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An assessment of the biodiversity information needs of the UK's environmental public bodies – Appendix 2

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On behalf of the Terrestrial Surveillance Development & Analysis (TSDA) Partnership: JNCC, Centre for Ecology & Hydrology and British Trust for Ornithology

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Appendix 2: Questionnaire responses

This appendix provides the questionnaires as filled in by the respondents. We note that they were consulted because of their responsibility in their organisation, and most people undertook a consultation with some others within their organisation. However, their written responses should not be taken as categorically representing their organisation's views. These written responses were followed up with a 1-hour telephone conversation to ensure that their written responses were properly understood to be synthesised in this report.

Department for Environment, Food and Rural Affairs (Defra)

This response was not released due to the organisations' internal publication requirements. However, the respondent from Defra played a full role in the evidence gathering and review of the report and their input was fully incorporated into the main report.

Welsh Government (WG)

This response was not released due to the organisations' internal publication requirements. However, the respondent from Welsh Government played a full role in the evidence gathering and review of the report and their input was fully incorporated into the main report.

Forestry Commission (FC)

This is the collation of the responses received from the Forestry Commission, and from contacts in England, Scotland and Wales.

1. Your details

Name	***[removed from the publically available information]***
Organisation	Forestry Commission Eng: Forestry Commission England Sc; Policy adviser on woodland biodiversity Cym: Welsh Government
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	GB Eng: England Sc: Scotland Cym: Wales
For what taxa do your answers relate to?	All that relate to woodland habitats and including but not restricted to trees, plants, insects, birds, fish and mammals. Eng: Woodland species Sc: All that relate to woodland and open habitats identified for new woodland creation. Cym: Woodland related species and habitats
For interviewees: briefly describe any consultations that you undertook in your organisation	I asked colleagues in England and Scotland to submit their own Evidence Needs Assessment and have attached those to my response.

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs				Information on biodiversity is of most importance for **longer term strategic** planning and research			Neither
Strongly agree ○	○	○	○	◉	○	Strongly agree ○	.

5, Eng:6, sc 4 cym:2

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

Information on biodiversity is integral to defining the ecologically safe limits for forest development. The data is used for medium to long term planning activities such as opportunity mapping and monitoring progress against strategic policy aims. It is also used in monitoring activities to better understand the relationship between biodiversity and ecosystem service provision and to inform management intervention to slow and reverse biodiversity loss. Decision makers need information at a scale and temporal resolution appropriate to their needs. Differentiating these needs (national, regional, local) is not a trivial task, especially in forestry where we typically deal with landscape scale management over long time scales. Information at the appropriate scale and in good time is vital to facilitate effective organisational planning. It is difficult for managers to plan and allocate resources in the absence of adequate information. Thus, there is a risk that inadequate information may lead to environmental degradation and a loss of ecosystem service provision.

Eng: Targeting of incentives for woodland creation and woodland management to help reverse declines in S41 species. Reporting against international and national (BIO2020) outcomes through the Country biodiversity governance structures. Bespoke reporting to respond to formal and informal requests for information on measures to protect and enhance biodiversity

Sc: Scottish Government forest policy is evidence based: we need good biodiversity data both to report on delivery of biodiversity focused targets in the Scottish Biodiversity Strategy, to understand the delivery of the UK Forest Strategy, and against our commitments in the Scottish Forest Strategy and also to develop our long-term strategic thinking.

The balance between the two is weighted towards planning future directions because we have to deliver SG targets under the draft climate change report (woodland expansion target). Although we monitor and report on some biodiversity topics the majority is undertaken by Scottish Natural Heritage.

Cym: Woodlands for Wales strategy indicators on woodland species.

Data at a Wales level is small/ scarce, meaning that reporting on the indicators is less meaningful.

Data also needed by woodland managers to inform their management strategies and applications for planting grant.

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years				Key priorities have **been stable** over the past 5-10 years			Neither
Strongly agree	○	○	○	○	○	◉ Strongly agree	○ .

UK:6, Eng:2, sc:2, cym:5

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

Even though responsibility for forestry policy is devolving, the countries' high level aims continue to adopt a consistent language that is centered around "sustainable forest management" for the benefit of people, communities, the environment and the economy. Sustainable forest management has been a key aim for more than 10 years and so has provided a stable foundation for the FC's information requirements.

Eng: Adopting targeting of woodland incentives using priority species distribution data e.g. woodland bird assemblages etc. . Consensual approach working with key stakeholders rather than imposed.

Sc: Devolution of the biodiversity duty to each country has driven a more representative Scottish focus on biodiversity needs with respect to forestry in Scotland.

Currently policies are changing as Forest policy transfers completely to Scottish Ministers.

Cym: Improving biodiversity outcomes continues to be a desired outcome within the Woodlands for Wales strategy and is also reflected in other Welsh Government policies e.g. National Nature Recovery Plan and Sustainable Management of Natural Resources as part of the Environment (Wales) Act as well as the Future Generations Act wellbeing goals.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)			Neither		Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)
Strongly agree ○	○	○	○	○	◉ Strongly agree ○ .

UK:6, Eng:4, sc: 5, cym:2

What particular aspects or details of these are particularly important for you?

Both categories of are relevant, but the greatest need is knowing why and how the environment is changing and what we can do to slow and reverse undesirable change, and to stabilise and build on any positive developments.

A research emphasis is vital for directing effective management intervention and will, by default, provide some answers to the "how much and where" questions.

Eng: Both questions equally important to ensure impact (positive or negative) of management interventions can be reliably and objectively assessed.

Sc: Although both sets of information type are required – there is a greater need to be able to provide policy guidance on the impacts of forest policy and delivery of SG targets on key habitats and species. This is especially true for new woodland creation impacts on existing land management practices and the species assemblages affected, and for the effect of operations in existing woodlands on species present.

Cym: Information required to report on biodiversity related indicators for our woodland strategy.

Information also used by woodland management planners and agents to inform woodland management plans, woodland planting proposals and Environmental Impact Assessments where these apply.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity				Information is most important for informing **projections into the future** (e.g. future scenarios of change)			Neither
Strongly agree ○	○	○	○	○	◉	Strongly agree	○ .

UK 6, Eng 6, sc: 6, cym: 2

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

Forestry and woodland development starts with the creation of new woodland or bringing of existing woodland into management. Thus, before starting any work, it is important to know what the base state of the resource is. It is also vital to have a strong vision for what the desired future state of the resource is expected to be. With these two pieces of information it is possible to plan how best to get from point A to B. So, basic resource information is needed at time "0", thereafter, it is wise to check progress once a year until the woodland has established (approximately 10 yrs for new conifer woodland, 15-20yrs for broadleaved woodland, longer for both types (+5-10 yrs) if relying on natural regeneration). Thereafter, visits can be less frequent depending on how ephemeral the monitoring target is e.g. for specific plants and animals, annual monitoring programmes will be necessary (e.g. deer monitoring), whereas for landscape scale monitoring, every 5 to 10 years may suffice.

Eng: Targeting of incentives linked currently to RDPE programs and Country Biodiversity Strategies (so 10 years). For developing and implementing climate change adaption measures up to 30 years.

Sc: Woodland creation – immediate (1 year) effects of planting trees. Annual update.

Woodland creation – 10 -20 year medium term effects of establishing new habitat suitable for colonization by a range of woodland species. As new information or evidence is available to support the design of new woodlands.

Woodland creation - >20 year long term effects of habitat creation at landscape scale and integration of new habitat networks. As new information or evidence is available.

Forest operation – immediate (1 year) effects of managing a woodland where certain species of interest are present. Population level information of greater value than at individual scale.

Cym: WfW (Woodlands for Wales) indicators report annually but we acknowledge that some sources e.g. National Forest Inventory, are on a 5 yr reporting cycle due to logistics or available funding.

Data for woodland planners – preferably as up to date as possible subject to resources

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

Knowing how climate may affect host (trees) and pathogen (insects and fungi) interactions would have been useful. Particularly, when considering native hosts and non-native pathogen interactions, which intuitively, may be considered to present a higher risk. However, latency amongst native hosts and native pests, in response to climate change is also of interest.

Eng: Condition of habitat (including woodland) on priority habitat inventory. Note woodland condition soon to be addressed through National Forest Inventory.

Sc: How many species benefit from UKFS compliant woodland management or the creation of UKFS complaint new woodland, and what effect the expansion of forestry in the past has had n the expansion of woodland species (eg pine martin).

What were the impacts of deer on woodland biodiversity and regeneration recruitment and the associated effects of the lack of regeneration on associated woodland species. (eg heavy grazing reduces bird diversity).

How raptors use restructured commercial woodlands.

How new woodlands create a prey base for driving biodiversity at landscape scale – eg trees provide food source for lepidoptera, benefits birds, mammals and lager raptors and so on.

Better evidence of the effects of forest operations on woodland specialists – eg new work suggests red squirrels are not negatively impacted by forest operations, but that in the medium term this operational activity will create new and improved habitat.

Cym: Good baseline information would have been useful – a starting point on which to measure trends, with a consistent approach to on-going monitoring. Priority species and habitats under the NERC Act (section 42) now Environment (Wales) Act section 7.

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

Stronger policy lines are emerging in Scotland and England for woodland expansion. While undoubtedly offering opportunities, the potential land-use change will inevitably stimulate discussion about the possible impact on non-woodland habitats and birds. So, information to inform these discussions is likely to be most welcome. In particular, I would be interested in the strategic level information e.g. how good are models at predicting potential impacts at landscape scales, thinking here about connectivity and forest habitat networks. Will enhanced networks benefit biodiversity or pose a threat, e.g. potential threats to red-squirrel territories? Opportunity mapping e.g. can we map opportunities to add value to new woodland by identifying opportunities to enhance the landscape impact at the margins?

Eng: England Peat Strategy - ambition to restore all peatland including shallow peat. Will need to identify spatially all peat sites (not just deep peat) and condition.

Condition of habitat on priority habitat inventory (outside of protected sites network) needed to inform decisions on where to place new woodlands to meet political ambition for significant afforestation. Also to inform decisions on where it may be appropriate to remove woodland for open habitat restoration.

Sc: Creation of 10,000 ha of new woodland per annum (increasing to 15,000 ha) in the Scottish landscape: how this will benefit woodland specialists and what effect will the creation of new networks have on biodiversity at the landscape scale.

Improvement of native woodland condition: how will increased deer management activities drive this improvement and what additional biodiversity benefits will we see.

As tree health issues continue to affect some native woodlands (eg Chalara in Ash, Dothistroma in scots pine, phytophthora in juniper) how will the policy of not planting new native species in close

proximity to existing infected stands effect he composition and functioning of native woodland biodiversity. What are the longer term impacts of the loss of ash trees from the landscape.

Cym: Sustainable management of natural resources (SMNR) as a principle of the Environment (Wales) Act 2016. This will look at resilience of the environment at a landscape scale .

Information on the contribution to ecosystem function by a different habitats/ species would help to evidence landuse change or conservation. This should include ecosystem contributions by conifer plantations.

