climateXchange Scotland's centre of expertise connecting climate change research and policy

Workshop report: How is climate change affecting biodiversity in Scotland?

A workshop run by ClimateXChange for Scottish Natural Heritage and stakeholders to identify signals and indicators, Thursday 7th December 2017, ECCI, Edinburgh.

Scottish Natural Heritage promotes, cares for and improves Scotland's natural heritage. The organisation is the lead public body advising Scottish Ministers on natural heritage matters. Advice on action to tackle climate change – reducing carbon emissions and increasing the natural environment's resilience to the impact of a changing climate – is a key task. A wide range of people – from land managers to local authorities to the public look to SNH to tell them what is happening to nature in a changing climate.

While SNH and other organisations currently gather a considerable amount of data on the health of the natural environment, it has proved difficult to give an overall assessment of the impact of climate change on biodiversity in Scotland.

In its Independent Assessment of the Scottish Climate Change Adaptation Programme (SCCAP) (Sept 2016) the Adaptation Sub-Committee recommended:

Scottish Natural Heritage should commit to developing a monitoring system before the next SCCAP which can measure (a) the impact of climate change on the condition of sites and species and (b) the effectiveness of conservation interventions, thereby enabling the tracking of progress towards favourable ecological condition. https://www.theccc.org.uk/wp-content/uploads/2016/09/Scottish-Climate-Change-Adaptation-Programme-An-independent-assessment-CCC-September-2016.pdf

Against this backdrop SNH asked CXC to help plan and facilitate a workshop to:

- prioritise 'signals' for a monitoring framework; and
- identify existing datasets that can be used to detect and interpret climate impact signals in Scotland's terrestrial biodiversity data.

The workshop covered biodiversity of land and fresh water, including soils. Participants were sent pre-workshop information including:

1) CXC have developed a large number of climate change indicators to analyse issues identified for Scotland in the Climate Change Risk Assessment (CCRA) and show progress towards the objectives set out in Scotland's Climate Change Adaptation Programme (SCCAP) (http://www.climatexchange.org.uk/adapting-to-climate-change/indicators-and-trends/).
2) The SNH Ecosystem Health Indicators will be relevant and a link can be found at: https://www.environment.gov.scot/our-environment/state-of-the-environment/ecosystem-health-indicators/
3) A recent study by The British Trust for Ornithology (BTO) tracking changes in over 500 species since the 1970s https://www.bto.org/science/latest-research/climate-change-impacts-uk-biodiversity-declining-moths-and-increasing-aphids

Outline agenda:

Setting the scene:	James Pearce-Higgins (BTO): Climate change impacts on UK biodiversity – the experience from work in the BICCO-Net https://www.bto.org/science/climate-change/documenting-impacts/biodiversity-impacts-climate-change-observation-network-bicco-net
Session 1:	Identifying climate signals and the current information source for detecting the signal
Session 2:	Where are the gaps in source detection, and who might help?
Sessions 3:	Are there new ways in which we could interrogate existing datasets?

Identifying climate change signals

The workshop started by asking the participants to write their response to: 'The thing about climate change impacts on climate change on biodiversity in Scotland is…'

By identifying the core elements of each individual story the participants created a rich set of possible elements that needed to be part of the knowledge base we need to answer the overall workshop question.

Through table discussion and whole room agreement the participants identified nine climate signals:

1) Non-native species (increase in)
2) Range change of species
3) Winners & losers
4) Ecosystem health
5) Seasonal change
6) System change (the complicated, hard to predict changes)
7) Distinctiveness (loss of)
8) Land use change
9) Pest & disease (increase in)

Across all of these signals the group noted:

- Changes take place across these signals that are NOT driven by climate change. Analysis needs to focus on attributing to climate change (as opposed to correlation)
- Analysis needs to be done across different settings, e.g. urban, coastal etc

The signals interconnected and are not prioritised. The list should be regarded as a starting point for a possible monitoring framework.

The rest of the workshop was spent identifying datasets and sources of knowledge relating to these nine signals, who to collaborate with to fill data gaps, and ways to interrogate the existing data to identify climate change impacts. **Annex A** sets out the notes of the discussion sessions

1. sources of information identified for each signal,
2. identified gaps and potential collaborators to fill these gaps
3. new ways to interrogate the date

Annex B gives a list of participants and material circulated in advance of the event.

