SEFARI LEADING IDEAS FOR BETTER LIVES

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Ecosystems and Land Use Stakeholders Engagement Group (ELSEG)
Biodiversity – notes and presentations

Monday 21st January 2019, Victoria Quay, Edinburgh

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.

Appendix 1 - Presentations

The following pages show the biodiversity meeting presentation slides

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)

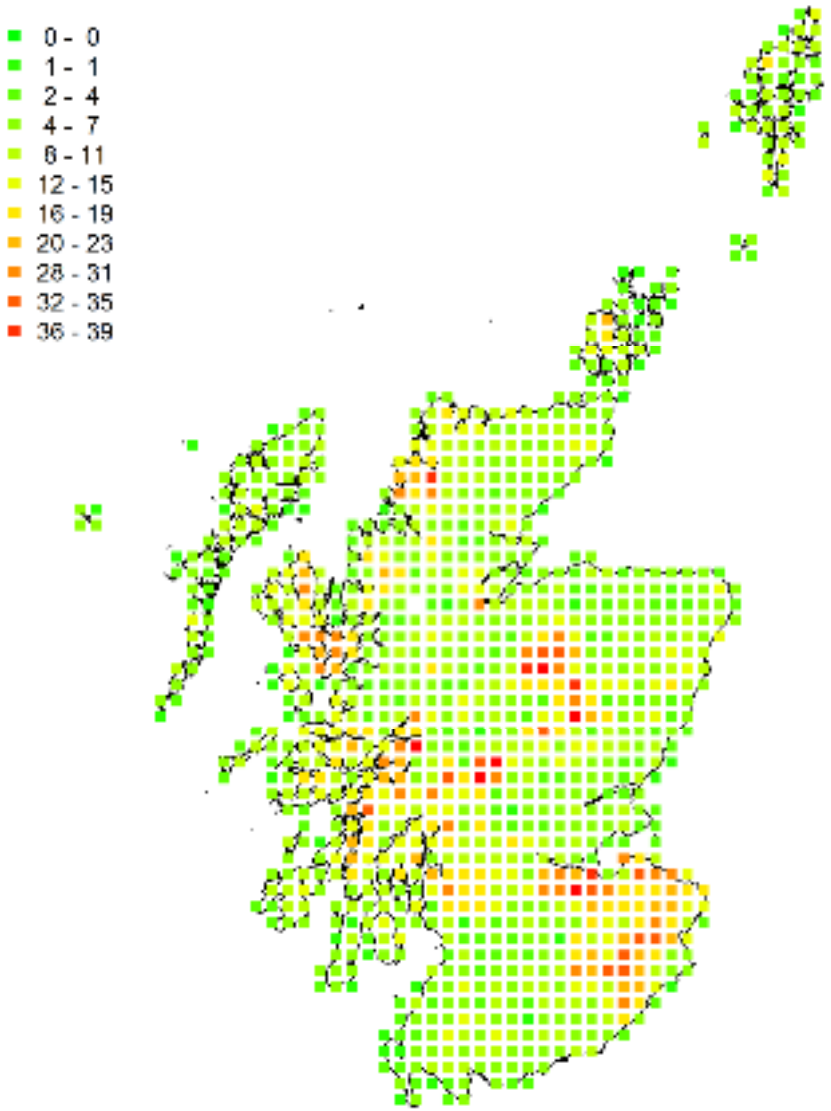
Bryophyte data

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

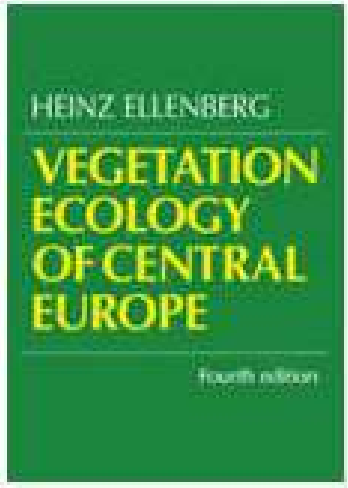


The approach

- 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)