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	○	◉ eng sc cym	○	1 eng1 sc1
Abundance: knowing how many/much of a species/habitat is present	○	◉ sc	○ eng cym	○	2 eng2 sc7
Trend in distribution/abundance: knowing how it has changed over time	○	○	◉ eng sc cym	○	3 eng3 sc4
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉ sc	○	5 sc3
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○ sc	◉	○	6 sc6
Drivers of change: knowing environmental mechanisms underpinning changes	○	○	◉ eng sc	○	4 eng4 sc5
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	◉ eng sc	○	7 eng5 sc2

Please give specific examples of the gaps you have:

- Need to Identify suitable sites for alternative tree species
- E.g. what is the distribution and abundance of phytophthora species?
- How has the distribution of phytophthora species changed over time?
- E.g. does greater biodiversity equate to greater resilience?
- How does climate change affect native host / pathogen interaction?
- What level of confidence can we have in medium-term habitat modelling forecasts? E.g. what is the likely medium-term impact (positive, negative, no-change) of climate change on native pinewood habitat and the ecosystems services provided?

Eng: Dormouse distribution and trends over time of national population. Monitoring is exclusively based on use of artificial nesting habitat i.e. introduced boxes rather than natural nest sites.

Sc: Where are the Annex 1 habitats in Scotland – to a scale that enables individual sites to be mapped and identified as suitable / not suitable for land use change?

How have woodland EPS changed in relation to woodland expansion and management of existing plantations. Has this benefited their expansion into new habitat (eg pine martin, capercaillie).

How have deer and INNS impacted on native woodland ecosystem functioning and delivery of services.

How is climate driving a change in species distributions and the suitability of protected areas to continue to function as key areas for certain species. - How do we increase woodland resilience – what role is there for creating new woodlands and how can forest management support resilience building in existing woodlands.

Cym: Appreciate the above are of importance but not up to speed to comment on gaps/ provision.

NRW lead on monitoring and reporting on biodiversity in Wales.

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs			Neither
Strongly agree	○	○	○	○	○	◉ Strongly agree	○ .

Uk6, eng6, sc6, cym: 5

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Difficult to justify the expenditure needed to increase taxonomic coverage. Concentrating on spatial coverage is likely to offer better value for money.

Eng: Focus should be on improving our spatial knowledge of where key species e.g. European Protected Species are present and for Habitat Directive monitoring/reporting of priority habitat extent and favorable condition status.

Sc: There are too many individual species to take full account of – we need better evidence to be provided for broad scale groups at a larger spatial scale.

Cym: Information on key indicator species at a regional level would be useful.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

There are significant gaps in all of these. The key issues are:

- how best to deploy resources to maximise environmental benefit?
- Engaging in forest management in such a way as to minimize environmental damage

So, with these in mind, it would seem that indicators of "ecosystem health" and habitat condition might offer the best value for money. Monitoring individual species is not likely to be cost effective unless the activity can be added to other more routine site based work.

Eng: Condition of priority habitats outside of protected sites.

Fungi, lichens (under represented taxonomic groups)

- Sc: **Special'** species – what are the direct benefits of new woodland creation in providing new habitat for these species. How does appropriate woodland management
- **Indicators** of 'ecosystem health' – species on the Scottish Biodiversity List (SBL) that benefit from new woodland creation, effects on woodland management on SBL species. Numbers of SBL species that benefit from commercial (eg non-native tree species) creation or mixtures at landscape scale.
- **Specific guilds – raptors:** role of predator cascades in landscapes where woodlands and forests create mosaics of habitats and provide a safe environment for all predators to exist free from persecution. **Lepidoptera** – how important are networks of woodlands for leps.
- Species from currently **under-represented** taxonomic groups – the role woodland lepidoptera play in driving diversity in higher taxonomic groups.
- **Condition** (of habitats) – how the reduction in deer impacts will benefit woodland condition and how this will deliver changes in biodiversity value at landscape scale.

Cym: Population trends in species of principal importance - EPS and Section 7 (Environment Wales Act) in Wales. Currently reliant on UK Biodiversity Action Plan reporting – information on individual species limited and not available at country level.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area

- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

With increasing recognition of the value of ecosystem services it is becoming more important to be able to show value for public money. In addition, as forestry policy becomes more devolved and Brexit looming, there si less of a need for UK data. So, with this in mind, I would suggest that the important gaps are at the Country and Catchment/landscape level.

Eng: Fine resolution grid cell for EPS species and condition of priority habitats

- Sc: UK – national trends in abundance of BoCC red listed bird species, EPS and other 'protected' species.
- Country – Scotland specific trends in abundance of BoCC red listed bird species, EPS and other 'protected' species.
- Catchment/landscape area – regional specific trends in abundance of BoCC red listed bird species, EPS and other protected species. To enable site specific context of woodland creation in the presence of 'protected' species (all those on the SBL) to be judged against the national and regional trends. > 10km grid cell – as above.
- Fine-resolution grid cell (2km or 1km or 100m) – as above.
- Site – presence of EPS, Annex 1 habitat, Schedule 1A, A1 birds and protected species.

Cym: Fine resolution would be helpful for EPS, Section 7 priority species and habitats.

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Eng3 sc5 cym5

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Eng5 sc1 cym2

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

A key consideration is to ensure value for money. Knowing where best to make the effort is important. So knowing the comparative ecosystem value of a wider range of habitat types and how these are distributed across e.g. Scotland, England, and Wales would help managers decide where best to deploy scarce resources to maximise benefit.

Eng: Mapping of peat habitats at smaller spatial scales. Important evidence for forthcoming England Peat Strategy.

Sc: [none]

Cym: Coverage at a Wales level is needed. Also to update existing data held in Record centres – some is over 10 yrs old. Up to date information is needed to inform woodland management plans at a local level.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

My main interest is not so much in the statistical parameters of the data, but more in how statistics can be used to support decision making based on remote sensing and modelling data. i.e. Decision makers need to have confidence when making resource allocation decisions. They need to have some measure of confidence that the information provided by remote or abstract decision support tools does represent current or future real life. This is especially pertinent to long term land-use systems such as forestry, where decisions can have long-term implications.

Eng: For NFI/Stats colleagues to answer.

Sc: We would only use evidence or data that had undergone some peer review process and was accepted by specialists groups.

Cym: none

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

Good information available for birds, bats and butterflies.

Eng: Birds, butterflies & bats well covered.

Sc: Not directly relevant in Scotland?

Cym: UK BAP reporting and Breeding bird survey are sources used to report on the WfW indicator on woodland species.

Data does not appear to be available at a Wales level.

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

Increasing use of "Citizen Science" networks, but the bottle neck remains the lack of expert analytical capacity.

Recruiting for a PhD on "Monitoring Forest Ecosystem Services with Multi-Sensor Earth Observations". Investigating the potential to combine earth observation with high volume genetic sequencing and statistical inference to extrapolate from finite sets of point samples to spatially continuous biodiversity maps.

Sc: None at present.

Cym: The contract for ERAMMP – Environment and Rural Affairs Monitoring and Modelling Programme has been recently awarded in Wales. Aims to address evidence needs of a range of policy makers across Welsh Government including Forestry Policy. The focus is to work collaboratively with existing data collectors to share information and re-use data already collected, and build upon this, in order to make best use of resources.

CEH, Forest Research and others are working as a consortium to deliver this.

Animal and Plant Health Agency (APHA)

1 Your details

Name	***[removed from the publically available information]***
Organisation	APHA
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	Mostly, England and Wales, with some involvement in Scotland.
For what taxa do your answers relate to?	Mammals and birds, with some involvement for other vertebrates, bees and some plants.
For interviewees: briefly describe any consultations that you undertook in your organisation	Discussion with ***[removed from the publically available information]*** (… specialist).

2 What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs			Neither			Information on biodiversity is of most importance for **longer term strategic** planning and research
Strongly agree ◉	○	○	○	○	○	Strongly agree ○ .

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

Our role includes the use of biodiversity information to produce predictions of population size, abundance and distribution over short, medium and long-terms, as well as validation of the approach using historical data. However, temporal consistency/comparability in descriptions are of lower priority than the best possible description of the current state – as it is this that is one of the most powerful drivers of predictive power and anchors real-world predictions – successive best possible current predictions obviously compile to produce a historical sequence – however, as so many factors confound the robust analysis of long-term data, some variation in methodology is just one more and can probably be accommodated in modern analysis.

This is especially true in contexts of rapid multi-dimensional environmental change where ecological behaviours in the past (community composition, population dynamics etc) may poorly inform future behaviours.

For current approaches, data of occurrence and density at a 1km resolution (or better) is being used, along with any national population index or estimate. This information feeds directly into risk assessments and modelling – e.g. rabies control in foxes, spread and potential management of Egyptian Geese, assessing the effects of licensing of cormorant shooting on population size.

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years					Key priorities have **been stable** over the past 5-10 years	Neither
Strongly agree ◉	○	○	○	○	○ Strongly agree	○ .

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

Both the range of issues, species of interest and the scales (temporal and spatial) of operation of our predictive models have changed, and are likely to do so

The concept of a library of biodiversity information, waiting to be used to support research on the next issue is still powerful, especially if this is dynamic and 'real-time' rather than decadal static atlases or periodic trend reports.

With a reduction in Defra funding, our priorities are being more focused on exotic disease contingencies, control of bovine TB and non-native species management.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)					Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)	Neither
Strongly agree ○	◉	○	○	○	○ Strongly agree	○ .

What particular aspects or details of these are particularly important for you?

Both are critical.

If top-quality unbiased information is being collected then we can resolve the statistical assumptions made in its analysis and inference as long as we can see the raw data.

Ultimately, no derived question (your research for whys or hows) is of social use or decision-making quality if the underlying 'how much' type answers are poor.

Examples of current questions of interest include annual cormorant population numbers from WeBS (BTO), up to date information on non-native species such as Asian hornet (CEH), distribution of fox density for simulating exotic disease control.

We thus require unbiased information on where and how much, and in most cases so we can predict the consequences of Defra policy decisions.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity			Information is most important for informing **projections into the future** (e.g. future scenarios of change)			Neither
Strongly agree ○	○	○	○	○	◉ Strongly agree	○ .

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

Future projections are our stock in trade, but are of limited power if we can't validate them against past states and don't have a solid quality current state to use as our starting point.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

We really require consistent and rapid access to raw data and a better understanding of how the data collection coheres with other citizen science projects – e.g. quality of observers or observations.

Most of our decision making is with regard to a 5-10 year horizon at the most. Longer-term changes due to climate change are of interest, but not very relevant to the work we are doing today. We are also less concerned with biodiversity change per se, than we are with population change (spread and abundance)

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

We need to do a degree of horizon scanning for future issues within the Defra landscape. Currently there is an interest in ASF of wild boar spreading across Europe, so more interest in wild boar populations and spread today. There is almost an annual interest in wild birds and AI. The focus of this interest will change with time depending on which wild species appear to be most important.

Yes, Brexit will change these priorities, but until decisions are made the future direction is uncertain – e.g. PET travel scheme and risk of ticks, tapeworms, etc.

3 What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	○	◉	○	3
Abundance: knowing how many/much of a species/habitat is present	○	○	◉	○	1
Trend in distribution/abundance: knowing how it has changed over time	○	◉	○	○	2
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	○	◉	5
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	○	◉	6
Drivers of change: knowing environmental mechanisms underpinning changes	○	○	◉	○	4

Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	○	◉	7

Please give specific examples of the gaps you have:

Distribution: e.g. urban foxes, wild boar, monthly wild bird distribution over winter. There are specific gaps that change with time, but most information can be obtained from the NBN. We prefer raw data and make our own interpretations.

