

Monday 5th September THEME 1: Generating Ecological Data

PARALLEL 1 (Great Hall)

08:30-10:15 **Registration in the foyer of the Great Hall**
TEA/COFFEE

10:15-10:25 **Welcome and introduction to the conference**
Mark O'Connell

10:25-11:05 **Plenary 1, Keynote 1**
Peter Leimbruger, Director of Conservation GIS, Smithsonian

Session 1 Survey, census, monitoring & tracking

CHAIR: Beth Scott

- 11:10-11:30
 - More with less: how the SEPA is making the jump from paper to digital field data capture
- 11:30-11:50
 - Mapping the extent of scrub encroachment on heathland using LiDAR data
- 11:50-12:10
 - Ants on mountains, space and environment along an altitudinal transect in a centre of endemism: implications for long term monitoring
- 12:10-12:30
 - Integrating diverse datasets: a new approach to estimating the at-sea density of a centrally-placed marine vertebrate

LUNCH & EXHIBITION

- 14:00-14:20
 - What makes a happy home for an urban bird? Identifying valuable features of the urban environment for avian biodiversity
- 14:20-14:40
 - Radar as a tool for conservation ecology: applications, utility and refinements

PARALLEL 2 (WG05)

Session 2 Remote sensing: data sources, access & integration

CHAIR: Geoff Groom

- Measuring the un-measurable: deriving fine-scale quality indicators of natural habitats from remote sensing images
- Density of scanning positions in primeval forest using terrestrial laser scanner
- Designing a multi-scale service for Natura2000 monitoring based on remote sensing
- Gunnery, Grassland and GIS: condition assessment on Salisbury Plain, UK

CHAIR: Philippe Gros

- Integration of field survey and orthophoto image based information for Danish coastal habitats conservation
- The potential applications of bio-acoustics for ecological survey and monitoring

and refinements

- 14:40-15:00 • Using acoustic methods to identify bats: a tool for generating distribution data
- 15:00-15:20 • Monitoring species behaviour within a rapidly changing environment: seabirds foraging in areas of high tidal energy
- 15:20-15:40 • Just how far is far enough? Using GIS re-sampling procedures to evaluate the reliability of detection during monitoring of an elusive carnivore on lowland rivers

monitoring

- Using time series of aerial photography and very high resolution satellite imagery for modelling of woody species spreading
- Using Object-based Image Analysis to support EC Habitats Directive assessment in riverine landscapes
- Continent-wide assessment of land cover changes in and around protected areas in Africa

15:40-16:10 TEA/COFFEE & EXHIBITION

- 16:10-16:30 • Spatial patterns and temporal variability of forest-interior birds in an urbanizing watershed, Southern Ontario
- 16:30-16:50 • *In situ* optical characterization of a coastal lagoon in Tunisia for ecological assessment

- Remote sensing image data and automated analysis for marine bird ecology EIA operations
- Meteorological and environmental information: through the animal's eye

Session 3 Spatial tools: software & freeware

CHAIR: Olivier Rovellotti

- 16:50-17:10 • Partitioning the impact of spatial and environmental factors on wild bee communities in protected habitats
- 17:10-17:30 • Quantifying the impact of sampling intensity on the detection of long-term trends in vegetation condition in montane swamps
- 17:30-17:50 • Appraisal of invasive plant species through Geoinformatics: a case study of *Prosopis Juliflora* in Karachi, Pakistan

- Open-source mapping and services for Web-based landcover validation
- ECORELEVÉ: Open Source software for census data and online visualization
- Climate change of biomes in African Protected Areas – results from a Web Processing Service (WPS) application

17:50 EXHIBITION & POSTER SESSION 1

19:30 **Social gathering : bar in Mason**

20:00 **CONFERENCE BANQUET**

Tuesday 6th September THEME 2: Undertaking Spatial Analysis

PARALLEL 1 (Great Hall)

PARALLEL 2 (WG05)

09:00-09:05 Welcome and introduction to the day: Mark O'Connell

09:05-09:45 **Plenary 2, Keynote 2**
Florian Jeltsch, Head of Plant Sciences and Conservation, University of Potsdam

Session 4 Analysing patterns, trends & change: from species to landscapes

CHAIR: Colin McClean

- 09:50-10:10
- Analysing trends : how to deal with missing data?
- 10:10-10:30
- Differences between tree spatial patterns of alluvial hardwood forest and fir-beech forest over 30 years

Session 5 Species-habitat interactions: measuring & modelling

CHAIR: Jason Matthiopoulos

- 09:50-10:10
- Grasping the nettle, or clutching at straws? Increasing the predictive reach of resource selection functions
- 10:10-10:30
- Species distribution models accurately predict observed range shifts for many British species

10:30-11:00 TEA/COFFEE & EXHIBITION

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| <p>11:00-11:20</p> <ul style="list-style-type: none"> • Elevational range and extinction risk in birds: a macroecological perspective <p>11:20-11:40</p> <ul style="list-style-type: none"> • Estimating relative population size and distribution using large scale count data and habitat structures <p>11:40-12:00</p> <ul style="list-style-type: none"> • Habitat fragmentation and the historical decline of woodland birds in Britain <p>12:00-12:20</p> <ul style="list-style-type: none"> • Linking landscape and genetic structure: presenting an objective and interpretable landscape genetic method | <p>11:00-11:20</p> <ul style="list-style-type: none"> • Assessing the impact of land-use change on biodiversity – method development and application <p>11:20-11:40</p> <ul style="list-style-type: none"> • Habitat connectivity in African forested protected areas <p>11:40-12:00</p> <ul style="list-style-type: none"> • The impacts of sea level rise on the East Asian-Australasian migratory shorebird flyways: graph theoretical approach <p>12:00-12:20</p> <ul style="list-style-type: none"> • Landscape-based prediction of the occurrence of the introduced muskrat (<i>Ondatra zibethicus</i>) |
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12:20-14:00 LUNCH & EXHIBITION

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| <p>14:00-14:20</p> <ul style="list-style-type: none"> • Spatial variability and autocorrelation of stand structural features in beech dominated natural forests of Central Europe | <p>14:00-14:20</p> <ul style="list-style-type: none"> • Spatio-temporal modelling of cereal aphids' seasonal migration at France scale |
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features in beech dominated natural forests of Central Europe

- 14:20-14:40
 - *Boronia deanei*: using hyper-resolution imagery for effective conservation
- 14:40-15:00
 - Novel approaches to identifying marine protected areas: data collection, models, and boundary delineation
- 15:00-15:20
 - The importance of geospatial techniques for carnivore conservation
- 15:20-15:40
 - Optimising landscape selection in a dynamic agricultural region
- The spatial and temporal dynamics of plants associated with ephemeral pools in Cornwall
- Combining spatial scales to assess the suitable habitats of very small populations: the case of the brown bear in the Pyrenees
- Application of Bayesian Belief Network in the analysis of habitat preferences of macrophytes
- Spatial analyses in support of wildlife conservation across frontiers in the High Andes

15:40-16:10 **TEA/COFFEE & EXHIBITION**

Session 6 Ecosystem diversity & services: mapping & understanding

CHAIR: Stefania Pizzirani

- 16:10–16:30
 - Trade-off between map resolution and computational time in conservation planning
- 16:30–16:50
 - Spatial and Spatio-temporal point process modelling in population ecology
- 16:50–17:10
 - Spatially optimal allocation of new conservation areas to improve functional connectivity in conservation landscapes: a genetic algorithm approach
- 17:10–17:30
 - Multi-scale decomposition of ecological data for conservation
- 17:30-17:50
 - Inference for spatial processes based on areal unit data
- Assessing genotypic diversity in populations of dimorphic clonal plant species by spatial statistics
- Bayesian clustering techniques and progressive partitioning to identify population structuring within a recovering Otter population in the UK
- Integration of Forestry Decision Support Systems in GIS
- Landscape functionality in protected and unprotected areas
- Assessing the impact of land-use change on biodiversity and other ecosystem services

17:50 **EXHIBITION & POSTER SESSION 2**

19:30 **Social gathering : bar in Mason**

20:00 **CONFERENCE EVENING MEAL**

Wednesday 7th September THEME 3: Using Spatial Analysis for Conservation

PARALLEL 1 (Great Hall)

09:00-09:10 Welcome and introduction to the day

Session 7 Spatial ecology: from patterns & trends to action & policy

CHAIR: Colin Studholme

- 09:10-09:30 • Applying parcel-specific land-use data to assess conservation needs for semi-natural grasslands in Denmark
- 09:30-09:50 • Assessing the quality of seabed habitat maps for use in marine conservation
- 09:50-10:10 • Identifying marine protected areas for seabirds in the UK
- 10:10-10:30 • Placing land cover preferences by users on the map: Bridging the gaps of landscape preference surveys and spatial pattern analysis in order to inform planning and policy
- 10:30-10:50 • Rebuilding Biodiversity: the South West Wildlife Trust's approach to landscape scale conservation

TEA/COFFEE & EXHIBITION

- 11:20-11:40 • Remote sensing as a tool for agri-environment monitoring
- 11:40-12:00 • Using GIS to evaluate the coverage of vaccinating badgers against bovine tuberculosis
- 12:00-12:20 • Using vessel monitoring systems and telemetry for conservation management of endangered species
- 12:20-12:40 • Striking a balance: modeling migration of golden eagles through wind energy developments of the central Appalachians

PARALLEL 2 (WG05)

Session 8 Spatial data: access, capacity & funding

CHAIR: Stefania Pizzirani

- Assessing Regional Change to Natural Habitats (ARCH)
- The Cumbria Biodiversity Evidence Base: a tool for local authorities to facilitate their use of ecological data, so ensuring they fulfil their biodiversity duties when policy and decision making
- Understanding resource use and conservation: an example from Amazonian Ecuador
- Incorporating mobile technology (*Wildknowledge*) in wildlife conservation
- From field monitoring to web-based decision support - a Danish case
- Practical conservation and spatial analyses
- Modelled seabed habitat maps for integrated management in European waters
- A mathematical model emphasizing biological control and spatial structure
- Development of an online hatchery release data mapping application

through wind energy developments of the central Appalachians

12:40-14:10

LUNCH & EXHIBITION

14:10-14:30

- Identifying the drivers of fishers' spatial behaviour at Lake Alaotra, Madagascar

14:30-14:50

- A GIS method identifying the status and conservation of wildland in Europe

14:50-15:10

- Geospatial modelling of biodiversity in Uttar Pradesh, India

15:10-15:30

- Using spatial analysis to predict the vulnerability of Australian tropical savanna birds to climate change

15:30-16:05

Plenary 3, Keynote 3

Tom Books, Chief Scientist, NatureServe

16:05-16:15

Concluding remarks and thanks

16:15

END OF CONFERENCE

16:15

Goodbyes and TEA/COFFEE

Session 9 Single species conservation

CHAIR: Saija Sirkia

- Decrypting the Secret Life of South Africa's Brown Hyaenas

- Measuring the rate of spread in river networks: a case study with Eurasian Beavers

- Multiple levels of connectivity in spatial conservation prioritisation – Capercaillie (*Tetrao urogallus*) habitats in Southern Finland

- Multi-scale species-habitats relationships in forest ecosystems: a holistic management approach for the Eurasian Pygmy owl (*Glaucidium passerinum*) in the French Alps

SESSION 1

SURVEY, CENSUS, MONITORING & TRACKING

More with less: how the Scottish Environment Protection Agency is making the jump from paper to digital field data capture

Jonathan Bowes

Scottish Environment Protection Agency, Bremner House, Stirling, FK9 4TF

The Scottish Environment Protection Agency (SEPA) is Scotland's environmental regulator. Its main role is to protect and improve the environment. SEPA's jurisdiction covers 78,000 km² of land containing 125,000 km of rivers. Currently 63% of Scotland's waters are better than good status but the Scottish Government under the Water Framework Directive (WFD) has committed to this figure reaching 98% by 2027. This has to be attained in a climate of severe public sector spending cuts, including a 20% reduction in staff. Diffuse pollution is the most significant pollution pressure causing water bodies to fail objectives under WFD and SEPA has identified 102 of these catchments that need remediation by 2027, 14 of which by 2015. In summer 2010, SEPA embarked upon a comprehensive ground assessment of all diffuse pollution issues and compliance with new diffuse pollution legislation at two scales in two phases: (1) Catchment –scale walk along the full (1:50k) river network, and (2) farm-scale inspections. The anticipated volume of paper work involved in this exercise triggered the need for fundamental change in the way SEPA collects data.

The South Esk Priority Catchment was the first to be tackled and was selected as a pilot for evaluating digital data capture technology. The Algiz 7, TDS Yuma and General Dynamics GD-7DM ultra-mobile PCs (UMPC) were selected for trial alongside a field mapping and data collection solution GeoField from Sigma Seven. Based on the South Esk catchment walk the switch to digital data capture presented an overall resource saving of 82%. Extrapolating this over the first 14 Priority Catchments we estimate the savings to be 2.9 full time employees (FTE). Efficiency savings significantly increase when we apply digital data capture to the farm-scale inspections – 8.9 FTEs for the first 14 Priority Catchments, totalling 11.8 FTEs. SEPA found the UMPCs to be usable and effective in day-long operation in rugged and remote terrain and digital data capture on maps to be an efficient, accurate, robust and easy to use alternative to paper-based recording. To date some 12,000 km of Priority Catchment rivers have been assessed using some 40 staff with a large volume of photographic, point and line (GIS) evidence being captured in the traditional paper world. SEPA is currently making the transition to a purely digital capture system based around 26 Algiz 7 devices combined with GeoField that will integrate with our enterprise Oracle and spatial databases. This paper presents the background to the trials, the challenges faced by SEPA, the method and criteria for evaluation and the detailed results obtained. These results are extrapolated to the wider Priority Catchments project and SEPA other public tasks, and discussed together with the eventual successful business case. Finally the project is summarised, offering lessons learned and recommendations for other practitioners and agencies wishing to move away from paper-based surveys.

