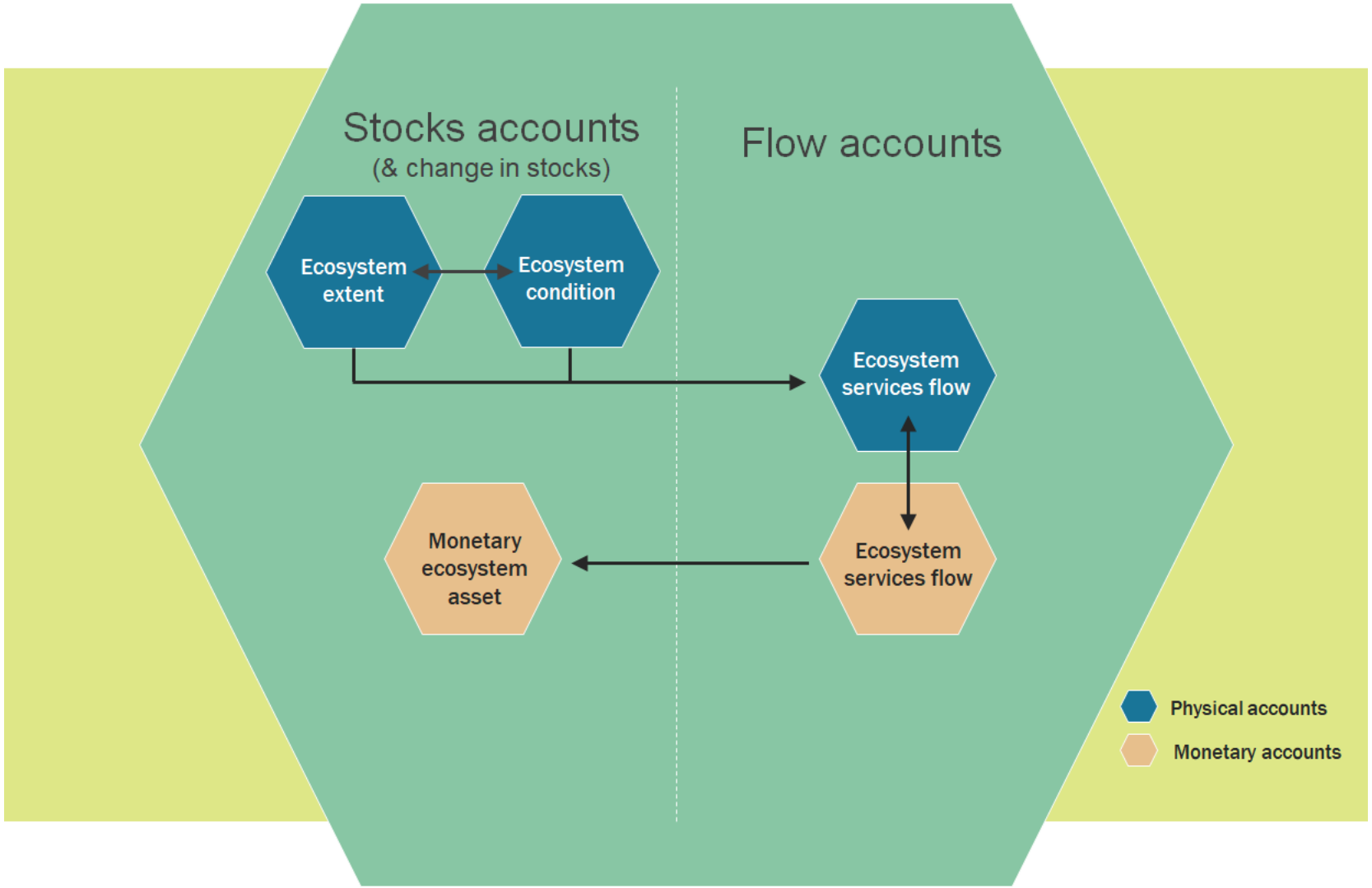
Ecosystem condition account and indicators

Joachim Maes; Virtual Expert Forum on SEEA Experimental Ecosystem Accounting 2020

Ecosystem condition accounts: framework



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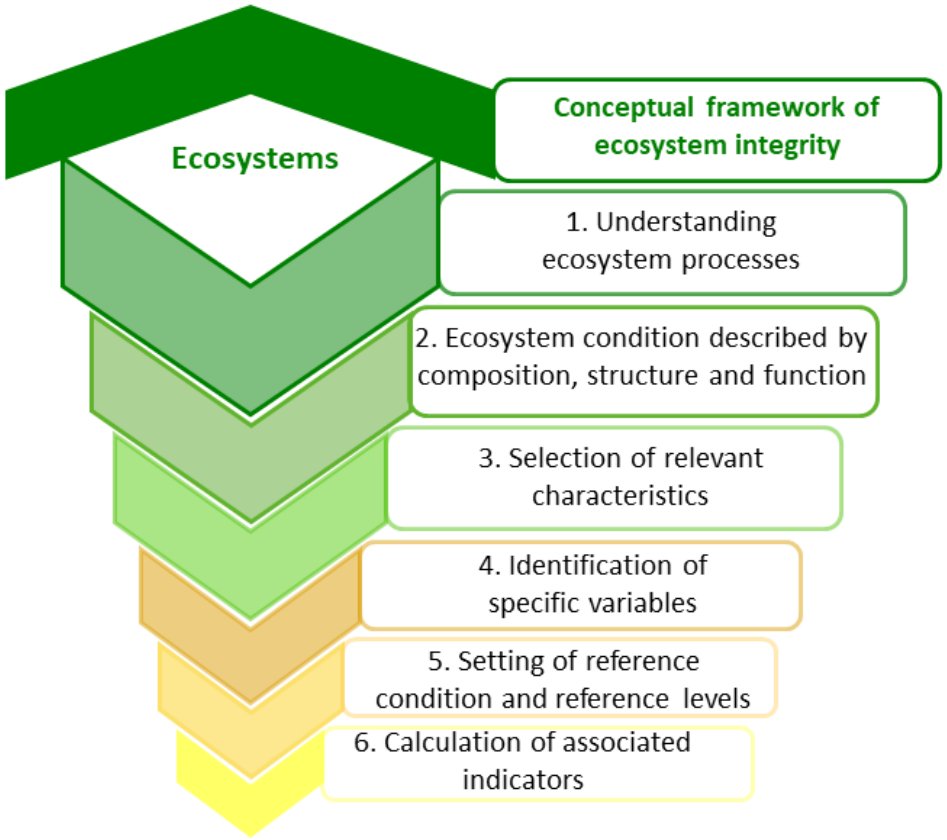
Ecosystem condition accounts: framework