Abundance: there is far too little information on local density for specific species, which is informative for calculations of disease spread, or man-power required to manage a population. We recently pointed this out (Croft t al. 2015 PloS ONE) and I am involved with the Mammal Society to help to fill some of these gaps – although they will not align well with our priorities for Defra.

Trends in abundance – Trend in population size is important for some species (e.g. wild boar), but this is to predict near-term changes.

Ecosystem function – Not very relevant to APHA's current interests, although we have used this for honey bees and pesticide assessment risks.

Descriptions of potential drivers of future states is useful, but not vital.

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs			Neither
Strongly agree	○	○	○	○	○	◉ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Fewer species done more authoritatively best informs our work. This is primarily for mammals and birds, but we can prioritize within these taxa.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

How about 'important species', those which affect man, his economy or may affect the health of his crops and livestock.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

We will work best with data collected at its native scale – the precise location of the observation – everything else is statistics, which may be useful for biodiversity monitoring, but less useful for our purposes. For risk of diseases and emergency planning purposes we do not think there is a reason to 'blur' the resolution, and as a Defra family member we would prefer access to any data at its best resolution for our (government) priorities.

Ensure sampling is unbiased at least at the national scale.

After that if there is more effort available use a continuously reducing spatial stratification scheme to resolve more spatial detail. Collaborative projects then leverage the power of the surveillance activity, without compromise to the quality of surveillance

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ○ ◉ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

My principle concern is that moving forward, in landscapes that are changing at an ever greater rate – the assumption that space and habitat are interrelated (i.e. landscapes are at equilibrium) becomes progressively less safe. Ultimately, research examining the relationships of habitats to observations are principally sub-ordinate to the question – has the species has a chance to get here – which means a robust and unbiased sample of space first.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

Firstly, whilst you may 'sell' derived products to some parts of policy I hope/expect the raw data will be available to those who require it – in that context 'unbiased' and accurate raw data is of primary importance even if this includes a measure of uncertainty. We are generally less interested in interpreted data than in the raw dat. Not sure what products you may be referring to here.

This includes maximising the precision of individual observations – I'm concerned that you may assume or infer a level of observer accuracy or precision across the whole sample, when it is the quality of particular observations in particular places which become important. Are you planning some sort of adaptive QA/QC sampling where sensitive observations are resampled with known quality?

4 Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking

about improvements and developments, we want to ensure that we understand where the information is working well.

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

Use of the Mammal Tracker app is really helping with data collection on presence. I'm trying to find automated ways of presence data transfer from camera images into the NBN. I'm working with Mammal Society to suggest projects that can be coordinated between various groups (e.g. university students and wildlife trusts). We have an interest in camera trapping to determine presence/density. Possibly distance sampling with drones.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Northern Ireland Environment Agency: Department of Agriculture, Environment and Rural Affairs (Northern Ireland) (NIEA)

1. Your details

Name	***[removed from the publically available information]***
Organisation	NIEA
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	Northern Ireland
For what taxa do your answers relate to?	Principally, Plants, birds, bats, butterflies
For interviewees: briefly describe any consultations that you undertook in your organisation	Held a short internal meeting with those with link officer roles with BTO, BCS; those who use biodiversity data for regulation/reporting; data management and CEDaR Client officer.

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs			Neither			Information on biodiversity is of most importance for **longer term strategic** planning and research
Strongly agree ○	○	◉		○	○	○ Strongly agree ○ .

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

Biodiversity information needed to report on impact of policy (including legislative) intervention – is it making a difference – long term trends etc. Whilst longer term view also important the reality of our focus is more operational at present to inform action/decision at local levels e.g. planning, PfG and ecosystem approaches. Reporting important for comms too e.g. recent state of the UK's birds. I didn't include policy colleagues in the response and it may be that their focus is more forward looking?

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years			Neither			Key priorities have **been stable** over the past 5-10 years
Strongly agree ○	○	◉		○	○	○ Strongly agree ○ .

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

It's a bit of both – similar to the first answer. Long term data are critical to understand system changes on sensible ecological time periods, as opposed to political ones. Short term targets have been the traditional focus but now there is a transition to other drivers e.g. natural capital – with economy and wellbeing being significant new drivers/approaches, including the value of nature to people. Brexit may lead to fundamental changes in how and what we report and so what we measure needs to be adaptable potentially. There is probably a subtle shift towards local agenda with planning responsibility having moved to councils a couple of years ago.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)					Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)	Neither
Strongly agree	○	○	◉	○	○	○ Strongly agree

What particular aspects or details of these are particularly important for you?

In short both!

Status is a key ingredient – you need to be protecting/regulating the right things and understand trends so can target action. We, however, also need to understand the relationship to drivers, causes, the 'so what' questions increasingly to be able to justify decision making especially in relation to scientific uncertainty.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity					Information is most important for informing **projections into the future** (e.g. future scenarios of change)	Neither
Strongly agree	○	○	◉	○	○	○ Strongly agree

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

Probably on balance more focus on 'blue' area – lack of activity in 'blue' area can impact ability to deliver in 'buff' area above.

Currently for us it is data to inform reporting e.g. Art 17 but also at more local scales the impact of agri-env schemes (the work Lisa Norton doing may be important here?). Future scenario work is important and is something we frequently undertake at UK level and then have to apply locally which can have limitations.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

Impacts of ammonia; did agri-environment schemes deliver nature benefits?; sensitivity mapping for renewable energy sector; maps of land cover assets – living map? (LCM wasn't used given accuracy issues); integration of schemes to improve understanding of where to put data consistently

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

Alignment of health and nature; health could be where money is (green space, paths, recreation), tourism too and other green economy benefits. Pollinators and the service they produce (there is a UK and all Ireland plan and food security could be important leading to and post Brexit; baseline needed for 'going for growth' strategy

https://www.daera-ni.gov.uk/articles/going-growth-strategic-action-plan

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

This was tricky to complete; different people may have slight differing opinion…	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	◉	○	○	3
Abundance: knowing how many/much of a species/habitat is present	○	○	◉	○	2

Trend in distribution/abundance: knowing how it has changed over time	○	○	◉	○	2
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉	○	1
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	◉	○	1
Drivers of change: knowing environmental mechanisms underpinning changes	○	◉	○	○	3
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	◉	○	1

Please give specific examples of the gaps you have:

Big gap with habitats; little knowledge or quantification of ecosystem resilience; whilst some taxa are well known e.g. trends for 30 birds, 4 bats generally its poor in NI c.f. to GB.

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs		Neither
Strongly agree ○	○	○	○	◉	○ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Our desire would be to the right hand of the options above.

Reflecting on this I think that to an extent some of our activity in surveillance and monitoring is related to nature conservation tradition e.g. people 'like' watching counting birds, butterflies and the like and they may or may not be the best things to measure. Given the dependency on citizens it is unlikely you can completely rethink surveillance design. Need to build framework that maximizes the value of what can be done and be realistic and accept that some elements that may be more beneficial e.g. aspects of soil ecology or other important foodweb/ecosystem keystone taxa that previously haven't been recorded.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

Not aware of data being collected on ecosystem health e.g. soil microbes; pollinator data increasing slowly. We noted if using citizens, which as part of partnership working is important, it needs to be simple and doable. Invasive species a gap? The sign posting exercise for priority species could prompt > recording locally.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

Data should be as fine scale as possible. Generally 8-10 fig grids a minimum requirement for operational work, regulation etc. Other resolutions can be derived. 10Km too coarse.

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ○ ◉ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ○ ◉ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

NI tends to be under-represented iro species surveillance e.g. Bats and the data we utilize needs to be representative and relevant too NI within both UK and island of Ireland context. Ecosystem functioning likely to be different in NI – smaller fields, wetter, reduced number of taxa etc

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')

- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

We lag behind GB here. We have aspiration towards JNCC QA approaches but the reality is different. We have expectation that UK reporting has statistical power and where feasible NI stats are also included.

Quote from our unpublished evidence strategy below:

One of its goals:

- Be known as a key port of call for clear, unambiguous, quality assured environmental data and information

The related principle:

- NH evidence will be quality assured, where necessary and

Strategically

- We will develop 'simple', transparent, risk-based approaches to **quality assurance** of evidence products, including the use of 'expert opinion'

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

WeBS, BBS (supplemented by professional surveyors in NI) good.

BCS – getting there in terms of NI indices

Bats – to get there!

NPMS – probably too soon to tell but hope to invest locally (link here to Lisa Norton work possibly)

Pollinators expected and developing

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

EO is a big area for us to pursue and formalize what is delivered and how to publish. We are also reviewing CEDaR which has relevance at the local level here and working with yourselves on building an integrated monitoring approach to the Environmental Farming Scheme here. Citizen science more generally, schools and use of Apps all important approaches.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Environment Agency (EA)

Combined responses from 3 people.

1. Your details

Name	***[removed from the publically available information – 3 people A, B and C]***
Organisation	Environment Agency
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	England
For what taxa do your answers relate to?	Invertebrates
For interviewees: briefly describe any consultations that you undertook in your organisation	Consultation with other advisors ***[removed from the publically available information]***

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs				Information on biodiversity is of most importance for **longer term strategic** planning and research			Neither
Strongly agree ○	○	○	○	◉	○	Strongly agree ○	.

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

[B] Environmental quality is defined in ecological terms. Our environmental objectives and current status measures are ecological. Chemical and hydrological standards support ecological quality. We use them for managing the environment in long and short-term, including permits to discharge and abstract and inform planning, flood risk management and wider catchment activities that affect the quality of freshwaters. Our ecological/environmental quality objectives protect natural capital and the ecosystem services that they provide.

[C] We pay Local Environmental Record Centers (LERCs) to access information on protected species and habitats. This information is combined with data from our national fisheries and biological survey programs, and other national schemes and converted to digital, England wide, maps of protected species and habitats.

The combined data is used every day, throughout the Agency for all staff to use, via our GIS mapping system (Easimap). It is essential to our work determining environmental permits; planning and design of projects and maintenance; and in creating and commenting on plans.

Environment Agency collected data is essential, as it is targeted specifically for our regulatory remit. However, we could not collect the vast amount of biodiversity information that LERCs

collect. Without the combined data, there is a considerable business risk that we will be non-compliant with our legal duties

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years					Key priorities have **been stable** over the past 5-10 years	Neither
Strongly agree	○	◉	○	○	○ Strongly agree	○ .

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

[B] Increasing prioritization of pressures other than chemical, particularly physical alterations (geomorphology) and biological (invasive species), as these pressures are as important to degrading ecological quality as chemical pressures. Impacts of climate change matched to increased political importance of flood risk management. Changes in anthropogenic pressures, in particular agriculture and new chemicals and political will to control agriculture. Increasing importance of natural capital accounting and use of ecosystem services to value the environment and prioritize work. Reducing budgets for all work also changes our priorities.

[C] Over the last 10 years the ever increasing swathe of environmental legislation has, quite rightly, meant that we needed to have access to more and better quality species and habitat data. As our complex regulatory remit increased – with 50+ types of permit regulation, we needed a swift and efficient mechanism to assess potential environmental risks of proposed regulatory activities. These could be plans, projects or permissions (permits).

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)					Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)	Neither
Strongly agree	○	◉	○	○	○ Strongly agree	○ .

