Biodiversity monitoring beyond 2010: What role for remote sensing?

Minutes of the plenary discussion of the

HABISTAT workshop

Monitoring Europe’s biodiversity in a post 2010 era: the role of remote sensing for Natura 2000 reporting and ecosystem assessment

Brussels, 13 October 2010

Jeroen Vanden Borre, Desiré Paelinckx, Maurice Hoffmann & Toon Spanhove
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Minutes of the plenary discussion of the workshop
“Monitoring Europe’s biodiversity in a post 2010 era: the role of remote sensing for Natura 2000 reporting and ecosystem assessment”

Organized by the HABISTAT-consortium, in cooperation with the European Commission, DG Environment.
Brussels, 13 October 2010.

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Alexis (Lex) Comber, University of Leicester, UK
Doug Evans, European Topic Centre on Biological Diversity (ETC/BD)
Geoff Groom, National Environmental Research Institute (NERI), Aarhus University, DK
Birgen Haest, Flemish Institute for Technological Research (VITO), BE
and all workshop participants who shared their thoughts in the discussion.

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1. Introduction

With the 2010 target of halting biodiversity loss far from being achieved, a renewed, post-2010 strategy for biodiversity in Europe is currently under discussion. This new strategy will not only consider conservation (e.g. Natura 2000), but will also factor in the role of ecosystems and the services they provide. Vital to a successful implementation of the strategy is our ability to establish a scientific baseline on the state of biodiversity in Europe, and to measure progress towards reaching the objectives. However, acquiring accurate and up-to-date information on biodiversity, both at site, member state and European level, remains a big challenge, as exemplified by the latest reporting on conservation status of Natura 2000 habitats and species in 2007. Remote sensing has been recognized as a powerful, innovative tool, but its use in biodiversity monitoring remains scattered and limited.

It is within this context that the Habistat-consortium (http://habistat.vgt.vito.be) organized its second user-oriented workshop on the use of remote sensing for biodiversity monitoring, in cooperation with the European Commission DG Environment, and with the financial support of the Belgian Science Policy Office (BELSPO, Stereo II programme) and the Research Institute for Nature and Forest (INBO). The workshop took place in the premises of the Museum of Natural Sciences in Brussels on 13 October 2010, coinciding with the 2010 International Year of Biodiversity and the Belgian Presidency of the Council of the EU. It was attended by 105 participants from 13 European member states.

Theme of the workshop was: "Monitoring Europe’s biodiversity in a post-2010 era: the role of remote sensing for Natura 2000 reporting and ecosystem assessment.” The workshop aimed to bring best-practice examples of the use of remote sensing in biodiversity recording and monitoring in Europe, as a source of inspiration to the biodiversity conservation community. Special attention was given to possibilities and opportunities provided by remote sensing for the mapping and conservation status assessment of Natura 2000 habitats, and habitat suitability assessments for Natura 2000 species. A concluding plenary discussion addressed questions on how remote sensing can contribute (more) successfully to an operational monitoring programme for Europe’s biodiversity.

2. Programme

The programme of the workshop can be found in annex to this report. All presentations (unless confidential), including poster presentations, are available on the Habistat-website: http://habistat.vgt.vito.be (click ‘Downloads’ in the main menu).
3. Plenary discussion

The workshop’s contributions showed a broad sample of how remote sensing can be put to use for biodiversity monitoring. But remote sensing is also a very diverse and complex field with a wide kaleidoscope of techniques, concepts and applications. The use of at least 50 different acronyms in only eight presentations was indicative for this level of diversity.

Setting up an operational monitoring programme requires choices to be made, that are most likely to determine the outputs of the programme for a long time to come. In order to integrate remote sensing in such a programme, monitoring experts first need to have a clear view on what is available and/or achievable with remote sensing, to help them decide what approach will work for specific cases.