New ways to interrogate existing datasets

A conclusion from the discussion in session 1 was that we need greater clarity on the questions – overall and sub-questions – we are looking to answer. These questions need to be at a level that enables the answers to inform action, particularly through biodiversity and climate change adaptation policy.

Some key points from the table discussion:

- SEWeb has a key role
    - as data repository – can all relevant data be stored here?
    - by setting protocol for spatial data, e.g. by all datasets using OS 1km^2 squares as spatial resolution? This would need to link to other relevant protocols e.g. WFD, Environment Network, BBS
- Citizen Science could have a key role, already heavily used in bird surveys
- Satellite images provide a huge amount of data on ground cover etc for visual comparison
- Can we use the signals for predictive analysis?

Next steps

The aim is to use the outputs from the workshop and other information to develop a succinct narrative around climate change and its effects on biodiversity. This can be put on Scotland's Environment Web and will:

- explain that climate change is going to have effects on biodiversity (the 9 signals we identified)
- explain how a range of monitoring & research helps us detect and understand these effects
- identify 3 or 4 indicators that we will use to track some of these effects

SNH will work with others, e.g. through the Scottish Biodiversity Strategy Indicators Sub Group, to identify and undertake some additional work that will be needed to develop this narrative and indicators, and any further work that needs to be done to make use of the datasets that underpin these.

Everyone can help to communicate messages around these nine signals through the work that they are doing.

ClimateXChange Secretariat

April 2018

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ANNEX A – Sources for each signal & data gaps

Ecosystem Health

Session 1

Sources of knowledge	Who holds this
Countryside survey (Randomly stratified sample (none since 2007) (Soil/water/veg/habitat)	CEH
Environmental change network Terrestrial and fresh water sites	ECN website data centre and publications
Woodland sites	Forest Research
Water framework directive - condition of rivers/water courses State of soil report	SEPA – available on-line
Breeding bird survey (including mammals and even habitat?)	British Trust of Ornithology
Natural capital asset indicators	SNH (combination of multiple datasets)
Ecosystem heath indicators	SEWEB/SNH etc.
Intensive forest monitoring (level II) sites	Forest Research
Fresh Water temperature monitoring	Marine Scotland - Pitlochry
Native woodland survey Scotland	Forestry Commission Scotland
Peatland action delivery base (??)	SNH
Site information	SNH
Site condition monitoring on designated sites	SNH – features in favourable/not favourable condition
montane bird surveys/habitat change	RSPB/SNH
Trotternish grassland study and soil erosion study (20 year)	SNH – Ness Kirkbride & G Sullivan, Alex Turner (University of the Highlands and Islands)
Scottish Tufas (ongoing) and SACS	SNH Ness Kirkbride University of Aberdeen Alex Brasier; potentially John MacDonald, Univ of Glasgow
Critical load exceedance (N deposition, etc)	Centre for Ecology & Hydrology

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Session 2

Information Gap	Who might know
Reference sites for function/ process, e.g. some respiration etc. i.e. long term monitoring rather than experimentation	Centre for Ecology & Hydrology /Forest Research ECN Sites and monitoring sites For soil national soil inventory, survey NSIS For soil/Forestry – Forest Research Forest Network already in place
Abundance of autumn – fruiting berries (eg Rowan, Blaeberry)	Centre for Ecology & Hydrology /James Hutton
Colocation of biodiversity and environmental data	ECN job for SNH/JNCC to give overview across surveillance
Botanical condition of habitats	NPMS
Environmental change network –ECN Financial cut backs – (loss of data collection, interruption of time series). Since 2017 terrestrial sites data collected 2 x month on CEH managed sites	Centre for Ecology & Hydrology Don Monteith analysis of loss of utility and reliability of data if collected every 2 weeks. (analysis of 20 years of existing records). ECN can't tolerate another further data collection cut backs.

