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   TECHNICAL AND TECHNOLOGICAL ADVICE
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Item 3 of the provisional agenda*

ESSENTIAL BIODIVERSITY VARIABLES

Note by the Executive Secretary

1.   The Executive Secretary is circulating herewith, for the information of participants in the seventeenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, a paper entitled "Essential Biodiversity Variables". The paper draws on a forthcoming guide being prepared by GEO-BON to assist with the monitoring of essential biodiversity variables and was prepared by a group of authors.[1] It is presented in the form and language in which it was received by the Secretariat.

2.   Information related to Essential Biodiversity Variables and on the adequacy of biodiversity observation systems was presented to the fifteenth meeting of SBSTTA as information document UNEP/CBD/SBSTTA/15/INF/8. In paragraph 13 of decision XI/3, the Conference of the Parties invited the Group on Earth Observation Biodiversity Observation Network (GEO–BON) to continue its work on the identification of essential biodiversity variables.

3.   Essential Biodiversity Variables represent a minimal set of fundamental observations needed to support multi-purpose, long-term biodiversity information needs at various scales. The Essential Biodiversity Variables can assist Parties to the Convention on Biological Diversity in establishing monitoring systems that address their reporting needs and provide the observational datasets for assessments to be developed by the Intergovernmental Platform on Biodiversity and Ecosystem Services. Most biodiversity indicators being developed for the Aichi Biodiversity Targets can be derived from Essential Biodiversity Variables datasets, with several Essential Biodiversity Variables, such as species population abundances, informing multiple targets.

4.   National focal points of the Convention on Biological Diversity are invited to provide comment on the concept of Essential Biodiversity Variables, as well as on the current proposed list via an online survey[2].

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* UNEP/CBD/SBSTTA/17/1.
[1] Michele Walters, Henrique M. Pereira, Simon Ferrier, Gary N. Geller, Rob Jongman, Robert J. Scholes, Michael Bruford and Belinda Reyers.
[2] http://www.earthobservations.org/geobon_ebv_survey.shtml

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In 2002, parties to the Convention on Biological Diversity (CBD) set a goal to reduce the rate of biodiversity loss by the year 2010. It has been widely acknowledged that this target has not been met (e.g., Butchart et al. 2010). Furthermore, for most of the indicators used to measure progress, data was unavailable or insufficient worldwide to demonstrate changes in biodiversity over time (Walpole 2010).

The CBD parties agreed to a new set of twenty biodiversity targets for the period 2011-2020, referred to as the Aichi targets (CBD 2010). On request of the CBD, GEO BON prepared an assessment of the adequacy of observation systems to provide the data needed for these targets (GEO BON 2011). It concluded that though a wide range of biodiversity information was available, it be unlikely that it would be possible to completely monitor progress towards the achievement of the Aichi Biodiversity Targets with current monitoring systems and indicators. However the development of a more comprehensive global observation system for delivering information on biodiversity change would change this.

Some lessons can be learned from the climate community, which identified 50 'Essential Climate Variables' through their Global Climate Observing System (GCOS). These variables, such as rainfall, temperature, and windspeed, form the basis for a global monitoring system that was agreed on by the parties to the UN Framework Convention on Climate Change (GCOS 2010). The system supports and enables the collection of detailed and harmonized long-term observations, worldwide, on a daily basis. A variety of programmes, organisations and agencies are involved, but the system relies on national and regional entities for implementation (GCOS 2010). GEO BON proposes a similar system for biodiversity monitoring, based on a set of Essential Biodiversity Variables (EBVs, Pereira et al. 2013). The need for a comprehensive, integrated observation system for biodiversity across multiple scales is great, to safeguard biodiversity but also to protect and improve human well-being.

The need for Essential Biodiversity Variables

Tracking biodiversity change is not as simple as, for instance, measuring rainfall or temperature. A 'change in biodiversity' could involve extinction, shift in range, change in abundance, or loss of genetic diversity. There are a multitude of pressures acting directly on biodiversity, such as land-use change, exploitation of biological resources and climate change. A first attempt at developing indicators for the 2020 CBD targets identified close to 100 operational indicators, though on-going work aims to shorten the list (AHTEG 2011). Considering this complexity it is be difficult to select a short list of variables which are useful and feasible to monitor everywhere.

To overcome this challenge, clear priorities need to be established to guide the development of biodiversity observation systems worldwide, both for *in situ* and remote sensing observations. EBVs focus effort on a finite set of measurements, essential for the characterization of global biodiversity change. EBVs are intended to facilitate the harmonization of existing monitoring schemes and guide the implementation of new monitoring schemes, especially in geographical areas where information on biodiversity change is still very sparse.

Essential biodiversity variables are mostly not indicators themselves, but processed observations required for the calculation of the indicators, for instance to assess progress towards the CBD 2020 targets. EBVs can also be used to develop scenarios for the future of biodiversity under different policy and management responses.

What are Essential Biodiversity Variables?