The aim of the discussion was to identify and address a number of aspects that could facilitate the integration of remote sensing in operational monitoring. The discussion was structured around five questions:

1) Do we need to harmonize methodologies?
2) Is a pixel map a suitable end product, or should producers deliver polygon maps?
3) Are the new technologies (hyperspectral data, LiDAR,...) feasible in an operational context?
4) What level of detail can remote sensing deliver in the context of Natura 2000 habitat monitoring (incl. both habitat mapping and quality assessment)?
5) What would be needed from the European Commission to get more successful experiences (GMES, from the policy and implementation units)?

This report summarizes the discussion and aims to draw conclusions and recommendations that will facilitate further progress in the integration of remote sensing in biodiversity monitoring.

Q1. Do we need to harmonize methodologies?

A wide range of remote sensing approaches and methodologies are available today, even for the same or similar goals (e.g. mapping heathland habitat). This hampers comparability between different areas, and makes it difficult for monitoring experts to decide which approach to apply.

- Is this a problem?
- Is there a need to harmonize and decide on standard approaches for a specific application?
- Is there a ‘superior’ technique in all aspects (that could become the standard approach)?
- What are the advantages and disadvantages of harmonization?

Most participants agree that there is no such thing as a superior technique. The success of remote sensing lies in the clever combination of available data and techniques, to develop a tailor-made product that suits the user’s needs. Forcing the producer into using a standard approach would in many cases result in less customization to the specific problem at hand, and hence lower quality end products.

Geoff Groom (NERI, Aarhus University) states that harmonization of mapping products and approaches has to be considered in terms of five information aspects, being:

- the adopted data concepts (i.e. the Worldview and purpose of the map data);
- spatial aspects (i.e. typology, scale, geometry, geodetics);
- temporal aspects (i.e. what timepoint / period do the data represent?);
- semantic aspects (i.e. the classification system and class definitions used for the legend);
- the quality (accuracy, precision) of the products.

The Geographical Information Science (GeoInformatics) community is developing answers on exactly this kind of problems, and should therefore be involved in this discussion. Lex Comber (University of Leicester) mentions the FPS-project REVIGIS\(^1\), which tackled a number of problems that are relevant to the topics discussed here, such as how to accommodate the uncertainties of different classifications, measurements, sensors, etc. when different spatial data are combined.

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Stefan Lang (Z_GIS, Uni Salzburg) argues that a harmonization of approaches or products ('maps') is not strictly necessary. Our general aim should be to produce 'spatial information', that can be re-used for other purposes as well. Developing a standardized hierarchical system of ecological units for Europe, and adopting it for spatial data production, would facilitate the up-scaling (and thus re-use) of estimates from smaller units into larger units. The precise methodology used for each of the data productions would then become less important.

Lex Comber further adds that harmonization should in fact be bottom up, meaning that it should look for ways to allow people to 'do what they do' in relation to extracting biodiversity information from remotely sensed data, while at the same build frameworks and identify mechanisms for recasting that remotely sensed data into other sorts of information. This could be done by defining 'data primitives' at the lowest level, i.e. features that record information describing the processes under investigation at the most fundamental level. The desired higher level information could then be generated from these data primitives through a process of aggregation (as e.g. in the example of the Habitat Map of Wales). Advantages of this approach would be that:

- it would allow other contemporary classifications to be generated from the same primitives (e.g. relating to different aggregations);
- it would allow as yet unanticipated classifications to be generated in the future. We cannot predict to what extent our scientific understanding of habitats will have changed in 20 years time, nor what the monitoring priorities will be at the time, but data primitives should allow us to retrospectively generate the required information. In this way they provide a method for time-proofing current research activities.

