The RUBICODE Project

Rationalising Biodiversity Conservation in Dynamic Ecosystems

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RUBICODE GLOSSARY (v. 20071126)

This document is a combination of existing published definitions and RUBICODE-generated definitions. If taken verbatim from a published definition, reference is given. This document remains open to discussion, and some specific discussion points are noted.

BIODIVERSITY
The variety of living organisms and the ecological complexes of which they are part.
This includes diversity within and among species and diversity within and among ecosystems.
(Adapted from Millennium Ecosystem Assessment, 2003)

SUSTAINABLE USE
The use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biodiversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.
(Convention on Biological Diversity, 1992)

ECOSYSTEM
A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.
(Convention on Biological Diversity)
Humans, where present, are an integral part of ecosystems.

DYNAMIC ECOSYSTEM
The concept of a dynamic ecosystem, central to RUBICODE, acknowledges the temporal and spatial variability in ecosystem characteristics due to natural or anthropogenic changes affecting the organisms individually or collectively, and hence the reality that a given ecosystem service cannot be maintained indefinitely at a given location. However, as all ecosystems are dynamic, the term is somewhat redundant and just serves as a reminder that a static approach to conservation will have limited usefulness.

ECOSYSTEM DYNAMICS
Ecosystem change in space and time resulting from the effect of external and internal forces on ecological functions
There may be continual change in biotic composition and structure at specific localities. Collectively, these changes may represent internal flux, or substantive and permanent alteration of the ecosystem regionally.

HABITAT
The place or type of site where an organism or population naturally occurs.
(Convention on Biological Diversity, 1992)

LANDSCAPE

Heterogeneous mosaics of habitat patches, physical conditions or other spatially variable elements viewed at scales relevant to the organisms or processes under consideration.
(Adapted from Wiens, 1995)

LANDSCAPE ECOLOGY

The study of how the complexity of spatial structure of landscapes affects ecological patterns and processes over any given range of scales.
(Adapted from Wiens, 1995)

CORRIDOR

Linear landscape structures that link similar landscape elements and facilitate movement of organisms between them.
(Adapted from Wiens, 1995)

POPULATION

A group of organisms, all of the same species, which occupies a particular area **(a geographic population),** is genetically distinct **(genetic population)** or fluctuates synchronously **(demographic population)**

BIOME

The largest unit of ecosystem classification that it is convenient to recognise below the entire globe. Terrestrial biomes are typically based on dominant vegetation structure (e.g., forest, grassland). Ecosystems within a biome function in a broadly similar way, although they may have very different species composition. For example, all forests share certain properties regarding nutrient cycling, disturbance and biomass that are different from the properties of grasslands.

COMMUNITY (= ASSEMBLAGE)

Any grouping of populations of different organisms found living together in a particular environment; essentially the biotic component of an ecosystem
(Based on Allaby, 1994)

ECOSYSTEM PROCESSES

The interactions (events, reactions or operations) among biotic and abiotic elements of ecosystems that lead to a definite result
(Tirri *et al.*, 1998; Wallace, 2007)

ECOSYSTEM FUNCTION

Redundant term synonymous with Ecosystem Processes
(Wallace, 2007)
For discussion. Many RUBICODERS do not agree that this term is redundant. This needs a rethink.

ECOSYSTEM SERVICES

Benefits that humans obtain from ecosystems that support, directly or indirectly, their survival and quality of life
These include provisioning, regulating and cultural services that directly affect people, and the supporting services needed to maintain the direct services.
(Enlarged from Millennium Ecosystem Assessment, 2003)

PROVISIONING SERVICE
Products obtained from ecosystems
(Millennium Ecosystem Assessment, 2003)

REGULATING SERVICE
Benefits obtained from regulation of ecosystem processes
(Millennium Ecosystem Assessment, 2003)

CULTURAL SERVICE
Non-material benefits obtained from ecosystems
(Millennium Ecosystem Assessment, 2003)

SUPPORTING SERVICE
Services necessary for the production of all other ecosystem services
(Millennium Ecosystem Assessment, 2003)

ECOSYSTEM SERVICE PROVIDER (ESP)
An organism, species, functional group, population or community, or trait attributes (*defined below*) thereof, that contributes to ecosystem service provision and hence to an SPU