What particular aspects or details of these are particularly important for you?

[B] Both are equally important. All our decisions and processes have to be underpinned by sound scientific evidence and understanding of causes and pathways that lead to ecological degradation. Changing pressures and priorities also drive the need for better understanding of the ecological impacts of different pressures, acting together, on the various biological components of the ecosystem. That drives changes in the tools we need to assess biological impact. Our scientific knowledge of ecosystem processes impedes our understanding of natural capital and pressures acting on it. Our understanding of the impact of climate change and invasive species on our

existing ecological assessment methods. We need to understand which measures are effective and how long they take to improve the biota to restore the required ecological quality.

[C] We use presence or absence searches to then trigger additional surveys or extra consultation with SNCB's.

[A] – from a natural capital long term point of view we are most interested in being able to capture data on final ecosystem services. This is something that the EA rarely captures, but in order to calculate NC accounts and make better decisions on improving ecosystem services this sort of data will be the most useful e.g. data on use of woodlands or wetlands in recreation, data on effects of natural flood management (different methods) on flood risk reduction, etc etc (working down a list of final ecosystem services. Particularly for cultural and regulating ecosystem services).

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity			Information is most important for informing **projections into the future** (e.g. future scenarios of change)			Neither
Strongly agree ○	○	◉	○	○	○	Strongly agree ○ .

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

[B] Both are equally important. We need to maintain good ecological quality and where it is not good we must plan and implement measures to improve it. We have a 6-year planning cycle so measures enacted now must protect for the future.

[C] The presence or absence data for species and habitats that we use, is used to make immediate decisions around environmental risk. We do not use it to assess long term changes.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

[B] Better understanding of the reasons for changes in distribution of biota, particularly pathways and factors influencing the expansion of Ponto-Caspian invasive species, not just through UK but over central Europe.

Better understanding of the ecology of rare/protected species and causes of population change and factors needed to support/re-introduce them. Particular concerns are changes in eel and salmonid fish; causes of decline in native breeding success in pearl mussels.

[C] It would be useful to overlap the scale of change with our active interventions. For example Water Framework Directive improvements, Asset Management Plans or habitat creation, SSSI improvements. Assessing these at a catchment scale would be ideal – otherwise a River Basin Management district, across England.

We could then see whether there was a clear correlation between intervention and rate of species/ habitat decline.

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

[B] Willingness to tackle agriculture will require better understanding of link between agricultural practices and ecological damage or improvement. We still struggle to measure the benefits of set-aside to freshwater ecosystems. Willingness to adopt natural flood management will increase the need for better understanding of ecological processes and run-off so we can provide better advice. Development of natural capital accounting and ecosystem services will require better understanding of the underlying ecological processes and their value. Linking enforcement (fines) to damage to ecosystem services. Changing technology, particularly impact of DNA analysis on taxonomy and identification may lead to better understanding of microbial communities and their functioning.

[C] The biggest change will be associated with Agricultural practices and whether the new mechanisms for payments and ecological protection are effective.

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	○	◉	○	2
Abundance: knowing how many/much of a species/habitat is present	○	○	◉	○	4
Trend in distribution/abundance: knowing how it has changed over time	○	○	◉	○	7
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉	○	6
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	◉	○	5

Drivers of change: knowing environmental mechanisms underpinning changes	○	○	◉	○	1
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	◉	○	3

Please give specific examples of the gaps you have:

[B]

a. In order to restore ecological quality or protect it, we need to know what has causes it to be impacted and what measures we need to implement to ensure its restoration. We need this also to maintain existing quality and prevent deterioration.

We lack a biological system for assessing and monitoring soil quality.

b. We need to know what natural communities live in intermittent streams and what determines their distribution so that we can protect them. We need to know which intermittent communities in UK are natural and which are not. We need to know the distribution of invasive species and how their distributions are changing. We must know where rare and protected species and habitats occur so we can protect them.

c. We need to be able to predict that areas in good and high status, including protected areas, do not deteriorate and areas that we aim to restore achieve their objectives as a result of the environmental management measure that we implement.

d. It is important for us to know the extent of invasive alien species and protected species that we have particular interest, such as pearl mussel, so we can ensure appropriate protective measures are in place. We need to know about the distribution and abundance of fish species, particularly those of angling and conservation interest, as well as the distribution and abundance of fish parasites and disease organisms to protect our fisheries interests.

e. Knowing how the functional impact of biodiversity has changed over time is a key area that drives monitoring that we undertake and use. The Environment Agency's primary aim is to protect ecosystem health so knowing how the biota changes with regard to key ecosystem functions is crucial. We are constantly revising our ecological assessment tools to better reflect the key aspects of ecosystem health that are impacted by different environmental pressures, so it is a key area also for our R&D.

f. An improved understanding of the functional impact of microbial biodiversity is likely to be of increasing importance as not only is the microbial community responsible for much of ecosystem functioning, particularly the decomposer and nutrient recycling components, but advances in DNA analysis could potentially revolutionize our understanding of these communities and the way we assess and monitor ecosystem heath (i.e. environmental quality). We are also likely to need a better understanding of ecosystem services provided by different biological communities and improved ways of evaluating them in terms of natural capital.

g. Understanding tends in distributions and abundance could be regarded as our top priority as it is the basis for our biological monitoring programmes. We need to understand natural trends as well as trends driven by human pressures so that they can be discounted when we determine where management intervention measures are needed and how effective they are.

[C] The Environment Agency knows a huge amount about our freshwater ecology and the changes – linked to WFD, However we have relatively little on terrestrial and coastal sites. The answers above are based on these sites.

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs			Neither
Strongly agree	○	○	○	○	○	◉ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

[B] Both are important, but some indicators are better than others, so increasing taxonomic coverage is usually not as important as spatial coverage. Currently, invertebrates respond to the widest range of environmental pressures and they are better understood that the other indicators that we use in aquatic environments (other main indicators being bacteria, macrophytes, algae (diatoms / seaweeds) and fish. If we don't undertake any monitoring in a place, we can't say much about its ecological quality. Increasing taxonomic penetration (i.e. lowering the taxonomic level to which we analyse the biota, in particularly, identifying invertebrates to mixed taxonomic level (species) rather than to family is important for improving the precision of our assessments of ecological health. In the future, I suspect we will want to increase the taxonomic coverage of bacterial and other microbial communities to take advantages of DNA for taxonomic identification. The biodiversity of bacteria far outstrips that of all other taxa combined.

[C] Our freshwater ecological sampling is constantly juggling the requirements to undertake monitoring versus the cost of this. This is regularly assessed to ensure we focus our attention on the most 'at risk' rivers. Where we have static data it is felt that the risks of reducing monitoring are minimal.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indices** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

[B] I've mentioned the potential need for better understanding of bacterial communities in the future, as an under-represented taxonomic group.

We probably have gaps in most of the levels listed.

Substantial cuts on monitoring driven by budget cuts probably mean that fairly soon we will have important gaps in coverage of current indicators of ecosystem health, despite improvements in efficiency and technology.

Special species are the second group where we have important gaps, largely because the distribution of these species (particularly alien invasive species) is changing so fast.

[C] Our terrestrial biodiversity data is focused on a sub-set of the Biodiversity 2020 list of species, which the EA leads upon. These are primarily freshwater dependent.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

[B] We use data at all these scales, because different environmental pressures are bet controlled at different scales. Given cuts in our monitoring budgets, we are likely to have gaps at all these levels.

Data or UK is needed at European level. Brexit may diminish this requirement.

Country is the coarsest level that we manage the environment, as this is the scale at which UK environmental protection agencies measure their performance.

Most environmental protection is undertaken at catchment scale (Catchment-based approach) and this is the level at which we engage partners.

10 km grid cell is less important to us.

Finer resolution is the scale we use to monitor and control individual discharges, abstractions and developments.

[C] We assess permits at a 30m distance resolution up to 15000m, so the data needs to be compatible with that range.

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ○ ○ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ○ ○ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

[B] I do not agree that there is such a trade-off for us. We need biodiversity information at the right scale for management and that is not necessarily always at a smaller scale.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

[B] We used to have a set of statistical standards, and this is what we based our monitoring design around. Accuracy determines what we can measure and this and the size of changes that we can detect and the size of changes that trigger environmental measures. We require a greater level of certainty for more costly measures. Documents describe this. I have been responsible for these aspects in relation to river invertebrate monitoring, and we have measured all aspects in your list: sampling error and inter-operator variation on research studies; we measure laboratory error in terms of the metric we use for assessment (both independent audit and internal AQC), not only in our monitoring but the models we use to predict reference values. We adjust our measures to take account of error bias.

Cuts in monitoring have eroded the precision of our monitoring. Monthly sampling use to be the norm to provide 36 samples over 3-years on which to monitor against a 10 or 90 percentile standard with sufficient precision to detect reasonably small change/failure. More usual now is quarterly sampling that only provides 12-samples and sometimes as few as 9-samples. As a result, the minimum size of change or deviation from standard that we can detect is now much larger.

[C] Unaware of any.

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

[B] Most of the biological monitoring data that we use is collected by our own ecologists. We do use data collected by national recorders and we do that either via the National Biodiversity Network or from local record centres (I know we had separate contracts with LRCs around the country to provide biological data, and I suspect that we still do).

[C] I like the quick access to your SAC/SPA/Ramsar information and links through to the species information.

The presentation is logical and simple to use. Much easier than the Natural England components of Gov.uk

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

[B] The main 'new' approach that we are investigating is DNA analysis. We are investigating use of environmental DNA for monitoring in the medium-long term. We already use DNA to assess the presence of key species in freshwaters, including newts, pearl and some alien invasives.

We use Anglers Monitoring Initiative data to provide warnings of problems in locations that we do not monitor.

There is potential for a better link-up English Nature's Common Standards monitoring and the Environment Agency's Water Framework monitoring.

[C] We are increasing our use of satellite data and drone surveillance – although it is really early days.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Joint Nature Conservation Committee (JNCC)

1. Your details

Name	***[removed from the publically available information]***
Organisation	JNCC
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	UK (as well as UK within a European or world context)
For what taxa do your answers relate to?	All terrestrial taxa
For interviewees: briefly describe any consultations that you undertook in your organisation	No consultations, but I checked answers against strategy documents.

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs				Information on biodiversity is of most importance for **longer term strategic** planning and research			Neither
Strongly agree ○	○	○	◉	○	○	Strongly agree ○	.

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

Whilst reporting on country and UK indicator sets is perceived as a critical 'must do', most advisory questions require additional analysis and interpretation. Analysis is generally done at a UK-scale, but we are always under pressure to use up-to-date data in order to ensure that it is capturing the current state. Without up-to-date UK-scale data we are unable to provide any input to the wide range of policy questions we are asked.

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years				Key priorities have **been stable** over the past 5-10 years			Neither
Strongly agree ○	○	○	○	◉	○	Strongly agree ○	.

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

Priorities for reporting / understanding have changed quite significantly in that time period, but they have not actually driven a change in the underlying information requirements. 'New' ideas such as natural capital or resilience change the analyses that are done, or the complementary datasets needed, but not the requirements. Change has largely been externally driven, although there has been some internal change as well, particularly through wanting to understand ecological processes.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)	Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)	Neither

Strongly agree ○ ○ ◉ ○ ○ ○ Strongly agree ○ .