Essential Biodiversity Variables represent a minimal set of fundamental observations needed to support multi-purpose, long-term biodiversity information needs at various scales (Pereira et al. 2013). The EBV framework (Figure 2.1) allows us to answer important questions about biodiversity change, its consequences for human well-being, effectiveness of responses and future harmful biodiversity changes.
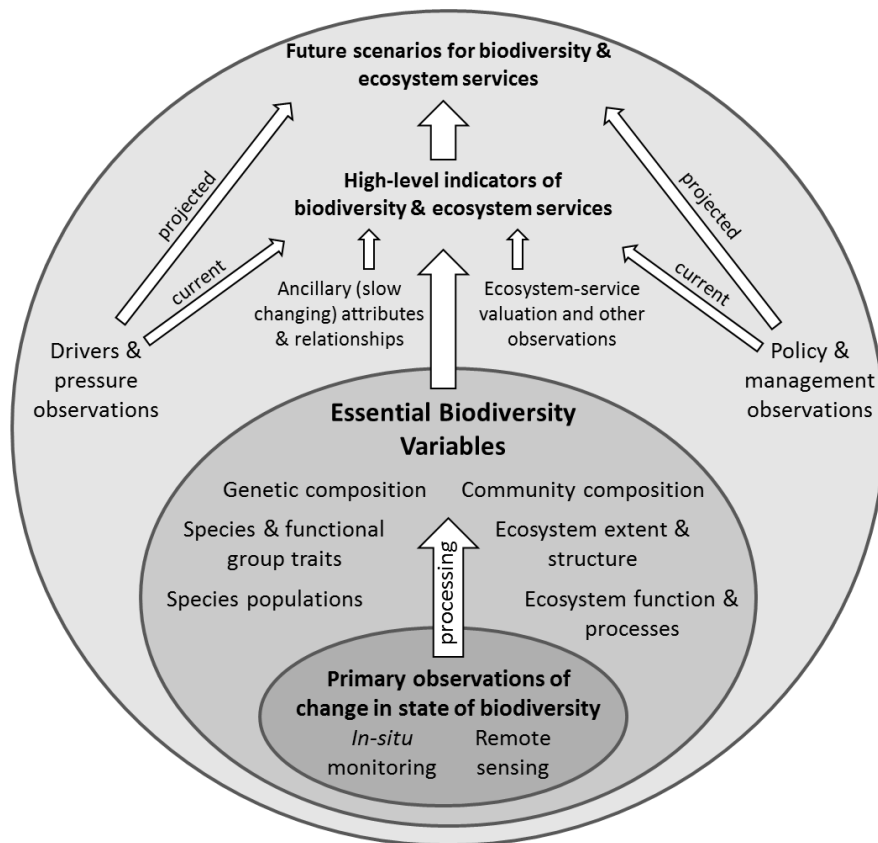
Figure 2.1: *The Essential Biodiversity Variables framework. Primary observations from in situ monitoring and remote sensing systems are pre-processed and combined into EBVs, which bridge the space between primary measurements and indicators. All EBV classes should be included in a biodiversity monitoring program. EBVs inform multiple biodiversity and ecosystem service indicators, such as those needed to assess the Aichi Biodiversity Targets. Some indicators require the integration of EBVs with other sources of information such as data on the 'slowly changing' attributes of the biodiversity entities being observed, drivers and pressures, management and policy responses, and valuation of and demand for ecosystem services. Future projections of drivers and policy responses can be used to develop scenarios for biodiversity and ecosystem services using models calibrated and validated with EBVs. Source: Science (reproduced with permission)*

EBVs are intended to help guide development of biodiversity observation systems. The distinction between EBVs and the very large class of general biodiversity indicators is an important one. EBVs are intrinsically linked to primary observations, both *in situ* and remote sensing. EBVs do not necessarily directly provide information that can be communicated simply to policy-makers. By combining EBV observations with other information, such as on the attributes of biodiversity, or drivers and pressures of biodiversity change, indicators can be developed which are directly useful for policy support. EBVs can thus have multiple uses (Figure 2.2).