The James Hutton Institute

- An example – your common lawn moss

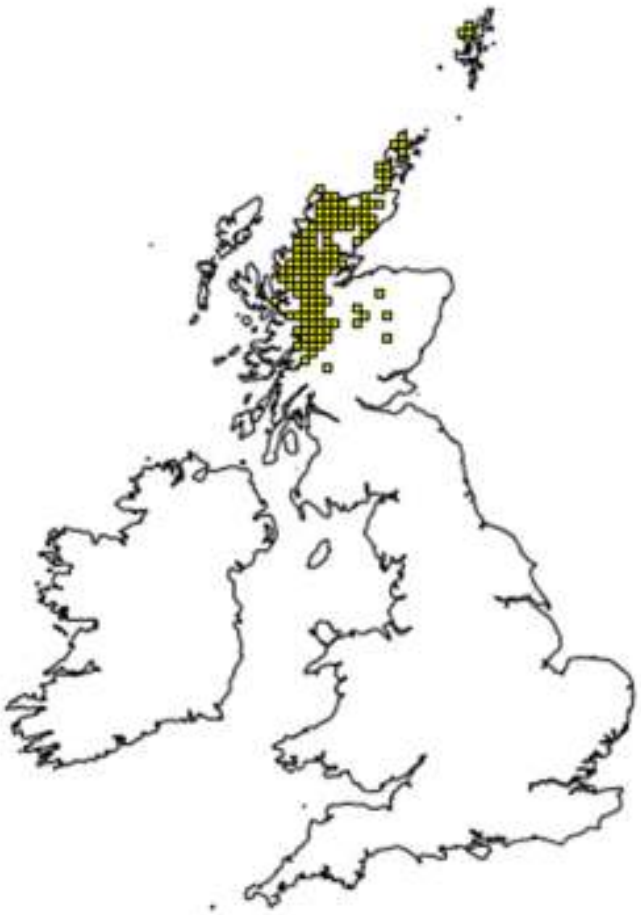
	L	F	R	N
Rhytidiadelphus squarrosus	7	5	5	4

- 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)

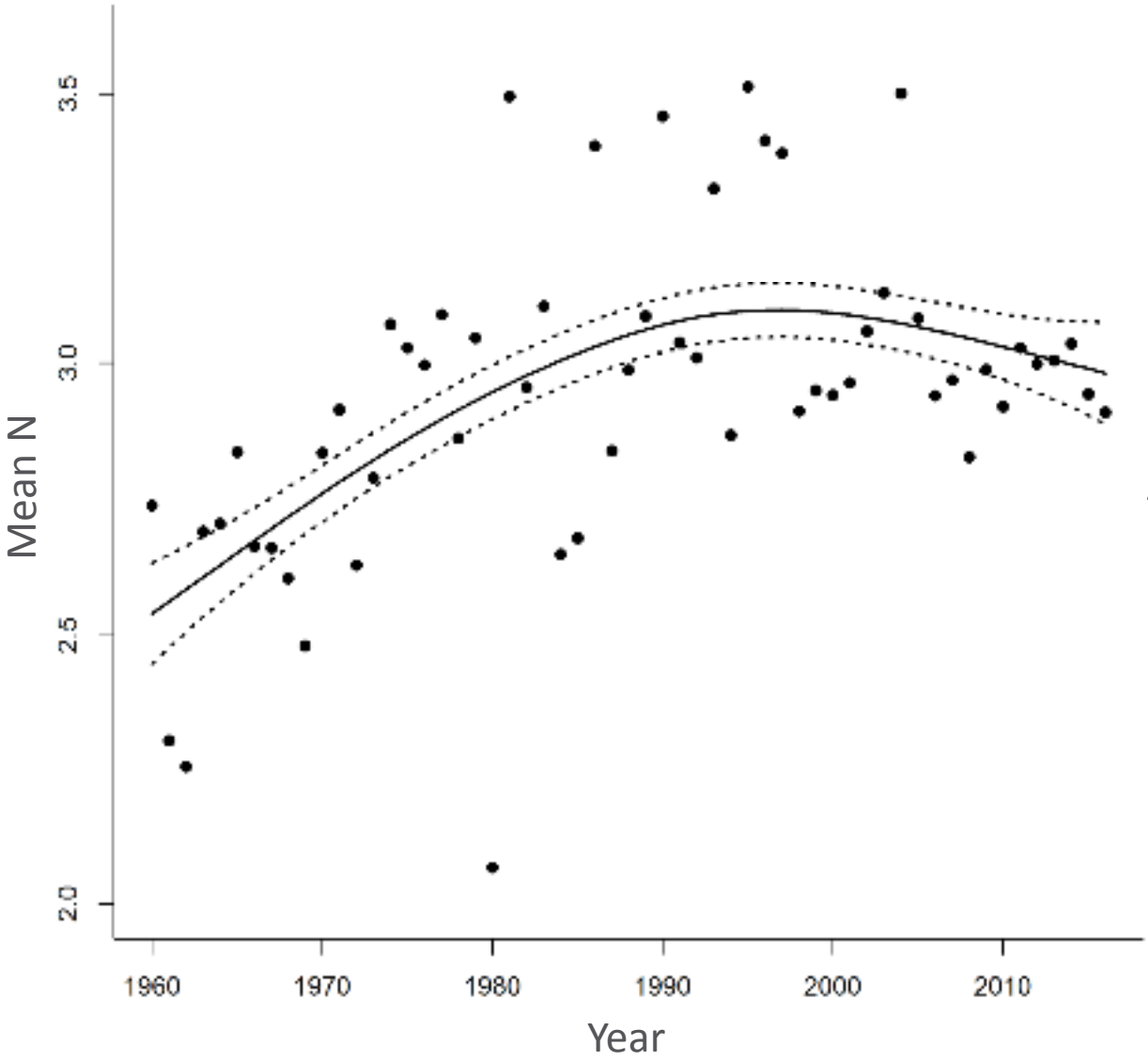


Cirsium acaule		*Arctostaphylos alpinus*
3.7	Tjan (°C)	1.6
16.1	Tjul (°C)	11.6
742	Prec (mm)	1750