Mapping the extent of scrub encroachment on heathland using LiDAR data

Sarah Petchey and Crispin Hambidge

Geomatics Group, Environment Agency

One requirement for habitat condition assessment and reporting is mapping scrub vegetation extent. Environment Agency (EA), in partnership with Natural England, investigated whether LiDAR data alone could be used to map scrub accurately and cost effectively. LiDAR data were acquired for Greenham Common near Newbury, UK. Ground data were used to determine thresholds for an automated technique to map the extent and height of scrub. Independent ground data were used to assess the accuracy of the scrub map. GPS was used to collect point data of scrub and non scrub. Using 0.25 m resolution data, class assignment was 95 % accurate and scrub boundary precision was within 0.34 m RMSE. Regression analysis applied to predicted scrub height against actual scrub height revealed a strong correlation (0.67 r^2), however the slope was 0.336, indicating that scrub height was generally underestimated. The model applied would not be sufficient to enable scrub height measurements directly from LiDAR data. Further work is underway to assess the effect changing resolution has on the classification and boundary position accuracy in the context of being able to monitor change and access existing archive LiDAR datasets, ranging from 0.25 to 2 m resolution, held by EA.

Ants on mountains, space and environment along an altitudinal transect in a centre of endemism: implications for long term monitoring

Foord S.H. & Munyai T.C.,

Centre for Invasion Biology, Department of Zoology, University of Venda, Thohoyandou, 0952 South Africa

Mountains might be the most cost effective way to measure the response of biotic communities to global climate change. We investigated to what extent ant diversity over the Soutpansberg mountain in South Africa can be related to spatial and environmental variables. Ant richness peaked at lower elevations on the southern aspect but had a hump-shaped pattern on the northern aspect. Spatially structured environmental variables, temperature and proportion of exposed rock, were significant terms in the final model for species richness and abundance explaining two thirds of the variation. Space alone explained less than eight percent of the variation. Ant assemblage structure was largely the result of temperature, available area, the proportion of exposed rock and vegetation cover. Species on the arid northern aspect were specific to vegetation types while species on the southern aspect were more generalist. Temperature and carbon content of the soil affected the abundance of the two myrmecochores. Temperature, as a consistent explanatory variable, could provide a predictive surrogate for future changes. High altitude species such as *Monomorium* sp. 02 and *Lepisiota* sp.06 are endanger of extinction while ongoing monitoring of indicator taxa identified could provide a measure of the nature and speed of these changes.

Integrating diverse datasets: a new approach to estimating the at-sea density of a centrally-placed marine vertebrate

Matthew J. Witt¹, Angela Formia^{2,3}, Catherine McClellan¹ and Brendan J. Godley¹

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For the leatherback turtle (*Dermodochelys coriacea*) that visits coastal tropical habitats every few years for reproduction, a variety of human activities pose risk, including oil and gas exploitation, pollution and fisheries. Building knowledge on the distribution of leatherback turtles, so that risk might be managed, is however a complex undertaking. Biotelemetry methods using electronic devices communicating the position of instrumented animals have revolutionised our knowledge of habitat use, yet the approach is expensive and logistically challenging, which has hindered the collation of large datasets. Aerial surveying holds promise, but while the spatial footprint of surveying can be extensive the method presents only a snap-shot in time and provides little information at the level of the individual. We present a novel method for determining the spatio-temporal footprint of leatherback turtles in coastal waters of Central Africa by merging diverse survey datasets, including foot patrols to assess seasonal nesting effort at index sites, aerial surveying to assess the spatial density of nesting and satellite telemetry work to describe at-sea movements. The resulting product holds much promise, particularly when contextualised with putative risk; such as from fisheries, and provides a synoptic view to aid effective conservation management of the leatherback turtle.

What makes a happy home for an urban bird? Identifying valuable features of the urban environment for avian biodiversity.

Emma Rosenfeld¹, Adam Bates¹, Stefan Bodnar³, Jim Reynolds² & Jon Sadler¹

1. School of Geography, Earth & Environmental Sciences, University of Birmingham

2. School of Biosciences, University of Birmingham

3. Birmingham City Council

Functional connectivity of green spaces in cities has been shown to lead to good ecological performance. This suggests that areas with higher levels of functional connectivity and complex wooded habitats should sustain a larger and more diverse avian population. We tested this hypothesis by assessing bird species and abundance across an urban gradient in Birmingham (UK) surveying 70 sites over three sampling periods in 2009, in combination with a tree survey and digital analysis of land use. The aims of the study were to: (i) identify habitat features that are most important to a diverse bird population; (ii) examine the effects of habitat fragmentation and connectivity upon the diversity and individual species distributions; and (iii) identify scales at which birds respond to habitat features. Preliminary data exploration indicates urban habitat features such as built land having an influence on species composition and abundance, with species falling into functional groups. Habitat features appear to affect different species at different spatial scales. Higher levels of connectivity, judged by structurally connected tree lines, is expected to benefit specialist bird species. The work provides insights into the nature and permeability of the urban landscape matrix.

Radar as a tool for conservation ecology: applications, utility and refinements

Dan Forman¹, Clive Alabaster², Evan Hughes², Wendy Harris¹, Penny Neyland¹, Laura Roberts¹ and Carolyn Greig¹

¹Conservation Ecology Research Team, Department of Biosciences, Swansea University, UK. SA2 8PP

²Department of Informatics and Systems Engineering, Cranfield University, Shrivenham, OXON, UK. SN6 8LA

Using acoustic methods to identify bats: a tool for generating distribution data

Charlotte Walters^{1,2}, Kate Jones¹ and Stuart Parsons³

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³School of Biological Sciences, University of Auckland, Auckland, NZ

To conserve biodiversity effectively, first we must know where it is distributed. Bats are an important component of biodiversity; they comprise a fifth of all mammal species and provide essential ecosystem services such as insect regulation, pollination and seed dispersal. However, they are challenging to survey using conventional trapping and visual sampling methods as they are small, nocturnal and many are difficult to catch and identify. Given that all European bats use echolocation to navigate and find prey, acoustic methods are a promising alternative method of generating distribution data. However distinguishing between the calls of different bat species can be difficult due to the similarity in temporal and spectral structures of calls and the intra-individual and intraspecific variability in calls. An objective statistical method of identification is required to give a robust classification of echolocation calls. Here I present work on developing ensembles of neural networks as an acoustic identification tool to distinguish between the echolocation calls of 33 European bat species. This will aid the collection of bat distribution data in Europe, which can then be entered into spatial models of bat distributions.

Monitoring species behaviour within a rapidly changing environment: seabirds foraging in areas of high tidal energy

B.E. Scott and E. Philpott

School of Biological Sciences, Institute of Biological and Environmental Sciences University of Aberdeen, Tillydrone Avenue, Aberdeen, AB24 2TZ, UK.

Human usage and preservation of the marine environment is set to change rapidly with the development of both offshore energy and the establishment of Marine Protected Areas. To be able to site these activities in optimal locations we must understand in

much greater detail the mechanisms of how mobile species utilize ever changing (hourly, daily, seasonally, annual) marine habitats as the high level of uncertainty in the results of most marine monitoring is driven by the rate and extent of habitat change. Pilot monitoring studies of dynamic regions such as areas with high tidal energy show clear species (seabird) preferences for foraging within very limited temporally occurring habitats. Some of the water column habitats in these sites do not exist at all during different phases of the tides and some drastically change the proportion of the region in which they occur. The preliminary results of our studies indicate the conclusions of monitoring surveys would be qualitatively different if less intensive or bias, with respect to time of tide, monitoring had been carried out. The pilots also highlight the need to deal explicitly and statistically with habitats that change during monitoring.

Just how far is far enough? Using GIS re-sampling procedures to evaluate the reliability of detection of an elusive carnivore, the otter (*Lutra lutra*), on lowland rivers

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European protected mammal species are monitored using a variety of survey tools. Many of these tools rely on the accurate identification of field signs (typically faeces and footprints) recorded over set distances. In the case of otters, monitoring programs are typically based on a commonly used survey design developed in the 1970s in which the presence of otter faeces ('spraints') are recorded over a 600 m river transect. Many monitoring programs require a detection probability level of 0.8. We used a GIS re-sampling approach to determine the accuracy of using 600m transects to detect otters on small rivers systems. We also applied a re-sampling approach to determine the minimum distance required to detect otters with a probability of 0.8. The mean probability of detecting otters based on a single 600 m transect survey was low (0.26 + 0.01 SE). A detection probability of 0.8 could not be achieved through a single visit transect survey. Increasing the number of replicate visits and study sites was a more efficient method of improving detection power than increasing transect length alone. This study emphasises the importance of validating survey tools using GIS re-sampling approaches to ensure that they are 'fit for purpose'.

Spatial patterns and temporal variability of forest-interior birds in an urbanizing watershed, Southern Ontario, Canada

1. Robert J. Milne and 2. Lorne P. Bennett

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Long-term species records provide a good baseline upon which to assess temporal variations at a range of spatial scales. This paper presents the results to date of a long-term avian monitoring program within the Credit River watershed, in Southern Ontario, Canada. Breeding bird populations have been monitored at 25 woodlots for the past nine years at sites representing a gradient of human impact across the watershed. The Credit River drains through three physiographic and corresponding land-management regions including agricultural land, urban centres and a biosphere reserve. Avian population patterns have been assessed at three spatial levels of land cover from the watershed to site-level and compared to temporal variability between breeding seasons. It was determined that diversity of avian guilds is a function of larger, regional patterns of physiography and land use. Similarly, at the landscape level increased pressures from land use and loss of habitat cause a shift from forest-interior to edge or urban species. However, at the landscape-level and site-level habitat diversity will influence temporal variations in population patterns.

In situ optical characterization of a coastal lagoon in Tunisia for ecological assessment

Nourisson D. H., Scapini F., Massi L., Lazzara L.

University of Florence, Department of Evolutionary Biology.

Ghar El Melh is a shallow lagoon, undergoing eutrophication due to growing human pressures. To assess the relations between its optical properties and its trophic state, downwelling and upwelling visible spectral irradiances were measured in 22 sampling stations across the basin. Apparent Optical Properties (AOPs), namely reflectance $R(\lambda)$ and diffuse attenuation coefficient $K_d(\lambda)$ were then calculated. From water samples, the concentrations of OASs (Optically Active Substances), chlorophyll *a*, particulate suspended matter and colored dissolved organic matter, were assessed. These showed elevated values both for particulate and dissolved matter ($13.2 \leq [SPM] \leq 46.8$ mg/l; $0.2 \leq a_{CDOM}(440) \leq 0.6$ m⁻¹). The use of an optical classification for basins rich in SPM and CDOM, integrating AOPs and OASs, highlighted a great spatial heterogeneity, with waters from clear to very turbid, the latter dominating where water exchanges were slower. The application of the Ecological Evaluation Index (EEI), based on macrophyte-cover distribution in shallow environments, where phytoplankton is not the main primary producer, indicated an intermediate ecological condition. So the integrated use of both methods permitted a complete, repeatable characterization, detecting more impacted sectors and suitable to understand links between optical and trophic classification in coastal basins.

Partitioning the impact of spatial and environmental factors on wild bee communities in protected habitats

Tomás E. Murray^{1,2*}, Úna Fitzpatrick^{3,4}, Andrew Byrne^{3,4}, Réamonn Fealy⁵, Mark J. F. Brown^{3,6}, Robert J. Paxton^{1,2}.

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³Department of Biology, School of Natural Sciences, University of Dublin Trinity College, Dublin 2, Ireland.

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⁶School of Biological Sciences, Royal Holloway, University of London, Egham Hill, Egham, Surrey TW20 0EX, U.K.

Despite the accumulating evidence-base for global declines in bee populations, few studies have addressed the relative importance of local environmental and regional spatial factors in maintaining diverse bee communities outside of agricultural

habitats, and particularly in areas protected for nature conservation. We analysed bee community data collected from 40 Special Areas of Conservation representing five distinct European Natura 2000 priority habitats within Ireland along with our quantification of local habitat features and surrounding land use. The importance of local environmental and regional spatial processes were determined by decomposing the total variation in the community matrix into unique environmental and spatial components by means of variance partitioning using partial canonical correspondence analyses. Wild bee species richness and abundance was highly dependent on habitat type, but relatively insensitive to the local area of conserved habitat. After controlling for the effects of spatial dependence, local-scale environmental factors such as grazing and surrounding land-use consistently explained a greater fraction of community variance within all habitats studied compared to pure spatial components. Therefore, management effort prioritising the maintenance of contrasting habitats within a broad network of protected areas best facilitates bee conservation.

Quantifying the impact of sampling intensity on the detection of long-term trends in vegetation condition in montane swamps

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A monitoring program that can detect changes in vegetation condition is critical for understanding and modelling ecological communities. However, vegetation communities vary both spatially and temporally and may exhibit changes that mask long-term trends. Sampling spatial and temporal resolution and measurement accuracy will determine whether long-term changes in vegetation condition can be identified. This study developed a probabilistic model that quantifies the relationship between vegetation temporal and spatial variability and monitoring strategies for a selection of montane swamps in central NSW, Australia. The model has three components: i) a landscape model that uses classified UAV data to describe vegetation condition; ii) a temporal change simulation model; and iii) a sampling model to describe the current plot-based and newer remote sensing monitoring methods. The aim of this study was to investigate whether current plot-based monitoring strategies required by government regulation could discern long-term trends in vegetation condition. It quantified the relationship between vegetation condition variability, monitoring intensity and monitoring performance. The study found that current plot-based methods did not perform as well as remote sensing methods because of their small spatial sampling size. However, when the remote sensing acquisition frequency was lower, the difference in performance was reduced.

