

The European Commission's science and knowledge service

Joint Research Centre

Research Area 2 Ecosystem condition

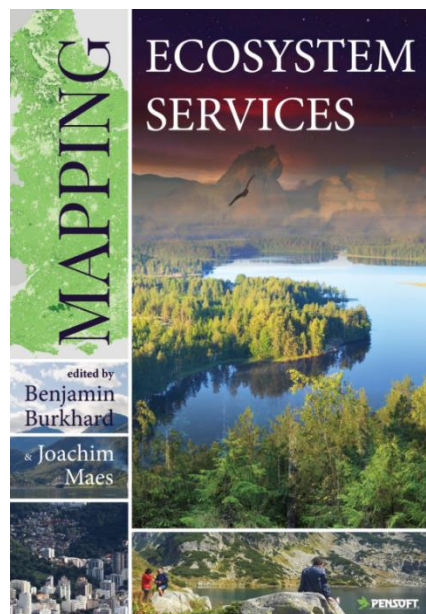
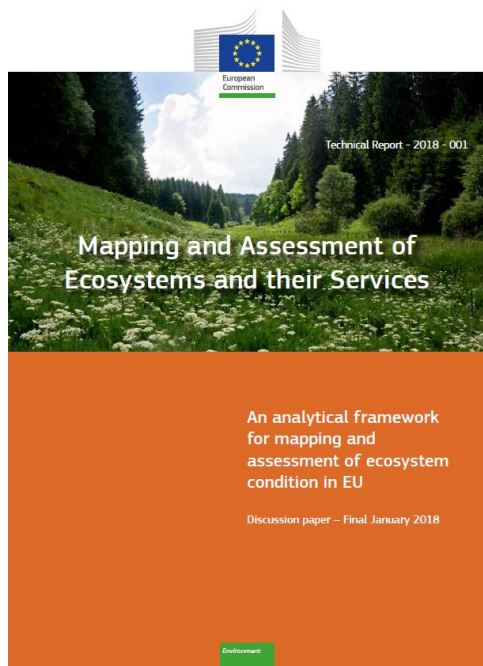
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European
Commission







- Joachim Maes
- European Commission – Joint Research Centre
- Biodiversity and ecosystem services (support to the EU policy on biodiversity)
- Ecosystem condition
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Your annual physical check-up

Which questions?

Indicators				
Units	yes/no	kg	mm Hg	beats/min
Type	pressure	state	state	performance
Reference	no	$19 < \text{BMI} < 25$	120/80	60-200
Aggregate		healthy	unhealthy	
Aggregate (2)		68.3%	31.7%	

The condition of ecosystems

What? Reflects the overall quality of an ecosystem asset in terms of its characteristics.

What steps to take to measure ecosystem condition and report it in an accounting table?

Step 1. Select ecosystem type and spatial units

Condition is measured for a specific ecosystem type and within a certain area.

See previous sessions:

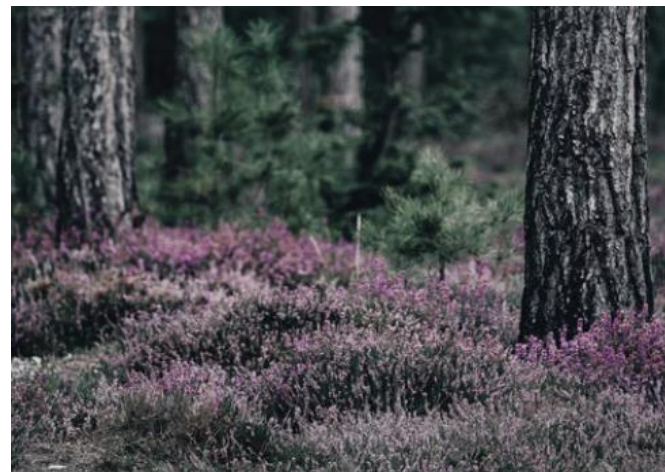
- Presentation by Francois Soulard (Canada statistics)
- Online modules on ecosystem types/spatial units