Whereas the need for a harmonization of methodologies is thus contested, all participants do seem to agree that there is a need to harmonize the evaluation of a product. Apparently one of the most confusing concepts, for remote sensing specialists and end users alike, is the concept of 'accuracy'. The discussion focuses on this concept, with the following recommendations:

- Accuracy is important and cannot be ignored, but some types of errors will make the product more contestable for users than others (e.g. forest/non-forest errors are obvious when going in the field and therefore less acceptable, whereas an estimate of the amount of cottongrass in a given patch is as difficult to make in the field as with remote sensing).
- There is a need to better define the concept of 'accuracy'. It should mean the same in all instances, or it should at least be clear what accuracy means in any case. In this respect, Alan Brown (Countryside Council for Wales) points to the fact that change detection, data fusion and accuracy assessment are all related. We should therefore first consider the problem of change detection, which will then allow us to approach the problem of accuracy in a more oriented way.
- Current accuracy measures (e.g. confusion matrices) are often non-spatial, while in reality errors (or regions of low quality) are not evenly distributed throughout the map product, but are spatially clustered. Measures of quality at the object level (i.e. the basic elements of the map product) could be more appropriate to support spatially informed data use.
- There is a need to communicate about accuracy. Too many users are currently applying (often downloaded) data for decision-making, without knowing or understanding whether the data are suitable for the purpose.

Lex Comber reminds that 'accuracy' and 'data quality' are not synonyms. Data quality is a relative measure (with accuracy just one aspect of it), which depends on the intended use of the data. Therefore, measures of data quality should be aimed at users rather than producers of data. One problem however is that it is difficult to anticipate every possible future use.

The Habitats Directive Article 17 reporting is in fact a major harmonization process, but Angelika Rubin (EC DG Environment) acknowledges that there has not been given much attention as to how data comparability could be assured. The EC hopes that a further harmonizing of the data to be reported (one of the aims of the EU Expert Group on Reporting under the Nature Directives) will also lead to more harmonization in data collecting approaches.

Finally, it is added that best practice examples and guidance, both for field work and remote sensing, could be very helpful in the process of harmonization and enhancing comparability.
**Q2. Is a pixel map a suitable end product, or should producers deliver polygon maps?**

Many users of geographical data (e.g. site managers, policy makers,…) are used to their maps having nicely delineated polygons. However, the basic unit at which remote sensing delivers information is the pixel. Moreover, some patterns or processes of interest to the user may be better represented by pixels than by polygons (e.g. gradients between vegetation types, encroachment of invasive species,…). Is it time for the users to make a radical shift in how they use geographical data (away from the paper-map mimicking digital polygon maps), or should producers continue to deliver polygon maps?

The discussion starts with the question about the necessity to produce maps. Hans Gardfjell (SLU) remarks that for the Article 17 reporting, member states need to report only area estimates (in km²) and rough distribution maps (10x10 km grid scale) of habitats to the EU. This makes extensive spatial mapping of habitats strictly not necessary, and remote sensing could thus equally well be used for ‘at a point’ information gathering. However, Doug Evans (ETC/BD) replies that spatial mapping is relevant for nature conservation management, and that the Art. 17 reporting should only be seen as the tip of the iceberg. The EC encourages member states to develop national nature data systems which include a.o. spatial mapping of habitats.

The rest of the discussion shows that there are strong supporters and opponents of both polygon and pixel maps. Arguments raised in favour of polygons are:
- Pre-processing steps (such as atmospheric correction, geo-referencing, combining multiple images,…) turn a lot of the pixels into artefacts, so it is better not to rely too much on single pixel values.
- The objects of interest (i.e. habitats) come in patches in real life, so it is better to represent these as polygons. A single pixel cannot be attributed to a certain habitat without looking at the context it is in.

Arguments raised in favour of pixels:
- Pre-processing is not messing up your pixels, it is removing artefacts that hide what should have been measured by the sensor.
- The starting point of object-based image analysis is mostly to make your data more easily interpretable, which is a false argument. The real goal should be to get more information out of your image, and that is only possible if you analyse at the pixel-level. Going from pixels to polygons means you are simplifying and hence losing information.

Geoff Groom points out that the discussion pixel- versus polygon-products is not the same as pixel-based (PBIA) versus object-based image analysis (OBAI). The strength of OBAI is in its object-based modelling (i.e. looking at the context), and this can be used to reveal information on a single pixel as well as on a whole polygon.

