UK-Environmental Observation Framework (UK-EOF) Statement of Need

Biosphere Observation Requirements

Alongside development of Towards a Statement of Need, the UK-EOF has also developed observation requirements tables to capture more detailed information to help articulate:

- The UK's requirements for observing the natural environment
- The questions that we need to answer
- How close we are to being able to provide the evidence via a balanced suite of observations.

For ease, information gathering has been split into environmental domains and for each domain, what the specific issues or sub issues that are of importance for the headline issues identified in the UK-EOF Statement of Need.

Information has been gathered from experts in their field via correspondence, a workshop and open consultation. The tables are not final and some gaps exist in the information. The UK-EOF will work to fill these gaps and revise the tables accordingly.

Some of the sub-issues identified fall under several fundamental issues and there are key dependencies with other environmental domains.

Observation requirements captured within the tables have not been prioritised in any way, nor has current capability been identified. Prioritisation will be addressed via a decision support framework which is also being developed under the UK-EOF and capability or current activities are searchable within the UK-EOF Environmental Observation Activity Catalogue (www.ukeof.org.uk).

Summary of Requirements (under each UK-EOF headline issue)

Pressure on all environments in the light of <u>Population Growth</u> and associated pollution.

The world population is growing, as is the population of the UK. This growth will inevitably result in increased pressures on the natural environment. On a national scale there is a need to monitor both broad ranges of species and targeted monitoring. This would help to address critical issues including the avoidance or mitigation of the impacts of pollutants on the biosphere. The surveys need to include monitoring of chemicals and tissue samples and incorporate measurements of trends from a wide range of species including those at the top of the food chain such as sharks and raptors. Looking to the global environment there remains a need to monitor diffuse pollutants such as the oxides of nitrogen and carbon dioxide. The impact of diffuse pollutants on valued natural habitats is also a critical issue.

In the future more will need to be done to address allocation of water resources for people, industry and agriculture whilst sustaining freshwater biodiversity. Addressing this question will require monitoring of wetland habitat condition, trends in selected freshwater species, and groundwater quality, demand and flow. Observations need to be taken in specific catchments with varied frequency according to what was being monitored.

Supporting economic growth reconciled with sustainable use of natural resources
Increased international trade is leading to greater introduction of non-native species. Measurements are needed to inform risk analysis and to determine the efficacy of control measures. There are already observation programmes in place however better co-ordination of these programmes and trans-national data sharing is needed.

Tourism provides a valuable income for the UK. Features of the biosphere, such as the array of flora and fauna, are factors that attract tourists and enhance their stay. However increased tourism has an impact upon the natural environment. Characterisation of these impacts and assessment of habitat condition could lead to better management of the natural environment frequented by tourists. Although currently out of scope for the UK-EOF understanding and monitoring tourist behaviour may lead to better solutions to address or mitigate impacts caused by tourism.

Understanding future states of the Earth, particularly the Carbon Cycle (but not excluding other element cycles)
There is a need to determine what role the biosphere plays in acting as a sink for carbon dioxide and other pollutants. Similarly there is a need to know how biodiversity might ameliorate emissions of, for example, methane. Measurements of carbon dioxide, methane, soil biomass, above soil biomass, habitat extent and condition would all contribute to a better understanding of the role of the biosphere in respect to carbon dioxide. Current measurements are not sufficient to address this question and there is a need to develop better sensors.

In addition there are numerous other areas where monitoring may offer valuable insights, for example measurements of resource sustainability; observations to determine the impacts of increased transport, energy use, major forest fires or volcanoes and assessing the effectiveness of various carbon sequestration techniques would all be useful when considering questions associated with the carbon cycle. Information on social awareness of and attitude to the biosphere would also be of value especially when considering the public's impact on the environment (and vice versa) and for policy development.

Fisheries, agriculture, food security and water supply
Looking to the future there may be a need to step up food production in the UK and this could impact biodiversity and the functioning of ecosystems. There is a need for measurements on trends in the extent and condition of various habitats, landscapes, and selected species (for example pollinators). Similarly observations of soil chemistry and soil biodiversity should be undertaken. Some of this work is already undertaken and may also be covered within the Lithosphere domain however the information needs to be drawn together so it is clear what is being done and where the gaps lie.