What particular aspects or details of these are particularly important for you?

Our evidence strategy commits us to all of status, trends, impacts of pressures, impacts of interventions. I have slightly favoured the status end, as this is the most fundamental. In general, we are required to commission surveys that are multi-purpose, rather than a survey that would be designed to answer a question about a particular intervention or pressure. Therefore, we also tend to collate additional information sources in these areas.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity	Information is most important for informing **projections into the future** (e.g. future scenarios of change)	Neither

Strongly agree ○ ○ ◉ ○ ○ ○ Strongly agree ○ .

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

Ideally, we need to know what the trend is for the last 5-10 years, so that questions such as 'is the UK halting the loss of biodiversity' can be answered – if the time frame is more like 25 years, there is a general perception that current efforts to halt loss will be lost within the overall trend. Future projections are often longer term – much focus currently on the 25 year plan, but also consideration of climate change scenarios and air pollution scenarios, that take a long time to play out. Parameterisation of models such as demographic models do not require constant updating, but there is still a desire to know that they are 'current' – probably within the last 5 to 10 years.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

What have the losses of pollinator abundance and diversity been, and how do these relate to patterns of land cover and floristic resources?

What are the linkages between delivery of flood mitigation, adaptation and water quality with biodiversity?

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

The policies that are being developed in Wales with regards to sustainable management of natural resources are likely to be developed (in some form) more widely. These do set new evidence needs, at least in the framing of the questions asked.

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	◉	○	○	
Abundance: knowing how many/much of a species/habitat is present	○	○	◉	○	
Trend in distribution/abundance: knowing how it has changed over time	○	○	◉	○	
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉	○	
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	◉	○	
Drivers of change: knowing environmental mechanisms underpinning changes	○	○	◉	○	
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	◉	○	

Please give specific examples of the gaps you have:

Abundance – what is the abundance of tree species in grid cells, so that epidemiology and impacts can be modelled?

Ecosystem function – how can a change in biodiversity impact the processes underlying e.g. soil water dynamics.

Drivers of change – what is causing all of the trends, and what policies can we use to change that?

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs			Neither
Strongly agree	○	○	○	○	◉	○ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Although we are frequently challenged on the taxonomic balance of the JNCC schemes, I actually believe that the unstructured data from BRC provide a really efficient means to get the best balance possible without major investments. The answers that I am required to provide to policy questions, and the increasing focus on a local scale (approximately catchment scale) means that the spatial coverage is much more important.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

I think of these I would focus on indicators of ecosystem health (if we could only define this), species providing ecosystem services (or indeed communities of species providing services) and habitat condition. These are where I am required to provide evidence, and I always struggle.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area

- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

There is a widespread belief that if a survey is well-designed it should be informative at all of these scales. Setting that belief to one side, catchment scale is important for understanding what actions or interventions should be prioritized in that area. Possibly catchment scale can also provide a more regionalized approach for modelling fine resolution data?

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ◉ ○ ○ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

Catchment scale information is always called for. However, unless you cut evidence by habitat it is very difficult to assess management interventions. Therefore I consider habitat more important, although again there is a trade-off regarding how narrow a habitat definition is used – information does not need to be at a very narrow habitat resolution.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

We can use evidence with a range of quality. We are required to set out clearly how accurate it is, what the significance level is, whether there are any sources of bias. These statements are then interpreted by policy colleagues according to the level of 'risk' that ministers are willing to accept. We get most criticized around issues of bias – this clearly plays out badly when we set out that a survey contains bias.

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Natural England (NE)

1. Your details

Name	***[removed from the publically available information]***
Organisation	Natural England
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	England
For what taxa do your answers relate to?	Various
For interviewees: briefly describe any consultations that you undertook in your organisation	Broad consultation across numerous monitoring leads and species specialists (14 individuals) within Natural England. No direct contribution provided by Avian or Lepidoptera specialists within the timeframe.

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs				Information on biodiversity is of most importance for **longer term strategic** planning and research			Neither
Strongly agree ○	○	○		○	○	○ Strongly agree	● .

NE consultation response tally…

1	2	4	0	2	2	3

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

We need biodiversity data for a variety of purposes, from strategic to more operational uses. There is no continuum from Reporting to Long Term Planning. The scale question posed is a false dichotomy. It also negates other important drivers like local operational delivery and decision-making. The Biodiversity Monitoring & Surveillance Strategy for the Defra Group sets out our overarching requirements. Aligning with Defra's overall strategic evidence needs, these include: *Supporting local delivery and decision-making* (targeting action to manage and restore biodiversity, mapping components of biodiversity, relating these to natural capital assets and making data openly available to local decision makers at the right scales); *Detecting and understanding environmental change* (to understand how and why important components of biodiversity are changing so we can address the reasons for change and predict how these will affect society); and for *Reporting and evaluation* (National reporting including national biodiversity indicators, official statistics like SSSI condition, EU and international reporting as well as evaluating the effectiveness of policies and interventions, such as planning and licencing, agri-

environment, designations). There is a shift towards wanting / needing to know more about ecological interaction between species and natural processes, the health / condition of these and how they are changing / responding to impact / intervention.

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years			Key priorities have **been stable** over the past 5-10 years			Neither
Strongly agree ○	○	○	○	○	○ Strongly agree	◉ .

NE consultation response tally…

4	2	1	3	2	0	2

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

The variation in NE staff responses along the scale question above may reflect difference in subject / role. The drivers for some topics / specialisms have remained fairly stable. However, we have had several big policy / strategy shifts that have significant implications for data and priorities. We are likely to remain in a period of transition as new government policies bed in (25YEP) and we exit the EU.

We know the focus of evidence is shifting further away from single species/taxa or single site focus to more community composition and ecological function considered at broader scales. We need to work beyond traditional site scale at more landscape, catchment and ecological network scales. We also increasingly want to integrate scientific, social and economic evidence to address local environmental management. We want to improve our ability to evidence our advice / decisions and evaluate what works, facilitating a more 'adaptive management' approach to outcomes.

Increasing emphasis on ecosystem services and natural capital assets means we need biodiversity data that helps us describe and assess the environment in these terms. This builds on / further expands the need for closer integration between habitat and species data collection and evaluation. The need to describe ecological function and evaluate its health underpinning the provision of ecosystem services is broadening areas of interest. Soils is a good example here, where biological data indicative of ecological function is now recognised as vital for understanding and managing for healthy sustainable soils.

We are rapidly embracing new technologies which in turn may well change the nature / type of biodiversity data we need to collect. For example, Fungal taxonomy is currently in a relatively rapid state of change owing to DNA sequencing and advances in eDNA/mycelial DNA survey techniques. As a result, some species that were thought to be conservation priorities are no longer considered so.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)	Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)	Neither

Strongly agree ○ ○ ○ ○ ○ ○ Strongly agree ◉ .

NE consultation response tally…

1	3	5	1	0	0	4

What particular aspects or details of these are particularly important for you?

We need a balance between these two roles / purposes for biodiversity data. It's definitely not a case of choosing one over the other. We tend to commission monitoring & surveillance to understand distribution, population and change, but these typically lead to a need to understand the 'why' or 'how' in order to put status into context and understand what, if anything, needs to change.

Traditional focus has been more towards 'how much' and 'where'. In recent years there has been a shift towards 'why' and 'how' to help address adaptation and develop more ecologically complete strategies. The UK species surveillance schemes have been useful for the 'how much' and 'where' questions for specific groups. They have also had value in addressing some of the 'why' and 'how', but often need to be interpreted with other data e.g. on land cover. Increasingly we need biodiversity information which relates to broader ecosystem function, underpinning the provision of ecosystem services and natural capital assessments. In addition we need better integration with physical data e.g. on soils, climate and air pollution. The Environmental Change Network has offered a useful way to bring different approaches together in well monitored and research places. Better integration with our own NE Long Term Monitoring Network also offers great potential to understanding change.

Natural England have identified 11 key evidence questions that we need to answer. Many of these need, but are broader than, biodiversity evidence:

1. How and where should we develop coherent ecological networks, including through the restoration of natural processes and taking account of how people may benefit?
2. How can we monitor the state of natural capital assets within the context of ecosystem services provision? What indicators and metrics should we use?
3. How can we best measure ecosystem structure, process, function and services? What are the opportunities presented through emerging innovative technologies and new approaches?
4. How, where and why is the natural environment changing? What are the current and future drivers of change? How might these affect the natural environment now and in the coming decades?
5. What are the attributes and indicators of natural and cultural environmental resilience, including terrestrial and marine biodiversity, landscapes and geodiversity, and social and economic systems?
6. How can we help secure environmental outcomes in ways that encourage more sustainable agricultural and fishing practices? What is the evidence of effective existing practice?
7. How might changes in the natural environment affect people's health and wellbeing? What interventions can enhance these benefits or mitigate any negative impacts?

8. What is the potential of Big Data and other datasets in support of our environmental outcomes and objectives? How can we best address inherent uncertainties and complexities in our analyses and advice?
9. How can we use evidence about human behaviour and systems of governance to influence decision making by local partnerships, government and/or businesses to deliver long-term benefits for the environment, society and the economy?
10. What do people and communities across England want and need from the environment? How can we integrate evidence about the values held in, and benefits provided by the environment into economic, social and spatial planning? How do we enable effective action and governance to deliver this?
11. What is the basic ecology of species of conservation concern? How can understanding of meta-population dynamics contribute to species conservation?'

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity			Information is most important for informing **projections into the future** (e.g. future scenarios of change)			Neither
Strongly agree ○	○	○	○	○	○ Strongly agree	◉ .
NE consultation response tally…						
2	3	4	2	1		2

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

Again not a case of either or. An important part of anticipating future changes is understanding past and present change. Anticipating future change is not just a matter of projection, and can be more qualitative. Projection can be useful but can also give a false precision.

The timeframes we work to are generally medium (5-10 years) to long (over 10 years). The administrative lifecycle of government, programmes and projects, drives a need for data, information and assessment in the shorter-term. But most biodiversity changes are comparatively longer-term, typically 10 years or more. To detect meaningful trends we need to gather biodiversity data over several generations of organisms. Changes in habitats tend to become recognised / appreciated as real over the longer term e.g. loss of sphagnum to acid rain; shifts in flood meadow composition as a result in more frequent inundation etc. The longer window of the 25 Year Environment Plan is potentially helpful in this regard.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

We found this tricky. Potentially lots, but much of the stuff we didn't know 5-10 years ago we still don't know now. We need to do more to describe and understand the more complex ecological functions we benefit from (ecosystem service) and their health. Possibly better climate change predictions, invasive species assessments, nitrogen deposition / air quality impacts, ecotoxicology data for novel pollutants and agricultural land use impacts on water quality and pollinators. How different management strategies would influence responses to climatic events and trends, e.g. the impact of floods on biodiversity. A better understanding of the chronic decline of widespread species, as well as expansions and contractions to species ranges. There has been some discussion about using modelling to inform Red List assessments, but no progress. Predictive models might have helped us better target conservation resources. However, as stated previously, anticipating future change is not just a matter of projecting which can give a false precision.

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

25 year Environment Plan, Natural Capital, and healthy ecologically functioning landscapes (e.g. soil health), resilience. Climate change adaption. National Emissions Ceiling Directive (or post-Brexit UK equivalent), future agriculture policy, support and agri-environment schemes, future land management technologies and innovation, Novel Pollutants, New species licensing policies (District Level Licencing).