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

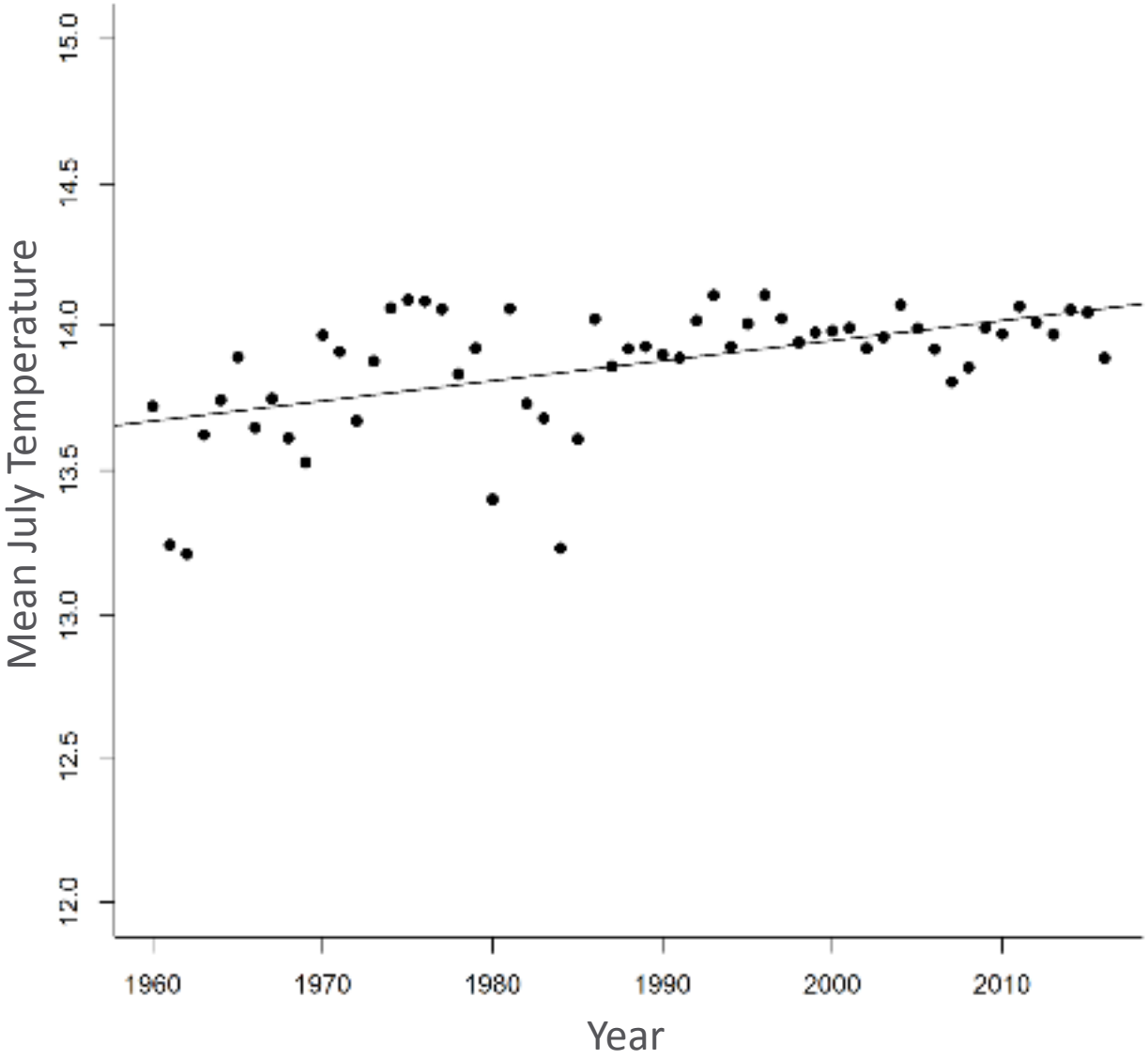
*Tests for the peak/trough to be inside the x-axis data range