Ecosystem condition is the quality of an ecosystem measured in terms of its **abiotic** and **biotic** characteristics.

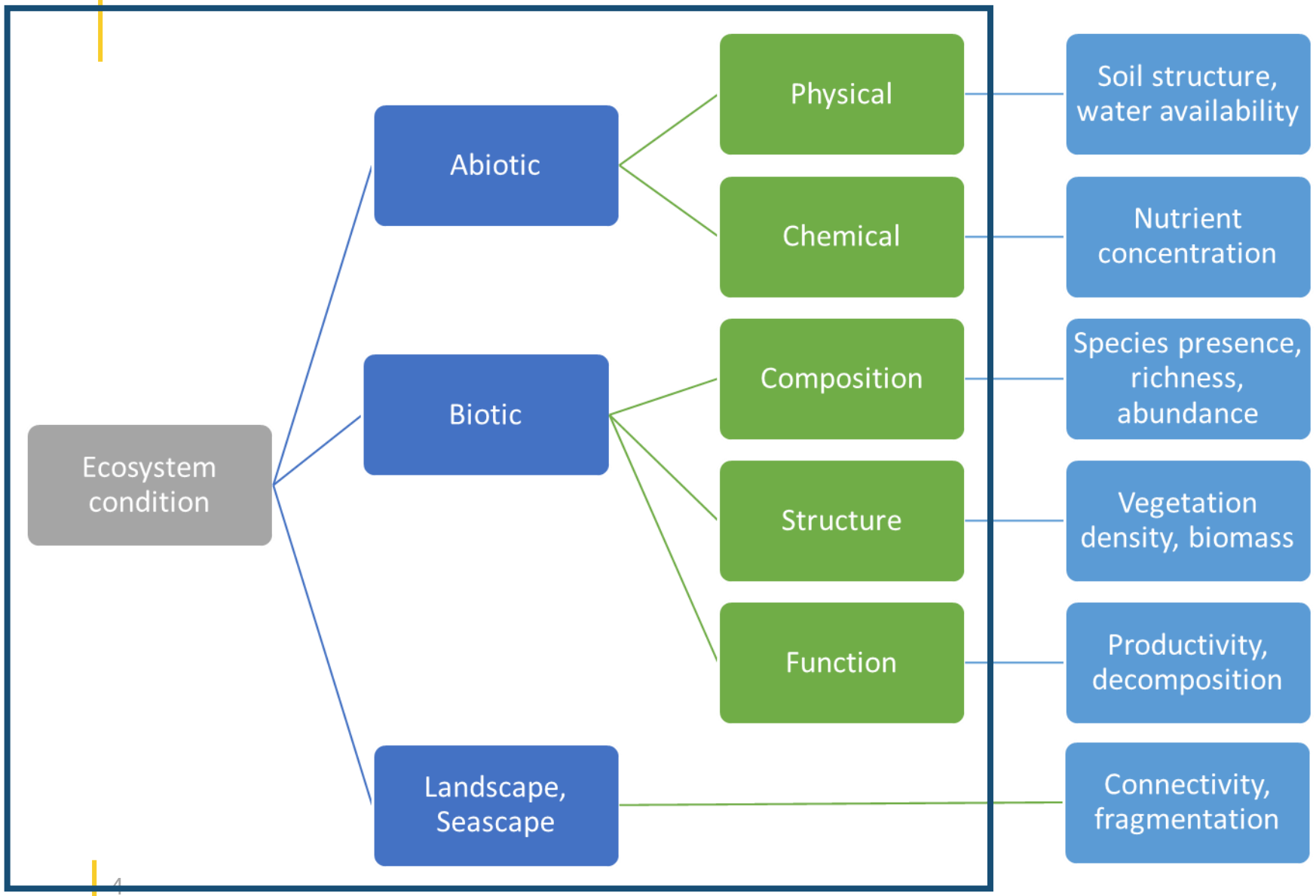
Ecosystem integrity is the ecosystem's capacity to maintain it characteristic **composition**, **structure**, **functioning** and self-organisation over time within a natural range of variability.

The practical basis for assessing ecosystem condition is to measure **the similarity, or distance, of a current ecosystem to a reference or least-disturbed ecosystem**.