In addition to policies there is the impact of new and emerging technologies such as Earth Observation and Genetic Sequencing may also create new evidence needs, abilities or research possibilities.

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

NE consultation response tally…

	Evidence need is **well**	There are **some gaps**	There are **major gaps**	Not relevant to me/my	Rank	OG	AN	RH	KW	DO	MS	TW
Distribution: knowing where species/habitats occur	2	6	6		1	5	2	1	5	2	1	6
Abundance: knowing how many/much of a species/habitat is present		4	9		4	6	5	2	1	1	7	7
Trend in distribution/abundance: knowing how it has changed over time		4	9		2	7	6	3	2	3	2	3
Ecosystem function/service: knowing the functional impact of biodiversity		3	10		3	1	1	6	6	6	4	4
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time		1	12		5	2	3	7	7	7	3	5
Drivers of change: knowing environmental mechanisms underpinning changes		8	6		3	4	4	4	4	5	5	2
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.		3	11		4	3	7	5	3	4	6	1

Please give specific examples of the gaps you have:

There are significant gaps across all aspects of the above. Difficult to use this list to highlight the most important gaps. There are common data gaps in general, but the detail / priority can vary between species, sites and habitats. Almost 40% of existing S41 species have a 'survey or monitoring' need identified that has not yet begun to be met (there are many more in the 'underway' but not necessarily completed category). Over 40% of existing S41 species have a 'research' need identified that has not yet begun to be met. The gaps in knowledge around Ecosystem function/service (a key concern going forward), and trends therein, and indeed with regard to Resilience will be even larger than those outlined above. There are really important issues around hydrology and ecosystems in relation to flooding and drought, but we don't think the UK species surveillance programme is necessarily well placed to meet them. To that end, working within a wider environmental monitoring context is essential.

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs			Neither
Strongly agree	○	○	○	○	○	Strongly agree	◉ .

NE consultation response tally…

2	1	2		3	2	2

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Difficult to answer and fairly wide split in responses to the scale above. All felt both were important and needed, with a lean one way or the other. Far too much weight is currently placed on conclusions from birds and butterflies which may not be robust for wider biodiversity. We need to think about innovative ways of achieving both for more & different things. For example, the complex communities of tiny animals and microbes inhabiting soil are likely to be assessed using community-based DNA techniques that are currently under development. Modelling may be able to increase spatial coverage (or make more useful at smaller spatial scales).

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

Traditional priority is Nationally Rare & Scarce and/or Threatened taxa and the habitats they require. We need a better balance of data across taxonomic groups, particularly for those most indicative of ecological function. The key growing priority is likely to be indicators of ecosystem health (which is closely related to habitat condition) and species providing ecosystem services. A report on natural capital indicator gaps is due to be published after March 2018, but there are details we can share now.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

There is a distinction between the scale at which we need to analyse / use data and the scale of data capture needed to enable this. Analysis and assessment at a catchment / landscape scale is an important new requirement for NE. We retain the need to work at site scale and various administrative scales (from county to national) as well as contributing to UK assessments. Data should be captured with a detailed/fine resolution (at least 100m precision) to maximise reuse value. Telling, for instance, a National Park that their patch is important for a given species is inevitably followed by the question, 'well where is it then?' Accompanying information is often limited but can add a lot of value. A specific example is the value of linking records to a relevant water body ID (which can be found here https://eip.ceh.ac.uk/apps/lakes/).

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

NE consultation response tally…

Unimportant					*Extremely important*
0	0	6	3	2	

Improving information from currently under-represented **habitats**?

NE consultation response tally…

Unimportant					*Extremely important*
0	0	3	4	4	

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

There are some differences in view but broadly we want both. Strategically our need is more to understand different places than a finer resolution of habitat types. Greater specificity of habitat definition has not been a limit on providing advice about species conservation, whereas not being able to say where a species actually occurs, very regularly is a barrier. Traditional species focus drives a desire to understand finer/niche habitat requirements for particularly rare species & to facilitate dispersal. E.g. Rare fish species in standing waters and migratory fish species requiring specific habitats. A particular case in point are headwater streams, which are highly under-represented relative to larger rivers but constitute around 70% of the river network by length. Both habitat condition and species assemblage are neglected. Thinking about the concept of 'habitats' in new ways that relate to organisms beyond just vascular plants. This is a massive specific gap we face addressing ecological function / health.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

Achieving good coverage and confidence limits is a real challenge. We typically use whatever is available and describe our uncertainties / caveats in any advice / decisions to be given. Going forward we will take account of the new UK Statistics Code to ensure we produce data and analysis that abides by the three principles of quality, trustworthiness and value.

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

The UK Surveillance Schemes have been good at informing us about national trends and (when combined with other data) understanding some of the drivers of change, but for a very narrow set of taxonomic groups. So there are significant gaps. Some schemes offer great value for site monitoring (e.g. BBS, WeBS and roost monitoring for National Bat Monitoring Programme). Schemes can be focused on long established sites, which is great for tracking change over the years, but not to track species movement. Habitats are not really addressed at all with no substantive information on habitat quality or type.

Countryside survey had its limitations but provided some excellent information, e.g. for soils. Investment in the CEH Biological Recording Centre is important for supporting the wider recording community and better data management including the development on-line recording infrastructure and community.

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

Development of remote sensing capability and provision of Analysis-Ready Data – satellites and drones – providing new / alternative observations and measurements. Development of DNA applications for survey and monitoring of a growing range of species and assemblages. Development of citizen science applications (with partners) and public contribution to species, habitat and condition data. Investment in long-term data sets and intensive site monitoring – e.g. Long Term Monitoring Network. Reform of our Protected Sites monitoring to among other things incorporate new tech and operating at a landscape scale. Better data management, making data openly available by default and supporting tools and infrastructure to enable others to do this. Developing analytical and modelling capability. Identifying ecosystem metrics that will be valuable in understanding Natural Capital stock and change – such as moorland burning, vegetation productivity or wetness indices, etc. Look for opportunities for join up between monitoring programmes, e.g. many rusts and smuts are host-specific to particular vascular plants and VP surveyors could be approached to look for these taxa during routine survey/monitoring work.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Natural Resources Wales (NRW)

1. Your details

Name	***[removed from the publically available information]***
Organisation	Natural Resources Wales
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	Wales
For what taxa do your answers relate to?	Have tried to be as all-encompassing as possible, with inputs from terrestrial and freshwater colleagues.
For interviewees: briefly describe any consultations that you undertook in your organisation	Consulted across evidence, policy and operational parts of NRW. Responses received from those leading on terrestrial species evidence; freshwater biodiversity evidence; forestry policy & evidence; State of Natural Resources reporting.

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs				Information on biodiversity is of most importance for **longer term strategic** planning and research	Neither
Strongly agree ○	○	○	○	◉ ○ Strongly agree ○ .	

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

We need biodiversity information for a variety of purposes, both operational (more immediate and usually site-specific) and strategic (longer term). Evidence available from different surveillance schemes under TEPoP lends itself variably to these different purposes, with most schemes at present tending to support strategic rather than site-specific, operational needs. This is a function of current spatial coverage; unless there is high spatial coverage, it is unlikely that evidence for any particular location (which may be subject to operational decisions eg local casework) will be available. (Exceptions to this might be eg WeBS, which works well at a site-specific scale as well as generating more general statistics; more generalized biological recording also has value in more site-specific applications eg assessing potential impact on protected species.)

Individual responses to this were variable, but I've recorded as most useful for strategic purposes based on the current value of surveillance schemes.

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years				Key priorities have **been stable** over the past 5-10 years		
Strongly agree	○	○	◉	○	○	○ Strongly agree

Neither ○ .

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

In practice, priorities have arguably remained largely unchanged, though the current direction of travel (driven by both new legislation and funding constraints) is towards more strategic solutions rather than site-specific solutions, and evidence may need to change to match that. Language used to describe priorities has changed with new legislation, so current focus is very much on 'ecosystem resilience' and the 'sustainable management of natural resources'.

Currently somewhat in flux.

Again, variable responses from colleagues.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)				Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)		
Strongly agree	○	○	○	○	○	○ Strongly agree

Neither ○ .

What particular aspects or details of these are particularly important for you?

We see the need for information to serve **both** of these purposes. The degree to which one might be favoured over the other at any point perhaps depends on the current state of knowledge in each area. If basic knowledge from research is lacking we may not know what or how to monitor (so investment in research might be appropriate); where this knowledge exists we may have established monitoring systems that need further investment still to ensure an adequate level of basic performance (so here we might prioritise continued investment in monitoring); where long time series of adequate monitoring exist, we might consider we have enough evidence to meet our needs for a while, and shift investment into answering questions relating, say, to the implication of current state and recent change (the 'so what?' questions).

But some risk that the need to meet statutory reporting obligations will tend to push us towards monitoring and surveillance, with research seen as more of a 'luxury'.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity				Information is most important for informing **projections into the future** (e.g. future scenarios of change)		
Strongly agree	○	○	○	◉	○	○ Strongly agree

Neither ○ .

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

To date, information has been used mostly for looking at change up to the present day, though some reporting requirements do require a forward look (eg Habitats Directive requires an assessment of 'future prospects').

Again, the two are related, with greater opportunity for making (reasonable) future projections where existing time series are strong. While the desire may be there to move more towards future projections (in line with the general shift to a more strategic approach), the reality may be that a better understanding of recent trends (and their causes) is required before this becomes a realistic possibility.

Reporting frequencies written into legislation as well as specific policy targets have often produced aligned monitoring cycles (eg previous 6-yearly Common Standards Monitoring (no longer in place); 6-yearly Habitats Directive Article 17 reports; 5-yearly Wales State of Natural Resources report)

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

Scaling-up of local effects (eg from agri-environment scheme agreements) to a larger scale (eg national) effect; and how might different configurations of agreements have affected this.

Consequences of not having had a regime of statutory nature conservation site designation, or a weakened regime – relative losses and gains.

Land management issues, can we use the data to project the impact of our policy direction.

Linking evidence to the management we have done or are recommending going forward.

Linking to habitat surveys, condition information linked to habitat management. Identify which species and levels represent a resilient state for each habitat, indicators.

Better information on catchment and freshwater activities that could be specifically linked to biodiversity change.

Impacts of hydro-power schemes on non-vascular plant populations

Impacts of ammonia on non-vascular plants- better modelling of aerial pollutants for this too-finer scale.

Use of modelling for strategic planning purposes for European protected species and other species

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

Ongoing evolution of Welsh natural resources legislation and associated policy: Environment Act Wales (including Sustainable Management of Natural Resources Duty, Area Statements and SoNaRR), Well-being Act (and associated indicators), Nature Recovery Action Plan – and then, whether other Welsh Government policies change in response to these initiatives. A particular challenge is to develop a consistent evidence base that can operate at multiple spatial scales (national -SoNaRR; local – Area Statements), with associated, nested indicators. A general requirement to understand the consequences of biodiversity change for ecosystem services and well-being benefits, and the relative values associated with these.