Appraisal of Invasive Plant Species through Geoinformatics: A Case Study of the *Prosopis Juliflora* in Karachi, Pakistan

Jamil H. Kazmi and Syed Ali Naqi

Department of Geography, University of Karachi, Karachi – 75270, Pakistan

Prosopis juliflora (*Pj*) is a dominant invasive plant species in the arid and semi-arid areas of Pakistan, especially in disturbed ecosystems. This unique complex plant has become a major factor for eliminating the habitat of many local indigenous species at a catastrophic level. It is being reported as in the IUCN's new list of 100 world's worst invasive alien species. Despite the experience of ecologists around the globe, it is almost impossible to terminate the growth of this plant, as it spreads widely in most of the arid areas of the world. Attempts to eradicate or control its dispersion have largely failed and the species is now naturalised in many regions. Thus, it is important to monitor its extent and dispersal through emerging scientific tools such as geoinformatics. The intensity and frequency of *Pj* thickets can also be determined through Satellite Remote Sensing (SRS) techniques. With the help of the Point Center Quarter Method in the field, its competition with other species can be evaluated and generalized on SRS imagery.

SESSION 2

REMOTE SENSING: DATA SOURCES, ACCESS & INTEGRATION

Measuring the un-measurable: deriving fine-scale quality indicators of natural habitats from remote sensing images

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Efficient nature conservation requires accurate information on the quality of natural habitats. Therefore, several protocols have recently been developed to assess conservation status in the field, based on both coarse-scale indicators (such as tree and grass encroachments), as well as very fine-scale elements that require precise fieldwork (such as the number of key species present). While the coarse-scale parameters can mostly be derived with remote sensing, the fine-scale parameters pose much larger challenges to be detected from the air. We tested whether the fine-scale characteristics can be modelled by coarse-scale field characteristics, and extended this idea to remote sensing techniques to derive information on fine-scale indicators that cannot directly be measured by the sensors. Using boosted regression trees with coarse-scale quality indicators as predictors, we successfully obtained estimates of fine-scale parameters relevant for conservation status assessments. By doing so, we achieved accuracies that approach those of field work. These results clearly illustrate the possibility to derive information on the conservation status from remote sensing imagery using advanced modelling, even for characteristics that are expected to be too small to measure from the sky.

Density of scanning positions in primeval forest using terrestrial laser scanner.

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LIDAR technology has significantly improved our measurement and understanding of forest dynamics. For the first time, forest structure can be captured in 3D. However, with the acquisition of such data, new questions have been raised about how to deal with the technical difficulties of LIDAR beam passing through forest? How many positions are needed for recording every tree in 1ha plot and how dense should be the positions inside the plot? Comparing maps of stem positions from conventional measurements and point cloud data, the percent of trees detected from one position according to distance can be evaluated, as well as the average diameter of registering hemisphere. It is also possible to make decisions on how to best fit the position of the terrestrial laser scanner to scan the plot with every tree according to terrain conditions, shadows of trees and distance. The results will be used for better planning of data acquisition with LIDAR scanner in forest.

Designing a multi-scale service for Natura2000 monitoring based on remote sensing

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The implementation of the Habitats Directive (HabDir) in 1992, as the European contribution to the Convention on Biological Diversity (CBD), has been a major step towards a more harmonized and knowledge-driven approach to nature conservation in the European Union (EU). Member states have protected habitats and species of 'Community interest', and designated sites of high nature value as so-called Natura2000 sites. But the work is not finished. Protected sites need to be managed appropriately, and impacts carefully monitored. Also, member states have to report the conservation status of habitats and species to the EU every six years, thus enabling the EU to monitor achievements of the HabDir. As a result, extensive and diverse information needs occur at three different scale levels (EU, member state, protected site), which cannot be met by field work alone. The potential of remote sensing to assist in fulfilling these needs has already been demonstrated, but its use in operational Natura2000 monitoring is still limited. We argue that a successful remote sensing based service for monitoring in the Natura2000 context should be multi-scale, versatile, user-friendly, and cost-efficient. The FP7-project MS.MONINA intends to set the basis for such a service at three scales, complying with pan-European efforts for data harmonization, and relying on strong user involvement.

Gunnery, Grassland and GIS: condition Assessment on Salisbury Plain, UK

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Calcareous grassland has a high richness and diversity of flora and fauna, and is a vital habitat for many scarce and threatened species. The defence training estate on Salisbury Plain (DTE SP) contains some 40% of the UK's remaining calcareous grassland, as military ownership over the past century has protected the grassland from degradation by ploughing and agricultural improvement. However, maintaining the habitat in good condition requires extensive conservation management. The 38000 Ha extent of DTE SP means that a whole-landscape approach is vital to the targeting, monitoring and overall effectiveness of conservation activities. This presentation details the application of remote sensing methods in order to monitor two of the most pervasive threats to the quality of calcareous grassland on DTE SP – scrub encroachment and disturbance by military vehicles. Image enhancement and classification of high resolution aerial photography have been used to create a time series of scrub and bare ground levels across the plain. Combining this information with field survey data has provided information on the effectiveness of scrub clearance techniques and highlighted areas at risk of disturbance. The methodology is both rapid and cost-effective, and has potential to be a valuable tool for calcareous grassland conservation.

Integration of field survey and orthophoto image based information for Danish coastal habitats conservation

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EU Habitats Directive work in Denmark in the monitoring period 2004-2009 has relied upon field survey methods. Whilst this has been successful for many habitat types the extensive habitats associated with coastal areas (e.g. EU Habitats Directive habitat types 1230, 1320, 2110, etc.) have been inadequately covered. The extent of the Danish coastal habitats limits the possibilities for use of field survey methods alone and remotely sensed image analysis methods are therefore seen as relevant to enable a sufficient level of geographic coverage. For the monitoring period 2011-2015 a strategy is being implemented that integrates the characteristics of the habitat information acquired from field survey with the characteristics of habitat information that can be interpreted from image data. Representative sampling within areas covered by existing detailed habitat maps within EU Nature-2000 sites provide a basis for linkage of field survey mapped key habitat species and structure descriptors with landscape primitives that can be mapped through object based image analysis of sub-meter RGB/CIR orthophoto image and digital elevation model data. Texture and contextual properties have a key role in the linkage. The established relationships are applied to provide predictive mapping of habitats in the previously unmapped extents.

The potential applications of bio acoustics for ecological survey and monitoring

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The advent of inexpensive, broad-spectrum recording devices provides an opportunity for a potentially powerful new tool for field ecologists. Previously the preserve of researchers, bio-acoustic recording, coupled with advances in software, has the potential to provide high quality data for many applications. This paper will explore the technology and, drawing upon research in the USA and Europe, will look at the applications of acoustic remote sensing for a range of species groups including birds, bats, invertebrates and amphibians.

Using time series of aerial photography and very high resolution satellite imagery for modelling of woody species spreading

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The spreading of forests and shrubs in abandoned landscape is a common trend in many European countries. This study combines historical and recent aerial photography for monitoring changes in a fully abandoned landscape in an unused part of military area in Czech Republic. The study site is 2x2,5 km large and all management is restricted since 1953. The former rural landscape of fields, meadows and few forests changed into a mosaic of shrubs, forests and few grasslands. Linear mixed effects models based on orthorectified, object oriented classified imagery from each decade show faster spreading of trees and shrubs along forest edges, steep slopes and in valleys, influence of former landuse is still significant. Using high-resolution satellite data from World-View 2, we classify hawthorn, broad-leaved trees and conifers and we test algorithms based on all four multi-spectral bands to separate more broad-leaved species and make the model species specific. Hawthorn is a main pioneer species in this area and knowledge of its recent extent combined with the historical development helps us to model the change more accurately. Final model could help to predict changes on a landscape scale, plan management practices in similar areas and effectively protect diversity.

Using Object-based Image Analysis to support EC Habitats Directive assessment in riverine landscapes

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Riverine landscapes are heterogeneous habitat complexes in different vegetation succession states, shaped by the spatio-temporal dynamics of the water regime. Preserving areas underlying the EC Habitats Directive (HD) and improving their connectivity is one of the ecological objectives within the *Integrated River Engineering Project on the Danube to the East of Vienna* (IREP). Especially in riparian habitats, water level transitions induce a shift in the plant species composition from aquatic plants to ephemeral communities, resulting in different HD types within the same spatial dimension but different temporal occurrence. Therefore, the aim of this study was to map the aquatic-terrestrial transition zone by applying the Object-based Image Analysis approach. The extents of the water surface and the transition zone were delineated by extracting spectral and contextual information from aerial images, groundwater and elevation models. All process steps were executed within a rule-based environment incorporating two evaluation steps. This processing delineated a surface cover of 23% within the project area of the IREP. The water surface accounts for 11.6 km² and the transition zone for 3.3 km². The rule-based environment proved to be a replicable, systematic framework for the extensive field studies as they are carried out within the IREP.

Continent-wide assessment of land cover changes in and around protected areas in Africa

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Africa is home to some of the most vulnerable natural ecosystems and species on the planet. Around 7000 protected areas seek to safeguard the continent's rich biodiversity, but many of them face increasing management challenges. Rapid human population growth, often right up to the protected boundaries, increases the demand for natural resources. Its direct and indirect impact on land cover in and around protected areas put the ecological functioning and integrity of the protected area at risk. The continental distribution of human pressures and their driving factors is not well understood and problems faced by protected areas remain a major concern. We discuss the use of land cover change derived from MODIS data between 2001 and 2009 as an indicator of human pressures and present the first results of a continent-wide assessment of land cover changes in and around protected areas. Rates and types of land cover change in protected areas were mapped and compared to changes observed in their surroundings within different buffer zones. The land cover change assessment is an important step to develop statistical and ecological models and predict future land cover changes. Uncertainties and limitations of the utilized MODIS dataset are also presented.

Remote sensing image data and automated analysis for marine bird ecology EIA operations

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**Blom UK, Cheddar, UK*

Advances in image data capture with airborne digital cameras and in object-based image analysis (OBIA) have provided a basis for new arenas of applied remote sensing, one of which is the direct, rather than estimated, counting and mapping of animal individuals. The derived data represent significant inputs to population size estimation and study of animal-habitat interactions.

One growing application is bird ecology in relation to EIAs for marine installations such as wind turbine farms and sea crossing transportation infrastructure, with the "EIA Ornithological Survey at Crown Estate Round 2.5" work being undertaken jointly by NERI (Aarhus Univ. DK) and BLOM UK being an example of the former, with monthly surveys over two years of two offshore areas (total area ca. 660 km²) in the Irish Sea. Image coverage comprises acquisition of 4 cm and 3 cm GSD image data. Object based image analysis methods are used to map all birds and identify species using both pixel tone and object shape/context in the forms and patterns of signal (i.e. bird) and noise (e.g. sun-glint, whitecap, wave-foam) image data. This paper presents results and image data analysis methods and use of the derived bird data in applied ecology.

Meteorological and environmental information: through the animal's eye

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Satellite technology has been used extensively to track and monitor wildlife mobility. It is also used to make global earth observations at high resolution, and collect environmental data. The combination of tracking and earth observation technologies has been successfully used to conduct research and monitoring on a range of animals and habitats. We will present research on *Beluga* mobility in relation to ocean habitats through the use of co-visualisation techniques. These innovative support tools have proved to be of considerable value in ecological research and can be enhanced by adding user functions to integrate data types and derive new information. To extend the use of such tools to terrestrial animals or birds, additional expertise is needed to: (i) identify the required environmental data sources to be associated with the animal and specific area of interest, and (ii) review the tool configuration to meet the requirements of the new application domain. We will also highlight two EU FP7 projects that are currently working on similar issues to address the 'fitness for purpose' of remotely sensed environmental data for studying climate change impact and oil pollution prevention. We will also show how integrated data and analysis systems can support conservation action planning and provide an understanding of both the causes and consequences of anthropogenic pressure.

SESSION 3

GIS & SPATIAL TOOLS: SOFTWARE & FREWARE

Open-source mapping and services for Web-based landcover validation

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We present an example of Web-based mapping based on free and open-source software and standards (including PostGIS, OpenLayers, WMS/WFS and Geoserver) to support expert / community validation of global landcover maps. Authorised users are permitted to validate the accuracy of automated landcover classifications, using site-specific imagery and local knowledge. Users may optionally provide uncertainty information at various levels: from a general rating of their confidence in a site validation to a numerical ranking of the possible landcover types within a sample polygon. Versions of this tool have been developed for the TREES-3 initiative which monitors tropical landcover change through ground-truthing at latitude / longitude degree confluence points, and for monitoring of change within and around Important Bird Areas by Birdlife / RSPB. We present further details on the potential use of the latter application, in combination with NDVI and other time series data from the eStation - a system for receiving, processing and disseminating environmental data. We show how these tools can be used to increase the usability of earth observation data by local stakeholders and experts, and can assist in evaluating the impact of protection regimes on landcover change and habitat fragmentation.

ECORELEVÉ: Open Source software for census data and online visualization

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Ecologists have struggled with environmental data management issues for many years now. It has become urgent to focus on building the technological solutions required for a more efficient process of data collection, exchange, and analysis. To address this issue, Natural Solutions and Reneco are starting an ambitious open source effort based on open source components such as Flex/Air, GeoServer, and PostGreSQL. The ecoRelevé platform is built on a modular architecture consisting of three main components implementing ecological protocol definition, field data collection, and visualization. These components share common architecture style (REST) and communication standards (XML based languages). The different ecoRelevé components, ecoRelevé Data, ecoRelevé Concept, and ecoRelevé Explorer are designed respectively to provide online and offline data entry, manage protocols and taxonomies, and basic GIS functionality. As part of the platform, we have created a mobile solution, named Pocket eRelevé designed to replace the old pen and paper method on field data surveys. Observation data are automatically structured and associated with GPS points. Data will be exported automatically to the ecoRelevé Data Portal for visualization, this tool is currently being ported to mobile phone platform such as Android and Windows Phone. The previous version of this platform, named eRelevé, is currently used to collect, structure, and record biodiversity data by the Emirates Center for Wildlife Propagation with the aim of ensuring the restoration of a sustainable wild Houbara Bustard (*Chlamydotis undulate*) population.