Step 2. Select indicators

- Many indicators for ecosystem condition are available (a review of 400 studies resulted in about 350 possible indicators):

- Land Cover and Land Use; Agricultural land area; General distribution of land use ; Green urban areas ; number; Accessibility; Landscape class area; Landscape composition; Land patch size; Number of patches; Landscape attractiveness for tourism; Number of areas; Total core area; Binary link between landscape function and land characteristics; Proportion of species per red list category; Number of Species of European Conservation Concern (SPECs); Percentage of Species of European Conservation Concern (SPECs); Conservation status of species; Conservation status of habitats; Protected natural area ; Percent natural area; Nature conservation; Presence of endangered species; Nitrate (NO₃); pH; Total Phosphorus (TP); Dissolved Oxygen (DO); Chlorophyll a concentration; Total Nitrogen (TN); Salinity; Conductivity; Water quality. E.g. Water Quality Index (QAEIS); Water Quality Degradation Index (PWQ); Biomass; primary productivity; Ecological Quality Ratios (EQR); body size; total fish catches; carbon sequestration/burial and storage; habitat modification E.g. Habitat Modification Score (HMS); Catch per Unit Effort (CPUE); ecological status/condition; habitat structure; Temperature; meteorological variables including climate change monitoring; connectivity; erosion; open water surface; water supply (actual and potential); carbon stock; current velocity; hydrological regime; beach nourishment; Normalized Difference Vegetation Index (NDVI); plant cover; riparian quality E.g. Riparian Quality Index (QBR); Riparian Buffer Area (RBA); Riparian Quality Index (RQI); vegetation structure; leaf area; tree growth; regeneration; Depth/depth variation of water; altitude/elevation; catchment area; forest area; habitat size; channel/stream width; slope; flow regime; geomorphology; water level; Water in soil; grain size; percentage of sand particles; C:N; nutrient/matter cycling; proportion of clay on soil; silt; nitrogen budgets; Nutrients; organic matter; oxygen (O₂); phosphorus compounds; silicate (SiO₃); Phytoplankton; Macroalgae; Biological Monitoring Working Party index; Diatom assemblages; Inter calibration Common Metric Index (ICMI); STAR; Sensitivity indices: Ir; Ip; Ec; El; Ermax; Specific; Pollution Sensitivity Index; Algal situation e.g. algal blooms; Epiphytes; Feeding; taxonomy based metrics. E.g. Ellenberg Index of Taxonomic Composition; Average Score per Taxon (ASPT); food web; filter and suspension-feeder; food type; Spawning E.g. stock; spawners; areas; Life span; Recruitment rate; Bacteria; Bacteriological Quality Index (BQI); bacterial carbon production; Pollination: nesting cell area; distance between arable fields and nesting habitats; visitation by native pollinators on arable fields; visitation rate; Air quality; percentage of fine particles; Agriculture (actual and potential); Agriculture production; Intensive crops/total area; Livestock production; Grazing; Agricultural soil use; Agriculture in/around site (wetland; river); Agriculture productivity; Intensive crops/extensive land use; Livestock weight units; Climate change; Degradation due to climate change; Fragmentation; Fishing (actual and potential); Water consumption; Shipping/Navigation; Human population density; Tourism ; Mobility and transport; Recreation (actual and potential); Aquaculture; Energy demand; Roads; Gradients of disturbance; Hunting/shooting; Intensity of shore use and embankments; Anchoring; Anthropogenic Pressure E.g. Anthropogenic Pressure Index (API); Cables and pipelines; Consumption of produced goods; Energy and petrol industry exploration; Human population; Renewable energy production; Wind turbines; Bridges; Construction E.g. construction licences ; Demography; Energy from wood resources; Land abandonment-land take; Sedimentation; Waste