For instance, an observation system that collects data on species abundance for several taxa at multiple locations on our planet, can support the derivation of the Living Planet Index (Collen et al. 2009), the Wild Bird Index (Butchart et al. 2010), the Community Temperature Index (Devictor 2012), measures of species range shifts (Parmesan 2006), and a number of other high-level indicators on the CBD's indicative list of indicators for the strategic plan for biodiversity 2011-202 (CBD, 2012; Figure 2.2). Some biodiversity indicators require the integration of two or more EBVs, together with other datasets. For instance, the species extinction risk estimates that are the basis of the Red List Index include information on trends in species abundance and occurrence (an EBV); trends in ecosystem extent and distribution (another EBV); complemented with non-EBVs ancillary information about the species, such as the generation time or migratory behaviour.
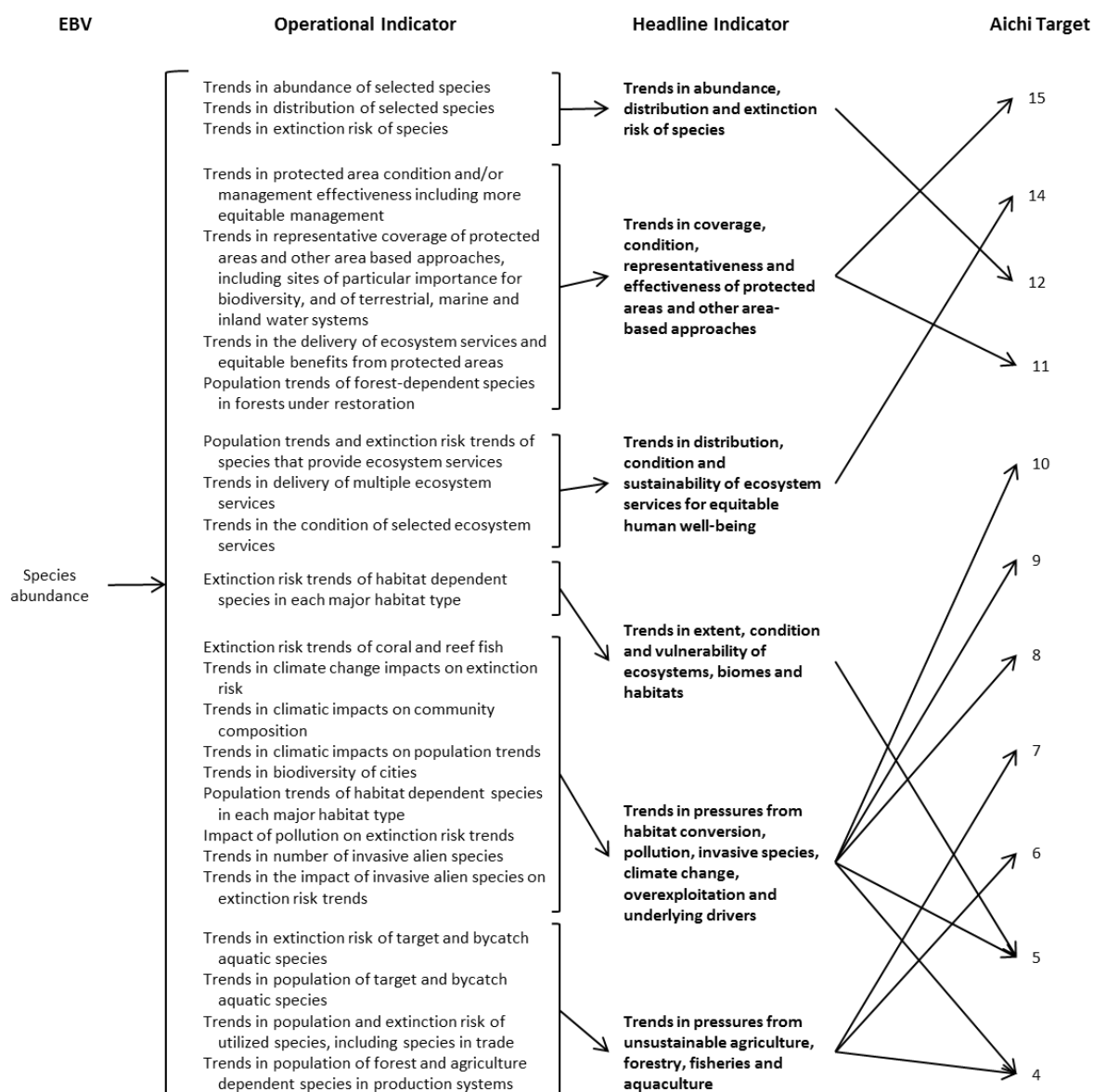
EBV	Operational Indicator	Headline Indicator	Aichi Target
	Trends in abundance of selected species Trends in distribution of selected species Trends in extinction risk of species	**Trends in abundance, distribution and extinction risk of species**	15
	Trends in protected area condition and/or management effectiveness including more equitable management Trends in representative coverage of protected areas and other area based approaches, including sites of particular importance for biodiversity, and of terrestrial, marine and inland water systems Trends in the delivery of ecosystem services and equitable benefits from protected areas Population trends of forest-dependent species in forests under restoration	**Trends in coverage, condition, representativeness and effectiveness of protected areas and other area-based approaches**	14 12 11
	Population trends and extinction risk trends of species that provide ecosystem services Trends in delivery of multiple ecosystem services Trends in the condition of selected ecosystem services	**Trends in distribution, condition and sustainability of ecosystem services for equitable human well-being**	10
Species abundance	Extinction risk trends of habitat dependent species in each major habitat type		9
	Extinction risk trends of coral and reef fish Trends in climate change impacts on extinction risk Trends in climatic impacts on community composition Trends in climatic impacts on population trends Trends in biodiversity of cities Population trends of habitat dependent species in each major habitat type Impact of pollution on extinction risk trends Trends in number of invasive alien species Trends in the impact of invasive alien species on extinction risk trends	**Trends in extent, condition and vulnerability of ecosystems, biomes and habitats** **Trends in pressures from habitat conversion, pollution, invasive species, climate change, overexploitation and underlying drivers**	8 7 6
	Trends in extinction risk of target and bycatch aquatic species Trends in population of target and bycatch aquatic species Trends in population and extinction risk of utilized species, including species in trade Trends in population of forest and agriculture dependent species in production systems	**Trends in pressures from unsustainable agriculture, forestry, fisheries and aquaculture**	5 4