Keith et al. (2020)
https://doi.org/10.3897/oneeco.5.e58216

Ecosystem condition typology



Czúcz et al. (in press) https://doi.org/10.3897/oneeco.5.e58218

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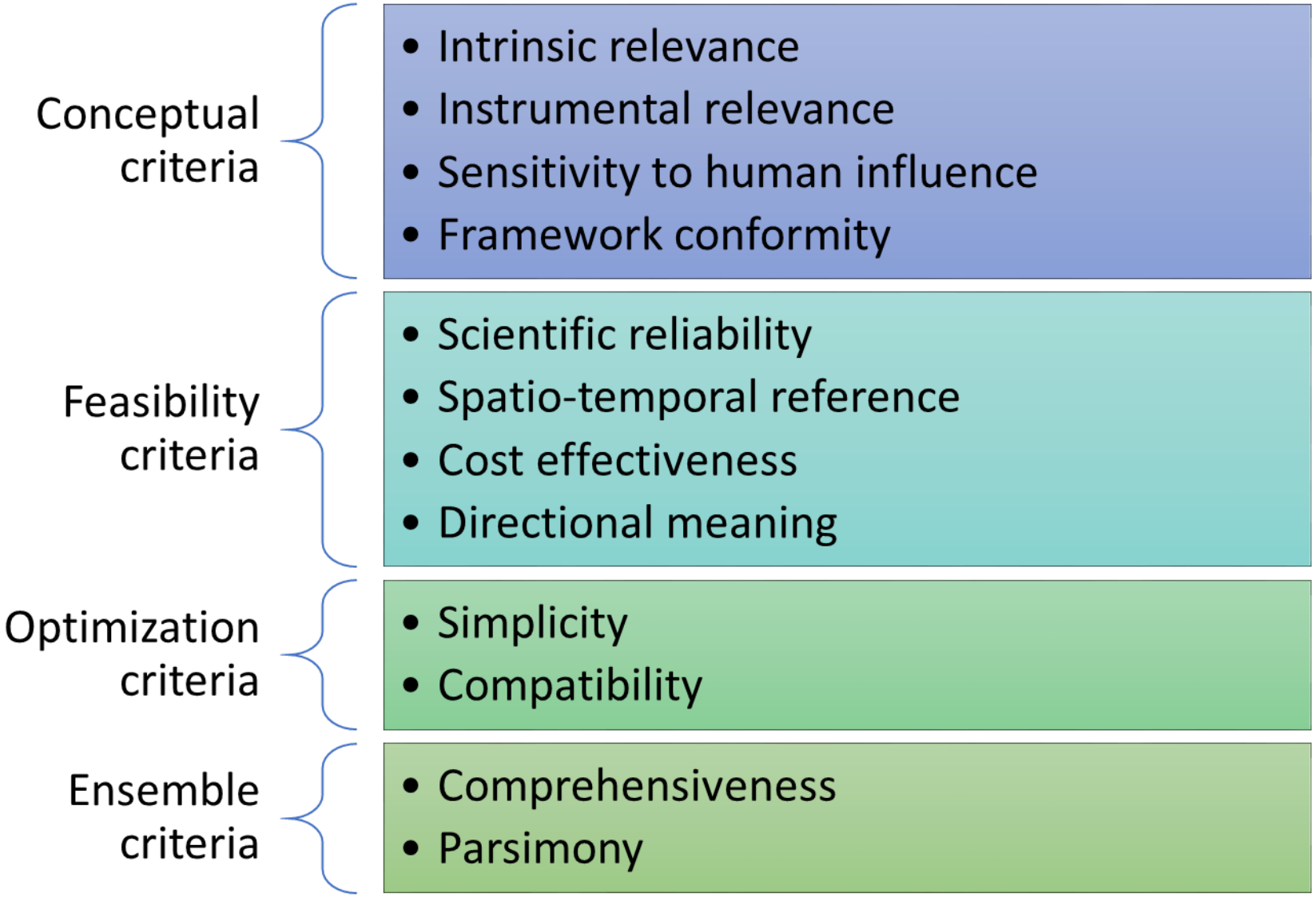
Selection criteria for ecosystem characteristics and their metrics (variables and indicators)



Czúcz et al. (submitted)

Table 5.3: Ecosystem condition variable account

SEEA Ecosystem Condition Typology Class	Variables		Ecosystem type		
	Descriptor	Measurement unit	Opening value	Closing value	Change
Physical state	Variable 1	ml/g	0.4	0.25	0.15
	Variable 2	% area	10	30	20
Chemical state	Variable 3	g/g	0.05	0.04	0.01
Compositional state	Variable 4	no. species	85	80	5
	Variable 5	presence	1	0	1
Structural state	Variable 6	t/ha	110	65	45
Functional state	Variable 7	t/ha/yr	15	10	5
Landscape/waterscape characteristics	Variable 8	% area	50	20	30

Table 5.7: Indicative ecosystem characteristics for selected ecosystem types[34]

