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Biodiversity indicators for the OECD Environmental Outlook and Strategy

A feasibility study

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with a contribution

from the World Conservation Monitoring Centre (WCMC), United Kingdom

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Summary

This study addresses the question of feasibility for measuring the trends in nature and its diversity at the OECD level. The answer is ‘yes’, provided certain recommendations are followed.

The study analyzes, in particular, the possibilities of the Natural Capital Index, a framework developed and discussed within the Convention on Biodiversity. Here, the key element is to assess changes in biodiversity as changes in the mathematical product of natural areas (ecosystem *quantity*) and some measure of the ecosystem *quality* within the areas. Because data on quality parameters are not always and everywhere available, the method provides simple protocols to use information on various pressure factors in and around the natural area as a fall-back option.

The study provides a review of existing biodiversity indicators and a comparison of major indicator frameworks. Building on a contribution by the World Conservation Monitoring Strategy, it also provides real-data applications of the Natural Capital approach to the biodiversity in some of the larger ecosystems of the OECD as a preliminary estimation. These include forest, grassland, tundra, inland waters and (semi-) desert.

From this study the Natural Capital Index is concluded to constitute a feasible method for assessing biodiversity in a crude but comprehensive manner. The fall-back option (using information on pressure when information on quality is not available) will make it possible to start using the framework in the short term. Pressure information will also allow us to make projections for scenario analyses into the future.

Contents

1 Introduction

This report investigates whether the Natural Capital Index framework, developed in the Convention on Biological Diversity (CBD), is suitable to assess biodiversity in the OECD Environmental Outlook and Strategy study. It focuses on the availability of data. Commissioned by the OECD, the study reported here has been carried out by the National Institute for Public Health and the Environment (RIVM) in co-operation with the World Conservation Monitoring Centre (WCMC).

Requirements on biodiversity indicators for the OECD Environmental Outlook
To fit into the OECD Environmental Outlook and Strategy biodiversity indicators should:
- be quantitative, feasible and affordable
- easy to understand and policy significant
- show whether progress has been made
- be interlinkable with socio-economic scenarios for future projections
- allow comparison of results between member states
- allow aggregation at regional and OECD levels
- take into account country-specific biodiversity
- be scientifically sound

This short report[1] comprises:
i) a brief description of the Natural Capital Index (NCI) framework (section 2);
ii) a preliminary application of the NCI framework to test the data availability (section 3);
iii) conclusions and recommendations (section 4);
iv) supporting appendices, including a review of existing indicators;
v) a summary of the WCMC report: “Natural capital indicators for OECD countries” (available in pdf from www.wcmc.org.uk/species/reports/index.htm).

Appendix 1 contains a glossary of abbreviations and definitions used in this report. Appendix 3, Appendix 4, and Appendix 5 provide, respectively, an overview of biodiversity indicators for policy-makers, a short description and review of their suitability for integrated environmental assessments and a schematic comparison of major indicator frameworks.

[1] The RIVM/WCMC study period encompassed approximately 45 days.

2 Natural Capital Index framework

2.1 Aims and users of the NCI framework

One of the goals of the OECD Environmental outlook and Strategy is to evaluate whether or not progress has been made on the conservation of biodiversity. This is one of the three major goals of the Convention on Biological Diversity (CBD), as shown in Figure 1.

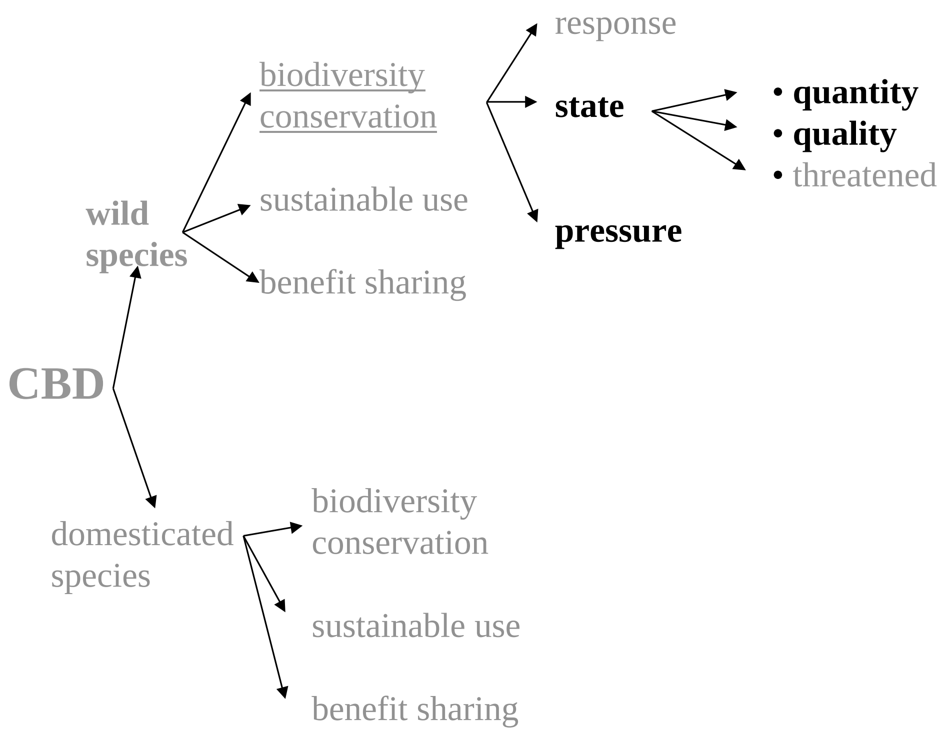

Figure 1: Flow chart illustrating in bold the type of indicators examined in this report. They are related to the first of the three objectives of the UN Convention on Biological Diversity: i) biodiversity conservation; ii) sustainable use and iii) benefit sharing.. This report deals with both indicators of wild-living biodiversity at the species and ecosystem level, and pressure indicators.

The Natural Capital Index (NCI) framework has been developed to assess this -first- Convention objective (UNEP, 1997b, 1999). The NCI framework aims at providing a quantitative and meaningful picture of the state of and trends in biodiversity to support policy makers in a similar way as socio-economic figures support policy makers such as GNP, employment and Price Index. The NCI framework is designed in such a way that it can be applied on all scales -national, regional and global- and for all ecosystems, from forest and marine to agriculture. It deals with wild-living species, not with domesticated species (crops and livestock). The NCI indicators are intended for linkage to socio-economic developments. This enables analysis of socio-economic scenarios on their effect on biodiversity, and makes the NCI framework suitable for integrated environmental outlook reports. The state of biodiversity can be given in many detailed figures, but also in a few or if necessary in one single highly aggregated Natural Capital Index. The OECD

Environmental Outlook and Strategy will demand for highly aggregated figures. Depending on the budgets, NCI may be implemented in a fairly simple and affordable way, but a more sophisticated and expensive way is also possible.

Although the general framework is universal and the results of different OECD countries or regions mutually comparable, the elaboration and implementation is country-specific. Derivatives of the NCI framework have been applied on a global scale to UNEP's Global Environment Outlook (UNEP,1997a) and tested on Europe (Heunks et al., in preparation) and a few countries and ecosystems. The development of the framework is an ongoing and open-ended process fed by discussions and experiments.

2.2 The NCI framework

Quantity and quality indicator

The NCI framework provides information on the state and changes in biodiversity due to human interventions. It focuses on the changes during industrial times, the period in which loss of biodiversity in natural and agricultural ecosystems was accelerating rapidly (UNEP, 1995).

In general the process of biodiversity loss results in a decline in the abundance and distribution of many species and the increase in the abundance of a few other species (Figure 2). Species extinction is only the last step of a long process of ecosystem degradation.

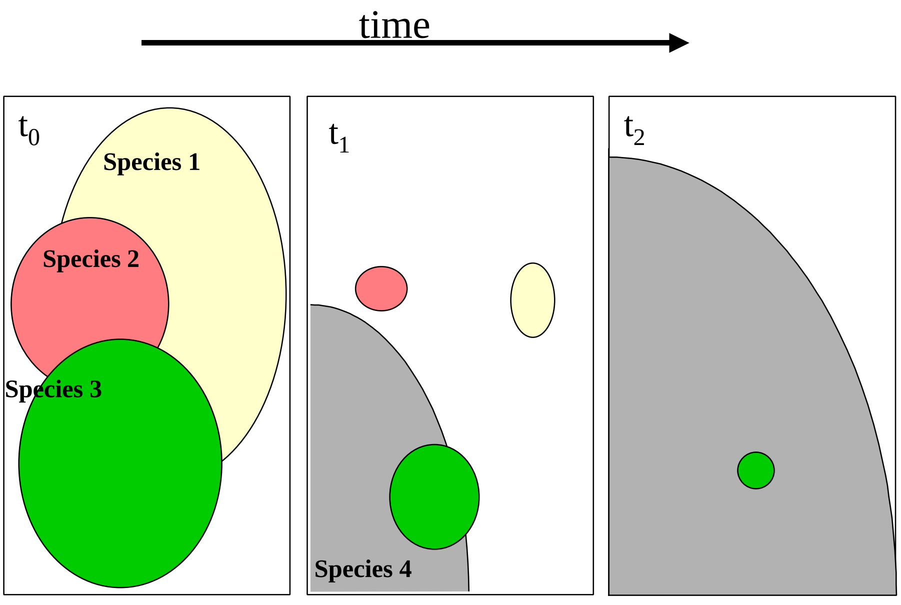

Figure 2: The essence of biodiversity loss is the decrease in abundance of many species and the increase of some other species, due to human interventions. In this illustration the abundance of species 1, 2 and 3 decreases over time while the abundance of species 4 rapidly increases.

Note: the decrease in species abundance (numbers of one species) is a far more sensitive indicator of biodiversity change than the traditional indicator “species richness” (the number of species). Initially the species richness increases from 3 to 4 (in t_1) while the average species-abundance of the original species dramatically decreases.

The NCI framework considers biodiversity as a natural resource containing all species with their specific abundance, distribution and natural fluctuations. The decrease in abundance of species due to human interference on the one hand and the consequent increase in abundance of other species on the other are considered as a depletion of the “*biodiversity resources*”, or in other words as the depletion of the “*natural capital*” [2]. Globally, *habitat loss* as a result of converting natural area into agricultural and built-up areas is a major causal factor of this loss of natural capital. The change in abundance of species in the remaining natural areas due to various pressures such as pollution, exploitation and fragmentation is another major factor (*Figure 3*).

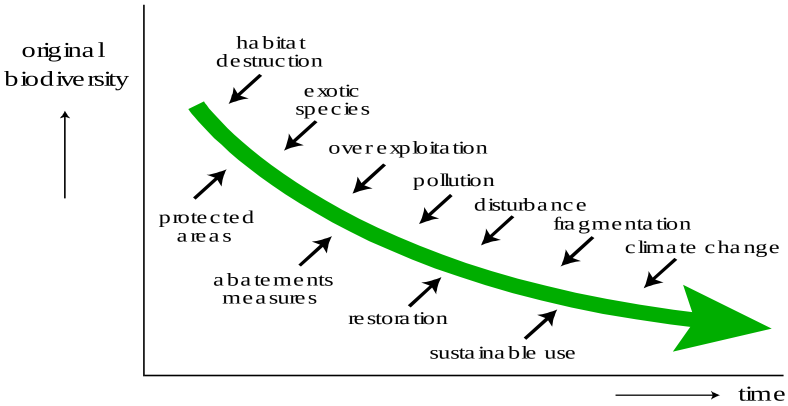

Figure 3: The main causes of biodiversity loss and gains. Habitat loss due to land conversion is the major factor. This affects the ecosystem size or “ecosystem quantity”. Other pressures such as over-exploitation and fragmentation change result in loss of quality in the remaining natural areas. This affects the “ecosystem quality”. Both the loss of ecosystem quantity and ecosystem quality result in the loss of the biodiversity resource or natural capital.

The loss of biodiversity due both to loss of habitat and to pressures on the remaining habitat are called the loss of *ecosystem quality* and *ecosystem quality*, respectively. Given these two factors the NCI framework has defined the natural capital as the product of the size of the remaining area (ecosystem quantity) and its quality (*Figure 5*):

NCI =*ecosystem quantity ´ ecosystem quality.*

Ecosystem quantity is defined as the size of the ecosystem (% area of country or region). Ecosystem quality is defined as the ratio between the current and a baseline state (% of baseline). (Figure 4).

[2] So not only is the extinction of a species a part of the biodiversity loss but also its decline in abundance (numbers of one species). This approach incorporates the spatial aspect of biodiversity which is generally considered very important.

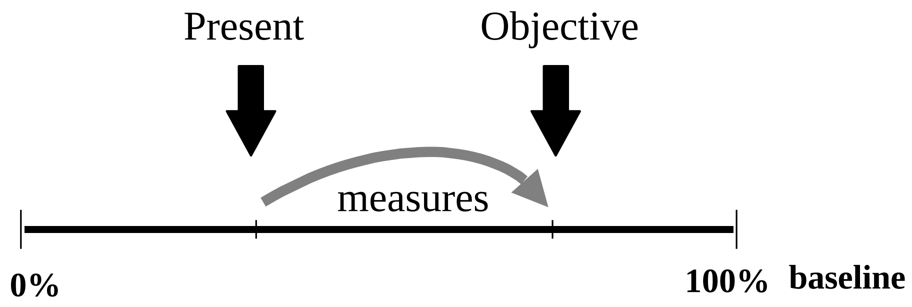

Figure 4: Ecosystem quality is calculated as a percentage of the baseline state.

The Natural Capital Index (NCI) ranges from 0 to 100%. For example, if 50% of a country still consists of natural area and the quality of this area has been decreased to 50%, than the $NCI_{natural\ area}$ is 25% (Figure 5). An $NCI_{natural\ area}$ of 0% means that the entire ecosystem has deteriorated either because there is no area left, or because the quality is 0% or both. An $NCI_{natural\ area}$ of 100 % means that the entire country consists of natural area of 100% quality.

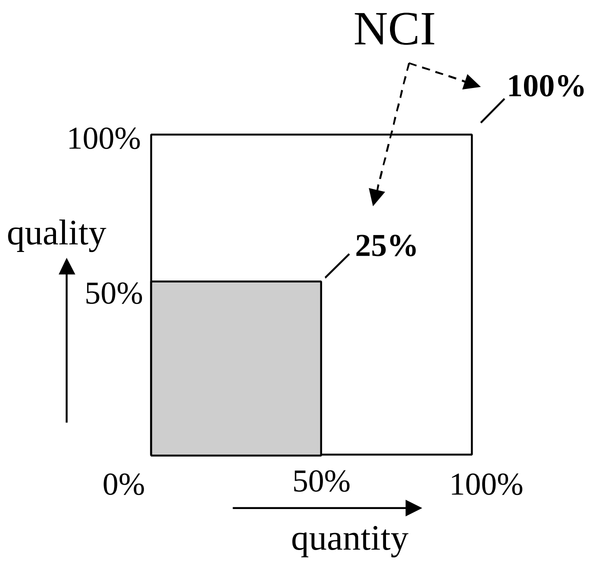

Figure 5: Natural capital is defined as the product of the remaining ecosystem size (quantity) and its quality. For example, if the remaining ecosystem size is 50% and its quality is 50%, then 25% of the natural capital remains. The NCI can be worked out on any spatial scale and for both natural and man-made ecosystems.