Figure 2.2: *Essential biodiversity variables (EBVs) may be combined with other variables to derive multiple high-level indicators used to measure progress against multiple targets. In this example the EBV 'species abundance' feeds into 24 indicators used to derive the headline indicators for monitoring progress towards 11 of the Aichi biodiversity targets.*

The characteristics of EBVs

The versatility of EBVs and the way they support each other is an important characteristic of the observation system they create. EBVs as a whole have a number of characteristics that render them suitable to biodiversity observation systems at multiple scales.

Relevance

EBVs are relevant not only for today's scientific and policy questions, but are also general enough to address questions that might be asked in the future. There are many important questions about global biodiversity change processes and patterns (Sutherland et al. 2009). The broad questions that EBVs need to help answer are: (1) What aspects of biodiversity are changing, in what direction and how fast? (2) Why is biodiversity changing? (3) What are the consequences for human well-being? (4) What is the risk of harmful biodiversity change? (5) How effective are actions to protect and manage biodiversity? EBVs do not try to address all of these questions by themselves. For

instance, to address question 3 above we would need to combine information on changes in the abundance and distribution of beneficial elements of biodiversity with physical, social and economic data (Figure 2.1).

Sensitivity to change

EBVs are responsive in policy-relevant time-frames, the 'near-term', meaning on the order of a decade, rather than seasonally or annually, which represent 'noise'. Variables that change over longer time-scales, for instance in evolutionary time scales (e.g. the number of species in a taxonomic group), although very important for the study of biodiversity, are not the focus of the EBVs as they do not drive the requirements for an observation system. EBVs should be repeatedly measured at the same sites at time intervals defined by their temporal sensitivity. This emphasis on repeated measures of biodiversity contrasts with other calls that have been made to an inventory approach of biodiversity (Wilson 2000).

Biological and generalizable

EBVs focus on the biological attributes of biodiversity, rather than on the human-system drivers of, or responses to, biodiversity. For instance, the value of a particular ecosystem service to humans is not considered an EBV. EBVs are, to the extent possible, generalizable across the terrestrial, freshwater and marine realms. Collectively, they capture the different levels of biodiversity from genes to ecosystems.

Scalable

EBVs are equally applicable at local, regional and global scales. Furthermore, they are spatially scalable, allowing information to be aggregated or disaggregated.

Feasible

EBVs are selected to be measurable with available technologies, with a proven track record of feasibility in on-going initiatives. This includes a consideration of cost, but does not preclude the inclusion of variables that, despite not being measurable in a cost-effective manner in the present day, are likely to be measurable at reasonable cost in the near future. An example is gene-level observations, which are rapidly decreasing in cost.

Stable

Detecting changes in biodiversity composition, structure or function implies that repeated measurements are required. EBVs must therefore be stable enough to allow them to be measured for decades to come. EBVs are not based on theoretical 'fashions' and are not sensitive to changes in the technology used to measure them.

State variables

EBVs measure the *state* of ecosystems and species and their genetic composition. Thus they are just one component of the DPSIR (Drivers-Pressures-State-Impacts-Responses) framework that is commonly used for environmental reporting.

Reaching consensus

The concept of EBVs was developed in March 2012 by a group of over thirty biodiversity experts, covering all domains, taxon groups and parts of the world. Subsequent discussions and workshops led to a concept paper (Pereira et al 2013) and a list of candidate EBVs.

An online survey using this refined list was designed to gauge opinions on the EBVs and allow opportunity for comments and suggestions for new candidates. This survey will continue until the end of 2013 and CBD focal points are invited to provide comments.[3] Respondents are requested to score each of the EBVs on a scale from one to three based on how important they consider each to be in the context of a global monitoring system for detecting biodiversity change. Candidates wishing to

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[3] http://www.earthobservations.org/geobon_ebv_survey.shtml

suggest a new EBV are asked to provide information on whether it was a replacement/alternative or a completely new EBV, which class it fell in, its temporal sensitivity, and how it would be measured.

The concept of EBVs is been presented at several conferences and meetings of key biodiversity players such as CBD, Ramsar, IPBES and the World parks Congress.

The EBVs

Essential Biodiversity Variables fall within six classes: genetic composition; species populations and ranges; species traits; community composition; ecosystem structure; and ecosystem function. Monitoring programmes should include EBVs from all six of these classes.