Seasonal Change

Session 1

Sources of knowledge	Who holds this
Phenology network?	UK phenology network
Aphid database	Rothamsted SASA(SG)
Citizen science	i.e. BBC Springwatch, Nature's Calendar (The Woodland Trust)
BTO nest record scheme (bird laying dates)	British Trust of Ornithology
Birdtrack for migrant arrival. Overview for birds and climate change	British Trust of Ornithology Newson, S.E., Moran, N.J., Musgrove, A.J., Pearce-Higgins, J.W., Gillings, S., Atkinson, P.W., Miller, R., Grantham, M.J. and Baillie, S.R., 2016. Long-term changes in the migration phenology of UK breeding birds detected by large-scale citizen science recording schemes. Ibis, 158(3), pp.481-495.
Steve Trackeray – phenology network	Centre for Ecology & Hydrology and many others
Paper-nature 2016 GCB 2010	Global change biology

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Sources of knowledge	Who holds this
ECN sites	Centre for Ecology & Hydrology (also spatial change)
Lakes monitoring	Centre for Ecology & Hydrology
Site based monitoring	Centre for Ecology & Hydrology
Long term nature monitoring network	Natural England
Earth observation (Sentinel programme) for charges in cropping/leafing etc.	ESA – we will be looking into this for Scotland in 2018 and beyond SNH
Garden bird watch (weekly biodiversity data from gardens)	Garden bird watch - British Trust of Ornithology
Centre for Ecology & Hydrology review of phenological trends in Scotland	SNH – commissioned report around 2000
Bird track	British Trust of Ornithology
Plant phenological change	Royal Botanic Garden Edinburgh
Living with Environmental Change biodiversity report card	On the web
Papers on phenology by Tim Sparks – review current knowledge	Phenological indicators of climate change in Scotland (2006), Sparks et al Roame No F01NB01 (SNH report 167)
Forest Research tree phenology fata (possibly mostly England data)	Forest Research
Met office weather records	Met office
National nature reserves records	SNH
Scottish Government environmental monitoring report around 2005	Jon Pickup to source
Professor Fred Last (Longniddry)	Royal Botanic Garden Edinburgh weather records

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Session 2

Information gap	Who might know
Invertebrate abundance trends in uplands	James Hutton?
Seasonal observations at reference sites	SEFARI/SNH/ etc
Freshwater & marine	SEPA, Fisheries boards
RISK – ECN funding cuts means reduction in monitoring (environmental change network) frequency; a further reduction in frequency will result in reduction of time series sensitivity.	Centre for Ecology & Hydrology, SEPA, JHI, SNH Don Monteith's analysis of 20 years data from terrestrial sites in the network suggested good tolerance of halving data collection frequency (from weekly to 2 x monthly), but further cut backs would result in loss of usefulness especially seasonal signals.
Impacts on ecosystem health/ function	Scientists

Non-native Species (more)

Session 1

Sources of knowledge	Who holds this
BRC data	Centre for Ecology & Hydrology /NBN
Countryside survey (some)	Centre for Ecology & Hydrology
National plant monitoring scheme	Plantlife
Breeding bird survey (and other surveys)	British Trust of Ornithology
Bird track	British Trust of Ornithology
Tree species suitability in relation to climate	Forest Research, Ecological site classification
Bird study paper: Jenni Border, 2017	British Trust of Ornithology/Bird Study
Plantlife INNS Studies	Plantlife
Site condition monitoring	SNH
River-basin monitoring/WFD (Ecological Health)	SEPA
Citizen science records – INNS App	NBN
Tree health pest/pathogens e.g. ash dieback	Forestry Commission/DEFRA
Wetland Bird Survey (WEBS)	British Trust of Ornithology
UK non native species	NBN, OPAL

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Sources of knowledge	Who holds this
Secretariat/Scottish Government – Inns group	
National nature reserves	SNH + others

Session 2

Information gap	Who might know
Risks and benefits of non-native species – e.g. sycamore filling some functions of ash, e.g. Current project on alternatives to oak	Ruth Mitchell, JHI, JNCC paper, Richard Ennos (Edinburgh) Action Oak project (also Ruth Mitchell)
[more of a policy question] - Extent to which England-native species should be considered Scotland native	Stan Whitaker, SNH

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Climate Driven Range Change of Species

