Natura 2000 Biogeographical Process

4th Natura 2000 monitoring workshop:

the roles of new technologies and citizen science

Sanlúcar de Barrameda, Spain 9 - 11 April 2019

Workshop Programme

NATURA 2000

European Commission

Estación Biológica Doñana CSIC

Eurosite

For more information and updates, please visit the Natura 2000 Communication Platform:
http://ec.europa.eu/environment/nature/natura2000/platform/events/

4th Natura 2000 monitoring workshop

The roles of new technologies and citizen science

Sanlúcar de Barrameda, Spain, 9-11 April 2019

Venue
The monitoring workshop will be held in Hotel Palacio de Arizón:

Plaza Quinto Centenario
11540, Sanlúcar de Barrameda
Spain
www.palaciodearizon.es

Background
Monitoring of habitats and species is a recurrent issue in the Natura 2000 Biogeographical Process. During the seminars and workshops of the Natura 2000 Biogeographical Process held so far it has been stressed that monitoring is still a key issue in most habitats.

In June 2010, at Eurosite's Habitat Restoration workshop in Krkonoše National Park, in attendance of Stefan Leiner, the idea arose to hold a Eurosite workshop aimed at monitoring issues. Eurosite and the Countryside Council for Wales then organised the workshop "Natura 2000 Monitoring Workshop: Nature, Pictures and People" in Wales in March 2013. This three-day workshop was attended by 110 people.

In October 2015, a follow-up workshop was held in Barcelona, linked to the Natura 2000 Biogeographical Process. This workshop focused on monitoring at site level with a particular emphasis on integrating monitoring with conservation management. During the course of this workshop, the delegates agreed a model for the integration of conservation management and monitoring on Natura 2000 sites. This model was subsequently presented at the 13th meeting of the Expert Group on the Management of Natura 2000 (Brussels, 19 November).

Following up on the recommendations from the Barcelona Workshop, in 2017 Eurosite has organised a third Natura 2000 Monitoring workshop focusing on 'objective-setting' to help overcome the decision-making issues that can arise during the course of the objective setting process and to align objectives with monitoring. The workshop was held in spring 2017 in the Czech Republic and aimed to provide guidance and case studies to help navigate a logical course through the objective-setting process. It was during this workshop that the idea was formed to organise the next workshop with the focus on the roles of new technologies and citizen science in Natura 2000 monitoring, as such tools are becoming more and more available and affordable, and offer numerous possibilities for practical applications in monitoring.

Target audience
The workshop is aimed at experts from EU Member States from across the Biogeographical Regions. Typically, these experts are involved in the implementation of management and monitoring of Annex I habitats and Annex II species on and beyond Natura 2000 sites.

Workshop focus

- Accessing and processing satellite imagery and products for Natura 2000 monitoring;
- Designing, collecting and processing drone imagery for Natura 2000 monitoring;
- The roles of other new technologies and citizen science, including, for example, using open source software for bird counts, DNA sequencing to aid species identification, using DNA sequecning of scats collected by volunteers to estimate large carnivore numbers, developing phone apps to aid citizen science data capture.

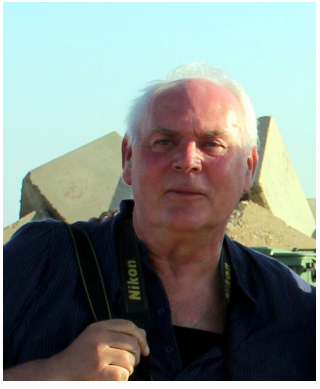
About Eurosite

Eurosite is working to create a Europe where nature is cared for, protected, restored and valued by all. We do this by providing practitioners with opportunities to network and exchange experience on practical nature management. We are a network of site managers, non-governmental and governmental organisations, and individuals and organisations committed to our vision. Our members are based across Europe - from the Atlantic islands to the Black Sea; and from Scandinavia to the Mediterranean. Nature knows no boundaries: we believe the future protection and conservation of Europe's nature will only be achieved through international cooperation.

Not yet a member? Find out more about the benefits of membership: http://eurosite.org/join-us/

About Estación Biológica de Doñana (CSIC) [workshop host]

Doñana Biological Station (EBD) is a research centre from Spanish Research Council which, since the Doñana area was formally protected in 1968, has been deeply involved in conservation management. Most of EBD's contribution has been based on the provision of scientific evidences of population trends of different taxa, mainly threatened species, and on setting up and maintenance of a long-term ecological monitoring programme. Although periodical surveys started early in the 60's, it was at the beginning of the century when EBD together with National Park managers developed the plan to permanently monitor species, habitats and processes, including ecological and geomorphological. Since then, up to 80 protocols have been systematically applied to collect both in the field and through remote and in situ sensors indicators on conservation status. Many of them are applied at landscape scale by using the different available remote sensing data sources, such as satellite, airborne and UAVs, contributing to upscale the in-situ variables measured as ground-truth, enhancing and enlarging the information to larger areas inside Doñana. Data is curated and provided to practitioners and managers to allow them take informed decisions affecting Natura 2000 protected habitats and species. Staff from EBD also monitor the effects of different management actions to assess the success of implementation. In the last years, a deep revision of the monitoring programme has been put in place and stakeholders, including park managers, have been incorporated in order to co-design the new requirement and goals of the monitoring program. Website: http://www.ebd.csic.es/inicio



About Clive Hurford (co-organiser)

Clive has worked in conservation monitoring since the late 1970s, initially as an ornithologist with the Royal Society for the Protection of Birds (RSPB) and then as a botanist specialising in monitoring habitat condition since the early-1990s. Since then he has: led a field team to demonstrate the links between conservation management and monitoring; regularly contributed to monitoring workshops across Europe, including on several occasions with Eurosite. After 27 years of working for the Welsh conservation agencies, initially the Countryside Council for Wales and then Natural Resources Wales, he is now a freelance ecologist in the process of establishing a new ecological monitoring consultancy.

About the Natura 2000 Biogeographical Process

The Natura 2000 Biogeographical Process is an initiative of the European Commission. The purpose of the Biogeographical Process is to help Member States to manage Natura 2000 as a coherent ecological network, whilst exchanging experiences and best practice, addressing objectives and priorities and enhancing cooperation and synergies. Consensus building through the participation of diverse stakeholders is a key tool in the essential dialogue required for the effective management of Natura 2000 sites.

Wageningen Environmental Research is the lead contractor to support the European Commission in the development and implementation of the Natura 2000 Biogeographical Process. This includes a continuing series of networking events (Seminars, conferences, workshops, ad hoc expert meetings, study visits, etc.).

In this framework, this workshop has been organised as a thematic networking event on monitoring as a cross-cutting issue, benefiting from ideas coming from several biogeographical regions. As detailed in the Background section of this programme, monitoring is a key knowledge gap that has been identified across all these regions. This workshop will harness the participation of strategic stakeholders, increase opportunities to network (through the Knowledge Market and discussion sessions) and generate recommendations for the integration of conservation management and monitoring (via the final workshop report).

About the Natura 2000 Platform

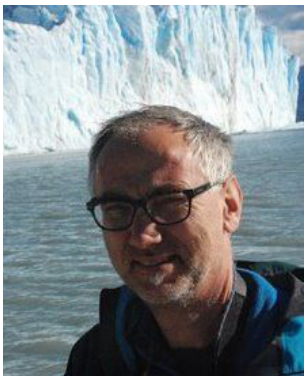
Launched in 2013, the Platform is set to become a vital source of information for Natura 2000 practitioners throughout Europe. The Natura 2000 Platform is a web based resource that facilitates and underpins the face-to-face networking of the Process and provides information about upcoming events, as well as reports and documents from previous events. The platform contains a forum, through which stakeholders and experts can ask questions and make contact with others involved in Natura 2000 management, as well as contribute news about their projects and other Natura 2000 related activities.

Visit the Natura 2000 Communication Platform:

ec.europa.eu/environment/nature/natura2000/platform/index_en.htm

For more information contact: natura2000platform@wur.nl

Speakers



Theo van der Sluis, project leader of the Natura 2000 Biogeographical Process, Wageningen Environmental Research

Theo is the project leader of the Natura 2000 Biogeographical Process and a senior researcher at Wageningen Environmental Research. He is currently working on biodiversity and governance for international projects, mostly dealing with Natura 2000 and Green Infrastructure. For many years he worked on the development of ecological networks, in an international context. He was the scientific coordinator for the project 'How Much Biodiversity is in Natura 2000', with six partner organisations. As project leader and advisor for many international projects he worked and lived in Ukraine, Italy, UK, Poland, Bosnia/Serbia/Croatia, Russia and Israel. Besides this, he lived in Botswana and Ghana, supporting in particular National Parks on conservation policies and Community Based Natural Resources Management and human-wildlife conflicts. He defended his PhD-thesis research on European landscape change and impact of policies in December 2017.