SERVICE-PROVIDING UNIT (SPU)
The total collection of organisms and their trait attributes required to deliver a given ecosystem service at the level needed by service beneficiaries
The SPU must be quantified in terms of metrics such as abundance, phenology and distribution.
For discussion. The definition of an ecosystem includes non-living aspects of the environment such as rock structure and topography. The SPU definition only relates to biodiversity, and thus assumes that supporting structures (abiotic conditions and physical structures) are suitable.
For discussion. It is important to define the level of service required. If it is simply `the more the better' it is impossible to define an SPU. There needs to be a level of service that is considered the minimum adequate. Where there is a threshold relationship between biodiversity and service level, defining an SPU may be easier than where the service increases in proportion to the providers.
For discussion. The need for resilience needs taking into account.
For discussion. Defining SPUs from a functional (rather than species) perspective.
Functional diversity is the part of biodiversity that provides the service of interest because of a particular trait attribute composition. Consequently WP5 will define **SPUs** ***as:***
`The collection of trait attributes required to deliver a given ecosystem service at the level needed by service beneficiaries'. This is proposed as a generic definition of SPUs applicable in all cases except when the service of interest is provided by a single species, although even within species there will be genetic variation, so this definition can still apply. Even a monoculture is only a special and simplified case. SPUs may therefore be quantified by any of the metrics of functional diversity (defined below), by a specific syndrome, or by a combination of otherwise independent trait attributes.
Understanding service provision from a functional perspective is seen as a necessary condition to track and predict the dynamics of services linked to species' trait attributes.

ECOSYSTEM SERVICE ANTAGONISER (ESA)
An organism, species, functional group, population or community, or trait attributes thereof, which interferes with ecosystem service provision
Such interference may be direct (e.g. through eating the provider) or indirect (e.g. through competition for resources or through direct interference with organisms that support ESPs).

(SERVICE-ANTAGONISING UNIT)
This term will not be used as it is virtually intractable. Following the definition of an SPU, it would be ` The total collection of organisms and their trait attributes required to disrupt delivery of a given ecosystem service at the level needed by service beneficiaries'. However, this will depend on whether the service is only just adequately being provided (i.e. there is an SPU but no excess ESPs) or whether some ESPs can be lost without losing the SPU.

FUNCTIONAL TRAIT
A feature of an organism, which has demonstrable links to the organism's function
As such, a functional trait determines the organism's response to pressures **(RESPONSE TRAIT)**, *and/or its effects on ecosystem processes or service* **(EFFECT TRAIT)**. *Functional traits are considered as reflecting adaptations to variation in the physical and biotic environment and trade-offs (ecophysiological and/or evolutionary) among different functions within an organism. In plants, functional traits include morphological, ecophysiological, biochemical and regeneration traits, including demographic traits (at population level). In animals, these traits are combined with life-history and behavioural traits (e.g. guilds, organisms that use similar resources-habitats).*

FUNCTIONAL TRAIT ATTRIBUTE
The value/state of a functional trait
It may be categorical (e.g. C3 vs C4 for plant photosynthetic pathway) or quantitative.

FUNCTIONAL GROUP
A group of species with similar functional trait attributes
Groups can be associated with similar responses to pressures and/or effects on ecosystem processes. A functional group is often referred to as 'guild', especially when referring to animals, e.g. the feeding types of aquatic organisms having the same function within the trophic chain: the group (guild) of shredders or grazers.

FUNCTIONAL SYNDROME
A suite of co-occurring trait attributes, sometimes associated with particular environmental conditions or processes

FUNCTIONAL DIVERSITY
The range, actual values and relative abundance of functional trait attributes
(Díaz & Cabido, 2001; Díaz *et al.*, 2007)
This distribution can be characterised by different metrics, including the weighted average, and different indices of functional diversity
(See Petchey et al. 2004 for a review).
The most relevant metrics are as follows.

COMMUNITY WEIGHTED MEAN (also called aggregated mean or community weighted average)
The mean of trait attributes in the community, weighted by the relative abundance of the species or populations carrying each value
(Garnier *et al*., 2004; Violle *et al*., 2007)
It is usually calculated as the mean across species of their trait values weighted by their relative abundances (i.e. the mean across individuals). It can also be used for instances where a trait expresses only one value for the whole community (e.g. total root density).

FUNCTIONAL RICHNESS *can be defined in two ways*:
a) the range of trait attributes represented in the community
i.e. the amount of niche space filled by species in the community
(Mason et al. 2005)
b) the number of functional groups or trait attributes in the community
(*Petchey et al. 2004*)

FUNCTIONAL DIVERGENCE
The functional differentiation within the community
i.e. the degree to which abundance distribution in niche space maximises divergence in functional traits within the community
(Mason et al. 2005).
This represents the probability that two random samples within the community will have different trait values.
(Lepš et al. 2006).