management; Agrienvironmental measures; Baltic Sea Pressure Index; Clogging risk; Demographic changes; Dwelling; Eco-efficiency of transport; service; residential sectors; Food demand; Hydroelectric power; Hydrological instability; Impacts on ecosystem; Irrigation; Material flows; Oil spills; Overexploitation; Scuba diving; Stone dumping; Total inputs consumed; Opportunistic; invasive or introduced species; Opportunistic/native species; Alien fish pressure; Mining; Hydromorphological pressure; Anthropogenically affected shoreline; Anthropization E.g. Anthropization Index; Eutrophication; Dredging and extraction of sand; gravel and maerl; Harbours/marina; Flooding risk; Reservoirs; Disposal of dredged material; Presence of barriers; Bottom trawling; Flood defence works; Bank alterations; Straightening; Burning/clearing/pruning; Change in biochemical cycles; Damage and adaptation cost; Soil loss; Water temperature modification; Pollutants E.g. max and average concentration ; Atmospheric deposition; Urban solid waste; Greenhouse gas emissions; Nitrogen export; Nitrogen Dioxide (NO₂); Acidification; Inputs of heavy metals; Pollution E.g. Pollution Load Index (PLI); Estimated discharge of pollutants; Fertilization; Wastewater; Diffuse and point pollution sources; PM10 emissions; Toxicity E.g. EC50; LC50; Bioconcentration Factor (BCF); Fluoranthene (C16H10); Noise level; Trace metal in animal tissues; Critical load exceedance; Dioxins and furans; Harmful cyanobacteria; Marine litter; Nitrogen loading rate; Number of discharge points; Phosphorus loading rate; Underwater noise; Urban sewage; Waste water treatment (number of plants; volume of water treated); Acidifying compounds emissions; Anthracene; CO₂ emissions; Contaminant concentrations on fish and other species; Contamination E.g. Index of contamination; contaminated sites; contamination ratios; NOx total emissions; O₃ precursors emissions; Organic pollutants; Ozone (O₃); Persistent Organic Pollutants (POP); Radionuclides. E.g. Radionuclide cesium-137; VOC total emissions; Intensity of forestry; Wood/timber production; Felling; Forest utilization; Cutting; Fall processes; Paper pulp production; Urbanisation: e.g. urbanisation segment (US); Industry; Surface of urban areas; Number of urban areas; Artificial surfaces; Human settlement areas; Industrial area; Land claim; Services percentage; Industrial percentage; Housing; Population around the wetland; Services area; Urban surface areas around wetland; Richness; Abundance; Number of species; Community/species diversity; Community/species composition; Benthic organisms; Fish; Shannon diversity index; Shannon-Wiener Index; AZTI Marine Biotic Index (AMBI); (M-AMBI); (microAMBI); Birds population; Communities/species distribution; Evenness; Species density; Margalef Index; Number of individuals; Frequency; Macrophytes; Reproductive technique; Simpson Index; Tolerance of species; Zooplankton; Taxa groups; Age structure; BENTIX; Diatoms E.g. Diatom Index; Frequency of threatened species E.g. Species at risk (SPEAR); Decline in species; Dispersion; Invertebrate status. E.g. Macroinvertebrate index; Dominance; Number of families; Size structure E.g. Large fish indicator (LFI); Estuarine resident; Living habit; Maturity E.g. Maturity Index; Pielou Index; Proportion of sensitive species; Aquatic stages; Average sex ratio; Biodiversity status; Coleoptera and heteroptera species; Fish communities densities; Fish-based estuarine biotic index; Individuals mobility; Invertebrates; Longevity; Macrophyte Index ; Meiofauna assemblages; Movement type; Nematode assemblages; Number of Ephemeroptera; plecoptera and trichoptera families (EPT); Number of genera; Odonata Habitat Index (OHI); Piscivorous teleosts; Planktivorous teleosts; Plants population; Population structure; Predatory teleosts and cephalopods; Fecundity; Taxonomic distinctness; The Fish in Balance index (FIB)