Session 1

Sources of knowledge	Who holds this
NBN Atlas (Scotland)	Public web portal
BRC	Bespoke analysis
British Trust of Ornithology	British Trust of Ornithology web site/bespoke analysis
Countryside survey	Centre for Ecology & Hydrology
BMS (butterfly)	BRC/NBN
Academic literature on maximum speed of movement for individual species to occupy new range available – overview of range changes	Lots of published literature Mason, S.C., Palmer, G., Fox, R., Gillings, S., Hill, J.K., Thomas, C.D. and Oliver, T.H., 2015. Geographical range margins of many taxonomic groups continue to shift polewards. Biological Journal of the Linnean Society, 115(3), pp.586-597.
Rothamsted insect survey	Rothamstead & SASA
Montane bird surveys	RSPB/SNH
Breeding bird survey – bird study	British Trust of Ornithology Massimino, D., Johnston, A. and Pearce-Higgins, J.W., 2015. The geographical range of British birds expands during 15 years of warming. Bird Study, 62(4), pp.523-534.
Bird Atlas	British Trust of Ornithology
Environmental change network UK scale European scale (Long term maintaining network and GLORIA?	ECN website Data Centre (including Rothamsted and Forest Research Some publications also listed on ECN website - Morecroft et al climate change (mix of UK sites- Morecroft, M.D., Bealey, C.E., Beaumont, D.A., Benham, S., Brooks, D.R., Burt, T.P., Critchley, C.N.R., Dick, J., Littlewood, N.A., Monteith, D.T. and Scott, W.A., 2009. The UK Environmental Change Network: Emerging trends in the composition of plant and animal communities and the physical environment. Biological Conservation, 142(12), pp.2814-2832.) - ECN publications (NK will provide list)

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Sources of knowledge	Who holds this
Water temperature - Woodland stream water temperature - Forest Research possibly has data!	Upland water temperature Monitoring network. Forest Research! Marine Scotland Pitlochry has this!
Shifts in internationally important wintering water birds – (Maclean et al 201X? Global change Biology, Leihikonen et al 201x?)	WEBS, British Trust of Ornithology
Data on loss of tree species (in Scotland) from disease and pests e.g. Larch, Ash, Pine species	Forestry Commission Scotland/Forest Research
Bioclimatic envelope In relation to peatland habitat	Luoto, M., Pöyry, J., Heikkinen, R.K. and Saarinen, K., 2005. Uncertainty of bioclimate envelope models based on the geographical distribution of species. Global Ecology and biogeography, 14(6), pp.575-584.
State of Nature – global species model. EC state of European Environment.	Global/EU
WP1.1 and PW1.4 and WP1.3	Scottish Government research programme
State of Scotland's Environment	SE Web/SEPA
TWC.org ok citizen science in Scotland (OPAL, Scotland, Cambridge….)	
Modelling of range change of scots pine around current pinewoods	Academic paper (Durham University) 2016/17?

Session 2

Information gap	Who might know
Tracking range change	NBN Atlas (Scotland)
Tracking indicator species	NBN Atlas/BRC
Attribution to climate change often challenging	Research questions/ academic literature
What can buffer change at warm edge of range	
What limits or aids expansion	

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Information gap	Who might know
Non-butterfly/moth invertebrates	
What do the changes mean? For ecosystem health/function	See Mason, S.C., Palmer, G., Fox, R., Gillings, S., Hill, J.K., Thomas, C.D. and Oliver, T.H., 2015. Geographical range margins of many taxonomic groups continue to shift polewards. Biological Journal of the Linnean Society, 115(3), pp.586-597.

Pest & Diseases

Session 1

Source of knowledge	Who holds this
Suction trap data (aphid pests)	Rothamsted
Garden bird watch – bird disease	British Trust of Ornithology
DEFRA plant health risks register	DEFRA & UK plant health risk register
Forestry Commission – pest/disease local ecological reports ???	Forestry Commission Scotland/Forest Research
Remote sensing data?	Forest Research exploring this
Information on specific current diseases-multi risk sources Lyme disease Ash dieback Dothistroma Phytophthora ramorum Farmland/ agricultural health data???	Google Western Isles study & deer (GWCT?) SNH? SASA SNH? SASA SASA Hutton/SRUC
I think Rothamsted publish lists of current insect pest and their host crops	Rothamsted?
Scottish centre of expertise for plant health	SASA, Scottish Government, SRUC, JHI

NOTE – where there are three question mark, it means the text is indistinct

Session 2

Information gap	Who might know
Soil based pest/disease?	anecdotal but may be important for food production