All in all, it is concluded that the choice for pixels or polygons should depend on the intended use of the product. But most users in the field of biodiversity conservation (e.g. site managers, policy makers,…) are currently not well equipped to handle pixel maps, and would need specific software and education on the topic, for which time and funding are usually lacking. If we want remote sensing products to be used for biodiversity purposes, we will have to make them readily applicable for these users, and this is only possible with polygon maps that can easily be integrated into existing GIS-systems.

**Q3. Are new technologies offered by remote sensing feasible in an operational context?**

New technologies such as hyperspectral and LiDAR data offer exciting new possibilities for biodiversity surveillance and monitoring through remote sensing. However, they are expensive and often difficult to obtain (especially over larger areas). Is it then realistic to rely on such data when putting into place operational monitoring programmes?

Everybody seems to agree that there is a problem with the availability and continuity of highly specialized data like hyperspectral or LiDAR for biodiversity conservation purposes. For instance, there is a lack of hyperspectral sensors available, and even newly planned sensors will not be enough to cover large areas such as Europe or even single member states. Hyperspectral satellite sensors are only to be expected within a few years, and these will deliver lower spatial detail than
current airborne sensors. As for LiDAR, many countries are now flying LiDAR over their territories in order to derive digital elevation models. But once this is finished, it will remain to be seen whether countries will be prepared to repeat this coverage at regular intervals. Maybe only countries with lots of forests will do so, or the focus may shift entirely towards LiDAR applications for the market of urban mapping, with limited utility for biodiversity monitoring. There may be another downside to the plethora of new sensor developments we have seen in recent years, namely that the continuity of long time series of similar data (as e.g. the Landsat and NOAA-AVHRR systems), may be jeopardised, with possible severe impacts on the value of remote sensing data for long term habitat (change) monitoring. However, taking into account successful examples where many remote sensing sources, each with its own characteristics, were combined, it cannot be ruled out that the use of the more advanced techniques may be inevitable to obtain the required levels of detail and reliability. Highly specialized airborne data can be obtained through EUFAR, but this facility has limited capacity and is mainly meant for research projects, rather than operational monitoring programmes. It is felt that there should be a lobby group for an airborne network of advanced sensors around Europe (e.g. as part of GMES), in order to ensure both higher availability of data, and continuity in sensors/image types.

Q4. What level of detail can remote sensing deliver in the context of Natura 2000 habitat monitoring?

For the reporting under the Habitats Directive, member states need both distribution maps of habitats (to estimate area and range), as well as an assessment of the habitat quality (called ‘specific structures and functions’ in the Habitats Directive). A logical question would therefore be to what extent remote sensing can deliver such data. INBO prepared a quick-and-dirty overview of what seems feasible and unfeasible, as a basis for discussion, and based on own experiences as well as limited knowledge from experiences of others (see Table 1).

Table 1: A tentative overview of the applicability of remote sensing for the mapping and quality assessment of Annex I-habitats.