Human Health, Wealth and Wellbeing
There is a complex interaction between human health (and well-being) and the environment in which we live. This interaction is not well understood and measurements are required to determine how biodiversity, landscape and green spaces may provide benefits that are related to human health and well-being. Coverage should be national, on a 5-10 year cycle - the data could be used to better manage the environment to provide benefits to man. Many observations of biodiversity, urban and rural land cover are underway, however research is needed to improve the objectivity/repeatability of landscape measurements and interdisciplinary working is required to better understand the interactions between the environment and human health.

Measurements that provide reliable information on the level of human exposure to new pathogens resulting from changes in agricultural production, which are inevitable as a result of increasing population and climate change, are required. For similar reasons there are increased risks of emerging diseases and their appearance will initiate a need to determine any economic impacts. This information could be helpful in the development of predictive models.

Understanding, avoiding and mitigating the effects of Extreme Events and Disasters

There is a fundamental need to assess the condition and extent of wetland, forests and salt marsh habitats which provide natural resilience to flooding and contribute to the reduction of erosion. To address this, measurements of the structure and diversity of the vegetation, vegetation density, habitat land cover and topography are required. Observations to quantify how the condition of the natural environment affects its ability to retain water and/or reduce run-off rates would also be beneficial.

Looking to the longer term future there is a question of how urban vegetation moderates temperature extremes. In the light of predictions about severe temperature increases in inner-city areas (relative to the surrounding countryside) due to climate change, this question is worthy of careful attention.

Understanding and reducing the impacts of environmental change on marine and terrestrial biological diversity, ecosystems & services

Pressures on the natural environment are increasing and changing in nature because of increases in the human population, climate change and changes in land use. There is a need to establish priorities for future action to sustain biodiversity in the light of these pressures. Similarly there is a need to make measurements to monitor the effectiveness of interventions to sustain biodiversity. Measurements of trends in selected species (guilds and communities), in the extent and condition of habitats, and in landscape heterogeneity would go some way to providing the information needed. In order to understand better the link between ecosystem function and service research combined with observations is required. Critically there is a need to ensure the UK has an adequate number of scientists with the necessary field skills in species identification.

Measurements are needed to enhance the UK's ability to manage land for biodiversity objectives. Required measurements include habitat condition and selected species (both presence and population status). However further research is needed to improve the selection of parameters which are both cheap to measure and which provide a reliable indication of the impact of land management. Changes in ecosystems will inevitably take place and the availability of economists with biodiversity skills is essential to determine the economic impact of these changes - this skill set is currently lacking in the UK.

Understanding climate variability and climate change within Earth System Science.

There is a need to determine how to mitigate the impact of climate change on species and habitats as well as how well mitigation measures are working. Whilst action is already underway more could be done to promote data sharing and to enhance the compatibility of measurements made in various EU countries. By measuring and understanding local scale climate change impacts it may be possible, through the use of models, to scale these up to address impacts across the whole country. Much monitoring is already in place, for example the Environmental Change Network.

Scientific & Technological Advancement/Innovation

Within the biosphere there is a need to find better ways to use remotely sensed data sources to aid change detection as environmental change occurs. Initially this may involve repeated data collection to known standards across large areas of land. Better measurements of water flow or remote logging of birds are both possibilities. Research now could open the way to widespread use of remote sensing applied to monitoring biodiversity and biosphere assessment.

Biosphere Observation Requirements Table

Information captured in the table will help to articulate what the UK's requirements are for observing the natural environment, what the questions are that we need to answer and how close we are to being able to provide that evidence via a balanced suite of environmental observations.

For each environmental domain information has been collected on the specific issues or sub issues that are of importance for the headline issues identified in the UK-EOF Statement of Need.

Consultation with the community has led to the population and validation of the table. The information is not fixed and will continue to be revised as requirements and priorities change.

