Ecosystems and Land Use Stakeholders Engagement Group (ELSEG) Workshop Report

Monday 21st January 2019, Victoria Quay, Edinburgh

Purpose

The 2019 ELSEG workshop had three main purposes:

- To discuss progress across the Biodiversity and Ecosystems and the Integrated Natural Assets work packages of the Strategic Research Programme.
- To get stakeholder feedback on research direction.
- To address the request from our Oct 2018 Ecosystems & Land Use Policy Exchange Group (ELPEG) meeting to engage with the topic of 'Land use competition'. In particular, what are the drivers and pressures, and how do we avoid conflicting policies.

Workshop Structure

The **morning** activities outlined the work we have been doing, focussing on two key topics: biodiversity and land use. Each thematic session included three "spotlight" talks, providing examples of current work, followed by short question and answer sessions. Under each thematic session time was also allocated to discuss the work currently underway, as well as future research direction.

In the **afternoon** we considered how research can provide tools to explore and address land use competition. We framed this around four short demonstrations and discussions which delegates had the opportunity to circulate among.

This report provides a record of discussions from throughout the day; the report, including the presentations in an annex, will be circulated to all meeting attendees and made available on the relevant web page: http://www.hutton.ac.uk/research/srp2016-21/elpeg-ecosystems-and-land-use-policy-engagement-group

We would welcome any comments or edits to this draft version before we finalise the report.

Overview

The aim of the workshop was to update stakeholders from organisations with an interest in ecosystem services and land use about progress on our research in the Scottish Government Strategic Research Programme, specifically research on Biodiversity and Ecosystem Services (WP1.3) and Sustainable and Integrated Management of Natural Assets (WP1.4). The discussions provided useful guidance about which specific areas of research could be developed and have identified some opportunities for collaboration. The workshop was a mixture of short presentations followed by discussion groups. Feedback suggested that although some perceived an imbalance between presentations and discussion, many of the stakeholders welcomed the breadth and depth of information. The afternoon demonstrations sessions have indicated how work might be developed to make it more readily accessible for timely information provision for those developing policy post-Brexit. However, the discussions also highlighted a need for training researchers in how policy processes work. Overall, most participants found the event useful and stimulating and all wanted to continue to engage with the research.

Contents

Agenda

Time	Agenda Item
10:30	Registration Tea, coffee and biscuits
11:00	Introduction to the day and overview of the Biodiversity and Ecosystems and the Integrated Natural Assets work packages – Rob Brooker
11:10	**Biodiversity & Ecosystems** Chair: Jenni Stockan Spotlight presentations: • Robin Pakeman – Linking species records to ecosystem function • Katy Hayden – Minimising the biosecurity risk to plant conservation • Philip Skuce – Liver fluke risk to livestock under agri-environment schemes Q&A /discussion
11:50	**Land Use** Chair: Graham Begg Spotlight presentations: • Antonia Eastwood – People and adaptive management of woodland • Paula Novo – Biodiversity governance • Klaus Glenk – Benefits of woodland recreation Q&A /discussion
12:30	**Lunch**
13:30	**Discussion – Land use competition** Introduction to the afternoon session Demonstrations: • Alessandro Gimona – A decision support tool to explore land use change options based on stakeholder's priorities for different land functions • Ilkka Leinonen - Land requirement for sustainable protein production • Kirsty Blackstock – New instruments for multiple benefits • Chen Wang – Forest monitoring via mobile data collection
14:50	Report back and full group discussion
15:10	Wrap up and next steps
15:30	Close

Notes from morning discussions

Rob Brooker gave an overview of the Strategic Research Programme's Natural Assets theme and in particular the overarching questions being addressed within the Biodiversity & Ecosystems and Integrated and Sustainable Management of Natural Assets work packages.

Biodiversity

Robin Pakeman presented on Linking Species Records to Ecosystem Function, Katy Hayden on Minimising the Biosecurity Risk to Plant Conservation and Philip Skuce on Liver Fluke Risk to Livestock under Agri-Environment Schemes.

There was a request to say more about Ecosystem Health Indicators and what we can learn from them: Ecosystem Health Indicators cover a range of data sources that provide information about the state of Scotland's ecosystems. Linking indicators to habitat is difficult because most species records on which indicators are based are available at a spatial scales too large (e.g. mapped only at 10 km or 1 km level) to be related to habitat maps.

The presentation referred to two indicators and the question was raised about the consideration of others. In response, Robin explained that for Bryophytes, nitrogen and summer temperature were the indicators that provided most ecologically relevant information and easy interpretation (winter temperature gave the same information as summer). Despite good statistical models, it proved difficult to interpret some indicators and to make ecological sense of them. For example, the light indicator that measures the change in aggregate light tolerance of the species assemblage, exhibited a decline over time which could be interpreted as a response to more woodland (good) or to grasslands and heathlands becoming rank (bad). A technical question was raised asking about the method linking the species record to an environmental variable at the national scale? Robin provided additional detail setting out the process in which records are averaged within 10 km squares per year and then related to environmental conditions using linear mixed models at the Scotland and sub-catchment level. This two-step approach was necessary as the data are mostly zeros.

In response to her presentation on biosecurity in plant conservation, Katy was asked if consideration is given to risks associated with the transfer of plants into the field during translocation processes (e.g. *Cicerbita* example). Katy confirmed the importance of this and that research into this aspect was planned for the future. The endemic plant pathogen communities are important in evaluating biosecurity risk and it was asked what pathogen communities are present naturally in Scotland? Katy stated that given the absence of historical records it is difficult to know what has been present in the landscape historically, and that there is a current Government-funded project using high-throughput sequencing to better understand *Phytophthora* species in the wider landscape. It was also asked whether there was a strategy to foster conservation in the home countries and if there are strategies for ex-situ collections bringing species into the UK? Katy confirmed that this was explicitly part of the Global Strategy for Plant Conservation and RBGE's goals too. The GSPC strictly emphasizes to use material from the country of origin. At RBGE everything that comes in from a different country is kept in quarantine until cleared. It was noted that the horticulture retail sector often sell sick looking plants and the potential for RBGE to spread its influence to other sectors was queried. In response Katy stated that there are tenders from the Plant Health Centre to look at high risk sectors for communication and knowledge transfer.

In considering the trade-off between conservation and livestock management, Philip was asked whether his research was helping to find a path for compromise. Conversations with landowners help to raise awareness and allow for knowledge exchange to identify tensions and win-wins. Philip noted

however, that it can be hard though to do systematic research on working farms due to changes in farm management practices with little/no warning, this requires good two-way communication between ourselves & farmers/land managers. A question was then raised about fluke transmission and specifically the importance of livestock movement. Philip considered that information on animal movements would be helpful in determining when, how and where animals picked up infection. Some animals never leave the farms, others do, this has obvious implications for farm biosecurity. The potential to use fencing to help to reduce stock access to 'fluky' areas was raised. Philip pointed to practices such as drainage and fencing as ways to reduce the fluke risk to grazing livestock, although the former is increasingly discouraged in favour of some agri-environment schemes. Small-scale tree planting can also help reduce fluky areas on farms.

Land Use

Antonia Eastwood presented on People and Adaptive Management of Woodland (or putting the social into AM), Paula Novo on Biodiversity Governance; Values and Perceptions and Klaus Glenk on Economic Benefits of Woodland Recreation.

Antonia was asked whether she thought the attitudes toward woodland management in the Cairngorms and whether they would be representative of other locations. She replied that they were hoping to expand the work to Cumbernauld which would help answer this question. The role of peer pressure was then questioned. Antonia suggested that the role of peer pressure was important, land owners are very keen to know what their neighbours are doing and then go one better. In general, there is a large element of competition. A question was then asked about the relationship between public goods and adaptive management? It was Antonia's view that the move to delivering more public goods seems to be reflected by the ability, capacity and resources of land owners, it being more difficult for poorer land owners to make changes and bridge gaps.

In response to the presentation of Biodiversity Governance, Paula was asked whether there was any way to cross check what land owners *think* is driving decision making with reality? Paula's view is that it is difficult to answer at this stage as they have mainly used SG and organisations (e.g. RSPB) but not farmers/land owners. It is something they will consider in the future. It was also queried whether views are dependent on demography or region? This has been mentioned in workshops but at responses too variable to draw any conclusions. In considering how attitudes might change Paula was asked if marketing people/companies had been approached for input; should we be looking to learn something from large companies (e.g. coca cola) about how to change people's perceptions? Paula noted that some work is being done on this in other contexts but not within this piece of work. It does raise ethical concerns.

In considering the Economic Benefits of Woodland Recreation, Klaus was asked whether he could compare perceived and actual naturalness of woodlands? In response, Klaus said that there were strong correlations with some features of naturalness, e.g. forest structure, but in general there is not enough information available for all the forests. The potential of subjects to accurately score naturalness was also discussed, including the influence of the specific context provided by individual forests that were visited and the heterogeneity of that forest.

Notes from afternoon demonstration groups

A decision support tool to explore land use change options based on stakeholder's priorities for different land functions

Alessandro Gimona (presenter); Alice Hague (facilitator); Laure Kuhfuss (notetaker)

The objective of this session was to gauge stakeholders' interest in the adaptation and use of a land use planning decision support tool that was initially developed for the Lake District national park. Based on local stakeholders' inputs, the tool combines maps of land functions and suggests locations for land use change to achieve specific environmental objectives, under set constraints. It provides alternative solutions that can then be used as a support for discussions in the local land use planning arenas by mapping the trade-offs between alternative land uses. Stakeholders perceived the tool as being potentially very useful in several alternative locations in Scotland, especially as a stakeholder engagement tool providing scientific basis for discussions as well as way to illustrate the potential environmental outcomes of current trends in land use changes (reduction in sheep farming), for targeting policies or as part of the approval process of applications to current schemes (e.g. woodland scheme). Useful additions to the tool would be to include data and maps of economic (benefits and costs) of land use changes and potential employment consequences. Users are actually free to add any data they have, including their own modelling outputs, as additional input to the tool, making it flexible to users' needs.

Land requirement for sustainable protein production

Ilkka Leinonen (presenter); Davy McCracken (facilitator); Alistair McVittie (notetaker)

This demonstration considered the issue of protein production and the potential for Scotland to meet its human dietary protein requirements through home-grown plant sources. Globally, the production of plant protein is dominated by four crops: soybean, maize, wheat and rice. A large proportion of these crops are used as livestock feed. Crops such as peas and beans are a relatively small part of protein production. A key issue with plant protein is that it is not a complete source of essential amino acids. Lysine, in particular, is found in very low levels in cereals, but is high in animal-based proteins. Soybeans are comparable with meat, but production is concentrated in North and South America, with three countries, Argentina, Brazil and the United States accounting for 80% of global production. This leads to potential food security concerns.

The research demonstrated that the land needed to produce human lysine needs through the cultivation of peas and beans in Scotland is approximately equal to the land currently used to grow human edible plant protein (e.g. feed grains) for cattle to produce an equal amount of animal-based lysine. Therefore, Scotland is not constrained by land capability to grow sufficient plant-based protein for human needs through shifting production from animal feed to peas and beans.

Discussion of this result touched on a number of themes:

There is a strong cultural attachment to livestock production in Scotland. Shifting consumption away from livestock protein would have considerable impacts on farming communities, land use and land values.

Consumer attitudes would also need to change considerably, both to overcome existing over-consumption of protein and to avoid substitution of home-grown protein with imported sources. That

is, if Scotland reduced production of animal protein, without changing consumer attitudes, it would simply be imported from elsewhere.

Reducing the variety of protein sources, and concentrating production on a small number of crops and a limited area may also have food security implications.

The analysis only considered land use change. However, there will also be important greenhouse gas impacts from shifting protein production from animal to plant sources. It was noted that cattle production could be more efficient in land use terms if grazing was supplemented with the use of distillery by-products, however, these are increasingly being diverted to renewable energy production.

Wider impacts were also recognised. Increased cultivation of peas and beans would require pollination and the need to ensure adequate pollinator habitats. The production of nitrogen fixing crops would also reduce nutrient inputs with potential benefits for water quality.

New (private sector) instruments for multiple benefits

Kirsty Blackstock (presenter); Antonia Eastwood (facilitator); Paula Novo (notetaker).

The session started with an overview of the role of the private sector in developing instruments (investment, management or information) that have the potential to conserve or restore natural capital. The question was whether these instruments could be used in the Scottish land-based sector. This was followed up by some questions and a discussion. The main points raised by participants across the two sessions held are:

- There is a lot of interest in investing more in land management, but businesses need to have a better understanding of what the tangible (multiple) benefits to their businesses are.
- More companies focusing now on stewardship. Peer-pressure, information disclosure and sustainability ratings are important drivers for this.
- When it comes to farmland, it is so dominated by agricultural subsidies that it's hard for mechanisms such as the Peatland or Woodland Carbon Codes to have an impact. Also, many investment opportunities require large parcels of land and capital instruments to reduce transaction costs.
- Drivers for private investors to get involved in the land-based sector aren't always economic. Some pointed out that sometimes it's difficult to find what's driving the private sector involvement. Reputational and supply chain risks are two of the main drivers for multinationals, but these may not be the same for smaller companies.
- Investment is generally about capital funding, but revenue for ongoing management activities was highlighted as a key challenge for conservation.
- Internationally, the UK is lagging in getting real engagement the private sector. There are too many once off instances or discussions but not a sustained change in how business invests in natural capital (unlike in US, Netherlands or France).
- In some cases, decisions to invest sit within an individual which was seen as risky from a longer-term perspective.
- A long-term legal framework is needed for businesses to see where they would fit and enable their business planning.

- There is a lack of evidence about whether these instruments do lead to a change in environmental outcomes – this may be because firms haven't shared these data in the past – and also because monitoring to illustrate outcomes is challenging.
- There is a potential to transfer private instruments to land-based industries, but it would be important to have a better understanding of the factors that may inhibit this transfer, what would be the barriers and how policy makers could incentivise this transfer.
- In terms of the categorisation proposed, it might be helpful to check with private businesses how they would categorise the different instruments.
- Insurance firms as investors in natural capital approaches; and differential insurance premiums needed to be made more explicit in the list of instruments.

Forest monitoring via mobile data collection

Chen Wang presented on Forest monitoring using mobile data collection. He described the Open Data Kit which is a suite of tools to help data organizations and can be custom-designed for specific purposes. It is designed to work on any mobile system and a wide range of data can be entered such as text, photos, video, historic records and updates. This has been trialled at two study sites to date and will be publicly available following publication. Further work will explore another pilot site and move to 3D visualisation, e.g. looking at other habitats/environments such as buildings, 3D scenarios under woodland expansion and what would the landscape look like.

The discussions that followed explored potential users of the technology and overlap with other mobile recording apps.

Participants could see that this technology might be useful for local community groups, people reporting problems such as pathways, broken gates, fungal infections. Vice versa, land owners could communicate management plans for the forest, e.g. clear-fell. Other uses identified were forestry workers, general public, estate agents (3D scanning of buildings), botanic gardens to spot plant health problems and to collect data over time. Potential for scientists to use it to collect data to save on data entry, or to take automated measurements e.g. light measurements, vegetation cover.

Given that there is already a wide variety of mobile recording apps (e.g. inaturalist, irecord, ispot, myforest), participants discussed possible integration and questioned whether anyone was using EU citizen observations to do something similar that could be tapped into.

Presentations from the day

See appendix 1.

Feedback received from participants

Feedback forms were received from 1 researcher, 10 stakeholders and 1 unknown.

Overall, these respondents found the meeting useful or very useful. The reasons given were that it was informative, providing a good overview of relevant work. They also felt it allowed them to identify who to talk to about specific work and an opportunity to network and make contacts.

The facilitation, format and quality of interaction were generally rated good or very good. There were comments requesting both more time for presentations and more time for discussion. We will again

review the format for the next meeting. There was also useful feedback around ensuring a more structured and focussed debate on the main theme of the meeting.

Most respondents agreed, or strongly agreed, that the meeting had: given them new knowledge about the Strategic Research Programme, helped them understand how the research might benefit them; believe the information they provide will be used; and would like to attend future meetings.

In terms of future participants, respondents suggested inviting those organisations listed below. Most of these were invited but were unable to attend. However, those highlighted were not on our mailing list and will be added for the next meeting.

- Farming interests
- Crofters
- LEAF
- NFUS
- Policy makers
- Scottish Land and Estates
- Representatives from community buy-outs of land.
- National Trust Scotland
- RSPB
- Local authorities
- Local government representatives/policy officers
- National Park Authorities
- SE Link/NGOs
- HBRG/recording community
- Scotland's Moorland Forum
- Business interests

Appendix 1 - Presentations

The following pages show the meeting presentation slides

Ecosystems and Land Use Stakeholder Engagement Group (ELSEG) 2019 Meeting

Rob Brooker, Theme Lead, Natural Assets Theme

Scottish Government
Riaghaltas na h-Alba
gov.scot

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LEADING IDEAS
FOR BETTER LIVES

Aims for today

- To discuss progress across the Biodiversity and Ecosystems and the Integrated Natural Assets work packages of the Strategic Research Programme.
- To get stakeholder feedback on research direction.
- To address the request from the Oct 2018 Ecosystems & Land Use Policy Exchange Group (ELPEG) meeting to engage with the topic of **'Land use competition'**. In particular, what are the drivers and pressures, and how do we avoid conflicting policies.

Structure

Morning -

- Outline the work we have been doing, focussing on two key topics: biodiversity and land use.
- Each thematic session includes three "spotlight" talks, providing examples of current work, followed by a short Q&A session.
- Also time allocated to discuss the work currently underway, as well as future research direction.

Afternoon

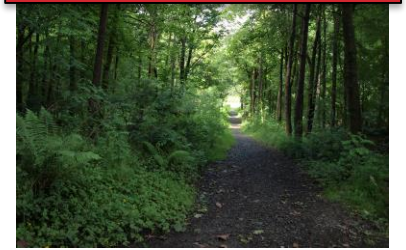
- Consider how research can provide tools to explore and address l**and use competition**.
- Frame this around four short demonstrations and discussions which delegates will have the opportunity to circulate among.
- Keep a record of discussions throughout the day; will be made available after the event as a meeting report; will be circulated to all meeting attendees and made available on the work package's web pages.

Natural Assets Theme

1.1 - Soil

1.2 – Water resources and flood risk management

1.3 – Biodiversity and ecosystems



1.4 – Integrated and sustainable management of natural assets

Overarching questions

1. Function, health, and safe limits for Scotland's natural assets;
2. Measuring and managing for resilience (incl. Climate change)
3. Benefits: assessing and managing trade-offs
4. Improving the management of natural assets
5. Integrated management for delivery of ecosystem services

ELPEG/ELSEG

Biodiversity and Ecosystems and Integrated Natural Assets Work Packages

WP 1.3 (B&E) – Understanding the processes contributing to the functioning and resilience of our natural assets, in particular biodiversity; developing approaches for focussing and delivering sustainable land management actions; new metrics for monitoring ecosystem health and services.

WP 1.4 (INA) – Systematically monitoring and accounting for ecosystem services in Scotland; Identifying and understanding multiple benefits and trade-offs; Developing practical interventions to realise multiple benefits and manage trade-offs.

ELPEG/ELSEG

Joint engagement activities to help steer research work within 1.3 and 1.4 and

ELPEG – Ecosystems and Land Use Policy Engagement Group

ELSEG – Ecosystems and Land Use Stakeholder Engagement Group

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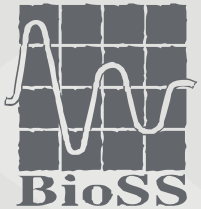
Collective name for…



THANK YOU

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Scottish Government
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Linking species records to ecosystem function

Robin Pakeman & Rob Brooker (JHI)

David O'Brien & Dave Genney (SNH)

The James Hutton Institute

Sphagnum magellanicum
(10 km records)

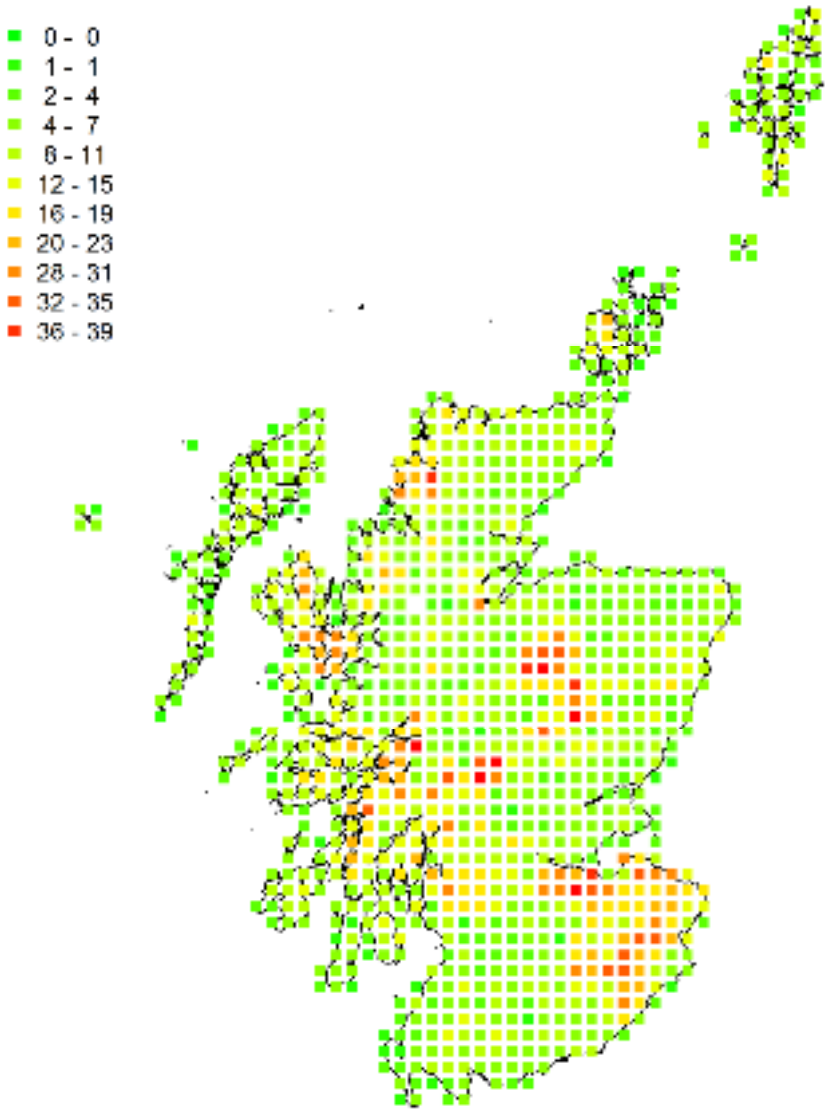
Bryophyte data

The James Hutton Institute

- > 0.5 M individual records in the National Biodiversity Network for Scotland
- Records date back to the 17th century
- But records are patchy over time
- Challenge – to develop an Ecosystem Health Index

Bryophyte data (2)

- Years post 1960 with any records

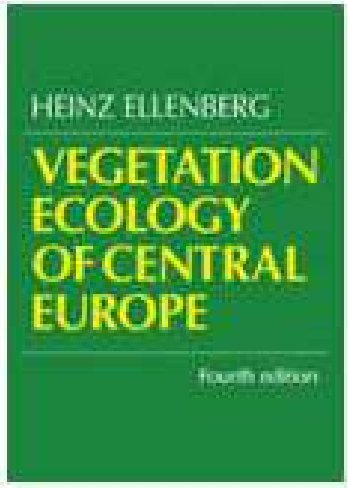


The approach

- Looking at species richness or changes in individual species would be highly problematic
  - Obvious differences in recorder effort
  - Little repetition of records through time
- Better to ignore species and focus on their "traits"

The approach (2)

- Heinz Ellenberg (1913-1997)
- Developed a set of indicators about species' preferences (vascular plants only)



- Mark Hill extended this to British bryophytes in BryoAtt

The approach (3)

- An example – your common lawn moss

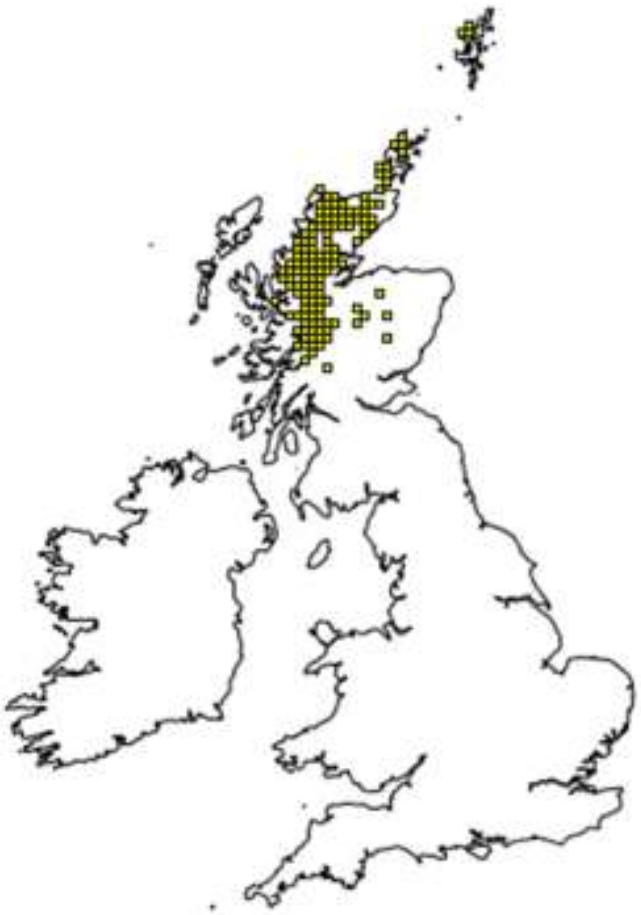
	L	F	R	N
Rhytidiadelphus squarrosus	7	5	5	4

- L = Light (1-9)
- F = Moisture (1-12, but aquatic species 10-12 removed)
- R = Reaction/pH (1-9)
- N = Nitrogen/fertility (1-9)

The approach (4)

- BryoAtt also has similar data for climate
- Mean January temperature (°C) of 10 km squares where a species has been recorded
- Mean July temperature
- Annual precipitation (mm)

The approach (5)



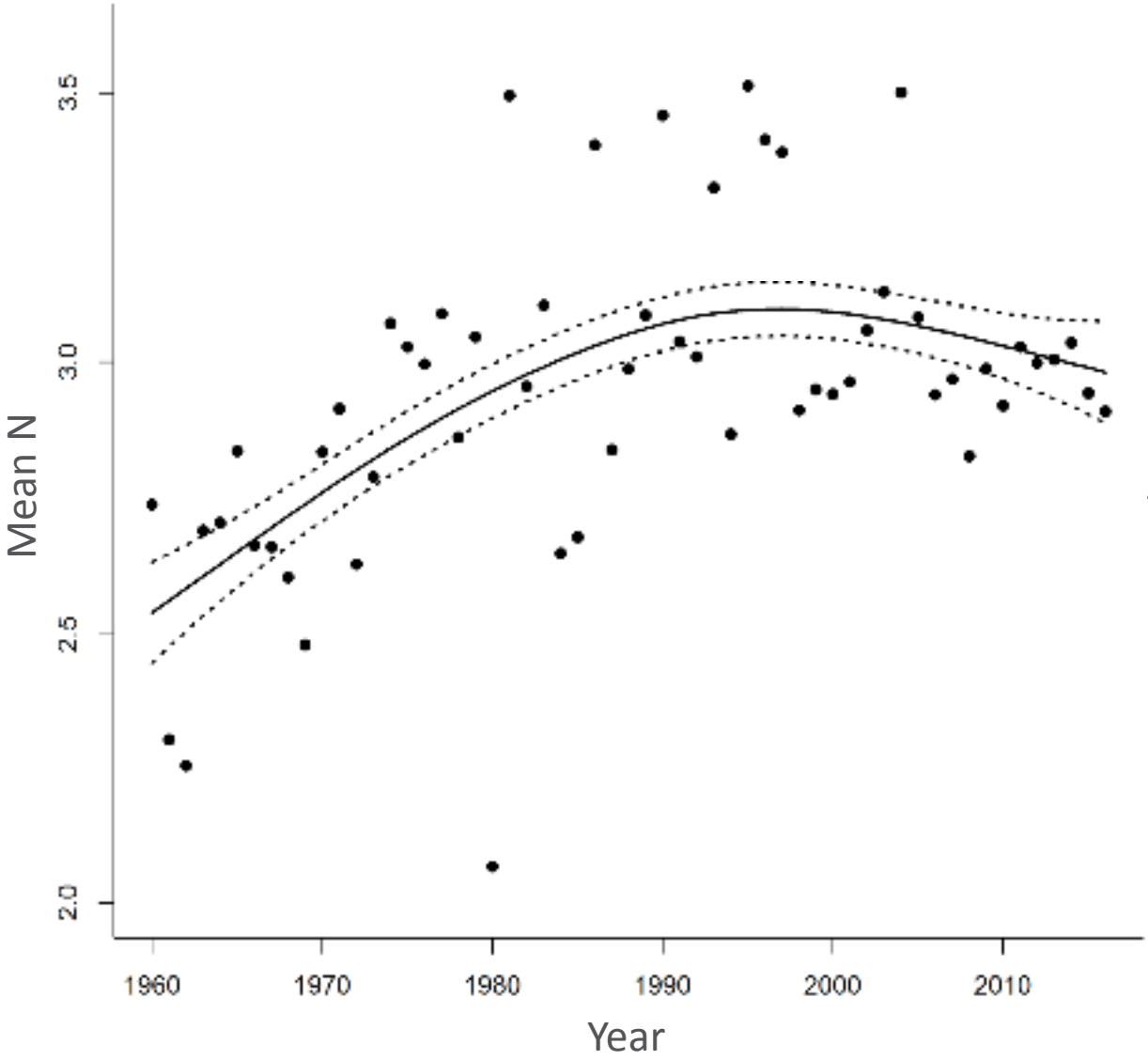
Cirsium acaule *Arctostaphylos alpinus*

3.7	Tjan (°C)	1.6
16.1	Tjul (°C)	11.6
742	Prec (mm)	1750

The method

- Convert each species record into indicator values
- Calculate mean indicator value for each 10 km square for each year
- Scotland or sub-basin value calculated as the mean of these mean indicator values