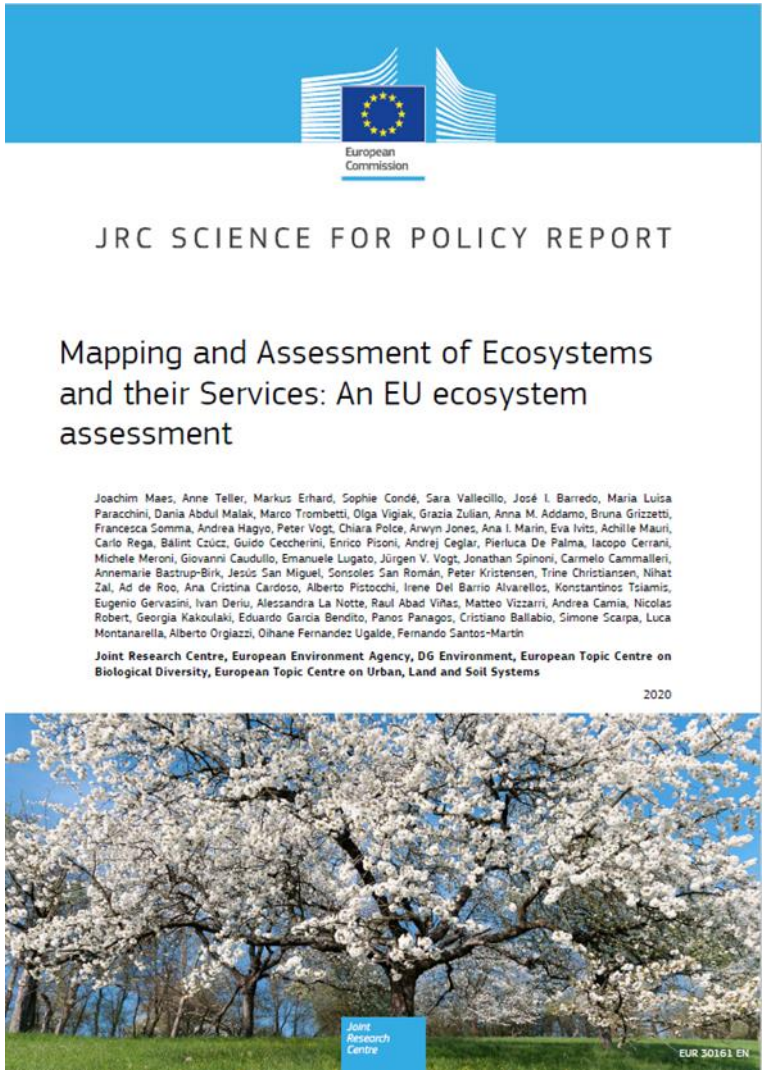
IUCN Global Ecosystem Typology: Selected Biomes	Physical state	Chemical state	Compositional state	Structural state	Functional state	Landscape/waterscape characteristics
T1 Tropical-subtropical forests	Soil water availability in the driest quarter Topographic wetness index	Soil organic carbon Leaf and litter nitrogen concentration	Tree species richness Density of epiphytes	Tree cover density; Dominant tree height Number of canopy layers deadwood; forest age	Dry matter productivity Presence of specific fruit-eating species for seed dispersal	Forest area density; landscape diversity; forest connectivity Ratio of edge distance to interior area of forest patches
T2 Temperate-boreal forests & woodlands	Litter depth Water infiltration rate	Soil organic carbon Air pollutant concentration	Tree species richness Presence of top predator species	Tree cover density; deadwood; forest age	Dry matter productivity Density of trees with hollows	Forest area density; landscape diversity; forest connectivity Age class distribution
T3 Shrublands & shrubby woodlands	% Burnt area; soil layer thickness (degree of erosion)	Soil organic carbon Soil phosphorus concentration	Bird species richness	Tree cover density; an NDVI-based (biomass?) index	Dry matter productivity Proportion of re-sprouting species after fire	landscape diversity; shrubland/forest connectivity
T4 Savannas and grasslands	% bare ground	Soil organic carbon Soil pH	Bird species richness; Butterfly species richness Proportion of cover by exotic species	The presence/ density of trees/ small woody features	Dry matter productivity Abundance of termite mounds	landscape diversity; grassland connectivity; the presence/ density of trees/ small woody features
T5 Deserts and semi-deserts	Water availability (index) Degree of surface crusting	(Soil organic carbon) soil pH	Reptile abundance	an NDVI-based index	Density of viable seeds per gram soil	Spatial distribution of waterholes
T6 Polar-alpine	% bare ground Snow depth	Pollutant deposition	Lichen abundance	an NDVI-based index Lichen cover on rocks	Extent of sea ice	Altitudinal gradient of habitat types Connectivity of routes for migratory species
T7 Intensive land-use systems	Water infiltration rate Soil bulk density	Soil organic carbon phosphorous concentration Nitrogen concentration	Bird species richness	% organic farming Number of cropping cycles per year	Soil nutrient availability Soil respiration rate	The presence/ density of seminatural vegetation fragments (or just ...of trees/ small woody features); Landscape diversity (mosaic)

IUCN Global Ecosystem Typology: Selected Biomes	Physical state	Chemical state	Compositional state	Structural state	Functional state	Landscape/waterscape characteristics
T7.4 Urban and infrastructure lands	Imperviousness	NO_2 concentration	Bird species richness	% urban green space	Leaf Area Index	Maximum distance of houses to open green space
TF1 Palustrine wetlands	Wetness (index)	Nitrogen concentration Phosphorous concentration	Bird species richness	NDVI (or an NDVI-based index)?	Rate of water flow	landscape diversity; wetland/water connectivity
F1 Rivers and streams	River flow (relative to ecological base flow); water regime (permanence)	Nitrogen concentration Phosphorous concentration Sediment load	Macro-invertebrate species richness	Vegetated river banks	Permanence of water flow	Share of river flow controlled by dams or barriers / Presence of anadromous fish; river system fragmentation
F2 Lakes	Water clarity; water regime (permanence)	Nitrogen concentration Phosphorous concentration Sediment load	Fish species richness	Steepness of water temperature depth profile	Rate of water flow	Connectedness of riparian vegetation within the catchment
F3 Artificial fresh waters	Water clarity	Nitrogen concentration Phosphorous concentration	Occurrence of algal blooms	Steepness of water temperature depth profile	Habitat requirements for fish breeding	Proportion of catchment vegetated
M1 Marine shelves	Water depth	Chlorophyll a % anoxic area		Trophic composition number; ratio fishing mortality and fishing at MSY		
M2 Pelagic ocean waters		Chlorophyll a; % anoxic area		Trophic composition number; ratio fishing mortality and fishing at MSY		
M3 Deep sea floors	Light intensity	Oxygen concentration	Invertebrate species richness	Habitat diversity	Sea floor sediment density	