The need for a baseline to assess ecosystem quality

A baseline is indispensable in assessing ecosystem quality. Baselines are “starting points” for measuring change from a certain date or state (Figure 4). For instance, a baseline might be “the natural state” or “the year the CBD was ratified (1993)”. Although some indicators are used simply for comparison over time (for example, the Dow Jones Index and the Price Index), biological indicators are far more significant if they are measured against a specific baseline. Setting such a baseline is a complex and rather arbitrary process. As shown in Box 1 there are many alternative baselines possible. Each alternative generates a different result and different policy information. For the Natural Capital Index framework various options have been considered by the 1st CBD Liaison Group on Indicators of Biological Diversity including the following (UNEP, 1997b):

- at the time that the CBD was ratified
- before *any* human interference
- before *major* interference by industrial society.

According to the Liaison Group, measurement against the conditions at the time of the ratification of the CBD is likely to be an attractive choice. However, using only this baseline raises some important questions. How can a change since 1993 be assessed as positive or negative without a theoretical, optimal baseline? (points 2 and 7 in Box 1). Furthermore, only assessing biodiversity with reference to a baseline set in 1993 (1993 = 100%) would be perceived as a bias towards the developed countries, because these have already achieved a high level of socio-economic development, partly at the expense of their original biodiversity. Using the state that existed before any human intervention would be more appropriate in this respect, but does not appear to be feasible. Since there is no unambiguous natural baseline point in history, and all ecosystems are also transitory by nature, a baseline must be established at an arbitrary but practical point in time. Because it makes most sense to show the biodiversity change when human influence was accelerating rapidly, "a postulated baseline, set in pre-industrial times", further referred to as “natural baseline” or “low-impact baseline”, appears to be most appropriate (Appendix 6).

According to the 1st CBD Liaison group, a particular problem relates to the distinction between intensively managed, man-made areas on the one hand and self-regenerating or natural[3] areas on the other hand. Comparing, for example, an area of farmland with the original forest, savannah or wetlands system is of little value, because it will simply show that most of the original biodiversity has disappeared. However, agricultural or other man-made ecosystems might be highly valued because of their cultural-historical values, landscape, and species-richness, even though the latter may be partly due to introduced (exotic) species.

[3] Definitions of natural and man-made ecosystems are given in Appendix 7. The Liaison Group used the word “self-regenerating”areas for “natural” areas. To promote readability this report uses “natural” areas.

Box 1: Baselines and their role in policy making (Ten Brink, in prep.)

Biodiversity data as such have no meaning. For example: "the **currently 1,000 dolphins** in the Y-sea" only have significance in relation to baseline values. Baselines make such statistics meaningful indicators. The type of baseline determines the policy message. Some examples:

Baseline type	*Baseline value*[4]	*Meaning of current value Vis a vis baseline*	*Policy signal*
1. Natural state	> 10,000	Currently 10% of original population is left. 90% was destroyed by anthropogenic factors, such as pollution, depletion of major fish stocks and drowning in fish nets.	The population is still heavily deteriorated. Let's work out further measures for decision making.
2. Specific year 1993: CBD was ratified	500	The current population has been doubled	Policy makers did a very good job. Fishermen speak about a plague. They propose to limit the population to 500. Limitation measures?
3. Genetically Min.pop. size	250	The current population is 4 times above the critical level	No need to worry about dolphins
4. Red list	750	The current population is 33% above red list criterion	Great job done in last years. Dolphins can be removed from the red list. "Let's go back to business"
5. Species richness	200 species	Much of the population can still be lost without losing a species. Even if extirpated it would not affect the species-richness. An alien seal species compensates the loss.	1000 dolphins is fine but not interesting. The species richness is only affected when the population is zero. No measures are needed, even if the dolphins were to disappear.
6. None	---	1000 dolphins seems a lot, and the population appears to be growing.	Fishermen say dolphins are becoming a plague and must be limited. Conservationists state that 1000 is not much at all. To restore a healthy marine ecosystem it should increase to several 1000s. A political discussion is unavoidable

[4] In number of dolphins

The CBD Liaison Group had some important considerations in relation to integrated environmental assessment reporting. These are:
- the need for aggregation of the state of biodiversity between countries up to regional and global levels, therefore to have *agreed on a* scientifically coherent baseline;
- the need for comparability of the figures between countries and regions;
- the importance of *equality* between countries, i.e. not setting baselines that favour some regions over others;
- the need for baselines which take into account the specific value of biodiversity in agricultural landscapes and other man-made habitats.

According to the 1st CBD Liaison Group the pre-industrial baseline is also appropriate to meet the above needs. The baseline: i) allows for aggregation to a high level, ii) makes figures on countries comparable, iii) is a fair and common denominator, and iv) is relevant for all habitat types. As for the latter, natural ecosystems are compared with the low-impact, natural, baseline. Agricultural ecosystems are compared with the traditional agricultural state as baseline, actually before industrialisation of agricultural practices started. This is usually a species-richer state (UNEP, 1997b). More information on baselines is given in Appendix 6

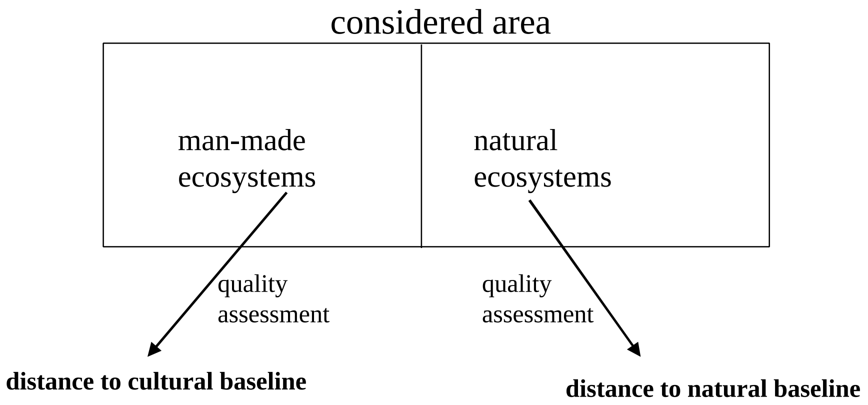

Figure 6: Man-made ecosystems, mainly agricultural, are assessed by comparing with the traditional agricultural state as baseline: a “cultural” baseline. Natural ecosystems are assessed by comparing them with a natural or low-impact state as baseline.

Baselines are not targets
It has to be stressed that baselines serve as a calibration point or benchmark to quantify the extent of change due to human activities in modern times. The baseline is *not* necessarily the targeted state. Policy makers choose their targets on ecosystem quantity and ecosystem quality somewhere on the axis between 0 and 100% (Figure 4) depending on their balance of social, economic and ecological interests.

Aggregation of data to one single Natural Capital Index
The natural capital is calculated by the product of the ecosystem quantity and the ecosystem quality. Ecosystem quantity is defined as the percentage of the country’s total area. Ecosystem quality is calculated as a function of many different ecosystem quality variables. To determine *ecosystem quality* it is impossible to measure all species, genes and ecosystem features.

Operational choices similar to that for socio-economic indicators such as Price Index[5] has to be made. Ecosystem quality is derived from a representative core set of quality variables. These could be the *abundance of various species*, *variables on ecosystem structures* and *species-richness* (Figure 7). They are all expressed in terms of percentage of the baseline. These quality variables are region-specific because each region has his specific species and ecosystems. They could be chosen by each country, but it is also possible to make concerted choices on the level of the OECD regions.

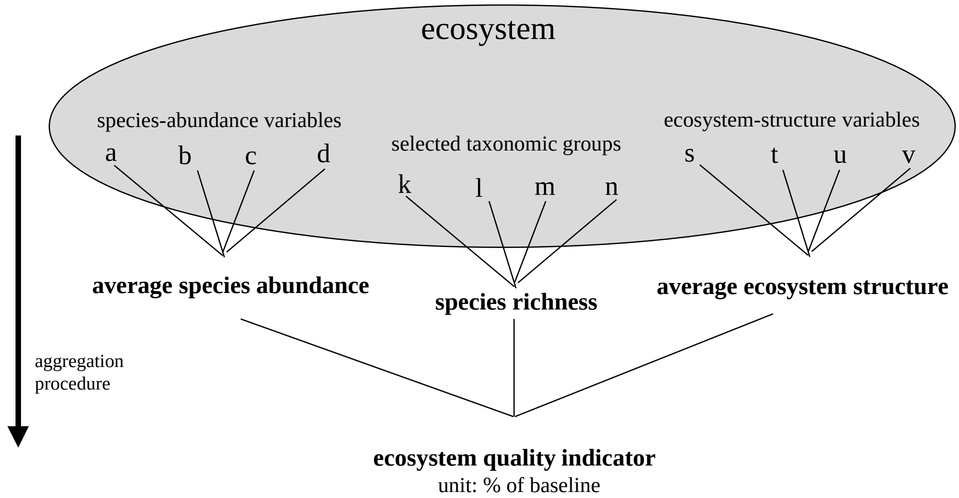

Figure 7: Ecosystem quality could be determined for example as the average of a representative core set of quality variables. These could be variables on species abundance, species-richness and ecosystem structure. These are region-specific.

Figure 8 gives an over-all scheme of the NCI framework. Figures can be given in great detail on specific ecosystems or species as well as highly aggregated or even as one-single index on entire countries, OECD regions or the OECD as a whole, depending on the purpose.

[5] To determine the Price Index or inflation of a country it is not the prices of millions of products that are monitored in all shops. Instead, a so-called theoretical "shopping bag" is filled with a representative core set of products and subsequently monitored in a subset of shops. The changes in prices are averaged with different weightings because the price increase of bread cannot simply be averaged with the price increase for a car.

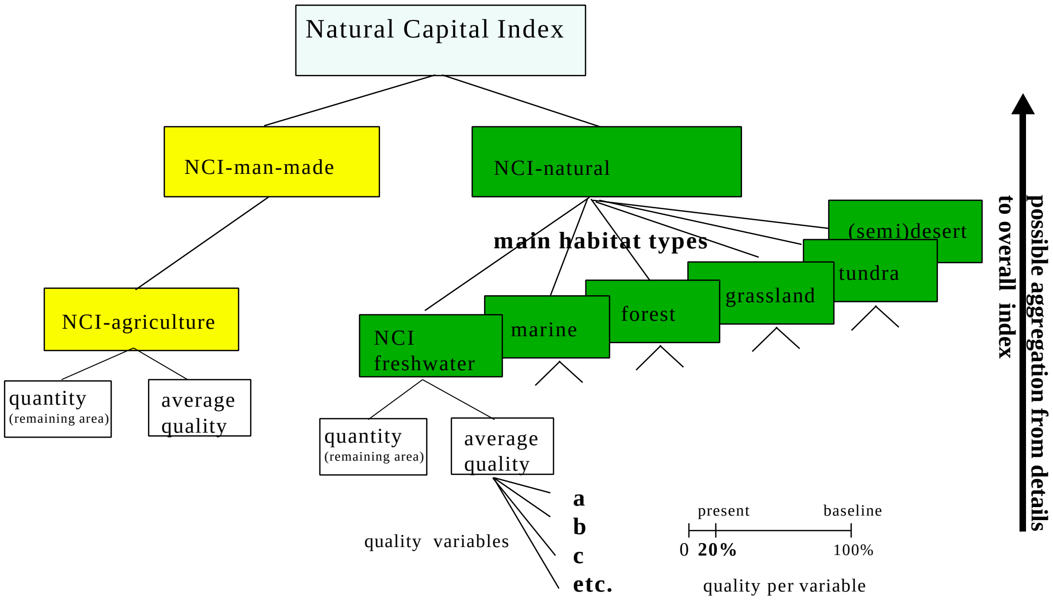

Figure 8: The Natural Capital Index consists of two components: NCI-$_{natural}$ and NCI-$_{man-made.}$ Each covers various habitat types (third layer). Each habitat type has a quantity (area size) and a quality (fourth layer) aspect. Ecosystem quality is determined by a core set of quality variables, which are measured in specific sample areas (fifth layer). The ecosystem quality is calculated by averaging the current/baseline ratios of the core set of quality variables.

2.3 Pressure indicators as substitute for state indicators

If there are no data on ecosystem quality available a pressure index may be used as substitute to provide an indication on ecosystem quality. The underlying assumption is that the higher the pressure on biodiversity the lower the probability of high biodiversity (Figure 9). Pressures could be climate change, eutrophication, acidification, fragmentation, etc. Often information is available on current and future pressures based on monitoring and modelling of socio-economic scenarios. When that is the case, each pressure can be graded on a linear scale from pressure 0 (no pressure) to pressure 1000 (very high pressure). Pressure 1000 means high probability of extremely poor biodiversity compared with the baseline state. For each area the considered pressure values are added to one single Pressure Index, providing a rough estimation of the probability of high biodiversity (for more elaboration see UNEP, 1997a; Heunks et al., in prep; RIVM, in prep.).

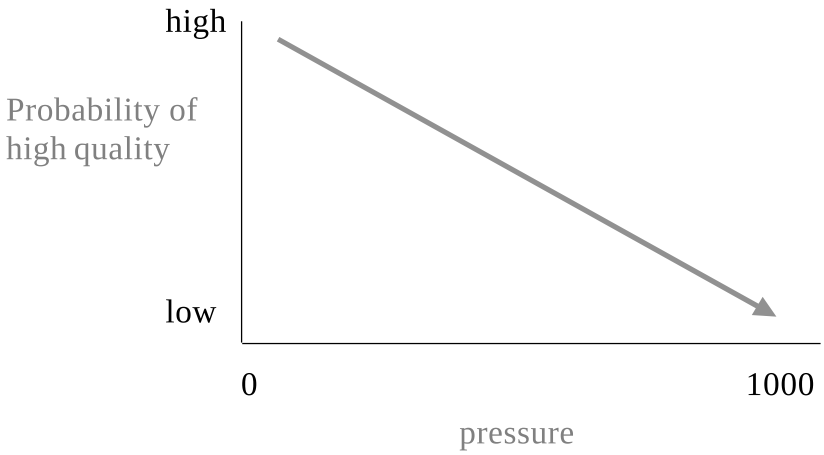

Figure 9: A pressure index might be used as substitute for ecosystem quality. This is particularly interesting if data on the quality of ecosystems are lacking but calculations are possible on current and future pressures. The assumption is made that the higher the pressure, the lower the probability of high ecosystem quality. The figures 0 and 1000 are derived from values known from literature.

