importance of considering self-selection bias in the design and evaluation of regulatory biodiversity offsetting policy, and the challenges of conducting robust impact evaluations of jurisdictional biodiversity offsetting policies.


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