<table>
<thead>
<tr>
<th>Habitat group (from Habitats Directive Annex I)</th>
<th>Mapping</th>
<th>Quality assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. COASTAL AND HALOPHYTIC HABITATS</td>
<td>good (most habitats)</td>
<td>?? (possible)</td>
</tr>
<tr>
<td>2. COASTAL SAND DUNES AND INLAND DUNES</td>
<td>good (most habitats)</td>
<td>possible to some extent (grass encroachment, tree encroachment, dynamics ~ amount of open sand)</td>
</tr>
<tr>
<td>3. FRESHWATER HABITATS</td>
<td>bad (no differentiation between most freshwater habitats)</td>
<td>?? (impossible)</td>
</tr>
<tr>
<td>4. TEMPERATE HEATH AND SCRUB</td>
<td>good (most habitats)</td>
<td>possible to some extent (grass encroachment, tree encroachment)</td>
</tr>
<tr>
<td>5. SCLEROPHYLLOUS SCRUB (MATORRAL)</td>
<td>unknown (probably some habitats)</td>
<td>?? (possible)</td>
</tr>
<tr>
<td>6. NATURAL AND SEMI-NATURAL GRASSLAND FORMATIONS</td>
<td>bad (almost no differentiation between most habitats, but possible to distinguish as a group from anthropogenic/ improved grasslands)</td>
<td>?? (impossible)</td>
</tr>
<tr>
<td>7. RAISED BOGS AND MIRES AND FENS</td>
<td>good (most habitats?)</td>
<td>?? (possible)</td>
</tr>
<tr>
<td>8. ROCKY HABITATS AND CAVES</td>
<td>unknown (probably some habitats)</td>
<td>?? (possible)</td>
</tr>
<tr>
<td>9. FORESTS</td>
<td>bad (no differentiation between forest habitats, but possible to distinguish from plantations; tree composition can often be determined)</td>
<td>?? (possible for some structural characteristics)</td>
</tr>
</tbody>
</table>
Several participants feel that the table is too simplistic. Many factors are of influence to the success of a remote sensing driven approach, such as:

- the amount of knowledge input on the objects of interest;
- the amount and quality of (image) data available;
- the scale at which the output is desired;
- the kind of habitat quality aspects one is looking at (e.g. typical species, specific habitat structures, disturbances,...)

Moreover, even if individual habitats cannot be mapped or assessed, it may well be possible to get useful information on habitat groups (e.g. natural and semi-natural grasslands versus improved grasslands).

A more elaborate overview would be needed. It is suggested that this could be made in the frame of the two upcoming FP7-projects MS.MONINA and BIO_SOS.

Despite the criticisms on the simplicity of the table, Hans Gardfjell confirms that the table largely corresponds with the experiences in Sweden, and he stresses the fact that remote sensing cannot deliver all the answers. A combination with field work will always remain necessary.

**Q5. What would be needed from the EC to get more successful experiences (GMES, from the policy and implementation units)?**

The European Commission is interested to see more successful examples of how remote sensing is put to use for biodiversity monitoring. The question to the audience is what would be needed from the EC to see this happen.

Michael Bock (DLR) points to the fact that a more reliable funding source for biodiversity monitoring with remote sensing should become available. Many of today’s examples are short-term projects that develop some approaches, but lack the continued funding to subsequently bring the approach into operational monitoring.

Lex Comber adds that GMES should be more bottom-up. More attention should go to finding ways to incorporate existing activities of habitat information generation from remotely sensed data and add value to them, rather than trying to sell novel applications and products to replace existing activities. GMES should promote the science work needed for that. For example, one of the possible GMES products could be a toolkit for integrating divergent spatial and thematic habitat data, accommodating divergent classifications, their semantics, raw data etc., constituting a data framework upon which to hang existing data collection activities.

Arno Kaschl (EC DG Environment) replies that GMES is open to receive more input from users.
4. Conclusions

- The workshop has shown several successful, as well as also less satisfactory, examples of the use of remote sensing in biodiversity monitoring. It appears that the chance of success is raised when:
  - the problem to be tackled is specific and well-defined. Solving all the users’ needs at once is impossible, and vague or too broad objectives hinder the focus on the problem.
  - the future users (the nature conservation community) and producers (remote sensing community) communicate and cooperate from the very beginning to develop the most efficient approach to the problem. The input of ecological knowledge in the first phases is often vital for the success of a project.

- Operational methods exist, but their application to a wider scale is often hampered by a lack of availability of suitable image data. The participants welcome the choice for a more open data access policy from satellite sensors recently made by GMES, and encourage the EC:
  - to develop in parallel a facility for airborne sensors in Europe.
  - to ensure data continuity, in terms of long time series of similar data types, as these constitute an important stimulus for long-term monitoring.