The results - Nitrogen



MOS test*, hump at 1996.5, p = 0.015

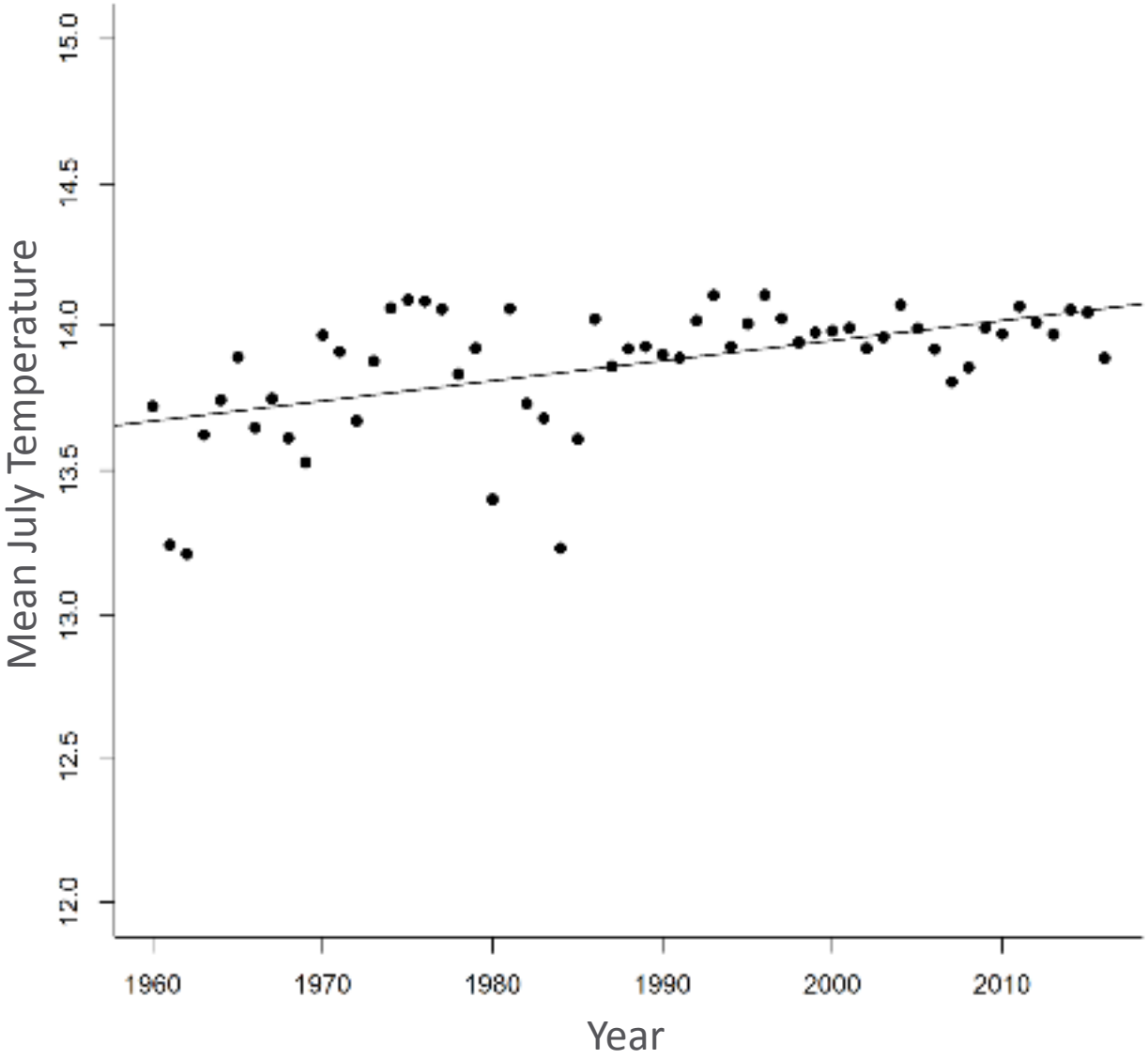
*Tests for the peak/trough to be inside the x-axis data range

Fitted line from Generalised Additive Modelling (GAM)

Interpretation - Nitrogen

- Recovery from nitrogen deposition? Peaked in 1990.
- For farmed habitats it may represent a reduction in fertiliser use – but probably not that important for this dataset

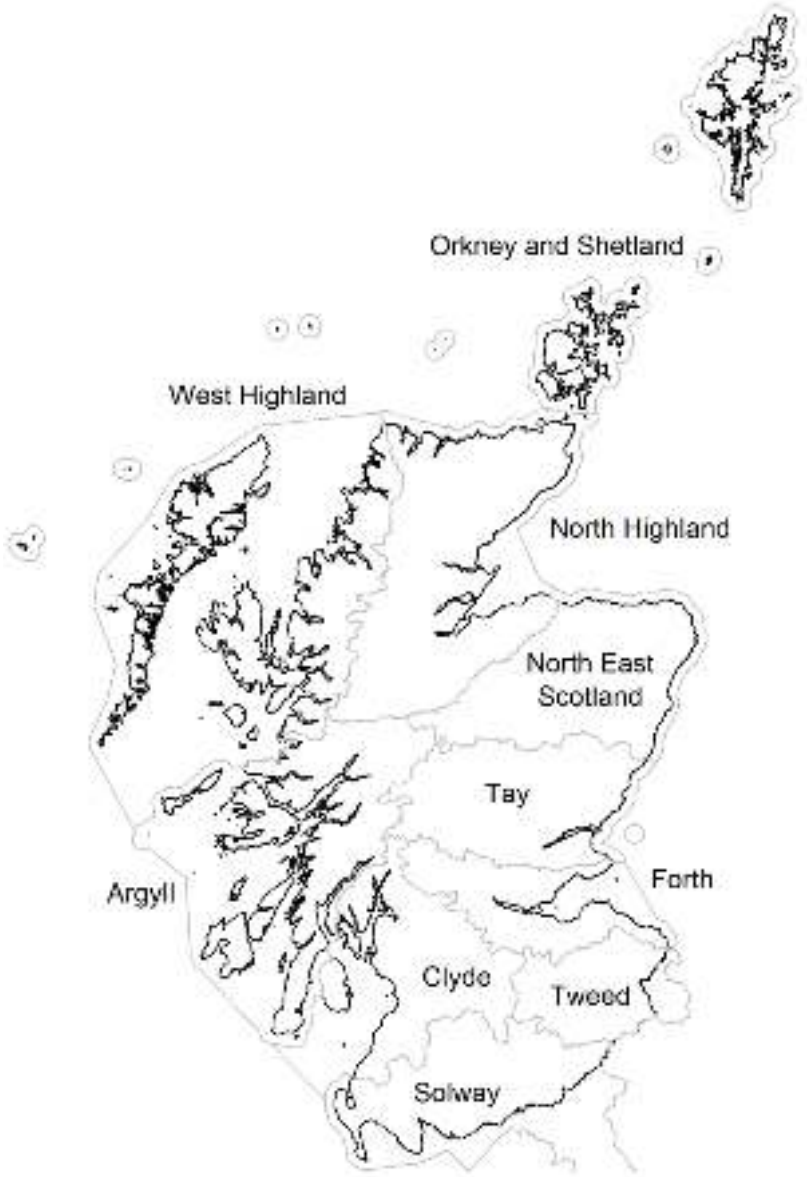
The results – July Temperature



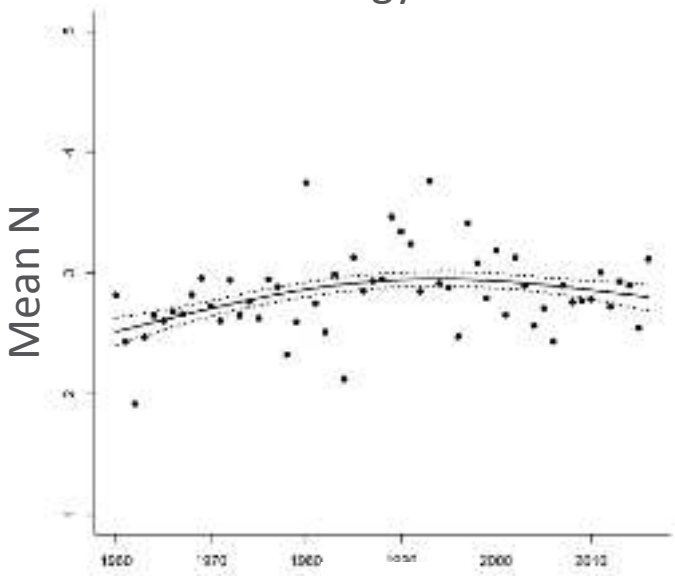
Interpretation - Temperature

- Tracking rising temperature

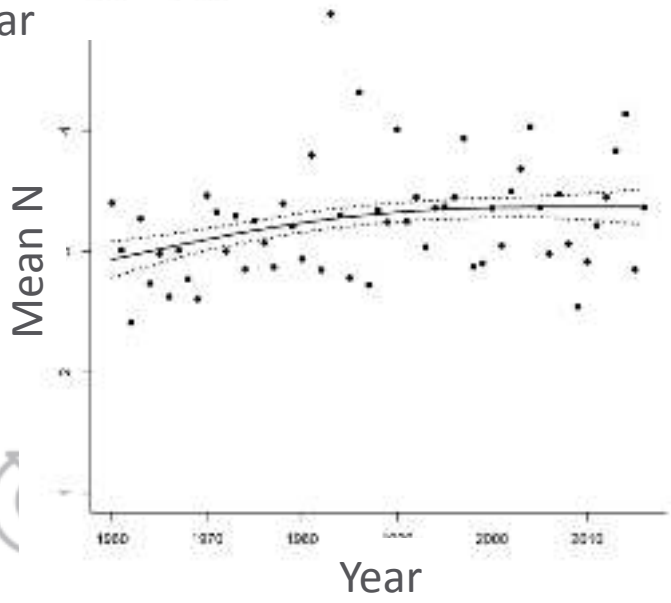
Sub-catchments (examples)



Argyll



Tweed



Conclusion

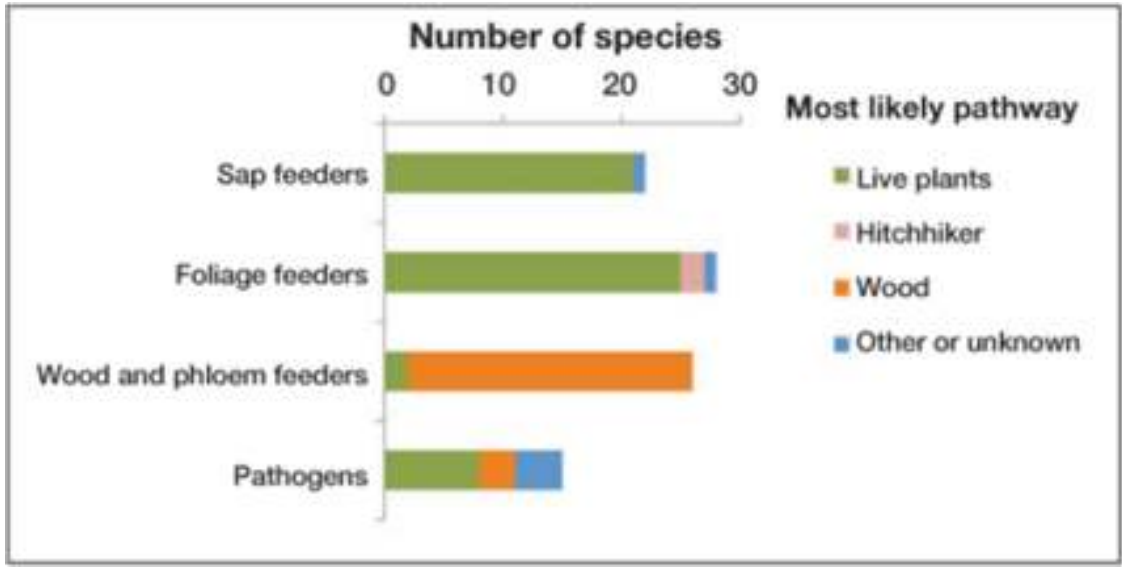
- Nitrogen appears to be a robust indicator of the impacts of nitrogen deposition
- Climate indicators are all highly correlated – July temperature indicator easier to present
- Indicators are down-scalable to catchment and habitat, but power to detect change is limited for some areas/habitats

Royal Botanic Garden Edinburgh

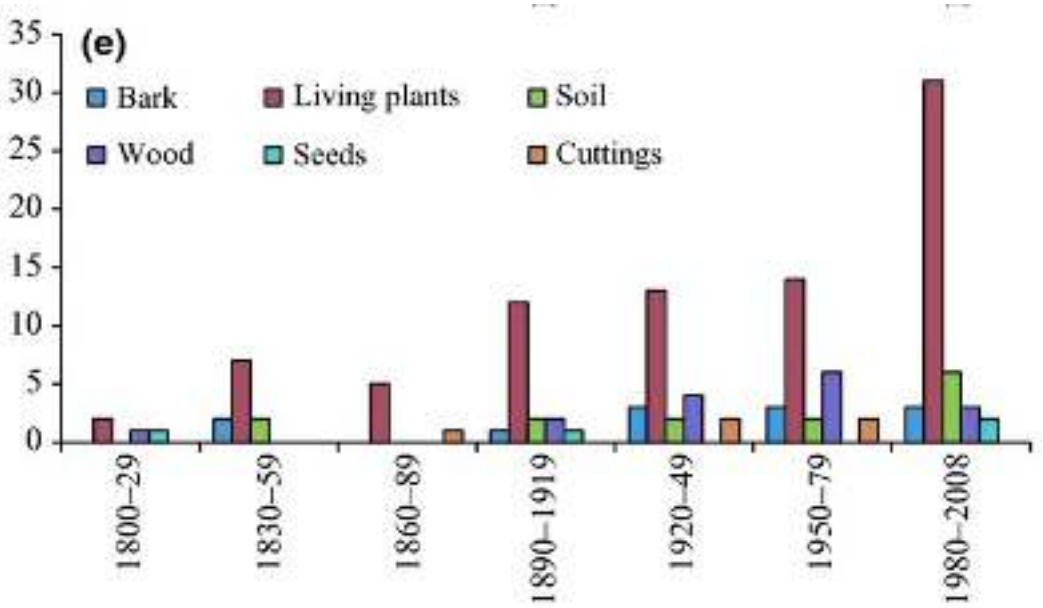
Katy Hayden
khayden@rbge.org.uk

Minimising the biosecurity risk to plant conservation

Live plant imports are the primary pathway for forest pest and pathogen invasions



US, by pest type



Europe, by year

Liebhold et al 2012, Frontiers in Ecology and the Environment Volume 10, Issue 3, pages 135-143, 5 MAR 2012 DOI: 10.1890/110198

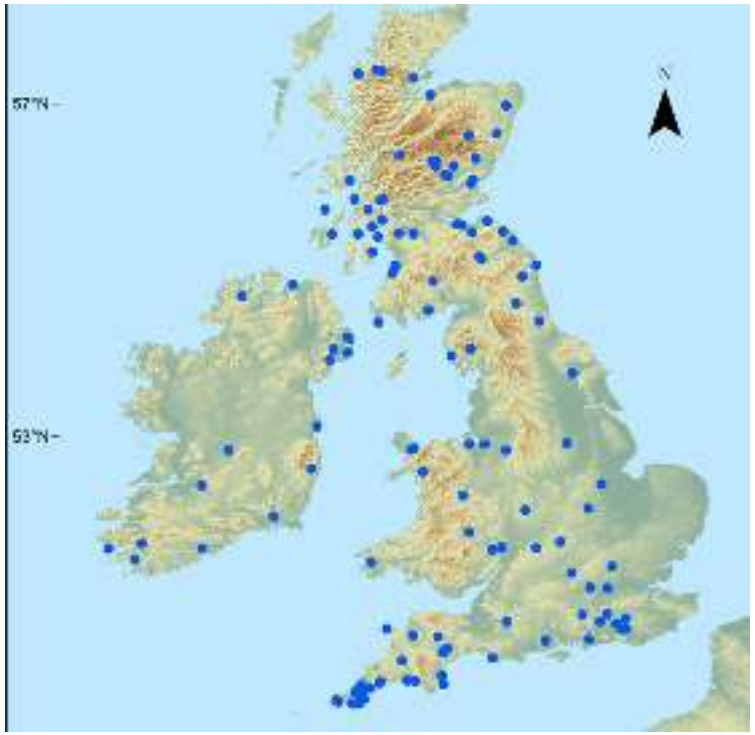
Santini et al 2013 New Phytologist, Volume: 197, Issue: 1, Pages: 238-250, First published: 11 October 2012, DOI: (10.1111/j.1469-8137.2012.04364.x)

Special challenge for *ex situ* conservation…and the Strategic Research Programme

- Impossible to propagate plants without sometimes also propagating plant pathogens
- Pests and pathogens are most dangerous when established in new locations
- Collections-based research and translocations— including re-introductions—are critical to plant conservation and are a key part of WP 1.3.1, Biodiversity and Ecosystem Functions
- Biosecurity and understanding pathogen transmission is a key part of WP 1.3.3, Resilience of Ecosystems and Biodiversity

International Conifer Conservation Programme

- 170 sites with
- 13000 plants
- more than 150 threatened taxa



Cicerbita alpina (Alpine sow thistle) translocation programme

- Nationally rare
- Restricted to 4 sites in the Cairngorms
- Conservation action plan
  - Monitor existing populations
  - Establish new populations in suitably inaccessible areas

Using RBGE as a laboratory to understand distribution and transmission of cryptic pathogens

- Testing for *Phytophthora* pathogens in soil, asymptomatic, and symptomatic plants
- Routine monitoring, surfaces and materials in propagation nursery
- Soil and roots of healthy-looking plants before distribution from RBGE, e.g. for ICCP or *Cicerbita* translocation programmes
- Reactive testing, rhizosphere of diseased plants
- Longitudinal monitoring, systematic sampling soil in garden and nursery

Why *Phytophthora*?

Water moulds and a high-risk pathogen

- 160+ species
- Wide host and/or ecological range
- Prefer mild, moist environments
- Propagules prolific and easily dispersed
- Cryptic presentation
  - Persistence/reproduction on asymptomatic hosts or in environment

Bellwether for any cryptic pathogen

Pear baiting for *Phytophthoras*

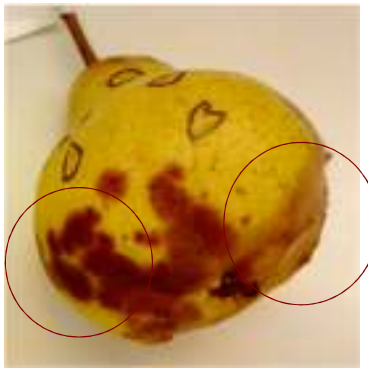
Bellwether for cryptic soil pathogens

Set unripe, green pears in plant runoff or soil-water mixture

3-7 days at 18-20°C

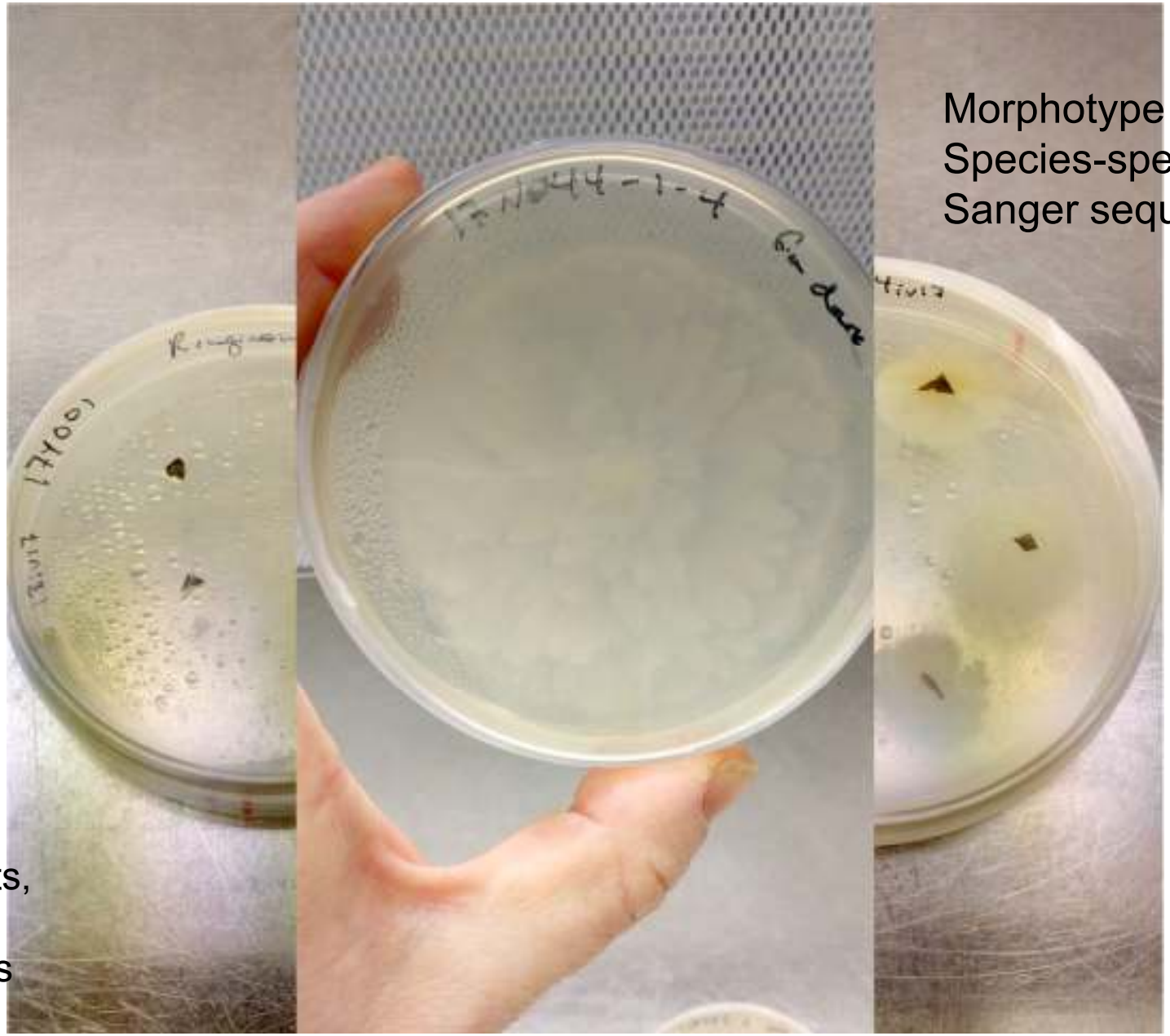
\-

Phytophthora



\+ *Pythium*

PARP selective media



Morphotype
Species-specific PCR
Sanger sequencing

Pro

- Low tech
- Course grain sample
- Viability assay

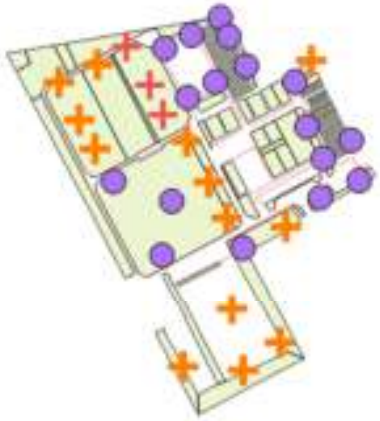
Con

- Miss specialists, slow-growers, special triggers

Systematic monitoring: longitudinal dataset

Monitoring points
~20 m grid
First 2 sets
In 2018

Early data
May-Jun 2018
As expected



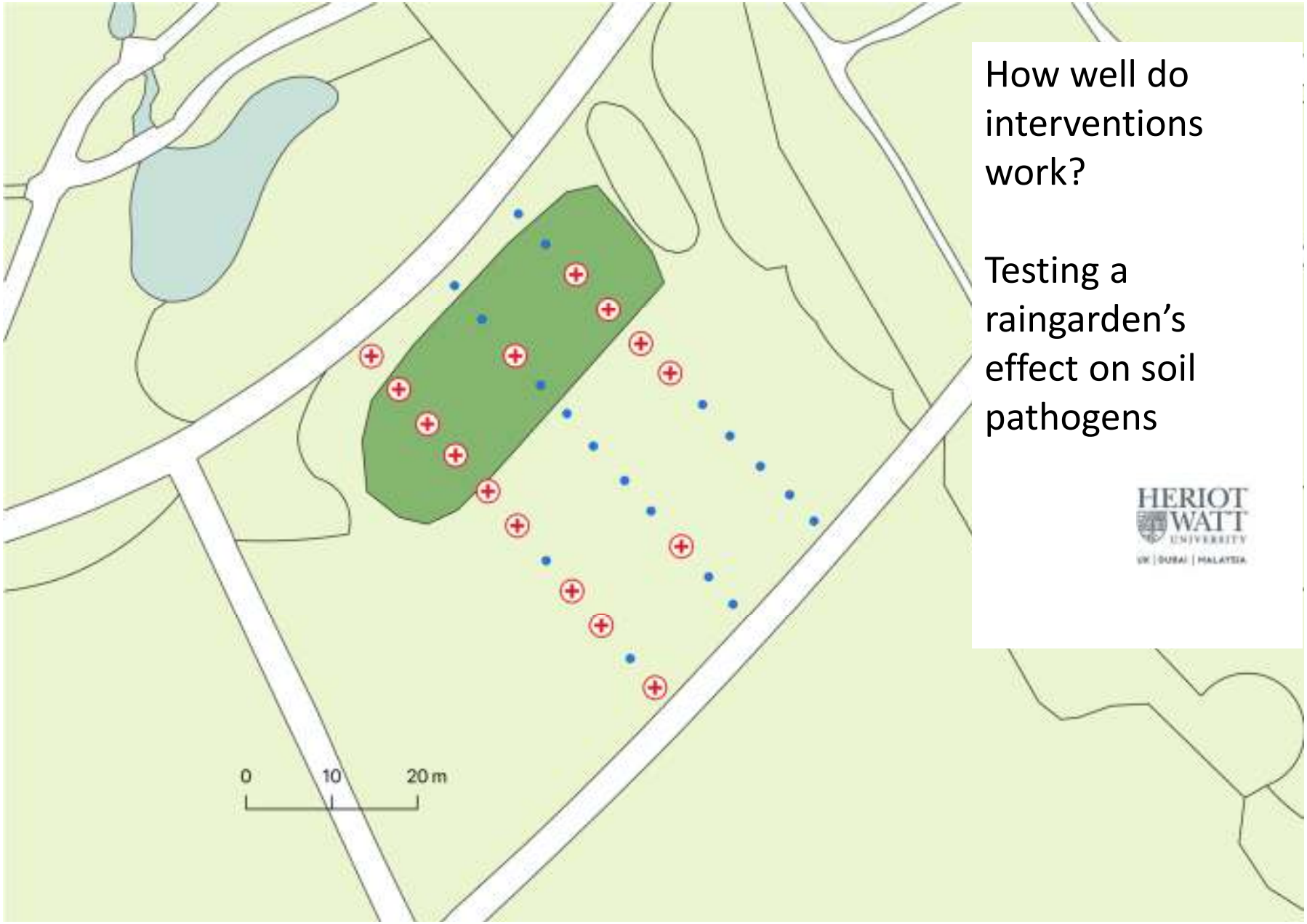
Nursery
21 isolations
13 morphotypes
Incidence 34.3%
Shannon index = 2.85

Garden
16 isolations
10 morphotypes
Incidence 31.6%
Shannon index =2.22

How well do interventions work?

Testing a raingarden's effect on soil pathogens

HERIOT WATT UNIVERSITY
UK | DUBAI | MALAYSIA



How well do interventions work?

Testing a raingarden's effect on soil pathogens

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Phytophthora detections 2017-2018

Programme	Batches	~N plants	Interceptions	Rate
Cicerbita	39	<390	2	5%
ICCP	147	<655	7	5%
Other distribution	55	<275	3	5%
Reactive	20	20	5	25%
Routine nursery surfaces	60	Soil	22	37%
Systematic nursery	77	Soil	22	29% (23-34%)
Systematic garden	134	Soil	27	42% (23-51%)

Conclusions:
Biosecurity research at RBGE

- Key part of continuity of delivery of global conservation targets, e.g. Target 8 of BGCI Global Strategy for Plant Conservation (GSPC)
  - At least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin
  - at least 20% available for recovery and restoration programmes
- Interactions with Scotland's Plant Health Centre
- Communication—with industry and the public
  - Trainings and workshops e.g. with Botanic Garden Education Network, PlantNetwork, Plant Heritage
  - SEFARI Gateway-funded interactive exhibit

Acknowledgements

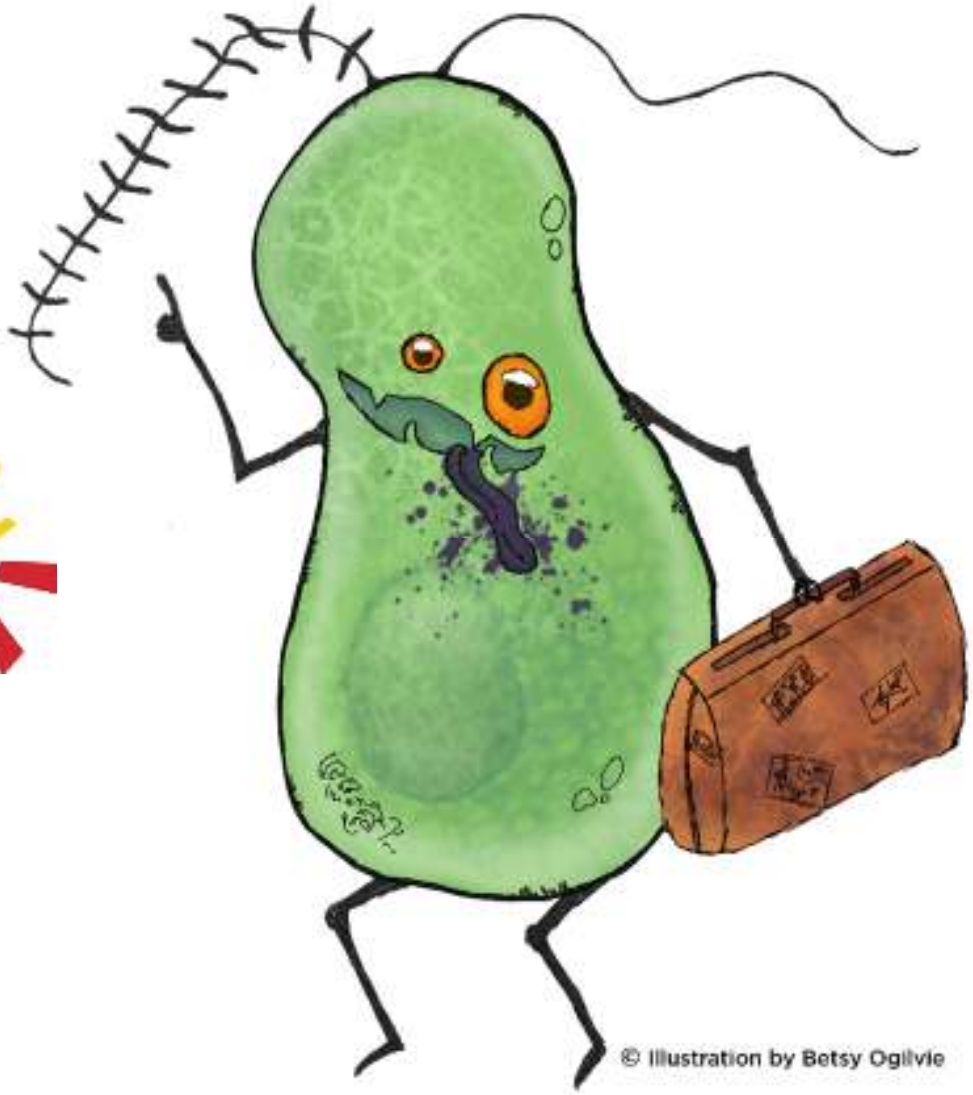
The Royal Botanic Garden Edinburgh is supported by the Scottish Government's Rural and Environmental Science and Analytical Services Division.