FUNCTIONAL REDUNDANCY
A characteristic of species within an ecosystem in which certain species (or other taxa) contribute in equivalent ways to ecosystem processes such that one species may substitute for another
Note that species that are redundant for one ecosystem process may not be redundant for others.
(Millennium Ecosystem Assessment, 2003)

INDICATOR
An indicator is a simple, measurable and quantifiable characteristic responding in a known and communicable way to a changing environmental condition, to a changing ecological process or function, or to a changing element of biodiversity.
The definition basically follows the criteria defined by McGeoch (1998), but includes the categories recently defined by the EEA (EEA, 2007).
McGeoch principally distinguishes between environmental, ecological and biodiversity indicators. For the latter, the EEA has given four functions to be served by suitable indicators: 1) simplification as it summarises often complex and disparate data, 2) quantification as statistically sound and comparable measures are related to a reference or baseline value, 3) standardisation as they are based on comparable scientific observations and 4) communication as they provide a clear message that can be communicated.

DPSIR

The scoping framework for describing the interactions between society and the environment adopted by the European Environment Agency: driving forces, pressures, states, impacts, responses (extension of the PSR model developed by OECD)

The framework assumes cause-effect relationships between interacting components of social, economic, and environmental systems, which are:

Driving forces of environmental change (*e.g.* industrial production);
Pressures on the environment (*e.g.* discharges of waste water);
State of the environment (*e.g.* water quality in rivers and lakes);
Impacts on population, economy, ecosystems (*e.g.* water unsuitable for drinking) and
Response of the society (*e.g.* watershed protection).

DRIVER

Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem

(Millennium Ecosystem Assessment, 2003)

The MA's `direct drivers' (equivalent to DPSIR's `pressures') are physical, biological or chemical processes that tend to influence directly changes in ecosystem goods and services. The MA's `indirect drivers' (equivalent to DPSIR's `drivers') are factors that operate more diffusely than direct drivers, often by altering one or more of the direct drivers.

(Alcamo *et al.*, 2005; Nelson *et al.*, 2005)

RESILIENCE

The capacity of an ecosystem to tolerate impacts of drivers and pressures without complete loss of processes that ensure self-regulation, sustainability and capacity to recover from perturbations

(Gary Luck)

STAKEHOLDER

A person or group of people having an interest in a physical resource, ecosystem service, institution, or social system, or someone who is or may be affected by a public policy

(Millennium Ecosystem Assessment, 2003)

BENEFICIARY

A stakeholder who benefits from a physical resource, ecosystem service, institution, or social system, or someone who is or may be affected positively by a public policy

LOSER

A stakeholder who loses from a physical resource, ecosystem service, institution, or social system, or someone who is or may be affected negatively by a public policy

SOCIO-ECOLOGICAL SYSTEM

A system that includes societal (human) and ecological (biophysical) subsystems in mutual interactions (Gallopin, 1991) and thus captures interactions between people, biodiversity and ecosystems.

SOCIO-ECOLOGICAL RESILIENCE

The adaptive capacity of socio-ecological systems for regeneration after disturbance, and reorganisation or evolution of new trends, trajectories or states (Folke, 2006).

TERMS ASSOCIATED WITH VALUE AND VALUATION

(The following definitions and discussion were provided by Michalis Skourtos.)

The process of assigning importance and necessity is called **valuation**. The reason we have to value (=evaluate) is **choice**: '*The issue of valuation is inseparable from the choices and decisions we have to make about ecological systems*' (Constanza 2000).

The **criteria** for choice can be manifold: economic, moral, cultural, aesthetic, ecological *etc*. The **economic criterion** of choice is tantamount to choosing the least cost option to achieve a certain utility level or, in its dual form, choosing the maximum utility option to be achieved with certain expenditure. An **ecological criterion** of choice (*e.g.* choosing which species to prioritise for protection) could be the degree of rarity.

By the act of choosing we inevitably produce rankings, that is (relative) **values**. Such values are always **instrumental**: '*We use the term 'value' to mean the contribution of an action or object to user-specified goals, objectives or conditions*' (Costanza, 2000). On the contrary, we define as **intrinsic** all those values that are disassociated from the concept of choice: items or beings possessing intrinsic value are to be preserved in their own right, irrespective of them serving any user-specified goals, objectives or conditions. It is common in the environmental literature to identify instrumental values with **anthropocentrism** and intrinsic values with **biocentrism**. However, instrumental values can be non-anthropocentric and intrinsic values can be anthropocentric (see table below). All values are quantified on the basis of a **value metric** (or numeraire): energy, money, commodities.