- Over the past years, the nature conservation and remote sensing communities have come closer together and intensified communications and discussions, but this happened mostly in the frame of short-term projects. There is a clear need for a continuation of the dialogue between both communities, preferably in a more formalized structure with more secure funding (e.g. a COST action).

- Harmonization of remote sensing methodologies over larger areas and periods may seem logical, but there is a risk of making the system more rigid and less adaptable to specific situations, or to progress in understanding of concepts over time. Rather than promoting standard methods for processing and information extraction from remotely sensed data, there is a need to develop frameworks that allow comparability of results in space and time (through upscaling and/or recasting of basic measurements (‘data primitives’)), despite the variation in sensors, thematic legends and processing methods used. This need should receive more scientific attention, and the Geo-informatics community should be involved.
ANNEX 1 – PROGRAMME OF THE WORKSHOP

Programme

9h00 Arrival & coffee
9h20 Welcome (Jurgen Tack, INBO, Belgium)
9h25 Introduction (Marco Fritz, DG Environment, European Commission)

9h40 From hyperspectral images to Natura 2000 habitat patches and quality indicator maps: results from the HABISTAT-project (Birgen Haest for the HABISTAT-team, VITO, Belgium)
10h10 Photo interpretation and remote sensing methods used for Swedish Natura 2000 mapping (Birgitta Olsson, Metria, Sweden)
10h30 Capturing loss and change in Danish protected nature areas using object based image analysis tools (Geoff Groom, NERI, Aarhus University, Denmark)

10h50 Coffee break

11h10 Habitat mapping in Wales using multiple date remote sensing imagery (Alan Brown, CCW, UK)
11h30 The application of airborne remote sensing in woodland and landscape ecology: a bird's eye view (Shelley Hinsley, CEH, UK)
11h50 Applied vegetation monitoring with high resolution sensors (Annett Frick, LUP, Germany)
12h20 Habitat mapping through remote sensing in the Piemonte region: a methodological approach (Fabio Giannetti, IPLA, Italy)

12h40 Lunch break

13h40 Towards a pan-European assessment of riparian zones (Nicola Clerici, JRC, European Commission)
14h00 MS.MONINA – an integrated multi-scale earth observation based monitoring service as European contribution to sustaining global biodiversity (Stefan Lang, Z_GIS, Univ. of Salzburg, Austria)
14h20 Global Monitoring for Environment and Security (GMES) - state of play and opportunities for biodiversity monitoring at a European scale (Arno Kaschl, DG-Environment, European Commission)

14h40 Coffee break

15h10 How to choose between operational remote sensing methods and products? Towards a common validation framework for the end users (Anne Schmidt for the HABISTAT-team, WUR-ALTERRA, the Netherlands)

15h30 Discussion: Biodiversity monitoring beyond 2010: what is the role for remote sensing? (moderated by Maurice Hoffmann, INBO, Belgium)

17h00 Closing of the workshop + reception
18h00 End
Poster presentations

**BIO_SOS-** Biodiversity multi-source monitoring system: from space to species, FP7-SPACE-2001-1 project (Palma Blonda, ISSIA-CNR, Italy)

**Life+ MOTH:** Monitoring of terrestrial habitats (Hans Gardfjell & Helena Forsman, SLU, Sweden)

**NILS, Swedish landscape monitoring program** (Hans Gardfjell & Helena Forsman, SLU, Sweden)

Application of LiDAR remote sensing and photogrammetry techniques to vegetation classifications in the Corrubedo dunes and Carregal and Vixan lakes natural park (Galicia, NW SPAIN) (Miriam Fernandez-Nuñez & Maria del Pilar Díaz Cuevas, Univ. of Sevilla, Spain)

**Mapping of direct and indirect drivers for changes in ecosystems services (Mediterranean region)** (Faidra Maria Bazigou & Joachim Maes, VUB, Belgium)

**HABIT-CHANGE:** Adaptive management of climate-induced changes of habitat diversity in protected areas (Marco Neuberg, Leibniz-IÖR, Germany)

All presentations will be made available on our website soon after the workshop; so have a look at http://habistat.vgt.vito.be/
Dear workshop participant,

Please help us documenting the use of remote sensing in biodiversity surveillance and monitoring initiatives throughout Europe. We would be grateful if you could fill in this small questionnaire, and return it in the box at the registration desk. We may contact you afterwards for more information or to identify relevant publications, websites or contact persons. You may also contact us directly at jeroen.vandenborre@inbo.be, or habistat@inbo.be. The results of this inventory will be included in the workshop report, which will be made available to all participants. Many thanks for your help.