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

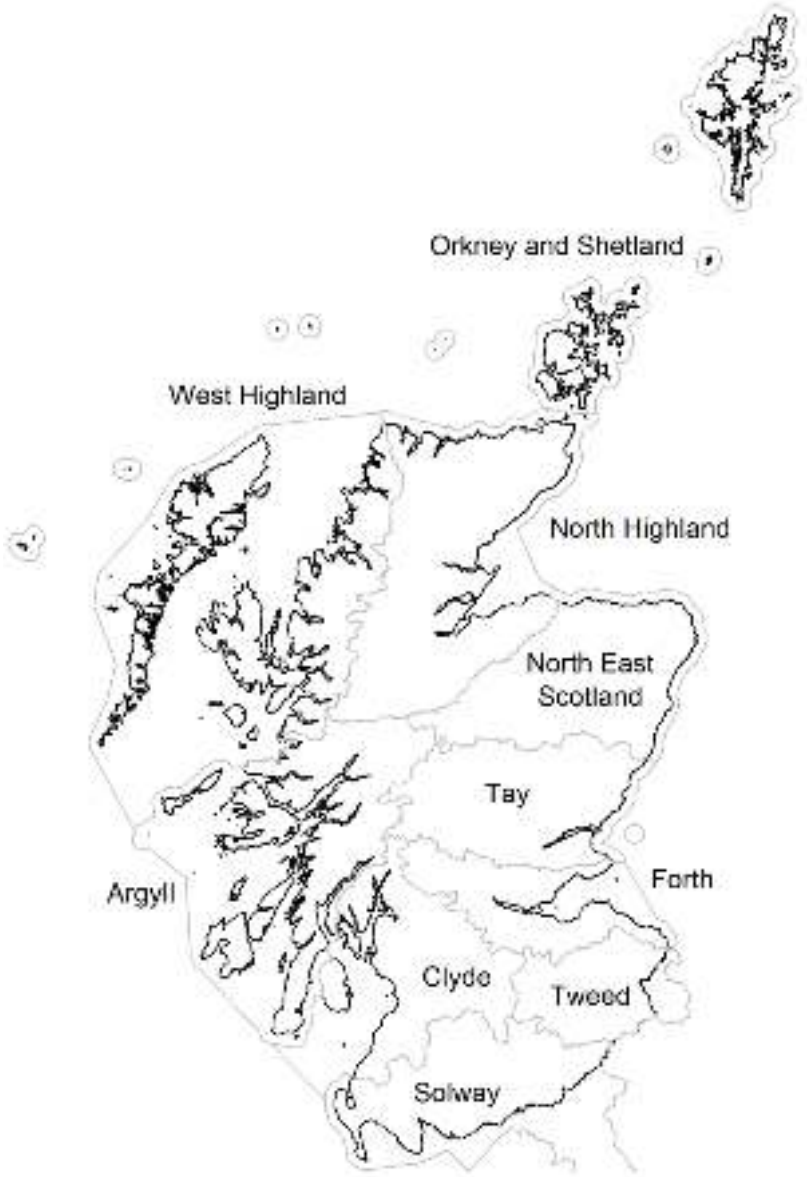
The results – July Temperature



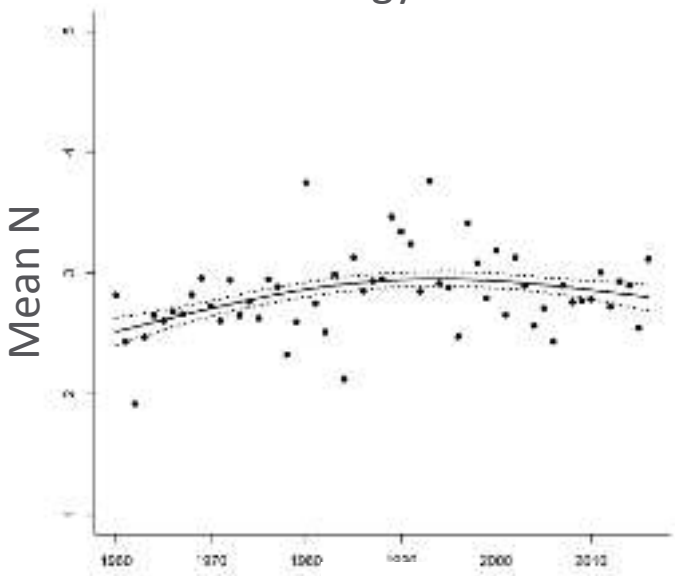
Interpretation - Temperature

- Tracking rising temperature

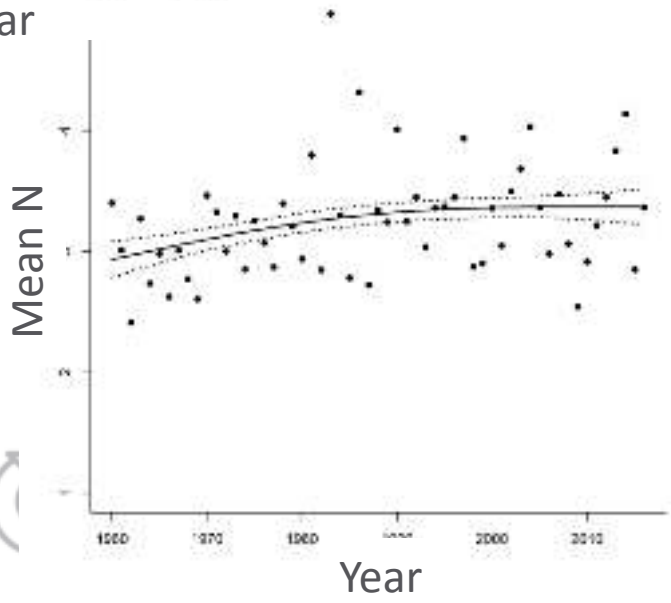
Sub-catchments (examples)