Examples

- A review of ecosystem condition accounts: lessons learned and options for further development (UK, SA, AU, CA, NL): https://doi.org/10.3897/oneeco.5.e53485

- EU ecosystem assessment https://publications.jrc.ec.europa.eu/repository/handle/JRC120383



Forest condition variables

Table 3.3.6. Summary of trends in pressure and condition of forests in the EU-28.

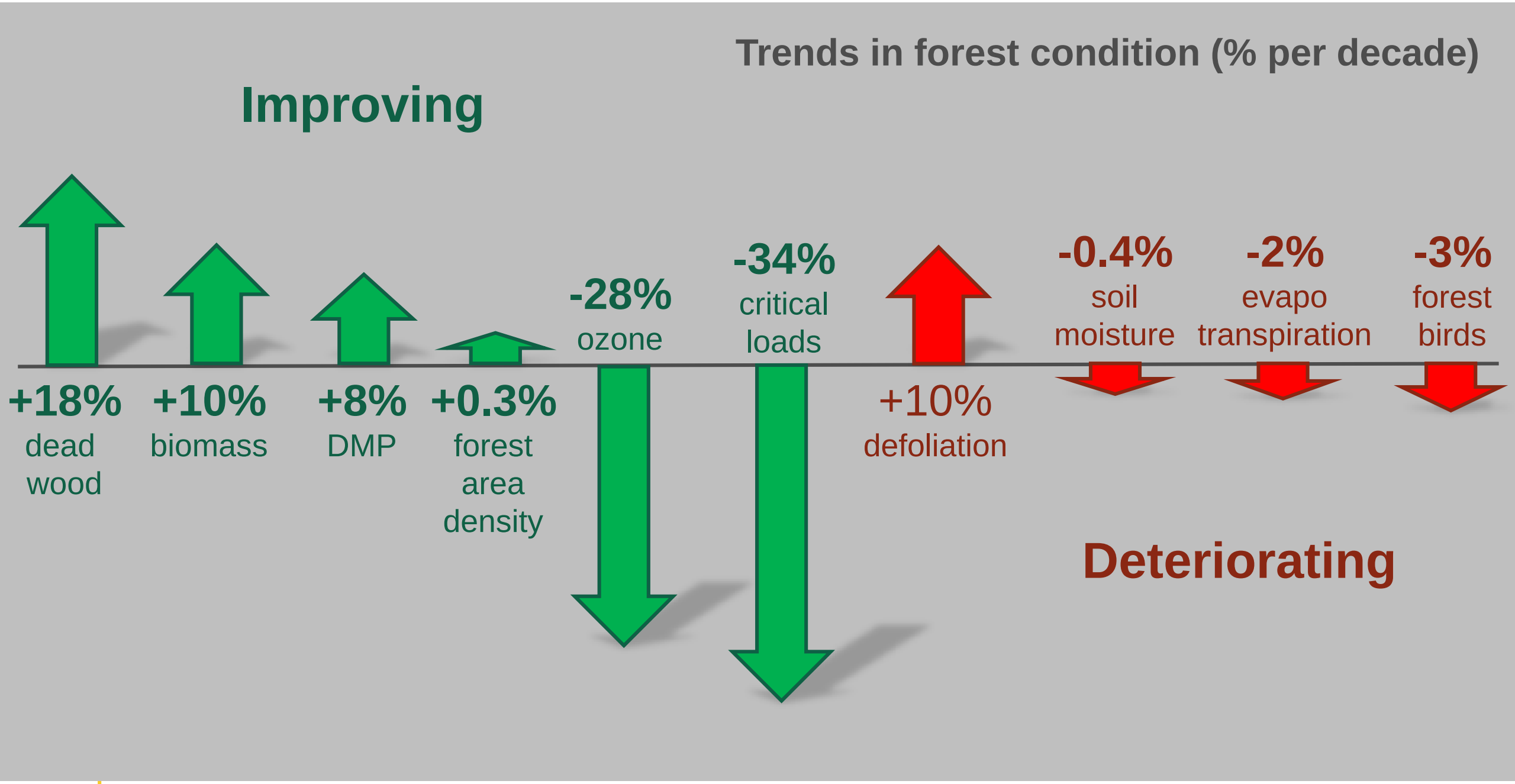
	Indicator	Short-term trend - Since 2010	Long-term trend
Pressures	Forest cover change (net change)	→	→
	Tree cover loss	↓	↓
	Forest fragmentation	→	→
	Forest land take	↑	↑
	Fires – burnt area	↓	↑
	Number of fires	↑	↓
	Effective rainfall (annual)	↓	↓
	Mean annual temperature	↓	↓
	Extreme drought events	↓	↓
	Soil moisture (soil water deficit)	unresolved	→
	Drought and heat induced tree mortality	unresolved	unresolved
	Storms	unresolved	unresolved
	Effect of drought on forest productivity*	↓	→
	Tropospheric ozone (AOT40)	↑	↑
	Exceedances of critical loads for acidification	↑	↑
	Exceedances of critical loads for eutrophication	↑	↑
	Ratio of annual fellings to annual increment	unresolved	→
	Pressure by invasive alien species	unresolved	unresolved
	Forest pests, parasites, insect infestations	unresolved	unresolved
	Soil erosion	unresolved	unresolved
Condition	Dead wood	↑	↑
	Landscape mosaic (index)	→	→
	Biomass volume	↑	↑
	Forest area	↑	↑
	Defoliation	unresolved	↓
	Abundance of common forest birds	↑	→
	Forests covered by Natura 2000	→	→
	Forest covered by Nationally Designated Areas	→	→
	Soil organic carbon in forests	unresolved	unresolved
	Dry matter productivity	↑	↑
	Evapotranspiration	→	↓
	Land Productivity Dynamics – (NDVI)	unresolved	↑
	Nutrient availability	unresolved	unresolved