Name: ........................................................................................................

E-mail: ........................................................................................................

Do you know of any remote sensing-based biodiversity surveillance or monitoring schemes in your country (or elsewhere in Europe)?

□ YES □ NO

If yes, please provide some more information:

Project title/reference: .......................................................................................

Country/Geographic location: ...........................................................................

Please describe (targeted organisms/habitats, geographic coverage, image types used, information extraction strategy (e.g. manual interpretation, (semi-)automatic,…), responsible organization, contact person,…):

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Please tick:

□ Surveillance (one-time measurement) OR □ Monitoring (repeated measurements)

Was/Is Natura 2000 involved? □ YES □ NO If yes: □ Species □ Habitats
Annex 3 – Replies to the Questionnaire

Seven participants responded to the questionnaire. Their replies are reproduced below. This overview is of course far from representative of what is going on in EU-member states with respect to the use of remote sensing for biodiversity monitoring. Compiling a more complete overview will be the subject of ongoing and future work.

Respondent: Hans Gardfjell
hans.gardfjell@srh.slu.se

Project title: LIFE08/NAT/S/264, MOTH (http://www.slu.se/moth)
Country/Geographic location: Sweden
Description:
- Terrestrial Annex I habitats, areal coverage, conservation status
- Two-phase method combining manual interpretation of aerial images and field survey of field plots
Surveillance/Monitoring: Monitoring
Natura 2000 involved: Yes – Habitats
Contact: hans.gardfjell@srh.slu.se

Project title: NILS (http://nils.slu.se; http://www.slu.se/nils)
Country/Geographic location: Sweden
Description:
- General landscape monitoring programme
- Grid of 5x5 km plots distributed all over Sweden
- Aerial images, manual interpretation
- Field plots
Surveillance/Monitoring: Monitoring
Natura 2000 involved: Yes – Habitats
Contact: johan.svensson@srh.slu.se

Project title: EMMA (http://emma.slu.se)
Country/Geographic location: Sweden
Description:
Research project developing methods for evaluation of biodiversity measurements using LiDAR
Contact: hakan.olsson@srh.slu.se

Project title: "Change analysis in peatlands" (title to be checked)
Country/Geographic location: Sweden
Description:
- Change analysis in peatlands in Sweden
- Satellite images
Surveillance/Monitoring: Monitoring
Natura 2000 involved: ? – Habitats
Contact: johan.abenius@naturvardsverket.se

Respondent: Lex Comber
ajc36@le.ac.uk

Project title: Land cover map 2007
Country/Geographic location: All UK – Census survey
Description:
- Broad habitats
- Segmented using Ordnance Survey Mastermap
- Medium-scale imagery (10 – 30 m)
- Object-based image analysis (OBIA) → object-level metadata, automatic (with knowledge-based corrections, but different methods)
Surveillance/Monitoring: Monitoring
Natura 2000 involved: Yes? – Habitats
Contact: Dan Morton, Centre for Ecology & Hydrology, Lancaster, UK (danm@ceh.ac.uk)

Project title: Countryside Survey (http://www.countrysidesurvey.org.uk)
Country/Geographic location: UK
Description:
- Sample survey, stratified across biogeographic zones \(\sim 700 \times 1 \text{ km}^2\)
- Field survey/aerial photo interpretation (API)
- Species/assemblages recorded → re-cast into other classifications
Surveillance/Monitoring: Monitoring, since 1978
Natura 2000 involved: Yes? – Species and Habitats
Contact: Centre for Ecology & Hydrology, Lancaster, UK