Argyll



Tweed



Conclusion

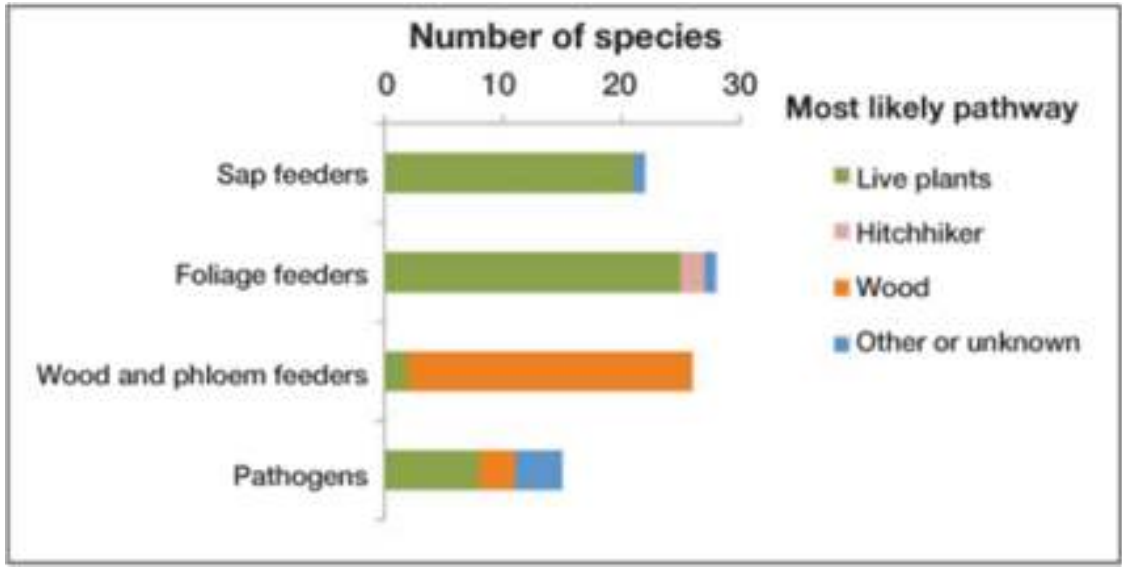
- Nitrogen appears to be a robust indicator of the impacts of nitrogen deposition
- Climate indicators are all highly correlated – July temperature indicator easier to present
- Indicators are down-scalable to catchment and habitat, but power to detect change is limited for some areas/habitats