↑: Significant improvement (significant downward trend of pressure indicator; significant upward trend of condition indicator); →: No change (the change is not significantly different from 0% per decade); ↓: Significant degradation (significant upward trend of pressure indicator; significant downward trend of condition indicator); Unresolved: The direction of the trend is unclear or unknown; data are not available; data are available but still need to be adapted to the ecosystem typology used in this assessment
Indicators of conservation status of habitats, species and birds are excluded.

SEEA ECT	Variable
Physical state	Soil moisture
Chemical state	Exceedances of critical loads for eutrophication Tropospheric ozone concentration
Composition	Abundance of common forest birds
Structure	Biomass volume Dead wood Defoliation
Function	Evapotranspiration Dry matter productivity
Landscape	Landscape mosaic (forest area density)

Forest condition variable account (accounting area= EU)

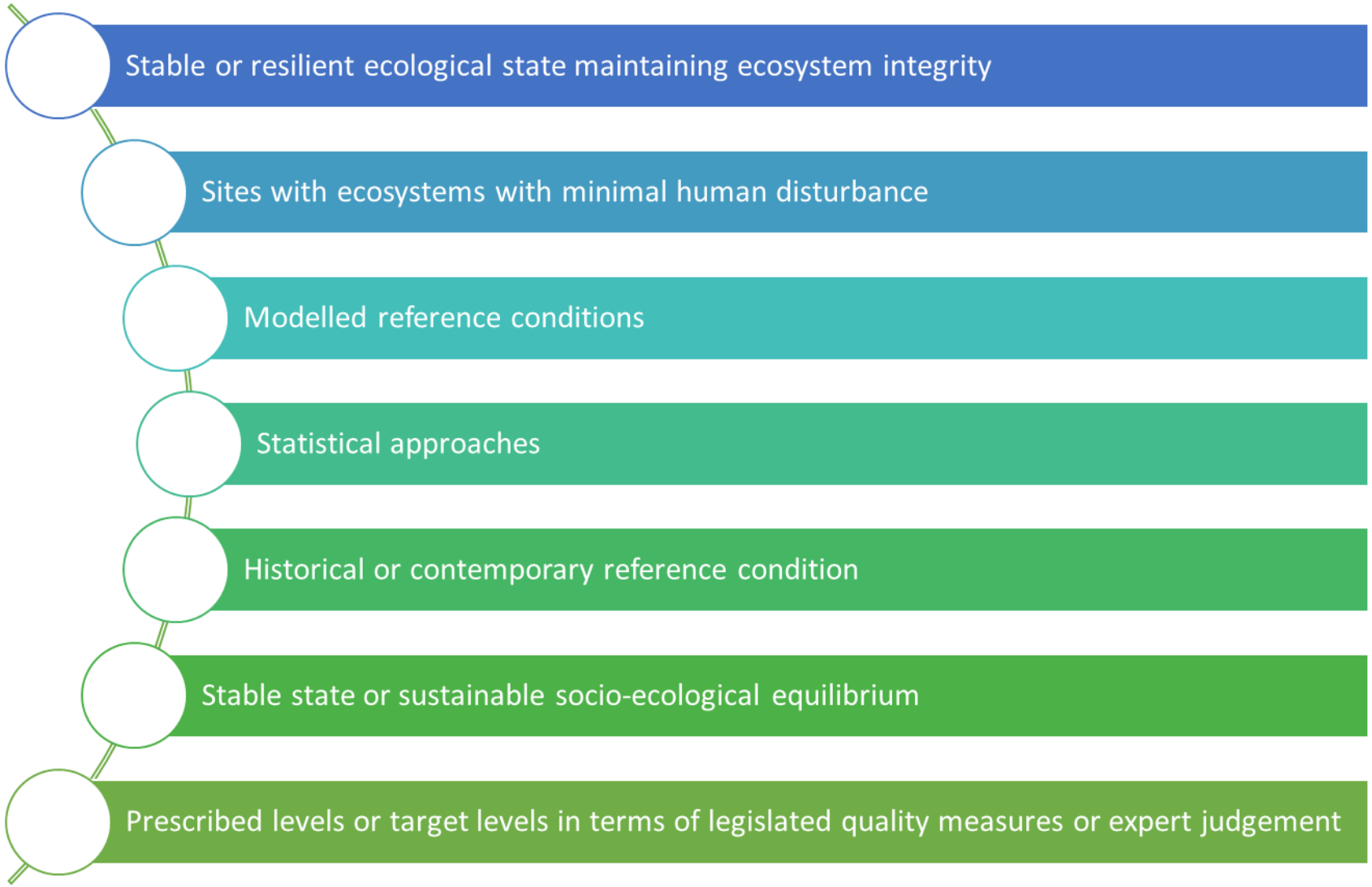
SEEA ECT	Descriptor	Units	2010	2020 (projected)	Change (%)
Physical state	Soil moisture	%	13.5	13.5	-0.4%
Chemical state	Exceedances of critical loads for eutrophication	eq/ha/year	251.8	166.2	-34.0%
	Tropospheric ozone concentration	ppb hours	19265.0	13870.8	-28.0%
Composition	Abundance of common forest birds	(1990 = 100)	94.0	91.2	-3.0%
Structure	Biomass volume	m3/ha	200.0	220.0	10.0%
	Dead wood	tonne/ha	4.1	4.8	18.3%
	Defoliation	%	20.0	22.0	+10.0%
Function	Evapotranspiration	mm/year	482.0	473.2	-1.7%
	Dry matter productivity	tonne/ha/year	11.8	12.8	8.3%
Landscape	Landscape mosaic (forest area density)	%	43.1	43.3	0.3%