UK common agri and fisheries frameworks

Green energy increases

Ability to show we meet EU requirements without EU rules, market accessibility, trade

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	◉	○	○	=3
Abundance: knowing how many/much of a species/habitat is present	○	◉	○	○	2
Trend in distribution/abundance: knowing how it has changed over time	○	○	◉	○	5
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉	○	=3
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	◉	○	6
Drivers of change: knowing environmental mechanisms underpinning changes	○	◉	○	○	7
Resilience: knowing that the species/habitat/function will be at a	○	○	◉	○	1

certain level in the medium-term future.					

Please give specific examples of the gaps you have:

- Gaps in understanding of how elements of biodiversity contribute, via ecosystem services, to aspects of wellbeing (and the relative value assigned to these).
- Are there key indicators within these complex pathways that can provide reliable early warning of undesirable change (eg to ecosystem resilience)?
- Wales and regional level population estimates of many terrestrial and freshwater species, and trends in abundance.
- We have variable knowledge of the distribution of different taxa eg good for birds and vascular plants, poor still for invertebrates, non vasculars. Gaps in local knowledge hamper site-specific decision-making.
- Freshwater decision support tools based on sustainable principles that can be used in regulation and other decision making processes.

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs		Neither
Strongly agree ○	○	◉	○	○	○ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Diverse views expressed by colleagues, some favouring increased taxonomic coverage, others spatial coverage.

To be useful at a strategic level (probably the main role for surveillance scheme data) evidence needs to be representative of relevant situations/locations, and spatial coverage is an important part of realizing this. There is limited value in expanding taxonomic coverage if it is at the expense of representative spatial coverage for already informative/valued taxa (unless it is much greater than it needs to be). Recent increases in uptake of some schemes has led to improved spatial coverage, suggesting that future effort might be usefully focused on improving coverage of some other taxa (e.g. invertebrates, fungi and freshwater species generally were highlighted as groups for which taxonomic coverage is poor).

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

New Welsh environmental legislation and policy drives us increasingly towards the need for a balanced set of biodiversity evidence that is informative in relation to the provision of well-being benefits that arise through ecosystem services. If a healthy or resilient ecosystem (or a habitat in good condition) is one that continues to provide such services and benefits, then indicators of health and condition will be valuable measures. Weak coverage of invertebrates (eg hoverflies, bees and wasps, beetles), fungi, freshwater species generally (eg non-salmonid fish), amphibians and reptiles are likely to include important specific gaps.

Existing legislation also asks for evidence relating to 'special' species and habitats (e.g. those listed in annexes of the Habitats Directive). Adequacy of existing data to support status assessments for such species is mixed – especially where species extend widely beyond protected sites (eg great-crested newt, though this species has been the subject of recent new activity). [We should note though that some (but perhaps not all) of these species can be viewed as providing valued cultural services, so evidence about 'special' species is not at odds with new policy direction.]

Generally, habitat-specific information about species is often poor (so assessments of 'typical species' as required under Habitats Directive are difficult). In the freshwater environment, ponds and ditches were singled out in responses.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

It is important again to distinguish between operational (local, site-specific) and strategic (eg national, river basin district) applications. This also links through to a difference between the resolution at which data are collected and then subsequently brought together in analyses.

For operational use, data are generally only useful at a fine scale (site or fine resolution grid cell, properly attributed). In reality, given coverage and intensity of recording, this will usually be raw, rather than analysed data.

For spatial planning advice (using modelled distribution of European protected species, for example) fine resolution and 10km-scale data are useful, though the aim here is to extrapolate across wider areas (eg county).

For strategic purposes, national down to perhaps catchment scale (where feasible) are most valuable. These will tend to be analysed or at least collated summaries at this scale. New Welsh legislation divides the land surface of Wales into six areas for which Area Statements have to be produced, including summaries of evidence available for these areas. Evidence at this 'Area' scale is likely to become increasingly important (if challenging).

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

Following on from the previous answer, if we equate region and Area, there is a clear policy steer to generate useful evidence at this scale. If the availability of evidence for particular Areas is found to be light, then improving the situation is likely to be a reasonably high priority.

Similarly, for habitats that are identified as being of high value for provision of well-being-benefits, a lack of relevant evidence (to track their status) is likely to make these a priority for improved evidence gathering.

Not enough work has been done to date in relation to the new legislative requirements to provide more specific answers.

Typically, structured and unstructured recording shows some distributional bias, with remoter, more upland areas often less well represented than lowland, more populous areas. In some cases, filling a regional gap may tend to fill a habitat gap also.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

We have no hard standards relating to the above statistical concepts, though in some exploratory analyses an 80% rule-of thumb has been used to define an adequate level of statistical power. More generally though, we are seeking transparency around these various measures and an understanding of the trade-offs between them, so that the implications of our decisions are clear. With trend analyses, the amount of change that it's possible to detect over different time periods is an important consideration.

In addition to the above listed measures, we also wish to understand how representative sampling designs are of the target 'population'.

Where applying qualitative measures, we have tended to urge caution in the use of the term 'stable' because of the difficulty of distinguishing this from situations where data are insufficient to identify a trend.

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

The existing schemes are key sources of evidence for us; and we've supported them consistently and, in some cases, sought to strengthen their value at a Welsh level (e.g. providing additional funds to explore current level of performance and ways it might be improved). As our own resources for funding biodiversity monitoring have reduced, the value of the schemes becomes only greater. That's not to say they are perfect (there is some taxonomic imbalance as described in earlier answers), but what they do provide is highly valued.

Examples of use include the production of Wales-level indicators (starting with birds, but aspiring to broaden to include butterflies and bats); contributions to Habitats and Birds Directive reporting; state of the environment and more recently, State of Natural Resources reporting. Some of the birds data we've used to support assessments of the condition of bird features on protected sites (SPAs and SSSIs).

We've probably made more use of data from the more established, structured schemes than the smaller schemes (eg many of those that BRC work with) – and this is probably something we should have a look at. Are any of these nearing the point where they might become more structured schemes akin to, say, NBMP or UKBMS. (NARRS is an example that has been mentioned specifically in this context.) We've yet to see the gains made in analyzing unstructured data applied to Welsh data specifically, and are keen to see how this performs.

We see the National Plant Monitoring Scheme as a work-in-progress, but again look forward to seeing how this develops and how we can help make it work at a Welsh scale.

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

There's not a huge amount to report here that relates specifically to species monitoring, though we've been involved in GB-level work in the use of eDNA to monitor great-crested newts (and also, separately, diatoms as part of WFD monitoring). Also work on species distribution modelling (great-crested newts again) to support planning decisions, mainly in NE Wales.

Use of Earth Observation methods for monitoring habitats is an ongoing area of our work, and though this hasn't been applied directly to species, there is clear potential to (for example) use maps to assess how representative current sampling designs are and to provide weightings to improve national estimates.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Scottish Natural Heritage (SNH)

1. Your details

Name	***[removed from the publically available information]***
Organisation	SNH
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	Scotland
For what taxa do your answers relate to?	All on Directives
For what habitats do your answers relate to?	All on Directives
For interviewees: briefly describe any consultations that you undertook in your organisation	6 named individuals ***[removed from the publically available information]***

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs	Information on biodiversity is of most importance for **longer term strategic** planning and research	Neither

Strongly agree ○ ○ ◉ ○ ○ ○ Strongly agree ○ .

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

Data required for development of environmental policy and the effective directing of resources – e.g agricultural grants. Data required to inform the planning system with respect to the location of features of interest Lack of data would result in potential damage to the natural heritage. Data required to support conservation actions and management plans (AT)

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years	Key priorities have **been stable** over the past 5-10 years	Neither

Strongly agree ○ ○ ○ ○ ◉ ○ Strongly agree ○ .

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

Our priorities are in the main set by external obligations such as the requirements of the EU Directives, Government targets on the condition of designated sites and targets set in the 2020 roadmap for Biodiversity.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)			Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)			Neither
Strongly agree ◉	○	○	○	○	○ Strongly agree	○ .

What particular aspects or details of these are particularly important for you?

Population sizes, habitat area and condition – trends.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity			Information is most important for informing **projections into the future** (e.g. future scenarios of change)			Neither
Strongly agree ○	○	◉	○	○	○ Strongly agree	○ .

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

Currently a 6 year cycle for EU reporting.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

Baseline data on species populations of critical groups - eg. Pollinators, INNS, EU Directive species. Baseline data on habitat extent

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

Emerging policies: natural capital asset analysis, woodland expansion target, carbon capture / peatland restoration, pollinator strategy

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	◉	○	○	
Abundance: knowing how many/much of a species/habitat is present	○	◉	○	○	
Trend in distribution/abundance: knowing how it has changed over time	○	○	◉	○	
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉	○	
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	◉	○	
Drivers of change: knowing environmental mechanisms underpinning changes	○	◉	○	○	
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	◉	○	

Please give specific examples of the gaps you have:

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs		Neither
Strongly agree ○	○	○	○	◉	○ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

The list of key species is well understood and the main need is for information on the population trends, range and condition.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)
- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

Pollinators - relates to all of the above apart from Condition of habitats

Disease agents - viruses/ fungi which are a threat to plant communities eg juniper and ash die back, diseases of Scots pine

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

Scotland - We have a habitat data gap for some 2.7 million hectares of the uplands

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ○ ◉ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

We have a habitat data gap for some 2.7 million hectares of the uplands. For some habitats we have rather poor data but whether these will continue to rank as highly important after Brexit is debateable.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

Measures of precision, statistical power & effect size would be very helpful in guiding our invertebrate policies, but almost completely unavailable. We only have some rudiments of qualitative scoring (AT)

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

I think the JNCC schemes are mainly species based. The bird / bat related schemes feed directly into our EU Directive reporting

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

Increasing use of citizen science / volunteers either through grant funding or direct input into data stores.
We continue to fund local records centers and a major review is underway to improve the efficiency and coverage of this system across the country
Development of 3D infra red aerial imagery analysis to detect habitats
Investigating the uses of eDNA
Field capture of digital data by volunteers using GIS systems

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.

Scottish Environment Protection Agency (SEPA)

1. Your details

Name	***[removed from the publically available information]***
Organisation	SEPA
Role	***[removed from the publically available information]***
Brief description of role (in respect to biodiversity monitoring)	***[removed from the publically available information]***
Over what geographic region/country do your answers relate to?	Scotland
For what taxa do your answers relate to?	Freshwater and terrestrial habitats & SEPA priority species
For interviewees: briefly describe any consultations that you undertook in your organisation	Consultation with 6 individuals ***[names removed from the publically available information]***

2. What are your terrestrial biodiversity evidence needs?

In this section, we are interested in your evidence needs (in terrestrial and freshwater biodiversity monitoring and surveillance).

2.1 Why do you require biodiversity information?

Information on biodiversity is of most importance for **reporting** against current/immediate needs			Information on biodiversity is of most importance for **longer term strategic** planning and research			Neither
Strongly agree	○	○ ◉	○	○	○ Strongly agree	○ .

Can you comment on your different uses for the data. What is the impact of not having this information at the appropriate scale or temporal resolution you require?

Biodiversity data are used for both immediate and longer term strategic needs. The need for a sound evidence basis for decision making is one of the SEPA organizational characteristics.

Current needs are for use in decision making during impact assessment for permitting determination, setting permit conditions and for advice to Planning authorities. Data used includes distribution of priority species, European protected species and sensitive habitats. These are used in CAR and PPC permit determinations and in Planning advice, e.g. for developments on peat and forestry woodland creation.