Royal Botanic Garden Edinburgh

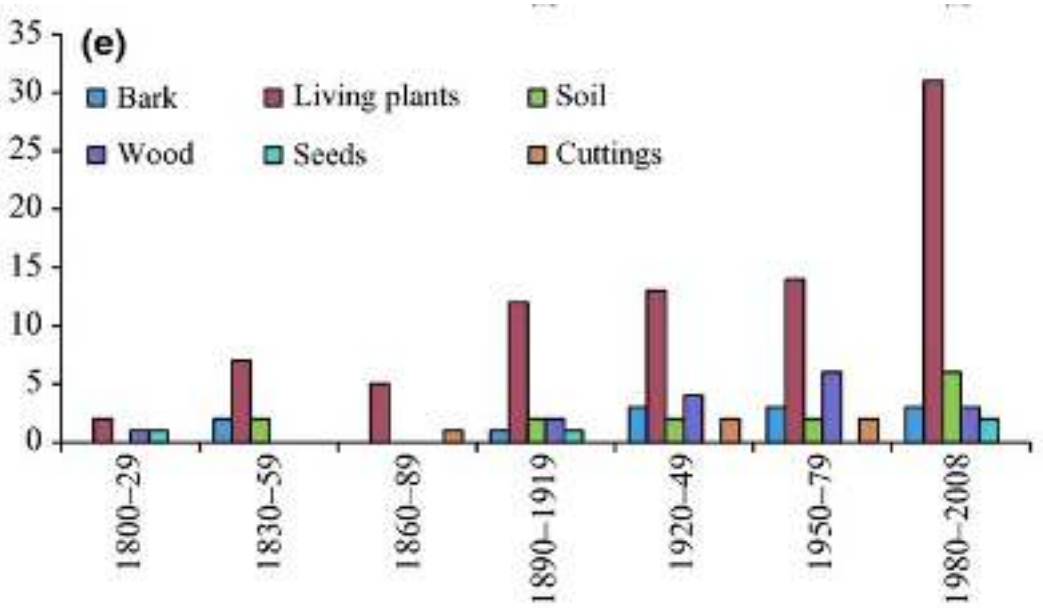
Katy Hayden
khayden@rbge.org.uk

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

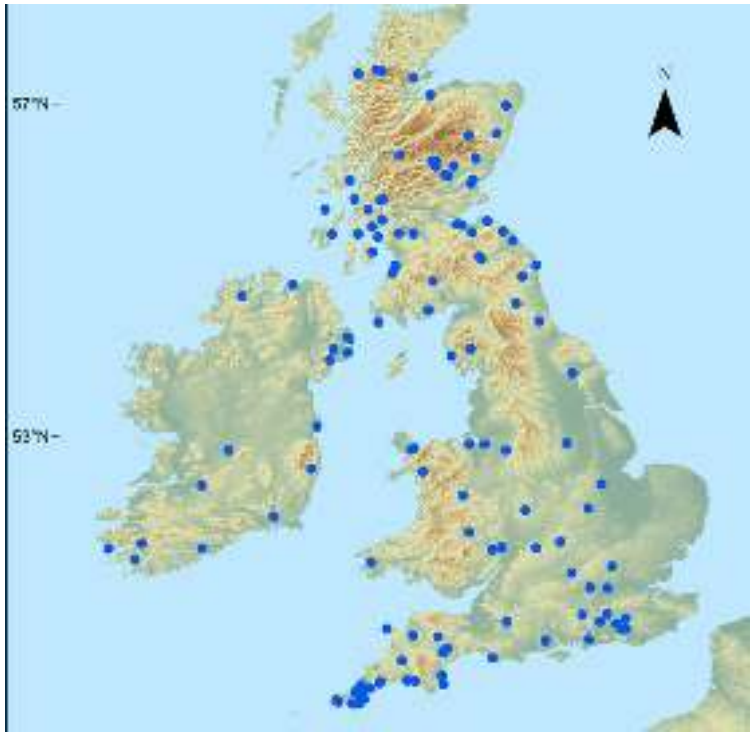
Santini et al 2013 New Phytologist, Volume: 197, Issue: 1, Pages: 238-250, First published: 11 October 2012, DOI: (10.1111/j.1469-8137.2012.04364.x)

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

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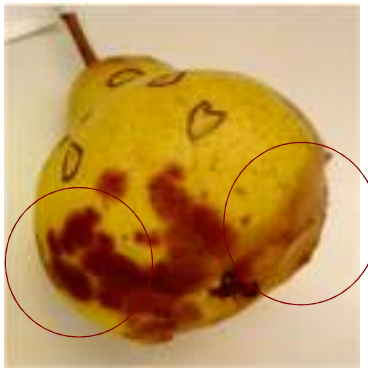
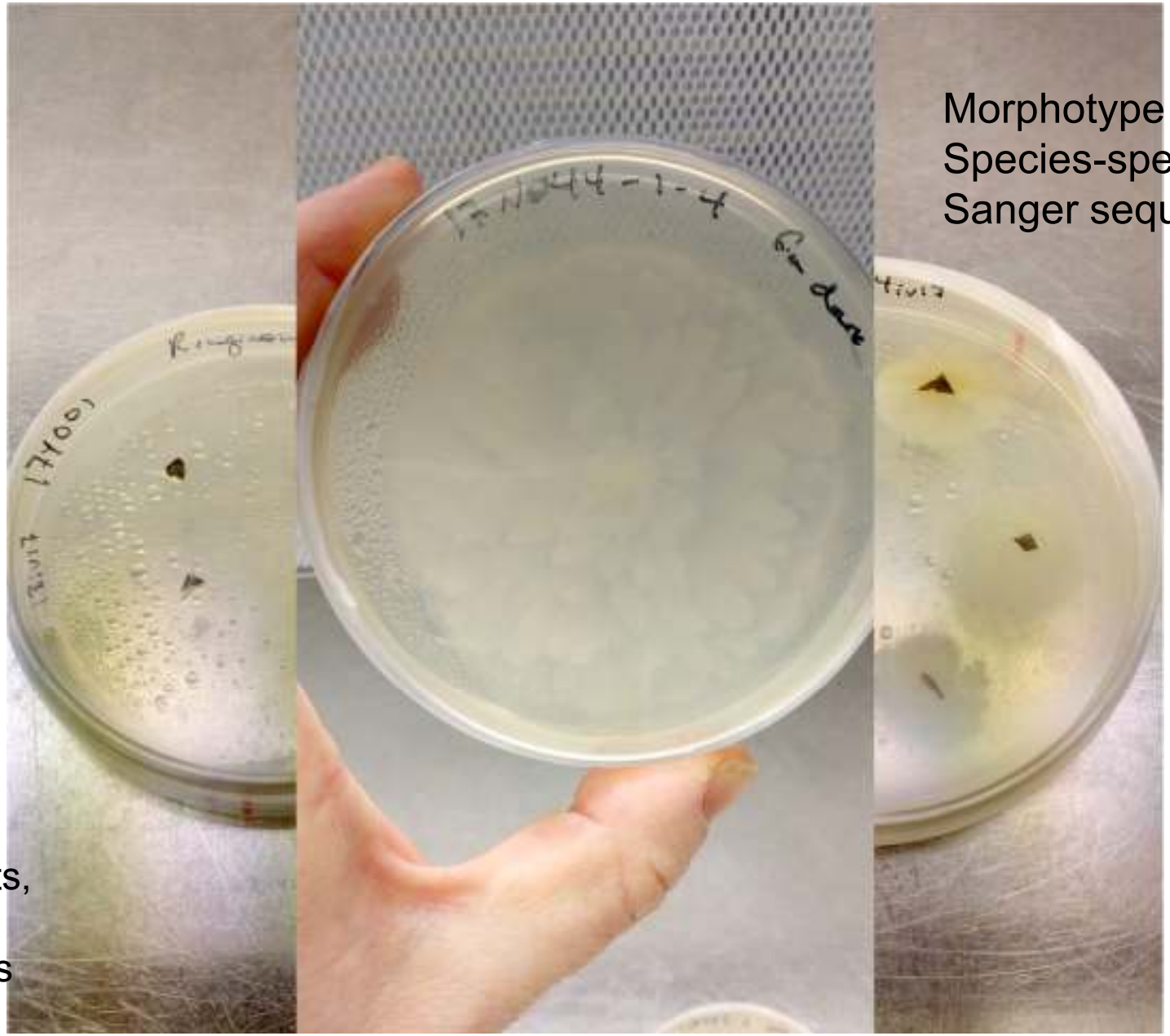
Phytophthora