Specific/Sub issue	**What are the key questions that require answering in order to address the specific/ sub issue?**	**Measurement Type** (variables that would need to be measured to provide evidence to address the specific issues)	**Frequency of collection** e.g. A continuous measurement for 1 week in Spring, repeated every 2 years. Or A spot measurement, once a week, every week throughout the year. Or Irregular measurements as required i.e. extreme event monitoring.	**What geographic coverage do we need?** A) UK B) England C) N. Ireland D) Scotland E) Wales F) Localised UK G) Europe (non UK) H) Global I) Other (please specify) J) Ocean/Sea (please specify	**What is the primary use for the data?** A) Basic Science B) characterising environmental issues/solutions (influencing policy) C) Direct env. Management D) Modelling & Prediction E) Complying with Legislation F) Development & Growth	**Are the current actions / measurements sufficient to provide the evidence needed to address the issue?** If known, please list the current programmes/sensors which are capable of providing the evidence (e.g. for Sea Surface Temperature AATSR, SLSTR. AVHRR, AMSR and Modis satellites are capable of measuring SST).
Population Growth (Pressure on all environments in the light of population growth and associated pollution.)						
Pollution	How can we avoid or mitigate the impacts of pollutants, such as chemical flame retardants? (How can we Manage pollution?)	Targeted monitoring of chemicals in tissue samples	2-3 time/yr (varies with species groups)	A-E	B, C, E	Broad range of species are monitored and this should pick up any large scale effects although attribution may be difficult. Targeted monitoring of particular chemical impacts is partly in place – especially when under legislative control. However new 'pollutants' e.g. endocrine substances and allergenic crop pollens are not covered.

Pollution Continued		Trends from a wide range of species including top food chain species e.g. tuna (Cross over with food standards)	2-3 time/yr (varies with species groups)	A-E	B, C, E	CCW tranquil areas report uses light pollution as measurement (12 year intervals)
	Diffuse pollution e.g. major biogeographical elements such as N	N CO_2 (needs global governance)		H - Global		
	How do we manage the response to diffuse pollution? (Using biodiversity as a trigger)	Community trophic scale measurements	Annual			
		Phytoplankton/ zooplankton	5 yearly?	A – UK	D, C	
		Community level measurements for C/N ratios	Annual	A - UK		
		Valued biodiversity e.g. natural habitat, community monitoring plants, vertebrates & birds	Annual?	A – UK		Birds are good indicators of pollution and previous studies have provided evidence for this bird monitoring.
	How do we respond to (manage) pollution globally as human population grows rapidly & achieves a higher standard of living?	Plankton community structure	Annual	A – UK to H – Global	C, D	SQID I & II, UKCS 2007 (microbiological diversity & function) Defra published 187 soil biological methodologies, 11 trialled.
		Soil fungal (bacterial ration phenotype & functional capability)	5 yearly	A- UK	A, C, D	
		Birds (occupy large number of niches & are mobile thus giving an opportunity to examine species that move between different areas.				Various bird monitoring projects e.g. RSPB, BTO etc
	How can we identify emerging pollutants?	Continuous monitoring of all media?				

Water resources, sustainability & security	Can we define & manage equitable allocation of water resources for people, industry & agriculture whilst sustaining freshwater biodiversity	Trends in selected freshwater species & other dependent on specific humidity	Once every 3-6 years. 2-3 time a year (varies with species groups)	F (catchment)	C, D, E, F	Water Framework Directive, Habitat Directive (condition).
		Demand Flow Groundwater quality	Once every 3-6 years. 2-3 time a year (varies with species groups)	F (catchment)	C, D, E, F	
Land use (change & management)	How will the demand for land use increase & how will land use change? What are the most effective ways of influencing land use change, grants etc?					
	What is the biodiversity value of competing land uses and how does this relate to the likely future economic conditions?					
	Are there functional units?	Soil biodiversity		A (Uk wide) F (local/ regional)		
		LCM phenotype & function				
		Process				
		Functional Maps				

	Is there a sustainable future for housing? How can wood contribute to this & should there be greater means for encouraging this? This should take into account the substitution benefits & also of not using other materials.					
	Can biodiversity help sustain and manage urban environments?	Correlative impact of biodiversity (& services): rural (farms) vs open (net reserves vs gardens. Required pilot scope & public participation				
	What are the implications of increasing urbanisation on biodiversity? Are the trends in urban biodiversity relative to rural biodiversity?					
	What are the environmental implications of shifts in agricultural systems?					
	Will land use demain affect food security? (Including marine & freshwater resources).			F		
	What are the trends in agricultural habitat extent, condition, maintenance, crop changes etc?					