Table 2.1: *The 22 EBVs fall into six categories covering composition, structure and function of both species (genetic composition, species populations, species traits), and ecosystems (community composition, ecosystem structure, ecosystem function).*

EBV class	Essential Biodiversity Variable
Genetic composition	Allelic diversity
	Co-ancestry
	Population genetic differentiation
	Breed and variety diversity
Species populations	Species distribution
	Population abundance
	Population structure by age/size class
Species traits	Phenology
	Body mass
	Natal dispersal distance
	Migratory behaviour
	Demographic traits
	Physiological traits
Community composition	Taxonomic diversity
	Species interactions
Ecosystem structure	Habitat structure
	Ecosystem extent and fragmentation
	Ecosystem composition by functional type
Ecosystem function	Net primary productivity
	Secondary productivity
	Nutrient retention
	Disturbance regime

Below we expand on each of the EBV classes and their variables. We provide suggestions on how they should be measured, which organisms should be targeted, which biodiversity indicators and Aichi Targets they feed into and what data are currently available.

Genetic composition class

Genetic diversity provides the raw material on which natural and artificial selection operates. Thus conserving genetic diversity is necessary to maintain adaptive potential. Aichi Target 13 (See Textbox 2.1) explicitly acknowledges this. Aichi target 13 refers to domesticated species, their wild relatives and culturally and socio-economically valuable species; but the argument can be extended to all species, and especially those critical in provision of ecosystem services.

Allelic diversity – Allelic diversity refers to the number and frequency of alleles existing in a population or sample and is the basis of other genetic diversity variables. It is important since it represents the fundamental 'library' of variation; the result of natural experimentation over billions of years. It is measured by extracting the DNA from populations of representative species at a given location and analysing it. Allelic diversity is measured at discrete positions within the genomes of target organisms. Microsatellite markers have been the main source of allelic diversity information to date. The FAO has recommended sets of markers for most domestic species. However microsatellite markers are being gradually replaced by Single Nucleotide Polymorphism (SNP). DNA-based diversity data has accumulated dramatically during the last 20 years and is now available for many species at many sites. Some species have been measured at more than one time during the recent past, allowing change detection. Single time-point data can also be used to infer past demographic trajectories, provided full genotype data are present and this represents the most immediate opportunity and may only require re-analysis of existing data. Those wild species that are directly exploited by humans (e.g. fisheries, hunted species, predators, forest trees, medicinal plants) are also well represented. Other species are more sparsely represented and need to be priorities for future data collection.

Co-ancestry – Co-ancestry is a measure of the evolutionary history of a species or population, and is the basis of the 'phylogenetic trees' which are revolutionising taxonomy. It is built from measures of allelic diversity and supports the calculation of phylogenetic distance, which helps to prioritise the conservation of particular species or regions, where they represent a highly-unusual, often very ancient set of genes. Co-ancestry observations are available for an increasing part of the scientifically-known biodiversity

Population genetic differentiation – This is another term for 'heterogygozity', the degree to which different populations within a species vary in their genetic composition. It is also built from fundamental observations of allelic diversity, and guides decisions on how large a fraction of species populations needs to be protected.

Breed and variety diversity – These measures of genetic diversity predate modern DNA techniques, and are based on traditional knowledge and phenotypic expression. They represent the variation that has been developed by human selection withing domesticated species. It is important for cultural and economic reasons. There are large datasets covering many breeds, land races and populations of domesticated animals and plants.

Species populations class

Species distribution – The presence or absence of a species at a given location and time is perhaps the most widely collected piece of biodiversity information. It is derived from field observations and from 'collections' data in museums and herbaria. There are hundreds of millions of such observations in digital form, covering all species and parts of the world, in repositories such as the Global Biodiversity Information Facility. The primary observations are used to construct distribution maps, using various interpolation techniques, and these form the basis of 'species richness' indicators and of most systematic conservation planning and studies of how diversity is likely to change in the future, in response to habitat loss and climate change.

Population abundance – The number of organisms of a given type is fundamental to the functional aspects of biodiversity, including the calculation of sustainable harvest rates. When counting the individuals is not practical, abundance can be proxied by biomass, cover or judgement in classes such as 'common' and 'rare'. Population abundance is the continuous variable of which 'extant' or 'extinct' is an information-poor subset. It is the input to indicators such as the Living Planet Index, which currently includes only several thousand species of the millions known to exist. Population data are available for many species, sometimes in unexpected forms, such as forestry survey data or fisheries stock assessments, as well as in bird counts, wildlife census, the continuous plankton survey etc.

Population structure by age/size class – The proportions of the species population in different age classes provides information about its longevity, turnover and past and future trends – is the population growing, declining or stable? It is needed for determining harvest rates and strategies, and

for assessing extinction risk. For populations where individuals are hard to age, the sex of the organism (its height, length, girth or mass) can be used as a proxy.