Bruno Combal, Policy Officer Directorate-General for the Environment, European Commission

Bruno has a PhD in physics, specialised in the modelling of radiative transfer and inference of vegetation biophysical parameters from remotely sensed data. He worked in the field of precision farming and environment monitoring since 1999. He joined the European Commission Joint Research Centre (JRC) in 2004, where he developed a series of environment monitoring products, for GMES (Copernicus) and automated processing systems for GMES&Africa. He joined the European Commission's DG Environment Nature Protection Unit in 2018 to help with developing the geospatial capacity required to support Natura 2000.

Anne Schmidt, Wageningen Environmental Research (Alterra)

Anne Schmidt is a senior researcher in the field of biodiversity policy and environmental governance. Since 2004, she has been leading the Dutch national research program on monitoring, assessment and reporting on biodiversity in the framework of international conventions and EU directives in assignment of the Dutch government. At present she and her colleagues are organising the Atlantic Seminar, part of the Natura 2000 Biogeographical Process, in close cooperation with the Flemish government (host MS) and Natura Bureau. Since 2018 she has been coordinating a service contract with the EC on Evidence Based Improvements of the Birds and Habitats Directive (E-BIND).

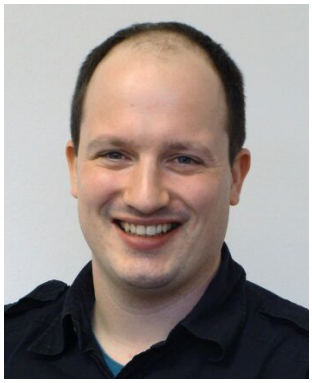
Peter Kullberg, Biodiversity Centre of the Finnish Environment Institute (SYKE)

Peter is a researcher with the Biodiversity Centre of the Finnish Environment Institute (SYKE). His duties involve several projects that revolve around measuring the state of biodiversity and ecosystems. He is coordinating the Finnish Ecosystem Observatory project that aims to develop methods and data structures for monitoring the state of ecosystems in Finland. Their approach involves gathering scattered ecosystem data, including remote sensing and *in-situ* observations, and further creating reports and new information, for example using machine learning methods.

Peter is also involved in several other projects that deal with things like evaluation of ecosystem services, national capital accounting and biodiversity indicators. As part of the Habitat Bank of Finland research consortium he develops tools for estimating losses and gains related to biodiversity offsetting. His scientific background is in ecology and conservation science, especially spatial conservation prioritization.

Speakers

Dr. Jose Manuel Álvarez-Martínez, Environmental Hydraulics Institute 'IH Cantabria'
Jose Manuel has a PhD in ecology and environmental technology from the University of Léon (Doctor Europeus Cum Laude). He is a Postdoc researcher at the Environmental Hydraulics Institute and formerly worked at the National Museum of National Sciences (CSIC) in Madrid. His main research topics relate to the effect of land use and cover change on vegetation dynamics and functioning within the field of landscape ecology. He is particularly focused on large-scale species/community distribution monitoring using remote sensing and spatial statistics. He is experienced in evaluating ecological consequences of Global Change on ecosystem functioning, with a special interest in the effects of forest dynamics on soil and hydrological properties across environmental gradients.



Dr. André Große-Stoltenberg, Institute of Landscape Ecology and Landscape Planning
André is a postdoc researcher at the Institute of Landscape Ecology and Landscape Planning at the Justus-Liebig-Universität Gießen (Germany). The main topics of his research are biological invasions and their impacts on biodiversity and ecosystem functioning, the application of remote sensing in ecological and ecosystem research, and the use of landscape connectivity analysis for conservation. he is particularly interested in identifying early warning signs of high impact after invasions by nitrogen-fixing ecosystem engineers. His focus is invasions by Australian Wattles (Acacia spp.) in Mediterranean ecosystems. His research approach is multi-method, as he aims to combine different kinds of remote sensing data and platforms together with ecophysiological tools such as stable isotopes to assess ecosystems properties from leaf to landscape scale.

Professor Richard Lucas, Centre for Ecosystem Science
Richard holds a Sêr Research Chair within the Earth Observation and Ecosystem Dynamics Research Group, Department of Geography and Earth Sciences, Aberystwyth University, which he established in 2002. He also held positions at the University of New South Wales Australia, the Australian Federal Government and Swansea University (UK). He has expertise in quantifying and understanding the response of terrestrial and coastal ecosystems and environments to change (including that associated with climatic variation), through intregration of Earth observation data from various sources. He has also developed innovative methods for extracting relevant information on terrestrial ecosystems at scales ranging from individual trees to the global. Key achievements include the generation and public release of the Australian Mangrove Portal and Plant Biomass Library, the development of the Earth Observation Data for Ecosystem Monitoring system for routine monitoring of land cover and change and advancing both the retrieval of forest biomass and structural attributes at regional to global scales and local to global characterisation, mapping and monitoring of mangroves. He currently leads the Living Wales project which is facilitating the development of national land cover monitoring to support national and international conservation and sustainable use of environments.

Andreas Press, Department of Forest Resource Management, Swedish University of Agricultural Sciences
Andreas is a research engineer with a M.Sc. in Biology at the Swedish University of Agricultural Sciences in Umeå, where he is engaged in two major monitoring schemes: the National Inventory of Landscapes in Sweden (NILS), and Terrestrial Habitats Monitoring. Drawing from his years of experience as a field worker he is involved in many aspects: from field methodology, instructions and education of field workers to evaluating and developing new methods as well as working with remote sensing. Andreas is an avid birdwatcher, botanist and hobby entomologist and spends as much time as possible roaming the Swedish countryside looking for interesting species.

Speakers

Sander Mücher, Wageningen Environmental Research
Sander is senior researcher in Remote Sensing & GIS at Wageningen Environmental Research. He has been active in the field of remote sensing over 25 years, focussing on biodiversity, agriculture, and environmental monitoring. In 1997 he coordinated the EU-FP4 project PELCOM which explored European land use monitoring with sattelite data. Together with Wageningen University, in 2012 he set up ROC-certified Unmanned Aerial Remote Sensing Facility with a wide range of national and international applications in the agricultural and natural domain. Additionally, Sander has been involved in various European projects. For example, the FP7 project BIO-SOS aimed to support operational monitoring of protected sites by using advanced remote sensing techniques. Among other things, he is currently responsible for European habitat modelling, developing services for nature monitoring, researching the exploitation of drones and AI for identification and characterization of animals. Alongside these international activities, Sander is also involved in many national projects involving the use of LiDAR and UAV applications for biodiversity and agriculture monitoring. The integration of remote sensing and *in-situ* information for monitoring and modelling plays an important role in all his studies.

Pieter Beck, Joint Research Centre, European Commission
Pieter is an ecologist who specializes in the remote sensing and modelling of vegetation. He joined the European Commission in 2013 after working in academia in the US and Norway, studying the effects that climate and disturbance have on the seasonality, distribution, and growth of forests. At the Joint Research Centre, which is the European Commission's science and knowledge service, Pieter is part of a team studying threats to European forests, including climate change, exotic pests, and illegal logging. The work relies heavily on remote sensing, from satellites as well as aircraft, harnessing the ever-broader information streams they provide, from the level of individual plants to the entire globe. Pieter has published nearly 50 scientific articles, and strives to help ensure policy-makers have access to up-to-date scientific tools and knowledge for their work.

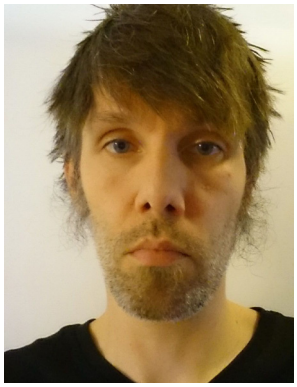
Wojciech Mróz, Ecological Consultancy
Wojciech is a naturalist, ecologist, botanist, and GIS analyst. He has been Head of Department at the Department of Vegetation Conservation at the Institute of Nature Conservation, Polish Academy of Sciences from 2006 to 2015. He is a project manager with 20 years of experience in multi-stakeholder projects focused on the implementation of Natura 2000, protected areas planning and management. He holds a M.Sc. in the dynamics of arctic vegetation and a Ph.D. degree, for which his research was on subalpine vegetation in Ukraine. Wojciech is interested in the advanced use of GIS, statistics and numerical methods in spatial data analysis.

Ricardo Díaz-Delgado, Estación Biológica de Doñana
Ricardo holds a Ph.D. in the application of remote sensing to fire ecology from the Autonomous Univeristy of Barcelona. He currently works at the Doñana Biological Station, where he has been since 2001, leading the Remote Sensing and GIS Laboratory. He also leads the Long-Term Ecological Monitoring at Landscape Scale of Doñana Protected Area, and is the current coordinator of the Doñana LTSER Platform. He has been the national coordinator of the Spanish Long-Term Ecological Research network LTER-Spain for six years, and he has been involved and leading tasks and work packages in research projects at European and national level. He has been the technical coordinator of Doñana ICTS for three years. His research focuses on the application of of remote sensing and spatial information systems to ecological monitoring, especially monitoring disturbing processes to aid biological conservation.