	What is the condition of semi natural habitats (many species are reliant on these); semi permanent features e.g. hedge rows & temporary features such as grass field margins.					
	What are the benefits to urban environments of the presence of trees? ***Is this a research question?***					
	How can trees help modify urban temperature/ climates? How can timber construction help modify climates?					
Food Security	***What are the main questions/issues that need addressing?***					
Energy, Supply and Demand	See Economic Growth for Alternate Energies	Habitat change (loss, fragmentation)				
		Ecosystem process disruption				

Economic Growth and Sustainability (Support economic growth whilst reconciling with sustainable use of natural resources)						
Non-native species and pathogens	How do we avoid/ mitigate the economic & biodiversity impacts of non native species (trade levels provide abundant vectors to move species)? NB. Not all Non native species are detrimental to the ecosystem/habitat – some have important economic contributions.	*Risk Analysis* Presence of new non natives Distribution change & impact of established non natives. *Operational* Presence/population parameters of non natives subject to control or eradication Hygeine/biosafety checks Economic Impacts (good and bad)	Continuous	A	B, C, E, D	Systems in place, but data sharing still slow. Need to share species observations at regional and global scales, targeted observation as feedback into control/mitigation. Need to enhance the culture of trans-national data sharing.
	Are there any particular traits that pre-dispose some non-natives to become problematic? ***Is this a research question?***					
	Can we manage change for the positive? (Adaptation/mitigation: value for new species)					
	Can we exploit new species for commercial purposes e.g. forestry? ***Is this more of a research question?***					

Tourism	How can we maintain and enhance tourism benefits attributable to biodiversity and attractive landscapes whilst managing the impact of tourism?	Sociological/economic monitoring of tourist behaviour	Periodic 5-10 year intervals	A, B, C, D, E, F	B, C	
		Trends in habitat condition, landscape character, selected 'charasmatic species'				
Mineral Use	Can we predict when resources will run out?					Need R&D, horizon scanning etc
	What are the likely scenarios for substitution/suitability of minerals & the impact of these on the biosphere? e.g. mineral component in goals to meet renewable energy targets	Land use cover				Need model development to show stock use and predict future levels.
		Land cover				
		Stock				
	What is the long-term effectiveness of post extraction mitigation?	Species abundance, biomass, distributions				Assessment of Ecosystem restoration
Land use and management - see population growth table						
Alternate energies & exploitation of resources	How would a woodfuel strategy impact on woodland structure?	Habitat structure	Regular	A (UK)		
		Exemplar species e.g. butterflies and birds				
	Does the impact of using short rotation forestry or short rotation coppicing for woodfuel outweigh environmental benefits in relations to factors such as soil carbon?					
	With regard to new biofuels; wind farms, microbial cells, coastal, tidal – Does the impact on biodiversity outweigh cost/benefit?			A (UK)	F	

	What is the extent of potential new uses of resources for drugs etc (Biotechnology, enzymes, antibodies)	Diversity (could be R&D)		F	F	
		Metabolomics **(Research or monitoring?)**				
		Genomics				
		Systems ecology				
Carbon Cycle (Understanding the Future States of the Earth, particularly the Carbon Cycle but not excluding other element cycles (e.g. N, P)						
Carbon Sinks & sources	What is biodiversity's contribution to reducing emissions, sinks?	CO_2	Annual	F	A, B, C, D, E	Need to develop sensor? Data assimilation?
		CH_4				
		Mapping of Carbon cycle & CO_2 & CH_4 mapping				
		Species biomass & soil biomass	Periodic (e.g. every 10 years)			
		Soil surveys	5-10 years	A		
		Habitat extent		A, B, C, D, E		
	What is the potential to increase forestry's contribution in absorbing carbon dioxide?	CO_2				
	What are the benefits of aforestration & preventing deforestation? Solid disturbance is a potentially large C emitter. More work on peatlands needed	peatlands				
	What is the contribution (to sources) from deforestation?					