Respondent: Katie Medcalf
katie.medcalf@envsys.co.uk

Project title: Habitat Inventory of Wales / Mapping peat bogs in Scotland / Mapping Invasive species Wales / Habitat mapping Ireland
Country/Geographic location: Wales, Scotland, Ireland
Description:
- Woodlands: We get to the level of woodland general type → models exist in UK to bring to Annex I
- Heathlands: Well mapped and can be described in various ways
- Grasslands: Can generally get to unimproved grassland types some Annex I are difficult because of lack of detailed geological data. + E.g. grassland well mapped in Galway, Ireland where 1:25.000 geology map, not so well in Wales where geology is too broad to use.
- Bogs: Well mapped / quality and gradation into wet heath is well mapped
- Scrub: Yes (Don't think any Annex I scrub in Wales) → I cannot see a difficulty in monitoring scrub if we need to
- Coastal: Yes, general habitats mapped

Surveillance/Monitoring: Monitoring
Natura 2000 involved: Yes – Species and Habitats

Respondent: Duncan Blake
duncan.blake@snh.gov.uk

Project title: Upland Habitat Inventory
Country/Geographic location: Scotland
Description:
- Pilot study to assess remote sensing techniques (aerial photo & satellite imagery) for creating habitat inventories of BAP priority and Annex I priority habitats. Initially two 20x20 km sample squares.
- Part of the Scottish Surveillance Strategy

Surveillance/Monitoring: Surveillance
Natura 2000 involved: Maybe – Habitats

Respondent: Shelley Hinsley
sahi@ceh.ac.uk

Project title: Remote Sensing Research in the New Forest
Country/Geographic location: England
Description:
- Develop objective and repeatable remotely sensed indicators of woodland condition and habitat status, that will link with measures of biodiversity value (e.g. cover of overstorey and understorey canopy, gap characteristics, canopy heterogeneity, dead wood, regeneration)
- Integrated airborne hyperspectral and LiDAR data
- Investigate 'up-scaling' of measurements from test areas using satellite remotely sensed data
- Investigate additional value of landscape scale ecological variables as indicators for forest habitat status

Contact: Bournemouth University

Respondent: Julian Perdrigeat
julian.perdrigeat@cr-npdc.fr

Project title: ARCH – ‘Assessing Regional Changes to Habitats’
Country/Geographic location: Nord-Pas de Calais (France) and Kent (England, UK)
Description:
ARCH is a ‘Interreg IV A – 2 Seas’ European project, led by Kent County Council in partnership with Conseil régional Nord-Pas de Calais. It aims at mapping natural habitats in both regions, spread up the data to users and update it with remote sensing in a long term view. The project was launched in May 2010 and runs till 2012. Budget is 2.46 Mio €, funded around 50% by the European Union.
Surveillance/Monitoring: Monitoring

Natura 2000 involved: No.

Respondent: Nico Koedam; Vrije Universiteit Brussel (VUB), Faculty of Science and Bio-engineering Sciences
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Project title: Master + PhD research VUB
Country/Geographic location: Greece, Thessaly
Description:
- monitoring ornitho- + herpetofauna
- surveillance landscape elements (“agricultural land”)
- non Natura 2000
- remote sensing: Quickbird
- fieldwork

Surveillance/Monitoring: Surveillance (3x), possibly monitoring in future
Natura 2000 involved: No.

Project title: Master + PhD research VUB
Country/Geographic location: Greece, Wetlands Amvrakikos Gulf
Description:
- surveillance, “retrospective monitoring”, possible monitoring wetland state
- wetland migrant habitat (migration corridor)
- Natura 2000 area + matrix
- remote sensing: ASTER, possibly Landsat, possibly Quickbird/IKONOS
- fieldwork

Surveillance/Monitoring: Surveillance and monitoring (see comment above)
Natura 2000 involved: Yes – Habitats