Speakers

Dr. Margarita Mulero Pazmany, Liverpool John Moores University
Margarita is a lecturer in drone applications in natural sciences in the UK. Her research focuses on new technologies in conservation biology. She uses Unmanned Aircraft Systems, and more recently Internet of Things for wildlife research and management. She investigates several topics such as spatial ecology, animal movement, epidemiology, infrastructures impact assessment, pollution and anti-poaching. She also works on road ecology, habitat fragmentation and tourism effects on wildlife populations. Most of her fieldwork is conducted in protected areas such as Doñana National Park, Kruger National Park and Hluhluwe-iMfolozi. Margarita did her PhD in Doñana Biological Station (CSIS Spain) where she worked from 2008-14 using drones and sensor networks for wildlife monitoring in protected areas. In 2015 she did a post-doc at the Swiss Ornithological Institute studying the impact of drones on animal species. She also joined the University of Cádiz, where she periodically teaches "Specialist on Unmanned Aerial Vehicles (RPAS) and their civil applications." Currently, she combines teaching in "Wildlife Conservation, environmental science and UAV Technology MSc" with research in ecology and conservation biology in multidisciplinary projects.

Alan Brown
Alan recently retired from the post of Senior Remote Sensing Manager at Natural Resources Wales, a UK Government Agency responsible for environment protection, forestry and nature conservation. He first started working on Scottish mountain surveys and nature conservation, leading one of the Nature Conservancy field teams and exploring the use of multivariate analysis to identify biogeographical patterns in upland habitats. Since the early 1990s he has been based in Wales, including working with Clive Hurford on field monitoring for nature conservation and running a LIFE-nature project on the integration of monitoring with species and habitat management. For the last 15 years he has specialised in the use of remote sensing for habitat mapping and change detection, following a joint project with the UK Space Agency, which led to the first remote sensing-based habitat map of Wales. He is currently working informally with Environment Systems, a consultancy based in Abersystwyth, comparing the benefits of machine learning and rule-based approaches to mapping land cover / land use from satellite imagery.



Arno Thomaes, Research Institute for Nature and Forest (INBO)
Arno Thomaes works for INBO, a governmental scientific institute that is responsible for applied conservation research for the Flemish region (Northern Belgium). Within the team of Forest ecology and management, he focuses on topics such as ecology, monitoring and conservation of saproxylic beetles and forest habitat types.The main study species are *Lucanus cervus, Cucujus cinnaberinus, Elater ferrugineus* and *Osmoiderma eremita* besides ancient woodland plants. His preference is to seek international alliances and to perform science with a policy of international cooperation, open data, KISS solutions and citizen science. The scope is directed to problem solving for applied 'in field' conservationists but also to raise awareness within the conservation community about 'forgotten' species. Outputs have included for example redlists, detection dogs, distribution and population modeling, experimental setups like pot experiments and beetle breeding experiments, statistical power analyses evaluating monitoring schemes and radio telemetry. Furthermore, Arno Thomaes is the driving force of the Belgian Entomological Index and the European Stag Beetle Monitoring Network and is editor of the Bulletin de la SRBE/KBVE.

Speakers

Andy Nisbet, Natural England
Andy is Principal Adviser at Natural England with responsibility for managing their Evidence and Monitoring Programme, which includes the monitoring of protected sites (Sites of Special Scientific Interest, Marine Conservation Zones and Natura 2000 sites). Natural England is developing new and innovative methods for collecting and using data on sites and species. Andy is leading their work to develop DNA based applications. He is also part of the UKDNA working group, which brings together government agencies, researchers and other stakeholders to share knowledge and develop collaborative apporaches.

Åsa Hagner, Department of Forest Resource Management at the Swedish University of Agricultural Sciences
Since 2008, Åsa has been organising the monitoring of Natura 2000 habitats within the Swedish National Forest inventory (NFI) and the National Inventory of Landscapes in Sweden (NILS). With a background in Population ecology from Umeå University she has a special interest in Botany and Mycology.

Karel Chobot, Nature Conservation Agency of the Czech Republic
Karel is an entomologist (by origin), acting as the head of the Biodiversity Monitoring Department at the Nature Conservation Agency of the Czech Republic, state official body. His main activities and responsibilities lie with biodiversity (species and habitats) data collection and management, organising large-scale biodiversity surveys and species assessment on the national level, including data reporting required under the EU Birds and Habitats Directives. He is an editor of national Red Lists of species, and the main collator of the Czech Species Occurence Database (national species diversity database).

Tuesday 9 April 2019 - The role of remote sensing in Natura 2000 monitoring

09:00 - 10:00 **Registration**

10:00 - 10:15 **Welcome and opening**
Kristijan Čivić, Eurosite & Dr. Ricardo Díaz-Delgado, Estación Biológica de Doñana

10:15 - 10:30 **The Natura 2000 Biogeographical Process**
Theo van der Sluis, Wageningen Environmental Research

The Biogeographical Process - networking for conservation
Theo van der Sluis (WER) & Carlos Sunyer (BGP)

The EU Biodiversity Strategy calls for significant improvements in the conservation status of species and habitats protected under the EU Birds and Habitats Directives by 2020. To help meeting this target, in 2012, the European Commission launched the Natura 2000 Biogeographical Process, a multi-stakeholders' co-operation process at the biogeographical level, including seminars, workshops and cooperation activities to enhance effective implementation, management, monitoring, financing and reporting of the Natura 2000 network

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The key objectives of the Process are to:

- Promote trans-boundary cooperation on implementing the nature directives;
- Collect and disseminate up-to-date information on threats and conservation needs for habitats and species;
- Share experiences, case studies and best practices;
- Identify common objectives, priorities and management actions;
- Develop new management insights, (cross-border) stakeholders' cooperation frameworks, networks of specialists and site managers, etc.
- Promote Natura 2000 management that integrates socio-economic objectives.

Since 2012, thirteen Natura 2000 Seminars have been organized, hosted by a Member State or region and co-organized with the support of the European Commission. This year, 2019 the Atlantic and Boreal seminar are being prepared.

Information on all seminars and networking events can be found on: http://ec.europa.eu/environment/nature/natura2000/seminars_en.htm , or by subscribing to our Newsletter or follow us on Twitter (@BioGeoProcess).
If there is any event related to the management of Natura 2000 you would like promoted through the website, please make sure you contact: natura2000platform@wur.nl

10:30 - 10:50 **Setting the scene, an introduction to the workshop**
Dr. Bruno Combal, Policy Officer Directorate-General for the Environment, European Commission

The Habitats and Birds directives require EU Member States to identify, designate, protect and manage Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), with a view to maintaining or achieving favourable conservation status of habitats types and birds. Together, the SACs and SPAs form the EU-wide Natura 2000 site network.

Article 6(2) of the Habitats directive indicates that appropriate steps must be taken to prevent the deterioration of sites and natural habitats and Article 17 imposes a reporting on conservation state.

Copernicus offers continuous (every 5 days) space borne observation at high resolution (10m-20m) with optical and radar imagery, allowing us to consider cost effective, harmonized and wall-to-wall land monitoring, to complement existing approaches.
In order to address the specific needs of Natura2000, DG ENV is exploring the potential offered by Copernicus, to automatically monitor changes in habitats for the whole Natura2000 network. In

Tuesday 9 April 2019 - The role of remote sensing in Natura 2000 monitoring

particular, DG ENV is developing an approach of systematic mapping of land cover changes with automatic detection of intense changes.

The reporting activities still require field observations of species. Technical progress was also instrumental in this domain (cell-phones, gps, digital photography, …). The emergence of citizen science offers a different perspective on data collection, into which EU institutions are investing research efforts.

10:50 - 11:10 **Evidence Based Improvements of the Birds and Habitats Directives**
Anne Schmidt, Wageningen Environmental Research

Evidence Based Improvements of the Birds and Habitats Directive (E-BIND). Subtitle/question: What remote sensing and monitoring approaches and methods can be applied for the purpose of conservation management?

The E-BIND consortium is performing a service for the European Commission on *Evidence Based Improvements of The Implementation of the Birds and Habitats Directive*. The objectives are to enhance the accessibility of scientific knowledge to policy makers and practitioners as well to make an appeal to the scientific community to offer solutions to strategic problems in the area of EU nature conservation. The service is focussed on the following 6 themes: monitoring of species and habitats, remote sensing for nature conservation, data and information access, network coherence and connectivity, effectiveness of conservation and restoration measures and the contribution of Natura 2000 to ecosystem services. Data will be collected on the latest techniques, methods, approaches and good examples. These data will be analysed and presented to stakeholders (key experts) in order to be validated and completed. The final results in terms of the state of the art, best practices, available data and information sources and tools will be made accessible to policy makers and practitioners in the form of on line handbooks. The EUROSITE workshop offers a unique opportunity for the E-BIND consortium to connect with experts in the field of remote sensing and monitoring as well as with practitioners.