	What is the carbon sequestration in different types of forestry under different management and soil types?					
Carbon Sequestration	How is carbon sequestration capacity changing? ***Related to sources and sinks?***					
	Mitigation	Flux (gas ***Which ones)?***	As required	A, F	A, B, C, D, E, F	
	Deep mines – Do they work in the long term – as sites for carbon storage?	Flux – gases CO_2 CH_4?		H. F	D, B, F	
	Is rewetting peat damaging (e.g. release of CH_4) or beneficial?	CO_2 & CH_4 flux & life history	Match emission excesses (?)	F (peatlands being restored)	A, C, D, E	
Biotic role and feedback fix-production **See also biodiversity table**	Define role of microbial assemblages (space/time & reliance)	Genomics - function - diversity	3-5 years	A (UK) F (more frequent if a questions is defined)	A	Also needs R&D
Social awareness (& attitude)	Global & social capital	Socio-economic surveys	Annual		A, B, C, D, E, F	
Economic value	***What are the questions/issues associated with this?***	Consumption pattern	Real time	F, G, H	A, B, C	

		Recharge/ rate of sensitivity (bioavailability)				
Transport & Energy Use	Cost to environment of increased use?	Social relation comparisons (lifestyle analysis)	Ongoing	F, H, G	E, F, D	
Natural geothermal (volcanoes)	What is the contribution made by natural sources? (Balance attribution vs human & nature)	EU- local C ratio flux (?)	Episodic to real time	H, F	D, B	
		Geology				
Forest Fires	What is the contribution (as a source) made by forest fires?	Earth observations	Satellite dependent	H, F	D, B, F	Worldwide the contribution will be large. NB not just forest fires – other destruction from pests and diseases – i.e. mountain pine beetle's forest destruction in British Columbia. Turned B.C. from net carbon sink into a net source.
		Life cycle				
FISHERIES, AGRICULTURE, FOOD SECURITY & WATER SUPPLY (The effects of environmental change)						
Food production	What are the likely impacts of increasing food production on: - biodiversity? - ecosystem functioning? Are the changes sustainable?	Trends agricultural habitat extent, condition, maintenance, crop changes etc	3-8 years	B, C, D, E	A, B, C, D, E	Partly (several separate systems). There is a gap on the integration of nutrients and land
		Condition of semi natural habitats (many species reliant on these habitats); semi-permanent features e.g. hedge rows and temporary features such as grass field margins.				
		Trends in landscape heterogeneity/connectivity				

		Trends in selected species including functions involved in production (e.g. pollinators)	2 - 3 times annually			
		Soil Chemistry	3 - 8 years			
		Soil biodiversity	3 – 8 years			
Rural development Programme Objectives	***What are the questions/issues that need to be addressed?***	Pest abundance & distribution	Risk dependent	A, B, C, D, E , F, G, H	A, B, C, D, E	
		Diseases and Emerging diseases	Risk dependent			
		Non Native Species (esp. Invasive Alien species)	Risk dependent			
Ecosystem integrity (see also population growth)	How is ecosystem integrity changing? (Ability to deliver ecosystem services)	Status and Trends in pollinators	Risk Dependent	A, B, C, D, E, F	A, B, C, D, E	
		Soil biodiversity				
		Fungal:Bacterial ratio				
		Phenotype				
		Functional capability				
		Algae				
	How are pressures on water quality and supply changing and what effect does this have on the ecosystem?	As above				
		Water borne diseases (Phenology & Status)				
	What is the role of forestry in flood mitigation?					