\+ *Pythium*

PARP selective media



Morphotype
Species-specific PCR
Sanger sequencing

Pro

- Low tech
- Course grain sample
- Viability assay

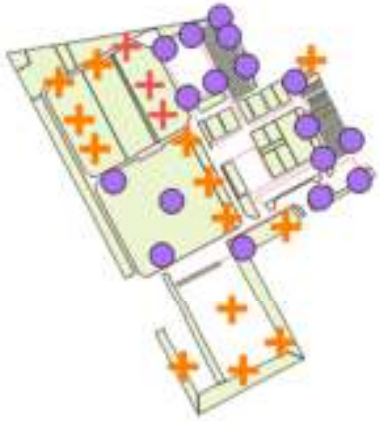
Con

- 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



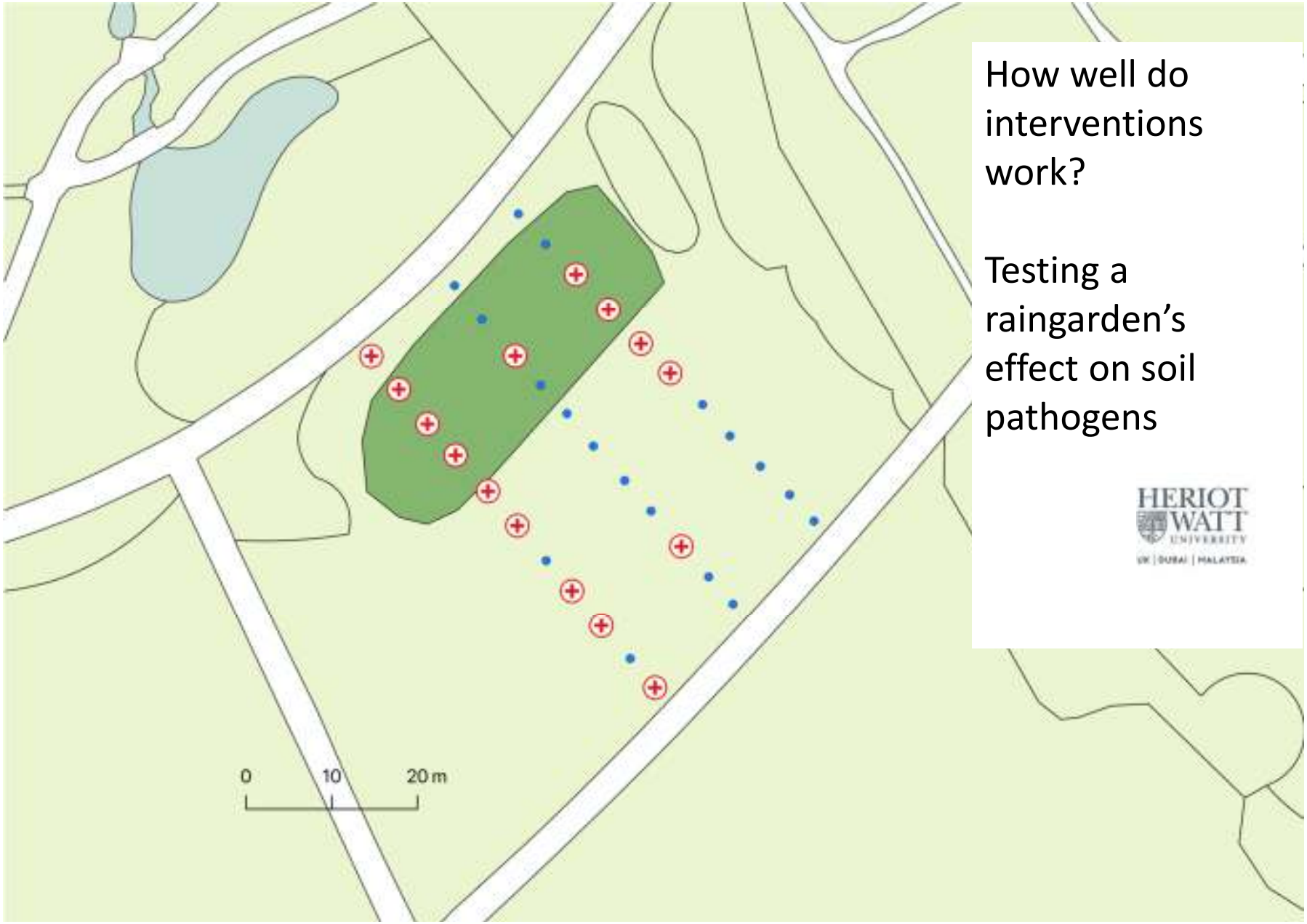
Nursery
21 isolations
13 morphotypes
Incidence 34.3%
Shannon index = 2.85