The EBIND consortium consists of the following organisations: Wageningen Research, Milieu Consulting SPRL, Ecologic institute, the Dutch Butterfly Foundation, the Society for Environmental Restoration (SER) and Eurosite.

11:10 - 11:40 **Coffee Break**

11:40 - 12:00 **Earth observations for biodiversity monitoring: experiences from Finland**
Peter Kullberg, Finnish Environment Institute (SYKE)

The Finnish Environment Institute (SYKE) is a governmental research and development organization responsible for monitoring and reporting on the state of nature in Finland. Remote sensing methods are an increasingly important part of SYKE's monitoring tool box. This presentation takes a look at how remote sensing has been used in SYKE for environmental monitoring of terrestrial and marine ecosystems and to provide support for decision-making. Some of the current work on mainstreaming Earth observations within monitoring and reporting actions, such as establishing the Finnish Ecosystem Observatory, will also be discussed.

On regular basis SYKE produces several satellite image based data products. Earth observation based data has been further used, for example, to prioritize the expansion of the protected area and Natura 2000 networks. SYKE has also been active in developing data infrastructures that gather and disseminate environmental information serving both experts and citizens. For example ENVIBASE and VELMU projects, focusing on data infrastructures on land and sea, have advanced environmental monitoring and data management with a strong remote sensing component. The Finnish Ecosystem Observatory project

Tuesday 9 April 2019 - The role of remote sensing in Natura 2000 monitoring

explores the possibilities for using remote sensing methods for ecosystem monitoring and development of essential biodiversity variables. The project also aims to provide support for national reporting responsibilities, for instance for the European Commission's Habitat Directive and the Convention on Biological Diversity. Although use of EO methods has advanced rapidly in recent years, development work is still needed to realize its full potential for environmental monitoring.

12:00 - 12:20 **Remote sensing-based spatial modelling for Natura 2000 management at a large scale: from habitat monitoring to sites selection**
José Manuel Álvarez-Martínez & Borja Jiménez-Alfaro & Santiago García

A current challenge of biodiversity management is to estimate the spatial extent and conservation status of habitat types over time. Since the initial steps of implementation of the Habitats Directive, many member states have highlighted a lack of initiatives to inform long-term conservation planning at the biogeographical level. Vegetation maps are traditionally carried out as regional snapshots digitalized from aerial imagery, while conservation status is defined using expert knowledge and sampling schemes often limited by time or resource availability. The current needs of large-scale mapping, which involve visiting inaccessible or unexplored terrain and a higher temporal resolution, has opened a new field of research related to predictive modelling. Recent developments in data availability (from stallites to ROCs in a continuous enhance of spatial, spectral and temporal resolutions, LiDAR and SAR), and image processing (from data mining to artificial intelligence) are unleashing new challenges in biodiversity monitoring. In a series of studies ranging from the Cantabria region in Spain to the Cenrtal Anatolia in Turkey, we developed a generalized community-level modelling approach that allows identifying local and realized Areas of Occurrence (AOO) of biodiversity distribution, coupled to spatial indicators of structural and functional properties, threats and pressures defined at European, national and site levels. The use of these spatial data within Systematic Conservation Planning (SCP) allowed fulfilling the criteria of the Habitat Directive (annex III) in Natura 2000 monitoring, bearing in mind opportunities and constrains, socio-economic costs, policy preferences and the integration of climate change within low-cost warning systems to increase the resilience of Natura 2000.

12:20 - 12:40 **Remote sensing of invasive plant species: identifying tresholds and early indicators of high impact**
André Große-Stoltenberg, Institute of Landscape Ecology and Resources

André Große-Stoltenberg, Christine Hellman, Jan Thiele, Christiane Werner, Jens Oldeland
High impact invaders, such as the N-fixing *Acacia longifolia*, are a major threat to ecosystems worldwide. While the local impact of *A. longifolia* on ecosystem structure and functioning in Mediterranean dune ecosystems is well understood, there is a lack of methods for early detection of its impact at larger scales. Thus, we aimed to identify impact and thresholds from leaf to landscape scale using remote sensing.
We show that *A. longifolia* can be mapped at landscape level by integrating high resolution airborne hyperspectral images and laserscanning (LiDAR) data. We then simulated satellite imagery. Even though the pixel size was larger, we detected a clear increase in productivity after invasion at the early stages of invasion when *A. longifolia* cover was below 10%. Thus, there is high potential to retrieve early indicators of high impact using freely available satellite data. This offers promising possibilities for monitoring invasions of such ecosystem engineers in sensitive and biodiverse ecosystems from space.

However, the impact of the invader surpasses its cover. Thus, we give an outlook on how to derive spatial thresholds of invader impact on the surrounding vegetation based on LiDAR data. We further present the potential to use plant functional traits as early indicators of high impact, and we discuss the challenge of mapping species with low abundance using drones.

Tuesday 9 April 2019 - The role of remote sensing in Natura 2000 monitoring

12:40 - 13:00 **Q&A: the roles of sattelite images for monitoring Natura 2000 habitats and species**

13:00 - 14:30 **Lunch and networking**

14:30 - 16:00 **Demonstration workshop: supporting local to global environmental protection, conservation and restoration through Earth observations**
Richard Lucas, Centre for Ecosystem Science

An awareness of the occurrence and impact of past, current and future (predicted) change events and processes is essential for environmental protection, conservation and restoration. However, such information is often unavailable or not accessible. Within the framework of the EU Ecopotential and Living Wales projects, this Workshop will demonstrate how Earth observation (EO) data acquired by optical, lidar, radar and thermal sensors can be used to retrieve a range of land, marine and atmospheric environmental variables (EVs). These can then be used subsequently to generate land cover and change classifications, according to the Food and Agriculture Organisation (FAO) Land Cover Classification System (LCCS), and associated descriptors. The approach can be applied at any spatial scale and between any two time-separated periods and can consider airborne, spaceborne and ground data. To support the retrieval of EVs and validation of classifications, the EarthTrack system has been developed which allows collection of relevant ground data and its open (if desired) release and dissemination through web-portals. The Workshop will demonstrate how the approach has been applied in a number of countries and highlight benefits for a wide range of users (e.g., scientists, land managers and conservation bodies).

16:00 - 16:30 **Coffee**

16:30 - 16:50 **A remote sensing monitoring methodology for vegetation structure in the Netherlands**
Sander Mucher, Wageningen Environmental Research

Regular mapping of vegetation structure is of importance for biodiversity monitoring. The conventional way of vegetation structure mapping based on field surveys in combination with visual interpretation of aerial photographs is time consuming and often limited in its consistency and efficiency to cover large areas. Meanwhile space and airborne imagery are increasingly becoming available at affordable costs and with a high spatial resolution of approximately 50 cm. Therefore, we used commonly shared data in the Netherlands, such as LiDAR-AHN data (LiDAR derived terrain models), very high resolution satellite imagery and/or aerial photographs, to develop simple and advanced methodologies that can help to map and increase the updating frequency of vegetation structure maps in the Netherlands. A first pilot was carried out to map all vegetation structure classes in the Natura 2000 site Ameland in the Wadden Sea. Here we compared the effectiveness of two well-known classification methods on segmented objects, namely Rule-Based (RB) and Random Forest (RF), the last as an easy machine learning model. At the same time a change detection pilot was carried out in the Natura 2000 coastal dune Meijendel-Berkheide. Here we combined LiDAR-data from AHN2 (2008) and AHN3 (2014) with very high resolution satellite imagery in order to detect changes in vegetation structure. Since LiDAR-AHN data is only updated every 6 years in the Netherlands, specific hot spots can be monitored more frequently if needed using our newly acquired LiDAR RiCopter.

16:50 - 17:10 **Improving monitoring schemes by multi-scale remote sensing-data**
Andreas Press, Department of Forest Resource Management, Swedish University of Agricultural Sciences

Remote sensing, including Satellite data, is an important integrated part of the Swedish monitoring schemes NILS and THUF. From making more efficient spatial random sampling for field visits to model assisted estimations and presentations. A good example of this is our process to classify and describe the vegetation and distribution of Annex I (Natura 2000) habitats in the Swedish alpine mountain range, including both protected and unprotected areas. The vast mountains are mostly unexploited and the

Wednesday 10 April 2019 - the role of drone data in Natura 2000 monitoring

vegetation cover relies on natural processes, which means that most of the landscape can be classified as Natura 2000 habitats. We use remote sensing data to create model-based vegetation maps that cover the entire alpine mountain range. These maps are used in our two-stage sampling approach where our field sample sites are selected. In the future, multi-temporal satellite images can provide phenological series, giving us the opportunity to detect changes in length of the vegetation season, snow cover duration etc.