Wild Food Supply	What are the impacts on wild foods (marine, freshwater & terrestrial)?					
Eutroph-ication	What is the impact on wetlands?			A, UK F localised		
Human Health, Wealth and Wellbeing (Consequences of environmental change for Human health, wealth and wellbeing)						
Human Well being and health benefits	What is the extent of use of biodiversity and land use contributions to well being?	Sociological parameters (health benefits of exposure to wildlife or countryside)	10 yearly	A – spatial scale planning B, C, D, E, F	C, E	Probably monitoring of biodiversity, urban & rural land cover need. (Status and trends in framework of habitats, species & landscape characteristics linked to perceptions of well being). Further research to improve objectivity/ repeat ability of landscape measurements may be required. CCW Tranquil area report
	What are the health benefits from the public use of forests?	Quality of green spaces and access to them (quality measured by feature of green space that encourage/contribute to well being).	12 year interval	A – spatial scale planning B, C, D, E, F	B, D	
Disease **See also Agriculture table**	What are the effects of new levels of exposure on agricultural production and therefore food supply? e.g. blue tongue	Trophic structure			D	
		Pathogen abundance and distribution			D	
	What are the effects of change on human diseases? e.g. changing climate, increasing population	Pathogen disturbance and distribution of known diseases (=/- range)			D	
	What are the economic impacts of the spread of disease? Can the impacts be minimalised e.g. New York WestNile Virus				B, F	
Biosecurity						

Management	Can we sustainability continue to: -provide land/water management - manage food & recreation conflict - manage urban/rural cultural differences - provide food/water supplies.	See other tables				
Extreme Events and Disasters						
Biodiversity's contribution to buffering extreme events and disasters	What is the condition & extent of wetland, forests, coastal & saltmarsh habitats? (i.e. those that improve the resilience of flood retention & erosion).	Structure/diversity of vegetation		F (dependent on scale)	A, B, C, D, E, F	Partial, main constraint cost effectiveness of habitat mapping and condition assessment. (Status and condition features relevant to buffering of selected habitats (eg: saltmarsh)). Main gaps include: Research quantifying the functions of biodiversity to aid contingency planning eg: whether condition of flood plain grassland alters run off rates/water retention and research into affordable habitat mapping methods eg: remote sensing
		Vegetation density (mixed forest decline etc)				
		Habitat land cover				
		Topography				
		Quality and benefits of unit areas of habitats e.g. rate at which water moves through a particular type of forest	Needs R&D to define further		D	
Ecosystem services **See biodiversity tables**	How will ecosystem service factors (e.g. water supply, flood retention, soil erosion etc) be affected by environmental change?					
Forest Fires **See also carbon cycle tables**	How ill the intensity/frequency of fires increase?					

Urban vegetation	How does urban vegetation moderate temperature extremes?	Uptake by vegetation of SUDS in urban areas (local authority urban drainage scheme)				
Biological Diversity, Ecosystem & Services (Impacts of environmental change on biological diversity, ecosystems and ecosystem services)						
Future of biodiversity	What is the impact of human development on biodiversity and the delivery of supporting/regulatory services?	Diversity	Range: Earth observations to field observations	F	F	
		Flow of desired services				
	Establishing priorities for future action to sustain biodiversity and measuring the effectiveness of interventions	Trends in selected species (guilds and communities)	2-3 / year(varies by species group)	A, B, C, D, E (stratified samples)	A B, C	Further research to link function to service is required. Along with improving the functional range of species and habitat cover of subset and increased affordable, repeatable habitat/function measurements (can remote sensing help deliver?) e.g. agri environmental spend may need shorter duration supplements to the basic framework. Lack of field skills in species identification
		Trends in the extent and condition of habitats	3-8 yearly	A, B, C, D, E (stratified samples)	A B, C	
		Ecosystem structure and function.	3-8 yearly	A, B, C, D, E (stratified samples)	A B, C	
		Trends in landscape heterogeneity (economic & social trends, horizon scanning)	3-8 yearly	A, B, C, D, E (stratified samples)	A B, C	