Climate change of biomes in African Protected Areas – results from a WPS application

Jon Olav Skøien, Gregoire Dubois, Michael Schulz, and Lucy Bastin

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Protected Areas (PA) were originally designed for protection of animals and vegetation against human influence. However, park boundaries offer no protection against climatic influences, so for conservation purposes we must assess the effects of climate changes on the future biomes of parks. It is important to identify areas where environmental change will be intolerable for a park's species, and to assess the possibility of migration to other areas if change is too dramatic. In the application presented here, we will apply a simple Species Distribution Model (SDM) using Mahalanobis Distance to compute the similarity between the bioclimatic conditions of PAs today and in the future. Some adaptations to the traditional SDM modelling are necessary as the boundaries of PAs are different from both the niches and the realized niches of different species. As climatic data we will use the variables which define Holdridges lifezones, computed from forecasted climate variables available from WorldClim (worldclim.org). The results presented will come from an interoperable OGC-compliant Web Processing Service (WPS), where the computational backend can easily be fed with different combinations of forecasted climate variables from available Web Coverage Services.

SESSION 4

ANALYSING PATTERNS, TRENDS & CHANGE: FROM SPECIES TO LANDSCAPES

Analysing trends : how to deal with missing data?

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Many monitoring schemes are developed to detect long-term trends in the abundance of species. For Gaussian data, the linear mixed model is a commonly used method to take into account correlations between measurements from the same site. However, for counts the analysis is less straightforward. One has the choice between a random-effects approach on the one hand, using generalized linear mixed models (GLMM), and a marginal model on the other hand, namely generalized estimating equations (GEE). While both methods may provide similar results in terms of hypothesis testing, things are different when the models are used for estimation purposes, because the parameters have quite different meanings. Also, in the presence of missing data, GEE is only valid under the assumption of MCAR (missing completely at random, Little and Rubin, 1987) and requires a modification to be valid under missing at random (MAR, conditional on the observed data, the missingness is independent of the unobserved measurements), being a weighted GEE (Robins, Rotnitzky, and Zhao, 1995). The idea is to weight each site's contribution in the GEE by the inverse probability that it drops out at the time it does. We will show how such analyses can be implemented in R, using data on butterflies in Flanders.

Differences between tree spatial patterns of alluvial hardwood forest and fir-beech forest over 30 years

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Although the spatial point pattern analysis is frequently used method in plant ecology, interpretations are oftentimes difficult. In order to increase validity of results we used data in the form of replicated spatial point patterns. In old-growth forests of alluvial hardwood forest and fir-beech forest we chose seven two-hectare rectangular plots for each forest type. Our research questions were (i) are there any statistically significant differences between tree spatial patterns of these forest types? and (ii) are these differences stable over time? The databases of living trees (dbh > 10 cm) from the 1970s and the 2000s were available for analysis. The univariate pair correlation function $g(r)$ was used to evaluate tree spatial patterns of the plots. To test a significant difference between the mean values of $g(r)$ from alluvial forest and fir-beech forest the bootstrap technique was applied. The study found significant differences between tree spatial patterns of both forest types at distances up to 4 m, where alluvial hardwood forest was significantly more clustered. This difference appears in both investigated periods. Tree spatial pattern of fir-beech forest shows more clustering at larger spatial scales over 20 m; however this feature was statistically significant only in the 2000s.

Elevational range and extinction risk in birds: a macroecological perspective

Rachel L. White & Peter M. Bennett

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Recent global studies of geographical range sizes have shown that major mountain chains within the tropics are the richest areas for avian biodiversity and therefore of key conservation importance. In comparison to lowlands, montane regions remain relatively unspoilt by anthropogenic activities, due largely to their inaccessibility and steep gradients. However, many mountain biodiversity hotspots are under increasing threat from human pressures, most notably: settlement sprawl, agricultural conversion and climate change. An understanding of the spatial distribution and drivers of extinction risk in these regions is essential for the effective prioritisation and implementation of conservation effort. We will present the results of our investigations that aim to address these issues. We analysed the relationships between elevational range and extinction risk in birds, and explored the potential evolutionary, ecological and environmental processes underlying these patterns – controlling for both spatial autocorrelation and phylogenetic non-independence of taxa. We performed a global analysis and also analysed the assemblages located in the richest mountain ranges for avian diversity, namely: the Andes, Western/Eastern Great Rift Valley, Himalayas and Guyana highlands. We used a unique and comprehensive global species-level database detailing taxonomic, morphological, life-history and ecological information.

Estimating relative population size and distribution using large scale count data and habitat structures

Le Rest Kévin, Pinaud David and Bretagnolle Vincent

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Estimating population size and distribution implies working at a spatial scale relevant to management planning. Public policies and population functioning all suggest a large scale actions, e.g. a nationwide scale in order to apply conservation plans in a country harbouring a population of a threatened species. Large scale count data are then frequently used, but their analyses rarely deal with inference problems such as overdispersion and spatial autocorrelation, which can falsify results without adapted tools. We provide a procedure to allow the analysis of large scale counts data, integrating overdispersion and spatial autocorrelation by combining different existing tools in the same framework. Several probability functions taking into account overdispersion were confronted and a spatial component representing the neighbourhood influence was added. To illustrate our method, we used a dataset of the Black kite (*Milvus migrans*) abundance in France and external information outlining environmental features. Results show that models taking overdispersion in account, lead to increase the accuracy and decrease the errors of predictions. Models with spatial dependencies also improve the estimates. This approach can be used for a wide range of species and geographical areas and we encourage scientists and managers to study large scale processes using this framework.

Habitat fragmentation and the historical decline of woodland birds in Britain

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Many species of woodland bird have undergone large population declines throughout the latter part of the 20th Century. The causes behind these declines are likely to be multi-factorial and partly species-specific, although large-scale habitat deterioration has been posited as a broad factor for many species. Little attention has focussed on the role of landscape composition, however, and particularly habitat fragmentation. We tested the hypothesis that changes in the distribution of some woodland bird species may be associated with habitat fragmentation using four sedentary, non-migratory, woodland-obligate species. The Lesser Spotted Woodpecker, Marsh Tit and Willow Tit all underwent large population declines and associated range contractions between the 1970s and 1990s, while the Nuthatch showed a population increase and range expansion over the same period and provided a useful control. We assessed changes in bird distribution using the British Trust for Ornithology national-scale Bird Atlases of 1968-72 and 1988-91, and employed remote sensed landscape data from the Centre for Ecology & Hydrology Land Cover Map 1990, and spatial summary data from the Forestry Commission National Inventories and the Monitoring Landscape Change report to assess habitat within the landscape, finding associations between changes in bird species range and woodland distribution.

Linking landscape and genetic structure: presenting an objective and interpretable landscape genetic method

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Restoring migration and gene flow in areas where it has been decreased by anthropogenic or environmental factors, is vital for species' long term survival. For this purpose the novel discipline of landscape genetics aims to assess the effects of the landscape on genetic structure. To quantify the landscape between two populations, landscape geneticists mostly use either resistance-to-movement surfaces or buffered straight-line transects. However, parameterization of resistance surfaces is usually a subjective process and transect-based approaches might oversimplify dispersal patterns by assuming only straight-line interactions between populations. To overcome these limitations, we present a new and more objective landscape genetic method: least cost transect analysis (LECTA). Habitat-matrix resistance surfaces are used to create least-cost paths, which are subsequently buffered to form transects in which proportions of landscape elements are quantified. The relationship between landscape predictor variables and genetic distances is assessed using multivariate regression analysis. We apply LECTA to an empirical genetic dataset of the endangered damselfly, *Coenagrion mercuriale*, within a fragmented agricultural landscape in Switzerland. We show that LECTA outperforms traditional methods statistically, but also provides more information to establish conservation strategies for the focal species.

Spatial variability and autocorrelation of stand structural features in beech dominated natural forests of Central Europe

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Current knowledge of the spatial variability of major stand structural features in beech dominated natural forests is limited. This study shows how major stand structural features are spatially organized and autocorrelated and how the spatial autocorrelation vary among particular structural features and study sites. Stem position maps of three natural forests in the Czech Republic (Zofin 71 ha, Salajka 19 ha and Zakova hora 17 ha) were used as input data. Each vector stem position map representing all live and dead trees with DBH 10cm was examined by computer-simulated placement of different sized square sample plots (10×10m; 20×20m; 50×50m) in a regular 10m grid. Six major stand structural features (density, basal area and volume of living trees, volume of coarse woody debris - CWD, total volume and proportion of CWD in total volume) were calculated for every simulated sample plot. This dataset was analysed by geostatistical tools - experimental semivariograms were calculated and using appropriate geostatistical measures the spatial pattern described. Nested structures formed by one or two zones of influence (ranges) and significant patch structure (sine oscillation) were uncovered. It appears that particular stand structural features have specific spatial pattern, although there are important differences among study sites.

***Boronia deanei*: using hyper-resolution imagery for effective conservation**

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Conservation priorities are often targeted to protect habitat and populations of rare species. Identifying the true habitat and geographic ranges for rare species is often difficult and results in uncertainty about the likelihood and significance of impacts from anthropogenic activities. The use of very high spatial resolution imagery, concurrent with selected on-the-ground verification, provides a powerful tool for mapping populations of rare plants with a high degree of certainty. The rare shrub *Boronia deanei* is found in close association with high altitude swamplands and is susceptible to fire. The vegetation of the swamplands is often difficult to access and is highly sensitive to physical impacts caused by ground observation. This paper describes the use of very high (<5cm) spatial resolution imagery collected concurrently with ground based species assessment to map populations of this rare species. The capacity of temporal and spatial hyper-resolution imagery is demonstrated by the ability to delineate small populations of plants with high confidence within a spatially heterogeneous and dense ecological community.

Novel approaches to identifying marine protected areas: data collection, models, and boundary delineation

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The JNCC are tasked with, amongst other things, identifying important areas for various species of seabird around UK waters to advise on protected area designation. This presentation focuses on the process of identifying suitable areas for four species of tern at breeding colony Special Protection Areas (SPAs) around the UK. There is a lack of UK-wide at-sea distribution data for terns, thus we are using novel methods to collect individual based data on foraging behaviour locations around sample colonies, followed by species distribution modelling to make wider predictions about the distribution of suitable foraging habitat around all breeding colonies. This presentation will discuss the analysis and modelling process and highlight issues with both the data and the approach. In the absence of comprehensive datasets on spatial distributions, a predictive modelling approach such as this may serve as the best available option for protected area designation for many species around the world, marine and terrestrial.

The importance of geospatial techniques for carnivore conservation

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Today, 27% of the known mammalian carnivore species are either extinct or threatened, undermining the health of many ecosystems, which provide resources and services that are crucial for human development. Carnivore research and management have been limited by their predominantly cryptic nature, sometimes large-scale habitat requirements and remote distributions. As a consequence, many species currently remain under-studied. The increased availability and facilitated interpretation of remote-sensing imagery, combined with recent developments in landscape ecology and Geographic Information Systems have provided a wealth of analytical tools to overcome many of these traditional setbacks. These can be coupled with advances on multivariate statistics and Species Distribution Models to formalise the link between spatial patterns in environmental variables and species occurrence. To illustrate this wealth of opportunity, I will demonstrate how information on the intrinsic and extrinsic factors shaping habitat use of elusive carnivores at the individual and species levels in the Serengeti-Ngorongoro landscape can be derived from occurrence data.

Optimising landscape selection in a dynamic agricultural region.

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Landscape selection in empirical field studies is a critical component of research design. Many studies suffer from lack of consideration of factors related to spatial distribution of landscapes, or the use of multiple predictor variables. We developed a landscape selection process to avoid common pitfalls of landscape selection and applied it to a pseudo-experimental study of the effects of heterogeneity on biodiversity in an agricultural region. Candidate landscapes were selected to represent the full range of heterogeneity in the region, and to avoid spatial autocorrelation and collinearity among heterogeneity metrics. Preliminary measures of heterogeneity derived from satellite data collected in 2007 were used to identify 130 candidate landscapes. We then obtained landowner permission to conduct biodiversity surveys in 50 of these landscapes in 2011, and will follow with 50 additional landscapes in 2012. Selection of the 50 survey landscapes was affected by land use changes that occur annually in agricultural regions, and by the process of obtaining landowner permissions. We discuss the success of this methodology in a dynamic agricultural region, and how the methodology can be adapted in the second year of the study, so that our total sample of 100 study landscapes fulfils the statistical criteria for our pseudo-experimental design.

Trade-off between map resolution and computational time in conservation planning

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The identification of gap species and irreplaceable conservation areas is routinely used in conservation planning to identify conservation priorities. Due to the lack of detailed distribution data for most species, global scale analyses have so far used low-resolution distribution maps (usually maps of the extent of occurrence, i.e., the limits of a species' geographic distribution). Recently published high resolution maps of environmental variables allow for the development of very high resolution habitat suitability models (HSM), which can be used as surrogates of species distribution. We used the HSM of 5027 terrestrial mammals at 300 m resolution, developed by the Global Mammal Assessment program, to evaluate the effect of distribution map

resolution on the result of global gap and irreplaceability analyses. We run a series of analyses based on the HSM re-sampled at increasingly coarser resolution using multiple re-sampling techniques, and for each run we estimated the amount of gap mammals and size of the irreplaceable area globally. We analysed the influence of geography, ecology and taxonomy on the result, highlighting the potential trade-offs of map resolution and computational time.

Spatial and Spatio-temporal point process modelling in population ecology

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Spatial point process models describe the overall properties of spatial patterns, while taking every individual in a community into account. The routine fitting and assessment of spatial point process models to (complex) data set is still in its infancy. Spatially explicit data sets have become increasingly available in many areas of ecology. Currently, these data sets are often analysed with methods that do not make full use of the available spatially explicit information. Hence there is a need for making the existing point process methodology available and accessible to applied scientists by facilitating the fitting of suitable models to help provide answers to concrete scientific questions. Cox point processes lend themselves well to modelling spatial point pattern data with spatially varying environmental conditions based on a latent random field. We discuss how recent developments in statistics based on INLA (integrated nested Laplacian approximation) may be used to efficiently fit complex spatial and spatio-temporal point process models to data sets derived from plant and animal populations. The approach provides a toolbox that makes the routine fitting of these models accessible to non-specialists.