2.4 Linkage with socio-economic scenarios

The NCI framework is designed in such a way that it can be linked to socio-economic scenarios. Ecosystem quantity and quality are both state/impact indicators within the Driving force - Pressure - State - Impact - Response framework (D-P-S-I-R). Ecosystem quantity is directly related to land use, land cover and physical planning, and can be easily linked to socio-economic scenarios.
The use of “abundance of species” as a quality variable for ecosystems is also suitable in this respect because species have *specific* dose–effect relationships to conditions and changes in the environment, in contrast to variables at the ecosystem level such as “deciduous forest” or “primary production”. Once the core set of species has been chosen, dose–effect relationships with eutrophication, climate change, fragmentation and exploitation can be investigated and modelled. Subsequently projections can be made on different socio-economic scenarios for each species according to the cause–effect chain of the D-P-S-I-R model. The change in species abundance of the core set of species determines the change in overall ecosystem quality (Figure 24).
Other advantages of “species abundance” as quality variable are that species abundance: i) is unambiguously measurable; ii) corresponds to most of the past and current data and monitoring programmes; iii) is appealing to policy makers and the public if the species are well chosen; and iv) is sensitive to environmental changes. Although “species-richness” is also a possible quality variable, it lacks the above features (Appendix 4). “Ecosystem structure” variables such as the “ratio between dead and living wood” have similar advantages to species abundance.

3 Results

3.1 Introduction

The WCMC and RIVM have applied the NCI framework on OECD countries. It was investigated whether data on ecosystem quality and ecosystem quantity were available or achievable. The WCMC results are reported separately (WCMC, 1999). The main results of both WCMC and RIVM are given in this section.

3.2 Ecosystem quantity

3.2.1 Example 1: ecosystem quantity assessment

The aim was to calculate the original and current area of the major natural habitat types: forest, grassland, (semi) desert, tundra and wetland[6] for the entire OECD, the OECD regions and individual countries. Also sought was area information on an intermediate points in time, such as 1970, to provide information on recent changes.

The five basic habitat types specified and four OECD continental regions (North America/Mexico, Europe, Japan/Korea, Australia/New Zealand), produce a matrix with 20 cells. However, not all the habitats of interest occur to a significant extent in all OECD regions, leaving 16 habitat/region combinations for which data are required. Void combinations are shaded in Table 1.

Table 1: Habitat and species data coverage (WCMC, 1999).

	Forest		Grassland		desert and semi-desert		Tundra		Wetland	
	Hab	Spp	Hab	Spp	Hab	Spp	Hab	Spp	Hab	Spp.
N America	•	•	•	•	•		•	•		
Europe	•	•	•	•	•		•			
Japan/Korea	•									
Australia/NZ	•		•		•	•				

Note:

•	indicates data available
empty cells	indicate no data located
shaded cells	are void (although some natural grassland exists in Japan/Korea, none is taken into account in this analysis).
Spp:	information on the abundance of species
Hab:	information on ecosystem size

[6] Habitat types according to major habitat types distinguished by the CBD (UNEP, 1997b).

WCMC used various data sources to calculate the habitat type areas over time. The greatest difficulty appeared to remain consistent given the different sources and different applied definitions of the habitat types, both in time and space. Data on freshwater/wetlands area were not found, nor were data on the original area of (semi-)desert and tundra, and on an intermediate point in time (approximately 1970) for all habitat types (see *Figure 10*, *Figure 11*, *Figure 12* and *Table 2*; WCMC, 1999).

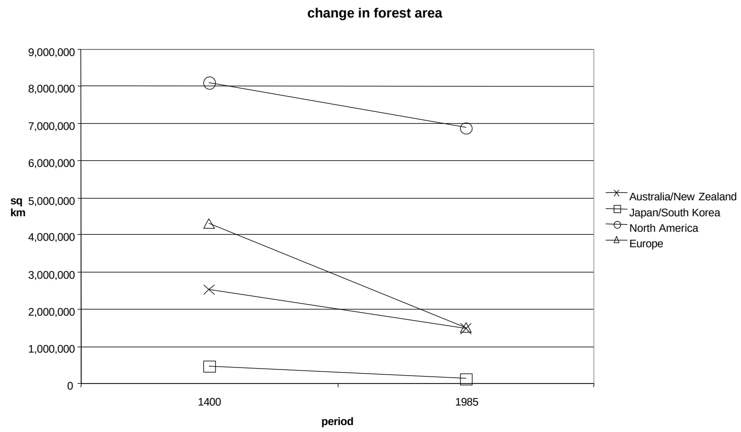

Figure 10: Approximate size and change in forest area in OECD regions between 1400 and 1985.

Note: 1400 AD represents approximate original area.

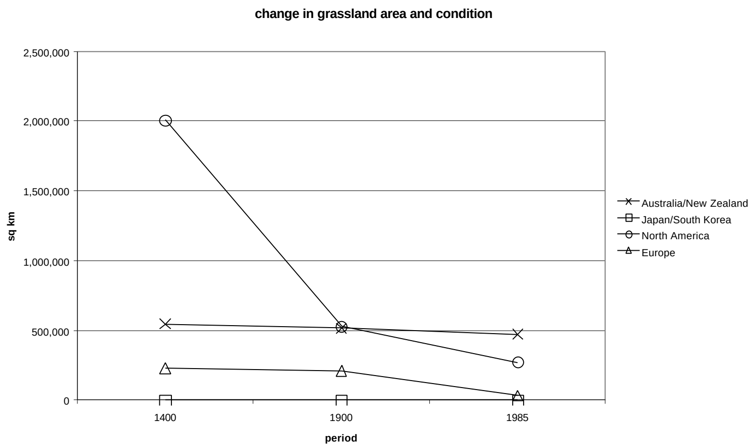

Figure 11: Approximate size and change in grassland area in OECD regions in 1400, 1900 and 1985.

Note: 1400 AD represents original area, 1900 approximate modern area of grassland, and 1985 approximate current extent of natural grassland.

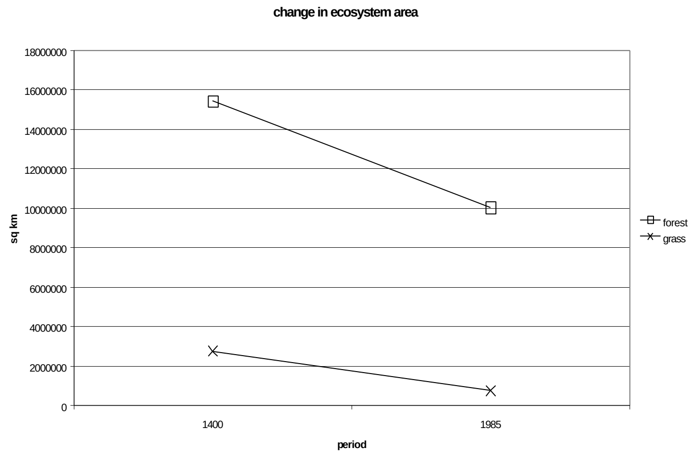

Figure 12: Approximate size and change in forest and grassland area in OECD (overall) in 1400 and 1985.

Note: 1400 AD represents approximate original area, and 1985 approximate current extent. Original grassland extent may be underestimated

The changes in the major habitat types at the regional level according *Table 2* are summarised in *Figure 13* (WCMC, 1999).

Table 2: Map-based estimates of ecosystem area in the OECD region

Note: nd = no data; past and present areas from different sources.

	FOREST AREA	FOREST AREA	FOREST AREA	GRASS AREA	GRASS AREA	GRASS QUALITY	GRASS QUALITY	SEMI-DESERT AREA	DESERT AREA	TUNDRA AREA
	past area	present area	present as % past	past area	present area	present area zero to medium degradation	present area zero to medium degradation as % total	[defined by humidity]	[defined by humidity]	
OECD COUNTRIES										
Australia	2,314,700	1,433,623	62	531,275	486,228	473,588	97	5,037,185	0	0
New Zealand	212,938	42,641	20	15,000	30,000	0				
						0				
Japan	375,183	133,285	36	0	0	0		0	0	0
South Korea	94,929	15,087	16	0	0	0		0	0	0
						0				
Canada	6,391,481	5,792,705	91	239,985	9,835	7,289	74	225,728	0	1,281,162
Mexico	1,115,493	712,262	64	1,103	37,355	10,578	28	863,560	9,896	0
United States	587,647	384,376	65	1,765,259	481,192	254,670	53	2,387,169	15,314	610,998
						0				
Austria	79,282	36,633	46	nd	5,575	5,526	99	0	0	0
Belgium	29,045	6,874	24	nd	9	3	33	0	0	0
Czech Republic	78,602	24,802	32	nd	253	0	0	0	0	0
Denmark	43,419	3,704	9	nd	236	236	100	0	0	0
Finland	305,464	256,356	84	nd		0		0	0	5,894
France	537,846	108,851	20	nd	13,771	10,535	77	274	0	0
Germany	349,606	104,070	30	nd	1,882	1,284	68	0	0	0
Greece	132,532	45,709	34	nd	11,992	7,055	59	22,703	0	0
Hungary	69,849	7,745	11	19,605	1,353	792	59	0	0	0
Iceland	36,864	1,229	3	nd		0		0	0	31,413
Ireland	60,968	4,567	7	nd	2,005	2,005	100	0	0	0
Italy	292,385	68,708	23	nd	11,727	6,454	55	17,874	0	0
Luxembourg	2,611	788	30	nd	5	5	100	0	0	0
Norway	239,001	113,302	47	nd		0		0	0	89,309
Poland	310,751	89,350	29	nd	129	11	9	0	0	0
Portugal	88,440	27,054	31	nd	2,799	2,709	97	4,117	0	0
Spain	493,915	143,454	29	nd	29,924	20,517	69	148,107	0	0
Sweden	410,329	305,873	75	558	13	13	100	0	0	28,807
Switzerland	34,796	12,883	37	nd	22	22	100	0	0	0
The Netherlands	24,635	2,349	10	nd	244	243	100	0	0	0
Turkey	482,361	123,508	26	128,743		0		324,840	0	0
United Kingdom	208,142	23,228	11	nd	519	519	100	0	0	0
OECD REGIONS										
Australia/New Zealand	2,527,638	1,476,264	58	546,275	516,228	473,588	92	5,037,185	0	0
Japan/South Korea	470,111	148,372	32	0	0	0		0	0	0
North America	8,094,620	6,889,343	85	2,006,347	528,382	272,537	52	3,476,457	25,210	1,892,160
Europe	4,310,841	1,511,035	35	148,906	82,458	57,929	70	517,915	0	155,422
OECD (entire)	15,403,210	10,025,014	65	2,701,528	1,127,068	804,054	71	9,031,557	25,210	2,047,582

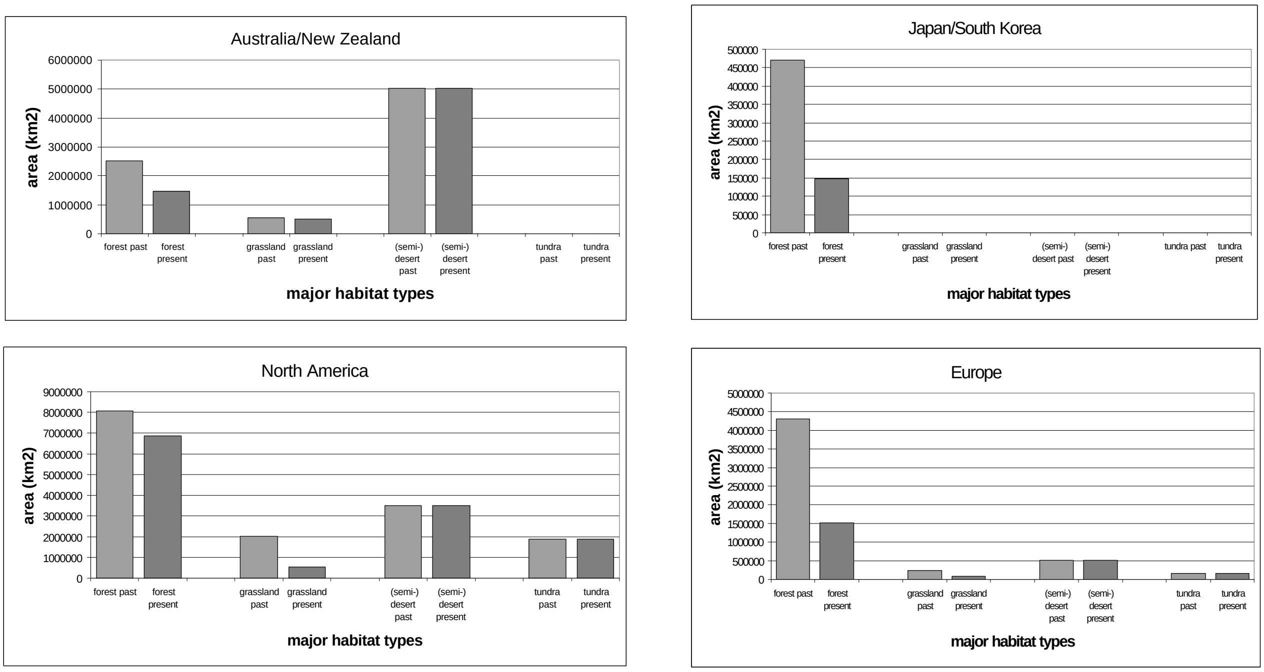

Figure 13: The changes in the major habitat types at the regional level (WCMC, 1999)

Due to the different sources the figures on the different habitat types are inconsistent and make them difficult to use (WCMC, 1999). Further, the used data sources are not up-dated regularly so they are not suitable to track changes over time. Some data seems to be inaccurate such as the forest-cover figures of the US, which are far too low in comparison with FAO data on forest.

3.2.2 Example 2: ecosystem quantity assessment in the Global Environment Outlook

RIVM made calculations on the change of natural and man-made areas from 1990 to 2020 and 2050 by the IMAGE model (Alcamo et al., 1994a, b and 1998; Klein Goldewijk and Battjes, 1997) for, as an example, UNEP's Global Environment Outlook (RIVM/UNEP, 1997a). Also the original natural land cover and the state in 1890 can be produced (Alcamo et al., 1994a, b, 1998; Klein Goldewijk and Battjes, 1997, derived form Richards, 1990 and FAO, 1990). The area of 5 natural and 2 man-made habitat types is given in Figure 14 for potential vegetation and the state in the years 1890, 1990, 2010 and 2050. Freshwater area is derived by comparing country area with total land area.