Species traits class

The traits or attributes of a species are underpinned by the genes which are present and allow the consequences of changes in the species abundance or distribution to be assessed. Traits databases are rapidly growing, and form a key link between the gene, species and ecosystem levels of biodiversity. The 'package' of species traits is often characterised by assigning the species to a 'functional type' or 'guild'.

Body mass – The size of an organism is one of its most fundamental attributes, and controls many other aspects of its biology, such as its resource needs, longevity and reproduction rate. It is know that mean body mass of a population can change under pressures such as harvesting, and therefore changes in mean body mass of a population can give important information about the level of pressure in a population and the adaptive capacity of the species to that pressure.

Phenology –

Phenology describes the seasonal or periodic behaviour of a species: when do they leaves appear and fall, when does it flower or nest or migrate? Phenology of either species or communities of species is a sensitive indicator of response to climate change, especially because phenology is readily observable by remote sensing. Phenological databases exist for many species.

Natal dispersal distance –

This is a measure of the mean dispersal distance of the propagule and is mostly applicable to sessile organisms. A species with a short dispersal distance and a long time between birth and reproductive maturity is unlikely to be able to keep up with a changing environment by shifting its distribution, and thus has a high extinction risk. Dispersal distance may also change under environmental pressure, for instance due to habitat fragmentation or climate change.

Migratory behaviour – This applies to non-sessile organisms and includes the size of the home range, the location of breeding and overwintering areas and the season pattern and speed of movement. It is particularly important in the context of international agreements, where the migration spans national boundaries, such as for the Ramsar Convention on internationally-important wetlands, and the Convention on Migratory Species. It is also fundamental to tracking the movement of new diseases and pests and to assess the impact of fragmentation in some populations such as freshwater fish.

Demographic traits – These include mean longevity, fertility, age at first reproduction and sex ratio. All of these traits can respond to environmental change. For instance, harvesting pressure can lead to lower age at first reproduction or changes in sex ratio.

Physiological traits – These include information about how the organism lives (what does it gain its energy? is it a primary producer, herbivore, carnivore or detritivore); physiological limits and optima (e.g. for temperature, moisture, salinity, light and oxygen); and the presence of particular metabolic pathways (form of photosynthesis, nitrogen fixation capacity). There is an increasing interest in understanding how physiological traits evolve under climate change and habitat change. The degree of adaptive plasticity of physiological traits is essential to understand how fast can species adapt to global change.

Community composition class

Taxonomic diversity – This consists of a list (sometimes with relative or absolute abundances) of species observed to coexist at a time and place, and inferred to form a community. It is the finest-scale representation of the combined species distribution data referred to above, if the latter was known to be complete, and if it were recorded with enough geographical and temporal precision – neither of which conditions are generally true. This is a fundamental measure of 'ecosystem diversity'. The information is widely collected, in the form of vegetation surveys, marine community surveys, mammal or bird assemblages, etc., but is currently poorly shared in interoperable databases.

Species interactions – Species form ecosystems by interacting with one another. These interactions can take a finite number of forms: predator, prey, competitor, symbiont, dispersal agent, pollinator, among others. This information is fundamental to the building of trophic webs and for understanding how biodiversity disturbances (such as the appearance of a new disease) propagate through ecosystems and spatially. For example, understanding pollinator-plant interactions can be essential to assess how pollination services might evolve in the future. Although the basic biology of species interactions is widely observed, few international databases of interactions currently exist.

Ecosystem structure class

Ecosystem structure is the organisation of ecosystems in space, taking into account the various functional types of organisms that are present (and thus, implicitly, their interaction structure) and how they are arranged in three-dimensions.

Ecosystem composition by functional type – This is the basis of ecosystem classification. It can be informed by community composition (see above) intersected by species traits (see above), or can be measured directly by assessing the degree of coverage by stratum for different plant life forms. The functional composition of ecosystems controls their delivery of ecosystem services, and thus their 'health' or 'degradation'.

Habitat structure – Habitat structure is the three-dimensional organisation of the ecosystem: how tall, how dense and how patchy? It is particularly important because it can be observed and mapped using remote sensing, in terms of cover in various layers – for instance the height layers on land (canopy, subcanopy, herbaceous) or depth layers in aquatic systems. Habitat structure is fundamental to productivity, intactness and suitability as a place to satisfy the life-history requirements of the species which live in it – is there place for them to capture resources, nest and survive predation?

Ecosystem extent and fragmentation – The area (extent) of ecosystems of different functional composition is the most widely-used indicator of ecosystem-level biodiversity loss. It has been used to assess both changes in the state of biodiversity (e.g. how many wetlands are being lost) but also as pressure (e.g. how many species are lost because of the disappearance of their habitat). The effective area can be modified by the size, shape and distance apart of individual patches – properties which are important for management and conservation, and are measured by indicators such as the mean patch size and the boundary-to-area ratio. Many local to global scale maps of ecosystem extent exist, but with legends that are difficult to reconcile without community composition data. The mapping is often implicitly based on habitat structure.