Spatially optimal allocation of new conservation areas to improve functional connectivity in conservation landscapes: a genetic algorithm approach.

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Habitat fragmentation is a continuing problem for the persistence of species of conservation interest. Good functional connectivity within landscapes is crucial in allowing populations of species to persist. This may become increasingly important as species are required to range-shift due to changing climate. However, the spatial location-allocation problem of adding new areas for conservation into a landscape, while optimising the landscapes functional connectivity, remains a challenge. A genetic algorithm-based spatial optimisation approach has been developed that seeks to add additional habitat patches into a landscape at locations which maximise the overall connectivity of the area. The connectivity measure used is an inter-patch distance matrix measure, the basis of accessibility calculations used in retail geography. The effects on solutions of the parameters used are considered including number of: chromosomes; mutations; generations. Solutions for a number of real and contrived landscapes are considered from the perspective of species with differing dispersal abilities, which lead to insights into the trade-offs between number of additional patches and size of additional patches. An investigation is made of approximations that can be made in the calculations of connectivity that make the use of the algorithm applicable to large areas at fine resolution.

Multi-scale decomposition of ecological data for conservation

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Spatial patterns in ecological data are the result of multiple processes that operate at multiple scales. Dynamic interactions among processes and patterns create spatial heterogeneity that comprise species' habitat and to which further processes respond. A central objective of conservation is to better understand how spatial patterns created through human activities may interact with and affect ecological processes. However, identifying such interactions can be challenging when patterns contain multiple spatial scales. Furthermore, some scales of pattern may be more relevant to specific species and of greater interest than others. Techniques are therefore needed to characterize complex spatial heterogeneity, tease apart different scales of pattern, and to assist in making inferences about the relative contributions of the different processes to observed patterns. We present a framework that combines wavelet analysis and spatial null models to assess local and global scale-specific significance of spatial patterns in ecological data. This framework can be used to decompose continuous ecological data into its constituent scales, assess the relative importance of different scales, and identify local hotspots. We demonstrate this framework and its associated challenges with specific application to boreal forest disturbance dynamics in Canada.

Inference for spatial processes based on areal unit data

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Inference for spatial processes of large importance for conservation is often based on aggregated counts of individuals within areal units, and this poses a challenging change of support problem. The spatial distribution of a species is a combination of the discrete point process operating on a small spatial scale with the covariance function for continuous population densities as function of geographic distance. The distinction between population density and point locations of individuals is essential for obtaining a proper description of individual counts within areas of different sizes and shapes. Here we introduce a novel approach for estimating parameters of the spatial process when data are only available at areal unit level. The log expected number of counts in different areal units are assumed to follow a multivariate Normal distribution. The mean vector and variance-covariance matrix are calculated from transformed parameters of the continuous log-Gaussian field of population densities accounting for the distribution of distances within and among areal units. The counts follow a negative binomial distribution parameterised to allow for a constant CV while taking overdispersion into account. Using MCMC-methods we obtain

parameter estimates for the log-Gaussian field describing spatial variation of population densities as well as the overdispersion of the point process.

SESSION 5

SPECIES-HABITAT INTERACTIONS: MEASURING & MODELLING

Grasping the nettle, or clutching at straws? Increasing the predictive reach of resource selection functions

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The main disadvantage of empirical models (as compared to more mechanistic ones) is their limited ability to predict the behaviour of a study system outside the scope of previously observed conditions. Resource Selection Functions (RSFs) for species distributions are the quintessential empirical model: They are phenomenological functions, fitted by multivariate regression to response data whose interpretation is often unclear. Furthermore, they are particularly difficult to apply to longitudinal data (such as those collected by telemetry devices). I briefly review these challenges and present two examples of how the predictive reach of RSFs can be extended. The first involves the use of Generalised Functional Responses (GFRs) which allow the combination of data from multiple sampling instances in order to predict how resource selection will change under changing habitat availability. The second example illustrates how data from predators and their prey can be used to estimate their joint resource selection.

Species distribution models fail to predict observed range changes of British species from climate

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Species distribution models (SDMs) are the primary tool for predicting species' range shifts under environmental change and are thus of increasing use in conservation planning. These models require a number of simplifying assumptions, and predictions are often ascribed a high degree of uncertainty as a result. Tests of model accuracy have so far relied primarily on data from a single snapshot of a species' distribution but, with global change well underway, field records of observed changes provide invaluable opportunities for testing predictions. We tested the ability of ten widespread SDM frameworks to predict observed recent range changes in three groups having unusually-detailed temporal data on distributions – British vascular plants, birds and butterflies. Independent validation of predictions using observed field records allowed us to derive reliable measures of prediction accuracy, which we analysed as a function of methodological and taxonomic variation. Overall, our models showed good accuracy to predict recent ranges from earlier ones. However, predictions of change were little of no better than random, especially for contracting species, indicating that climate alone cannot explain changes in British species' ranges. Differences among species were the most important determinant of variability in prediction accuracy.

Assessing the impact of land-use change on biodiversity – method development and application

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Land-use change, driven by increasing anthropogenic pressures, is a key determinant of landscape structure and biodiversity dynamics. Measuring and understanding this biodiversity response to changes in landscape structure is essential for sustainable land management. However, biodiversity is a complex concept, and while various attempts have been made to quantify biodiversity, including the use of indicator species, robust comprehensive data sets are rarely available, and there is little consensus on which measures to use. Consequently, the use of landscape pattern metrics as surrogate measures of species richness and therefore biodiversity has emerged as a prevalent alternative. However, the relationship between landscape structure and biodiversity is still not fully understood. Current methods are unable to distinguish between the effects of landscape composition and configuration on biodiversity. This is confounded by the availability of numerous landscape pattern metrics, making the selection of suitable metrics ambiguous. Our research aims to review existing methods for encapsulating the dynamic characteristics of landscape structure and relationships with biodiversity. Combined information on landscape structure and permeability will be explored to understand how land-use patterns affect species distribution and dispersal, and to evaluate the use of these relationships to predict the impact of future land-use change scenarios on biodiversity.

Habitat connectivity in African forested protected areas

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The African continent encompasses a large portion of our planet's biodiversity. Protected areas (PAs) in Africa are units designated for in situ conservation of native species, and are therefore of primary concern in preservation efforts. Landscape connectivity is a determinant factor in the long-term persistence of natural populations. Particularly, specialist forest-dwelling species will require abundant and well connected interior forest habitat. Here we analyze both structural and functional aspects of forest connectivity in African PAs, using freely-available software. Structural connectivity relates to the spatial arrangement and geometry of habitat and is estimated with a mathematical morphology approach, using the software GUIDOS which segments a binary habitat mask into seven mutually exclusive categories including core, connectors and branches. Functional connectivity relates to species' dispersal ability across a heterogeneous matrix. It is estimated using the CONEFOR

SENSINODE software. This models a patch network as a graph where habitat availability depends on the probability of movement between patches. In this study, 311 PAs with at least 60% of forest cover were selected from the World Database on PAs and used with the Global Land Cover map (GLC) for the year 2000 at 1 km spatial resolution to assess their connectivity.

The impacts of sea level rise on the East Asian-Australasian migratory shorebird flyways: graph theoretical approach

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Sea level rise is one of the most prominent threats of climate change in this century. Migratory shorebirds are known for their unusually long distance flights to cover thousands kilometres between their breeding and wintering habitats. Previous research on the impacts of sea level rise on shorebird survival only focuses the loss of habitats. In this paper, we explicitly modelled the network structure of migratory shorebirds in East Asian-Australasian Flyway (EAA Flyway), and estimated the impacts of sea level rise on the carrying capacity for each of them using graph theoretic framework. The application of graph theory for ecological process so far has been focused in the context of meta-population model, but not to migration modeling, where non-spatial approach is still dominant. The loss of inter-tidal areas for 224 internationally important sites for ten taxa was estimated with GIS. We applied maximum flow algorithm to evaluate the robustness of flyway network against sea level rise. We show the impact of sea level rise significantly depends on the structure of a network, and the sum of affected areas does not capture the magnitude of the impact to migratory species.

Landscape-based prediction of the occurrence of the introduced muskrat (*Ondatra zibethicus*)

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In Europe, muskrat (*Ondatra zibethicus*) is an introduced species that at high population densities can have profound effects on lake ecosystems. To target muskrat management, we developed a landscape-based prediction model for the occurrence of muskrat. For the analyses, we used 237 lakes with observed muskrat occurrence 1954–1974 and 236 randomly selected non-muskrat lakes in the county of Norrbotten, northern Sweden. In a geographic information system (GIS), we analyzed the importance of slope and cover of vegetation types for the occurrence of muskrat at 12 spatial scales (50–1000 m) from the lakeshores. Muskrat, in comparison to non-muskrat lakes were characterized by significantly flatter lakeshores and higher proportions of different herb-dominated vegetation types. Logistic regression models incorporating these vegetation types and the slope of the shoreline successfully predicted the occurrence of muskrat. The importance of the topographic and vegetation variables for occurrence of muskrat changed with increased distance from the shoreline. Our results were confirmed when applying our approach to an independent recent muskrat dataset (n=29) from the southern distribution range of the muskrat in Sweden. Our results indicate that a landscape approach such as applied here is crucial for the development of a management plan for muskrat.

Spatio-temporal modelling of cereal aphids' seasonal migration at France scale

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The Wheat Aphid *Sitobion avenae* is a major agricultural pest. It causes considerable damage by direct feeding and diseases transmission, and can reduce yield by up to several tons per hectare. Outbreaks are hard to predict due to the species' heterogeneous distribution in the landscape at different times. Therefore it is important to design a spatially explicit Decision Support System (DSS). In France, *S. avenae*'s migration can be represented as a wave from south-west to north-east which is linked to mean winter and spring temperatures. In order to represent this phenomenon, we develop two-dimensional convection–diffusion–reaction equations, including parameterization and coupled to a Geographical Information System (GIS). To estimate the model's parameters, we use a Hierarchical Bayesian Model (HBM) and a Malthusian model for our system's initialization and the landing rate of winged aphids; and determinist methods, mainly nonlinear regressions, for the other parameters. The simulations show both the spatial and temporal infestation's shape, by considering biotic (action of aphid's natural enemies, growth stage of the wheat) and abiotic (temperature, wind speed and direction) factors in the landscape.

The spatial and temporal dynamics of plants associated with ephemeral pools in Cornwall

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Much of conservation science is based on understanding spatial and temporal patterns in species occupancy or abundance. Habitat-association models can be used to infer these patterns, but often ignore the processes underlying spatial distribution independent of habitat quality, such as meta-population dynamics. We present an example of how habitat-association and meta-population models can be combined for a set of rare plants breeding in ephemeral habitat patches. We use remotely derived imagery to dynamically model the hydrological and habitat characteristics of a network of several thousand small temporary pools spread across the Lizard Peninsula in Cornwall. We use this information to determine habitat suitability for a suite of UKBAP listed plants that have adapted to living in these environments, accounting for spatial non-independence. Maps of pond size and suitability can then be applied to a stochastic patch-occupancy model to predict spatial and temporal dynamics of the plant meta-populations, to infer the likely consequences of changes in habitat quality resulting from different management options and future climate change.

Combining spatial scales to assess the suitable habitats of very small populations: the case of the brown bear in the Pyrenees

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Replicated data across space from a sufficient number of individuals are often lacking for very small populations, leading to unreliable habitat models. This is the case for the Pyrenean brown bear *Ursus arctos* population, with only 20 estimated individuals in two isolated groups. We conducted habitat suitability analyses at two spatial scales (coarse and local). At the coarse scale, given the low amount of data in the Pyrenees, we used data from the Cantabrian brown bear population in northern Spain to develop a two-dimensional model (human and natural variables) based on logistic regression, which we applied in the Pyrenees. At a local scale, we used bear presence in the Pyrenees to develop a habitat suitability model using Mahalanobis distances. We combined the coarse- and local-scale models to obtain a more integrative understanding of bear requirements and to identify areas that should be prioritised for management actions, or those that should be easier to manage, e.g. medium quality areas at a coarse scale that are of good quality at a fine scale. Our study illustrates how a nested-scale approach, combining coarse data from a different population and fine-scale local data, can improve conservation tools for a small population with sparse data.

Application of Bayesian Belief Network in the analysis of habitat preferences of macrophytes

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Surveys based on macrophytes are widely applied in biomonitoring of running waters. Worldwide literature is very rich in publications describing habitat preferences of macrophytes on the basis of mathematical and statistical analyses. However, there are just a few publications, which analyse this case with use of Bayesian Belief Networks. We tried to apply BBN approach in modelling of presence of three example macrophytes, which are used in Poland as indicative species for low, moderate and reference conditions. These were: *Lemna gibba* (typical for poor ecological conditions), *Ranunculus aquatilis* (moderate conditions) and *Menyanthes trifoliata* (reference conditions). The model was tested for the purposes of simulating changes in presence of these species along gradient of habitat conditions. Surveys were based on database, which included almost 600 survey sites located in different rivers in Poland. Each site was examined according to following parameters: catchment land-use, hydromorphology, physical and chemical water parameters and macrophytes composition. These parameters were included in Bayesian Belief Network created in Netica 4.16. Created model proved to be useful in simulating presence of analysed species along changes of habitat conditions. Such analyses may be used in dealing with restoration activities, which are focused on improvement of ecological conditions of rivers.

Spatial analyses in support of wildlife conservation across frontiers in the High Andes

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The region of the triple frontier between Argentina, Bolivia and Chile is important for the conservation of species with unique adaptations to arid highlands, including the Andean cat and its rodent prey, and three species of flamingos that converge there every year. Using these species as flagships for the conservation of the High Andes ecosystem, our conservation project promotes collaboration between researchers, conservationists and protected area staff on each side of the border. This study illustrates the role of spatial analyses as conservation tools for the protection of Andean habitats at risk from livestock grazing, off-road tourism, mining and climate change. Spatial analyses are particularly useful to study the rare and elusive Andean cat and their prey, since they depend on discrete highland wetlands for survival. For our spatial analyses we combined extensive field surveys and literature reviews, with species niche modelling of carnivores and their prey, and statistical analyses of presence-absence data. The maps produced can be used to disseminate information and raise awareness and among protected area managers, policy makers and the local communities in triple frontier.