17:10 - 18:00 **Q&A and discussion session**

Wednesday 10 April 2019 - Day 2

09:15 - 09:30 **Introduction**

09:30 - 09:50 **Use of hyperspectral and thermal sensors in combination with deep-learning algorithms for vegetation mapping**
Pieter Beck, Joint Research Center

Using novel and standard airborne imagery to monitor the quarantine disease Xylella fastidiosa in trees
The bacterium *Xylella fastidiosa* is native to America and considered one of the most dangerous plant pests in many regions of the world. It has now been found in Italy, France, Spain, and Portugal and poses a threat to vegetation and agriculture across the Mediterranean basin where it finds a suitable climate and can, at least in theory, infect hundreds of plant species. Monitoring landscapes for *Xylella* infections is often labour-intensive, requiring visual inspections and laboratory analyses of plant material collected in the field. Here, we discuss how airborne remote sensing can contribute both to monitoring landscapes for signs of new plant pest outbreaks, and to estimating the damage they cause over large areas.
Recent work in the *Xylella* outbreak in Apulia, Italy, demonstrated how very high resolution hyperspectral and thermal remote sensing can quantify the changes in plant traits associated with early, visible, symptoms of Xylella fastidiosa infection in olive trees. Changes in these traits (which included chlorophyll fluorescence and thermal stress indicators retrieved from the imagery) were often also detected in plants that were infected by *Xylella* but did not yet show visible symptoms. Airborne spectroscopy and thermography can thus help in the detection of new *Xylella fastidiosa* infection in olive trees by picking up stress symptoms that it causes, even when these are not yet visible with the naked eye.

09:50 - 10:10 **Drones and satellite data in Natura 2000 monitoring in military areas - Błędowska Desert, Poland**
Wojciech Mróz & Katarzyna Kępa, ecological consultancy

The project „The integrated conservation of non-forest natural habitats on military area in Natura 2000 sites" was carried out in 2013-2017 within the Life+ programme by regional military authorities (Regional Board of Infrastructure in Krakow). It focused on the improvement of the conservation status of natural habitats (6120, 2330) in a Natura 2000 site (Pustynia Błędowska, inland dunes and dry grasslands). The main activities included clearing the area of misfires and the removal of Scots pine, birch and willows (Salix acutifolia and S. arenaria) from 365 ha of military training areas used mainly for parachute training. One of the bigger challenges was to develop a monitoring scheme to be used as a tool in the planning of these actions. We present our approach in use of sattelite images and Inspire drones to optimalize costs of activities. Basing on GIS spatial analysis and numerical analysis we developed our own, cheap and useful tool to predict changes in vegetation.

10:10 - 10:30 **Multi-scale remote sensing for the long-term monitoring and conservation of the Doñana LTSER platform**

Wednesday 10 April 2019 -

Ricardo Díaz-Delgado, Estación Biológica de Doñana

One of the major challenges of remote sensing is the upscaling of natural processes. Although there is a huge availability of sensors, the nature of the process to be monitored constrains the upscaling possibilities. This is especially evident for phenological processes such as flowering, fruiting, leaf emergence or fall as well as for decay processes. This work will show several solutions entailed for the long-term monitoring program of Doñana LTSER platform in order to scale up the collected in situ information with the use of drone-borne, airborne and satellite images. After a short introduction on the background and rationale we will point out the relevance to complement traditional monitoring techniques with information provided at landscape scale. In the Doñana protected area several monitoring protocols have adopted the multi-scale approach, either to test the accuracy of remote sensing products or to enlarge the implementation scale. Similar procedures are being set up under the umbrella of eLTER RI for the whole set of eLTER sites.

10:30 - 10:50 **Drones and camera traps to study animal trail networs in Doñana National Park**
Margarita Mulero Pazmany, Liverpool John Moores University

Margarita Mulero Pazmany, Julián Terreros Martín, Alison Jones, Manuela González-Suárez, Marcello D Amico, Eloy Revilla, Pelayo Acevedo, Joaquín Vicente, Jose María Galán
We have used drones in Doñana National Park (Spain) since 2008. These systems have substantially improved monitoring wildlife and habitats. The high-resolution images obtained by drones serve to conduct accurate bird and mammal censuses and to do fine scale habitat characterization. They are also useful in management, providing data for assessing or minimizing human impact in protected areas. Drones have become an important tool in ecological research, allowing us to study the relations between animal species and the environment at a spatial and temporal resolution without precedents. We are currently investigating the use of animal trails as remote sensing indicators to inform animal populations characteristics and key resources distribution. Animal trails are formed when individuals repeatedly follow the same trajectories. These structures reflect the relation between animals and the environment (which is the basis of ecology) and are surprisingly under-researched. We are performing drone flights to collect high-resolution aerial images to characterize the physical properties of the animal trails (E.g. orientation, length). At the same time, we are gathering data of the trails traffic (animal species, number of individuals, sense of movement) using camera traps in selected locations. We think that this approach may constitute a novel low-cost and non-invasive methodology for inferring animal populations and habitat characteristics from aerial images. We foresee the potential of this method for conservation biology, ecology, wildlife management and epidemiology, as it may help in identifying key resources, assessing the impact of human induced changes, and informing conservation priorities in protected areas.

10:50 - 11:30 **Coffee break**

11:30 - 13:00 **Demonstration workshop: Simple automatic detection of small landscape changes using satellite imagery**
Alan Brown, Countryside Council for Wales

There are many good reviews of change detection using satellite imagery in the remote sensing literature, but these are not always very accessible to the non-specialist**.** Here we look at a range of easy methods of change detection from optical satellite imagery, starting with simple visual comparisons, explaining the role of atmospheric compensation (correction) and simple cloud

Wednesday 10 April 2019 - the roles of other new technologies (e.g. phone apps, camera traps, eDNA)

masking. We then contrast finding small changes to large areas — using objects and regression analysis — with finding big changes to very small areas — working at a pixel level.

We will look at how to avoid being overwhelmed with the amount of imagery and potential comparisons by starting with ecological hypotheses which capture what you already know. Finally, we look at the potential for automating methods using machine learning (Random Forests) and expert systems. Along the way we will highlight sometimes unexpected features of satellite imagery, how to benefit from seasonal comparisons using your understanding of landscapes and seasonality, and how to recognise and avoid properties of the imagery which can lead to apparent false changes.

All the demonstrations will be done using freely available Sentinel 2 satellite imagery and open-source software*. I will be happy to show how to use these over the course of the workshop and during the Knowledge Market.

* R, Fiji (ImageJ), QGIS, Snap

13:00 - 14:30 **Lunch**

14:30 - 14:50 **Using DNA to monitor protected sites and species**
Andy Nisbet, Natural England

Biodiversity survey and monitoring has often been limited to recording taxa that are easy to find, or that we have a legal obligation to report on. Identification of some groups relies on a small expert community and it can be a long time between sampling and making records accessible. DNA based techniques have developed rapidly in the last 10 years and have the potential to significantly change survey and monitoring by reducing costs, reducing sample to use times, improving our ability to detect species, and providing a tool for monitoring functional groups and ecosystem health.

Over the last five years Natural England has supported research into the use of environmental DNA (eDNA) to detect the presence of great crested newts (Triturus cristatus, an Annex II species) in ponds. Since 2016 we have run a number of projects looking at species detection across a range of taxa in different freshwater, marine and terrestrial ecosystems.

This presentation will examine the potential of DNA based applications using examples from Natural England, with a focus on using these methods to survey and monitor for:
- Annex II species,
- invasive non-native species, and
- communities and species assemblages as indicators of habitat quality.

It will outline the advantages and disadvantages of this technology and consider future developments.

14:50 - 15:10 **Multi-scale monitoring in practice: cost-effective ways to monitor the Swedish seashore and mountains**
Åsa Hagner, Department of Forest Resource Management, Swedish University of Agricultural Sciences

Sweden has a fairly long coastline, including both the salty conditions of Kattegat and Skagerrak as well as the more or less brackish waters in the Baltic Sea and Bothnian bay. But while the total seashore area is only around 60 000 hectares the actual sea-shoreline, when taking account for all islands in the different archipelagos, easily reaches the length of the equatorial line across the globe! In the Swedish mountain area, alpine habitats, including alpine birch forest cover, is approximately five million hectares.