The Scottish Government

SEFARI

International Plant Sentinel Network

Euphresco



Liver fluke risk to livestock under agri-environment schemes

[RD1.3.3; 1.4.3, link to RD2.2.6]

Philip Skuce, Moredun Research Institute

ELSEG meeting, Victoria Quay, 21st Jan 2019

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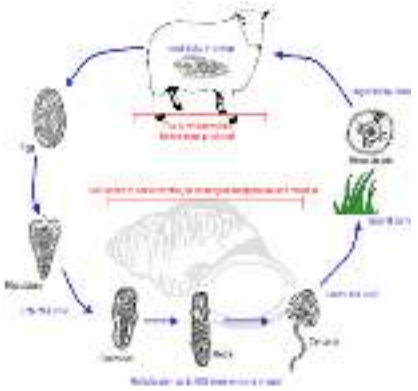
Moredun

SEFARI
LEADING IDEAS
FOR BETTER LIVES

Background

- Liver fluke – highly pathogenic flatworm parasite of grazing livestock
- Complicated life-cycle involving tiny mud snail intermediate host, fluke typically found on poorly drained boggy ground
- Some agri-environment options promote grazing of wetland areas for other environmental benefits
- Perceived reluctance amongst livestock farmers to engage in such schemes for fear of increasing liver fluke risk to their livestock



Approach

- Attempt to quantify fluke risk to grazing livestock under 3 different agri-environment scheme options
- Sampling ~monthly, determine fluke infection status of animals grazing these areas using non-invasive FEC methods
- Determine species ID and fluke infection status of collected snails by PCR/DNA sequencing
- Overall objective to provide an evidence-base to help formulate best practice advice to farmers & land managers

1. Conservation grazing of protected Natterjack Toad habitat

- NJTs protected species, only breeding population in Scotland at Caerlaverock Estate on Solway Firth
- Conservation grazing helps maintain short grass and open areas favourable for NJT hunting & breeding – fluke risk to livestock?
- Stock going onto merse (saltmarsh) infected with liver fluke and rumen fluke. New Zealand mud snail dominant species, known to act as liver fluke intermediate host, but no +ve snails identified as yet – currently investigating ability of fluke stages (eggs & cysts) to survive in Solway water
- Work in collaboration with SNH Project Team & ARC-Trust; planning to meet with Emma Harper, MSP & NJT Species Champion and local land managers to discuss project progress

2. RSPB Wader scrapes at SRUC H&MRC, Kirkton & Auchtertyre

- Wader scrapes introduced to promote feeding and nesting sites for key wetland birds e.g. curlew, lapwing, snipe, oystercatcher, which are in serious decline, nationally
- Grazing essential to keep vegetation down for nesting habitat, as well as to maintain muddy areas to promote invertebrate food supply for chicks – fluke risk to livestock?
- Results to date – fluke detected in livestock & snails in in-bye fields, none as yet in wader scrapes – deer samples fluke +ve, snails infected with fluke parasite of wetland birds inc. cysts in the water!
- Work in collaboration with SRUC, Soil Association & RSPB

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SRUC

Soil Association

rspb giving nature a home

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3. Liming experiments at GWCT Demonstration Farm, Auchnerran

- Raising pH of managed grassland can improve sward productivity and benefit invertebrate food supply for wading birds – ongoing JHI liming experiments, S. Newey et al.
- Mud snails also likely to benefit from approaching neutral pH – fluke risk to livestock?
- Snails collected from 14 sites 2017 to 'map' the farm, 2 of these are liming areas - 5% of *Galba* snails fluke +ve, big reduction in snail numbers 2018 due to exceptionally dry summer, PCR screening in progress
- Work in collaboration with JHI & GWCT

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Game & Wildlife Conservation Trust

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‘The Marvellous Mud Snail Project’

- Approached by RZSS, Buglife Scotland & SG AH&W
- Programme to release captive-bred pond mud snails, *Omphiscola glabra*, into marginal farm land
- Protected species, but known to act as intermediate host for trematode (fluke) parasites
- Screening collected snails from livestock farm sites – negative for both liver fluke & rumen fluke to date, but infected with other trematode parasites of frogs, birds etc.


It’s a bug’s life for politicians

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buglife Scotland

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Outputs & KE to date

- Interim progress reports submitted to SNH, RSPB, Arc-Trust
- 'Worming your way to profit' Soil Association on-farm event, SRUC Kirkton, 7th July 2017
- Joint Moredun/Hutton/GWCT 'Land management to benefit livestock farming and wildlife conservation' on-farm event, Auchnerran, Nov 6th 2017
- Caerlaverock Land Managers' meeting, Saville's, Dumfries, Dec 2017
- Guest blog on Soil Association website
- 'Fluke risk and agri-environment schemes' poster for Glensaugh Stakeholder event, 15th Sept 2017
- Liming study featured on GWCT website and associated P&J article
- Work presented at World Association for the Advancement of Veterinary Parasitology (WAAVP) Congress, Kuala Lumpur, 4-8th Sept, 2017
- Poster prize (Delegates' Choice) at Scotland's Biennial Land Use and Environment Conference XII, 28-29th Nov 2018

THANK YOU

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Adaptive management and woodland expansion *(or putting the social into AM)*

Antonia Eastwood, Anke Fischer and Alice Hague

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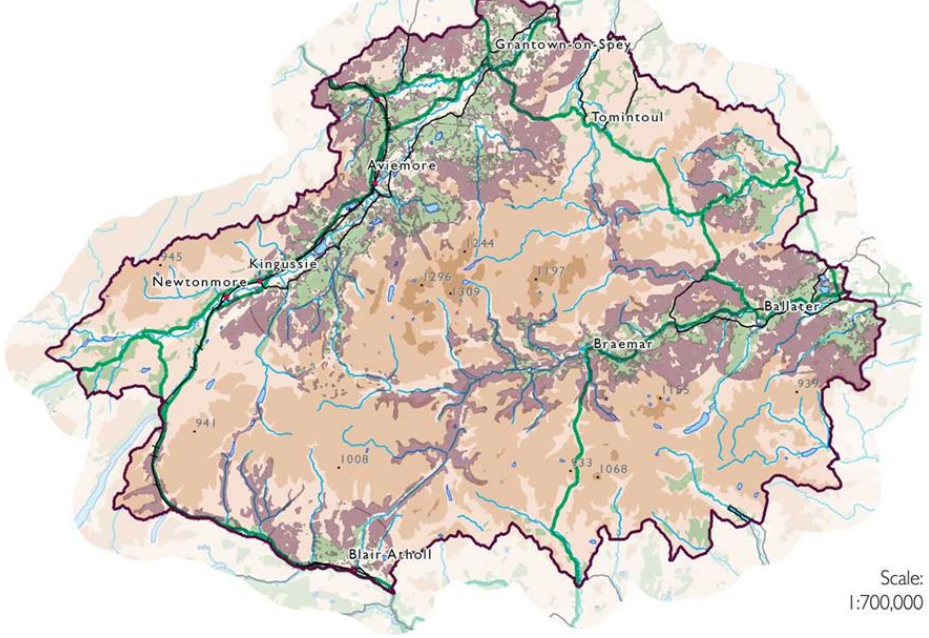

Areas of woodland and potential woodland expansion in the Cairngorms National Park

- Woodland expansion
- Peatland restoration
- Natural Flood Management
- River restoration
- Deer and moorland management

A changing environment …

- Greater importance of managing land for the public interest and public goods
- Delivery of multiple benefits; collaboration of land owners across landscapes

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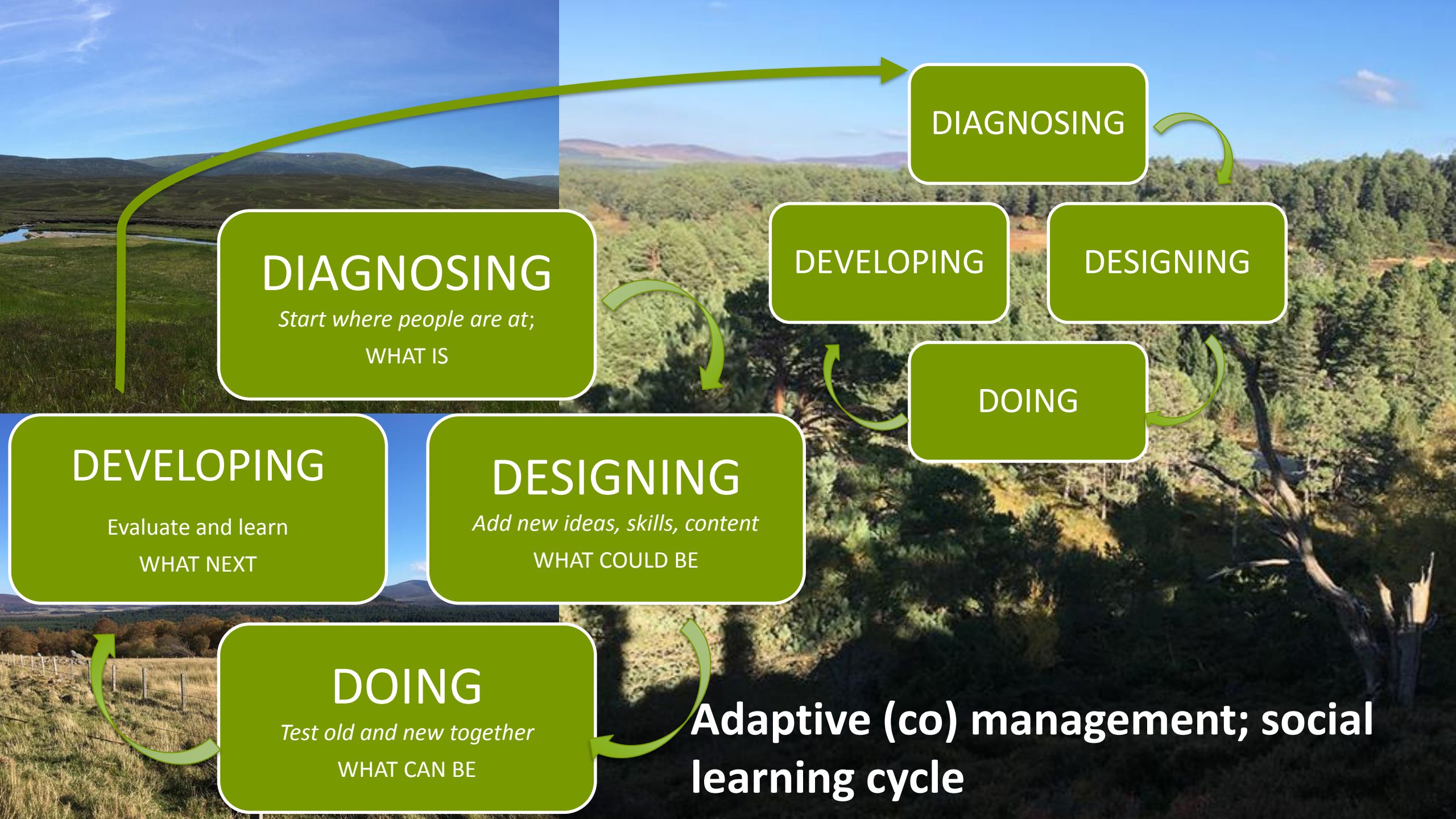
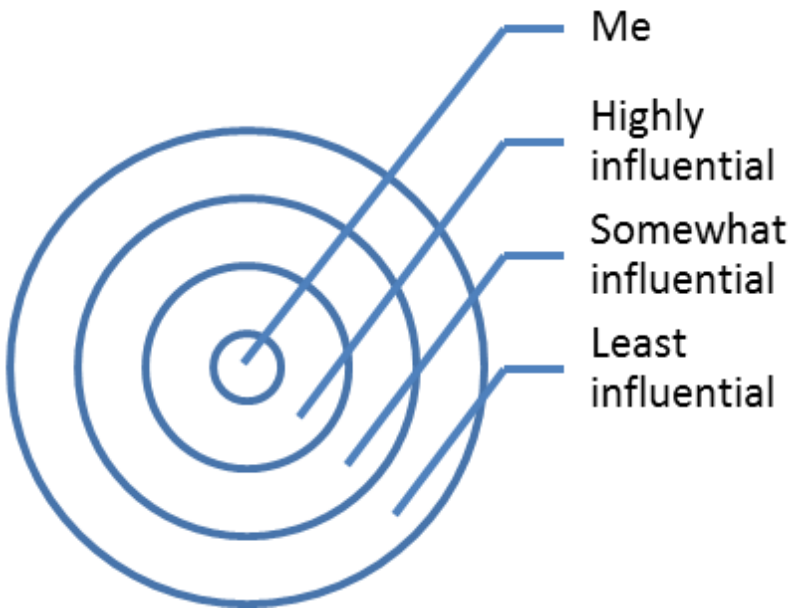

DIAGNOSING
Start where people are at;
WHAT IS
DESIGNING
Add new ideas, skills, content
WHAT COULD BE
DOING
Test old and new together
WHAT CAN BE
DEVELOPING
Evaluate and learn
WHAT NEXT
DIAGNOSING
DESIGNING
DOING
DEVELOPING
Adaptive (co) management; social learning cycle

Factors that influence my decision making



Qualitative study

- 15 land managers from v. different estates
- Interview
  - management objectives
  - changes in approach to management
  - key influences leading to change
  - role of collaborations in decision-making
- Social network map
- Preliminary findings

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Adaptive Management

The James Hutton Institute

Social learning

- Networks
- Reflection
- Trust
- Influences

Implementation

- Agency
- Capacity
- Incentives
- Disincentives
- Social relations

AM

Social networks are key influences

- Decisions strongly influenced by owner or trustees
- Decisions strongly influenced by family, close staff and community
- Social networks/influences vary in size, diversity and influence
- And can support ‘adaptation’
- Lack of trust between some social groups

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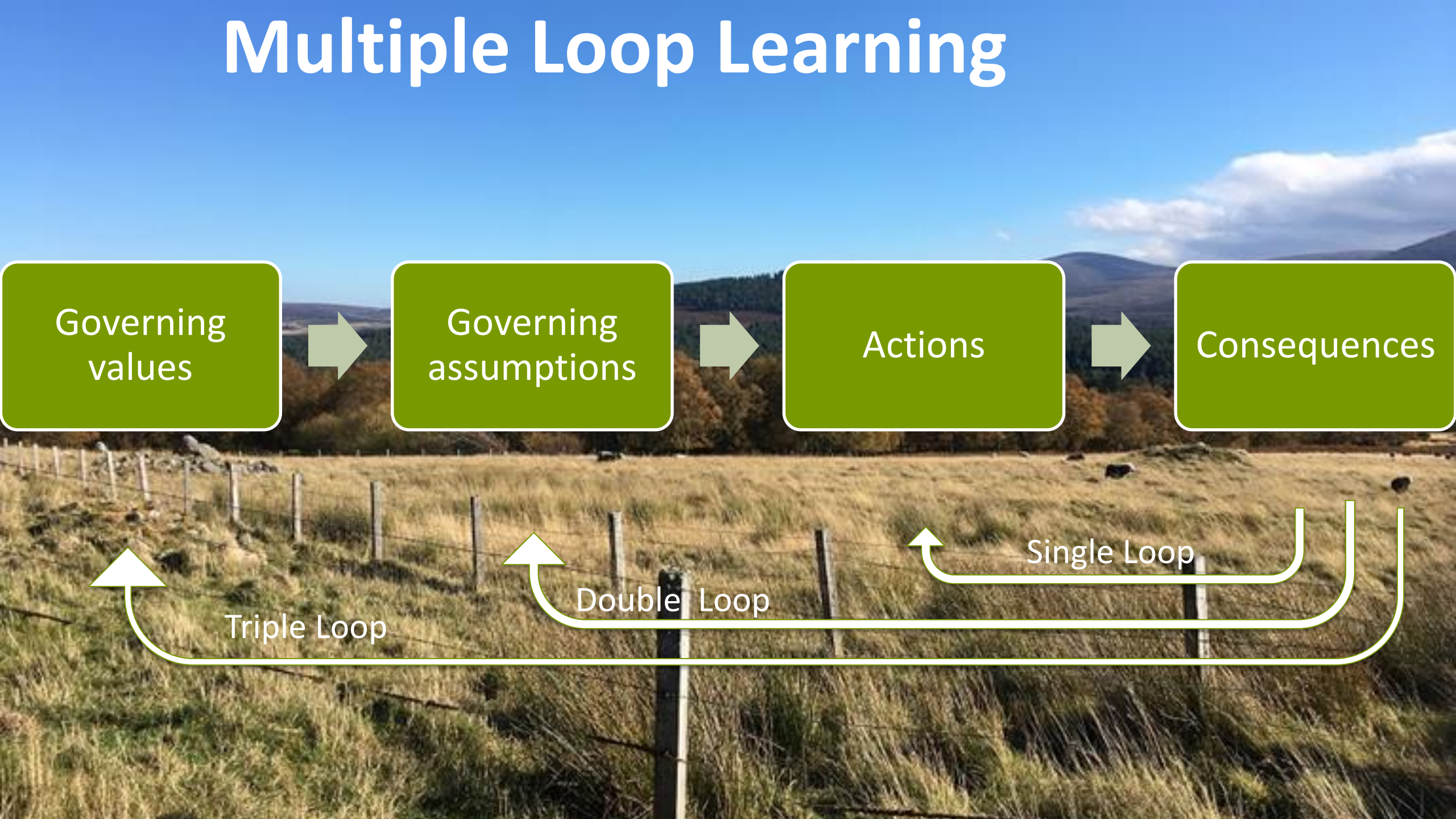
Facilitation of learning

- Significant event or memorable experience
  - Stress; change in visitor management approach
  - Fencing contractor - poor condition of hill deer in fenced areas; sustainability of deer populations
  - Section 7 agreement and statutory culling/media attention
  - Independent review; forced dialogue and engagement with communities
- New settings and experiences
  - Norway trip/Trip to Canada
  - Social occasions vs formal meetings (guards are down)
  - The personal touch
- Not being an expert/specialist
  - More open to different perspectives
  - Openness to learn from other (personality?)
- Bridge makers
- Reflection
- Government policy changes

Multiple Loop Learning



Key message and next steps

- Preliminary analysis: Social relations and learning is key to AM
- Analyse further and those factors that may promote or hinder AM implementation
- Research brief

Governing biodiversity: the role of values and perceptions

Paula Novo[1], Scott Herrett[2], Anja Byg[2], Nazli Koseoglu[2]

Ecosystems and Land Use Stakeholder Engagement Group (ELSEG) – 2019 Meeting

1: Scotland's Rural College, 2: The James Hutton Institute
This research was funded by Scottish Government's Strategic Research Programme, 2016 - 2021

Rationale for this research

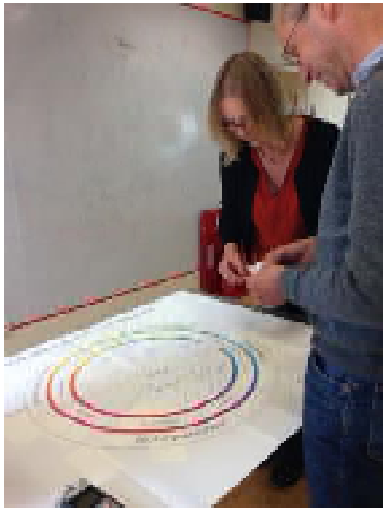
- Large number of governance mechanisms seek to get land managers to adopt 'biodiversity friendly' practices
- Biodiversity continues to decline
- Many studies have looked at barriers to uptake
- But role of values explored to a lesser extent

Values in biodiversity governance

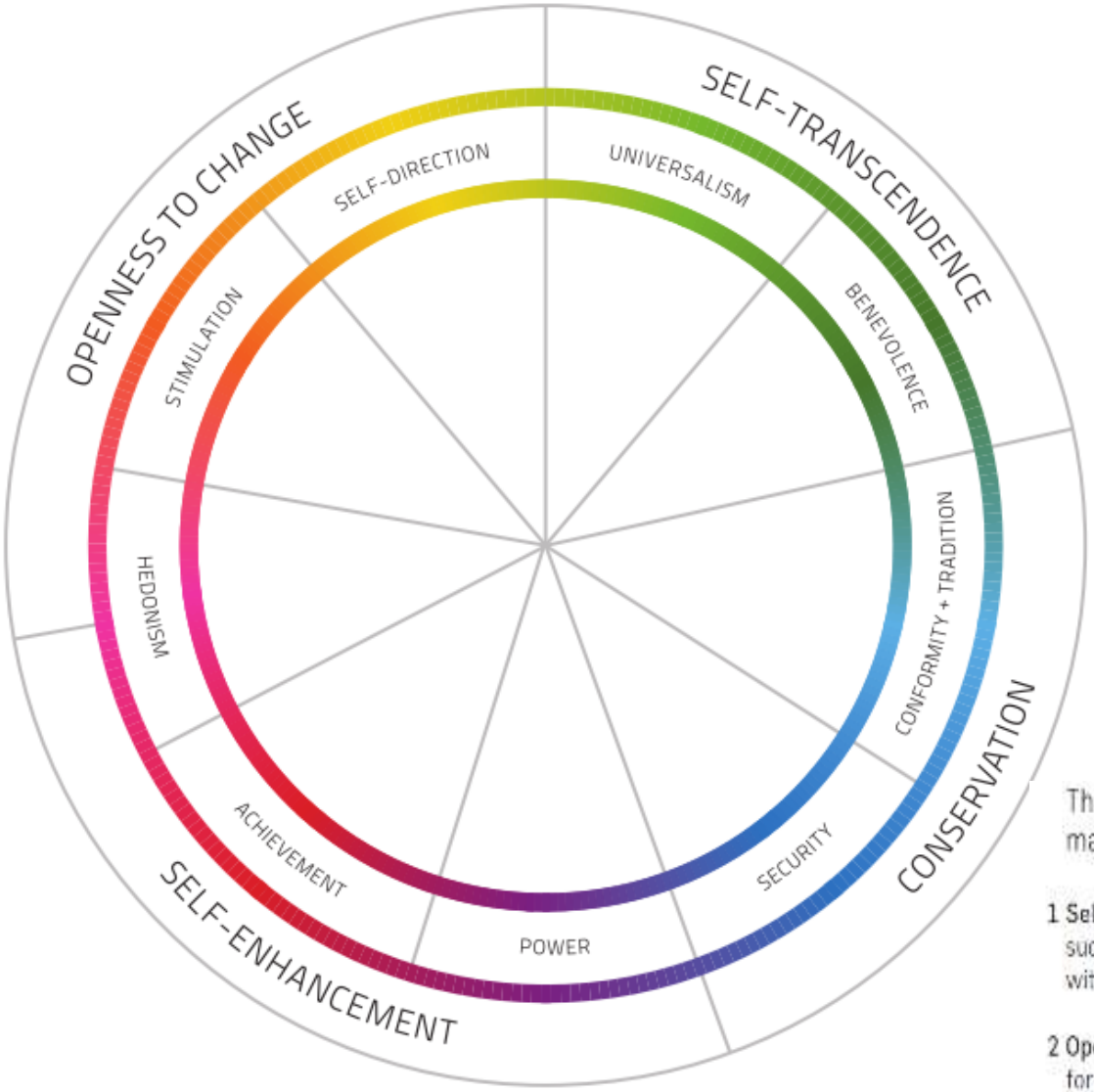
- Values as abstract goals and guiding principles (Schwartz, 2012)
- Values guide decision-making, e.g. what and where to conserve, what to regard as acceptable ways of using and managing the land, what trade-offs to make, who and what is targeted
- What to see as appropriate governance solutions

Research: experiences with biodiversity governance and role of values

- Methods
  - 15 interviews with people involved in biodiversity governance (in Scotland):
    - what works /doesn't work
    - perceptions and values in relation to people and biodiversity
  - 2 workshops:
    - desirable governance characteristics
    - (fundamental) values to influence attitudes and behaviours towards biodiversity
    - implications of appealing to these values



Fundamental values: Schwartz's values wheel



↑ Figure 3. Schwartz's value circumplex.[16]

Image credit: Common Cause Foundation (UK)

The ten groups of values can then be divided along two major axes, as shown above:

1 **Self-enhancement** (based on the pursuit of personal status and success) as opposed to **self-transcendence** (generally concerned with the wellbeing of others);

2 **Openness to change** (centred on independence and readiness for change) as opposed to **conservation** values (not referring to environmental or nature conservation, but to 'order, self-restriction, preservation of the past and resistance to change').

Results: the role of values

- Values are reflected in different governance mechanisms
  - Values feed back into the relationship between humans and nature (human-nature divide)
  - Creation of trade-offs and potential conflicts
- Governance mechanisms appeal to different values to engage stakeholders in particular land management practices
  - Different approaches for different people?
  - Rational language and logical arguments and/or emotive language
  - Normative and relational values
  - Taboo trade-offs
- Values also determine what is seen as good governance

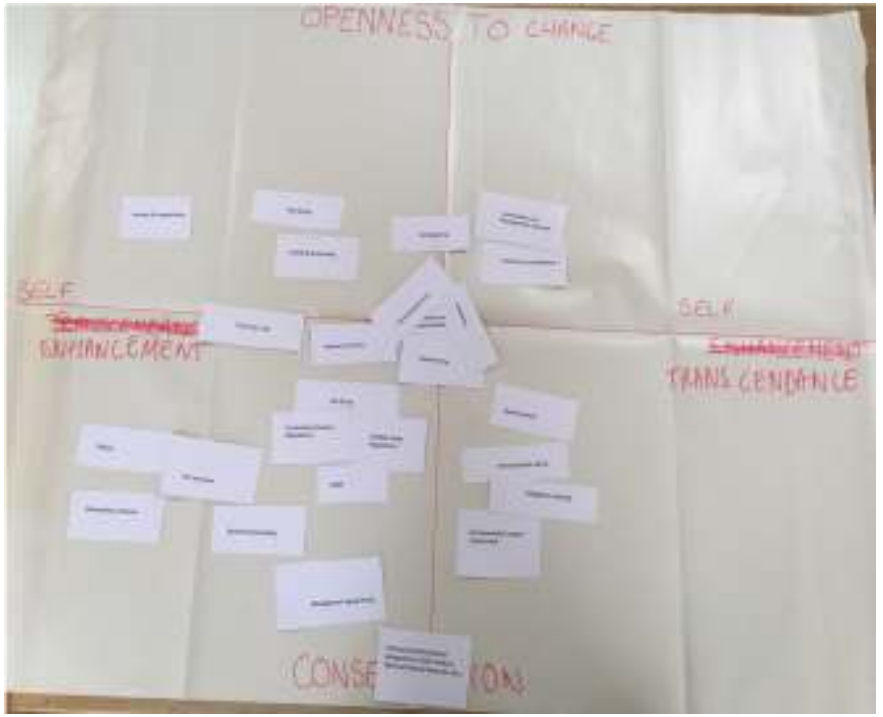
Results: good governance

Characteristics related to…	Detailed governance characteristics
Stakeholders	Engaged land managers, accessible language, inclusive, legitimate and respected
Monitoring and evaluation	Relevant to ecological processes, evidence and outcome based, multiple outcomes, accountable, fairness and compatibility with social welfare measures
Governance structure and processes	Continuous engagement, joined up, integrative approach across policy areas, bottom-up, collaborative, transparent, links to resourcing
Effectiveness and efficiency	Efficient, landscape scale, robust, provides an opportunity for creativity and bespoke solutions, flexible for change, targeted, realistic, allows for uncertainty

Results: fundamental values to influence attitudes and behaviours

- Self-transcendence (universalism and benevolence)
  - Natural fit with motivations for conservation
  - Belief that there is more than our individual selves
  - Sense of stewardship
- Conservation (security and conformity)
  - Comply with the regulations and avoiding threats
  - Responsibility of passing down the land
- Self-enhancement (achievement and power)
  - Making a return on biodiversity
  - Social recognition (tied with universalism)
- Hedonism
  - Stimulation, beauty of nature
- Self-direction
  - Pioneering farming practices
  - Sense of ownership and responsibility over the local environment

Results: to what values different governance mechanisms appeal?



Results: to what values different governance mechanisms appeal?

- Cluster of governance mechanisms appealing to self-enhancement and conservation values
  - Mechanisms dominated by regulations and economic incentives
  - Recognises the economic impact on land managers
  - Compliance-based measures are ‘convenient’ to implement
- Only a few mechanisms appealing to self-transcendence and openness-to-change values
  - Role of larger scale mechanisms (e.g. partnerships and other collective actions) in promoting these values

Conclusions

- Outcome of biodiversity governance is also a question of what and whose values are brought to bear
- Notions of fairness, equity and participation recognised as key characteristics but often fall out of formal governance processes and structures
- Need (opportunity) for re-thinking policies to promote human connections with nature and reconcile different values, uses and needs
- Mismatch between values of those involved and the values expressed by actual governance
- Understanding these complex relationships can provide the basis for governance designs rooted at the value base of the stakeholders involved

Thank you!

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Reports available here:

http://www.hutton.ac.uk/research/srp2016-21/wp134-biodiversity-management/assessment-current-biodiversity-management-measures

Acknowledgements: We are indebted to the interviews and workshop participants for taking the time to share their thoughts and opinions with us. This research was funded by Scottish Government's Strategic Research Programme 2016-2021.

Benefits of woodland recreation

Klaus Glenk, Alistair McVittie (SRUC)

Leading the way in Agriculture and Rural Research, Education and Consulting

Background

- Research to inform part of Natural Capital Accounting work in WP1.4

- Two main aims
  - Generate updated welfare estimates for Scotland
    - Comprehensive approach to allow for flexibility e.g. to distinguish by forest patch size or recreational activity
  - Improve understanding of heterogeneity in forest use
    - What explains differences in intensity and type of recreational forest use?