	Anthropocentric	**Non-anthropocentric**
Instrumental	Total Economic Value (TEV): use and non-use (incl. value related to others' potential or actual use) / utilitarian	The values to other animals, species, ecosystems, etc. (independent of humans). For instance, each species sustains other species (through different types of interactions) and contributes to the evolution and creation of new species (co-evolution).
Intrinsic	"Stewardship" value (unrelated to any human use) / non-utilitarian	Value an entity possesses independently of any valuer

Classification of environmental values (Source: Adapted from DEFRA, 2006)

DEFRA (Department for Environment, Food and Rural Affairs), 2006. *Valuing our Natural Environment*. Report No. 0103.

Economic values for ecosystem services are characterised as **subjective values** because they are based on human preferences and quantified on the basis of the intensity of these preferences. The intensity of preferences is expressed in the amount (usually of money) an individual is willing to pay in order to enjoy a certain level of provision of services (**Willingness to Pay, WTP**). Reversing the standpoint of the trade-off, the intensity of preferences can also be expressed in the amount an individual is willing to accept as compensation in order to tolerate a certain level of loss in the provision of services (**Willingness to Accept, WTA**): '*The process of inferring preferences and estimating the* *willingness of individuals to sacrifice to achieve some outcome is termed '**VALUATION**''* (Armsworth and Roughgarden 2001).

On the other hand, choices based on scientific criteria (*e.g.* the criterion of rarity mentioned above) produce what are conventionally called **objective values** (*e.g. ecological* values). Quoting from Webster's New World Dictionary 1988, Freeman (1997) asserts that '*I have found that economists and ecologists typically use the term 'value' (….) in two different senses when they use it in discussions of ecosystems. Ecologists usually use the term to mean 'that which is desirable or worthy of esteem for its own sake; thing or quality having intrinsic worth'. Economists use the term in a sense more akin to 'a fair or proper equivalent in money, commodities, etc..., where 'equivalent in money' represents that sum of money which would have an equivalent effect on the welfare or utilities of individuals*' (p. 241).

In instrumentally valuing a resource such as an ecosystem, the **total economic value** (TEV) can be usefully broken down into a number of categories. The initial distinction is between **use value** and **non-use value**.

Use value involves some interaction with the resource, either directly or indirectly.
1) Indirect use value derives from services provided by the ecosystem. This might, for example, include the removal of nutrients, providing cleaner water to those downstream, or the prevention of downstream flooding.
2) Direct use value, on the other hand, involves interaction with the ecosystem itself rather than via the services it provides. It may be consumptive use such as the harvesting of reeds or fish, or it may be non-consumptive such as with some recreational and educational activities. There is also the possibility of deriving value from 'distant use' through media such as television or magazines, although whether or not this type of value is actually a use value, and to what extent it can be attributed to the ecosystem involved, is unclear.

Non-use value is associated with benefits derived simply from the knowledge that a resource, such as an individual species or an entire ecosystem, is maintained. It is by definition not associated with any use of the resource or tangible benefit derived from it, although users of a resource might also attribute non-use value to it. Non-use value is closely linked to ethical concerns, often to altruistic preferences, although for some analysts it stems ultimately from self-interest. It can be split into three basic components, although these may overlap depending upon exact definitions.
3) Existence value can be derived simply from the satisfaction of knowing that some feature of the environment continues to exist, whether or not this might also benefit others. This value notion has been interpreted in a number of ways and seems to straddle the instrumental/intrinsic value divide.
4) Bequest value is associated with the knowledge that a resource will be passed on to descendants to maintain the opportunity for them to enjoy it in the future.
5) Philanthropic value is associated with the satisfaction from ensuring resources are available to contemporaries (the current generation).

Finally, two categories not associated with the initial distinction between use values and non-use values include:
6) Option value, in which an individual derives benefit from ensuring that a resource will be available for use in the future. In this sense it is a form of use value, although it can be regarded as a form of insurance to provide for possible future but not current use.

7) Quasi-option value is associated with the potential benefits of awaiting improved information before giving up the option to preserve a resource for future use. It suggests a value in particular of avoiding irreversible damage that might prove to have been unwarranted in the light of further information. An example of a quasi-option value is in bio-prospecting, where biodiversity may be maintained on the off-chance that it might in the future be the source of important new medicinal drugs. It has been suggested that quasi-option value is less a distinct category of total value than the difference between an ex-ante perspective yielding 'option price' (consumer surplus plus option value) and an ex-post perspective giving expected consumer surplus, as a measure of value.
8) Insurance value is conceptually linked to the above notions of option values: '*Identifying how close a system might be to collapse of some or all functions is itself extremely difficult, yet one would expect willingness to pay to avoid that collapse to be related in some way to the chances that the collapse will occur. If the chances are known, the value sought is then the premium that would be paid to conserve resilience*.' (OECD 2002, p.31).

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