Initiated during, and developed through the outcome of, the LIFE+ project MOTH “Demonstration of an

Wednesday 10 April 2019 - the roles of other new technologies (e.g. phone apps, camera traps, eDNA)

integrated North-European system for monitoring terrestrial habitats" (LIFE08 NAT/S/000264), Terrestrial Habitat Monitoring program (THUF) will monitor the Swedish Natura 2000-habitats confined along seashores and in the alpine region. Using systematic approaches combining remote sensing and field inventories, THUF will deliver data on conservation status for the targeted habitats regardless whether they occur within Natura 2000 sites and/or formally protected areas or not. This talk will focus on how to do cost effective monitoring of habitats in relation to a short vegetation period, restrictions in protected areas and the logistical difficulties when performing field work in remote areas.

15:10 - 15:50 **Cofee break**

15:50 - 16:10 **Improving the accuracy of bird counts with ImageJ**
Clive Hurford

Observer variation trials using images of birds counted in ImageJ suggest that 80% of bird flock counts, even by experienced ornithologists, are underestimates, with the median counts for four images ranging from -13 to -57%. This level of observer variation will mask significant changes in bird populations and undermine confidence in making any decisive conservation response.

ImageJ is an open-sourced software package originally developed for medical purposes, specifically for counting blood cells in blood samples. However, using appropriate images, it can also count the number of birds in large flocks: in flight, at staging, breeding and feeding grounds. This presentation describes the options and processes for carrying out bird counts in ImageJ.

16:10 - 16:30 **BioLog: a recording app and distributional atlas in your pocket - a Czech approach to reaching citizens**
Karel Chobot, Czech Nature Conservation Agency

Citizen science has developed into an important information source with the most data potential. One of the principal roles of the public is species recording. This process has its intrinsic limits, based in the limited knowledge and abilities of general public and limited will of amateur scientists/experts. The Android app BioLog, which is a part of Czech Nature Conservancy Information System, tries to overcome both of these limitations. The BioLog app serves as a simple and fast off-line notepad for your observations of animals, plants or mushrooms in the field. The application simplifies the recording via the automated localisation, date and time input and easy species input. BioLog could be also used as a small scale search engine of the official Species Occurrence Database. This function makes the app a mobile (and actual) distribution atlas and source of information for repeated species recording.

Wednesday 10 April 2019 - citizen science approaches to monitoring while using new technologies

16:30 - 16:50 **European stag beetle monitoring network: a joint effort works best**
Arno Thomaes, Research Institute for Nature and Forest (INBO)

Arno Thomaes, Natalia Fanega Sleziak, Laura Bower, Sylvie Barbalat, Marco Bardiani, Luca Bartolozzi, Alessandro Campanero, João Gonçalo Soutinho, Deborah Harvey, Colin Hawes, Marcin Kadej, Valery Korneyev, Hannes Ledegen, Marcos Méndez, Bruno Meriguet, Markus Rink, Lucija Šerić Jelaska, John Smit, Adrian Smolis, Eduard Snegin & Al Vrezec
When the Habitats Directive was established, little expertise was available on the conservation and monitoring of some listed species, among them saproxylic beetles. This opened opportunities for new research focusing on a broad group of species. Several countries started up research initiatives to investigate the ecology, conservation requirements and monitoring protocols of the European stag beetle. We soon teamed-up, which gave rise to several joint research papers.

We successfully tested a standardized transect monitoring technique in eight different countries, obtaining data both from researchers and volunteers. A power analysis, using data coming from different sources, clarified that 240 transect walks need to be walked annually to meet the EU requirements.

From 2016, a citizen science project was set up to bring this monitoring into practice over the entire range of the species rather than within national boundaries. International internships have been funded to build the needed facilities such as the website and newsletter. This fostered opportunities for young graduates and allowed some initiatives to start up, though with limited funding. The authors formed a network representing 14 countries, all using the same protocol. However, some transects are walked by citizen science volunteers, while others are followed up by researchers. We will compare the success factors of both approaches. The citizen science approach goes beyond the gathering of data with the help of citizens and has an educational and conservation orientated goal as well by educating the volunteers and local stakeholders. To date, we have gathered data from more than 70 transects and 500 transect walks.

16:50 - 17:30 **Facilitated session: Taking stock of the best practise, strategies, needs, and perspectives in developing and implementing the use of these monitoring tools**

18:30 - 20:00 **Knowledge market**

20:00 **EuroCocktail**

Knowledge market - posters, demonstrations and speed presentations

"Detection and impact assessment of invasive species using remote sensing" (poster)
Dr. André Große-Stoltenberg, Justus-Liebig-University Giessen

"Counting birds in ImageJ - in practice (demonstration)
Clive Hurford, freelance ecologist
Observer variation trials using images of birds counted in ImageJ suggest that 80% of bird flock counts, even by experienced ornithologists, are underestimates, with the median counts for the four images ranging from -13 to -57%. This level of observer variation will mask significant changes in bird populations and undermine confidence in making any decisive conservation response.
ImageJ is an open-sourced software package originally developed for medical purposes, specifically for counting blood cells in blood samples. However, using appropriate images, it can also count the number of birds in large flocks: in flight, at staging, breeding and feeding grounds. In the knowledge market, Clive will give a practical demonstration of counting birds in ImageJ.

"Change detection using open source satellite images and software - in practice" (demonstration)
Alan Brown
Here we look at a range of easy methods of change detection from optical satellite imagery, starting with simple visual comparisons, explaining the role of atmospheric compensation (correction) and simple cloud masking. We then contrast finding small changes to large areas — using objects and regression analysis — with finding big changes to very small areas — working at a pixel level.

We will look at the potential for automating methods using machine learning (Random Forests) and expert systems. Along the way we will highlight sometimes unexpected features of satellite imagery, how to benefit from seasonal comparisons using your understanding of landscapes and seasonality, and how to recognise and avoid properties of the imagery which can lead to apparent false changes.

All the demonstrations will be done using freely available Sentinel 2 satellite imagery and open-source software*.

* R, Fiji (ImageJ), QGIS, Snap

"Mapping and monitoring blanket bog using Earth Observation" (poster)
Andy Nesbit, Natural England
Blanket bog is an Annex 1 habitat (H7120), on which Natural England is testing a number of Earth Observation approaches to map and monitor these sites. Two of these approaches look to monitor change at a landscape scale with very different methods and outputs. The first approach is being developed as a partnership between Natural England, Manchester Metropolitan University (MMU) and United Utilities. Where on the Bowland Fells we have used a Sentinel 2 derived vegetation index, trained using plant community data to classify and map blanket bog habitats, mire and heath and assess condition by developing a Bog Wetland Index. The other approach is specifically to identify and map burning on blanket bog and the wider heather moorlands. This approach is also using Sentinel 2 data and through Google Earth Engine has created cloud free mosaics from before and after the burn season. These are then used to create and compare the NDVI. This NDVI difference dataset is then used to identify and map burning.

"Rum Wild fire - extent and severity" (poster)
Karen Frake, Scottish Natural Heritage
Summary: At the start of April 2018 a hill fire affected approximately 200ha of land on the Isle of Rum on the west coast of Scotland. In order to understand the impact on the habitat within the Special Area of Conservation, the fire boundary and severity was assessed using Sentinel imagery.

Knowledge market - posters, demonstrations and speed presentations

"Sniffing for nature: proceeding detection dog training in real life environment" (presentation)
Bente Stockmans, Arno Thomaes (presenter), Ellen van Krunkelsven, Hilde Vervaecke
Scent detection dogs can provide a fast, reliable and non-invasive method for detection of a variety of target species for nature monitoring, offering a charismatic tool for communication. However only limited experience is available in Europe. A volunteer program was set up where a professional scent dog trainer selected eight human-dog dyads and assisted them in scent training on either scats of the European pine marten (Martes martes) or the otter (Lutra lutra), nests of the hazel dormouse (Muscardinus avellanarius) or the European hamster (Cricetus cricetus), the larvae of hermit beetle (Osmoderma eremita) or the stag beetle (Lucanus cervus), bat (Chiroptera) victims under windmills, the lion's mane fungus (Hericium erinaceus) or the American bullfrog (Lithobates catesbeianus). We documented if the dogs could reliably detect the target species in a controlled as well as natural setting. We interviewed the volunteers and trainer to identify which problems were encountered when the training proceeded from a controlled setting to a natural environment. Each dog was trained on one or two target species. Training experience of the volunteers ranged from very restricted to professional level. All dogs - of varying breeds, both sexes and ages between 1.5 and 5 years - managed to correctly discriminate the target species, with inter-individual differences in learning speed and drive. Detection problems in the field related to species-specific natural history traits of the target species such as depth of hiding under ground, seasonality of markings and ease of possible detection of the target by humans.

"Monitoring of breeding waterbirds with drones (UAVs)" (presentation)
Thomas Eske Holm, DCE, Aarhus University

"Mapping coastal vegetation with satellite imagery and spectral signatures. Experiences with seagrasses and saltmarshes on intertidal areas" (presentation)
Felipe Calleja Apéstegui, IH Cantabria
Mapping coastal and estuarine vegetation using remote sensing and spectral signatures entails several challenges that are not always present in terrestrial remote sensing. The Environmental Hydraulics Institute "IH Cantabria" has developed research projects aiming to implement mapping methods that overcome these difficulties, while helping in management projects and environmental surveillance of natural coastal areas. Some examples are mentioned.