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Information gap	Who might know
Lack of knowledge on the climate change impacts of diseases	?
Impact on social economic/social environmental values of pests & diseases in Scotland	Project by Scottish Government plant health (in progress)
Private sector forestry pests and diseases	Limited from Forestry Commission Scotland (supplied by private owners)
Interaction between other drivers and vulnerability to pests and diseases	Research
Emergence of new pathogens – good guys turn bad in response to environmental change Interrelationship between agriculture response to climate driven pests and diseases and impact on biodiversity.	James Hutton Institute

Winners & Losers (attributing the change to climate)

Session 1

Sources of knowledge	Who holds this
Terrestrial surveillance schemes (BBS, BMS, MPMS, BMP, Rothamsted, published in BICCO-NET reports. WEBS etc.)	British Trust of Ornithology, CEH, Rothamsted, BCT – overseen in many cases by JNCC.
Fish surveys – arctic charr records - Salmonid monitoring	? Marine Science Scotland Pitlochry
BRC data – large range of taxon	CEH
Possibly countryside survey (never looked)	CEH
Site base work - The Bibury verge experiment - Park grass experiment - ECN/ Long-Term Ecosystem Research (LTER) and (ILTER) International Long-Term Ecological Research network, ILTER, European environmental change and climate change trends papers	ECN/lakes Rothamsted Environmental Change Network publications ECN data co-ordination centre/available on IMO. Times series data
SNH snowbed vegetation survey	SNH/RBGE
Permanent plots for Cairngorm dwarf heath (for resurvey 2023)	RBGE

Sources of knowledge	Who holds this
Breeding bird survey and others	British Trust of Ornithology
Bird Atlas	British Trust of Ornithology
BICCO Net project and literature published for this	British Trust of Ornithology and others
Birse & Robertson plot resurvey (vegetation)	James Hutton Institute
RSPB/SNH montane bird surveys	RSPB/SNH
Change in land capability for agriculture/Forestry/restoration/ habitats	James Hutton Institute, Forestry Commission Scotland, Forrest Research SNH
Native woodland survey	Forestry Commission/Forest Research
National plant monitoring scheme	Plantlife
Farming retreat from hills – grazing winners and losers	SRUC
Snowbed vegetation monitoring	SNH
SCARBBS surveys of birds	RSPB/SNH/NE/CCW

Session 2

Information gap	Who might know
Poorly monitored species groups. Priorities include keystone species groups eg soil invertebrates, most diptera, pollinators, small mammals. Population trends rather than occurrence.	May infer crude trends from biological records (BRC). May need new data.
Pollinator trends	BRC/NBN/JNCC note – Strathclyde University, Gray & Peterson, (2017)-, Investigating honey bee colony losses from surveys of beekeepers
Tree growth – need better remote sensing data i.e. LIDAR scan for whole Scotland	Scottish Government should pay for this!

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Distinctiveness

Session 1

Sources of knowledge	Who holds this
Birse & Robertson vegetation surveys and re-survey	James Hutton Institute (Robin Pakeman, Ruth Mitchell)
McVean & Ratcliffe vegetation surveys and re-survey	
Other vegetation surveys that could be re-surveyed	
Habitat map of Scotland	SNH & public web portals
NVC maps – Rodwell etc BSBI records	NBN Gateway
Breeding bird survey	British Trust of Ornithology
Several papers by British Trust of Ornithology	Davey, C.M., Chamberlain, D.E., Newson, S.E., Noble, D.G. and Johnston, A., 2012. Rise of the generalists: evidence for climate driven homogenization in avian communities. Global Ecology and Biogeography, 21(5), pp.568-578.
Snowbed vegetation surveys	SNH (Dave Genney)
Countryside survey	CEH
JNCC condition monitoring	JNCC/NE
RSPB data from reserves and status of Scottish species of conservation concern	SCARABBS (Statutory Conservation Agency/RSPB Annual Breeding Bird Scheme)
NSIS 1 and 2 national soil monitoring survey	James Hutton Institute & Scottish Government website
Peatland Action database	SNH
Soil risk/ susceptibility map	James Hutton Institute
Biodiversity/natural heritage indicators	SNH web site
Protected areas condition	SNH/SE web
Bird Atlas	British Trust of Ornithology
Caledonian pinewood	SNH/Forestry Commission Scotland
National Nature Reserve monitoring	SNH et al

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Sources of knowledge	Who holds this
Wetland database	SNH/JNCC
Tufa	SNH Ness Kirkbride