SESSION 6

ECOSYSTEM DIVERSITY & SERVICES: MAPPING & UNDERSTANDING

Assessing genotypic diversity in populations of dimorphic clonal plant species by spatial statistics

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Populations of clonally growing plants possess a high proportion of genetically identical individuals, with far less genotypes than individuals. Assessing the number of genotypes by a molecular genetic analysis is still expensive and time consuming. Therefore, even rough estimates gained by spatial statistics can help to select populations for conservation. In the *Populus euphratica* forests of north-western China, the degree of clonality varies strongly among populations as a result of varying historical ground water supply. This dioecious tree forms nearly monospecific stands, allowing to use male and female trees as markers, since all individuals sharing one genotype must be of equal sex. Thus, a departure from complete random spatial distribution of sexes indicates the presence of clones. Our goal is to estimate the number of genotypes from spatial patterns in flowering stands. First we apply mark-connection-functions (from spatial point pattern theory) to estimate the spatial extension of groups of individuals sharing the same genotype. Second, we define a neighbourhood radius around trees and estimate the

average proportion of neighbours that share the same genotype. Finally we conclude from this proportion on upper and lower limits of the number of genotypes in a stand.

Bayesian Clustering Techniques and Progressive Partitioning to Identify Population Structuring Within a Recovering Otter Population in the UK

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After a major decline, the UK otter population is now recovering in its known strongholds (northern England, Wales and Borders, southwest England) and also in central England where the population had become small, fragmented and was reinforced with captive bred individuals. Bayesian clustering and GIS are used here to identify the genetic structure of the UK otter population and to assess expansion from strongholds and the contribution of introduced otters. Three Bayesian clustering techniques were used (STRUCTURE, GENELAND SPATIAL, BAPS4 SPATIAL) to estimate the number of populations (K). A novel progressive partitioning approach was tested to identify genetic sub-structuring at various hierarchical levels using successive partitions at $K=2$. Four regional populations were identified that reflect known population history. Isolated populations in southwest England and in Wales and its borders showed the lowest levels of genetic diversity. Higher diversity and private alleles in northern and central England reflect the proximity to genetically diverse Scottish populations, and the positive effect of reintroductions. The identification of sub-structure (11 groups) will provide a tool for management efforts in protecting genetically differentiated, geographically isolated populations.

Integration of Forestry Decision Support Systems in GIS

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Landscape characteristics underpin the ability of the forestry industry to deliver in an increasingly complex operational environment. Until recently it was not possible to effectively assess the scale of soil or exposure constraints and spatially allocate land appropriately to the objectives suggested by policy makers. Stand level forestry decision support systems (DSS) have been developed to address these issues but it is difficult to incorporate their outputs into the spatial forest plans, limiting their operational use. The MOTIVE project (EU 7th Framework Programme) provided an opportunity to integrate stand level tools with spatial inventory data. The output is a comprehensive GIS shapefile layer containing silvicultural, geophysical and climate data, and site-specific DSS outputs. The impact of spatially joining site and climate data together has been powerful. The results can be displayed in GIS and queried at multiple levels; from a whole forest district and landscape level to one forest stand. Furthermore, this methodology has allowed the models to interact with each other. The integration of these models allows managers to compare tradeoffs between different management objectives and to quickly identify the potential of the landscape to support multipurpose forestry objectives and maximise ecosystem services.

Landscape functionality in protected and unprotected areas - case studies from the Czech Republic

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Landscape structure reflects not only the natural settings of the landscape but also its history and the impact of human activities over extended time periods. We can assume that information about the characteristics of patches expressed by structural functionality plays a central role in the assessment of their ecological quality. To conserve and maintain 'valuable' parts of the landscape, legal tools in the form of nature protection are used. In this paper we address the question of whether protection status influences the functionality values in four case studies from the Czech Republic. Landscape structure indices (derived from landcover maps) were selected and used for the assessment of functionality in protected and unprotected areas. Mean functionality was calculated for five different functionality groups. We also focused on the degree of the protection status and its relation to functionality. The results show that landscape functionality on a class level is higher in protected than in unprotected parts and is also relatively high in connecting corridors and valuable matrix. The results also indicate a strong correlation between status and functionality.

Assessing the Impact of Land-use Change on Biodiversity and other Ecosystem Services

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Assessing the impact of land-use change on biodiversity is currently of great political interest, but there appears to be little consensus on what measures of biodiversity to consider, and obtaining appropriate data on species distributions is challenging. A common approach seems to be to use measures of landscape structure, notably landscape heterogeneity and habitat connectivity, as surrogates for biodiversity, though there is little strong evidence to support this assumed relationship. We will present simple approaches for measuring landscape heterogeneity and habitat connectivity using pixelated land cover map data, and illustrate the use of these approaches to assess the impact of different strategies for introducing biomass crops into the UK agricultural landscape. An interesting challenge is how to combine habitat connectivity measures across multiple generic species, and how to combine measures of landscape heterogeneity and habitat connectivity to provide an overall assessment of the impact. Further research is focussed on assessing the relationships among land-use and a range of ecosystem services, currently considering the impacts of different scenarios for introducing renewable energy generation into the landscape, and aiming to take account of the spatial correlations between the different measures of land-use.

SESSION 7

SPATIAL ECOLOGY: FROM PATTERNS & TRENDS TO ACTION & POLICY

Applying parcel-specific land-use data to assess conservation needs for semi-natural grasslands in Denmark

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The quality and extent of semi-natural grasslands is closely linked with intensity of agricultural management. Semi-natural grasslands often depend on extensive management in terms of grazing or mowing. Lack of management is followed by succession into scrub and forest vegetation, leading to declining quality or even disappearance of grasslands. In contrast, intensive management in terms of ploughing, sowing and often draining alter the biophysical conditions to such a degree that characteristic vegetation compositions of grasslands disappear. For Denmark, we apply parcel-specific data on agricultural land use to map convergences and conflicts between agriculture and conservation of semi-natural grasslands. We group land-uses into intensive and extensive types and overlay these with a map of semi-natural grasslands. 61 % of grasslands overlap with extensively managed land, indicating convergence between agriculture and protection of semi-natural grassland. In contrast, 13 % of grasslands overlap with intensively managed land, pointing at severe conflicts between agriculture and conservation. 27 % of grasslands lack any kind of agricultural management. We conclude that parcel-specific data on agricultural land use have a high potential for detailed mapping of convergences and conflicts between agriculture and semi-natural grasslands and consequently for assessments of conservation needs.

Assessing the quality of seabed habitat maps for use in marine conservation

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Full-coverage, national-scale seabed habitat maps are required to support marine protected area designation, quality assessments and marine spatial planning. There are two general approaches to mapping seabed habitats under the European Nature Information System (EUNIS) classification: (i) interpreting remote-sensing and ground-truthing data from local detailed surveys (current coverage: ~10% of UK waters) and (ii) predicting broad-scale habitats based on remote sensing of physical parameters. The UKSeaMap 2010 project has used the second approach to develop a broad-scale habitat map for the entire UK continental shelf at ~300m resolution. A measure of the quality of habitat maps is required to determine the most appropriate map to use where there is more than one option. For detailed survey maps, the MESH project developed the Confidence Assessment Tool. This scores individual habitat maps based on criteria relating to data collection and interpretation techniques. UKSeaMap's confidence scoring system assigns scores to each 300m cell based on confidence in the model's input parameters. Combining habitat maps from various sources and techniques into a full-coverage, single layer map is not straightforward as the two confidence assessment methods are not directly comparable; however, this must be done to ensure policy decisions are based on the best-available data.

Identifying marine protected areas for seabirds in the UK

Kober, K.

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The European Union Birds Directive places a legal obligation on its member states to establish a network of Special Protection Areas (SPAs), both at sea and on land, for rare, vulnerable and migratory bird species. In the UK, the Joint Nature Conservation Committee has undertaken an extensive analyses of the European Seabirds at Sea database to meet this obligation for 'true seabirds'. This database hosts more than 2 million records of seabird distribution in NW European waters, collected mainly from vessels of opportunity since 1979. This presentation will focus on the different analytical steps undertaken in this large-scale analysis to identify the most important areas for seabirds in offshore and inshore areas. It will highlight issues around the conservation of long-ranging seabird species and will discuss the outcomes of this analysis. The analysis may serve as a potential model for the identification of marine protected areas in other parts of the world where a similar data resource exists.

Placing land cover preferences by users on the map: Bridging the gaps of landscape preference surveys and spatial pattern analysis in order to inform planning and policy

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Landscapes provide several public goods, which, because they offer social, environmental and economic benefits, have become the focus of policy interest. Land cover patterns, being dynamic landscape components, are essential in delivering public goods. Public goods based on the social demand, such as recreation & landscape appreciation, have been progressively more acknowledged in environmental management as amenity demands steadily increase throughout Europe. As a result, there is a huge body of literature reporting landscape preferences both by the general public and of specific user groups in relation to multiple aspects of European landscapes. However, this empirical work has been revealing enormous challenges to be integrated into landscape planning and policy. This work offers two innovative outputs. One is to progress on gathering user group's preferred land cover patterns, using in an innovative way, a non spatial model that is meaningful for respondents. The other is to map the preferences by different users into land cover pattern maps in one Alentejo municipality in order to assess

the extent to which a certain landscape is likely to meet a specific social demand. Finally, the challenges for integrating the findings of this study into landscape planning and policy are discussed.

Rebuilding Biodiversity: the South West Wildlife Trust's approach to landscape scale conservation

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The SWWTs developed their Rebuilding Biodiversity methodology in 2005 based upon a similar methodology applied successfully in the US. Using available biodiversity data by Natural Area for priority habitat types in the south west the process identified a series of Strategic Nature Areas across the region. SNAs represent biodiversity hotspots and are formally identified as areas where conservation effort to link and expand priority habitats will bring greatest rewards. The methodology was refined county by county such that SNAs combine a sound ecological structure with local expert knowledge. From its original home within the SWWTs the framework was adopted by Biodiversity South West and the result was the South West Nature Map. This has been used to drive landscape scale restoration across the region, not least by the SWWTs themselves who have gone on to implement the methodology in at least 9 Living Landscapes projects. The presentation will explain how the methodology was developed and translated into delivery projects on the ground. With the first project now 5 years old the paper will also consider how the methodology is helping to rebuild biodiversity in the south west and what lessons have been learned to help inform work during the next five years.

Remote sensing as a tool for agri-environment monitoring

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The Welsh Assembly Government is funding a project to monitor Welsh agri-environment schemes (AES), and the RSPB is undertaking monitoring of birds as one of the components of this project. For one species, though *Pyrrhocorax pyrrhocorax*, which feeds preferentially on short swards with bare ground, the introduction of more lenient grazing regimes as part of AES agreements might be expected to have had a negative effect. There exists an historic data set of chough site occupancy and nest success for a large number of sites in Wales (Cross & Stratford Welsh Chough Project), which will be related to the presence of various management options within AES agreements in the vicinity. Additionally, for a subset of these sites, remote sensing has been undertaken to provide data relating to grass sward productivity and evenness. These data will allow assessment of whether the introduction of AES agreements did indeed lead to changes in grass swards, and whether these changes differ from background changes that may have been occurring due to other causes. Other potential applications of remote sensing to historical data in the context of AES monitoring will be discussed.

Using GIS to evaluate the coverage of vaccinating badgers against bovine tuberculosis

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Bovine tuberculosis (TB) is a serious disease of cattle in England and the Eurasian badger can contribute to a significant proportion of recurring infections in cattle. One potential option for reducing the risk of TB transmission between badgers and cattle is vaccinating badgers with *Bacillus Calmette-Guérin* (BCG). In 2009, Defra set up the Badger Vaccine Deployment Project in order to deploy BCG to wild badgers in England. Badger populations across 100km² of farmland, in an area with a high incidence of TB in cattle, will be trapped and vaccinated annually for 5 years. In 2010, 541 badgers were vaccinated and commercial capacity in lay vaccinators was developed. Here we discuss the applications of GIS in the planning, implementing and analysis of the vaccination programme. Determining the area covered by vaccination is challenging and we will be describing how we use methods such as tessellations and hotspot analysis to estimate the area and number of badger territories protected by vaccination. We will analyse the spatial relationship between cattle herds and vaccinated badgers and make suggestions for future vaccination work through interpolation/extrapolation techniques across the study site.

Using vessel monitoring systems and telemetry for conservation management of endangered species

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Many marine vertebrates face anthropogenic risks throughout their range, but long-lived species are particularly susceptible to extirpation due to their life history characteristics. Threats to species of concern are likely to be highest in coastal ecosystems where encounter rates with human activities increase. In cases where these high-risk areas intersect with important developmental and foraging habitat for species of conservation interest there is a compelling need for management scenarios. One such conflict occurs in West Central Africa where green turtles are at threat from fisheries. Here, industrial fisheries pose a survival risk to developing juvenile and foraging adults in one of the few shallow-water seagrass habitats along Africa's coast. With the advent of tracking technologies of both wildlife and fishing vessels it may be possible to manage risk with a spatial dimension. We elaborate on work undertaken in Corisco Bay as part of a Darwin Initiative project where we have detailed spatio-temporal knowledge on both green turtles and the risk posed by industrial trawl fisheries. We show that there is considerable overlap and provide the empirical evidence of a need for conservation management approaches such as incorporating observers to quantify the absolute threat and installing Turtle Excluder Devices to mitigate interactions.

Striking a balance: modeling migration of golden eagles through wind energy developments of the central Appalachians, USA.