The spectral signatures of the seagrass Zostera noltei, saltmarshes and bare surfaces were measured to map the seagrass' distribution in various estuaries of northern Spain. These signatures guided the selection of the base layers used in the species' mapping with satellite imagery, by showing the bands with the greatest differences between classes. They also revealed important relations between the vegetation's reflectance. For example, the analysis revealed that the resolution of the satellite images would impede the differentiation of Z. noltei from Ulva spp. (opportunistic seaweed), but would allow us to separate the seagrass from some saltmarshes present in the estuaries. The measured signatures started a spectral library that gathers useful information for future research around the globe.

The Institute's efforts on measuring spectral signatures and mapping vegetation also encompass other vegetation. The presence of the invasive species Baccharis halimifolia, a North American shrub of high concern, was mapped in estuaries using mid-resolution satellite imagery. In addition, a current project on measuring the spectral signature of Cortadeira selloana, an invasive grass in Spain, aims to measure its spectral signature in various phenological stages and map its current distribution using satellite imagery.

"Drone footage and images of National Nature Reserves in Wales" (demonstration)
Nick Edwards, Natural Resources Wales

Knowledge market - posters, demonstrations and speed presentations

"Showcase of Landsat sensors NDVI/EVI time series retrieval for any point in the globe" (demonstration)
Ricardo Díaz-Delgado, Estación Biológica de Doñana
Our tool consists of the visualization of vegetation indices (NDVI and EVI), for any given point in the world. Google Earth Engine was used to produce our application, whilst employing the following data sets to represent surface reflectance: Landsat 5, 7 and 8 (sensors TM, ETM + and OLI; Google Earth Engine Collections: LANDSAT/LC08/C01/T1_SR, LANDSAT/LE07/C01/T1_SR, LANDSAT/LT05/C01/T1_SR). These data have been atmospherically corrected using LEDAPS (Landsat 5 & 7) and LaSRC (Landsat 8), and include a cloud, shadow, water and snow mask produced using CFMASK, as well as a per-pixel saturation mask.

In the first step we merged the three collections into one Landsat collection, resulting in a data set from 1984 till present. Secondly, we used the pixel quality band, based on CFMASK, to remove the pixels of clouds and their shadows. Finally, we performed the NDVI and EVI calculations, which are displayed on the app in two separate frames. These data can be exported as an image or csv data. In addition to the above, the app shows the median NDVI value for any pixel within the study period (excluding data containing pixels from: clouds, shadows and Landsat 7 gaps).

"Multiannual monitoring in streams from the Picos de Europa National Park (Northern Spain)"
José Manuel Álvarez-MartínezMario Álvarez-Cabria, Marta Sainz, Ignacio Pérez, Edurne Estévez, Alexia González-Ferreras, Tamara Rodríguez, Ana Silió, Alejandra Goldenberg, Francisco Peñas & José Barquín
Environmental Hydraulics Institute 'IH Cantabria' (Universidad de Cantabria)
The Continental Ecosystem group of the IHCantabria has designed a biological and physical monitoring programme in Picos de Europa (ZECs of Cantabria, León and Asturias) in order to monitor the effects of global change over aquatic ecosystems of this area. The monitoring network is composed by 8 gauge stations emplacement in 6 streams and 2 springs that record continuous measurements of flow and water temperature, and 2 terrestrial stations that take pictures and measure the air temperature, the relative humidity, luminosity and the atmospheric pressure. To complete this infrastructure, invertebrate and fish communities and river metabolism (primary production and respiration) are also characterized in 13 study sites (10 rivers and 3 springs) combining the use of emerging molecular techniques (i.e. eDNA: genetic material, nuclear or mitochondrial DNA, obtained directly from environmental samples) with traditional biological samplings. The network is distributed following a Control-Impact design (CI) with temporal (inter-annual) replication. All the information obtained since 2012 from the aquatic and terrestrial sensors (environmental data) and field surveys (biological data) is uploaded in near-real time to a free access web site. With this information, we are able to discriminate between changes due to the natural variability of aquatic environments from those changes produced by anthropic alterations (global change). Furthermore, the monitoring network includes a land cover-biodiversity mapping programme based on remote sensing in order to assess the ecology status of the existing habitats.

"Big forest fire 'las Peñuelas' 2017, Moguer (Huelva Province, Spain). Earth Observation for updating thematic cartography of affected areas. Practice case: Community Interest Sites (CIS)." (presentation)
Juan José Vales Bravo, Agencia de Medio Ambiente y Agua de Andalucía
The Great Forest Fire "Las Peñuelas" (GFF) happened from 24 to 27 June 2017 over almost 10.000 hectares of four Municipalities of Huelva Province and affected the sensitive area "Doñana Natural Park".
The Environmental Information Network of Andalusia has wide experience working as support in emergencies management by using information from satellite and airborne sensors, and with the aim of producing and updating thematic cartography. The results are directly applied to define "Affected Areas Recovery Plans".

World Café: New opportunities (and challenges) for remote sensing techniques for scientists, decision-makers and practitioners in conservation/Natura 2000 management

Day and time
Tuesday 9 April, 16:30 - 18:00

A World Café or Carousel method is used with scientists, experts and practitioners in order to address questions related to the overarching question 'How can nature conservation and Natura 2000 management best benefit from the newest insights and developments of remote sensing and drone techniques?'

With several 'stations' (stands with flipcharts) were groups passed by, a group had 10 to 15 minutes per flipchart to discuss and answer one to three presented questions. During the last round, groups summarised and formulated conclusions based on the answers of previous groups. In total there were six stations with two questions each. The World Café was facilitated by Theo van der Sluis, Anne Schmidt, Sander Mücher, Carlos Sunyer, Ellen Meulman, and Kristijan Čivić. Please find the questions and their key take away messages below.

Questions

STAND A:
1. Which remote sensing products do you think have an added value for Natura 2000 monitoring?
2. Is there a scale range of remote sensing products which is currently not well covered?
3. What habitats are most suitable for monitoring with remote sensing?

STAND B:
1. What are, in your opinion, the most promising remote sensing products and techniques for Natura 2000 monitoring now and in the future?

STAND C:
1. Which are the problems in remote sensing products for monitoring?

STAND D:
1. What are suitable remote sensing techniques for monitoring land use or land cover change and (impact of) other pressures?

STAND E:
1. Do you know remote sensing products cheaper than field visits, and what are the most-cost effective remote sensing techniques for monitoring Natura 2000 areas?

STAND F:
1. What are barriers for site managers to (not) use remote sensing products?
2. What remote sensing products at which scales are useful for site managers?

Answers

A1:
- The accessibility of the terrain defines the added value of remote sensing. Also, the purpose, e.g. for monitoring trends, or the frequency of observation.
- Drones are in particular useful for animal counts, e.g. deer. They are versatile, flexible, fast, with low emissions.
- All remote sensing products have the benefit that they give no disturbance, except perhaps for some low-level flying drones.

A2:
- The large scale (e.g. LIDAR) is well covered, although another group added that that is not the case for HR-LIDAR, which is insufficient.
- At site level it is insufficient, e.g. at plant species level, or rare species mapping. Also, for the purpose of habitat modelling, the products are currently not good enough.
- Estuaries are difficult, the scale is limiting, but multi-scale analysis of various products is promising.

A3:
- It depends on the purpose - e.g. for mapping threats, or habitat types.
- In general, large scale and dynamic habitats are better suitable for mapping.
- Habitats in Favourable Conservation Status, dry types, wet types, and habitats with clear dominant species (e.g. Molinia) are suitable. The remark was made that FCS is a difficult concept.
- Remote sensing can help to pinpoint areas where management interventions are required, or those where no intervention is necessary.
- A remark is made that all the terrain should be mapped for threats, in- and outside Natura 2000. In Spain some 60% of all habitats is covered, which is 90% of the country.
- Some groups stated that semi-natural habitats are difficult, although apparently in Poland it is possible (semi-natural grasslands), but the quality of those habitats is tricky. Aerial photographs may be better for that purpose.
- In the Netherlands the mapping of habitat types is difficult, due to too many details.

B1:
Now
- Google maps, bing maps.
- Ortho-photos, Stereo-photos, LIDAR products (DTM, DSM, CHM), Forest Cover, RADAR data (e.g. subsidence), Tropical Forest Mapping with RADAR, Corine land cover, Copernicus HR products.
- Tracking devices, camera traps, ground radar for bird detection.
- Essential Biodiversity Variables (EBVs), such as, LAI, vegetation height, biomass, phenology, flooding, land cover, soil moisture.
- Vegetation structure and vegetation cover monitoring.
- Remote sensing products can fill gaps intermediate in a frequency, e.g. vegetation mapping every 12 years, intermediate products derived from remote sensing.
- Good ecologists with remote sensing knowledge.