Session 2

Information gap	Who might know
How is the species composition of semi-natural grasslands changing?	Info to 2007 from CS – but not since Jane MacKintosh 's grasslands reports (SNH) Elspeth Christie (SNH) Practical knowledge SRP WP 1.1 (Hutton) research
Atlantic bryophyte assemblages	Royal Botanic Gardens Edinburgh/SNH
Oceanic Woodlands	Royal Botanic Gardens Edinburgh/SNH/James Hutton Institute
Identifying what is distinctive/ appropriate diversity	

Land Use Change

Session 1

Sources of knowledge	Who holds this
Agricultural census	Scottish Government RPID
Historic land use assessment	H.E.S/Geography publications 18th confiscated land survey (forfeited estates?)/ Statistical Account of Scotland
Citizen science "camera posts"	Lancaster University CNPA
Future – crop map	Scottish Government remote sensing group
Habitat map of Scotland	SNH & public web portals
National forest and woodland inventory	Forest Research/Forestry Commission
National countryside monitoring scheme around 1947, 1973, 1988	The Stationery Office/SNH
Countryside survey around 1978, 1984, 1990, 2000, 2007	CEH – web site and publications
Breeding bird survey habitat paper	British Trust of Ornithology

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Sources of knowledge	Who holds this
	British Trust of Ornithology - could be: Martay, B. and Pearce-Higgins, J.W., 2018. Using data from schools to model variation in soil invertebrates across the UK: the importance of weather, climate, season and habitat. Pedobiologia.
Actual land use change vs land capability for agriculture	James Hutton Institute
Earth Observation (Sentinel programme etc) land cover	Land cover map 2015 CEH, ESA, SNH
Fertiliser & Pest use survey (Farm practice)	FERA/EUS (SASA-pesticides)
'burning index' – ie grouse moors	RSPB
IACS data	Scottish Government
SE Web citizen science apps	SE Web
Capability/risk soil map (erosion, leaching, compaction, runoff)	James Hutton Institute/SE Web
RPID Agri-environment scheme (grants)	Scottish Government
Farm account survey/soil analysis	SRUC/James Hutton Institute
ECN network	CEH
Planning system/local development plan/strategic planning	Local authority/planning authority
Greenspace map	Greenspace Scotland data.gov.uk
Industry records (windfarm/water supply)	Multiple sources
Trotternish grassland and soil erosion study - 20 years	SNH – Ness Kirkbride, G Sullivan, A Turner Ex James Hutton Institute – Dick Birnie
Atmospheric deposition (critical loads, N etc)	APIS database and JNCC/CEH/SEPA

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Session 2

Information gap	Who might know
Ongoing monitoring if countryside survey (land cover mapping) aren't repeated 2015 and next one planned 2018/2019	CEH/NERC
Agriculture changes in cropping/timings of management/agri-envrionment scheme	SNH, Scottish Government, Farmers, etc
Sentinel satellite data looking at climate change	JNCC
Interpretation - fit for purpose - outcomes	
Agri-environment monitoring	Scottish Government RPID
Habitat map of Scotland?	SNH recent data
Forest/woodland lost to windfarms	Forestry Commission Scotland

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Complicated & Hard to Predict Systems Changes

Session 1

Sources of knowledge	Who holds this
Sniffer report on 40 years weather in Scotland	SE Web/Sniffer
Any long term flood studies for river systems (looking at magnitude and frequency of flooding).	Geoscience literature Natural flood management data – Forest Research
Costal change – historical & contemporary coast	Scottish Government Dynamic Coast project. Available online (Ali Rennie)
Environmental reconstruction literature Debris flows, river channel changes Soil degradation Pollen, diatom environmental archives	Geoscience literature
Long term climate change and environmental readjustments Britice Chrono	Britice website NERC consortium project modelling ice sheet/climate change/sea level change
UKEOF metadata catalogue (co-ordinator of knowledge)	UKEOF – data gov.uk
Importance of species interactions	Ockendon, N., Baker, D.J., Carr, J.A., White, E.C., Almond, R.E., Amano, T., Bertram, E., Bradbury, R.B., Bradley, C., Butchart, S.H. and Doswald, N., 2014. Mechanisms underpinning climatic impacts on natural populations: altered species interactions are more important than direct effects. Global change biology, 20(7), pp.2221-2229.
Analyses of numbers/impacts of new pests and pathogens – especially 'surprise element'	Scientific literature
Forest wind risk modelling for tree species	Forest Research 'forest gales'