Survey of forest and woodland recreation in Scotland

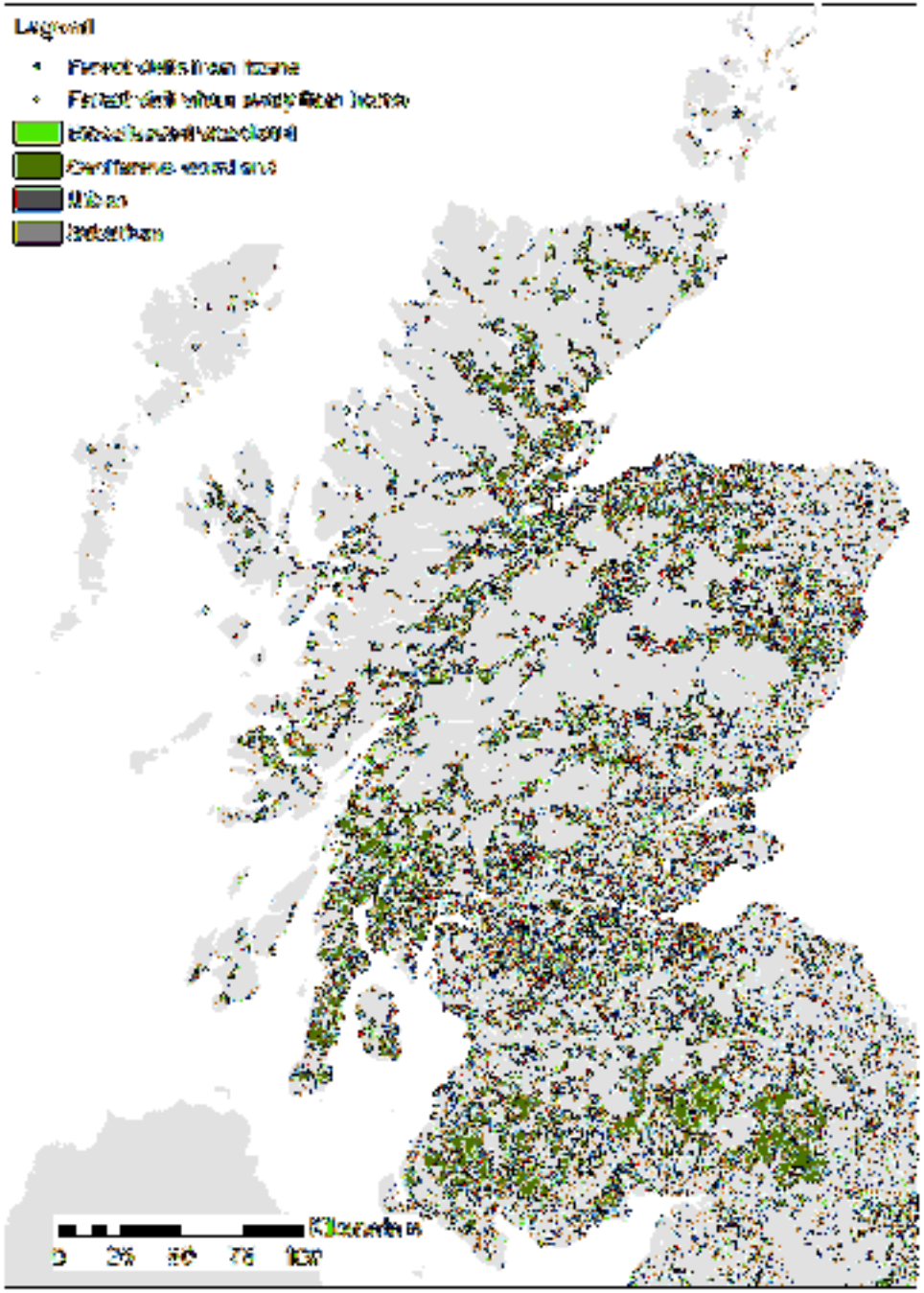
- Part of wider European research effort – countries: AT, BY, CH, CZ, DE, DK, FR, PL, SK, UK
- Spring (April/May 2017) – potential seasonality effects; explored in French sample
- Online panel
- 1,001 usable responses in Scotland

- Revealed preference part
  - forest(s) recently visited
- Stated preference part
  - Preferences for and perceptions of forest characteristics

Forest recreation data: characteristics (Scottish sample)

- Screening question – 'have you visited a forest or woodland for recreation in the past 12 months?'
  - 71% Yes
  - Comparable to 78% reported to have visited forest/woodland at least once in past 12 months (SNH Scotland's People and Nature Survey 2013/14)
- Forest/woodland visited last:
  - Visiting forest was single purpose of trip: 70%; …was part of other activity (e.g. family visit, holidays, business trip etc.): 30%
  - Weekend/holiday: 57%; weekday: 43%

Forests (last) visited



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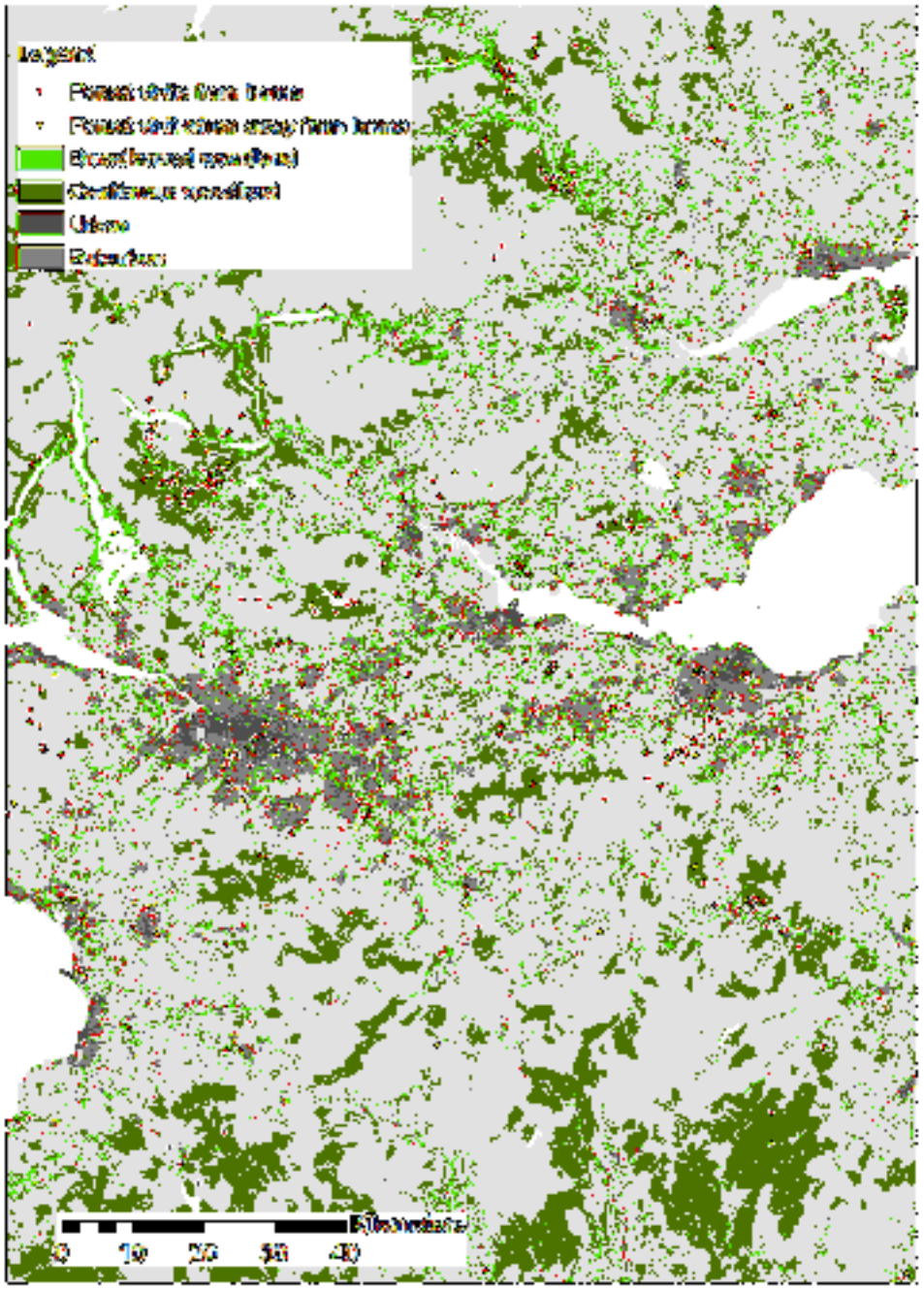
Forests (last) visited (Central belt)



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RP: Consumer surplus estimation

- Consumer surplus per trip based on incurred cost
- Recreationists are WTP at least as much to access site as they incurred in travel costs
- Assumption: data on last visited forest is across sample representative of general forest recreation behaviour

- Data:
  - Frequency of visiting this forest over past year
  - Travel cost estimated from survey data

- Count data model

RP results – consumer surplus/trip

- Only travel cost (weekday)

	DE	DK	FR	PL	SCOT
CS	**0.8**	**1.0**	**1.4**	**1.5**	**1.0**
s.e.	0.1	0.2	0.3	0.5	0.1
N	167	289	189	163	223

- Only travel cost (weekends/holiday)

	DE	DK	FR	PL	SCOT
CS	**4.9**	**7.2**	**8.5**	**4.9**	**5.8**
s.e.	0.8	0.6	0.9	0.5	1
N	423	351	437	419	335

RP results – consumer surplus/trip

- Travel cost and time cost (weekday)

	DE	DK	FR	PL	SCOT
CS	**3.7**	**6**	**5.7**	**2.7**	**4.4**
s.e.	0.5	0.9	1	1.0	0.4
N	167	289	189	163	223

- Travel cost and time cost (weekends/holiday)

	DE	DK	FR	PL	SCOT
CS	**23.0**	**43.7**	**35**	**9.1**	**25.5**
s.e.	3.6	3.9	3.6	1.0	4.4
N	423	351	437	419	335

RP summary

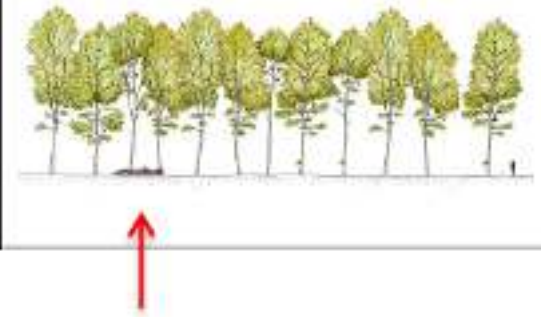
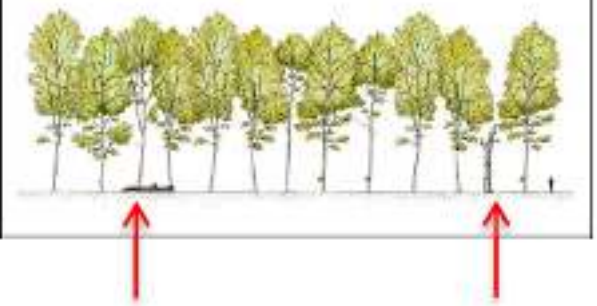
- Comparison of consumer surplus estimates with some previous UK studies
  - Christie et al (2006) £9.8 - £19 per trip (TCM) depending on activity
  - Sen et al. (2014) £3.6 (MA)
- Extensions
  - Differentiation by trip type, activity, forest type
  - Refining travel cost assumptions
  - Potential for including forest characteristics (e.g. patch size) and other spatial variables (e.g. availability of substitute sites)

SP: Preferences for forest attributes

- Respondents choose between going to one of two hypothetical forests and the forest last visited
- Choice experiment format: 12 choices
- Attributes:
  - Forest type (coniferous, broadleaved, mixed)
  - Tree height (8m, 18m, 24m)
  - Number of tree types by habitus (1, 2, 3, 4)
  - Age variation (single aged; two-aged, multi-aged)
  - Trees left for natural decay 'deadwood' (none, low, medium)
  - Facilities (none; picnic facilities/benches; marked trails)
  - One-way distance to forest (miles)

Example: deadwood

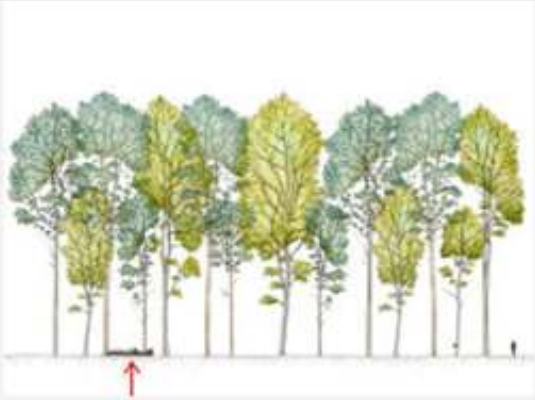
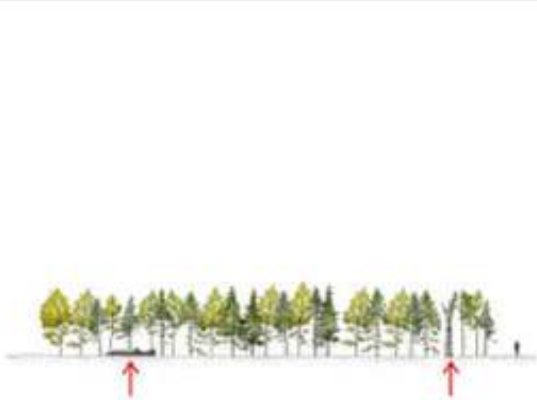
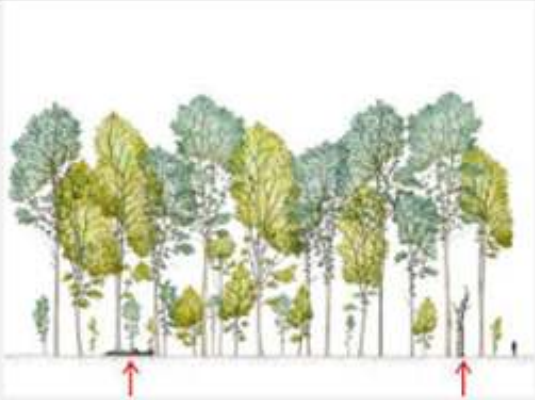
Dying or dead trees can be left in the forest for natural death and decay. They provide good living conditions for numerous rare species of animals, plants and fungi. Trees left for natural decay can be lying or standing. Only near natural forests have a high volume of dead and dying trees.

None	Low	Medium
No trees left for natural decay	Few trees left for natural decay; you find on average every 50 m wood left for decay	Several trees left for natural decay; you find on average every 25 m wood left for decay lying or stand upright
		

Choice card

As defined by respondents

Which of these three forests would you visit?

Forest A	Forest B	Last visited forest
Mix of 2 broadleaved tree species, tallest trees 24 m, two-aged, low amount of trees left for natural decay	Mix of 2 coniferous and broadleaved tree species (1 coniferous and 1 broadleaved), tallest trees 8 m, single-aged, medium amount of trees left for natural decay	Mix of 2 broadleaved tree species, tallest trees 24 m, multi-aged, medium amount of trees left for natural decay
		
Picnic facilities  Marked trails 	None 	Marked trails 
One way distance 2 miles	One way distance 8 miles	One way distance 0-2 miles
○	○	○

SP: results – Monetary value (£/trip)

Attribute	WTP (£/trip)	lower bound [2.5%]	upper bound [97.5%]
#trees: increase	0.94	0.55	1.32
#trees: decrease	-1.50	-1.96	-1.04
Tree height (m)	0.19	0.13	0.25
Two aged	0.15	-0.59	0.88
Multi aged	1.68	0.92	2.43
Deadwood: low	0.54	-0.01	1.09
Deadwood: medium	1.63	1.05	2.21
Picnic facilities	0.78	0.05	1.50
Marked trails	3.24	2.39	4.09
Picnic & trails	5.18	4.24	6.11

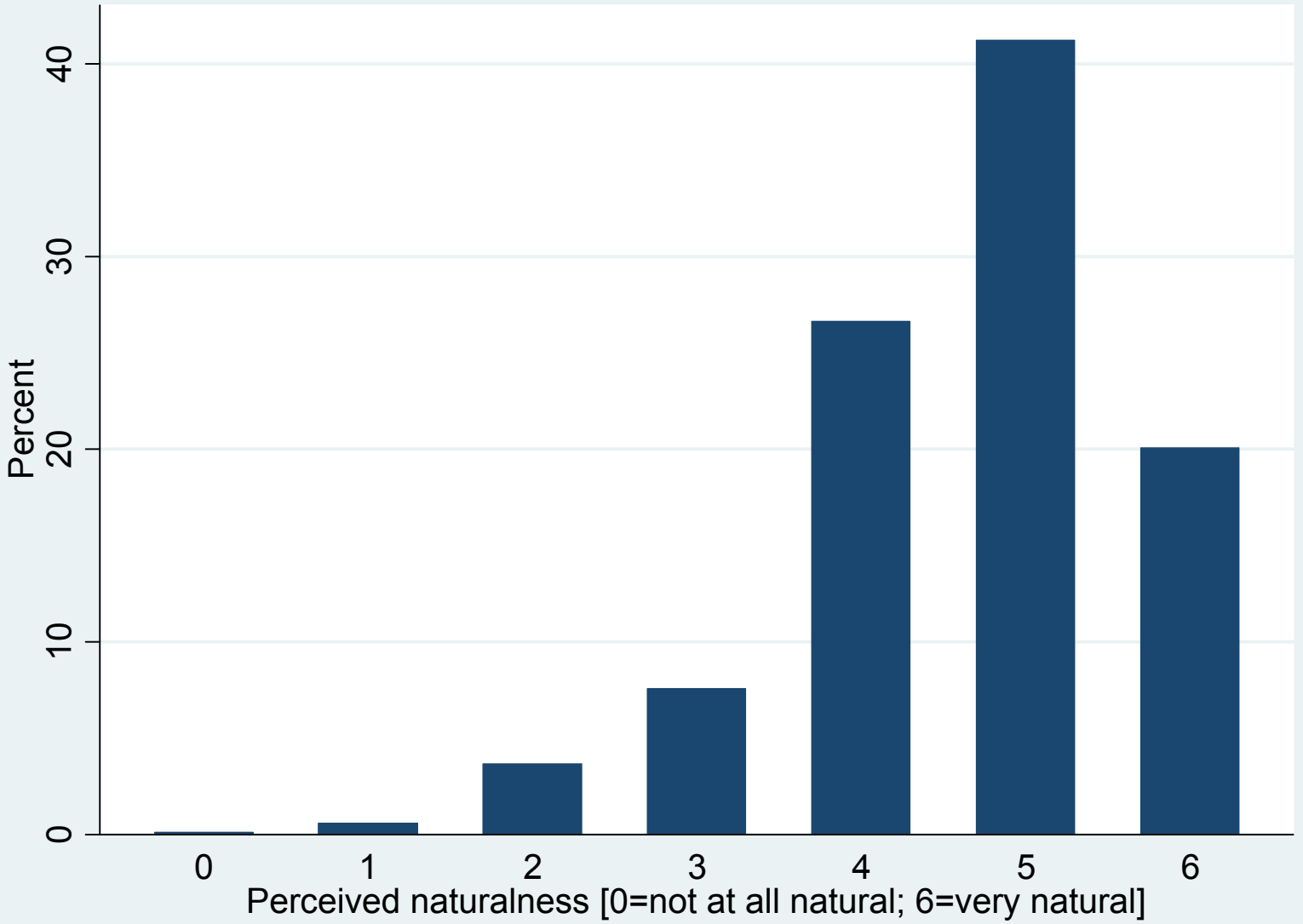
SP: summary

- Recreationists value structural forest attributes and facilities
- Preferences may – to a degree – help explain why some forest areas receive lower visitation

- Some structural forest attributes related to biodiversity and directly relevant for forest management
  - Variation in tree types
  - Age variation
  - Deadwood

- Extensions
  - Accounting for preference heterogeneity – also by activity etc.
  - Matching perceptions with objective data on forest characteristics (if possible)

Perceived naturalness



Perceived naturalness - findings

- Perceived naturalness found to have direct and indirect influence on emotional well-being associated with recreational experience (Marselle et al. 2016)

- We find positive association of perceived naturalness with:
  - Increased age variation of trees
  - Increased amount of trees left for decay (deadwood)

- Perceived naturalness is positively correlated with perceived restorativeness (Qualities: ‘Fascination’ and ‘Being Away’)

Summary

- Results (thus far) look promising and make intuitive sense
- More work on both RP and SP data needed
  - More refined estimates also considering what is most useful for natural capital accounts
- Links to mental well-being work interesting and could be expanded in future studies

RP: Assumptions

- Only single purpose trips considered (for now)
- Geodesic distance not network distance
- Car transport only (70%) – 'average' car/2 people
- High sensitivity to low number of very long trips
- Travel cost
  - Round trip distance – shortest distance x 'wiggle factor' (1.2)
  - Fuel cost (based on 7l/100km)
  - Travel time cost: assuming travel speed of 50 km/h; 1/3 of wage rate
- Truncated negative binomial count data regression

Table 5.1 Recreation values from the existing evidence base.

Source	Value per visit (converted to 2014 GBP)	Values for	Method/notes
Scarpa (2003)	2.23–3.69	Forests and woodlands only	Contingent valuation (open-ended and dichotomous choice willingness to pay surveys).
Christie *et al.* (2006b)	9.75–18.50	Forests and woodlands only	Travel cost method to estimate the value of improvements to recreational facilities in forests. Range depends on type of recreation activity (e.g. cycling, hiking).
Eftec (2010)	2.69	Forests and woodlands only	Low facility sites; constant value applied per trip. Does not vary with size of woodland, distance from populations, household incomes, availability of substitutes and so on.
Eftec (2010)	13.45	Forests and woodlands only	High facility sites; constant value applied per trip. Does not vary with size of woodland, distance from populations, household incomes, availability of substitutes and so on.
Sen *et al.* (2012)	3.35*	All outdoor recreation types across Great Britain, including forests and woodlands	Meta-analysis of over 100 studies, combining revealed and stated preference valuation techniques. Develops detailed Trip Generation Function (TGF**). Expressly models travel time and cost from each potential outset area to each recreation site, availability of substitute sites and household characteristics (e.g. income).
Sen *et al.* (2014)	3.59	Forests and woodlands only	Combines TGF with meta-analysis of 297 values from 98 studies to estimate per visit values. Expressly models travel time and cost from each potential outset area to each recreation site, availability of substitute sites and household characteristics (e.g. income).

Notes: Conversions to 2014 GBP using HM Treasury GDP Quarterly Deflators 30 September 2015 Update, available from: https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-september-2015-quarterly-national-accounts. * Based on Sen *et al.* (2012) base case scenario with 3231 000 visits totalling GBP 10 040 000 in value. ** The TGF developed in Sen *et al.* (2011) relates the number of trips observed to a variety of predictor variables including site type (e.g. mountain, lake, grassland); study details (sample size, treatment of substitutes, valuation methods); demographic details (population density). Some studies excluded due to age.

Example: age variation

Forests can also differ with respect to how different trees in the same place vary with respect to their age. The forests in our study can be:

Single-aged composed of trees are of the same age and similar size	**Two-aged** composed of trees that are of two age and size classes	**Multi-aged** composed of trees of varying age and size classes
		

SP: results – recently visited forest

Variable	Mean	SD	Min	Max
Distance (km)	37.61	45.22	0.5	150
Number of tree types by habitus	2.48	1.04	1	4
Tree height	21.94	3.79	8	24
Single aged	0.35	0.48	0	1
Two aged	0.12	0.32	0	1
Multi aged	0.54	0.50	0	1
No deadwood	0.08	0.27	0	1
Low deadwood	0.50	0.50	0	1
Medium deadwood	0.43	0.49	0	1
No facilities	0.21	0.40	0	1
Picnic facilities/benches	0.07	0.26	0	1
Marked trails	0.25	0.43	0	1
Both picnic facilities and marked trails	0.47	0.50	0	1

SP: results – choice model

Variable	Coefficient
Constant	0.504
Distance (8.6p/km)	-0.191
#trees: increase	0.148
#trees: decrease	-0.257
Tree height (m)	0.0402
Two aged	-0.01 (n.s.)
Multi aged	0.178
Deadwood: low	0.114
Deadwood: medium	0.241
Picnic facilities	0.212
Marked trails	0.620
Picnic & trails	0.913

N=832 respondents

Ordered logit – perceived naturalness

Ordered logistic regression — Number of obs = 1001
LR chi2(10) = 46.82
Prob > chi2 = 0.0000
Log likelihood = -1373.3211 — Pseudo R2 = 0.0168

X1	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
sum_tree	.0542775	.0574937	0.94	0.345	-.0584081	.1669632
tree18m	.3433222	.3494442	0.98	0.326	-.3415758	1.02822
tree24m	.1537995	.4013531	0.38	0.702	-.6328381	.9404371
two_age	.472852	.2847414	1.66	0.097	-.0852308	1.030935
mult_age	.7494592	.2483512	3.02	0.003	.2626998	1.236219
dead_med	.5237683	.2276781	2.30	0.021	.0775273	.9700093
dead_hig	.6438924	.2325197	2.77	0.006	.1881622	1.099623
infra2	.232173	.2529252	0.92	0.359	-.2635514	.7278973
infra3	-.0232317	.1721764	-0.13	0.893	-.3606912	.3142278
infra4	.2127885	.1531308	1.39	0.165	-.0873423	.5129194
/cut1	-5.566779	1.069618			-7.663192	-3.470366
/cut2	-3.611936	.5365522			-4.663559	-2.560313
/cut3	-1.721917	.4119279			-2.529281	-.9145536
/cut4	-.6149209	.3980955			-1.395174	.1653319
/cut5	.96529	.3986738			.1839038	1.746676
/cut6	2.863903	.4063092			2.067552	3.660255

SP: results – recently visited forest

Variable	Mean	SD	Min	Max
Distance (km)	37.61	45.22	0.5	150
Number of tree types by habitus	2.48	1.04	1	4
Tree height	21.94	3.79	8	24
Single aged	0.35	0.48	0	1
Two aged	0.12	0.32	0	1
Multi aged	0.54	0.50	0	1
No deadwood	0.08	0.27	0	1
Low deadwood	0.50	0.50	0	1
Medium deadwood	0.43	0.49	0	1
No facilities	0.21	0.40	0	1
Picnic facilities/benches	0.07	0.26	0	1
Marked trails	0.25	0.43	0	1
Both picnic facilities and marked trails	0.47	0.50	0	1
Perceived naturalness [not at all natural=0; very natural=6]	4.64	1.05	0	6

Supporting land use change decisions for sustainable land management

Alessandro Gimona
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Andera Baggio,
Justin Irvine

The James Hutton Institute

National Trust

Purpose:

- To illustrate approach to land use change decision support
  - Example project **: Lake District National Park**
- Provide basic knowledge of the Sustainable Land Management tool
- To discuss suggestions for

  application to Scotland,

  development and

  improvement

Sustainable Land Management Project (NT; Lake District National Park)

Study area: Lake District National Park

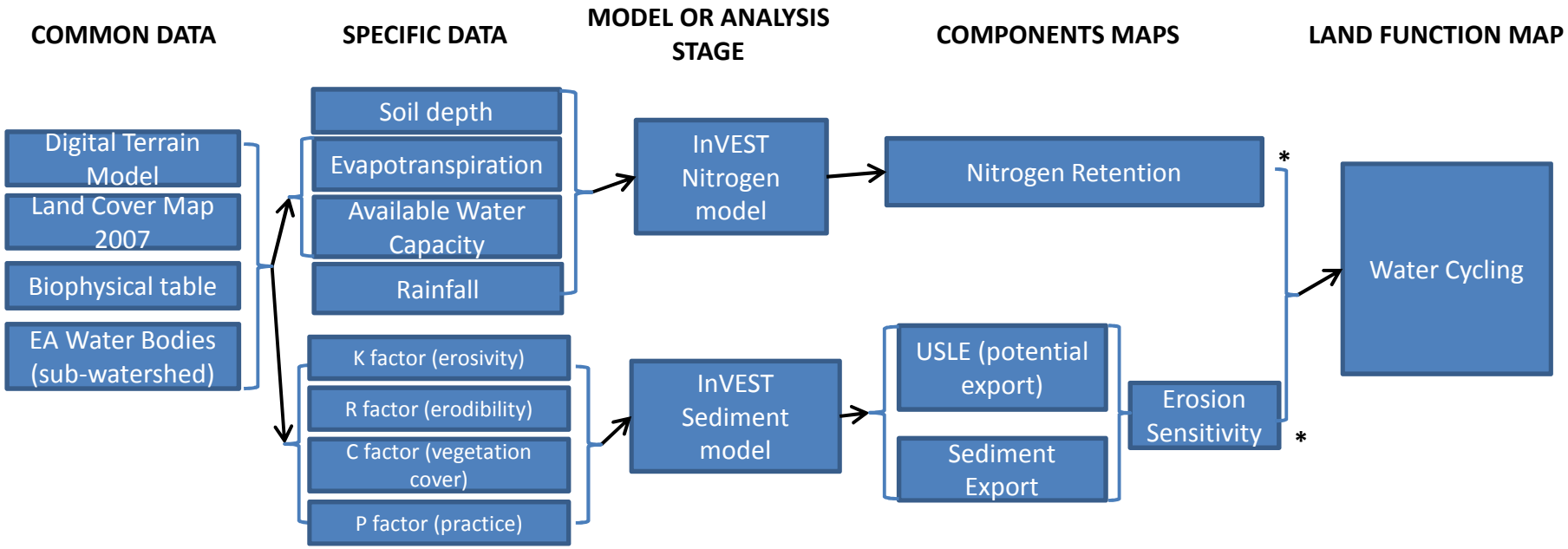
- Finding a more sustainable way to better mange the land and its resources **for multiple purposes and benefits**
- Providing **objective evidence and information** to support and inform landscape scale decision making about the future of the Lake District
- Supporting the development **of sustainable land management plans for NT's farmed estate**