Ecosystem function class

Net Primary Productivity (NPP) – The capture of solar energy by plants (largely phytoplankton in aquatic systems) and its conversion into biomass (less the respiratory losses by the plant itself) forms the energy input which sustains all life of Earth. It is the basis of most 'provisioning' ecosystem services such as food, fuel and timber. Sustained changes in NPP are a sensitive measure of ecosystem degradation. NPP can be directly measured using laborious field or aquatic ecosystem techniques, or by the growing network of flux stations and static or underway marine recorders, or it can be inferred from remotely-sensed measures of ocean colour and Fraction Absorbed Photosynthetic Active Radiation, fed into models along with climate and functional composition data. Such maps are available globally, every few days, at resolutions of a few hundred meters.

Secondary productivity – Secondary production is the growth rate of organisms that live on plants: zooplankton or fish in the sea, herbivores on land. Many ecosystem services, such as fisheries, meat or dairy products, are based on secondary production, and many culturally-important forms of biodiversity (birds, mammals etc.) depend on it. Secondary production is available from fisheries models and catch databases, and from livestock numbers and offtake statistics on land.

Nutrient retention – Nutrient retention refers to the 'leakiness' of ecosystems with respect to particular elements. For example the degree to which primary production is converted to a flux of carbon to deep ocean waters is key to the global carbon cycle and climate change. On land, the propensity of ecosystems to leak excess nitrogen and phosphorus to freshwater systems, and from

there to the coast is a both an important cause of biodiversity loss and a symptom of ecosystem stress. Large databases exist of nutrient inputs to ecosystems in the form of airborne deposition, fertilisers and waste streams, as well as databases of water quality. Their linkage to biodiversity monitoring are currently largely rudimentary.

Disturbance regime – The disturbance regime consists of the frequency and intensity of disrupting factors such as fires, storms or physical disturbance. The diversity of ecosystems and the species they contain is a complex function of the disturbance regime – too much disturbance or too little disturbance both lead to loss of biodiversity. Some forms of disturbance are easily and routinely monitored using remote sensing.

What about Ecosystem Services?

Ecosystems provide a variety of services to humans, including provisioning, regulating, supporting and cultural services (MA 2003), and that is one major reason why people care about biodiversity. The measurement of these services requires not only data from the biological domain but also from other domains, for example the economic, environmental and social environments. Whilst EBVs do not cover all of the variables required to measure and track ecosystem services, knowledge of EBVs is crucial for the assessment of ecosystem services. EBV information can be combined with other inputs and variables for determining the supply and valuation ecosystem services (Figure 2.3).
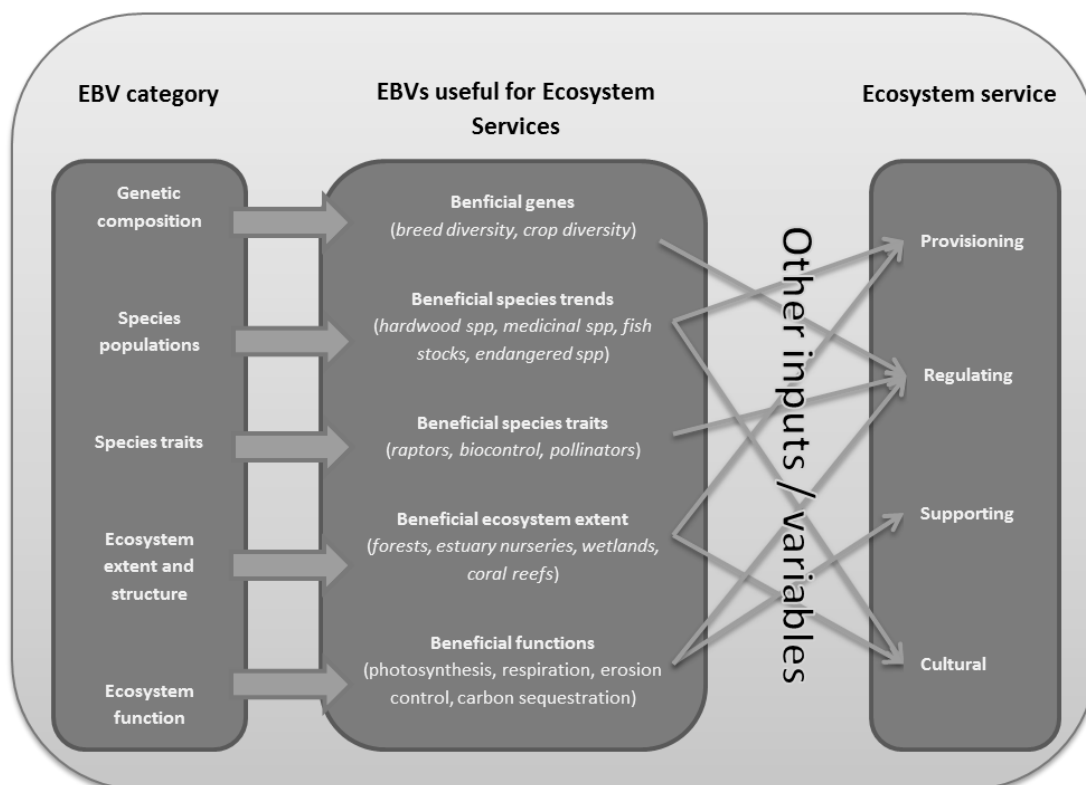