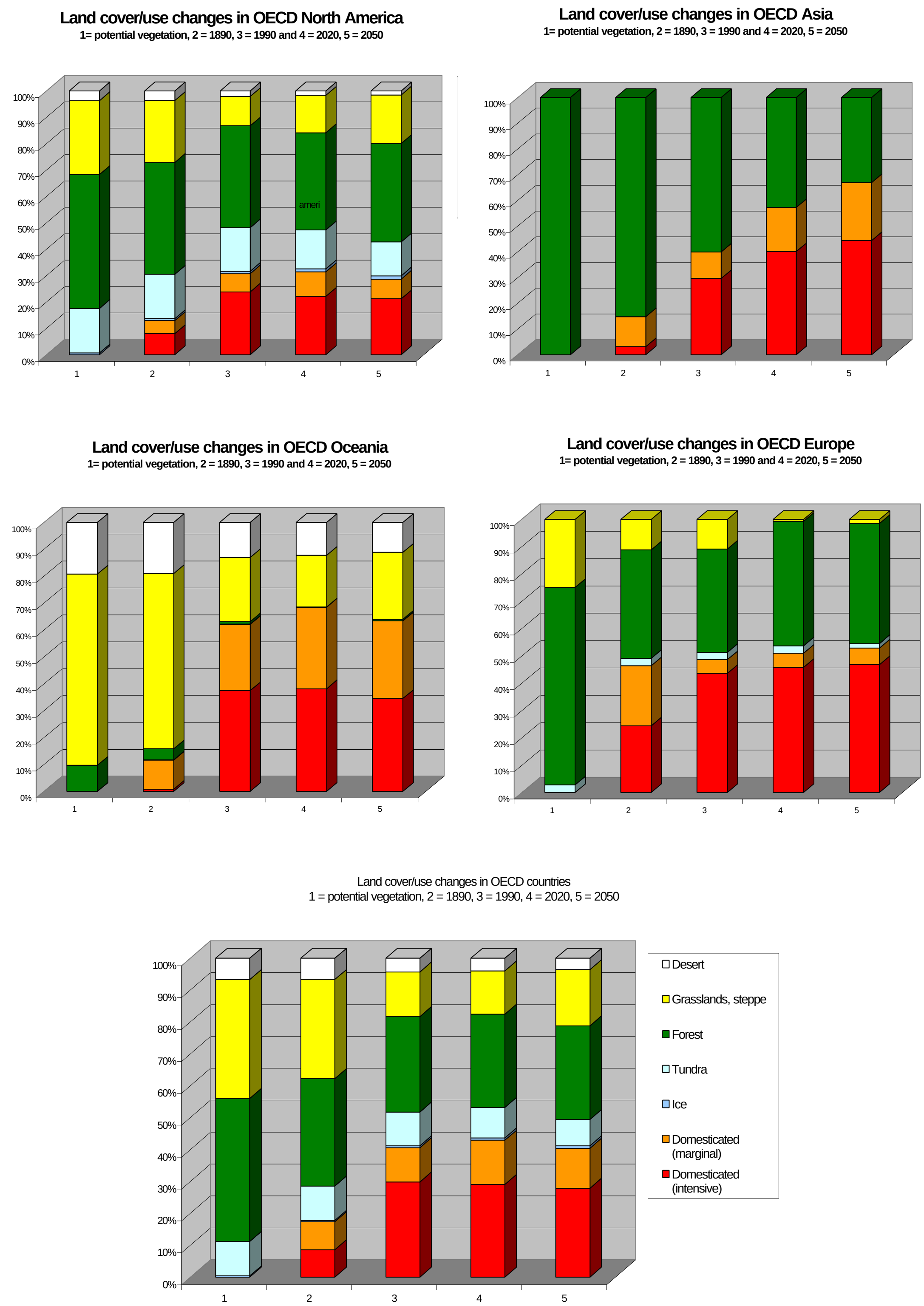

Figure 14: Land cover of two man-made and five natural habitat types as potential vegetation and in the years 1890, 1990, 2020 and 2050 (Alcamo, 1994) in the OECD regions and total OECD.

Note: North America: Canada, USA, Mexico; Asia: Japan, South Korea. Oceania: Australia, New Zealand; Europe: Western Europe, incl. Hongary, Polen, Czech republic, Turkey

The spatial scale of the IMAGE model is approximately 50 by 50 km around the equator. Although the figures are course, they have the advantage of being consistent in time and space. Calculations are possible for socio-economic scenarios. The information is geo-referenced so maps can be drawn. For small countries it is inaccurate. At the level of regions it provides a first estimate of the changes over time.

Another data source is the Pan European Land Cover Monitoring project which determines the current European land cover on a 1 km^2 basis (
Figure ***15***). Although this information is gathered on a regular basis from satellites (NOAA) the results appears to be still too in-accurate to track changes in time within a period less than 20 years (Heunks et al., in prep.). It does not provide information on the past. Nevertheless, new remote sensing techniques with various satellite images and the use of lidar and radar (multi scale and multi spectral approach) provide most promising possibilities on a more accurate global monitoring of habitat types within 5 to 10 years (Pelcom workshop, 1999).

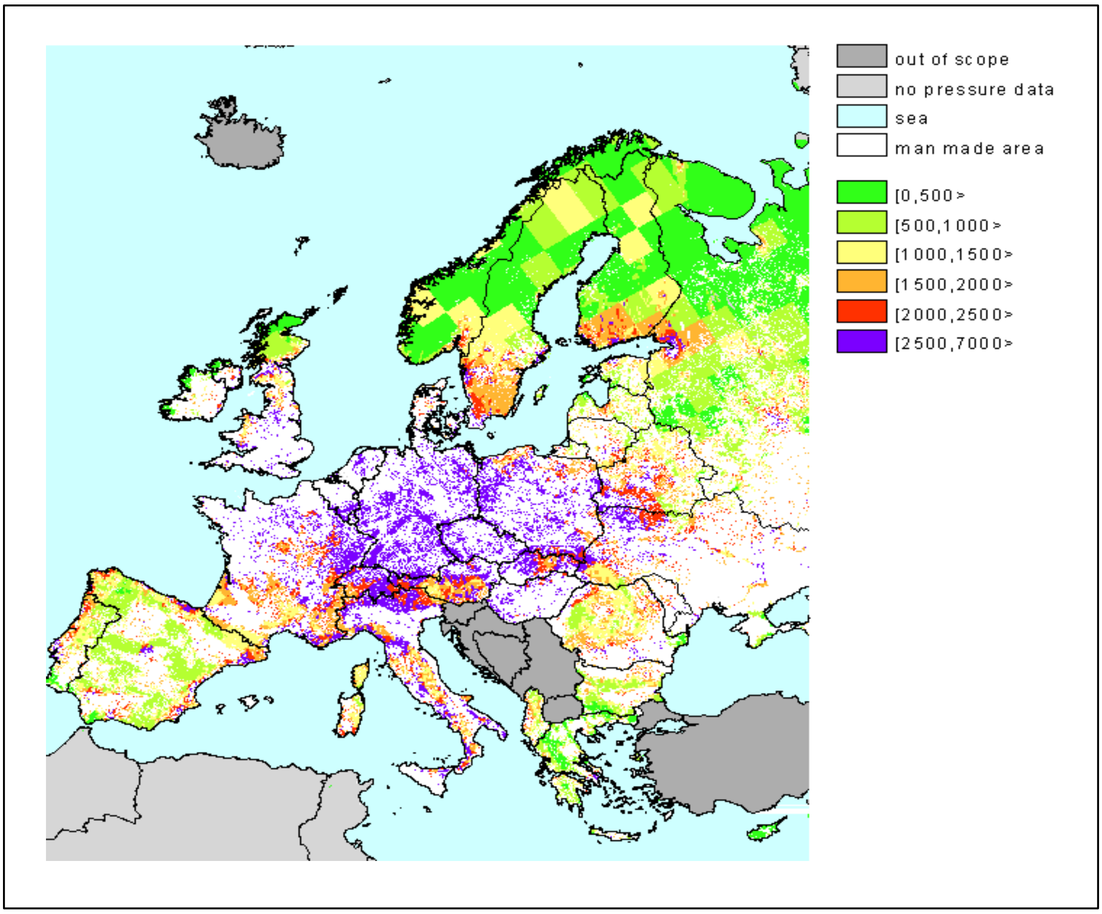

Figure 15: Map of the natural areas in pan-Europe in 1990 on the basis of adapted NOAA satellite data (Heunks et al., in prep.). The colours provide additional information on the pressure to Europe's natural areas (green low, violet high) based on ozone, acidification, eutrofication, temperature change, isolation, population and GDP (see further section 3.3.3).

3.3 Ecosystem quality

Which information is directly available on the quality of the major natural habitat types? For each of the OECD regions, WCMC selected species on which data on the change in their populations or distribution in the last 20 years were available. Baseline information was also sought. The baseline state is the expected or original status of the populations in these areas if not or hardly affected by humans. RIVM has added, as example, species-abundance information available on a national basis (The Netherlands) and for Europe information available on pressures, substituting for state indicators.

3.3.1 Example 1: species-abundance of some species groups in the OECD regions

The results are presented in Figure 16, Figure 17, Figure 18, Figure 19, Figure 20 and Figure 21 (WCMC, 1999).

Figure 16: Europe: forest species

Note: Average change in population size compared with 1970, based on data for 47 bird species.

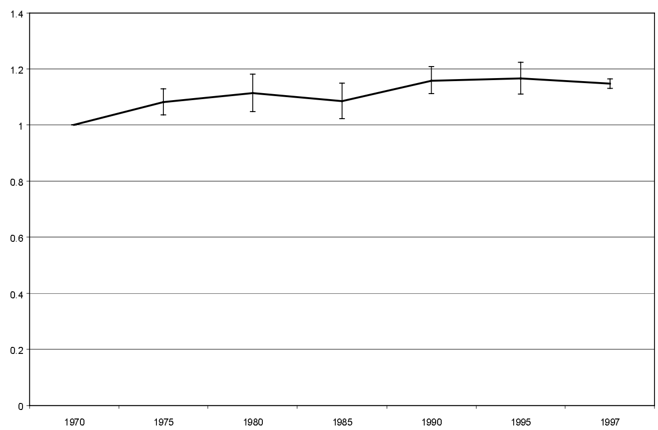

Figure 17: North America: forest species

Note: Average change in population size compared with 1970, based on data for 123 bird species.

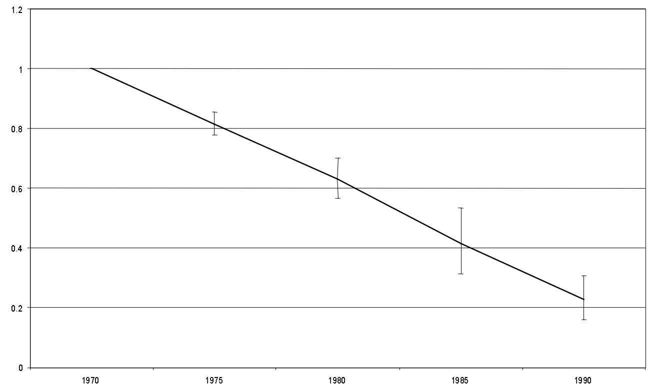

Figure 18: Europe: grassland species

Note: Average change in population size compared with 1970, based on data for 4 bird species.

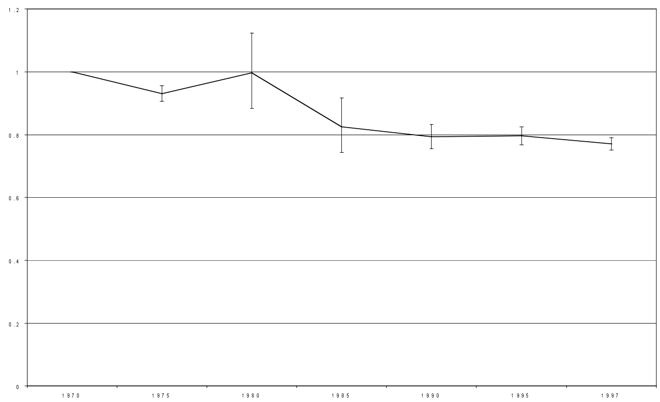

Figure 19: North America: grassland species

Note: Average change in population size compared with 1970, based on data for 25 bird species.

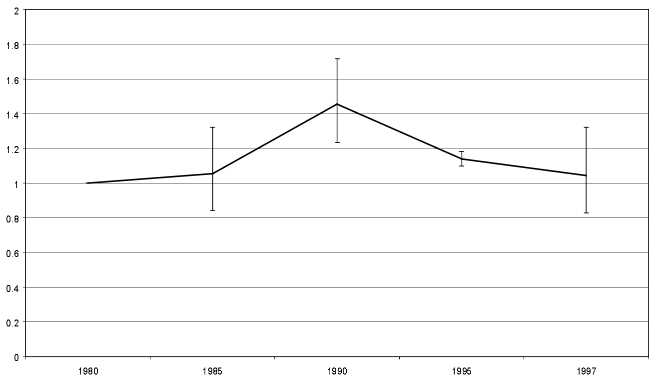

Figure 20: Australia/New Zealand: semi-desert species

Note: Average change in population size compared with 1980, based on data for 3 mammal species.

Figure 21: North America: tundra species

Note: Average change in population size compared with 1970, based on data for 4 birds and two mammals.

Within the limits of the WCMC study it does not appear to be feasible to collect baseline data. Baseline data are very important in this respect if an appropriate assessment of the quality of the remaining natural areas is to be made (Box 1). Although the American forest species, for example, appears to be stable in their abundance in recent times, it might be well possible that the quality as such is still low to date (Figure 22).

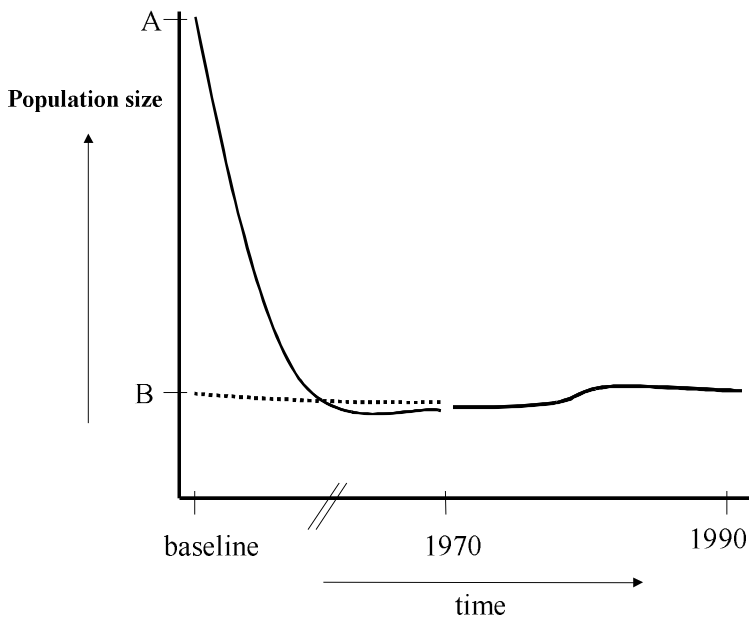

Figure 22: Baseline information is indispensable for assessing the current quality of an ecosystem. A baseline according to option A means that the quality of the last 20 years is stable but low, while a baseline according to option B means that the quality is stable and high.