Trends in forest condition (% per decade)
Improving
+18%
dead wood
+10%
biomass
+8%
DMP
+0.3%
forest area density
-28%
ozone
-34%
critical loads
+10%
defoliation
-0.4%
soil moisture
-2%
evapo transpiration
-3%
forest birds
Deteriorating

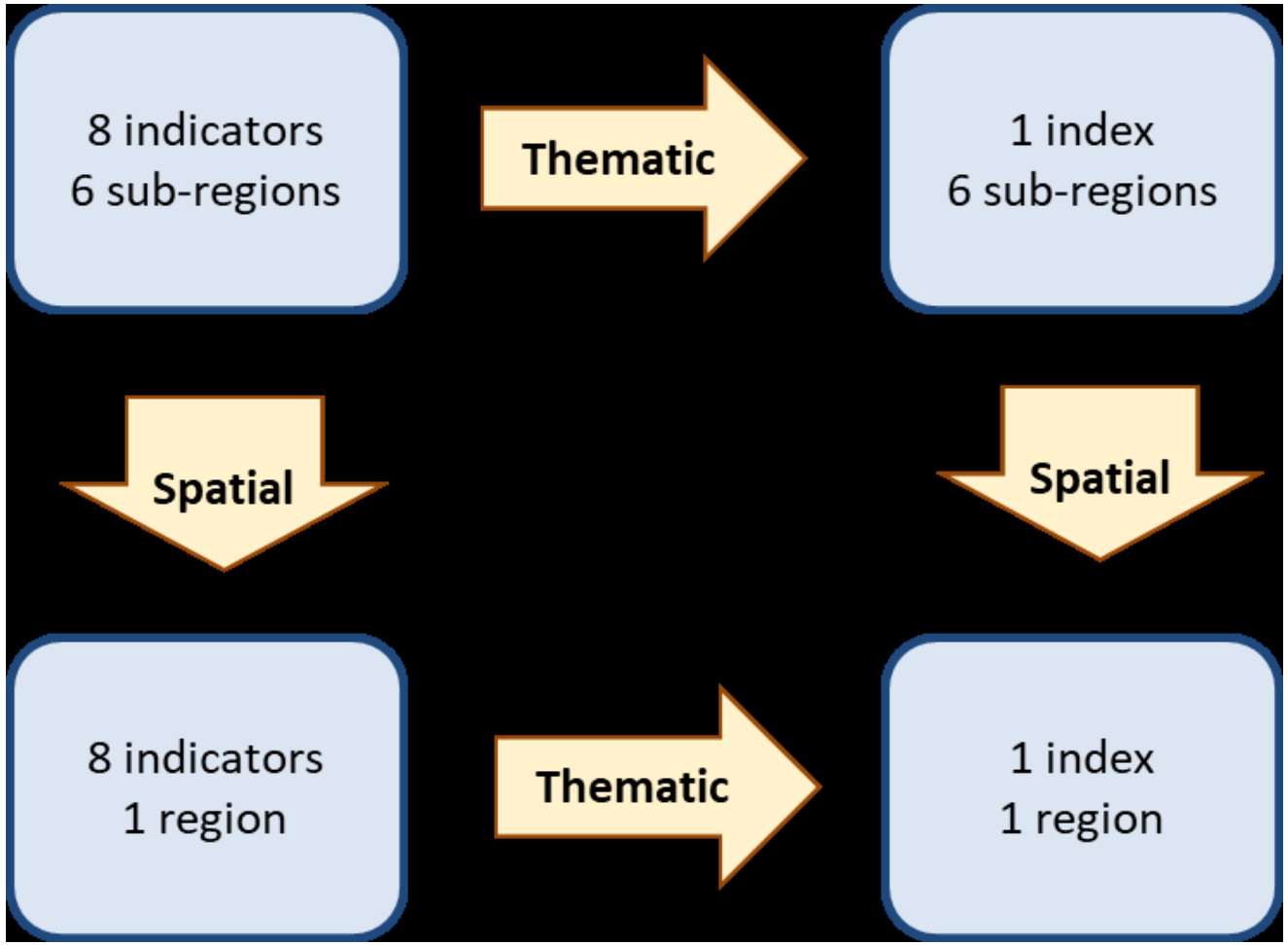
What is the actual condition? Are forests in a favourable or unfavourable condition?