Figure 2.3: *Essential biodiversity variables (EBVs) are used in combination with other inputs and variables, to derive ecosystem service valuations.*

Measuring EBVs in the Real World

A GEO-BON handbook, currently under preparation, will provide details of how to measure EBVs in many different environments – on land, in freshwater ecosystems such as lakes and rivers, on the coast and in oceans; and for different types of organisms and at various scales. Setting up an observation system for EBVs requires more and harder decisions than for setting up an observation system for a well-established field such as climate. In many cases proxy observations will need to be used while the methods evolve for routine, comprehensive and direct measurements of the EBV's themselves.

Additional Resources

For a summary table of the list of proposed Essential Biodiversity variables see:
http://www.earthobservations.org/documents/cop/bi_geobon/ebvs/201303_ebv_table.pdf

For information about EBVs, the 2012 Frascati workshop and the Science paper see
http://www.earthobservations.org/geobon_ebv.shtml.

The GEO BON report on the "Adequacy of Biodiversity Observation Systems to support the CBD 2020 Targets" can be downloaded from http://www.cbd.int/doc/meetings/sbstta/sbstta-15/information/sbstta-15-inf-08-en.pdf.

In 2012 the task team for an Integrated Framework for Sustained Ocean Observing (IFSOO) released a report titled *A Framework for Ocean Observing* (see: http://www.oceanobs09.net/foo/FOO_Report.pdf). This was in response to a recommendation from the OceanObs'09 Conference held in Venice in September 2009, for interdisciplinary ocean observation activities to be integrated and coordinated at international level. The task team recommended that activities within the Framework be organized around community-defined Essential Ocean Variables (EOVs) (UNESCO 2012). The biological component of the EOVs and the EBVs were developed concurrently with members from both communities represented in each of these initiatives.

References

AHTEG (2011). Report of the AHTEG on indicators for the Strategic Plan for Biodiversity 2011-2020. Secretariat of the Convention on Biological Diversity, Montreal.

Bubb, P. et al. (2011). National Indicators, Monitoring and Reporting for the Strategic Plan for Biodiversity 2011-2020. UNEP-WCMC, Cambridge.

Butchart, S.H.M. et al. (2010). Global Biodiversity: Indicators of Recent Declines. Science 328: 1164–1168.

CBD (2010). Decision X/2. The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets. UNEP/CBD/COP/DEC/X/2. http://www.cbd.int/doc/decisions/cop-10/cop-10-dec-02-en.pdf.

CBD (2012). Decision XI/35. Decisions adopted by the conference of the parties to the convention on biological diversity at its eleventh meeting (Hyderabad, India, 8-19 October 2012). UNEP/CBD/COP/DEC/XI/35. www.cbd.int/doc/decisions/cop-11/full/cop-11-dec-en.pdf.

Collen, B. et al. (2009). Monitoring Change in Vertebrate Abundance: the Living Planet Index. Conservation Biology 23: 317–327.

Devictor, V. et al. (2012). Differences in the climatic debts of birds and butterflies at a continental scale. Nature Climate Change 2: 121–124.

GCOS (2010). Implementation Plan for the Global Observing System for Climate in support of the UNFCCC. GCOS-138 (WMO-TD/No. 1523). August 2010. WMO, Geneva.

GEO BON (2011). Adequacy of Biodiversity Observation Systems to Support the CBD 2020 Targets. Group on Earth Observations Biodiversity Observation Network. http://www.earthobservations.org/documents/cop/bi_geobon/2011_cbd_adequacy_report.pdf.

[MA] Millennium Ecosystem Assessment. 2003. Ecosystems and human well-being: a framework for assessment. Island Press, Washington (DC).

Parmesan, C. (2006). Ecological and Evolutionary Responses to Recent Climate Change. Annual Review of Ecology, Evolution, and Systematics 37: 637–669.

Pereira, H.M. et al. (2013). Essential Biodiversity Variables. Science 339:277-278.

Sutherland W.J. et al. (2009). One Hundred Questions of Importance to the Conservation of Global Biological Diversity. Conservation Biology 23: 557–567.

UNESCO (2012). A Framework for Ocean Observing. By the Task Team for an Integrated Framework for Sustained Ocean Observing, UNESCO 2012, IOC/INF-1284, doi: 10.5270/OceanObs09-FOO.

Wilson, E.O. (2000). A Global Biodiversity Map. Science 289: 2279.