At a strategic level, data are used in WFD classification, in prioritizing condition improvement work, and in establishing evidence-based standards for regulation.

The impact of not having this information at the temporal resolution and appropriate scale needed would be an increase in risk to the environment through poorer informed decision making.

Long-term national programmes, such as the Upland Waters Monitoring Network and the Countryside Survey (to name two) are also important as they set the wider environmental change context within which our own (and others') monitoring data can be assessed and understood.

Such programmes are increasingly under pressure (or in the case of the Countryside Survey, uncertain or even closed).

2.2. How stable have past priorities been in driving these information requirements?

Key priorities relying on these data **have changed** over the past 5-10 years					Key priorities have **been stable** over the past 5-10 years	Neither
Strongly agree	○	◉	○	○	○ Strongly agree	○ .

Briefly, if your priorities have changed, what are the key ways in which they have changed?

How much has this been within your control (driven by or influenced by your organization, rather than imposed upon you from external bodies)?

In the last 10 years, the information required has changed in response to changes in SEPA strategy, development of internal processes and in response to legislation.

For example, requirements for groundwater dependent wetlands habitat data increased from 2014 when SEPA guidance was produced, and are in process of being updated through work with Forestry Commission on requirements for woodland creation proposals. Recent changes in the Planning Bill 2017 will affect how we consider carbon-rich soils. The SEPA Regulatory Strategy has increased focus on sustainability through encouraging going beyond compliance; it will affect our data priorities, e.g. in monitoring impact.

2.3 What questions do you need biodiversity information to answer?

Information is mostly needed for **survey, monitoring and surveillance** of biodiversity status. (To answer the questions 'how much?' or 'where?', e.g. current distribution, trends in abundance)					Information is mostly needed for **research**. (To answer the questions 'why?' or 'how?' or 'what?', e.g. the impact of management interventions, natural changes or gradients.)	Neither
Strongly agree	○	○	◉	○	○ Strongly agree	○ .

What particular aspects or details of these are particularly important for you?

Current habitat extent and condition is particularly important in assessing likely impact and resilience to proposed activities at a site level, and in catchment-scale partnership projects. Research information is needed to understand impacts of activities, and to establish indicators and metrics for regulation.

2.4 Over what time-frame do you need to answer questions?

Information is most important for showing **past/current changes** in biodiversity					Information is most important for informing **projections into the future** (e.g. future scenarios of change)	Neither
Strongly agree	○	○	○	○	◉ Strongly agree	○ .

Please give specific examples of the time frames that are relevant to you and how often information needs to be updated:

The data is needed to assess likely impact into the future over a range of timeframes, from the next 5 to 50 years depending on activity, although in general the next 3- 10 years would be most likely. For example:

A PPC monitoring condition could be for a baseline survey followed repeat survey after 5 years, assessment using critical loads should be protective over a 30 year period; a forestry management plan may be over 20 – 40 years; windfarms over 25 years, with habitat management plan surveys conducted at intervals during that period.

Our freshwater monitoring covers a selection of rivers and lochs. It is monitored on a rolling programme; depending on the level of risk (i.e. likelihood of change), the monitoring frequency varies. Some sites are monitored annually, with others 1:2 years, 1:3 or 1:6.

2.5 Future projections

We would like to know what sorts of issues it would be useful to address in our analysis and modelling of future projections.

Firstly, imagine you could go back 5-10 years and were able to make projections about biodiversity change. Are there specific issues where you wish you had information then to help with making decisions or giving advice?

Information on expected response of habitats and species to changes in climate, air pollution, hydrology (where relevant) and management would be useful.

Secondly, are there new and emerging policies which will create new evidence needs in the future? (Of course, Brexit makes the future policy landscape very uncertain – there is no need to discuss these uncertainties here.)

SEPA Regulatory Strategy (One Planet Prosperity) promotes going beyond compliance which will drive new evidence needs in order to demonstrate the benefits of business' change in practice.

Planning Bill (Scotland) 2017 will drive need for evidence for distribution and condition of carbon rich soils during Planning consultations.

3. What are the gaps in your evidence needs?

In the TSDA partnership we will be undertaking tasks to support the development of the JNCC partnership surveillance schemes. The developments could be enhancements in statistical analysis, data coverage, methods of collection or other activities. For us to be informed to undertake this work, we need to have a good understanding of your needs and gaps in evidence.

There are different reasons for there being a gap in an evidence need. We will consider: taxonomic coverage, spatial coverage, statistical coverage. These are inter-related, but they are also different. Through the following 5 questions we are seeking to understand the specific evidence gaps.

3.1 Different types of evidence

Considering your (and your organisation's) terrestrial & freshwater biodiversity evidence needs, how well are they being met? (Collating responses from different organisations will allow us to identify country-specific gaps and needs.)

	Evidence need is **well met**	There are **some gaps**	There are **major gaps**	Not relevant to me/my organisation	Rank the gaps, with 1 = most critical gap
Distribution: knowing where species/habitats occur	○	○	◉	○	2
Abundance: knowing how many/much of a species/habitat is present	○	○	◉	○	3
Trend in distribution/abundance: knowing how it has changed over time	○	○	◉	○	5
Ecosystem function/service: knowing the functional impact of biodiversity	○	○	◉	○	5
Trend in ecosystem function/service: knowing how the functional impact of biodiversity has changed over time	○	○	◉	○	5
Drivers of change: knowing environmental mechanisms underpinning changes	○	◉	○	○	4
Resilience: knowing that the species/habitat/function will be at a certain level in the medium-term future.	○	○	◉	○	1

Please give specific examples of the gaps you have:

Nitrogen-sensitive species data to assess impact of pollution from industrial applications.

SEPA priority (subset of Scottish Biodiversity List) habitat and species distribution.

Interactions between multiple co-existing drivers of change.

Habitat distribution and condition in the wider countryside outside designated sites (a solution to this could be to gain access to data submitted as requirement to Planning or permit applications).

3.2 Trade-offs between spatial and temporal coverage

Often resource is limited, so that it is difficult to increase taxonomic coverage (i.e. sufficient information on more species or more taxonomic groups) and increase spatial coverage (i.e. sufficient information from more regions) at the same time.

It is most useful to increase **taxonomic coverage** to fill gaps in my evidence needs				It is most useful to increase **spatial coverage** to fill gaps in my evidence needs			Neither
Strongly agree	○	○	◉	○	○	○ Strongly agree	○ .

Please describe specific needs and trade-offs between spatial and taxonomic coverage:

Both are required for different purposes. SEPA as national coverage, though further information on indicator species (e.g. bryophytes and lichens) would be useful.

3.3 Taxonomic coverage

Biodiversity information can be required at a range of taxonomic levels and for different sets of taxa:

- **'Special'** species (i.e. species of conservation concern, designated species etc.)

- **More common/widespread** species
- **Indicators** of 'ecosystem health'
- **Specific guilds**
- Species providing **ecosystem services**
- Species from currently **under-represented** taxonomic groups
- **Condition** (of habitats)

What are the important gaps in taxonomic coverage for your evidence needs? Please describe specific gaps, including reference to the taxonomic levels list above:

Examples include invasive species; particular pollinator species needing support at a local level to inform mitigation measures and restoration plans; indicators of ecosystem health (e.g. to assess against regulatory standards); bryophytes and lichens to inform standards for air pollution and to assess against.

Insufficient resolution in Scotland for most species groups, even for BTO bird data, to allow the regional resolution we would like for species indicators as part of the developing Ecosystem Health Indicator programme being led by SNH for the Scottish Biodiversity Strategy.

3.4 Spatial resolution

Biodiversity information can be required and provided (if the data are available) at a range of spatial resolutions:

- UK
- Country
- Catchment/landscape area
- 10km grid cell
- Fine-resolution grid cell (2km or 1km or 100m)
- Site

What are the important gaps in spatial coverage for your evidence needs? Please describe specific spatial gaps, especially with reference to the spatial resolutions listed above:

The most important spatial scale for permit and Planning casework decisions is site level and fine-resolution grid cell.

The catchment/landscape scale applies to invasive species and regional partnership working with communities and businesses.

Scotland-wide is relevant for our State of the Environment reporting.

3.5 Spatial gaps in coverage

Data can often be 'cut' in different ways (e.g. at smaller spatial scales, or at finer habitat categories), and there is a trade-off between these in providing high quality biodiversity information.

How important are your evidence needs in:

Improving information from currently under-represented **regions**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Improving information from currently under-represented **habitats**?

Unimportant ○ ○ ○ ◉ ○ *Extremely important*

Please describe specific gaps for your evidence needs with regards to information at smaller spatial scales versus for specific habitats.

3.6 Statistical coverage

Statistical analysis of data produces estimates. When using data and undertaking analyses there is often a trade-off between different aspects of statistical coverage such as:

- **Accuracy** (how well it represents 'reality')
- **Precision** (variability of the estimates)
- Statistical **significance** ('P values')
- Statistical **power** (the ability to identify effects that are real)
- **Effect size** (how the estimate relates to ecological meaning)
- **Bias** (consistent errors, e.g. based on biased sampling)
- Qualitative **scoring** (e.g. declining, stable, increasing)

Do you have set statistical standards below which information is not useful to you? (Are these written down and expressed quantitatively?)

What is the interplay between these issues of statistical coverage? How do these standards vary according to different uses of the data? How do issues of statistical coverage influence your decision-making (including considering the risks of making a wrong decision)?

Please comment on the statistical requirements of your biodiversity needs, with reference to the statistical terms above.

P values < 0.05 would be the usual expectation in terrestrial ecology research projects. For freshwater monitoring under the Water Framework Directive (to inform our understanding of the state of the environment, and/or the management of the environment), we report a "certainty of class" for each parameter used. These certainties are taken account of in decision-making, i.e. a decision which would have expensive implications (in terms of remediation measures) we would want to be highly certain in our assessment that the (e.g.) river is "truly" less than good status. Conversely, where there is a high degree of risk of harm to the environment, we would have to be highly certain that any proposed development would not result in serious harm being caused.

4. Ways of meeting your evidence needs

4.1 Where do the JNCC partnership surveillance schemes meet your evidence needs well?

Finally, we wanted to conclude by allowing you to describe where the JNCC partnership surveillance schemes already provide information that supports your evidence needs. Although we are thinking about improvements and developments, we want to ensure that we understand where the information is working well.

Currently we have minimal use in terrestrial ecology as our general focus is on habitats/ecosystems not species, however the National Plant Monitoring Scheme has potential.

4.2 New approaches

It would be helpful to know of 'new' approaches that you are using or investigating to support your terrestrial biodiversity monitoring and surveillance needs. This could be new approaches of working with volunteers, uses of professionals, or new technologies.

eDNA approach for aquatic species presence – SEPA moving towards conducting this analysis in-house, and would expect to be able to share data. Remote sensing – green LiDAR for river morphology; SENTINEL satellite data for loch colour; saltmarsh survey. We are working with professionals on placement e.g. through the NERC innovation and knowledge exchange fellowships, and through graduate schemes and HydroNation scholarship scheme.

Thank you for your thoughts. We will interview key contacts within each organisation after they have collated responses from within their organisation. We will then collate these responses, taking account of similarities and differences across the organisations, for a short report which will guide the work during the 5 year TSDA partnership project.