Session 2

Information gap	Who might know
Non-linearities and tipping points to better predict the future	Mark Reed (Newcastle University & Aberdeen) leading NERC project on peatland tipping points and climate change

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Information gap	Who might know
Predicting climate change impacts from species interactions	Can use CS & ECN data for modelling
Soil biodiversity (Not all?)	Richard Bardgett (University of Manchester) CS – up to 2007 Possibly in new CEH long term monitoring (if paid for)
No long-term monitoring of dynamic geomorphological systems away from coasts. Because of episodic activity seen as one offs.	Geoscience community

Session 3 – New ways to interrogate the data?

Group 1 (lead – Anne Marte)

Proxys

- Vegetation cover from satellite images as indicator for ecosystem health
- Satellite data e.g. land cover map (2015, next 2018/19) map for Scotland. Use to extrapolate across sites model climate change impact based on land cover map.
    - Moisture
    - Productivity
- Using data to what we can easily measure e.g. we have 1000s volunteers counting birds

Gather data on same scale

- Commonality
- Could we have guidelines for gathering biodiversity data?
- Use same 1km grid squares (OS)

Scales of reference - Can we

- Use same data for difference analysists
- Protocol for spatial data on SEWEB
    - With links to other protocols e.g. WFD, environment network, BBS
- What networks can help "match" those involved in monitoring
- Establish random stratified sample for Scotland
    - BBS, ECN, CH – monitoring system needs to acknowledge the value of each data set
- Need to tie in data sets
- Private met station – where is that data held?

Group 2 (lead – Sarah)

BICCONET

- climate change impacts (Defra stopped funding project based websites).
- Platform no longer available (new or alternative platform)
- Making results available for further analysis
- Perhaps using NBN Atlas as a platform?

NBA Atlas in its own right

- Partnership, managed by NBN Trust
- Potential to link projects on the platform

Satellite imagery – Defra centre of excellence – super computer (SENTINEL)

- Analysis ready data available 2018 – indices/processed
- Partnerships to explore co-produced questions
- SENTINEL data is continuously updated (weekly and archived)
- E.g. tracking snow beds, ice cover on montane lakes (??). Events e.g. fire events and recovery, rapid environment change, wind throw (forest research)

British Ecological Society

- Ruth Mitchell (co Chair of BES Scottish Policy Group)
- Scottish Policy Officer to be appointed soon)
- building relationships –e.g. through shared questions
- Collaborative workshop – predicting analysis and forecasting

Citizens Science with sentinel data – potential - Ground truthing 'living' maps?

New types of data – beyond observational. Sequencing data/sampling/meta-bar coding

Passive sound recording

- e.g. led by the British Trust of Ornithology with Bat Conservation Trust – SW Scotland, Norfolk. Borrowing expensive bat-recording, set up for 3 days, send in sound card for analysis.
- Contribution to range expansion.
- Booked through local library (or reserves).

CP18 – available 2018 and using existing models

- Content analysis and forecasting to help gain insight into potential risks
- Predictive analysis and collaborative workshop
- Potential partnership with Met Office

Another workshop?

A second discussion, looking at same questions but focused on predictive analysis – what we think will happen?

(Reference Rob Brooker's work - British Trust of Ornithology work on England funded by Natural England paper in journal conservation Ecology

Group 3 (lead – Ciara)

What do you need to interrogate the data for?

- Audiences for the data?
- What do different users groups need from the data? How do they want to use it? What does it mean to them?
- Feasibility e.g. Scotland soil website

Get all data in one place? E.g. Scottish Environment website holds a lot of data

Regarding interrogation, what is the question? What is the purpose of the ask?

Freedom of Information requests and making data available to public can raise issues. People may interrogate data not understanding fully how data were collected.

- Best to engage with person going to use data
- Software e.g. spotfire provide snapshot of data to answer particular question
- Application (more so to support collecting data)
- Different ways to interrogate data e.g. photo of soil to understand soil carbon, draws on data held and Hutton (Lorna Dawson)

Using data to view/understand historical data – what was here before? Visual comparison? etc

Connecting/linking databases?