Indicators for ecosystem condition



Marine ecosystems

Pressure indicators

Water quality

Terrestrial ecosystems

Land cover and land use
statistics

Freshwater ecosystems

Biodiversity indicators

Water quality

Typology for indicators

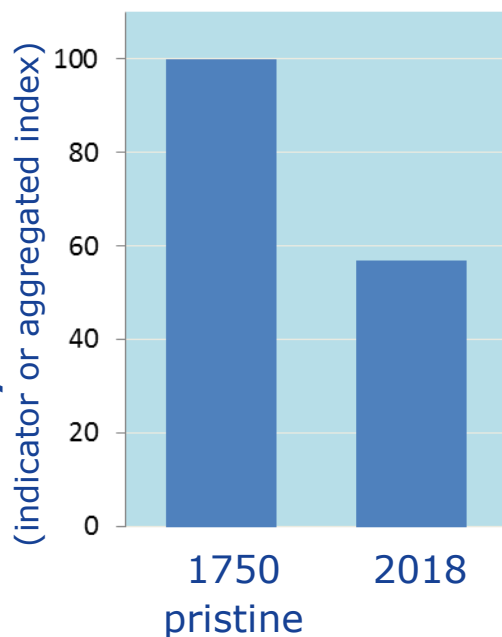


SEEA EEA revision process on condition

- Propose a general typology of characteristics or attributes for ecosystem condition
- What are criteria to include or exclude indicators from an indicator framework to measure ecosystem condition with the specific purpose of ecosystem accounting

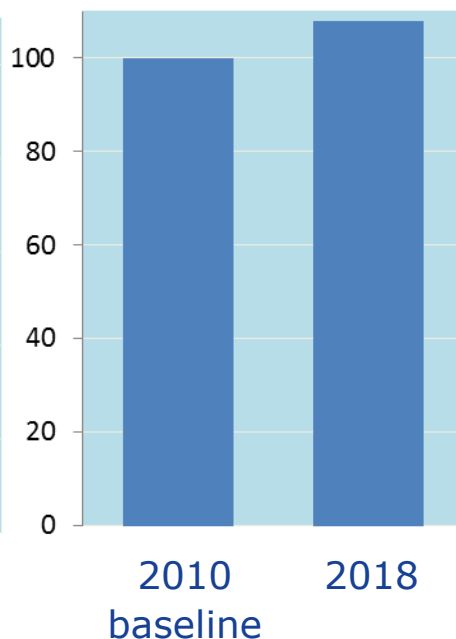
Step 3: Define a reference (approaches)

Approach 1



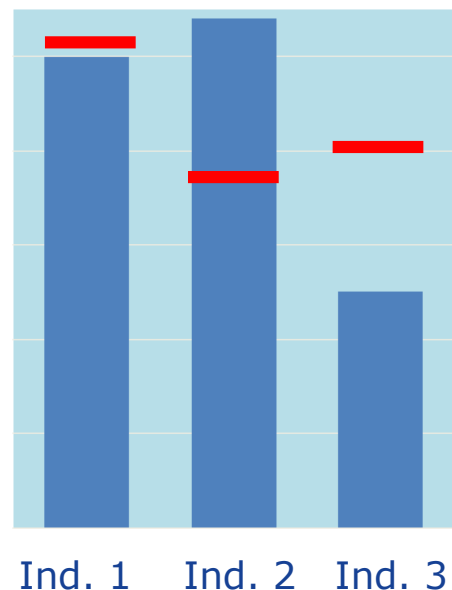
Set a reference year or a reference (pristine) ecosystem against which you compare the current indicator values

Approach 2



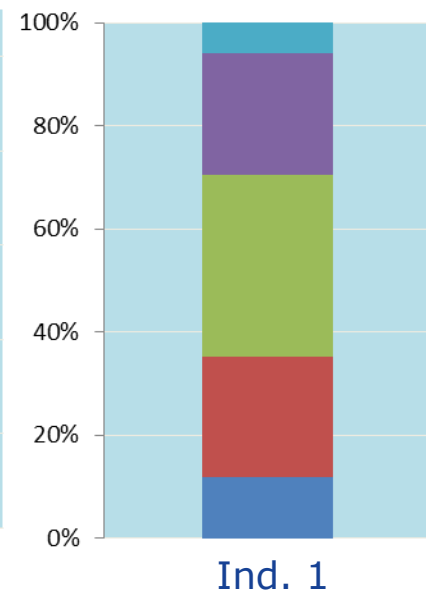
Set a baseline against which you compare change