1. *Tricia A. Miller*, 2. *Michael Lanzone*, 1. *Phillip Turk*, 3. *David Brandes*, 4. *Charles Maisonneuve*, 4. *Junior Tremblay*, 5. *Jeff Cooper*, 6. *Kieran O'Malley* and 1. *Todd Katzner*

1. *West Virginia University & The Pennsylvania State University*

2. *Cellular Tracking Technologies, LLC*

3. *Lafayette College*

4. *Charles Maisonneuve & Junior Tremblay, Ministère des Ressources naturelles et de la Faune*

5. *Virginia Department of Game and Inland Fisheries*

6. *West Virginia Division of Natural Resources*

Wind turbines are a known source of mortality to birds and certain turbines have caused significant mortality of local bird populations. Therefore, the rapid pace of wind energy development in the central Appalachians of the USA is of concern. Avian migrants are concentrated in this region because long-linear ridges provide orographic as well as thermal lift. Diurnal migrants can thus implement multiple energy-minimizing flight strategies, including thermal and slope soaring. Slope soaring can result in potential conflicts because birds fly at low altitudes often within the rotor swept zone of turbines. To improve siting and reduce impacts on wildlife we tracked 16 golden eagles with high-frequency GPS-GSM telemetry devices during spring migration 2009, 2010 and 2011. We used these data to develop spatially-explicit models of migration. To identify areas of potential conflict, we compared these models to turbine habitat suitability models. Additionally, we compared our models to proposed and existing turbine developments. Our results indicate that several developments pose a risk to migrating eagles while others pose little to no risk. Within individual developments, not all turbines present the same level of risk, thus we can make site specific recommendations for reducing risk by modifying siting of individual turbines.

Identifying the drivers of fishers' spatial behaviour at Lake Alaotra, Madagascar

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Inland fisheries are a key source of food and income for subsistence communities in many regions. However, unmanaged or excessive fishing activity can adversely impact adjacent wetland habitat, biodiversity, and ecosystem integrity, leading eventually to declining returns for fishing effort and livelihood insecurity. Management interventions may reduce environmental degradation and improve fishery sustainability, but often carry short-term costs to fishers. Understanding the spatial behaviour of fishers allows conservation planning to minimise the adverse impacts of interventions, increasing the likelihood of fisher support and compliance. However, factors that influence fishers' spatial behaviour are rarely identified or taken into account when implementing conservation actions. We conducted systematic catch monitoring, follows, and interviews with more than 700 artisanal fishers at Lake Alaotra, Madagascar. Generalized linear mixed effects models were used to determine the drivers of fishers' spatial behaviour, including age and experience, gear used, catch sizes, and time of year. The research provides methods to account for the spatial behaviour of fishers at a scale relevant for conservation planning, and demonstrates that it is critical to consider fisher behaviour to manage fisheries sustainably and promote effective long-term conservation of freshwater ecosystems.

A GIS method identifying the status and conservation of wildland in Europe

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In 2009 the Scottish Government commissioned a report to review the status and conservation of wildland in Europe. A wildland continuum, expressed as a Wildland Quality Index (WQI), was mapped using GIS to combine data on population density, remoteness from road and rail, naturalness of land cover and terrain ruggedness. The value of WQI in identifying wildland is confirmed by the spatial correlation between high WQI and datasets overlaid of Natura 2000 protected areas for the Annex II keystone species of wolf, brown bear, Eurasian lynx, Iberian lynx, Arctic fox, wolverine and bison. This correlation does not however extend to the full Natura 2000 protected areas database. In contrast, there is a high spatial correlation between protected areas in IUCN Categories Ia&b and high WQI, with 99% of category Ia&b areas found within the top 10% WQI. Protected areas in IUCN Category I are thus a very strong indicator for the presence of wildland across Europe, and represented 241,301km² (1.1%) of its land area. The protected area legislation across Europe designating IUCN Category I protected areas provide a basis for conservation of wildland and are reviewed along with Natura 2000 in regard to ongoing policy development on wilderness in Europe.

Geospatial modelling of biodiversity in Uttar Pradesh, India

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Biodiversity conservation necessitates not only preservation of single or multiple species but also the habitat as a whole. Prioritizing biological richness (BR) of any ecological habitat has implications in management and planning. Six biodiversity attributes (i.e., spatial, phytosociological, social, physical, economical and ecological) were integrated to stratify BR of forest vegetation in the state of Uttar Pradesh following a 'three-tier approach' with required field enumeration. Satellite image provided spatial distribution of vegetation types (corresponding to ecological habitats) which further subjected to landscape ecological analysis. Biotic disturbance buffers (i.e., proximity zones around roads and human settlements) along with landscape

parameters were combined to calculate disturbance index (DI), which in turn became an intermediate surrogate for BR assessment. Both flora and fauna species diversity (Shannon's index); their ecosystem uniqueness (IUCN status), biodiversity value (BV) and total importance value (TIV) were enumerated for BR computation along with terrain complexity (TC). Geospatial prioritization of biologically rich habitats of the state has many utilities such as gap analysis and conservation prioritization. The geospatial biodiversity database prepared for the state will (a) serve as a baseline data for forest managers and conservationists and (ii) have implications for long term biodiversity studies *in lieu* of 'climate change'.

Using spatial analysis to predict the vulnerability of Australian tropical savanna birds to climate change

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Tropical species are predicted to be severely impacted by climate change, and tropical lowlands projected to experience steep declines in species richness. Predictions for species distributions in tropical rainforests worldwide show dramatic declines for many endemic vertebrate species, including many extinctions. However, few studies have investigated the climate change impacts of tropical savanna biomes, many of which are likely to face the predicted 'tropical lowland biotic attrition'. The vast majority of tropical Australia exists as savanna, and to date little work has been done to assess the vulnerability of Australian tropical savanna fauna to climate change. To address this gap, our study uses spatial analysis to comprehensively assess the climate change vulnerability of birds in Australian tropical savanna. We use factors governing species' sensitivity to climate change (e.g. sensitivity to fire, range size, abundance) and factors influencing species' adaptive capacity (e.g. movement behaviour, diet breadth), coupled with projected changes in 2080 in relation to climate change. We show how spatial analysis can be used to identify the vulnerable elements of the faunal assemblages and the threats, and be an aid to prioritising conservation action.

SESSION 8

SPATIAL DATA: ACCESS, CAPACITY & FUNDING

Assessing Regional Change to Natural Habitats (ARCH)

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Kent County Council and the French Region of Nord-Pas de Calais have been working with the Conservatoire Botanique National de Bailleul since July 2009 on a 3 year Interreg funded project known as ARCH. The project aims to develop shared tools and methods to assess and monitor biodiversity, and to improve the way that habitats and species are mapped in both regions. Data and tools will be made available to a wide range of stakeholders. ARCH will develop:

- A cross-border map of natural habitats (using shared methodology, Corine biotope standards);
- A natural habitat map of Kent based on aerial photo interpretation supported by extensive ground truthing using IHS classification; recorded and analysed using ArcGIS (ESRI).
- A habitat change analysis for Kent between 1990, 2003 and 2011.
- A common index of the fragmentation of natural habitats;
- A tool to inform land planners about natural habitats and biodiversity; and
- A methodology for the use of remote-sensing technologies that monitor and update natural-habitats surveys.

Here we show current data from the Kent Habitat Study, including change analysis, as well as information on the tools developed for the project.

The Cumbria Biodiversity Evidence Base: a tool for local authorities to facilitate their use of ecological data, so ensuring they fulfil their biodiversity duties when policy and decision making

1. Judy Palmer, 2. Kate Willshaw, 3. Teresa Frost

1. Cumbria County Council, 2. Cumbria Wildlife Trust, 3. Cumbria Biodiversity Data Centre

The Cumbria Biodiversity Evidence Base (CBEB) is a major package of data, information, guidance and interpretation aimed at local authorities to help them fulfil their biodiversity duties when making planning policy and decisions. CBEB is maintained and updated by Cumbria County Council, Cumbria Wildlife Trust and the Cumbria Biodiversity Data Centre (CBDC) and circulated by CBDC. In 2008 a gap was identified between the total biodiversity information resource in the county and the data then available to decision makers in Cumbria. The CBEB was produced to fill this gap and provide advice to planners at local authorities with no in-house ecological expertise. Biodiversity information is delivered to the desktops of planners in an easily understandable format. This is achieved using GIS layers and frequently updated web pages explaining the distribution, legal status and conservation issues of various protected species and Biodiversity Action Plan species and habitats found in Cumbria. It enables planners to assess the biodiversity value of sites at both strategic and development control planning stages. The information delivered to planners via CBEB is continually updated, adding context to objective data. Ongoing development of CBEB will ensure it continues to deliver high quality, up-to-date information to local decision makers.

Understanding resource use and conservation: an example from Amazonian Ecuador

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Mapping human resource use is important in conservation to develop appropriate no-take areas or reserves, define land ownership and measure extraction sustainability. In the past, mapping resource involved one of two approaches: interviews and

drawn maps, or researchers accompanying individuals. Interviews and drawn maps can cause inaccuracies due to recall, miscommunication or a lack of clearly defined landmarks. When accompanying individuals, researchers may alter their behaviour, for example, by slowing normal activities. A simple alternate method was used to study patterns of local resource use in a Waorani community within Yasuni National Park, Ecuador. Members of the community were trained in the use of an inexpensive GPS receiver loaded with the program Cybertracker which provides a straightforward user interface. The receiver tracked the path of individuals when carried into the forest and a simple questionnaire was conducted before and after a forest trip to provide context. Borrowing from studies of animal movement behaviour, net squared displacement was used to a resource use in the community by comparing hunting trips with other uses of the forest. This approach to data collection benefits the researcher, but also allows the community to develop GIS skills and gives greater ownership of investigations.

Incorporating mobile technology (*Wildknowledge*) in wildlife conservation

Irene Amoke

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The Mara ecosystem sustains a diverse and abundant wildlife, attracting hundreds of thousands of visitors annually. This has resulted in a high number of ecotourism ventures in the ecosystem potentially leaving it vulnerable to adverse ecological impacts. The greatest challenge currently facing wildlife managers is how to manage the increasing visitor numbers without further disturbing the ecosystem. Because of the short term nature common within wildlife tourism studies, scientific monitoring and assessment of its potential long term impacts has been rendered difficult. There is need for ecological research to move beyond its observable and measurable effects and emphasise the relationship between its physical and biological effects. This research uses Geographical Information System techniques to evaluate distributional differences in key ungulate species as a consequence of increased wildlife tourism developments in the Mara ecosystem. Using Wild knowledge© software, biotic and abiotic data are recorded from static points in various sized tourist developments. GIS is used to create, analyse and visualise current and historical topographical and ecological data. It is further employed to create algorithms to construct predictive models of likely wildlife responses in light of future developments and for use by decision makers to indicate levels of acceptability of these developments.

From field monitoring to web-based decision support - a Danish case

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The Danish habitat monitoring programs established over the past eight years use a common core set of identical indicators. Data on hydrology, current landscape management, vegetation structure and species composition of the surveyed habitats are thus available for comparative analysis across the monitoring programs. High quality field data are continuously collected and stored in a central, and publicly available national database providing a solid foundation for decision making and landscape management. However, interpretation of the datasets is complex and often requires expert knowledge. To support proper decision making in governmental agencies and authorities, Aarhus University and the Danish Ministry of the Environment has developed an assessment system to be used in the NATURA-2000 nature management plans. Based on biological and structural indexes the nature management requirements can be deployed for the specific areas. The web-based and publicly available system includes a GIS and is used to identify the spatial distribution of the habitats and the possibility to prioritise the resource allocation between them.

Practical conservation and spatial analyses

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The Yorkshire Peat Partnership (YPP) undertakes peatland restoration and conservation over the Yorkshire region. Practical restoration such as drain blocking is informed using detailed GIS and mapping of sequential aerial and infrared imagery, specifically; detailed spatial digitisation of erosion, vegetation and aspects of land management. A spectral analysis technique has been developed which enables landscape-scale categorisation of erosion, vegetation type and burning regimes to be classified to a high resolution. There is potential to input environmental variables such as slope into the analysis to further improve accuracy and information generated. As well as informing restoration works, remote analysis as a monitoring tool is being applied. Sequential imagery is used to analyse trends in vegetation succession and infra-red imagery will be used to monitor changes in hydrology; key to peatland restoration. Spatial data generated is ground-truthed in the field and monitoring is coupled directly to works to provide data for direct adaptive management for conservation works. Applying spatial ecological data at such detail to directly inform practical conservation works outside of an academic context is advancement in the current knowledge base used as practical conservation guidance. YPP's work is a strong example of how spatial data directly informs and enhances conservation management.

Modelled seabed habitat maps for integrated management in European waters

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Acquiring sufficient full coverage data and biological ground-truthing for widespread direct mapping of seabed habitats at a European scale would be prohibitively expensive and take many years. There is now an implicit requirement for continuous mapping that can be applied across European regions for the Initial Assessments under the Marine Strategy Framework Directive (MSFD). Trans-national marine spatial planning and information-based management need to be informed by best-available data if they are to achieve long-term sustainable use and management of the marine environment and its resources. There is therefore a clear need to create full-coverage maps by predicting seabed habitats based on remote sensing of physical parameters. The European Commission funded project EUSeaMap (jncc.defra.gov.uk/EUSeaMap), under the initiative to build a European Marine Observation Data Network (EMODnet), has produced such maps for over 2,000,000km² covering four

geographic areas of European seas: Celtic, North, Baltic and western Mediterranean. Methods used to create these broad-scale predictive habitat maps and examples of their potential use are presented to demonstrate how they can be applied to support an ecosystem-based approach to management of human activities within European Seas. Special focus is placed on how these maps can be used to support the implementation of the MSFD.

A mathematical model emphasizing biological control and spatial structure

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In this study, we present some important points as a basis to build models applied to biological control and integrated pest management programs. We propose to combine host-parasitoid models with strategies of economic threshold level on a spatial scale. We used an extension of the classical host-parasitoid model proposed by Tang & Cheke (2008), which incorporates integrated pest management strategies, to investigate a system influenced by spatial structure. We conclude that spatial structure is essential for this model, because it alters the system population dynamics and also the economic threshold-level values. The spatial structure exerts negative effects on the efficiency of biological control methods. The density of the host population is set above the economic injury level and consequently, the economic threshold level should be lower when spatial structure is considered, to assure that the host density remains below the economic injury level. The results suggest that for the success of integrated pest management strategies, the spatial structure of the systems should be taken into account in pest control programs, because migration among local populations may cancel the effect produced by the economic threshold. Simulations with examples of hosts and parasitoids were run to show the system behaviour under these influences.