Further, information on more species groups than which are given here is necessary to provide a reasonable representative picture of the quality of the major habitat types. WCMC assesses it as being quite possible to get baseline information and information on more groups within the countries them selves (see example next section).

3.3.2 Example 2: ecosystem quality assessment in The Netherlands

RIVM has worked out a case study on the ecosystem quantity and quality of the Dutch natural and agricultural ecosystems (Ten Brink et al.; 1998; RIVM, 1999). The population numbers of about 350 plant species, 30 butterfly species, 90 bird species and 60 marine and river species were determined for the baseline state (1900 to 1950) and the current state (1990). Appendix 2 lists ten considerations for choosing these species. Figure 23 provides information -as an example- on the marine ecosystem. It shows the significant shifts in the abundance of species in 60-90 years as a result of various human pressures such as eutrophication (algae, benthic species, birds), fisheries (fish stock depletion, cockle beds, mussel beds), contamination (seal, dolphin), disturbance (seal, dolphin, tern), turbidity (sea grass) and damming/habitat loss (sturgeon, sea grass, salt marshes). Overall, a shift can be seen from long-lived to short-lived species.

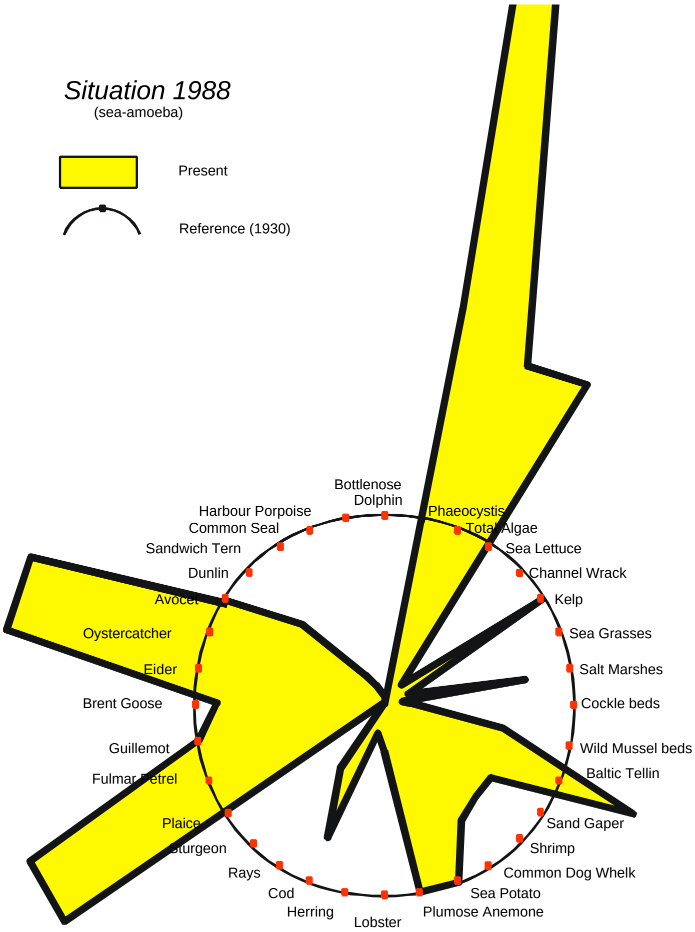

Figure 23: A core set of 32 species has been selected to describe and assess the state of the North Sea. The abundance of each species is calculated for the baseline state (period 1900-1930) and the current state (1988) and presented in a radar-diagram. The radius from the centre to the circle represents the baseline numbers (100%), the current numbers are superimposed on this circle and connected with a line, forming a star-like figure (Ten Brink et al. 1991). The average ecosystem quality is in this case 50%.

Box 2: An example of interaction between indicators and policy-makers

The interaction of the above indicators in Figure 23 with policy makers was as follows. Given the current state, various policy-options were developed at the request of policy makers on the reduction of nutrients, heavy metals, organic contaminants, fisheries, habitat restoration, river management, shipping, tourism and others aspects. The effects of various policy options on each of the species were calculated by models and expert judgement, resulting in various effect-radar diagrams and various new Ecosystem Quality Indices. The societal cost of each policy option was also roughly estimated. On the basis of this interaction the government adopted a new long-term policy strategy for the North Sea: the multi-track approach which dealt with i) a differentiated reduction of nutrients and contaminating substances such as heavy metals and organic-micro pollutants, ii) habitat restoration and iii) restricted uses of the aquatic ecosystem (Ministry of Transport and Public Works, 1989) providing a significant restoration of the North Sea ecosystem at relatively low cost.

The quality per habitat type has been calculated according to the procedure in Figure 24.

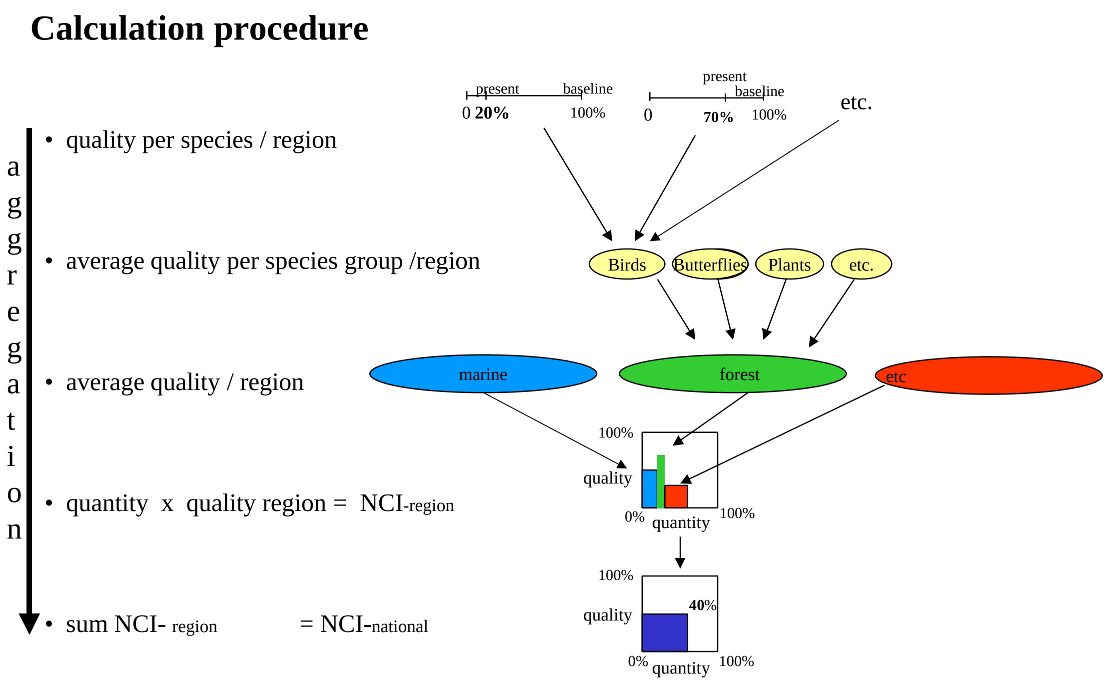

Figure 24:Calculation procedure on ecosystem quality, quantity and Natural Capital Index. Figures can be provided in detail on species and region level, and highly aggregated into one single national index, depending on the purpose.

Figure 25 shows the change in quantity and quality of natural areas and the resulting Natural Capital Index since 1900. The natural capital decreases from 58% in 1900 to 35% and 22% in 1950 and 1990 respectively, a loss of about two-thirds (62%).

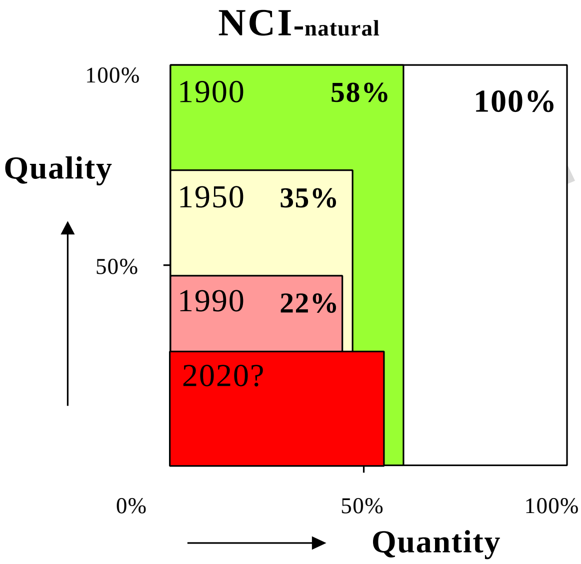

Figure 25: Quantity and quality of natural area (aquatic and terrestrial) in 1900, 1950 and 1990. The quantity (horizontal) and quality (vertical) of the Dutch natural ecosystems dramatically declined since 1900.

Figure 26 shows the change in quantity and quality of the Dutch agro-ecosystems and a resulting agro-Natural Capital Index since 1900.

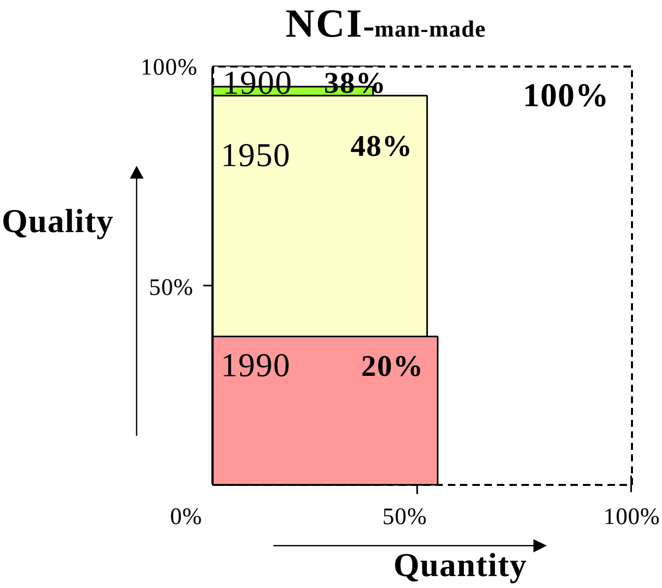

Figure 26: Quantity and quality of man-made area (mainly agricultural area, a few urban areas) in 1900, 1950 and 1990. The man-made area expended from 41% to 52% and 55% in respectively 1900, 1950 and 1990 (horizontal). The quality dramatically declined from 90% in 1900/1950 to 37% in 1990 (vertical). A slight quality loss is due to –low quality- urban area.

The agricultural area expanded, mostly until 1950, but its quality declined significantly since 1950. Quantity and quality combined, there was an increase on the agro-Natural Capital Index from 38% to 48% in the first half of the century, and, subsequently, a decrease to 20% in the second half. This first estimation shows that about 60% of the agro-biodiversity was lost since 1950.

3.3.3 Example 3: pressure-based ecosystem quality assessment for Europe

If data on the state of ecosystems are lacking, pressures might be used as substitute. At the Global and European levels a pressure based approach was worked out for UNEP's Global Environment Outlook (UNEP, 1997a) and has been further elaborated and applied for the Priority Study on European Environmental Problems (RIVM, in prep). For the former application is referred to the UNEP document. The latter example is summarised here:

For the study on Europe the remaining natural area and the sum of 7 pressures have been calculated on a grid cell basis of 1 km^2 for 1990 and 2020 according to the Baseline scenario. These seven pressures are: climate change; human population density; consumption and production intensity per km^2; fragmentation; eutrophication; acidification and ozone concentrations. This selection was pragmatic because: i) these pressures could be calculated for 1990 and projected for 2010 on a regional basis, ii) these pressures represent different supplementary types of pressures, and iii) from the literature knowledge was available on dose-effect relationships and critical levels. Each pressure is preliminarily graded on a linear scale from pressure 0 (no pressure) to pressure 1000 (very high pressure (Figure 9, Table 3). Pressure 1000 means high chances of extremely poor biodiversity compared with the baseline state. For each grid cell the seven pressure values were added (maximum 7000) to one single Pressure Index. A Pressure Index of >2500 is considered as extremely high and, consequently, has low chances on attaining high ecosystem quality.

Table 3: Pressures to biodiversity and scaling values.

Pressures	**High chance on high ecosystem quality** **Pressure = 0**	**Low chance on high ecosystem quality** **Pressure = 1000**
1. Rate of climate (temperature) change	< 0.2°C change in 20 years	> 2.0°C change in 20 years
2. Human population density	< 10 persons/km^2	> 150 persons/km^2
3. Consumption and production (GDP)	US$ 0 per km^2	> US$ 6,000,000 per km^2
4. Isolation/fragmentation	% natural area within 10 km > 64%	% natural area within 10 km < 1%
5. Acidification	Deposition < critical load	Deposition > 5 x critical load $Cl_{5\%}$
6. Eutrofication	Deposition < critical load	Deposition > 5 x critical load $Cl_{5\%}$
7. Exposure to high ozone conc.	AOT40 < critical level	AOT40 > 5 x critical level

Table 4 and Table 5 present the individual and total pressures per country, as well as a pressure-based NCI for 1990 and 2010 according to the Baseline Scenario.

The extent and distribution of Europe's natural areas and the pressure on them in 1990 and 2010 are presented in
Figure ***15*** and Figure 27, respectively.

Table 4: Summary of Mean Pressure, Mean Pressure Index[7], pressure-based quality and NCI[8] for natural areas in 1990. Countries are listed in descending order of the pressure-based NCI.