Approach 3



Select a desired state of ecosystems (e.g. policy targets, expert judgment)

Approach 4



Statistical approach based on percentiles (e.g., the top 10% values considered as reference value)

Step 4: Aggregation (if wanted)

Purpose: a single or aggregated index for ecosystem condition based on multiple metrics or indicators for condition

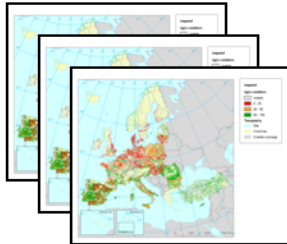
Thematic aggregation: Aggregating different indicators to deliver one single value

Spatial aggregation: Averaging or summing values of one indicator over space

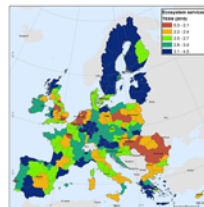
1. Mapping ecosystems



2. Mapping ecosystems condition



3. Thematic aggregation



3. Reporting in a table (spatial aggregation)

<i>Grassland</i>	Percentage of ecosystem extent
Poor	5%
Moderate	50%
Good	30%
Excellent	15%

Options for aggregation

- **Simple aggregation:** scale all indicators between 0 and 1 (or another number) and to sum them.
- **Hierarchical aggregation:** Ensure a balanced basket of indicators (based on a typology)
- **Weighed aggregation:** give more weight to certain indicators

Typology used in the EU for ecosystem condition

Pressures	Habitat conversion and degradation (land conversion)
	Introductions of invasive alien species
	Pollution and nutrient enrichment
	Over-exploitation
	Climate change
	Other pressures

Ecosystem Condition	Environmental quality (physical and chemical quality)		
	Ecosystem attributes (biological quality)	Structural ecosystem attributes	Structural ecosystem attributes (general)
			Structural ecosystem attributes based on species diversity and abundance
			Structural ecosystem attributes monitored under the EU nature directives
			Structural soil attributes
		Functional ecosystem attributes	Functional ecosystem attributes (general)
			Functional soil attributes

Step 4. Report the account

Two main approaches

- Report the condition indicators (or an aggregated condition index) as opening and closing stocks for different years
- Report the extent of ecosystem types over different categories of condition (this requires thematic aggregation)

Examples of condition tables

Wetland accounts, UK: Khan, J., Din, F. (2015) UK Natural Capital – Freshwater Ecosystem Assets and Services Accounts. Office for National Statistics

River accounts, South Africa: Nel, J.L., Driver, A. (2015). National River Ecosystem Accounts for South Africa. Discussion document for Advancing SEEA Experimental Ecosystem Accounting Project. South African National Biodiversity Institute, Pretoria

Table 1 - Wetland ecosystems assets account

		Ecosystem Characteristics of condition				
		Extent				
		Land cover		Accessibility		
		Ecological condition		Soil		
		Ecological condition		Accessibility		
Indicators		Wetland birds	Mean species richness	Mean total nitrogen stock	Mean carbon conc ⁶	Accessible wetlands - population with access to wetlands within X kilometres ¹
Units of measure	Size of area (hectares in '000)	No. of wetland birds at inland wetland sites in the UK ('000)	Diversity of species per pond	Mean total nitrogen in soil(% of dry soil)	Mean level of carbon in soil in (gram/kilogram ⁻¹)	-
Year 2008	2833 ² (2007) ²	4666	39.1 (2007)	1.5 (2007)	401.2 (2007)	-
Net change ³	0	163	-5.4	⁴ -0.2	-17.2	-
Year 2012	2833 ⁵	4829	33.7	1.3	384.0	-

Typology
Indicators

Opening stock

Closing stock

Table notes:

1. Further analysis is required to develop this indicator.
2. The bracket shows the year of the data.
3. Net change is the difference between the opening and the closing period.
4. Expressed in percentage points.
5. These numbers are based on extrapolating from 1998 – 2007. The rate of change between 1998 and 2007 was not statistically significant and therefore the area of land cover is estimated to have remained the same.
6. Mean carbon concentration.