“LM Principles in the Lakes”: Land Functions

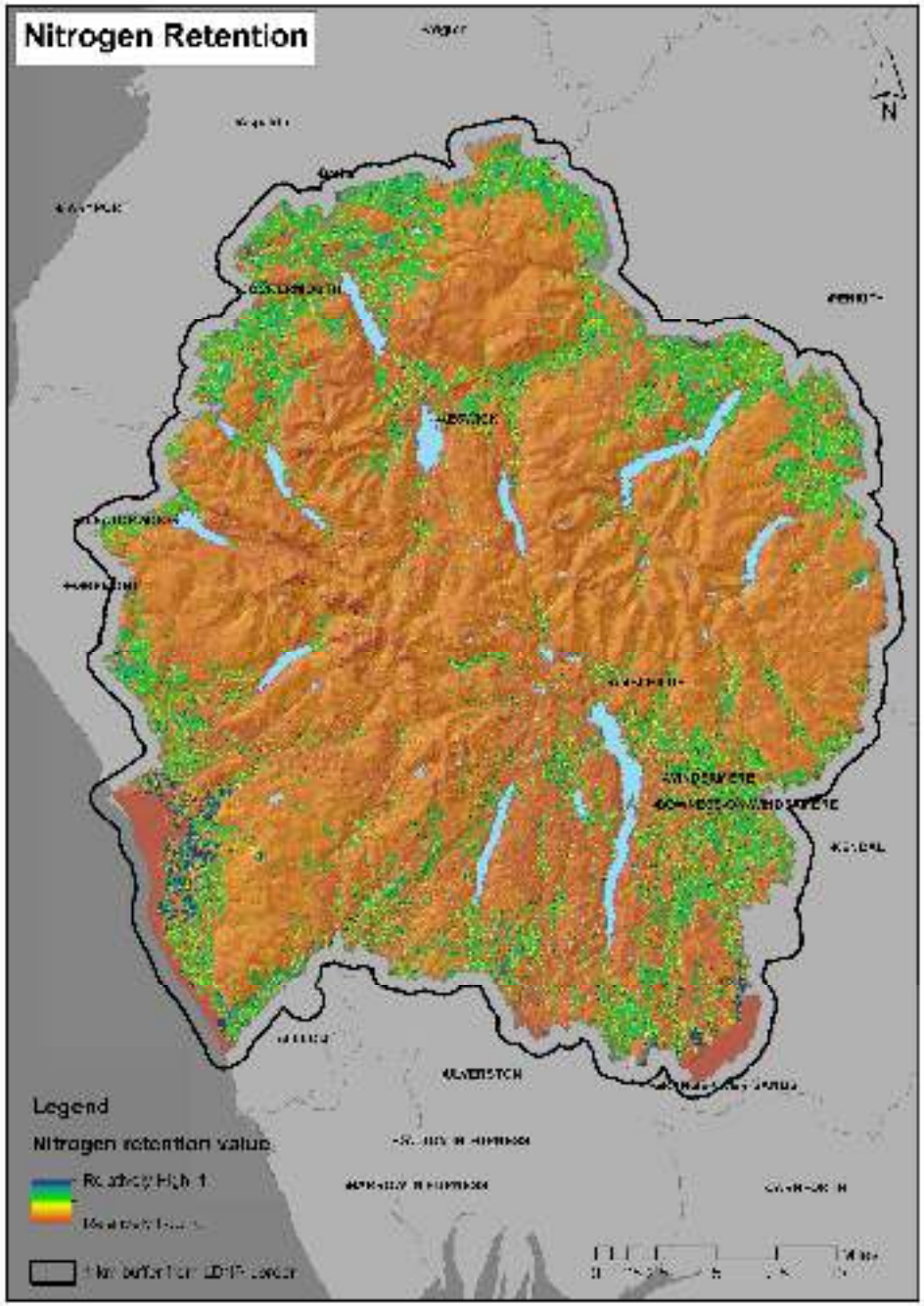
- Water cycling – sediment and nutrient retention, erosion, flood control
- Production – crops, grass, timber, water
- Carbon storage – sinks and emissions from peat land, soils, vegetation,
- Biodiversity – habitats, species, connectivity
- Landscape and cultural history – scenic beauty, historic and designed landscapes, archaeology
- Recreation and inspiration – access & attractiveness

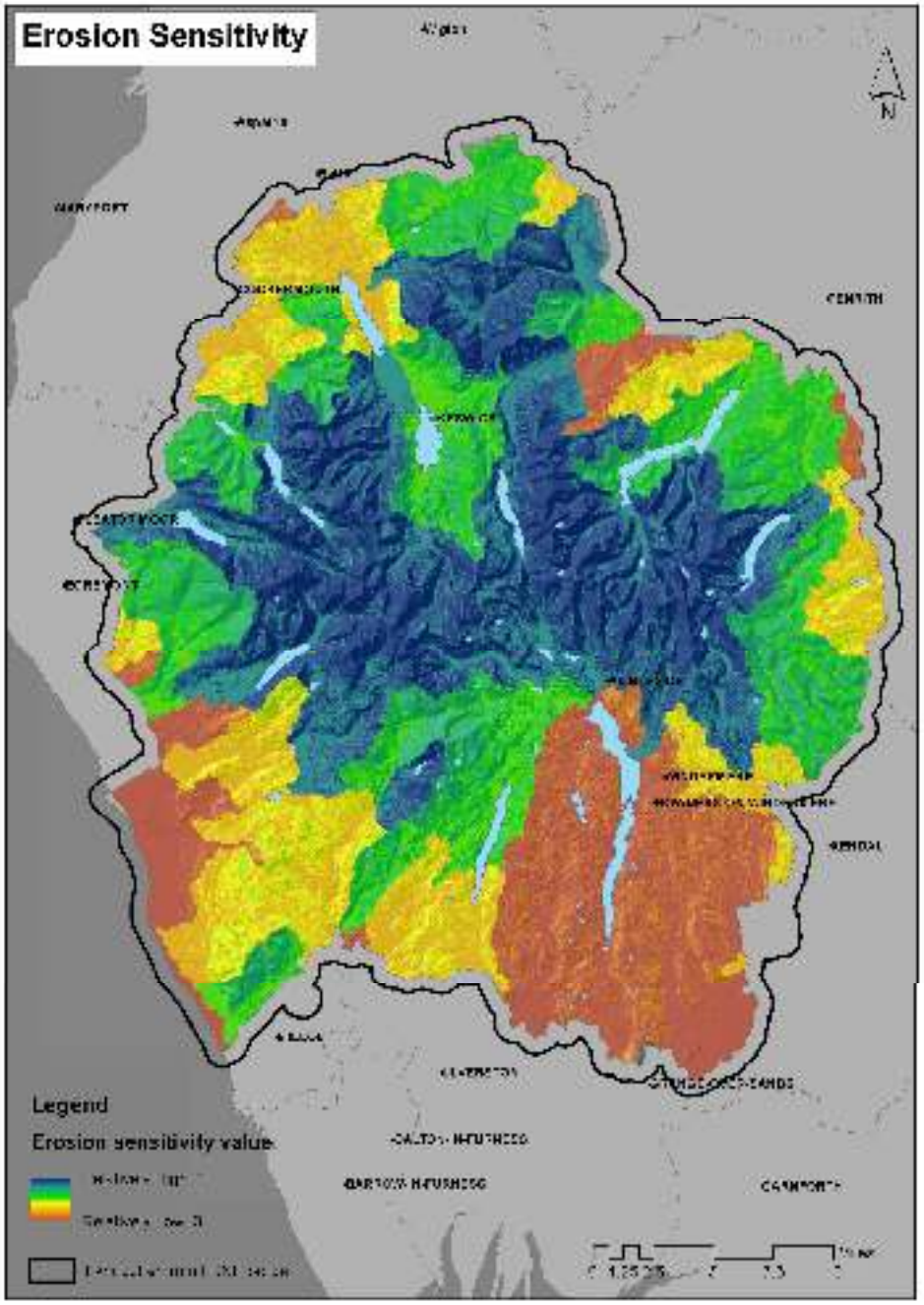
Combine

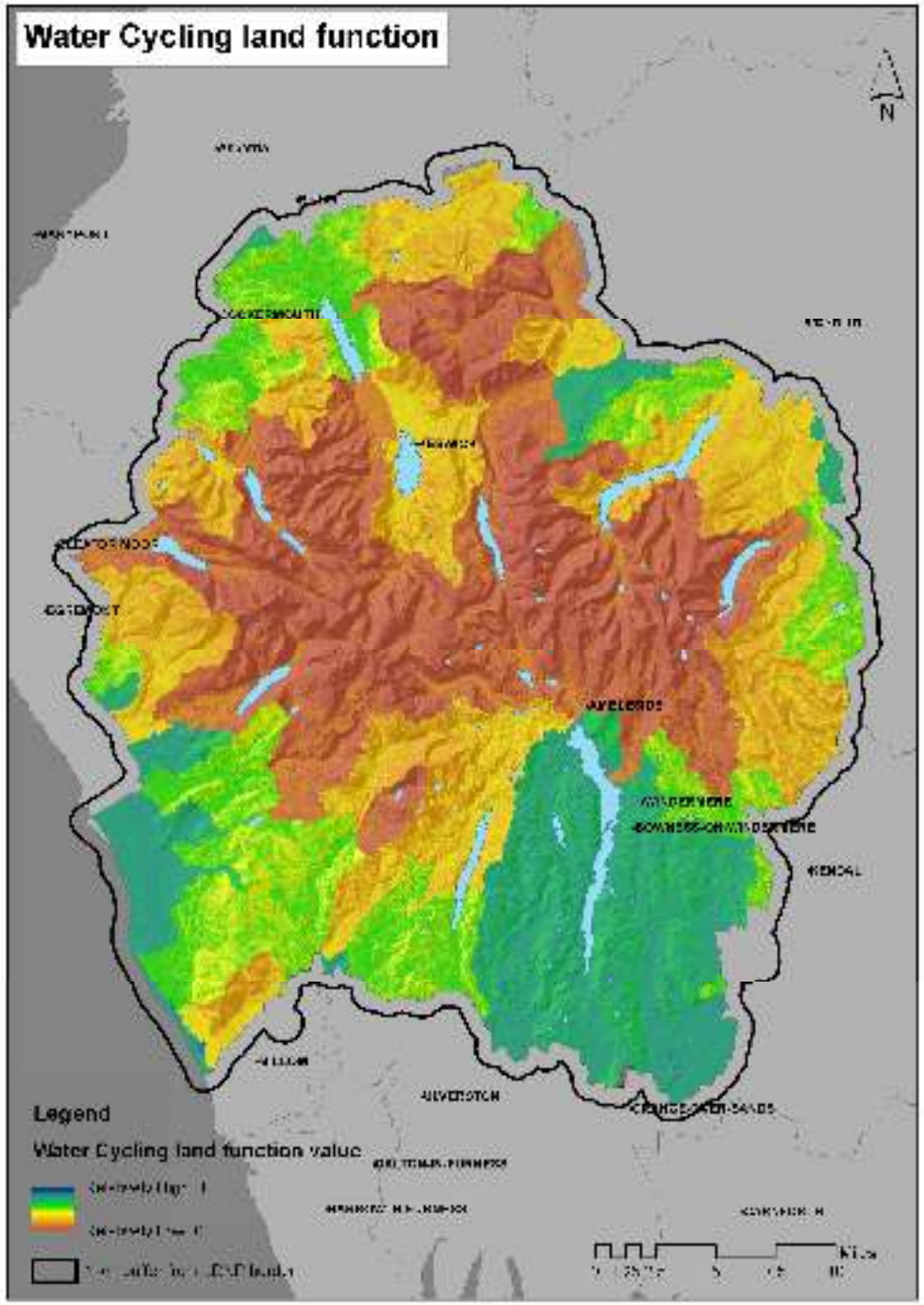
Water Cycling



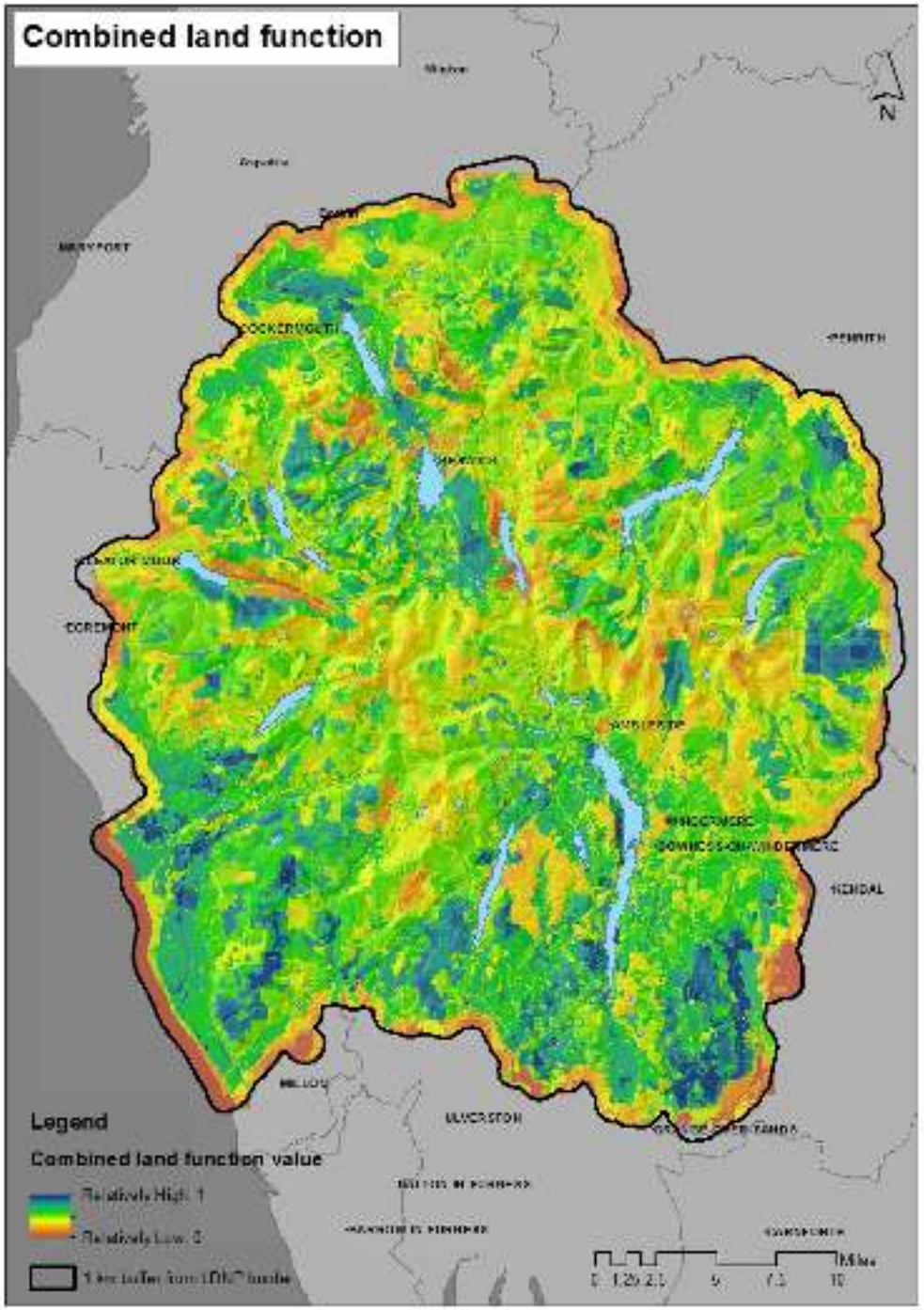
- We did not developed a water retention map (for flooding); It would have needed a separate project (check with other initiatives)


Nitrogen Retention
N
Legend
Nitrogen retention value


Erosion Sensitivity
N
Legend
Erosion sensitivity value


Water Cycling land function
N
Legend
Water Cycling land function value

Combined Land Functions



Advice on opportunities for change

- What are the priority functions/services to improve?
- Where are areas of low function/service, and therefore opportunities to improve?
- What do different land uses/covers deliver?
- What land use transitions are needed to improve function/service delivery?

Approach to land use change advice

- Which function/service should be improved?-

  stakeholders weights

- Which land use transitions (e.g. grassland to forest) would help?

  score the transitions

- Where are such transitions more advisable?

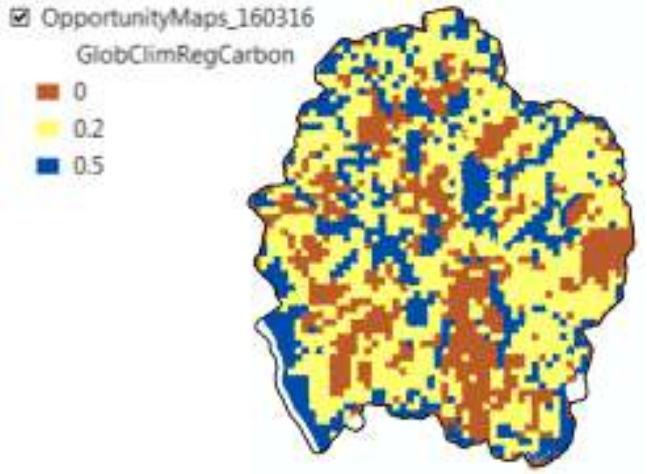
  Opportunity maps

Land Functions

- **For each land function in the tool: 3 components**

An Opportunity map

0 : no land use change
0.2 : low probability of land use change
0.5 : high probability of land use change



Land use transitions matrix using Scores

Glob.Clim.Reg.Carbon (scores)		Broadleaved, mixed	Coniferous	Arable	Imp. grassland	Rough grassland	Neutral grassland	Acid grassland	Heather, dwarf shrub	Heather grass	Bog	Montane
		1	2	3	4	5	6	8	10	11	12	13
Broadleaved, mixed	1	0	1	-5	-4	-1	-1	-1	-3	-3	2	0
Coniferous	2	-1	0	-6	-5	-2	-2	-2	-4	-4	1	0
Arable	3	5	6	0	1	4	4	4	2	2	7	0
Imp. grassland	4	4	5	-1	0	3	3	3	1	1	6	0
Rough grassland	5	1	2	-4	-3	0	0	0	-2	-2	3	0
Neutral grassland	6	1	2	-4	-3	0	0	0	-2	-2	3	0
Acid grassland	8	1	2	-4	-3	0	0	0	-2	-2	3	0
Heather, dwarf shrub	10	3	4	-2	-1	2	2	2	0	0	5	0
Heather grass	11	3	4	-2	-1	2	2	2	0	0	5	0
Bog	12	-2	-1	-7	-6	-3	-3	-3	-5	-5	0	0
Montane	13	0	0	0	0	0	0	0	0	0	0	0

Weight of this function in comparison to others

(spatial or non-spatial)

Land functions in the tool	Weights
Glob.Clim.Reg.Carbon	0.1
Water cycling - Purification	0.1
Water cycling - Nutrient	0.1
Erosion Regulation	0.1
Woodland Connectivity	0.1
Production - Crops	0.1
Production - Fodder	0.1
Production - Timber	0.1
visual amenity and recreation	0.1
Landscape cultural heritage	0.1

Land functions – FUNCTION (SERVICE) scores

CID	CIDname	Regulating services	Glob.Clim.Reg.Carbon	Water cycling - Purification	Water cycling - Nutrient	Erosion Regulation	Woodland Connectivity	Provisioning services	Production - Crops	Production - Fodder	Production - Timber	Cultural services	visual amenity and recreation	Landscape cultural heritage
1	Broadleaved, mixed		6	5	5	5	7		0	1	5		5	4
2	Coniferous		7	5	5	5	4		0	1	5		5	4
3	Arable		1	0	1	0	2		5	3	0		1	3
4	Imp. grassland		2	0	1	1	2		0	5	0		2	3
5	Rough grassland		5	3	4	5	2		0	2	0		4	3
6	Neutral grassland		5	3	4	5	2		0	2	0		4	3
8	Acid grassland		5	3	4	5	2		0	2	0		4	3
10	Heather, dwarf shrub		3	3	3	2	4		0	1	0		4	2
11	Heather grass		3	3	3	2	4		0	1	0		4	2
12	Bog		8	4	4	2	2		0	0	0		2	2
13	Montane		0	0	0	0	0		0	0	0		0	0
14	Inland rock		0	0	0	0	0		0	0	0		0	0
15	Salt water		0	0	0	0	0		0	0	0		0	0
16	Freshwater		0	0	0	0	0		0	0	0		0	0
18	Supra-littoral sediment		0	0	0	0	0		0	0	0		0	0
19	Littoral rock		0	0	0	0	0		0	0	0		0	0
20	Littoral sediment		0	0	0	0	0		0	0	0		0	0
21	Saltmarsh		0	0	0	0	0		0	0	0		0	0
22	Urban		0	0	0	0	0		0	0	0		0	0
23	Suburban		0	0	0	0	0		0	0	0		0	0

Exemplary ecosystem service potential matrix, after Burkhard et al. 2009 and 2012.

Example Opportunity Map
Carbon=>Climate Regulation

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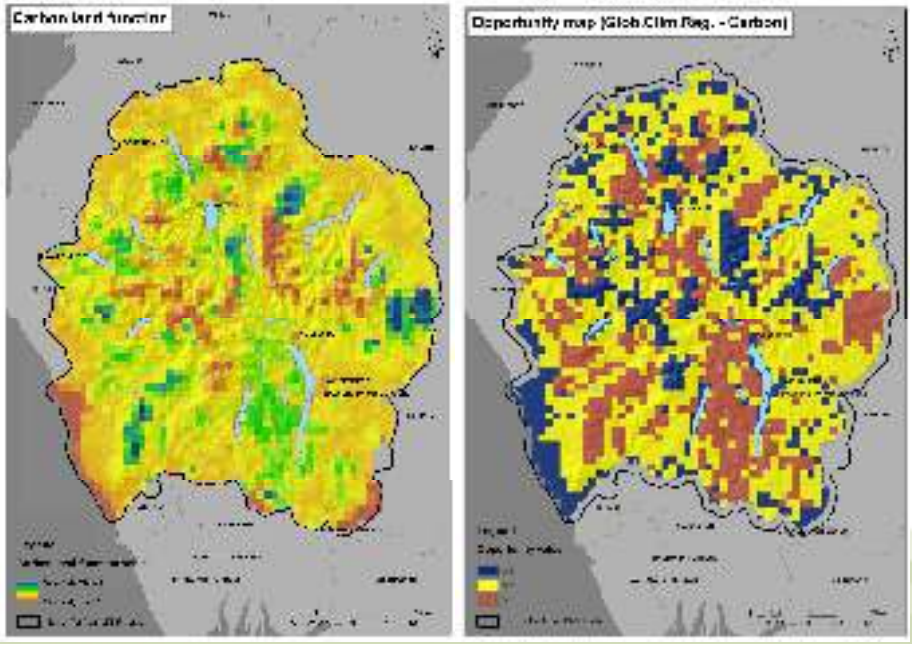
Lower C = higher opportunity to improve

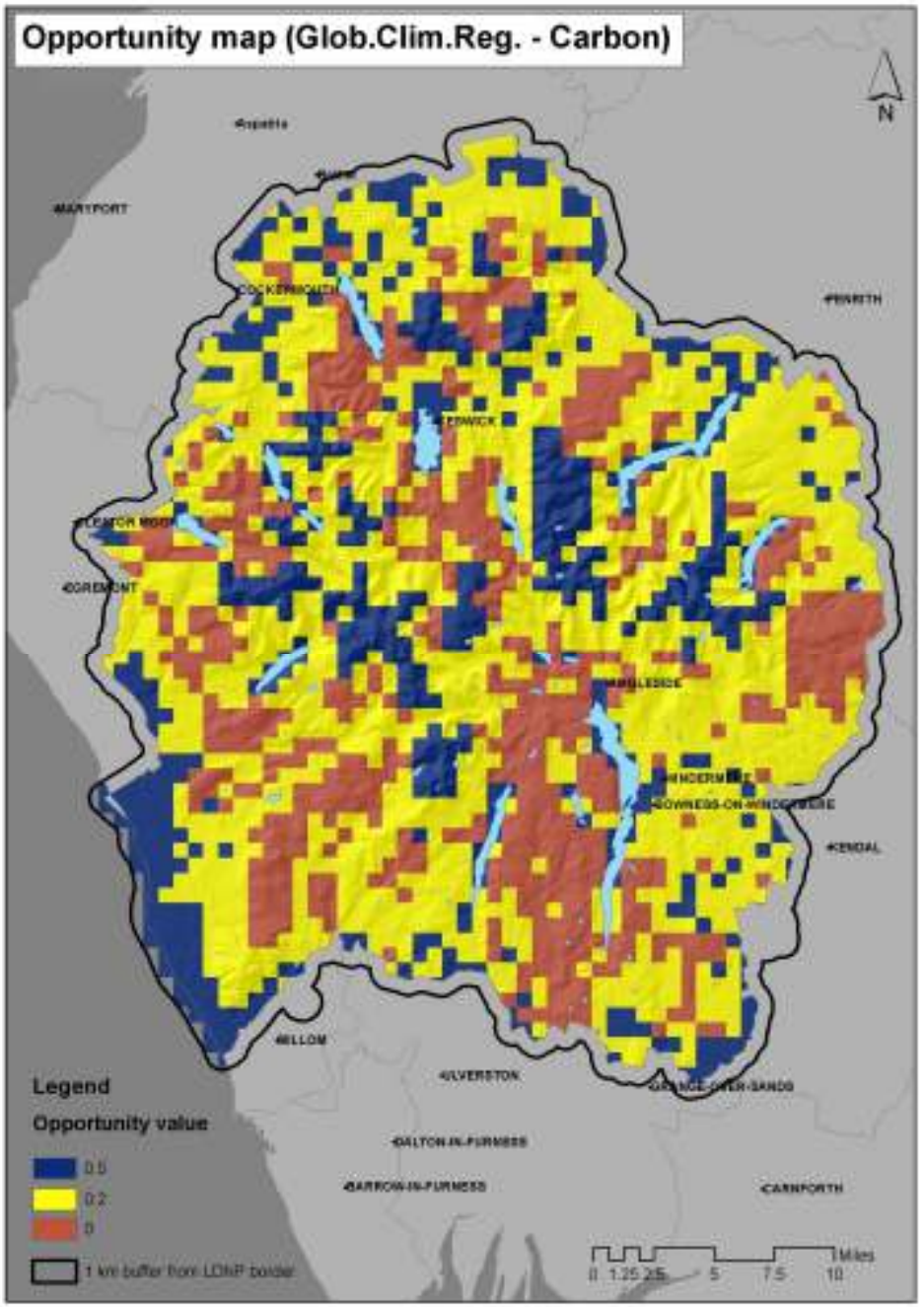
(3 intervals: 0-0.25;0.25-0.75;0.75-1)



Glob.Clim.Reg.Carbon (scores)		Broadleaved, mixed	Coniferous	Arable	Imp. grassland	Rough grassland	Neutral grassland	Acid grassland	Heather, dwarf shrub	Heather grass	Bog	Montane	Inland rock	Salt water
		1	2	3	4	5	6	8	10	11	12	13	14	15
Broadleaved, mixed	1	0	1	-5	-4	-1	-1	-1	-3	-3	2	0	0	0
Coniferous	2	-1	0	-6	-5	-2	-2	-2	-4	-4	1	0	0	0
Arable	3	5	6	0	1	4	4	4	2	2	7	0	0	0
Imp. grassland	4	4	5	-1	0	3	3	3	1	1	6	0	0	0
Rough grassland	5	1	2	-4	-3	0	0	0	-2	-2	3	0	0	0
Neutral grassland	6	1	2	-4	-3	0	0	0	-2	-2	3	0	0	0
Acid grassland	8	1	2	-4	-3	0	0	0	-2	-2	3	0	0	0
Heather, dwarf shrub	10	3	4	-2	-1	2	2	2	0	0	5	0	0	0
Heather grass	11	3	4	-2	-1	2	2	2	0	0	5	0	0	0
Bog	12	-2	-1	-7	-6	-3	-3	-3	-5	-5	0	0	0	0
Montane	13	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland rock	14	0	0	0	0	0	0	0	0	0	0	0	0	0
Salt water	15	0	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater	16	0	0	0	0	0	0	0	0	0	0	0	0	0
Supra-littoral sediment	18	0	0	0	0	0	0	0	0	0	0	0	0	0
Littoral rock	19	0	0	0	0	0	0	0	0	0	0	0	0	0
Littoral sediment	20	0	0	0	0	0	0	0	0	0	0	0	0	0
Saltmarsh	21	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban	22	0	0	0	0	0	0	0	0	0	0	0	0	0
Suburban	23	0	0	0	0	0	0	0	0	0	0	0	0	0

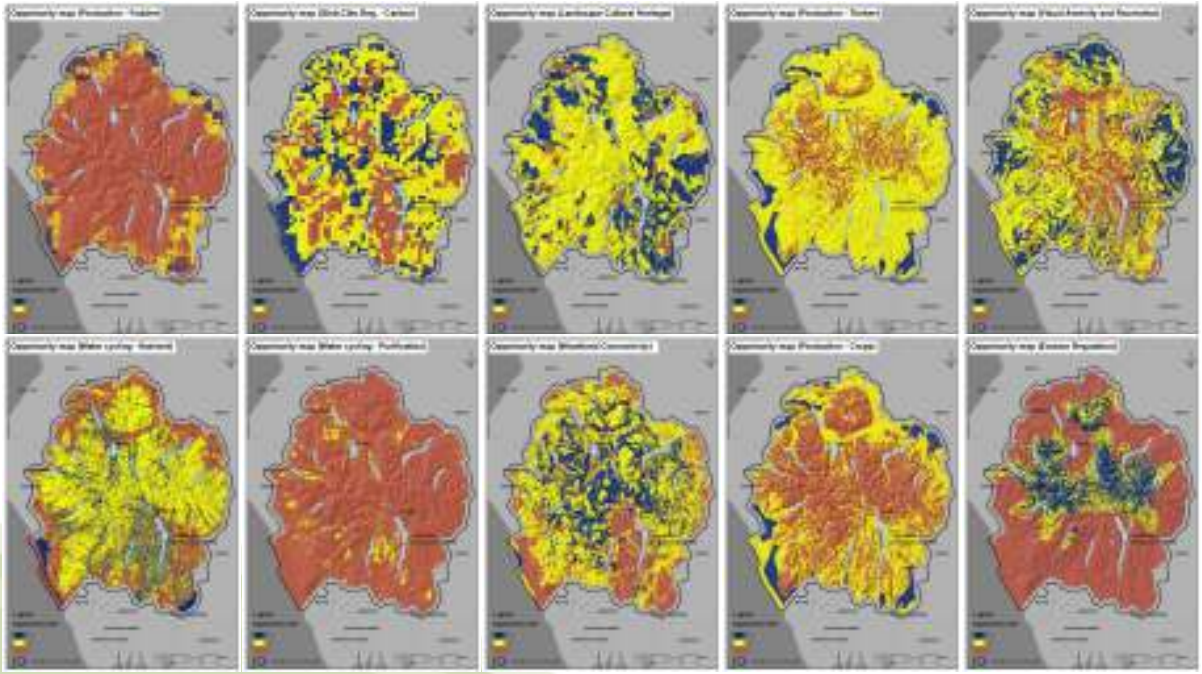
How land use transitions improve function/service delivery?

Where are opportunities to improve?