- Reference condition and reference levels for condition indicators
- Aggregation / decision framework to derive an aggregated index

Options for establishing reference conditions for natural and anthropogenic ecosystems

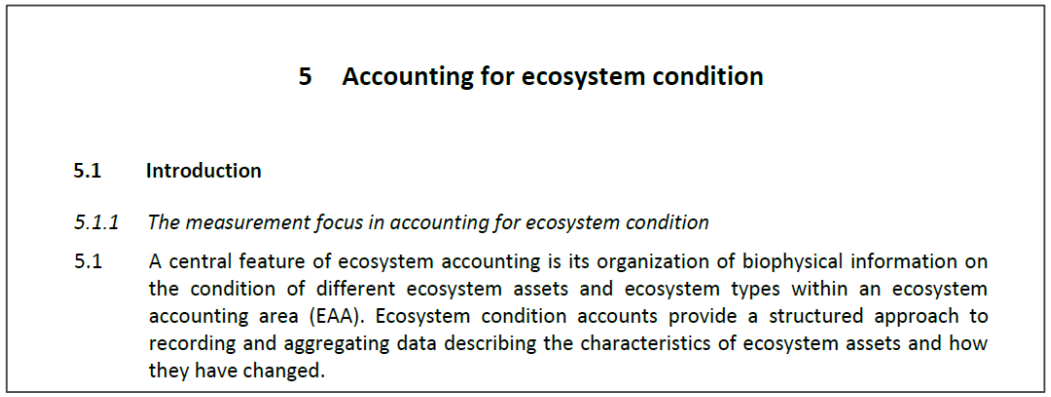


Aggregation and index



Sources

SEEA EEA ecosystem condition working group: Joachim Maes, Heather Keith, Bálint Czúcz, Bethanna Jackson, Amanda Driver, Emily Nicholson, Simon Jacobsson, Octavio Maqueo

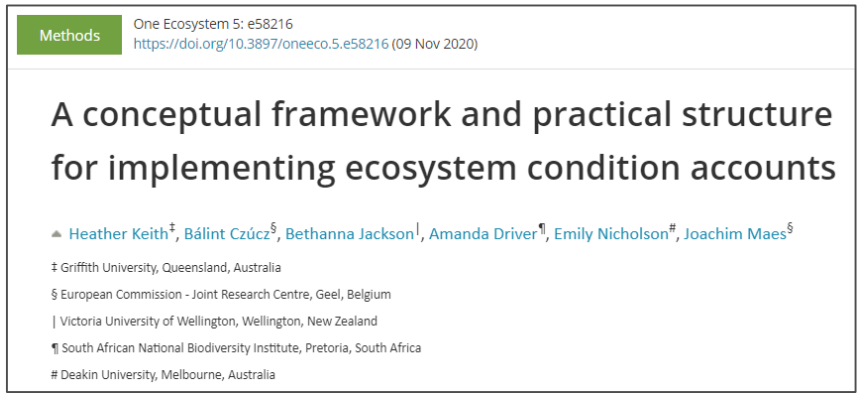


5 Accounting for ecosystem condition

5.1 Introduction

5.1.1 *The measurement focus in accounting for ecosystem condition*

5.1 A central feature of ecosystem accounting is its organization of biophysical information on the condition of different ecosystem assets and ecosystem types within an ecosystem accounting area (EAA). Ecosystem condition accounts provide a structured approach to recording and aggregating data describing the characteristics of ecosystem assets and how they have changed.



Methods One Ecosystem 5: e58216
https://doi.org/10.3897/oneeco.5.e58216 (09 Nov 2020)

A conceptual framework and practical structure for implementing ecosystem condition accounts

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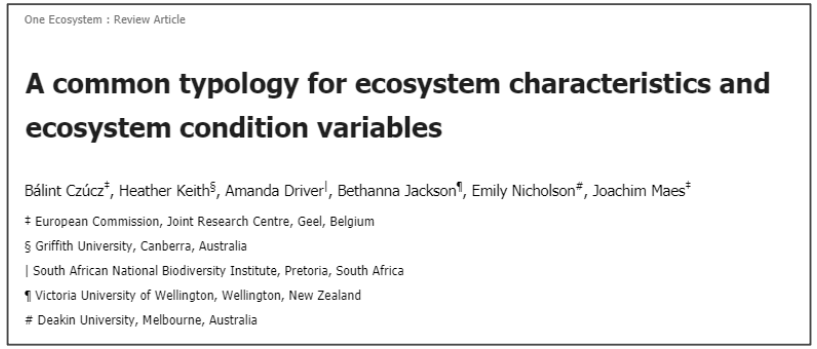

One Ecosystem : Review Article

A common typology for ecosystem characteristics and ecosystem condition variables

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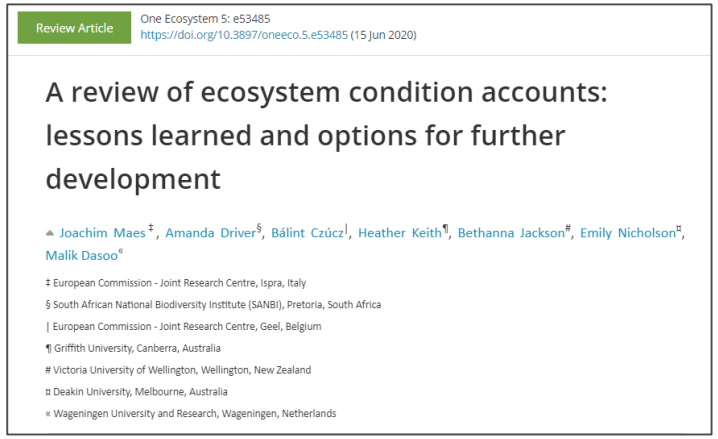

Review Article One Ecosystem 5: e53485
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A review of ecosystem condition accounts: lessons learned and options for further development

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