Remark: In the UK, Orthophotos are becoming too expensive for the government.

Future
- Remote sensing can map all Annex I habitat types (Natura 2000).
- Habitat maps every 6 years from remote sensing (with 10m resolution).
- Increase frequency.
- Species mapping with drones.
- Remote sensing measures all a-biotic site conditions (soil moisture, temperature, trophic levels, salinity).
- Non-disturbing drones.
- Complete integration of remote sensing products with in-situ data (e.g. vegetation relieves, species presence).
- High resolution LIDAR products everywhere concerning individual trees, height and diameter trees, and dead wood.
- Integrated camera systems (e.g. LIDAR and hyperspectral).

- Pocket drones with integrated camera systems that can do instantaneous habitat mapping.
- 'Everybody' in the possession of a drone.
- Toolboxes & apps with freely available high-resolution remote sensing products (e.g. temperature, flooding, soil moisture, vegetation structure, land cover, etc.), as well as easy access comparable to Google maps.
- Remote sensing derived alert services.
- Good, light batteries for drones.
- Remote sensing products and models integrated for future predictions.
- Copernicus products linked to ecosystem and climate services.
- All remote sensing products (everything) available in Google Maps.
- Everything free and easily accessible, and all in one projection.
- All remote sensing products downloadable for further processing.
- More accurate methods.

C1:

- They are very complicated to use, because the data needs to be interpreted since the products have been designed for other uses, not for ecology purposes. For data analysis a model has to be developed, and consequently, there is a lack of standardisation. Because all this, it is difficult to find specific training on these products. Therefore, many people are still somewhat reluctant to use these tools (in combination with scepticism regarding technological innovation), slowing down the uptake for nature conservation management which is mainly relegated to scientific purposes. For others, there might be too high expectations regarding results, leading to disappointment - caused by a lack of understanding on the tools' utility.
- The accessibility of the terrain defines the added value of remote sensing, as well as the purpose, such as for monitoring trends or the frequency of observations.
- Drones are particularly useful for animal counts such as deer counts. Drones are versatile, flexible, fast, with low emissions.

D1:

Remote sensing techniques

- Change detection techniques are more suitable than sequential image classification.
- Fuzzy techniques to improve accuracy.
- Aerial photographs and satellites, as well as images from drones.

Other type of pressures that can be monitored by means of remote sensing techniques

- Land fragmentation
- N pollution
- Invasive species
- Water conditions / desiccation / flooding
- Grazing
- Burning
- Diseases (like from pesticides)
- Productivity
- Recreation
- Human activities around a site

Time scale

- Difference between gradual changes and abrupt changes like pests.

Spatial scale
- Important on different scale levels from site level to landscape to Member State to EU
- Multiscale approach
- On site level drones are important for management actions, especially in areas that are hard to access.

Limitations
- Resolution of satellites is a limiting factor
- Aerial photographs are used in, among others, Sweden
- Archives remain important

Ancillary data
- Kadastral data
- Agricultural data, e.g. parcels and subsidies

Historical context
- It is important to have the historical context, for instance through old aerial photographs.

E1:
Considerations
- Remote sensing still needs to be combined with field visits - but remote sensing can provide an added value.
- It is still not quite clear if remote sensing techniques are cheaper.
- A lot of the costs are not made while acquiring data, but while getting the set-up in place: storage and processing (i.e. the IT infrastructure), interpretation and calibration (i.e. obtaining the right knowledge and expertises).
- Remote sensing works very well for an Early Evidence and Alert System to indicate large changes for any habitat type in Europe. However, to detect the real causes one needs to follow-up with field visits.
- How: use different Copernicus / Landsat / Sentinel (and/or Planet) data sets from different years and detect changes.
- Combination of different remote sensing techniques (e.g. satellite with LIDAR) gives even more useful information.
- Remote sensing might not always be cheaper, but it can be a way to answer a certain question or fill a gap in data (e.g. 12 year frequency of vegetation mapping, what about in between?). It depends on the specific question and context.

Examples
- The use of tablets in recent years has revolutionalised the field work of site managers (e-mail, photos, GPS, GIS, forms, mapping, etc.).
- LIDAR is an effective way to estimate the biomass on a large scale in forestry (in use in Finland).
- Photo-traps for identifying insects (which involves machine learning) used in the Netherlands.
- EDNA sampling for fish and insect surveys.
- Combination of eDNA and satellite data (with involvement of some machine learning) can be used for mapping (estimating) the distribution of various species.
- Linking networks of all kinds of sensors (e.g. soil, water, etc.) and combining with satellite data gives numerous possibilities.
- Breeding birds' colonies counting with drones or planes.
- Satellite data for an Early Warning System for wildlife detection and monitoring.

F1:

- There is a huge difference in what can be done versus what is needed by site managers.
- Too complex, not easy to understand, too much (age barrier/knowledge barrier; complex to determine what method to use for what, costs).
- Fear of the unknown and what it means in terms of job(s).
- Necessity of (working with and buying) new (complex) software and hardware.
- Huge amounts of data that are not easily interpreted, analysed and/or recognised as visible patterns and classifications.
- Lack of engaging site managers in using remote sensing so that site managers do not recognise the advantages and its usefulness.
- Definition of remote sensing is not clear - does it also include eDNA, wild cameras, et cetera?
- The usefulness of remote sensing differs among site managers versus researchers versus conservation purposes.
- Whether or not remote sensing is cost-effective, e.g. money well spent?
- Fear of accessibility of data - (mis)used/misinterpreted - fear of being controlled/checked upon (data protection and ownership might be an issue).
- Liability in using remote sensing like drones.
- Not useful for small sites, where field observation is easier.
- Often not transferable from one site to another.
- Lack of recognition and being okay with limitations.
- Simplified communication of results is necessary! Whereas effects of actions require detailed information.

F2:

- Scale (spatial and temporal) and accuracy is context (and process) dependent.

Useful for:

- Seeing earlier effects of change.
- Transferring knowledge across sites.
- Comparing sites.
- Seeing effect of influences in surrounding areas of own site.
- Animal sensus (larger animals, birds, marine mammals).

Useful remote sensing products:

- Aerial photography (although be careful of degraded quality because of autocorrection and compression).
- Stereo photography (more historical data, good for habitats and structure for which LIDAR would then not be necessary).
- Dat/em summit software.
- Drones - small scale (more useful for own site).
- Landcover application (easy to use and understand, not directly related to own site - no fear of control).

Who could do what to get more remote sensing, and the new technology in general, applied widely in monitoring the Natura 2000.

European Commission

- Use remote sensing as a standard for reporting for the Habitats Directive;
- Support standardization of information and provide standards and best practice examples;
- Connect to already existing platforms (e.g. Copernicus Climate Services) and provide affordable (online) training courses for using the free tools that already exist;
- Provide specific funding programmes for Natura 2000 monitoring;
- Stimulate more LIFE Integrated Projects on this topic;
- Provide more COST Action and other funding opportunities to fund the development of new approaches to remote sensing.

Member States

- Formulate the Natura 2000 monitoring needs in coordination with site managers;
- Promote projects for demonstrating the application of remote sensing in monitoring;
- Provide funding for stimulating the development and application of remote sensing in monitoring;
- Provide knowledge infrastructure and support citizen science;
- Feed the European Commission with the examples of good practice.

Scientific Community

- Understand the needs of the end-users and provide them with the best available technology;
- Be more application oriented – provide operational applications;
- Provide the education and knowledge to the users (site managers);
- Make the outcomes more understandable and be honest about pro's and con's.

Site Managers

- Formulate the Natura 2000 monitoring needs;
- Communicate with the scientific community about the needs;
- Embrace the new technology.

Eurosite

- Bring the ideas of the site managers and the scientific community to the (funding programmes) of the European Commission – connect everyone;
- Provide capacity building and specific thematic networking opportunities;
- Set up a new working group on remote sensing (e.g. as a part of the Management Planning working group).

Others

- Link to business or private companies sharing biological data;
- Engage with the European Environment Agency (EEA) and the European Space Agency (ESA);
- Use citizen science projects to leverage remote sensing products.

Natura 2000 monitoring workshop

The roles of new technologies and citizen science

Sanlúcar de Barrameda, Spain, 7-9 April 2019

The workshop is co-organised by Eurosite, Estación Biológica de Doñana, and Clive Hurford (Serapias ecological monitoring consultancy.

This event is made possible with funding from the Natura 2000 Biogeographical Process and the EU LIFE Programme.

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Eurosite : Postbus 90154, 5000 LG Tilburg, The Netherlands ; Tel. +31 (0) 13 59 44 400 @ info@eurosite.org internet: www.eurosite.org