Country	ozone	isolation	population	temperature	gdp	acidification	eutrofication	Pressure index	quality	area(%)	NCI
Norway	4	1	40	162	0	305	26	538	78	97	**76**
Finland	0	1	52	233	40	442	105	871	65	97	**63**
Andorra	733	0	0	154	0	0	129	1016	59	99	**58**
Sweden	34	12	45	190	34	528	64	906	64	88	**56**
RussianFed	19	46	74	211	19	103	175	646	74	66	**49**
Greece	381	111	220	35	40	0	15	794	68	48	**32**
Albania	398	92	482	23	27	0	194	1215	51	58	**30**
Spain	559	84	244	119	91	9	55	1157	54	54	**29**
Portugal	528	90	382	77	79	0	67	1224	51	57	**29**
Estonia	4	160	132	204	35	111	424	1089	56	49	**28**
Bulgaria	385	94	298	36	35	0	158	1005	59	46	**27**
Latvia	85	231	200	191	54	4	337	1102	55	41	**23**
Romania	442	111	460	53	40	60	243	1409	43	42	**18**
UK	92	133	258	94	147	579	28	1384	50	33	**17**
Ireland	84	238	131	51	47	95	51	698	72	22	**16**
Belarus	175	190	221	143	37	450	471	1687	34	43	**15**
Lithuania	138	299	357	172	50	213	288	1518	39	27	**10**
Austria	731	48	334	135	155	546	495	2443	14	68	**9**
Italy	884	96	514	98	279	153	387	2412	16	42	**7**
France	952	161	301	175	162	164	410	2327	18	35	**6**
Ukraine	390	259	374	84	59	277	548	1992	24	18	**4**
Switzerland	703	48	440	174	3	608	731	2706	5	71	**4**
Liechtenstein	603	11	0	166	0	577	1000	2357	6	61	**3**
CzechRep	765	68	539	110	106	652	590	2829	5	52	**3**
Denmark	445	644	451	194	268	207	224	2398	16	13	**2**
MoldovaRep	400	665	685	48	102	98	0	1998	22	8	**2**
Poland	552	257	513	161	75	702	695	2955	5	32	**2**
Hungary	845	409	541	90	95	696	496	3172	2	14	**0**
Germany	902	239	610	187	382	898	880	4098	0	33	**0**
Slovekia	858	264	550	153	144	931	667	3568	0	33	**0**
Netherlands	702	400	582	203	435	992	986	4301	0	12	**0**
Belgium-Lux.	986	174	443	202	202	996	900	3903	0	21	**0**

7 “Mean Pressure” is the mean of all grid cells (1 by 1 km natural area) for one single pressure per country or Europe. “Mean Pressure Index” is the mean of the Pressure Indices of all natural grid cells per country or for Europe.

8 For each grid cell of natural area the % area (to the countries total) is multiplied by its quality (%). The quality per grid cell is derived from the Pressure Index on this grid cell: class 0 – 2500 corresponds linearly with 100% - 0% quality. Subsequently, percentages of all grid cells are added at country level. This pressure-based NCI value ranges from 100% – 0%, meaning 100% of a country is natural area with pressure 0, and no natural area with a pressure < 2500 remains, respectively.

Table 5: Summary of Mean Pressure, Mean Pressure Index[7], pressure-based quality and NCI[8] for natural areas for 2010 in the Baseline Scenario. Countries are listed in descending order of the pressure-based NCI.

Country	ozone	isolation	population	temperature	gdp	acidification	eutrofication	Pressure index	quality(%)	area(%)	NCI
Finland	0	1	57	378	56	11	29	531	78	98	**77**
Norway	1	1	43	278	58	279	3	664	73	97	**71**
Andorra	414	0	0	270	0	0	63	748	70	99	**69**
Sweden	8	12	49	317	50	141	18	593	76	91	**69**
RussianFed	3	46	73	347	18	8	60	517	79	87	**69**
Greece	271	111	226	104	58	0	9	714	71	65	**46**
Estonia	0	160	124	339	40	2	217	868	65	55	**35**
Albania	275	92	545	85	36	0	151	1166	53	61	**33**
Bulgaria	306	94	277	102	44	0	95	909	63	49	**31**
Spain	366	84	247	225	137	0	29	1069	57	52	**30**
Latvia	9	231	202	320	50	0	165	932	62	47	**29**
Portugal	386	90	383	165	135	0	49	1195	52	54	**28**
Belarus	35	190	219	250	42	82	311	1089	56	49	**28**
Austria	421	48	408	240	273	58	307	1749	34	71	**24**
Romania	312	111	447	124	51	24	182	1240	50	46	**23**
UK	53	133	263	181	198	273	3	1131	60	36	**21**
Liechtenstein	336	11	0	288	0	48	1000	1683	33	61	**20**
Lithuania	20	299	362	295	45	20	162	1147	54	36	**19**
Ireland	30	238	143	121	111	0	28	639	74	21	**16**
Ukraine	211	259	368	167	48	54	413	1421	43	31	**13**
France	622	161	319	299	220	36	245	1879	30	40	**12**
CzechRep	479	68	574	203	141	341	354	2145	19	56	**11**
Italy	647	96	514	192	374	55	290	2131	23	39	**9**
Switzerland	416	48	472	295	474	282	588	2577	12	71	**9**
Poland	309	257	532	275	135	71	447	2006	24	34	**8**
MoldovaRep	211	665	686	115	60	33	0	1650	34	21	**7**
Denmark	201	644	447	324	362	101	90	2079	24	20	**5**
Slovekia	498	264	560	265	199	187	361	2310	13	35	**5**
Netherlands	485	400	586	339	527	405	617	3327	20	16	**3**
Germany	542	239	617	313	429	412	444	2974	7	36	**2**
Belgium-Lux.	849	174	459	334	282	428	641	3141	6	23	**1**
Hungary	541	409	518	177	133	534	361	2646	7	17	**1**

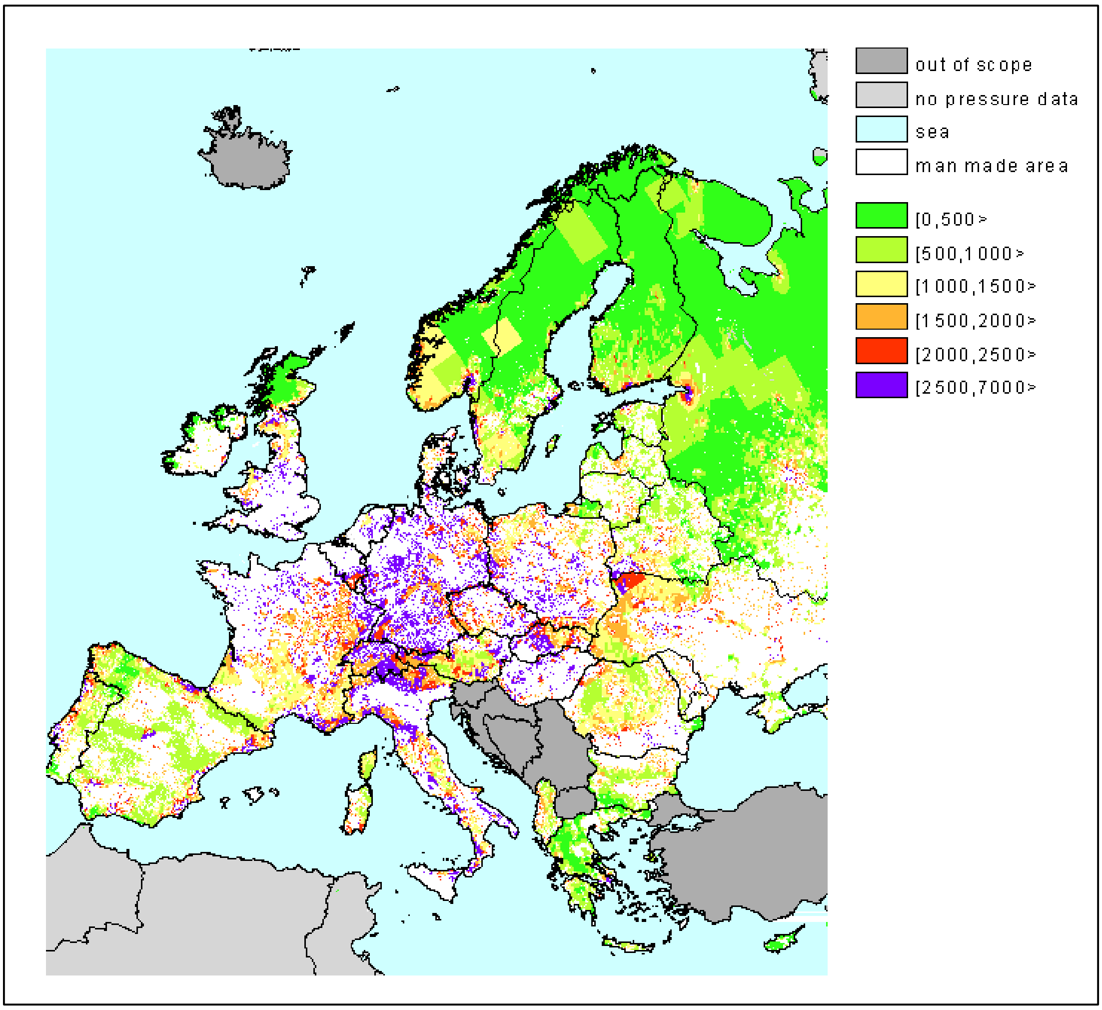

Figure 27: Pressure map of the natural areas in pan-Europe for 2010 in the Baseline Scenario on the basis of adapted NOAA satellite data (Heunks et al., in prep.). The coloured areas show the extent and distribution of Europe's remaining natural areas. The colour provide information on the pressures ranging from low (green) to extremely high (violet) based on ozone, acidification, eutrophication, temperature change, isolation, population and GDP.

The above case studies illustrate what could be possible when pressures are used as substitute information for ecosystem quality. It should be clearly emphasised that there are limitations to the implementation presented here. There are other, particularly local, factors which should be taken into account, such as forestry, water use, hunting, fire, infrastructure and extensive cattle grazing. Dose-effect relationships could be improved and better underpinned and differentiated for regions and habitat types. There is uncertainty in the modelling and projections for the future. In the longer term, the use of state indicators in preference to pressure indicators will provide a more direct picture of biodiversity it self. Nevertheless this pressure-based biodiversity assessment tool could provide useful policy information in the short term to assess efficacy of policy options.

4 Conclusions and recommendations

The goal of this study is to investigate whether the NCI framework could be a feasible, significant and universal assessment methodology for OECD's Environmental Outlook for the near future. Although preliminary estimations of baseline figures for species abundance, intermediate time points and wetlands were not feasible within the limitations of this study, it can be concluded that the NCI framework appears a realistic opportunity because (or if):

1. **The Natural Capital Index framework meets OECD's requirements**
   The Natural Capital Index framework appears to be a suitable indicator framework for the state of the natural capital at the country, OECD-region and entire OECD levels, meeting the requirements for the OECD Environmental Outlook in section 1.
2. **Countries are able to determine the change in <u>major-habitat size</u> (bottom up)**
   The size of the major habitat types can be best determined by the member states with national land-cover statistics. Generally they are periodically up-dated. Within 5-10 years remote sensing data could be a possible alternative –global- data source to track changes, provided that the accuracy of these data is highly improved.
3. **The distinction of just a few major habitat types advances the feasibility**
   Because ecosystems tend to grade into one another, there are fundamental logical difficulties in demarcating ecosystem boundaries and in classifying habitat types. To minimise these problems it is recommended to distinguish as little as possible habitat types. The 5 major habitat types as proposed by the CBD appear to be suitable for they are universally applicable. Definitions should be harmonised with the definitions used by organisations such as FAO and the Ramsar convention on wetlands. If less than 5 habitat types are distinguished (e.g. just "natural and man-made area") the significance and sensitivity of the indicators will be practically lost.
4. **If is focussed on consistency per country to track changes in habitat size**
   Consistency of data over time within a country is more important than comparability of data between countries. Consistency allows for tracking genuine changes in the major habitat types in time per country on the short term. Harmonised data between countries allow for better regional overviews on the longer term.
5. **Determination of the original size of major habitat types is not necessary**
   Historical figures on the extent of the major habitat types are useful to show the change in the last century, e.g. 1900, 1950 and 1970. The original size of the major habitat sizes is useful but not necessary to calculate the change in natural capital.
6. **Habitat <u>quality indicators</u> can be established in the mid-term by targeted research**
   Habitat quality can be determined on the basis of the abundance of a representative core set of species or on other quality variables. Although various data on current and baseline state are already available, it will take at least some years of targeted research to establish a representative picture of the state of the major habitat types for each country. Species abundance is most promising to determine habitat quality because it is: i) relatively easily measurable; ii) relatively easily linkable with pressures and socio-economic scenarios; iii) sensitive to human activities; iv) appealing to policy makers and the public; and v) most feasible, considering most data and knowledge are on the species level.
7. **Each country makes maximum use of its precious data on species and habitats**
   Current data and knowledge on species and habitats are precious and specific for each country. Therefore it makes no sense to introduce new –"uniform"- quality indicators. OECD member states chose their own representative core set of quality variables for each habitat type, given their data availability and capacity. The NCI framework allows for this country-specific approach keeping the results still consistent between the countries.

8. **Baselines are indispensable for assessing habitat quality**
   Baselines are necessary: i) to give meaning to data and statistics; ii) to have a common and fair denominator for all countries to assess their habitat quality, irrespective the stage of their economic development, and iii) as a means to aggregate many detailed figures to a few or one-single habitat-quality indicator (0-100%) and, subsequently, one Natural Capital Index.
9. **A pressure-based approach is a most promising application on the short term**
   A pressure-based approach could be useful to apply in the short term as a substitute for ecosystem quality indicators. It is more suitable for a centralised application.

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Appendix 1: Glossary

Acronyms

AVHRR	Advanced Very High Resolution Radiometer
CBD	Convention on Biological Diversity
DPSIR	Driving force-Pressure-State-Impact-Response framework
EEA	European Environmental Agency
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GBA	Global Biodiversity Assessment (UNEP, 1995)
GBF	Global Biodiversity Forum
GEO	Global Environment Outlook
GIS	Geographical Information System
IUCN	The world conservation union
NCI	Nature Capital Index
NCI framework	A universal and quantitative framework including assessment principles, baselines, indicators and calculation procedures to describe and assess ecosystems
NOAA	National Oceanic and Atmospheric Administration
OECD	Organisation for Economic Co-operation and Development
PELCOM	Pan European Land Cover Monitoring
RIVM	National Institute for Public Health and the Environment (Bilthoven, the Netherlands)
RS	Remote Sensing
UNEP	United Nations Environment Program

Definitions

Assessment frameworks provide a systematic structure for organising indicators so that, collectively, they paint a broad picture of the status of biodiversity. These consist of assessment principles (baselines), indicators (and underlying variables), and methods of aggregation.

Baselines are 'starting points," and can be used, for example, to measure change from a certain date or state. For instance, the extent to which an ecosystem deviates from the natural state or the year the CBD was ratified. The baseline used strongly determines the meaning of the indicator value.

Biodiversity is defined similar to the CBD as the variability among living organisms from all sources including, inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems .

Biodiversity loss is the anthropogenically caused reduction in biodiversity relative to a particular baseline. In general the process of biodiversity loss results in a decline in the abundance and distribution of many species and the increase of some other species.

Cultural area**:** see man-made area.

Driving Force- Pressure-State-Impact-Response assessment framework is an analytical framework which considers various different stages in the causal chain:

> ***Driving force***: socio-economic factors which cause pressures
> ***Pressures***: changes in the environment caused by humans which affect biodiversity
> ***State***: condition or status of biological diversity and the abiotic environment as such
> ***Impact:*** impact on biodiversity, public health and socio-economic aspects
> ***Responses***: measures taken in order to change the state.