- Or does this multiply deficiencies?
- But important to make different databases compatible

Can't use all data to answer questions about climate impacts on biodiversity

- Confidence in data
- Error bars
- Need to focus in on certain data

Parking Place

Non-native invasive species (non-climate change related)

Impact of extreme events wildfire, storms, floods…

Regarding all data sources: is the frequency, extent etc. suitable for monitoring climate change impact?

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Annex B – supporting material

Attendee list

Name	Organisation
James Pearce-Higgins	British Trust for Ornithology
Lisa Norton	Centre for Ecology & Hydrology
Bruce Nicoll	Forest Research
Ed Mackey	Scottish Natural Heritage
Christopher Ellis	Royal Botanic Garden Edinburgh
Mary Christie	Scottish Natural Heritage
Patricia Bruneau	Scottish Natural Heritage
Vanessa Kirkbride	Scottish Natural Heritage
Duncan Stone	Scottish Natural Heritage
Antonia Eastwood	The James Hutton Institute
Sandra Marks	Scottish Government
Jon Pickup	Science and Advise for Scottish Agriculture
Innes Sim	RSPB
David O'Brien	Scottish Natural Heritage
Brian Eardley	Scottish Natural Heritage
Robin Pakeman	The James Hutton Institute
Blaise Martay	British Trust for Ornithology
Anna Moss	University of Dundee
Sarah Govan	ClimateXChange
Anne Marte Bergseng	ClimateXChange
Ciara O'Connor	ClimateXChange

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Material circulated in advance

The event will build on earlier initiatives, including:

- **ASC's Independent Assessment of the Scottish Climate Change Adaptation Programme (SCCAP) (Sept 2016) Recommendation 3:** Scottish Natural Heritage should commit to developing a monitoring system before the next SCCAP which can measure (a) the impact of climate change on the condition of sites and species and (b) the effectiveness of conservation interventions, thereby enabling the tracking of progress towards favourable ecological condition. https://www.theccc.org.uk/wp-content/uploads/2016/09/Scottish-Climate-Change-Adaptation-Programme-An-independent-assessment-CCC-September-2016.pdf
- LWEC Report Card: Biodiversity - **http://www.nerc.ac.uk/research/partnerships/ride/lwec/report-cards/biodiversity/**
- **CXC Climate Change Adaptation Indicators:** The CXC indicators are aimed at assessing how well Scotland is doing against the objectives of the SCCAP. Monitoring climate change adaptation is a new area of policy and practice. We have established baseline information that gives us a picture of where we are starting from, and makes it possible to assess trends over time and to understand the nature, extent and effectiveness of adaptation responses. http://www.climatexchange.org.uk/files/4114/7738/6041/CXC_Adaptation_indicators_full_list.pdf
- And inks to the summary narratives - http://www.climatexchange.org.uk/adapting-to-climate-change/indicators-and-trends/environment/
- Climate Change Risk Assessment 2017 (Chapter 3 Natural environment and natural assets): Fourteen risks and opportunities have been identified

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Natural Assets

Terrestrial (3.2)

Ne1: Risks to species and habitats due to inability to respond to changing climatic conditions

Ne2: Opportunities from new species colonisations

Soils and Land (3.3)

Ne3: Risks and opportunities from changes in agricultural and forestry productivity and land suitability

Ne 4: Risks to soils from seasonal aridity and wetness

Ne8: Risks of land management practices exacerbating flood risk

Ne10: Risks to agriculture, forestry, wildlife and heritage from change in frequency and/or magnitude of extreme weather and wildfire events

Freshwater (3.4)

Ne6: Risks to agriculture and wildlife from water scarcity and flooding

Ne7: Risks to freshwater species from higher water temperatures

Coasts (3.5)

Ne11: Risks to aquifers, agricultural land and habitats from salt water intrusion

Ne12: Risks to habitats and heritage in the coastal zone from sea-level rise; and loss of natural flood protection

Marine (3.6)

Ne13: Risks to, and opportunities for, marine species, fisheries and marine heritage from ocean acidification and higher water temperatures

Cross-cutting Issues (3.7)

Pests and Diseases (3.7.1)

Ne9: Risks to agriculture, forestry, landscapes and wildlife from pests, pathogens and invasive species

Natural Carbon Stores(3.7.2)

Ne5: Risks to natural carbon stores and carbon sequestration

Landscape and Sense of Place (3.7.3)

Ne14: Risks and opportunities from changes in landscape character

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