10 opportunity maps

The James Hutton Institute



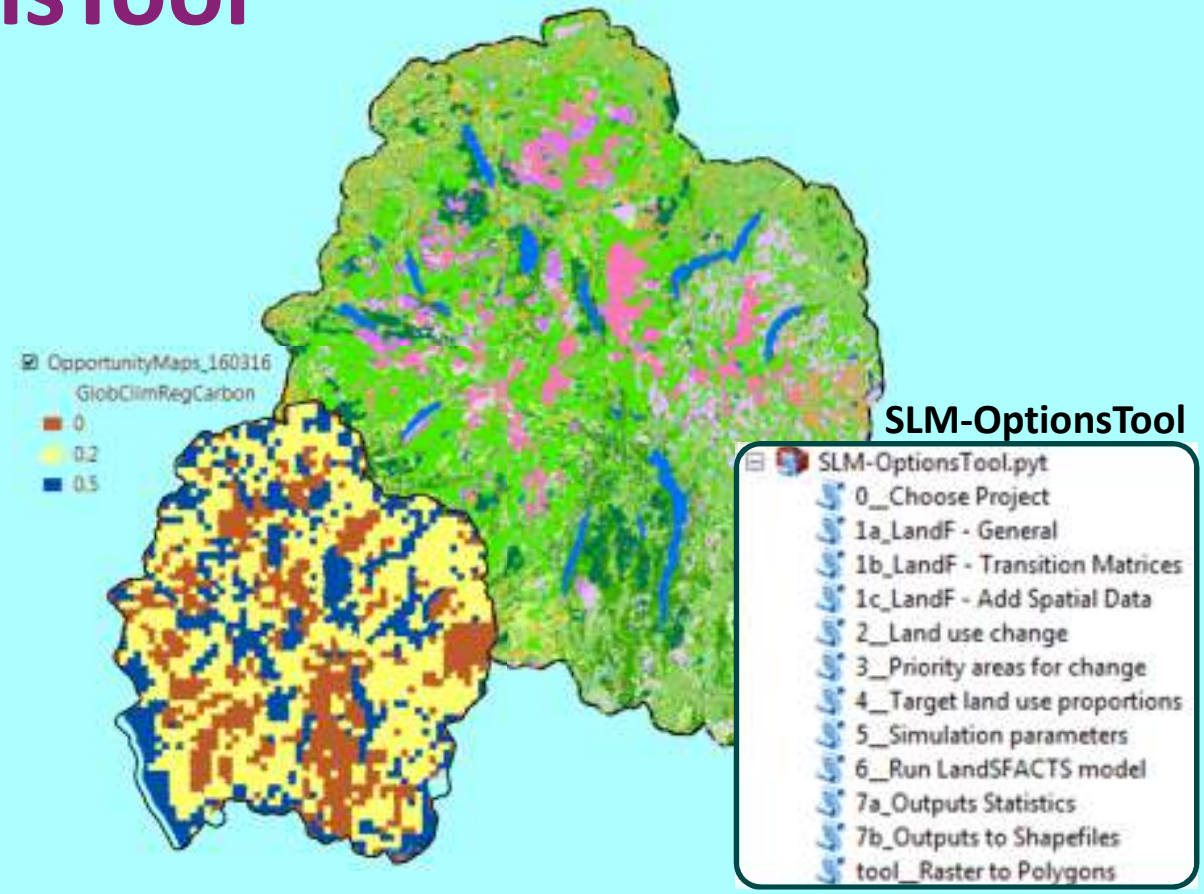
How to improve multiple functions?

- Software needed to handle the complexity and ***suggest*** options:

Sustainable Land Management OptionsTool:

Software to aid decision making about natural capital and ecosystem services

Sustainable Land Management - OptionsTool



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National Trust

Sustainable Land Management - OptionsTool

- **Overview:** project & tool
- **SLM-OptionsTool components:**
  - **LandSFACTS model** & developments
  - **ArcGIS interface**
- **Example of scenarios**

SLM-OptionsTool - background

- Designed for the National Trust in the Lake District National Park
- Main project focus was on mapping land functions

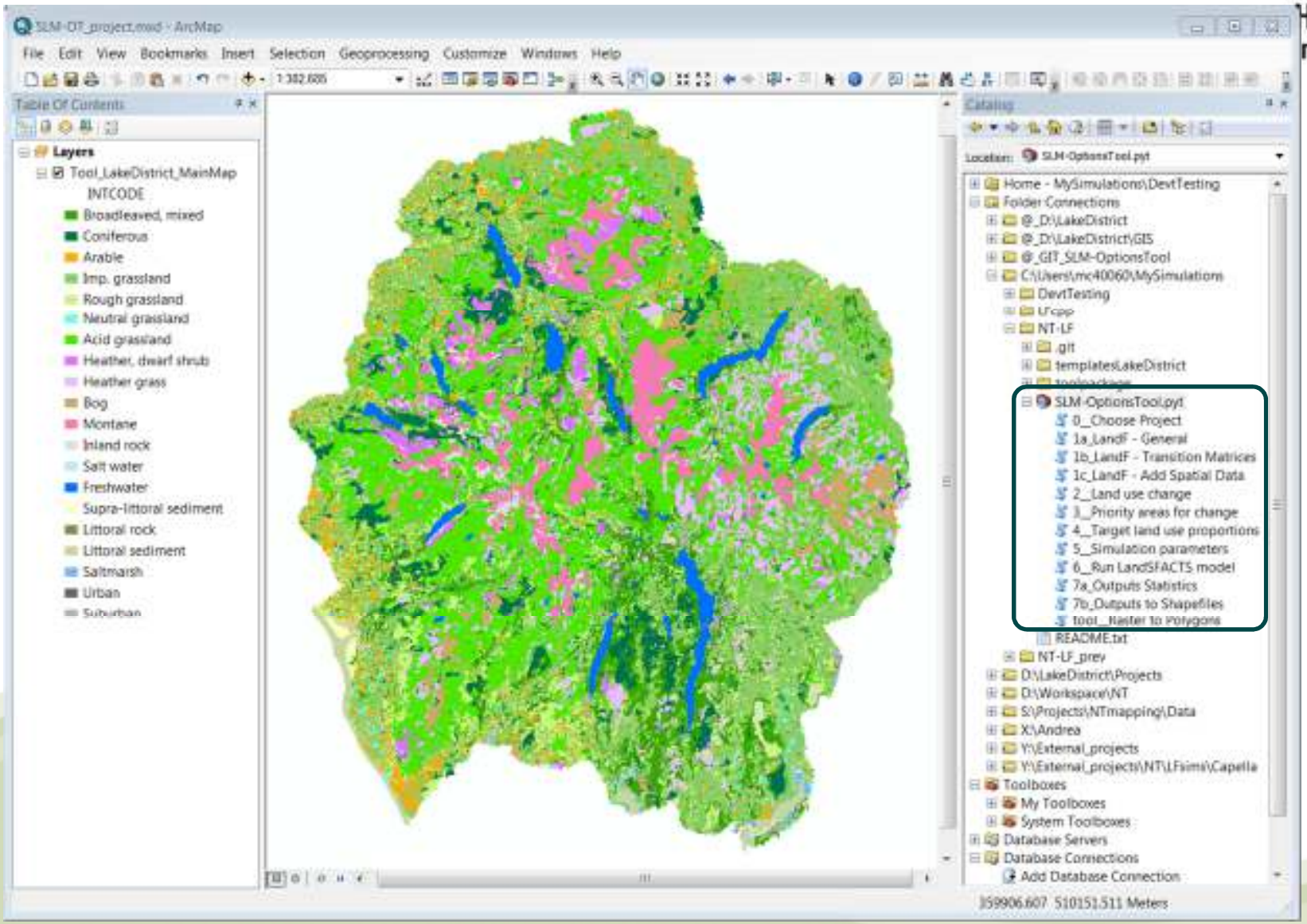
- Exploratory work: tool to help using those land functions maps for informed land use change

SLM-OptionsTool

- Suggests potential land use changes meeting user-defined land management objectives
- Considers:
  - multiple land functions
  - other land management constraints
    - for specific areas (e.g. protected areas)
    - land uses (e.g. no arable decrease)
- Accessible through ArcGIS 10.1

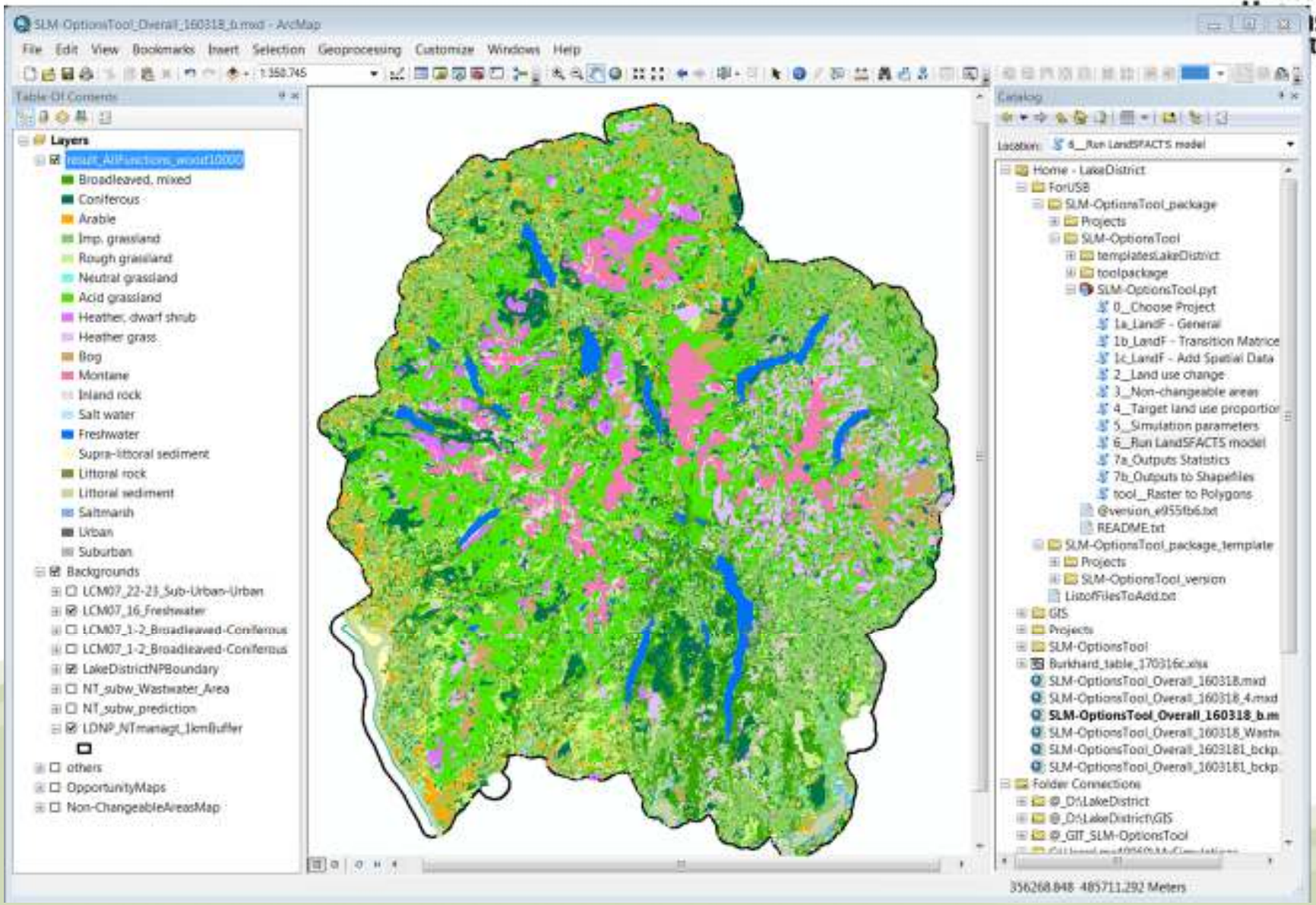
SLM-OptionsTool – Components

- ArcGIS toolbox



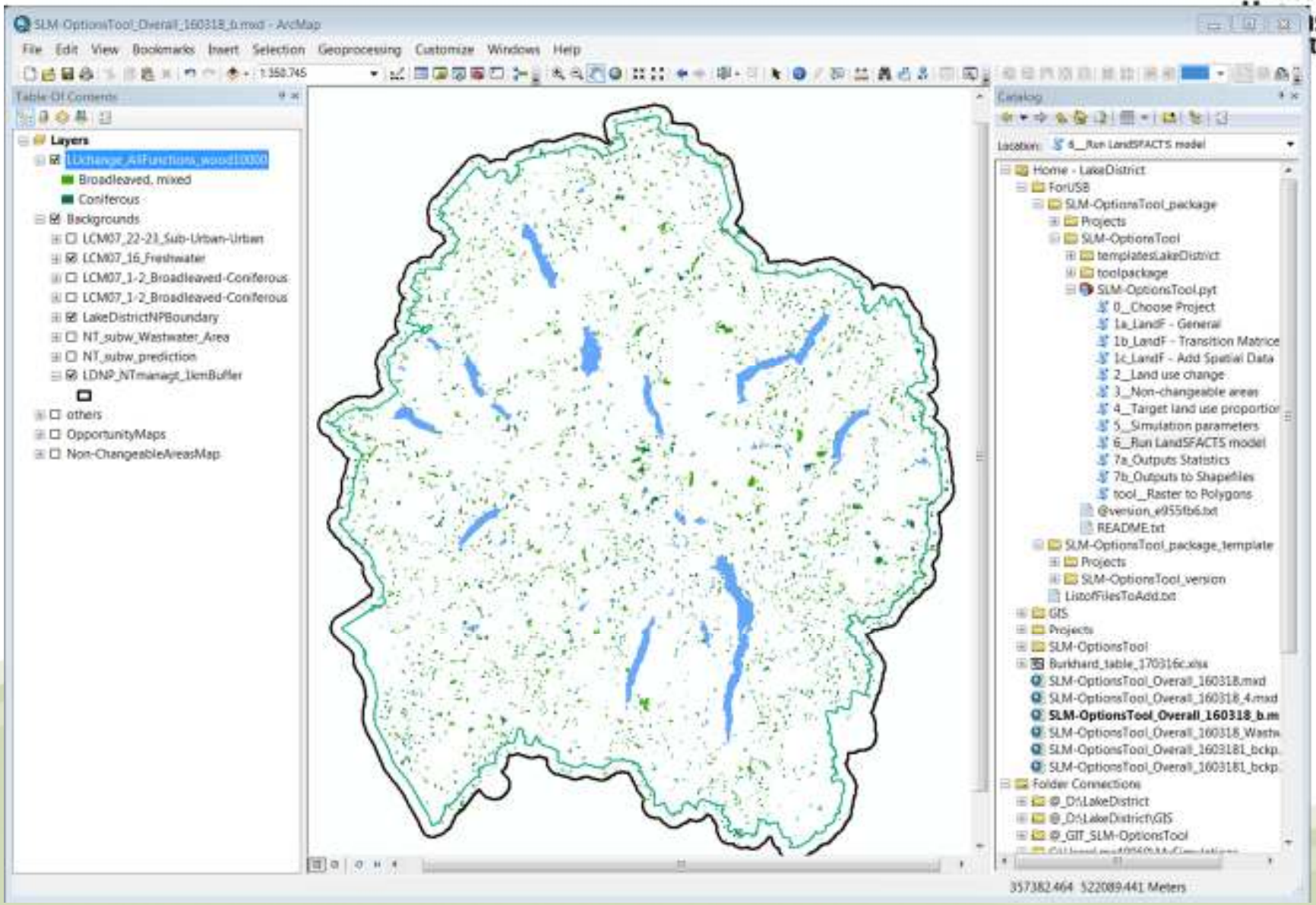
Running the model – Output map 1

- New land use map

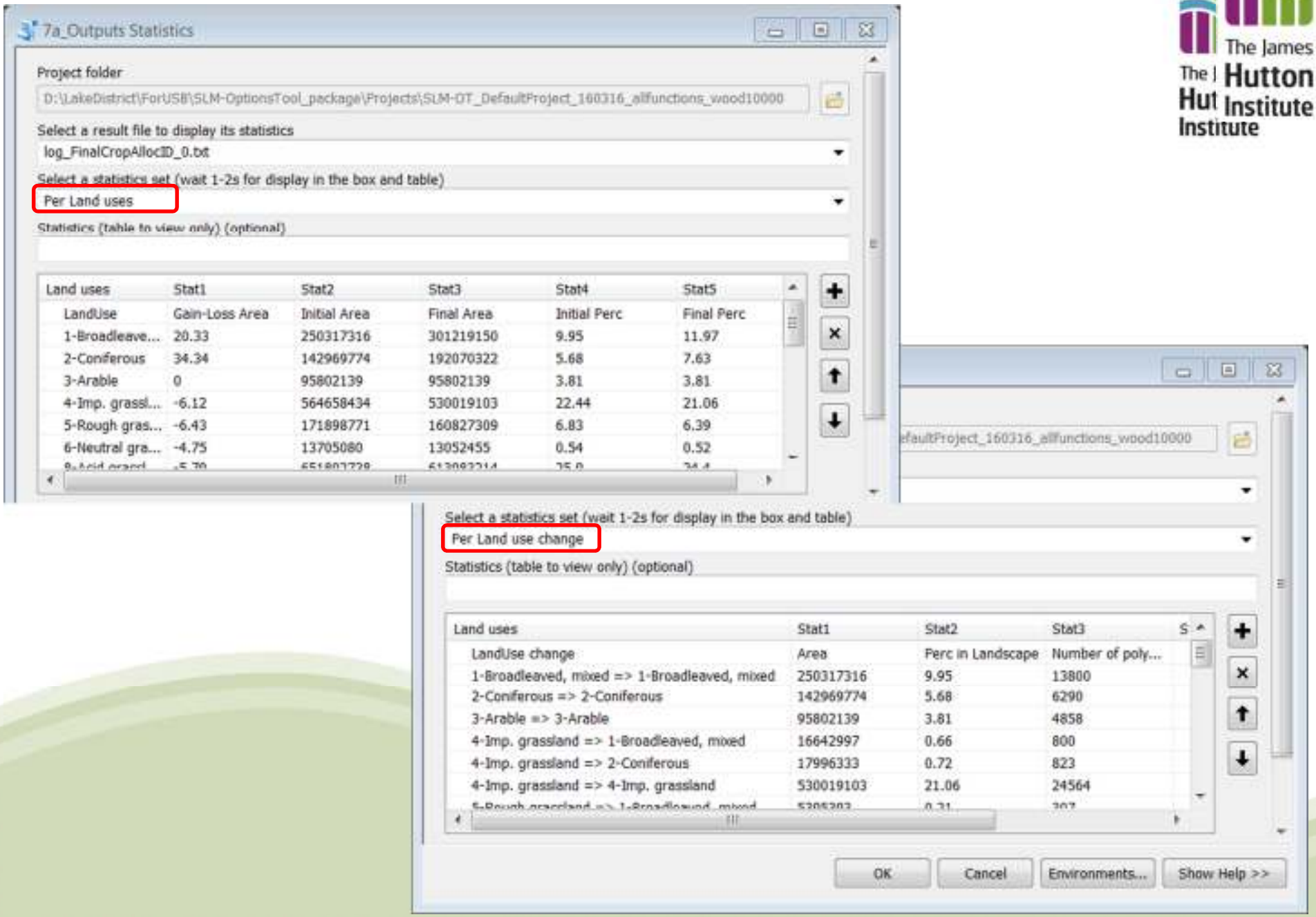


Running the model – Output map 2

- Land use map with only changed land uses



Viewing the results - Statistics



Scenarios

2 scenarios based on woodland expansion:

a) Enhancing water cycling

- 3 land functions:
  - water cycling – purification
  - water cycling – nutrient
  - erosion regulation
- 2 sub-scenarios

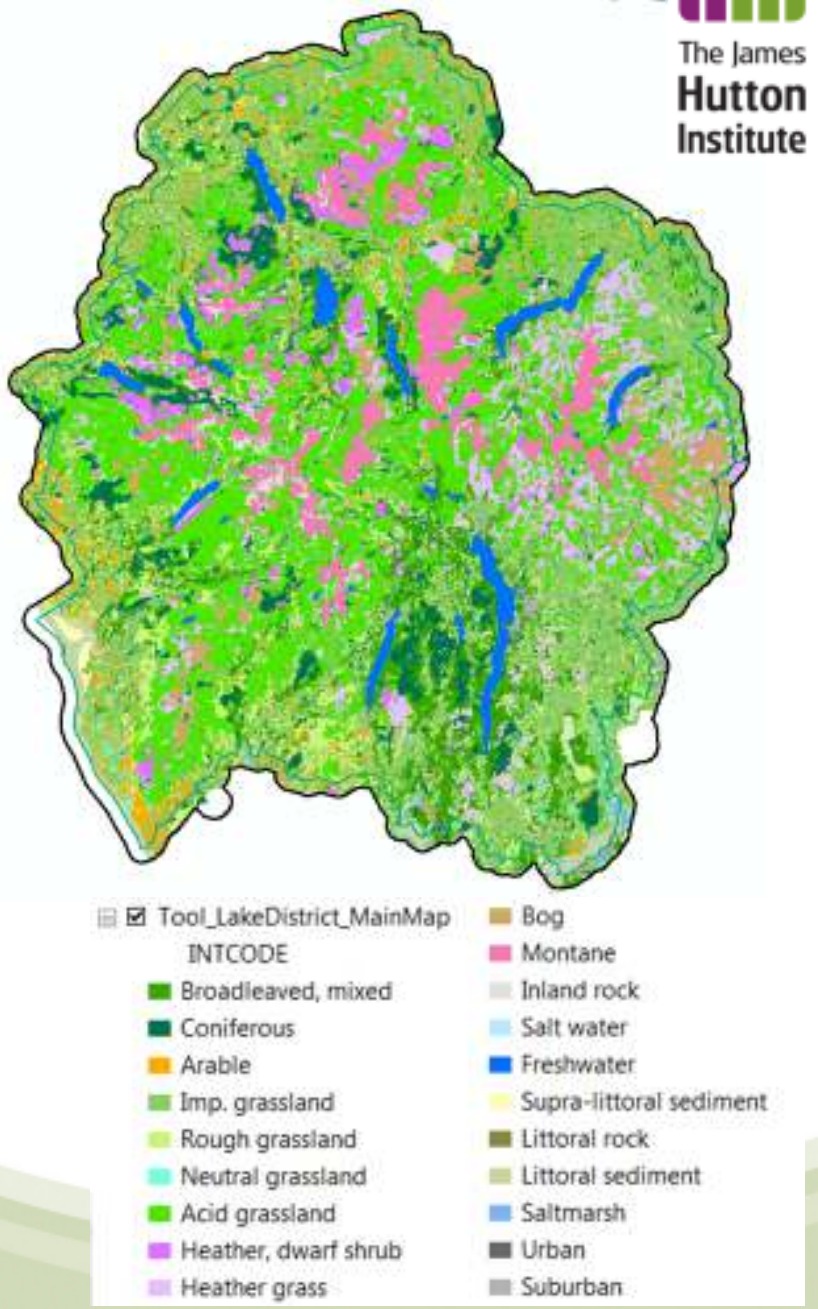
b) Enhancing all 10 land functions

- Highlight complexity & output variability

Scenario

Expand woodlands to enhance water quality

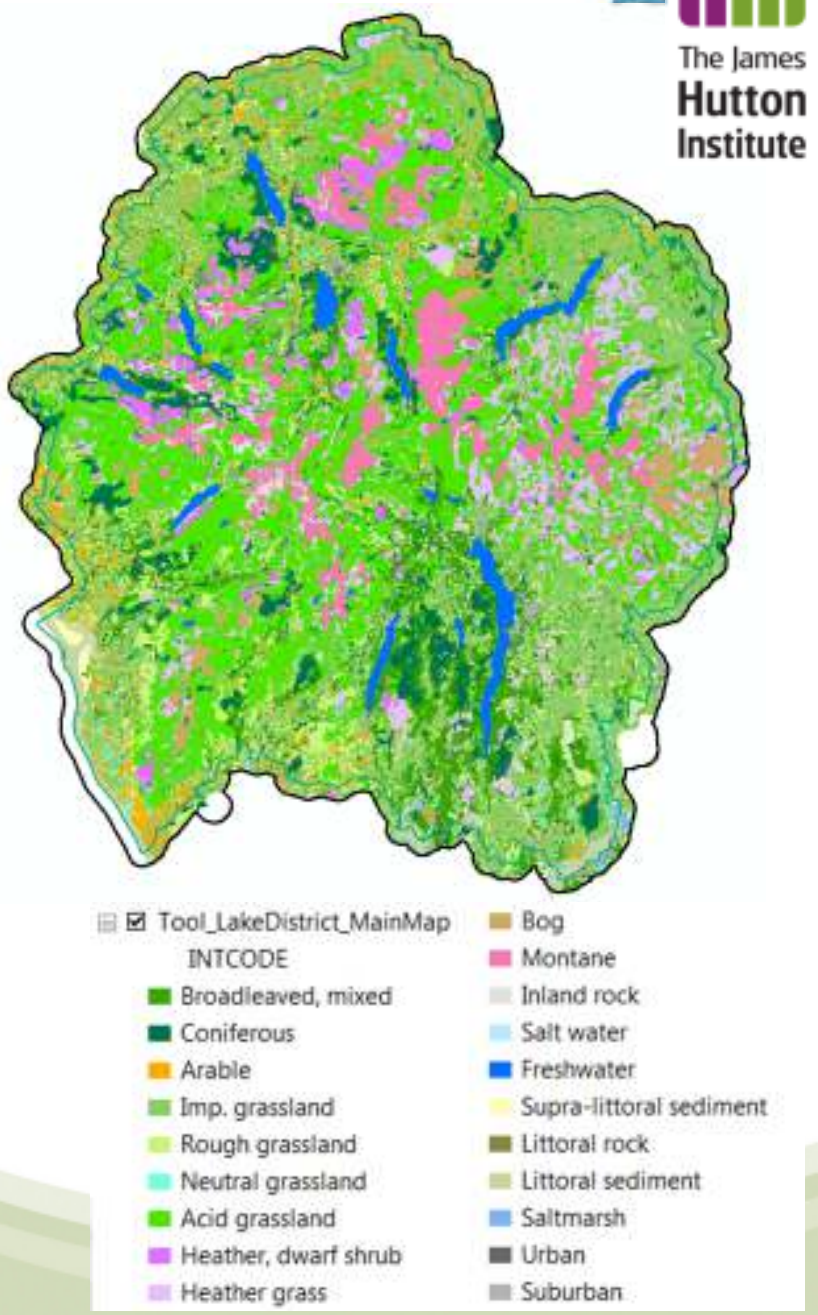
- LCM2007 (vector)
- Woodland expansion (10,000ha)
- No arable decrease
- 3 land functions with equal weights
  - water cycling – purification
  - water cycling – nutrient
  - erosion regulation



Expand woodlands to enhance water quality

- LCM2007 (vector)
- Woodland expansion (10,000ha)
- No arable decrease
- 3 land functions with equal weights
  - water cycling – purification
  - water cycling – nutrient
  - erosion regulation
- **Priority areas for LU change**

Enforce constraint:
Protected Habitats with no LU change

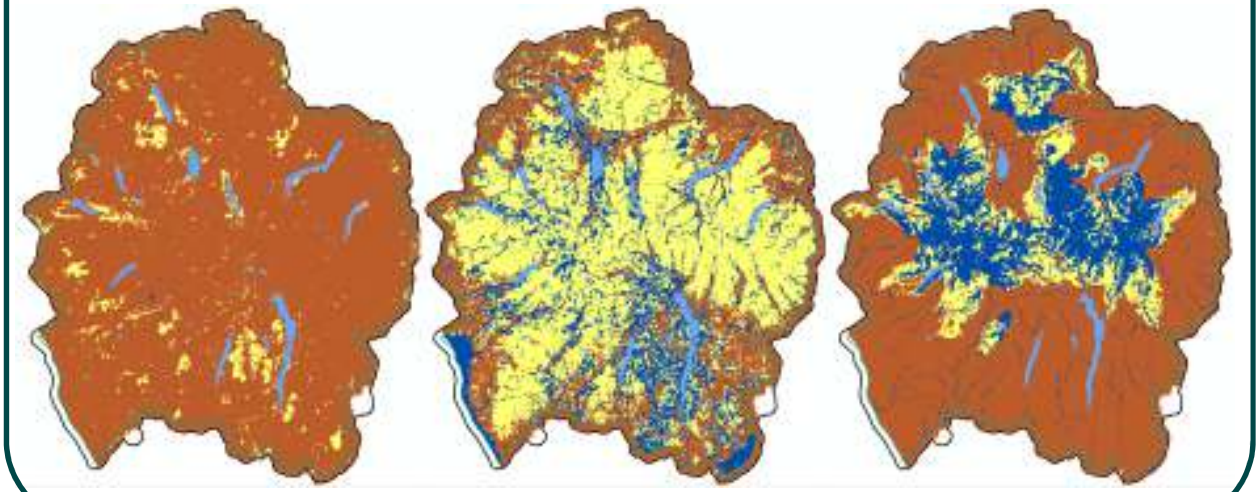


Scenario

a) Enhancing water cycling – land functions

Opportunity maps

- 0 : no land use change
- 0.2 : low probability of land use change
- 0.5 : high probability of land use change



Weight of these functions in comparison to others

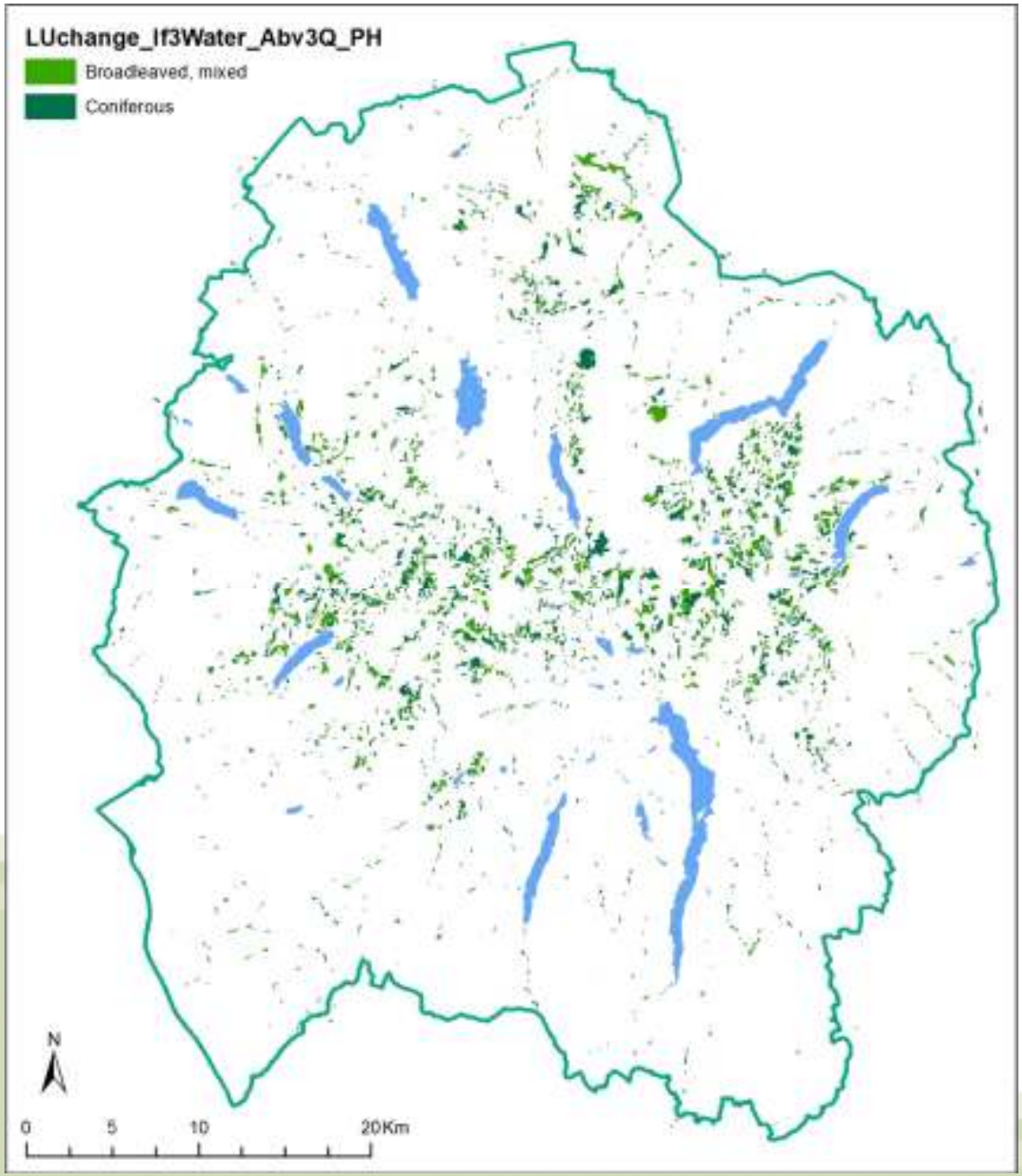
(non-spatial)