Ecosystem quality is an ecosystem assessment expressed as the distance to a well-defined baseline state, in terms of a percentage (current/baseline x 100%). Ecosystem quality is calculated as a function (for example the average) of the quality of many underlying quality variables.

Ecosystem quality variable is a variable, indicator or measure which shows one aspect of the quality of an ecosystem, e.g. the ratio of dead and living wood in a forest; the algae biomass in an aquatic ecosystem; the herring stock in a sea etc. The quality is always expressed as a percentage of a baseline. The lager the core set of quality variables of an ecosystem and the more representative the better it describes and assesses the quality of the ecosystem as a whole.

Ecosystem quantity is the size of an habitat type (ecosystem type) as percentage of the area of a country or other well-defined region such as the OECD, a continent or global.

Ecosystem type: synonymous with habitat type

Domesticated area: see man-made area

Habitat type is a specific type of vegetation. Major habitat types as distinguished under the CBD are forest, tundra, grassland, (semi) desert, inland waters, marine and agriculture.

Index is usually a ratio between two values of the same variable, resulting in a factor. Two or more indicators with different units are usually aggregated by converting them first into similar ratios, e.g. the “average distance from a baseline”, “distance to target”, or “annual change”.

Inventorying concerns the determination of the present biodiversity at genetic, species and/or ecosystem level in a specific area

Man-made area is defined as a human-dominated, cultivated land such as arable land; permanent cropland; wood plantations with exotic species; pasture for permanent livestock; urban areas; infrastructure; and industrial areas. Most of the man-made area is in fact agricultural land. Synonyms: cultivated area or domesticated area.

Mean Pressure is the mean of all grid cells (1 by 1 km natural area) for one single pressure per country or Europe

Mean Pressure Index is the mean of the Pressure Indices of all natural grid cells per country or for Europe

Monitoring is a periodic, standardised measurement of a limited and particular set of biodiversity variables in specific sample areas.

Natural area is defined as non-human-dominated land, irrespective of whether it is pristine or degraded, such as virgin land, nature reserves; all forests except wood plantations with exotic species; areas with shifting cultivation; all fresh water areas; and extensive grasslands (marginal land used for grazing by nomadic livestock). Synonyms: self-regenerating area and non-domesticated area.

Non-domesticated area: see natural area

Pressure Index is the pressure on biodiversity in one grid cell due to one or more different pressures. In this report it ranges from 0-7000.

Quality variable see ecosystem quality variables.

Self-regenerating area**:** see natural area.

Species abundance is the total number of individuals of one-single species in a particular area or per spatial unit. It can be measured in various ways such as numbers of individuals, total biomass, distribution area, density, ..

Species richness is the number of the various species present in a particular area or per spatial unit. For it is practically impossible to count all species, species richness is generally determined for some selected taxonomic groups such as birds, mammals and vascular plants.

Targets often reflect tangible performance objectives, developed through policy-planning processes. For example, a country has established a target of protecting at least 5% of each habitat type. One indicator for measuring performance would be the percentage of total habitat type protected, relative to the 5% target. Another example is the restoration of specific species populations to a particular level. Targets may include both those that measure pressure, state, and response (whether mechanisms and actions have been put into place) and capacity (whether resources are available to do the job).

Appendix 2: Ten considerations for choosing quality variables

Each quality variable should:

1. **have available quantitative data**
   - is *quantitative data about abundance, distribution and use for the past and present available or reconstructable? Is there data for pressure-effect relations?*

2. **be policy- and ecosystem-relevant**
   - *e.g. ecosystems/species of high economic, cultural or ecological interest (key species, see Annex 1 of UN-Convention on Biological Diversity), red list species, extinct or threatened (endemic) species.*

3. **be susceptible to human influence**
   - *predictable and able to be steered; is linkage to the outputs of socio-economic and environmental models possible?*

4. **be accessible to accurate and affordable measurement**
   - *does a monitoring programme exist? Is it financially feasible?*

5. **have indicative value**
   - does *the quality variable provide more information about biological diversity than only its own value?*

6. **be stable**
   - *can anthropogenically-caused fluctuations be reasonably distinguished from natural fluctuations?*

7. **be useful for at least a 20-30 year period.**
   - does the quality variable indicate a problem that will definitely not be solved within a few years (in that case it wo*uld lose political significance)?*

The set of quality variables should:

8. **provide a representative picture of the changes in biological diversity at the regional and global levels;**
   - *the quality variables must be a cross-section of the entire ecosystem so as to provide a representative picture relating to:*
     - *Different subsystems;*
     - *Different taxonomic classes;*
     - *High and low parts of the food web;*
     - *Terrestrial and aquatic ecosystems;*
     - *Present day and former biological diversity;*
     - *Sessile, migratory and non-migratory species;*
     - *Key species, threatened species, endemic species, species of socio-economic importance.*

9. **reflect the effects of the main anthropogenic pressures and nature conservation programmes affecting biological diversity:**
   - *the quality variables must be a cross-section of the main pressures in the area considered e.g.: exploitation, pollution, fragmentation, habitat destruction, disturbance, exotic species, climate change.*

10. **be as few in number as possible;**
    - *the fewer quality variables the more communicable to policy makers and the public; therefore aggregation to only a few, but preferably one, quality indicator must be possible.*

Appendix 3: List of biodiversity indicators for policy makers

(derived from Reid et al., 1993)

Table 6. Indicators of Biodiversity Conservation

Indicator	Biodiversity conservation Concerns: Genetic diversity	Species diversity	Community Diversity
Wild Species and Genetic Diversity			
1. Species richness (number, number per unit area, number per habitat type)	X	X	
2. Species threatened with extinction (number or percentage)	X	X	
3. Species threatened with extirpation (number or percentage)	X	X	
4. Endemic species (number or percentage)	X	X	
5. Endemic species threatened with extinction (number or percentage)	X	X	
6. Species risk index	X	X	
7. Species with stable or increasing populations (number or percentage)	X	X	
8. Species with decreasing populations (number or percentage)	X	X	
9. Threatened species in protected areas (number or percentage)	X	X	
10. Endemic species in protected areas (number or percentage)	X	X	
11. Threatened species in ex-situ collections (number or percentage)	X	X	
12. Threatened species with viable ex-situ populations (number or percentage)	X	X	
13. Species used by local residents (number or percentage)	X	X	
Community Diversity			
14. Percentage of area dominated by non-domesticated species		X	X
15. Rate of change from dominance of non-domesticated species to domesticated species		X	X
16. Percentage of area dominated by non-domesticated species occurring in patches greater than 1,000 sq km		X	X
17. Percentage of area in strictly protected status		X	X

Appendix 4: Review of existing indicators

The indicators 1-17 from Appendix 3 and nine additional, more recent, indicator proposals are reviewed on their suitability for integrated environmental assessments, especially OECD's Environmental outlook and Strategy. The suitability is determined according to ten considerations as shown in Appendix 2. Only the main advantages and disadvantages are mentioned. The numbers 1-17 refer to the number in Table 6 in Appendix 3.

1. Species richness (number, number per unit area, number per habitat type) (Reid et al., 1993)
The availability of data is often limited to a few distinct groups such as (some) vertebrates and vascular plants (Reid et al., 1993). Monitoring 'species richness' periodically, covering the whole world, would cost a considerable amount of money, even when it is limited to a small number of groups. The result is a function of the monitoring effort, which makes the trends less comparable and almost impossible to assess. Furthermore, it is difficult to relate this indicator with pressures in order to make predictions, because extinction is difficult to measure or to predict. Moreover, this has to be done for a large number of species, even when it is limited to some groups (vertebrates alone consist of ten thousands of species). Species richness depends on the spatial scale considered. The larger the scale, the greater the diversity. When areas differ in size, as is the case when countries or biogeographic areas are used, a coherent comparison between areas is problematic. Species diversity appears to be a slow indicator for biodiversity loss, especially when the area considered become larger. Before a species becomes extirpated or extinct, a long -fatal- process of population decline has already taken place. Generally this is the case in all regions: the abundance of many species decline while the abundance of some opportunistic species increase. However, the presence of species at the country or regional level changes at a much lower rate. Species-richness is an expensive, insensitive and barely predictable indicator. Trends may be a function of monitoring effort. Current data are only available for a few taxonomic groups. It is a useful indicator to compare areas and identify "hot spots" (spatial component). Species-richness is less useful for showing trends within an area (temporal component).

2/3.Species threatened with extinction or extirpation (number or percentage) (Reid et al., 1993)
To date, Red Lists and Red Data Books in general not only reflect those species considered most threatened, but also very strongly reflect the process and methodology of assessment (WCMC, 1996). Therefore, it is difficult to track changes over time. Another problem is how to assess a "specific number of threatened species". Is a high or increasing number a positive or a negative signal? Species might be re-introduced (increased number of threatened species) or might be extinct (a decreased number). Data are only available of a small number of species. Periodic monitoring will be expensive, even when the group considered is relatively confined, such as vertebrates or vascular plants. It is difficult to make predictions, as in "species-richness". "Threatened species" appear to be politically important often urging policy-makers to take direct action. Threatened species have one biogeographical feature in common: the existence of low numbers in a given area. As a group they do not provide a representative picture of the state and changes in biodiversity as a whole. Threatened species can produce direct, clear action to prevent irreversible biodiversity loss by extinction.

4/5. Endemic species, threatened with extinction (number or percentage) (Reid et al., 1993)
Endemic species are spatial-scale dependent since all species are endemic to some region. This feature makes this indicator a function of the chosen scale and of extirpation elsewhere. Furthermore, endemic species are a function of monitoring effort, as in "species-richness". This makes this indicator unstable and trends are hard to assess. As in "species-richness" and

“threatened species”, it is difficult to make predictions based on socio-economic scenarios. “Endemic species” appear to be politically relevant, especially when they are threatened and distributed in one country. Because of this, the endemic state adds an extra dimension to indicators 2/3. As in threatened species, the number of threatened endemic species does not give a representative picture of the state of biodiversity. Threatened endemic species do not reasonably reflect main causes of biodiversity change and conservation programmes, and are not sensitive to trends within areas, as in the above-listed indicators. The number of threatened endemic species might be useful *to compare areas* to set priorities. The selection of endemic species puts extra political weight on “threatened species” and can thus prevent irreversible extinction.

6. Species risk index (Reid et al., 1993)
This index combines the number of endemic species per area and the proportion of the natural area that have been lost. It does not provide an indication of the real risk for specific species in the present and future, but ranks/prioritises areas based on the potential number of endemic species at risk. Only “area loss” is included as pressure: there is no other sort of pressure. Thus, predictions based on different socio-economic scenarios are of limited value.

7/8. Species (populations) with stable or increasing populations, and with decreasing populations (number or percentage) (Reid et al., 1993)
Numerical estimations of population sizes are rare, but in many more cases it is possible to estimate whether species are increasing or decreasing (WCMC, 1996). Generally, monitoring populations is expensive. It is only affordable when a small number of relatively well-known and easily measurable species are chosen. When these species are also chosen on the basis of their representing changes of biodiversity as a whole, they become ecosystem- and policy-relevant indicators. “Representativeness” is a feature that has yet to be properly underpinned scientifically. Expert judgement could be used to approximate the choice of a representative set of indicators. In contrast to ”species-richness”, population changes are space-independent (density), sensitive to change, unambiguously measurable and providing early warning. For the selected species, specific measure-effect relations can be set up to base predictions on different socio-economic scenarios. This indicator has been implemented in various cases. Population changes in a representative core set of species are suitable for providing a timely picture of trends. They are not suitable for comparing biodiversity between areas (“hot spots”).

9/10. Threatened and endemic species in protected areas (number or percentage) (Reid et al., 1993)
The “number of threatened or endemic species in protected areas” indicates the potential conservation role of these areas. They do not provide information about the state of biodiversity itself. These indicators are merely response indicators, providing information on conservation measures taken, and are therefore important for making predictions on future biodiversity.

11/12. Threatened species maintained in ex-situ collections or viable populations (number or percentage) (Reid et al., 1993)
These indicators are similar to the response indicators mentioned above. They provide information needed for making prognoses for the future.

13. Species used by local residents (number or percentage) (Reid et al., 1993)
This is an indirect indicator of the state of biodiversity. If changes in species used are detected, this could indicate not only changes in the biodiversity as such, but also changes in local interests, market value etc. Therefore, this indicator is in essence an indicator for direct uses, and less suitable as state indicator of biodiversity.

14/15/16. Percentage (and extent) of area dominated structurally by non-domesticated species (in patches greater than 1,000 sq. km), and rate of change (Reid et al., 1993)
In general, data are available for this indicator. If the indicator “dominated structurally by non-domesticated species'” is well-defined it can be easily measured and linked to socio-economic factors and related land use and land cover. It is policy and ecosystem relevant because land conversion and ecosystem restoration are main factors of biodiversity loss (gain). This indicator has a high indicative value for biodiversity at the ecosystem level, and is stable because changes are not masked by natural fluctuations. This indicator has no significance for freshwater and marine areas.

17. Percentage (extent) of area with strictly protected status (Reid et al., 1993)
This indicator does not provide information on the state of the world's biodiversity as such, or the state within these protected areas. Actually it is a response indicator, providing information about the conservation measures taken, and essential for making predictions on the remaining area and biodiversity in the future. Apart from this, other information on responses is needed, such as measures for pollution abatement, poaching, water use, grazing, exploitation, fragmentation, etc. to make a prediction on the state of an ecosystem. This indicator has been implemented in various cases.

18. Habitat index (Hannah, 1994a, b)
The "Habitat index" aims to indicate the extent of area that is either not or only partially disturbed by human activities in a specified region using the following equation:

$$\text{Habitat index} = \frac{\text{undisturbed area} + 0.25\ (\text{partially disturbed area})}{\text{Total area}} \times 100$$

The level of disturbance is divided into three coarse classes, and is defined as follows. Undisturbed: e.g. primary vegetation and low human population density (maximum persons per km^2). Partially disturbed: e.g. secondary vegetation, fixed density ranges of persons and cattle. Human dominated: e.g. permanent agricultural or urban settlement. A high “habitat index value” indicates domination of natural area, and vice versa.
Data appear to be reasonably available at the global level, but changes found after re-assessment might easily be a product of different means of division into the three “disturbance” categories. The coarse classes result in a relatively insensitive indicator. It is relatively easy to make predictions, e.g. for land conversion by agriculture, urbanisation, and expected human density and livestock. Other pressures are not clearly incorporated. The index is highly aggregated, and easy to understand.
The habitat index does provide a coarse picture of the state of biodiversity itself (area and a coarse quality measure), and it is not possible to determine societal consequences as a result of an increasing or declining habitat index because it is not specific on economic relevant species or other relevant ecosystem quality variables. Furthermore, the habitat index assumes fixed disturbance by human activities, so it excludes the possibility of lowering human impact of activities by improving techniques and management regimes. These improvements are important options to be assessed in integrated environmental assessments. This indicator is not applicable to freshwater and marine areas. The indicator has been implemented on the global scale.