	How effective are biodiversity adaptation strategies? e.g. do habitat networks and large scale habitat creation schemes deliver the desired outcomes?	As above?				
Land Management **See also population growth table**	There is a need for feedback into management of land for biodiversity objectives	Habitat condition	Need assessment on risk/benefit basis by location, by species or by habitat	F	B, C, E	Further work to improve understanding of what parameters are cheap to assess, can diagnose impacts & indicate direction for management may be needed
		Selection species presence				
		Selected species population status				
Pressure	How are pressures on biodiversity changing?	Habitat change				
		Pollution				
		Non Native species (NNS)				
		Climate Change				
		Harvesting				
		Emerging Disease				
Change	How are ecosystems changing?	Extinctions				Programme/ integration roles (managers of individual observing systems) Wales developing an indicator to report on this in Wales (species range/abundance) Lack predictive ability of economics/modelling of *links* to biodiversity - gap in economists with biodiversity skills? Research could look at whether
		Changes in range/abundance				
		Introductions (colonisations, NNS, diseases)				
		New emerging communities				

		Trophic webs				physiological or expression frequencies can be cheap ways of measuring pollutants/metal flows etc – this could then be fed into the observation programmes
Impacts of Climate change – see climate change table						
Conservation and ecosystem services	For questions surround Carbon Sequestrations see Earth Systems table					
	How is the capacity of the environment to deliver clean water changing? How do we value it?	Pollution				Significant research and observations may be required to answer this.
		Habitat condition				
		Habitat extinction				
		Fisheries				
CLIMATE CHANGE: (Variability & Climate Change: Challenges in Earth System Science).						
Impacts of climate change	Which parts of biodiversity do we value most? What can we do to protect the most valuable parts? (gene conservation/hotspots)					

Changes to habitats **see also biodiversity table**	Determine how to mitigate for climate changes impact on species and habitats, and whether measures are working	Trends of wide range of species (Spatially and temporarily sensitive ideally across their bio geographic range, combined with models to predict range and population change under climate scenarios)	2-3 / year – varies by species group	A-E via stratified sample, co-ordination with sampling countries within biogeographic range, data sharing of observation data at regional scale	A; B; C; D; E	Partly- A gap exists in the promotion of compatible approaches to monitoring across Europe, improving data sharing
Local scale climate change	By determining local scale climate changes can we use models to help understand actual change?	In-situ, co-located data on physical environmental drivers and biological response Stratified samples supporting models Co-incident measurement of climate and biodiversity variables at subset See climate theme for detail of different measurements		UK	A; B; C; D; E	Reasonable-Targeted structured network across the UK, with multiple measurements of drivers and responses, using standard protocols to measure variables (“ECN”)
Climate models	How can we link observations and models?	Satellites to genes??	Variable in model development and use	F, G, H	A, D, B	
	Do we need finer resolution in models with biological and physical parameters in the same place?			F	A, B, C, D	

	Linking understanding of environmental pathways and how to apply these in models	Space and time	Frequent	F, G, H	A, B, C, D	
	Biosphere model Do we understand what life support is? (Climate change = input not an end point)			H	A, B, C	
Scientific & Technological Advancement/Innovation (Stimulation of Scientific & Technological Advance and Innovation)						
Remote sensed data and Earth Observation Networks	Increased need to use remote sensed data sources to aid change detection as environmental change occurs (already needed with current changes)	Repeated data collection to known standards across large areas of land	As needed	A	A, B C, D, E	
	How can we develop increased sensitivity/resolution?	Water Flow				
		Loggers (birdsets)				
		Toxicity/Function (biosensors)				
		Diversity (arrays, molecular) including pathogens				
		CO_2 / CH_4				
		Land use / cover (thermal maps)				

	Why is Remote Sensing/Earth Observation not more widely applied to biodiversity/ biosphere assessment?		A				
	Can we better align ground proof of Remote Sensing and Earth Observations data to increase prediction and evaluation		A				
Use of technology (Data capture) in field (i.e. Countryside survey 2007)							
Genetics/ Evolutionary potential	How is genetic diversity changing in isolated or very small populations? Howe do you reduce your fragmented populations?	Population size					
		Inbreeding rates					
	Does low genetic diversity put long term survival of certain taxa at risk? e.g. critically endangered species						
OTHER REQUIREMENTS							
Systems approach (to addressing climate change)	How can we take on a systems approach to the problems presented by Climate change?	Data integration (Scale, Time, place)		H	A, B, C, D		
Land Use/ Management Database	Do we need a UK Land Use database which could be used for research and monitoring						Some Invent

	change as well as analysis of ecosystem services?						