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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UK | DUBAI | MALAYSIA

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.

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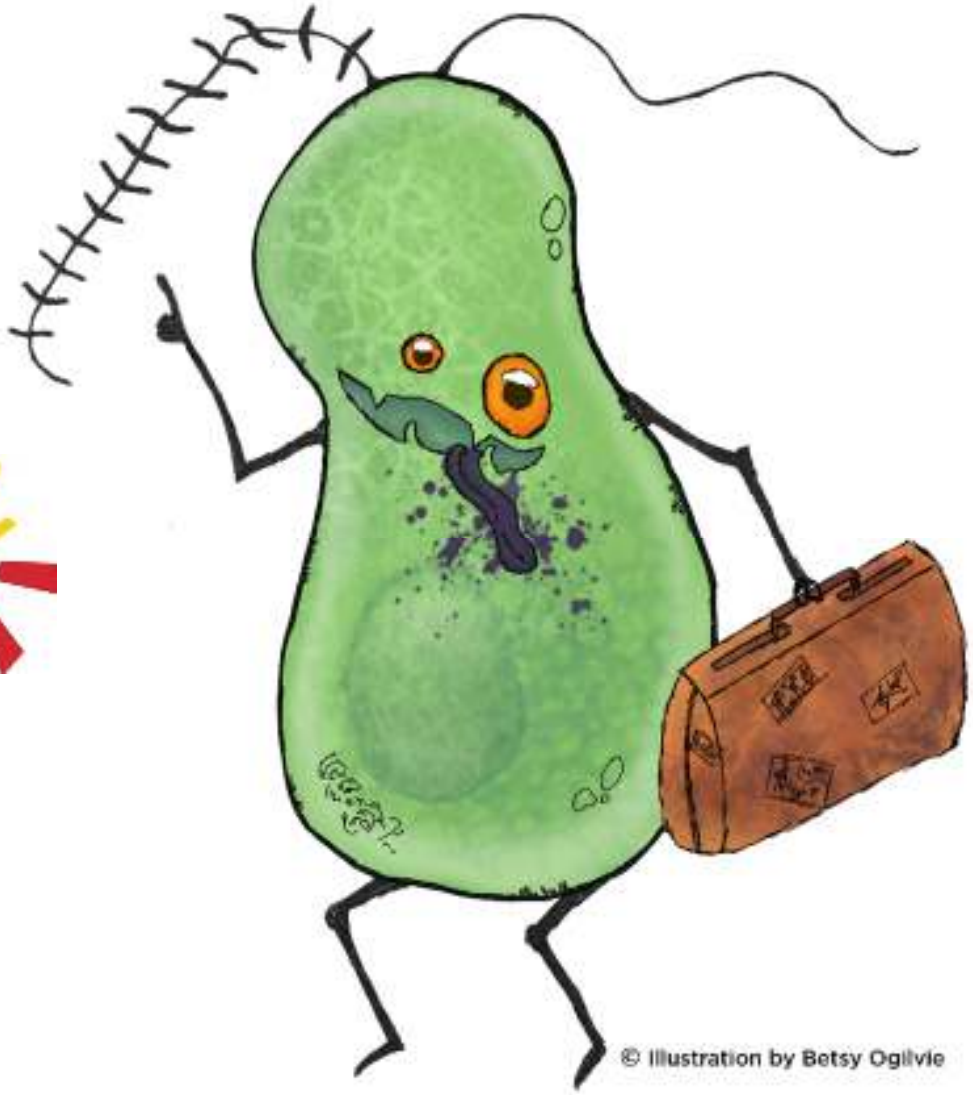
International Plant Sentinel Network

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

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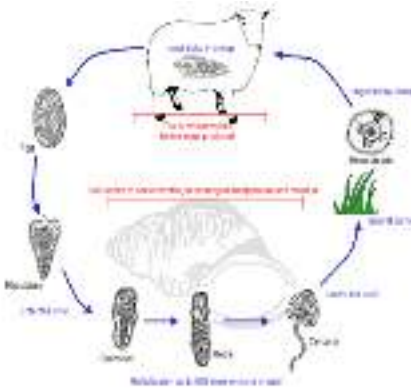
Background

- 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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The James Hutton Institute

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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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

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