19. Keystone species (Paine, 1969)
"Keystone species" are frequently mentioned as useful indicators for the ecological functioning of a community. Their presence is assumed to be crucial in maintaining the organisation and diversity of their ecological communities. However, the term is poorly defined and non-specific. It is difficult to say what is and what is not a keystone species

(Scott Mills et al., 1993). Nevertheless, some species have more impact on an ecosystem than others because of their biomass, energy transfer or ecosystem shaping and ecosystem structuring performance (e.g. phytoplankton, large herbivores, trees, coral reefs). When choosing species as indicators it would be favourable to have “key-stone-like” properties from a representativeness point of view.

20. World Bank/GEF's Natural Capital Indicator (Rodenburg et al., 1995)
The Natural Capital Indicator (NCI) is calculated as each country's part of the world's total of remaining natural areas, adjusted for (multiplied) by its biodiversity richness. The biodiversity richness has been defined as the actual number of species (vertebrates and vascular plants) plus the number of endemic species per country. This number is compared with the expected "average biodiversity" for a country with a given territory (ratio of actual/average biodiversity).
Data on natural and man-made areas appear to be available, as are data on species richness and endemics. The NCI ranks the country's current share of the world's biodiversity; it does not provide information on the state of biodiversity as such and consequently on possible societal consequences. The remaining natural area factor is easy to link to socio-economic scenarios, so predictions can be made. As indicated above (indicator 1) the species- richness factor is hard to predict and insensitive, so is the Natural Capital Indicator as a whole. The indicator is highly aggregated and concise. The ranking of countries is simple and appealing to policy makers. It is a useful indicator to compare areas and identify "hot spots" (spatial component). It is less useful for showing trends within an area based on socio-economic scenarios within regions (temporal component) . The indicator has been implemented.

21. World Bank’s Natural Capital Indicator (World Bank, 1996)
The Natural Capital includes the entire environmental patrimony of a country, expressed in monetary terms. The elements included are the monetary value of agricultural land, pasture lands, forests, (timber and non-timber products), protected areas, metals and minerals and coal, oil and natural gas (World Bank, 1996).
Data appears to be easily available at the global level. It is relatively easy to make predictions, given different socio-economic scenarios. However, the indicator omits biodiversity of no commercial value. The Natural Capital is changing due to changes in the economic market, and not of changes in the actual state of biodiversity. It also contains, to a great extent, elements which are not relevant for the state of biodiversity, such as subsoil assets. The indicator has been rudimentarily implemented.

22. World Resources Institute’s Ecosystems at Risk indicator (Bryant, 1995; 1997)
This method estimates the state of ecosystems as a function of a limited set of main pressures. It is assumed that the higher the (combined) pressures, the higher the risk for the ecosystem. Global assessments have been made of coastal zones and frontier forests, categorising them as being at low, medium or high risk (Bryant, 1995; 1997). It can be seen as a pressure-derived state indicator.
Data appear to be easily available at the global level. It is relatively easy to make predictions given different socio-economic scenarios. Furthermore, this indicator reflects important causes of biodiversity change. It is highly aggregated and easy to understand.
The Risk index does not provide information on the state of biodiversity itself, and it is not possible to determine societal consequences as a result of an increasing or declining Risk index. The Risk index also assumes fixed disturbance by human activities, so abatement measures, improved techniques or sustainable practices cannot be incorporated. However, integrated environmental assessments aim to show the interactions between human uses and the state of the environment, and whether a "state of sustainable development" or "sustainable use" has been reached. It is a very valuable early-warning indicator and could be used as a

substitute as long as no actual state indicators are available. The indicator has been implemented at the global level.

23. Biodiversity indicators in OECD development (OECD, 1993-1999)
The OECD is still developing biodiversity indicators on pressure, state and response (OECD, 1993, 1997, 1998, 1999). The OECD, 1997 draft report proposes the following pressures: "land use change index," "road density" and "loss of small-scale elements in farm land." As state indicators the report proposes the "numbers of threatened and extinct species as a share of assessed species" and "area of key ecosystems." In recent years indicators on agro-biodiversity were elaborated (OECD, 1998, 1999). The biodiversity of agro-ecosystems is considered a function of the size of the system and its quality: "ecosystem quantity" and "ecosystem quality", respectively. Ecosystem quantity is the extent of the agricultural area expressed as percentage of a country's area. Ecosystem quality can be expressed in various quality variables such as the abundance of a core set of species, species richness, proportion of semi-natural and uncultivated natural habitats on agricultural land and the extent per agricultural type.
The "land use change index" lacks a clear and unambiguous definition and assessment principle (what change is considered good or bad?) as do "loss of small-scale elements" (what is an "element"?) and "area of key-ecosystems". For "numbers of threatened and extinct species as a share of assessed species", see above. The agro-ecosystem indicators are very similar to the Natural Capital Index framework of the Convention on Biological Diversity, evaluated in this report. These indicators have been implemented in a several pilot studies within the OECD (1999).

24. Biodiversity indicators by UN/CSD (UN, 1996)
The Indicators of Sustainable Development programme (ISD) provide pressure, state and response indicators, as well as indicators for use. Biodiversity-relevant state indicators are: land use change, changes in land condition, satellite-derived vegetation index, land affected by desertification, forest area change, algae index, and the percentage of threatened and extinct species. Biodiversity-relevant pressure and use indicators are: sustainable use of natural resource in mountain areas, wood harvesting intensity, maximum sustained yields for fisheries & current yields, BOD in water bodies, faecal coliform in fresh water, population state and growth in coastal zones, domestic consumption of water per capita, discharge of oil into coastal areas, N and P discharge in coastal zones, total GDP per capita and GDP per km^2, use of agricultural pesticides and fertilisers, irrigated percentage of arable land, energy use per km^2 of agriculture, emissions of SO_2 and NO_x, area affected by salination and water logging, and area of land contaminated by hazardous wastes.
For evaluation of the state indicators see number 2/3. The pressure indicators can be seen as a list of possible, promising indicators. Their usefulness depends on the specific area. They could be useful in the way proposed by WRI (see number 22) as a substitute for state indicators. In that case they must have a known relationship with the chosen state indicators and they must be linkable to socio-economic scenarios. These indicators are to be implemented in the pilot studies of several countries.

25. Biodiversity indicators in Biodiversity Country Study Guidelines (UNEP, 1993)
These guidelines provide a comprehensive list of possible indicators providing a detailed picture of pressures and the *state* of biodiversity on the local and national scale. In addition, these guidelines help define the different issues to be dealt with and the structure of reporting. They do not aim at standardised, highly aggregated indicators at the regional or global level, and do not fit into a general framework of environmental assessment and modelling. The indicators have been implemented in several national pilot studies.

26. Convention on Biological Diversity (UNEP, 1997b, 1999) & Global Biodiversity Forum (GBF, 1997)

These reports propose pressure, state, response and use indicators. The pressure and state indicators are those dealt with in this paper.

Appendix 5: A comparison of major indicator frameworks

Table 7 summarises the main features of the major indicator frameworks (see No. 20-26 in Appendix 4).

Table 7: Major indicator frameworks: main features compared

Frame-works	**Biodiversity Indicators P - S - R**	**Use-Indic.**	**Scale**	**Past/pres/ Future**	**Integr. Framw**	**Integrated Modelling**	**Focus on state/change**	**Assessment principle**
GEO/NCI	+ + -	-	All	+ + +	+	+	+ +	+
WRI-risk	+ - -	-	All	- + -	-	-	+ -	+
GEF/NCI	- + -	-	Nat	- + -	-	-	+ -	±
WB/NCI	- monetary -	-	Nat	- + -	+	-	+ +	±
OECD	+ ± ±	-	Nat	- + -	+	-	+ +	-
CBD	+ + -	+	All	+ + +	+	+	+ +	+
GBF	+ + +	+	All	+ + +	+	+	+ +	±
Country Gl.	+ + +	-	loc/nat	- + -	-	-	+ -	-
ISD[?]	+ ± +	+	Nat	- + -	+	-	+ -	-

Legend:

P-S-R:	pressure, state and response indicators
scale:	local, national, regional, global
integrated framework:	part of integrated environment assessment framework
integrated modelling:	prognoses possible, linkable to models and socio-economic scenarios
state/change:	focus on actual state in absolute terms or the change in relative terms
assessment principle:	clear choice whether a change is considered positive or negative
+ :	yes, suitable for, designed for, explicit
- :	no, not designed for, not explicit
+ :	in some way; low elaboration

In UNEP's Global Environment Outlook (GEO) the *NCI* framework does *not* aim to offer a comprehensive, detailed and entirely representative description of the *state* of biodiversity on a national or subnational scale. It aims to provide a rough picture of the main *changes* in biodiversity from the past and present to the future at the regional and global level, as they are impacted by socio-economic developments and associated environmental changes.

The *ecosystems-at-risk indicator* of the World Resource Institute (WRI) is a pressure indicator at the regional and global level. It has been incorporated as a suitable indicator in the GEO/NCI framework.

The *Global Environment Facility (GEF)/Natural Capital Indicator* is a state indicator defined at the country level. It is not suitable to link with socio-economic scenarios.

The WorldBank (WB)/*Natural Capital Indicator* is a state indicator that includes the entire environmental patrimony of a country such as: agricultural land, pasture lands, forests products, protected areas, metals and minerals and coal, and oil and natural gas, expressed in monetary terms.

The Global Biodiversity Assessment (*GBA)(UNEP, 1995)* provides a broad overview of the current state of scientific knowledge, identifies gaps in knowledge and draws attention to scientific issues where scientists have reached a consensus, as well as to those where uncertainty has led to conflicting viewpoints. It is not intended to assess the state of the biodiversity as such for the various ecosystems in the past, present and future.

The *OECD* is developing biodiversity indicators on pressure, state and response at the national level. They are still in the making.

The *Convention on Biological Diversity (CBD*) and *Global Biodiversity Forum (GBF)* have proposed indicators which are identical to the proposal for GEO/Natural Capital Index framework (NCI). They are developed in a concerted action.

The *Biodiversity Country Study Guidelines* provide a kind of comprehensive list of possible indicators that can provide a detailed picture of the *state* of biodiversity on the local and national scale. In addition, these guidelines help define the different issues to be dealt with and the structure of reporting. They do not aim at standardised high aggregated indicators at the regional or global level, and do not fit into a general framework of environmental assessment and modelling. Several similar indicators are incorporated in the GEO/NCI framework..

The *Indicators of the Sustainable Development programme (ISD*) provide pressure, state and response indicators, as well as indicators for use. Several indicators are incorporated in the GEO/NCI framework.

Appendix 6: Defining a baseline for natural and man-made habitats

The definition and determination of a baseline corresponding to a more natural, pre-industrial state, or close to it, is the most challenging part of the framework. Nevertheless, if it were left out of the framework it would create new problems. The use of a less modified, "pre-industrial baseline" has three major advantages. First, it provides a fair and common calibration point to compare the current biodiversity, so policy-makers and the public can get an idea of the major (predominantly anthropogenic) changes which have already taken place in modern, industrial times. This point in time will be different from place to place, and from state to state, but it is a comparable point for all nations in their socio-economic development and the resulting high modification of "natural" ecosystems and traditional, highly diverse, agricultural landscapes. Second, it provides the possibility to assess whether any change in biological diversity since the start of the CBD agreement is good or bad from biodiversity conservation perspective. This is possible despite the possible absence of verifiable ecological objectives. The third reason is that a baseline point enables us to remove the units of the many different biodiversity variables and make indices: distance to reference (dtr). This allows us to aggregate many different biodiversity parameters to a few or perhaps a single, more or less representative biodiversity (quality) index for entire ecosystems. This is analogous to the GNP and Price Index as highly aggregated indicators for the state of the entire economy, consisting of figures from many different economic activities and price changes. The health of a person is also assessed using several health variables related to baseline values.

Assuming that a more natural baseline state has a crucial function in the assessment of biodiversity, the question arises on how to deal with the theoretical and practical difficulties . Pristine or non-human affected ecosystems no longer exist, because humans have been part of most ecosystems for the last 100,000 years. We know today that even in prehistoric times humans had a considerable effect. Many, large animals and forest systems have been exploited to extinction. The human's impact (per time unit) was low in early times, and has gradually increased with growing technology, population, production and consumption rates in modern times. Biodiversity is currently decreasing at an unprecedented high rate (see the Global Biodiversity Assessment, 1995). It is this unprecedented rapid change in modern times that we want (and are obliged) to show quantitatively in national, regional and global assessment reports. Since there is no unambiguous natural reference point in history, and all ecosystems are also transitory by nature, a baseline point must be established at an arbitrary but practical point in time. There is nothing wrong in this, provided the arbitrariness of the baseline is acknowledged and commonly applied.

Because it makes most sense to show the biodiversity change when human influence was accelerating rapidly, the baseline should preferably be just before modern times: a pre-industrial state. This choice means that pre-industrial human influences are part of the baseline. For every region, nation or location this point in time may be different. Also, the availability or reconstructability of data will play a role in this choice. Data availability will generally increase as time progresses, so in some cases the baseline must be set in (early) industrial times. It is up to countries to choose this point. Once the baseline has been chosen, it has to be used consistently over time, so that trends can be quantified unambiguously.

Given the above, it is proposed to use the concept "postulated baseline, set in pre-industrial times", or in short, the "postulated baseline." For heavily modified, man-made agricultural ecosystems, the often biodiversity-rich, traditional-agricultural ecosystem is applied as the baseline.

Parties will most probably identify baseline ranges for the different variables/indicators utilised. These ranges are subject to revision pending availability of new data and insights. This also requires adjustment of the assessment figures in the past to enable comparison over time. To enable aggregation of data up to regions and globally, these baselines should be internationally discussed. Major differences, which are initially inevitable between countries, could be harmonised in the longer term, as has also been the case (and still is) with economic indicators.

Appendix 7: Specification of natural and man-made ecosystems

Man-made ecosystems:
Heavily modified areas intensively used by humans such as:
- Built-up area
- cropland
- planted pasture for permanent livestock
- infrastructure
- industrial and mining area
- planted forest with exotic species
- channels, ditches, man-made reservoirs & mariculture ponds
- self- regenerating patches < 100 ha.

Natural ecosystems:
All other primarily natural and semi-natural areas, possibly extensively used ecosystems, irrespective of their ecological quality, larger than 100 ha., such as:
- nature area
- extensively used areas, such as shifting cultivation areas, areas with nomadic livestock and areas with indigenous people living in a traditional way
- all forest (including production forest, except for forest planted with exotic species)
- rangeland of native pastures
- all fresh water, except for channels, ditches, man-made reservoirs & mariculture ponds
- marine area