Development of an online hatchery release data mapping application

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The Fish Passage Center (FPC) maintains a hatchery database of anadromous salmonid species released from State, Federal, and Tribal hatcheries in the Columbia River Basin. The location of the hatchery release sites were mapped and an online mapping application was developed to allow the users a spatial view of where hatcheries have released anadromous salmonids throughout the basin since 1979. Application users spatially query for and select a specific hatchery and the map selects all of the locations where the salmonids have been released by that hatchery. The map then zooms to the spatial extent of the selected sites and a table with release data is opened and made available for download. There are other spatial queries available including: selecting release sites by watershed, river or river zone. The release data provide regional Salmon Managers with the information needed to assess the current year's migration of juvenile hatchery fish through the hydrosystem. In addition, the release data have been used to access present and historical production releases, timing and magnitude of salmon runs, population estimates and the proportion of hatchery fish that are tagged. The open source software used for the FPC Hatchery Mapping Application includes: MapServer, PostgreSQL and p.mapper.

SESSION 9

SINGLE SPECIES CONSERVATION

Decrypting the Secret Life of South Africa's Brown Hyaenas

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The brown hyaena (*Parahyaena brunnea*) is classified as near threatened (IUCN 2008), with only 1,700 free ranging brown hyena remaining in South Africa. The IUCN SSC hyaenid specialist group identified that hyaena numbers are under threat due to human persecution and habitat loss, and that a greater understanding on the species status throughout their geographic range is necessary. Preliminary findings identify that brown hyaena densities are four times lower in unprotected areas than protected ones in South Africa, which suggest that populations in unprotected areas are limited by either resources or by persecution. Currently baseline ecological information for brown hyaenas in South Africa is unknown. Therefore the study aimed to ascertain the home range sizes for brown hyaena in both protected and unprotected areas using cellular collars (GPS/GSM). Data points were instantly accessible via the internet and downloadable onto Google Earth for real-time tracking of individuals. ArcView GIS and extension packages were used to calculate individual home ranges sizes using a number of analysis tools. Habitat utilization, movement and activity patterns were also examined between individuals and treatment types. As a result, the findings from the study will be feed directly into an international management plan for this species.

Measuring the rate of spread in river networks: a case study with Eurasian Beavers

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The rapid expansion of organisms to new areas can cause large environmental and economical effects. For prediction and quantification of these effects, as well as for effective species-management planning, the estimation of the real spread rate is important. Number of methods has been developed for measuring the rate of spread. However, all of them are designed for one- or two-dimensional spread; no study addressed the case of species migrating along the river network, whose specific branching structure requires specific treatment. In this paper, we suggest possible methodology for such species, based on the

representation of the river network by means of a weighted graph; we demonstrate the methodology on the example of recolonization of the Czech Republic by Eurasian beavers; and finally, we show how this methodology can be used to compare spread of several distinct populations. Eurasian beaver is a semi-aquatic mammal of great conservation and management interest in large parts of Europe, because of its rapid spread and substantial impact on the ecosystems and water regime of landscapes.

Multiple levels of connectivity in spatial conservation prioritisation - Capercaillie (*Tetrao urogallus*) habitats in Southern Finland

Saija Sirkiä, Joonas Lehtomäki & Atte Moilanen

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In the face of global biodiversity loss, there is an increasing demand for efficient methods to support well-informed allocation of conservation resources on large spatial scales. Spatial prioritisation software Zonation is a freely available tool for quantitative conservation prioritisation across very large landscapes. Via iterative removal of the least important remaining site, Zonation creates a ranked prioritisation of the landscape according to the input features, a weighting scheme, species-specific connectivity and other factors, like the vicinity of avoided features. To create tools for conservation of a locally threatened game bird, we prioritised habitat for Capercaillie (*Tetrao urogallus*) in Southern Finland. Accounting for local habitat quality and multiple levels of connectivity, we indicated high-priority habitats for the species, and compared the results with Capercaillie lekking site data. We found that it is biologically well-justified and technically feasible to consider multiple connectivity levels (home range, dispersal) in a single habitat prioritisation analysis. Moreover, by including avoided features, i.e. human settlements and agricultural areas, in the analysis we further improved the accuracy of relevant connectivity levels. The resulting priority maps may be used in Capercaillie conservation and management, as well as for pointing out lower priority areas for alternative land use.

Multi-scale species-habitats relationships in forest ecosystems: a holistic management approach for the Eurasian Pygmy owl (*Glaucidium passerinum*) in the French Alps

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Forest and natural ecosystem management operations are generally planned and implemented on individual land management units (i.e. field, woodlots). Consequently the effects of such operations on neighbouring units are often poorly considered, at the expense of unwanted effects on the conservation of forest dwelling species. As increasing evidence shows that many species depend on habitats and resources at different spatial scales, the development of successful methods for biodiversity conservation and monitoring depends clearly on our ability to understand multi-scale wildlife-habitats relationships. In particular, operational tools to diagnose suitable species landscape structure can strongly improve species conservation in managed ecosystems. In order to reach this goal, we tested the respective relevance of local versus landscape variables to predict the distribution of the Eurasian Pygmy Owl (*Glaucidium passerinum*) in a heterogeneous mountain landscape dominated by forest, in the French Alps. We also searched for restrictive thresholds of related driving variables values at the forest landscape scale which could represent constraints for the species' presence. Our results showed that the species depends on local (20 ha) and forest mosaic related landscape variables. We also found threshold values for the landscape that supports multi-scale forest management recommendations in order to maintain the viability of the species within the Vercors Mountain range.

CONFERENCE POSTERS

Monitoring human activities and distribution in nature reserves: a case study of Swansea Bay SSSI

Abou-Turab, M, Forman, D.W. Proffitt, G and Brain, P.F.

Analysis of tree beta diversity patterns for conservation planning in the Mesoamerican region

Ivis Chan Aguilar, Duncan Golicher, Adrian Newton

Funding and associated biases in conservation assessments

Ahrends, A, Bulling, MT, Burgess, ND, Gereau, RE, Platts P, Marchant, RM, Lovett, JC, Marshall, A, Wikins-Kindemba, V, Owens, N, Fanning E, Sallu, AN, and Rahbek, C

Use of remote sensing to predict the impact of global warming on coastal habitats: a case study on Farasan Islands, Saudi Arabia

Monif Al-Rashidi, Tamás Székely Mohammed Shobrak, Mohammed Aleissa

Vegetation analysis of the Farasan Archipelago, Red Sea, Saudi Arabia

Khalid Al Mutairi, , Mashhor Mansor, , Magdy El-Bana, Mashhor Asyraf Mansor

Dynamic distribution of larks throughout breeding and non-breeding seasons in Kuwait 2008-09

Yahya Alshehabi

Valuing and mapping habitats and hot spots using object based image analysis

Räsänen, Aleks, Kuitunen, Markku & Lensu, Anssi

Using GIS and remote sensing to map missing agricultural data: a case study of Wadi Aldoasir, Saudi Arabia

Ali Aldosari

Wetland conservation & ecology: management, legal and regulatory issues - a case study of India

Dr.Gautam Kumar Basu & Dr.Animesh Halder

Climate and land use change affect the distribution of Ethiopian wolves: implications for conservation

Magdalena Bennett, Jorgelina Marino & Claudio Sillero-Zubiri

Data uncertainty and the selectivity of extinction risk in freshwater invertebrates

Lucie Bland

Alpine mixed forest characterization using LiDAR data: the ALIFORMIDI Project

Boscutti F, Bertacco C., De Simon G., Mercè A., Blasone G., Barilotti A., Alberti G., Cazorzi F., Sigura M., Bonfanti P.

The ARCH Kent Habitat Survey: Habitat and Land Cover Change Analysis Over 30 Years

Angela Brennan, Nienke Eernisse, Chris Blair-Myers and William Moreno

White Stork (*Ciconia ciconia*) nest census in Lithuania

Mindaugas Dagys, Daiva Vaitkuvienė

Landscape-based prediction of the occurrence of the introduced muskrat (*Ondatra zibethicus*)

Frauke Ecke, Andrew Henry and Kjell Danell

Modelling Fungus Dispersion Scenarios Using Cellular Automata

Iuri Emmanuel de Paula Ferreira, Rafael de Andrade Moral, Cláudia Pio Ferreira

Ants on mountains, space and environmental along an altitudinal transect in a centre of endemism: implications for long term monitoring

Foord S.H., Munyai T.C.

Effects of landscape properties on spatial distribution of ground beetles in French agricultural landscapes

Ewen Georgelin, Jacques Baudry, Stéphanie Aviron, Aude Vialatte, Nicolas Parisey and Manuel Plantegenest

Bird enumeration options with object based image analysis

Geoff Groom, Johnny Kahlert, Ib Krag Petersen

Integrated Constructed Wetlands (ICWs) working at the landscape scale - the Anne Valley Project, Ireland.

Rory Harrington, Grace O'Donovan, Guy McGrath

Spatial Distribution of Deforestation and Forest Degradation in Galgamuwa Forest Area in Dry zone Sri Lanka

H.M.B.S Hearath and E.A.P.N Edirisinghe

Landscape elements influence the spatial arrangement of the home range of Eurasian lynx

Katja Holmala and Jyrki Holopainen

Expansion of the rose chafer *Oxythyrea funesta* in the Czech Republic

Jakub Horák, Dušan Romportl, Karel Chobot

The predicted effects of vegetation and climatic changes on the diversity and distribution of Southeast Asian bats

Alice Hughes

How robust are biodiversity hotspots to climate change?

Takuya Iwamura, Kerrie A. Wilson, and Hugh P. Possingham

Scarabaeidae communities – patterns in dung preference and precipitation influence.

Robert James & Dr. Anja S. Rott.

Plant Diversity in Sacred Forest and Shifting Cultivation Fields of Mae Cheam watershed, Chiang Mai, Thailand

Auemporn Junsongduang, Arunothai Jampeetong, Angkhana Inta and Prasit Wangpakapattanawong

Monitoring Turtle Nesting Sites in Karachi, Pakistan: A Case Study of GIS Data Development and Conservation

Jamil H. Kazmi

Implications for Ecological Education using Ecological Web Site of Invasive Alien Plants in Korea

Ji-Hyon Kil, Kew-Cheol Shim, Kyoungho Kim, Keum-Hyun So, Jinho Bae

Plant communities and vegetation indicate environmental gradients in the Western Himalayas

Shujaul M Khan, David Harper, Sue Page, Habib Ahmad

Comparative patterns of usage by UK seal species

Esther Lane

Partial migration of wildebeest (*Connochaetes taurinus*) in the Kruger National Park: insights from movement segmentation at different spatial scales.

Jodie Martin, Yoganand Kandasamy, Simon Benhamou & Norman Owen-Smith

Semi-anthropogenic landscapes to save biodiversity: Saint Petersburg's experience

Olga N. Mandryka

Plant species variability in the Allt a'Mharcaidh Catchment, Scotland

Claire McDonald, Rognvald Smith, Jan Dick & Christopher Andrews

Vegetation analysis of the Farasan Archipelago, Red Sea, Saudi Arabia

Khalid Al Mutairi, Mashhor Mansor, Magdy El-Bana, Mashhor Asyraf Mansor

Demography affects migration dynamics of blowflies

Rafael de Andrade Moral, João Alfredo Carrara, Wesley Augusto Conde Godoy, Iuri Emmanuel de Paula Ferreira

Spatial patterns of plant invasion – the role of landscape structure and history

Jana Müllerová, Jan Pergl, Petr Pyšek

The distribution of *Gutenbergia cordifolia* and its effect upon the distribution of large herbivore species in Ngorongoro crater, Tanzania.

Louise Oates

Foraging strategy of black howler monkeys: how preferences and spatial knowledge of resources influence movements.

Sabrina Plante, Fernando Colchero, Sophie Calmé

Patch exploitation strategies of arrenotokous parasitoids: role of sex ratio and forager's interference in structuring metapopulations

Carolina Reigada, Sabrina B.L. Araujo and M.A.M. de Aguiar

Habitat suitability models as a tool for designing wildlife corridors

Dusan Romportl and Luděk Bufka

What makes a happy home for an urban bird? Identifying valuable features of the urban environment for avian biodiversity.

Emma Rosenfeld, Adam Bates, Stefan Bodnar, Jim Reynolds & Jon Sadler

Environmental impact prediction using time series satellite images

Pezhman Roudgarmi

Environmental Impact Assessment by GIS

Pezhman Roudgarmi

Environmental drivers of Antarctic krill distribution in oceanic waters and implications for fisheries management

Silk J.R.D, Hill S.L., Thorpe S.E., Murphy E.J., Trathan P.N. and Fielding S.

Estimation of tiger population by different methods to determine to accuracy, precision and cost in Ranthambhore Tiger Reserve, Rajasthan.

Randeep Singh, **Surendra Prakash Goyal**

Land use changes in selected parts of ecological networks

Hana Skokanová, Renata Eremiášová, Marek Havlíček, Petr Slavík, Tereza Stránská

How do we accurately estimate the foraging areas of seabirds?

Louise Soanes, Stephen Dodd, & John Arnould, Jonathan Green

Field monitoring of microclimate: new combined thermal and soil moisture standalone unit

Jan Wild, Martin Kopecký, Martin Macek, Jana Zmeškalová, Věra Hadincová, Pavla Trachtová, Olga Nováková, Adam Štípek, Martin Šanda and Tomáš Haase

A first-passage radial-scaling-of-time function for characterizing movement and its application to zebra and elephant ecology

Royi Zidon, Shimon Garti, Wayne M. Getz, Uzi Motro and David Saltz

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