Land functions in the tool	Weights
Glob.Clim.Reg.Carbon	0
Water cycling - Purification	0.34
Water cycling - Nutrient	0.33
Erosion Regulation	0.33
Woodland Connectivity	0
Production - Crops	0
Production - Fodder	0
Production - Timber	0
Visual amenity and recreation	0
Landscape cultural heritage	0

Land use transitions matrices

Scenario

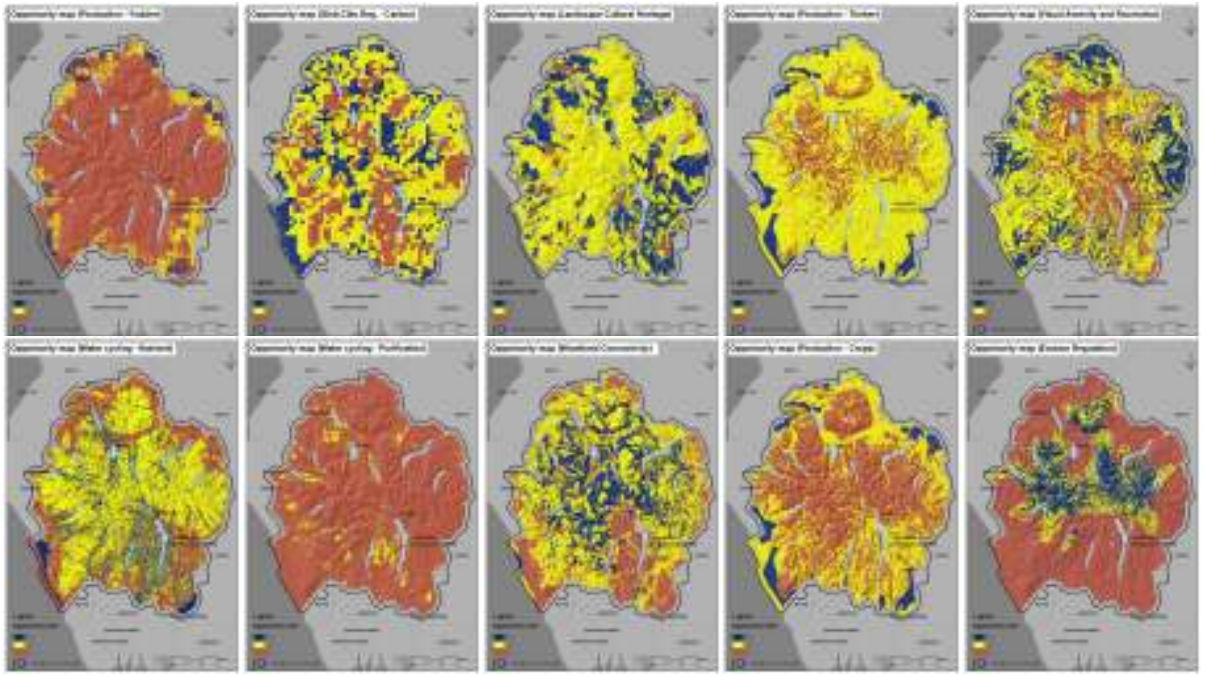
Water, priorities 3q + protected hab. – option 1



Scenario

b) Enhancing all 10 land functions scenario

- LCM07 (vector)
- Woodland expansion (10,000ha)
- No arable decrease
- Considers 10 land functions (opportunity & matrices), equal weight all functions

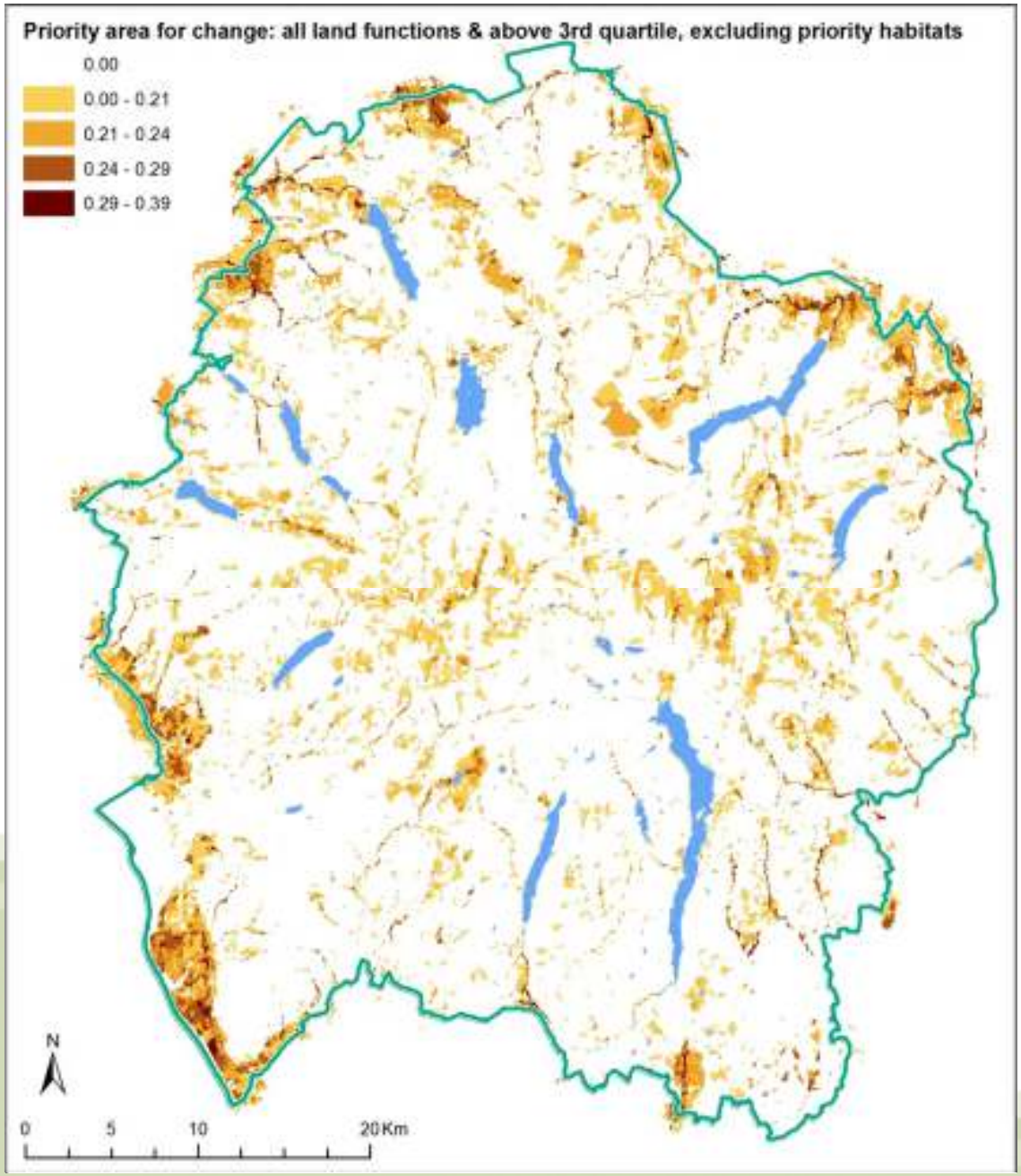


- Priority areas for LU change:
  - 10 land functions
  - values above 3rd quartile only
  - excludes priority habitats

Scenario

b) 10 land functions scenario, priority areas

Woodl. Expans.



10 land function opportunity maps

+ only above 3rd quartile

+ 'Protected Habitats' with no LU change

Scenario

10 land functions scenario, 1 example option

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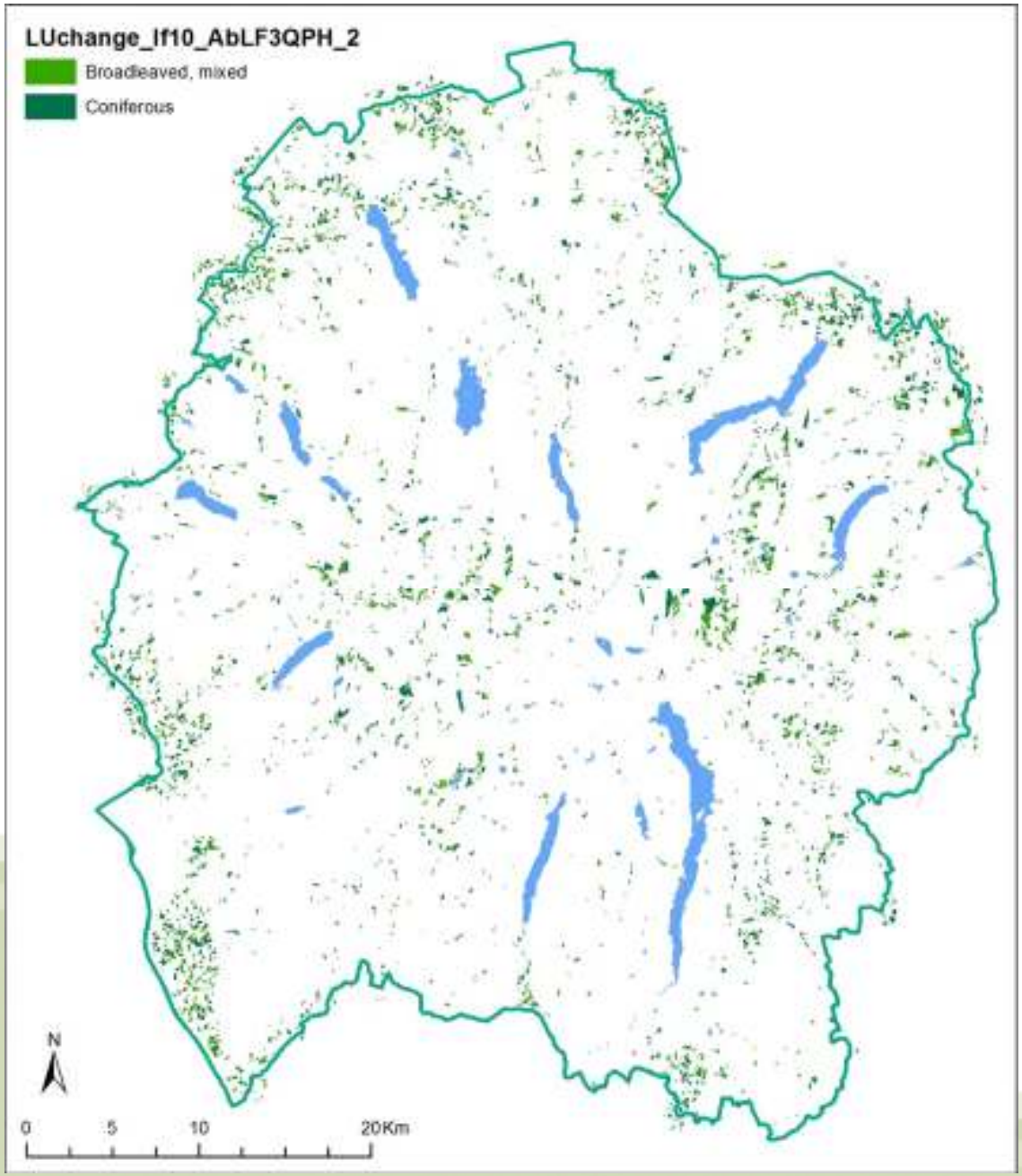
Woodl. Expans.



Equally weighted functions

Potential developments

- **for ArcGIS front-end tool**

  - Interface enhancements beyond NT project

    Implementation in Scotland for scenario development and analyses

    - allow **new area of analysis** and base maps (i.e. outside of Lake District)
    - allow **new land use classes** (e.g. to include land management)
    - multi-years scenario
    - Training sessions

Potential developments

- further output **interpretation tools**
  - if multiple runs: **summary map over** all new landscapes
  - Spider diagrams
  - export for **GoogleEarth**

Many Thanks for your Attention !

The James Hutton Institute

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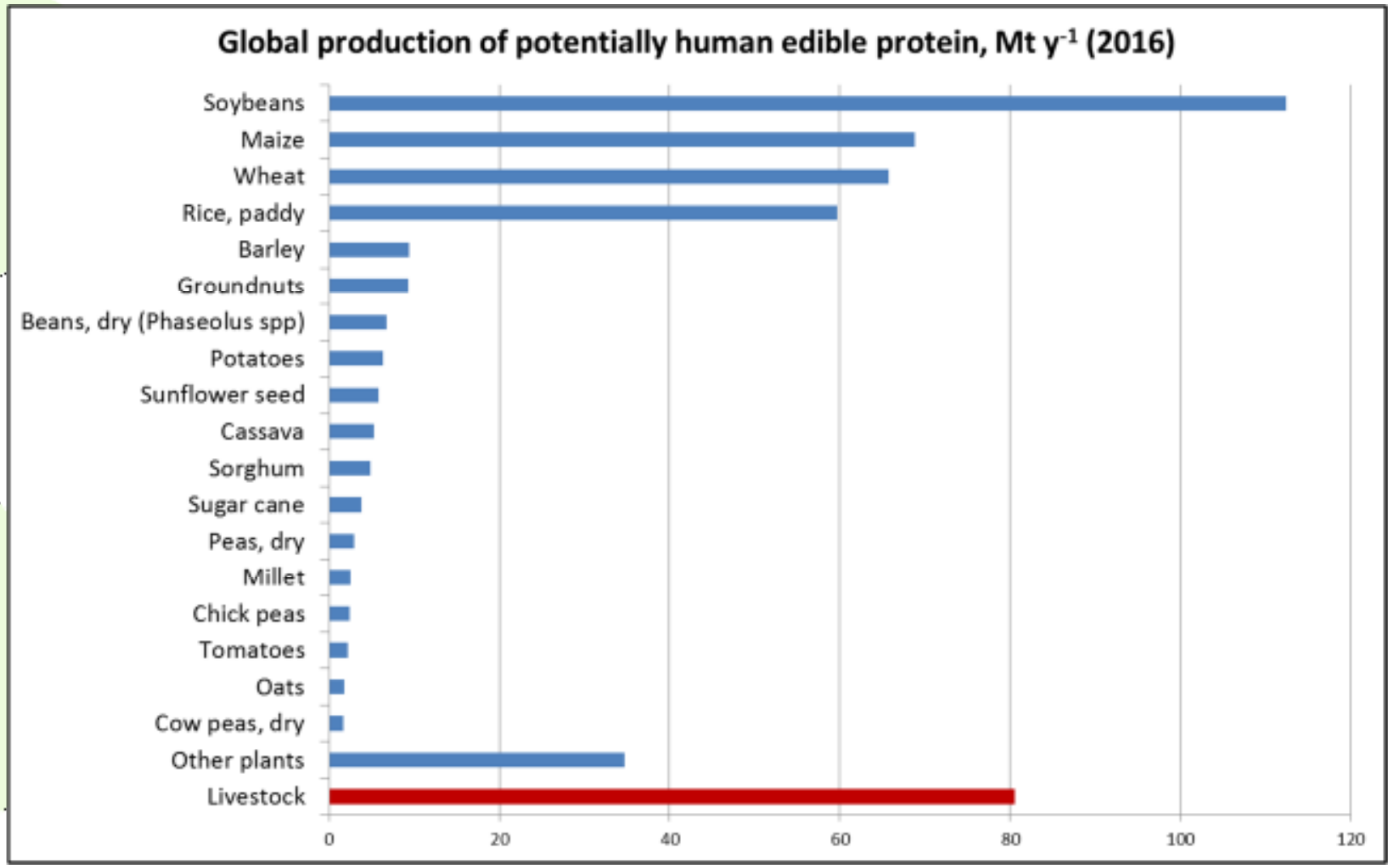
Land requirement for sustainable protein production

Ilkka Leinonen
SRUC
21/01/2019

Leading the way in Agriculture and Rural Research, Education and Consulting

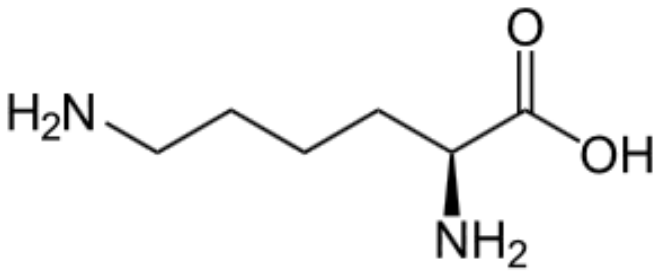
Background: global protein production



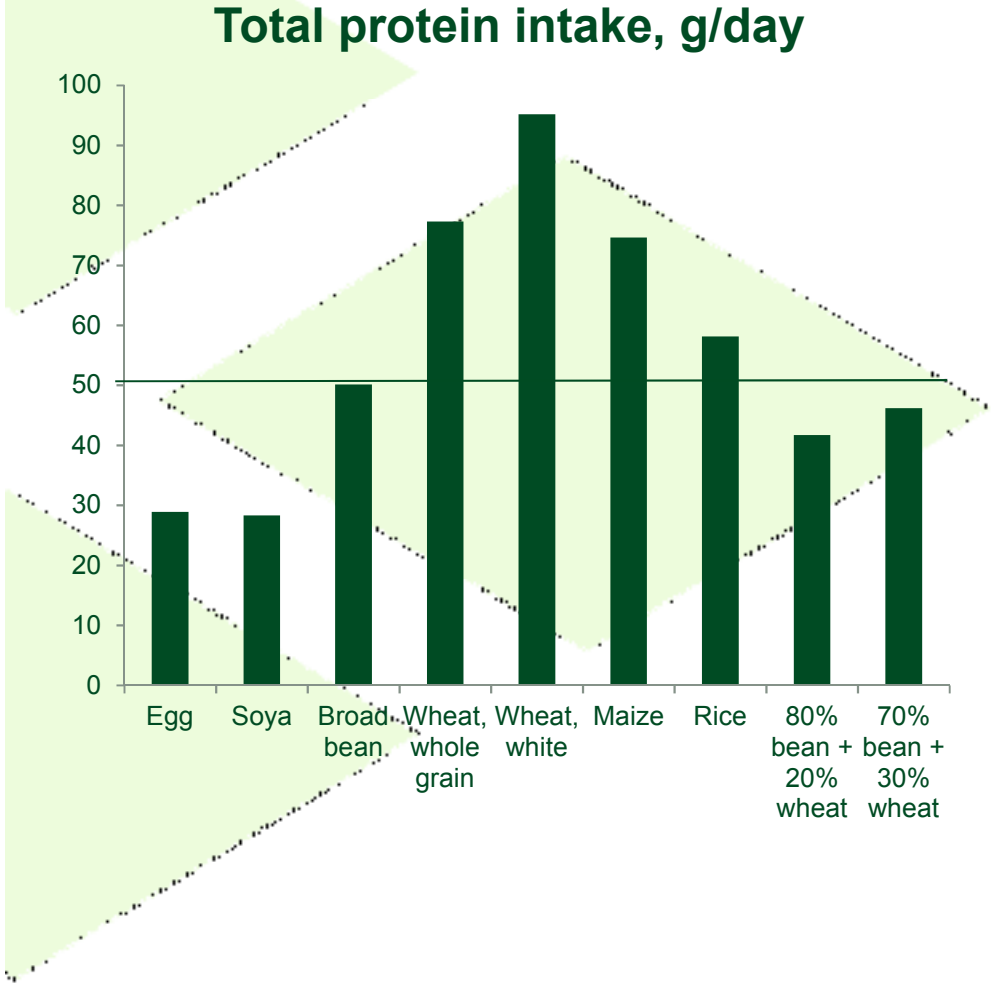
Sources: FAOSTAT, USDA etc.

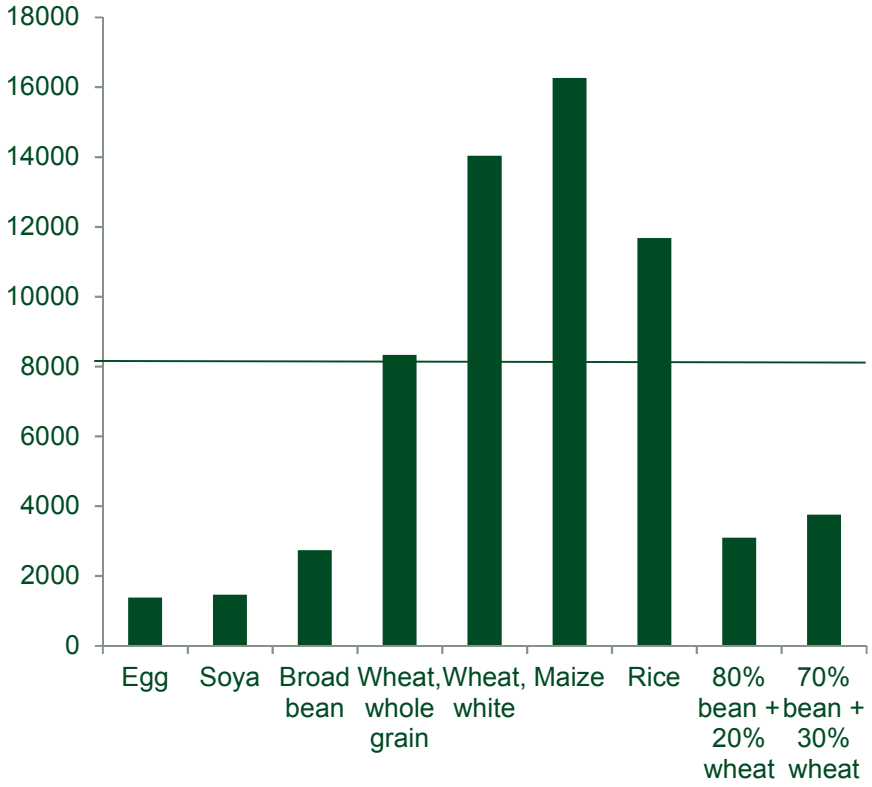
Background: quality of protein is critical

- Daily protein intake must contain a **sufficient amount** of **all** essential amino acids
  - Phenylalanine
  - Valine
  - Threonine
  - Tryptophan
  - Methionine
  - Leucine
  - Isoleucine
  - Histidine
  - **Lysine** (low in cereals)

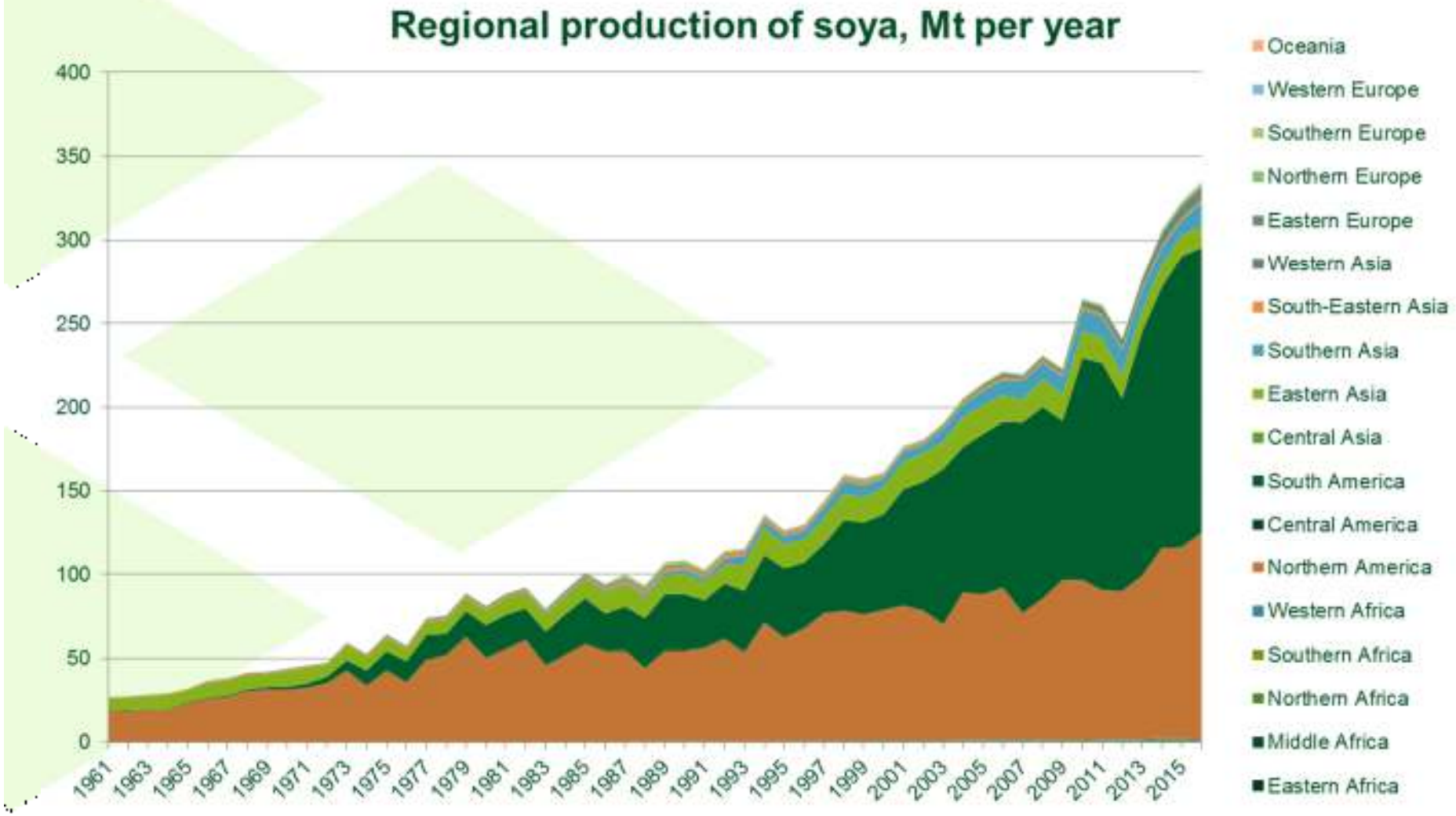


Getting lysine and other essential amino acids from food





Soya: main global source of plant-based lysine

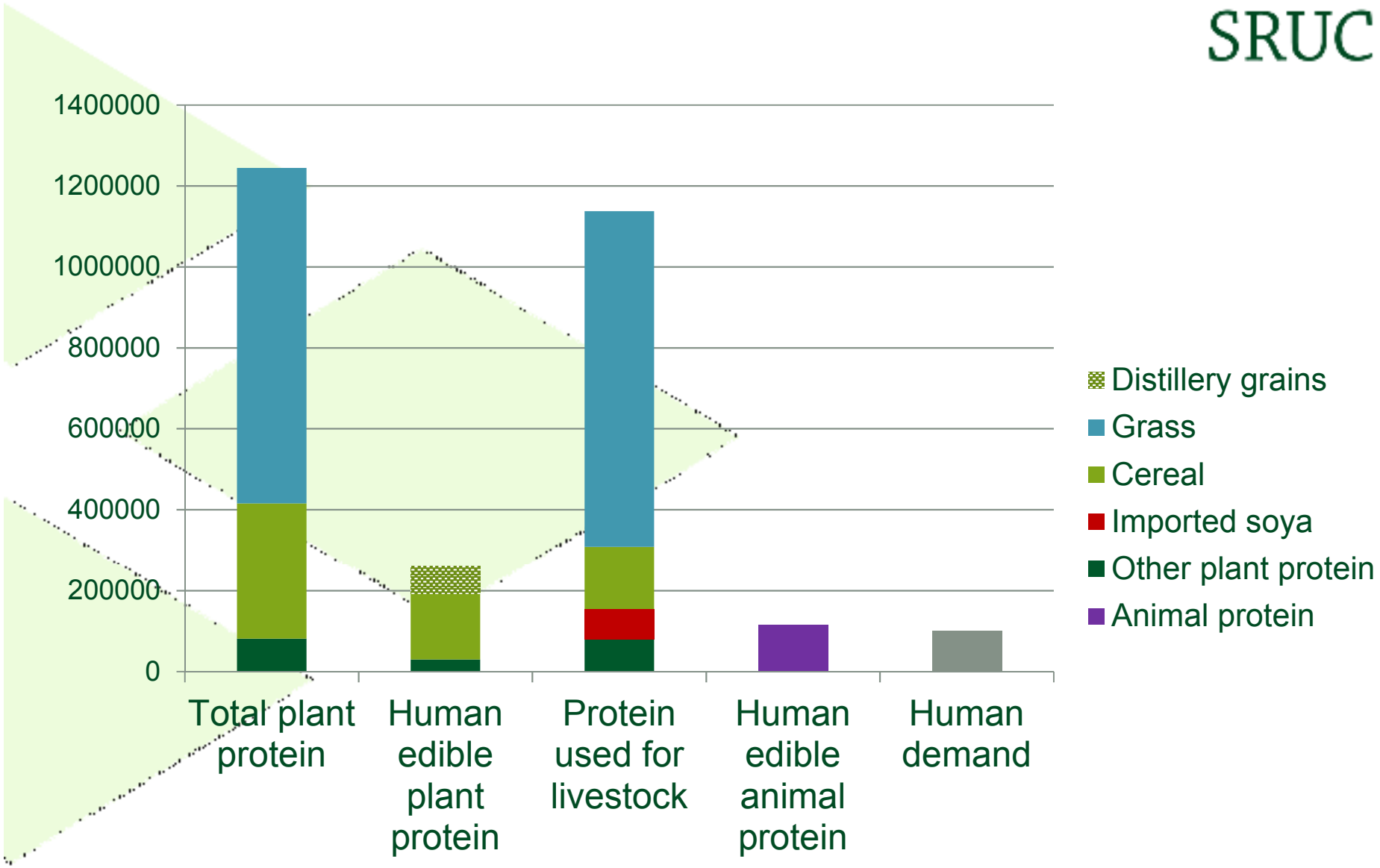


Source: FAOSTAT

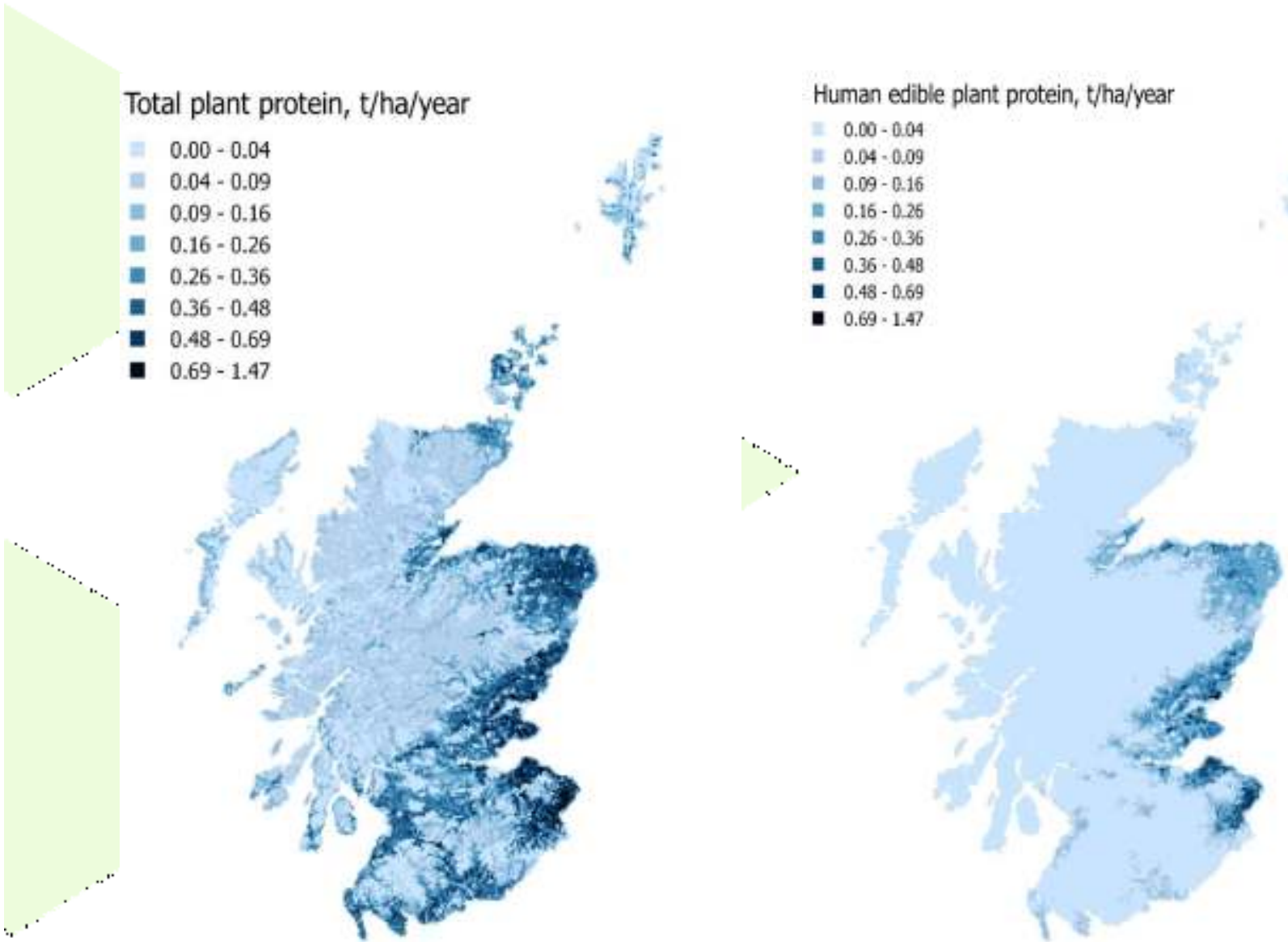
Protein production and demand in Scotland