Table D: Ecosystem condition account for main rivers using four ecological condition indicators, 1999 – 2011

Kilometres	Degree of modification from natural					Total
	None/ small	Moderate	Large	Serious/ Critical	No Data	
FLOW						
Opening stock 1999	34 084	22 814	10 328	5 447	3 637	76 310
Opening stock as a % total river length	45	30	14	7	5	100
Increase/decreases	-10 546	-2 316	6 017	5 129	1 715	
Increases/decreases as % opening stock	-31	-10	58	94	47	
Opening stock 2011	23 538	20 499	16 345	10 576	5 352	76 310
Opening stock as a % total river length	31	27	21	14	7	100
WATER QUALITY						
Opening stock 1999	40 579	24 634	5 518	1 943	3 637	76 310
Opening stock as a % total river length	53	32	7	3	5	100
Increase/decreases	-5 769	-3 591	6 149	1 496	1 715	
Increases/decreases as % opening stock	-14	-15	111	77	47	
Opening stock 2011	34 810	21 043	11 667	3 439	5 352	76 310
Opening stock as a % total river length	46	28	15	5	7	100
STREAM BANK/RIPARIAN HABITAT						
Opening stock 1999	22 469	32 951	14 164	3 088	3 639	76 310
Opening stock as a % total river length	29	43	19	4	5	100
Increase/decreases	-50	-3 612	1 255	1 667	740	
Increases/decreases as % opening stock		-11	9	54	20	
Opening stock 2011	22 418	29 339	15 420	4 755	4 379	76 310
Opening stock as a % total river length	29	38	20	6	6	100
INSTREAM HABITAT						
Opening stock 1999	39 736	26 188	5 446	1 301	3 639	76 310
Opening stock as a % total river length	52	34	7	2	5	100
Increase/decreases	-11 245	426	8 180	1 898	740	
Increases/decreases as % opening stock	-28	2	150	146	6 840	
Opening stock 2011	28 491	26 615	13 626	3 200	4 379	76 310
Opening stock as a % total river length	37	35	18	4	6	100

Table E: Ecosystem condition account for rivers based on the aggregated ecological condition category, for main rivers, tributaries and all rivers

Kilometres	Degree of modification from natural					Total
	Natural	Moderately modified	Heavily modified	Unacceptably modified	No Data	
MAIN RIVERS						
Opening stock 1999	46 541	22 315	2 791	1 026	3 637	76 310
Opening stock as a % total river length	61	29	4	1	5	100
Increase/decreases	-24 100	9 467	13 168	1 465		
Increases/decreases as % opening stock	-52	42	472	143		
Opening stock 2011	22 441	31 782	15 960	2 492	3 637	76 310
Opening stock as a % total river length	29	42	21	3	5	100
TRIBUTARIES						
Opening stock 1999	40 294	7 470	2 084	328	37 047	87 223
Opening stock as a % total river length	46	9	2		42	100
Increase/decreases	-17 062	11 339	4 766	957		
Increases/decreases as % opening stock	-42	152	229	292		
Opening stock 2011	23 232	18 809	6 850	1 285	37 047	87 223
Opening stock as a % total river length	27	22	8	1	42	100
ALL RIVERS						
Opening stock 1999	86 835	29 784	4 875	1 354	40 684	163 533
Opening stock as a % total river length	53	18	3	1	25	100
Increase/decreases	-41 163	20 806	17 935	2 422		
Increases/decreases as % opening stock	-47	70	368	179		
Opening stock 2011	45 673	50 591	22 810	3 776	40 684	163 533
Opening stock as a % total river length	28	31	14	2	25	100

Conclusions

- Measuring ecosystem condition is like measuring human condition (similar approach)
- Many challenges remain (in particular with respect to reference levels of indicators or a reference condition of ecosystems)
- A condition account is important to assess the capacity of ecosystems to provide ecosystem services.