- Tool: Scottish Agricultural Emission Model (SAEM)
  - One of the few tools that can handle the whole livestock production chains
- Input data:
  - Agricultural census and ERSA data on livestock numbers, area of crops and grassland, crop yields
  - Structure of Scottish livestock systems and data on animal performance (e.g. QMS, BPEX, poultry industry)
  - Feed information (e.g. Defra, livestock industry)
  - Protein and amino acid contents of products (e.g. USDA)
- Outputs
  - Plant protein (and amino acid) production
  - Livestock demand for protein and other feed
  - Protein (and amino acid) outputs from different livestock systems

Protein production and use in Scotland, t/year

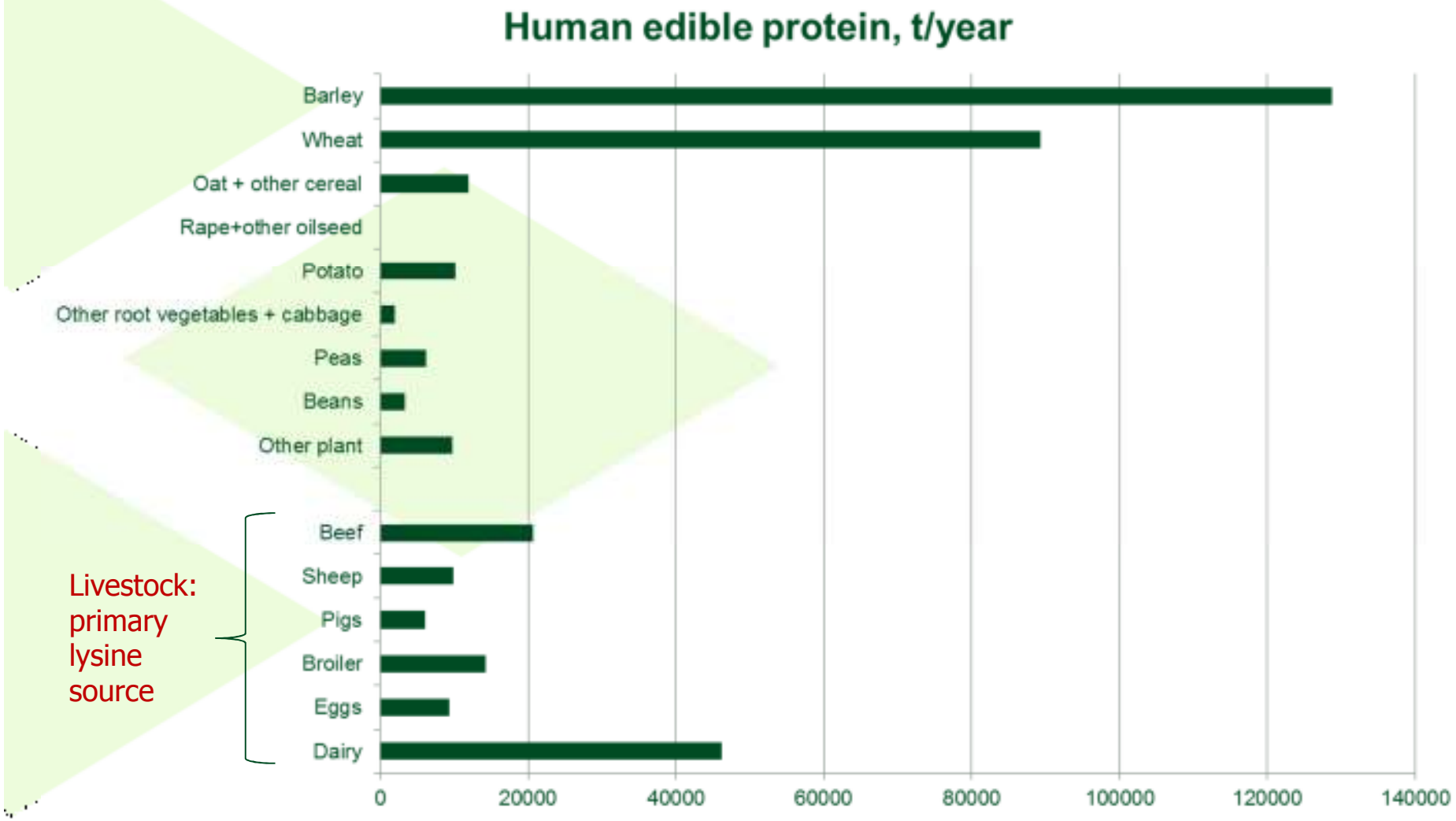


Plant protein production in Scotland



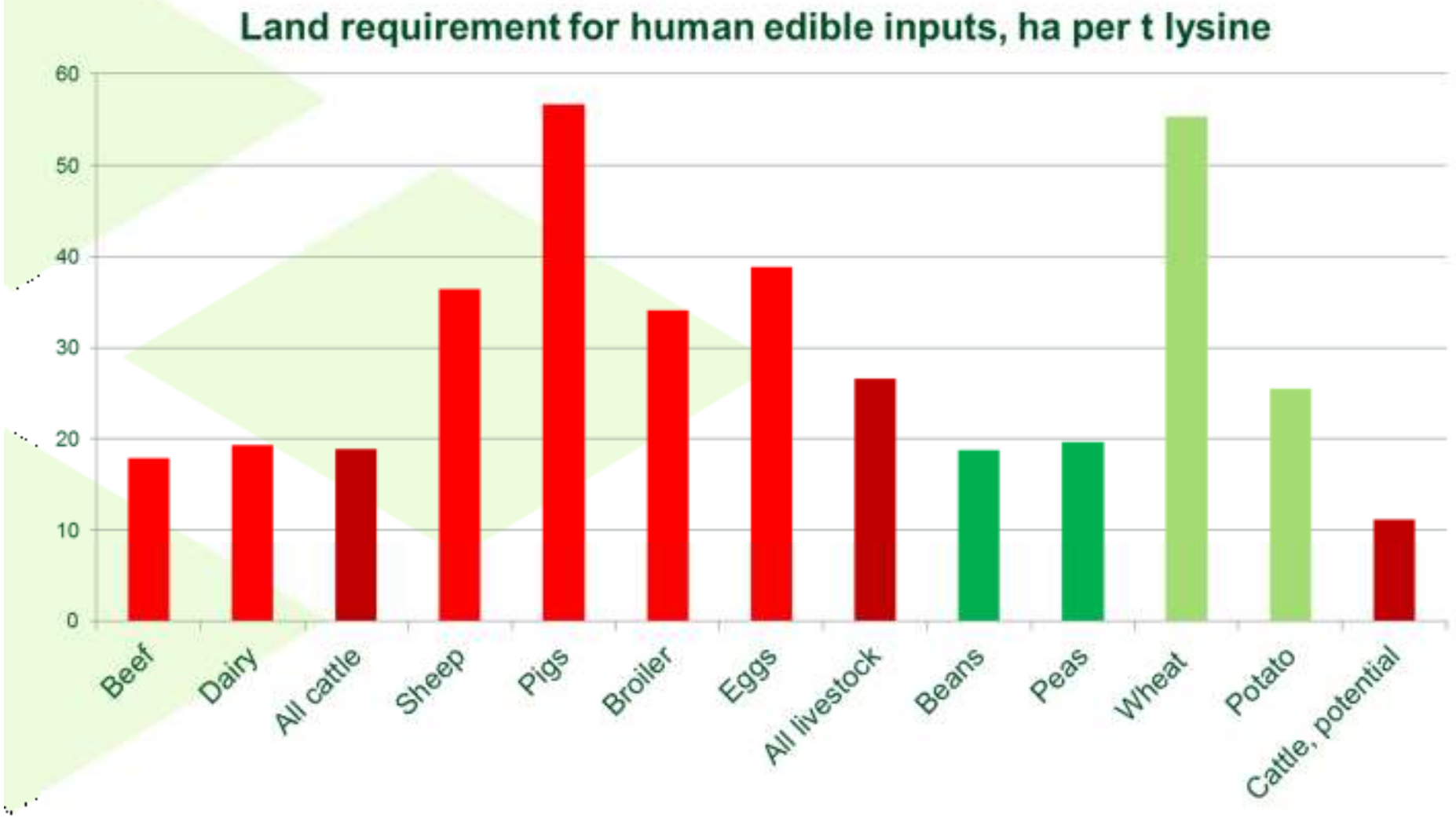
(Source of spatial data: EDINA agcensus)

Potentially human edible protein in Scotland



Sources: ERSA, EDINA agcensus etc.

Land use and lysine production in Scotland



Future of Scottish protein production?

- GHG mitigation-> shift from animal protein to plant protein?
- Should not compromise the quantity/quality of protein produced (e.g. lysine content)
- Replacing animal-based lysine by plant-based lysine (beans and peas) grown in Scotland?
  - Land requirement: about 170 000 ha need to be converted to bean/pea production
  - This land can be released from current livestock feed production
- Continuing low-input livestock production?
  - Utilizing land that is not suitable for human edible protein production
- Increasing the use of by-products in livestock feeding?

New instruments for multiple benefits

Kirsty Blackstock, Kerry Waylen, Alba Juarez-Bourke, Jessica Maxwell and Sophie Tindale

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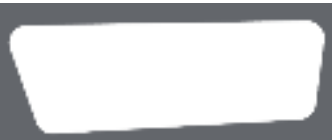
SEFARI
LEADING IDEAS FOR BETTER LIVES

INTRODUCTIONS



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Context

- Protection & restoration of natural assets
  - Scottish Government policy objective
  - Paris Accord, Sustainable Development Goals

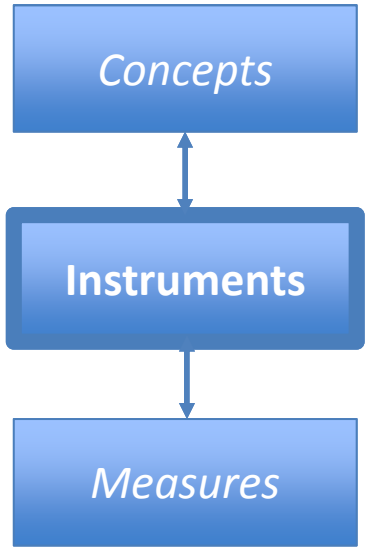
- Interest in the role of the private sector:
  - Limited public sector funding
  - More salient = more engagement with other actors

Objectives

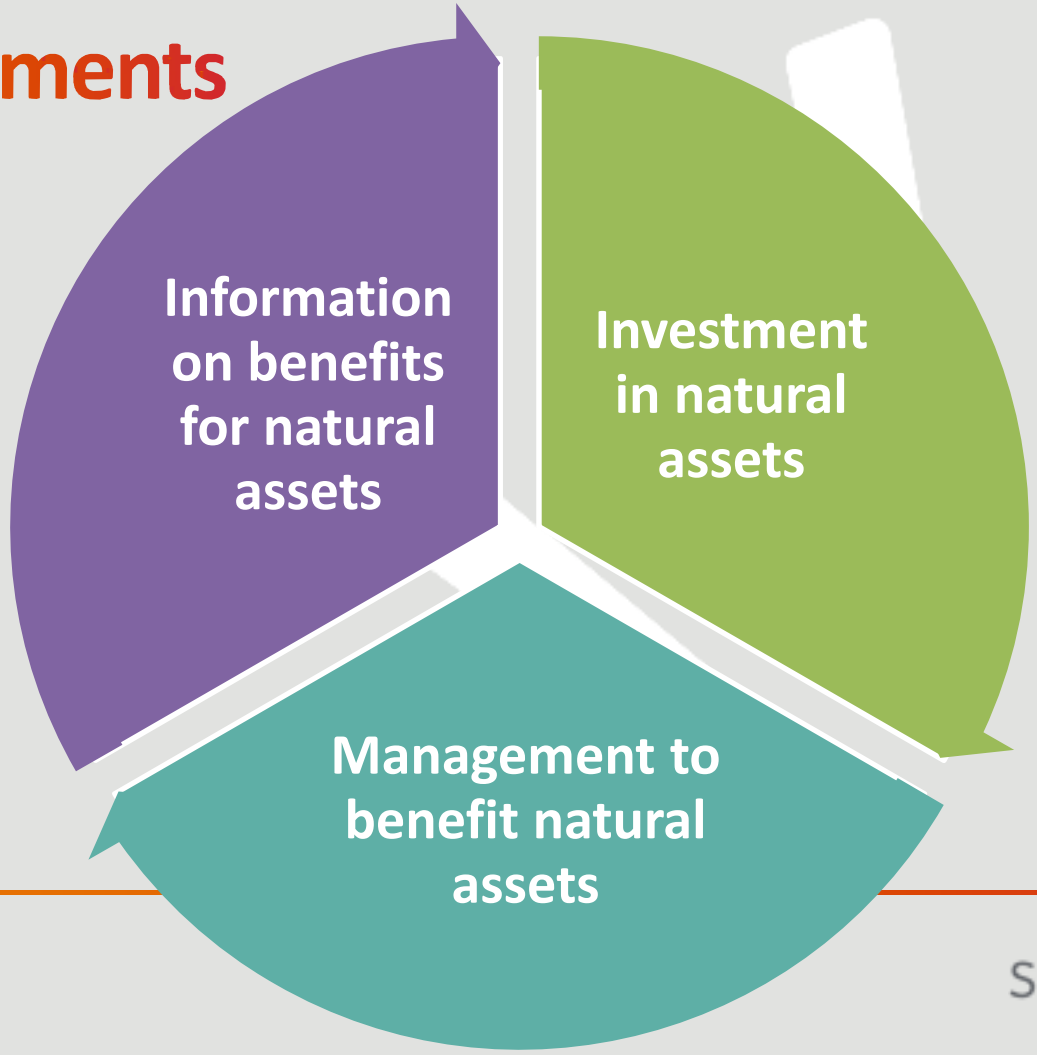
- Scope the range of instruments that can be led by non-state actors and are relevant to integrated management of natural assets;
- Focus on those that have emerged within the last decade, or where existing approaches have a novel twist; and
- Assess what is claimed about these instruments and whether they might deliver more than existing public policy-led approaches.

Focus

- Environmental stewardship by private sector not new
  - ➢ focus on those that are novel for Scottish land-based sector.
- Instruments initiated or led by private commercial companies that
  - ➢ reduce pressure on natural assets and invest in their protection.
- Voluntary action that go beyond compliance



Types of instruments



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Investment	Management cont.
Green Finance	Sustainable Procurement
Impact Bonds	Best Practice Guidance and Tools
Offsetting	Non-State Standards
PES Including Investment Models	Sustainable Supply Chain Management
Public-private Partnerships	**Information**
Management	Accreditation, Certification and Labelling
Conservation Covenants	Ecological Footprinting
Corporate Social Responsibility	Product Premiums
Green Lending Policies	Sustainability, Triple Bottom Line or True Cost Accounting

Investment

- Motivations - profit (investors) new sources of capital (Government)
- State and third sector are involved – brokers and accountability
- Not many examples - very few active examples in the UK or Scotland

- Private sector claimed to be more efficient but this is disputed
- ‘New’ investment or redirected existing investment?
- Alignment of profit motivation with conservation; alignment of business return period with natural cycles?

Management

- Individual companies & collective (sector) approaches – interact
- Motivations (private sector) protect supply chains, self-regulation, responsible global citizens – achieving Government and NGO aims
- State and third sector are involved – accountability, level playing fields

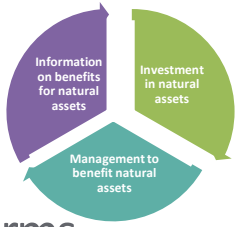
- Not new so much as increasingly mainstreamed
- Little data about to what extent they achieve protection and restoration of natural assets

Information

- Motivation – social licence to operate & brand differentiation
- 3rd sector involved – scrutiny and accountability, level playing fields
- 'Green washing' - only about product premiums brand differentiation OR changing norms of usual business practices?

- Not new but still powerful
- Mixed results on whether result in changed consumption practices

Summary



- Interconnected – information for investment, invest if well managed etc
- Not simple profit motivation –collective action, risk minimisation & social norms
  - Are they more effective? Fashion or improvement?
- Sustainability focus from multi-nationals
  - Transferability to Scottish land-based sector
- Appropriate for common pool or public goods?
- Not private v public sector - public-private-civic partnerships
  - Raises questions about 'private governance' (power, authority, accountability)
  - New skills and competencies, new ways of working

Questions for Discussion

- Were these ‘new’ to you? Have you ever experienced them in your work?

- Is the focus on the private sector (commercial companies) useful?
- Is the categorisation of instruments as Investment, Management or Information mechanisms helpful?

- Are there other delivery mechanisms that should be explored?

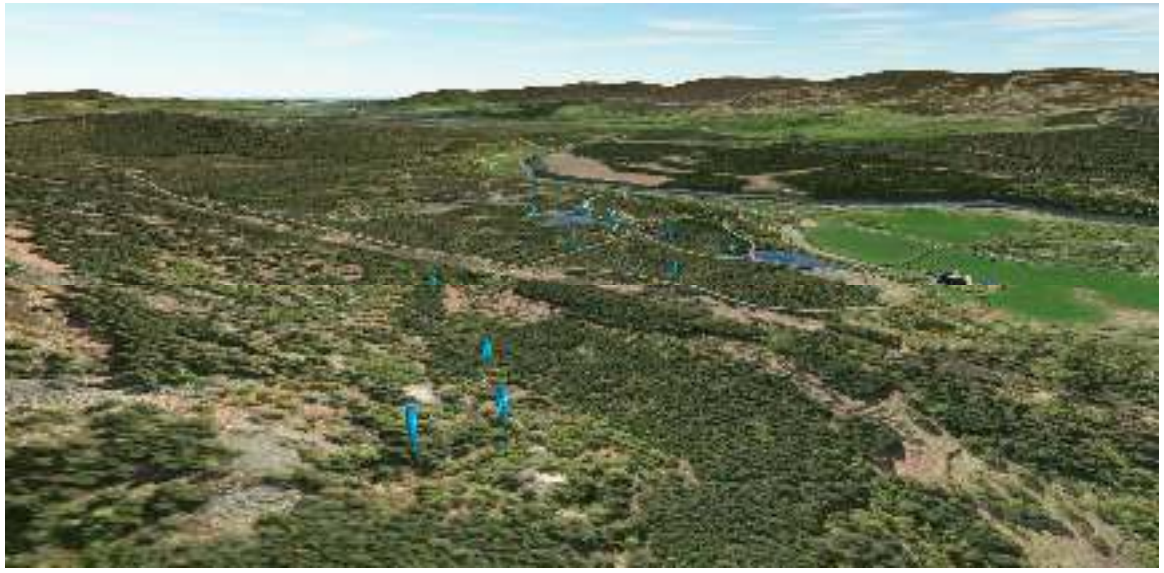
- What is the potential to transfer some of these mechanisms from other sectors or setting to Scottish land-based businesses?

Thank you

More information on project can be found at:
http://www.hutton.ac.uk/research/projects/analysing-how-policy-instruments-shape-soil-water-and-biodiversity

Research funded by Scottish Government Strategic Research Programme 2016-21

Forest Monitoring via Mobile Data Collection



Chen Wang and Alessandro Gimona

The James Hutton Institute

Scottish Government
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Introduction

The James Hutton Institute

- Introduction
- Creating and Designing ODK Monitoring Form
- Collect Data Through Mobile Device
- Visualizing Geographic data
- Implement in Pilot Sites: Tyrebagger and Cambus o'May
- Conclusion
- Demo

Introduction

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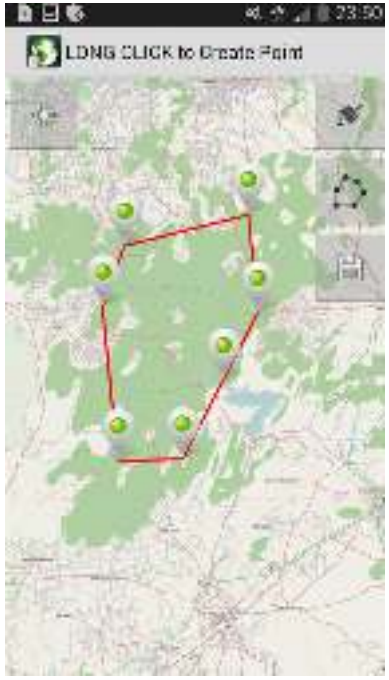
Community based monitoring have covered a wide range of applications, ranging from forest condition survey, natural disaster assessment and public health surveillance.

There are many arguments that lack of data to study how ecosystems work is an issue.

Compared with traditional data analysis through printed questionnaires, we propose a new method for forest data collections by use of mobile devices.

ODK

- Open Data Kit (ODK) is a suite of tools to help data organizations, including data collecting, aggregation and visualization.



GeoODK Collect, https://play.google.com/store/apps/developer?id=GeoODK

ODK Components

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- ODK-Build

ODK Build is a drag-and-drop form designer for ODK XForms.

- ODK-Collect

ODK Collect is an Android app for filling out forms. It's been used to collect billions of data points in challenging environments around the world.

- ODK-Aggregate

ODK Aggregate is a Java server that stores, analyzes, and presents survey data collected using ODK Collect.

Creating and Designing ODK Monitoring Form

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The form contains location, audio, images, video, barcodes, signatures, multiple-choice, free text, and numeric answers.

Collect Data Through Mobile Device

- It provides offline/online mapping functionalities, the ability to have custom map layer, as well as new spatial widgets, for collecting points and polygons.

Visualizing Geographic data

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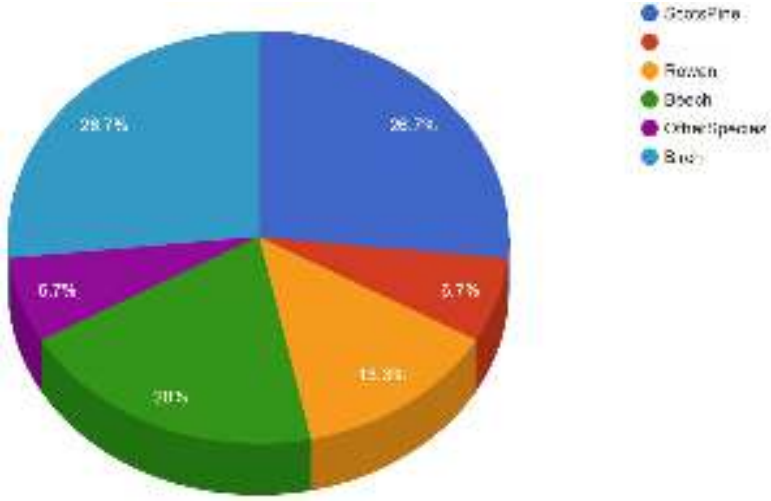
Geographic data has been presented on a custom map using Google My Maps, visualized through bar graph and pie chart, annotating by google earth.

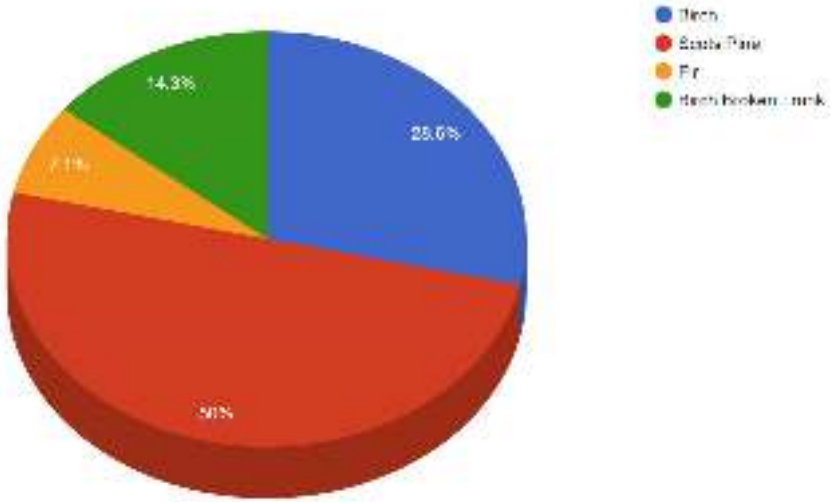
Implement in Pilot Site: Tyrebagger

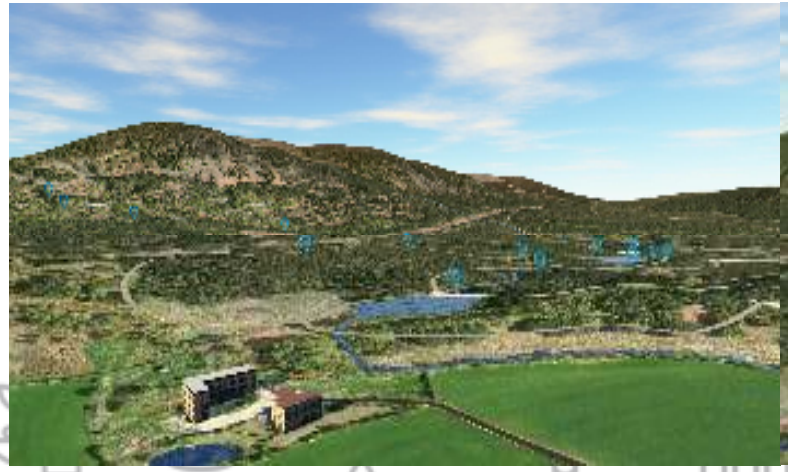
- Tyrebagger is a mature forest with its broadleaves and conifers.



Implement in Pilot Site: Cambus o'May

- Cambus O'May is on the north side of Dee River between Ballater and Dinnet with mixed conifer and birch wood.





Conclusion

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- We have tested the mobile application in Tyrebagger and Cambus o'May forests which contain different woodland types. Useful date related to tree species have been collected. Geo-reference ground photographs will be taken in other pilot sites which can help validate land-cover and soil maps. Further work can also focus on capturing forest activities such as small scale degradation, deforestation and reforestation.

Conclusion

- The findings have potential implications for the monitoring and assessment of woodland to increase the effectiveness of their use, and contribution to wider forest management. This has the potential to significantly change forest monitoring system which can provide local communities with information on indicators of forest loss, changing land-use practices and socioeconomic realities.

Demo

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- Forest Cambus o'May
- https://drive.google.com/open?id=19M8m6wE8geY_kk6hspP296k7wHqCgvlX&usp=sharing

- Forest Tyrebagger
- https://drive.google.com/open?id=1U9HEx6AoGWiKFFVx-DkSuKW8iNilC0Nq&usp=sharing

Acknowledgements

- This work is funded by Rural & Environment Science & Analytical Services Division of the Scottish Government.