10.6 Ecological integrity

Project Name: CONNECTING Nature (Grant Agreement no. 730222)

Author/s and affiliations: Stuart Connop

Sustainability Research Institute, University of East London, UK

Ecological Integrity	Biodiversity
Description and justification	Ecological integrity is an emerging concept that is in some ways analogous with human health in terms of defining normal boundaries for a 'healthy' condition and categorising traits that are 'desirable' and 'sustainable'. However, for the concept of ecological integrity, 'health' refers to the complexity of interactions between numerous species, and both living and non-living components of ecosystems, and evaluates them in relation to the state of the ecosystem being considered. This state refers to both the biodiversity value and the ecosystem service provision. As such, this measure brings together several indicators into a single metric in relation to ecosystem 'health'.
Definition	Ecological Integrity is a holistic measure of ecological value and refers to an ecosystem's capacity to support and maintain ecological processes and diverse communities of organisms. It is typically quantified in terms of a measure of 'Intactness (% score or Index).
Strengths and weaknesses	A strength relates to the ability to bring together numerous characteristics of the health of an ecosystem into a single measure. For example: • Physical stress • Wildfire • Pollution • Thermal stress • Biological stress • Resiliency and resistance • Biodiversity • Complexity of structure and function • Controlled nutrient cycling • Efficient energy use and transfer • Ability to maintain natural ecological values Weaknesses relate to: • the emerging nature of this concept, and thus lack of consensus on a precise definition. • the complexity of quantifying these values into a single measure, in particular to ecosystems where understanding is still evolving.

	• the methodology relies on proxy variables that include data on landscape characteristics such as patch size, abiotic factors such as hydrology, and some features of vegetation structure and composition. It has been argued that these proxy values can lead to imprecise results due to the distillation of complex systems into simple values (Brown and Williams 2016). • the scale that this evaluation tends to be implemented means that it is more suitable for large/landscape-scale areas that small-scale NBS interventions
Measurement procedure and tool	An ecological integrity assessment is a multi-metric index that assigns ranked ecological scores to a variety of spatial and ecological parameters (Brown and Williams 2016). It assesses ecological integrity using data based on remotely sensed landscape characteristics such as patch size and surrounding land use, some abiotic factors such as hydrology, and some attributes of vegetation structure and composition. The methodology relies almost entirely on proxy variables, such as structure of vegetation or the species richness of vascular plants as a proxy for diversity of a range of taxa (Faber-Langendoen et al. 2012a; 2012b). Faber-Langendoen et al. (2012a; 2012b) present a comprehensive methodology for ecological integrity assessment. Beyer et al. (2020) also present a method that uses nine categories of intactness to capture global habitat loss, quality and fragmentation patterns at a 1km x 1km resolution. Forestry integrity mapping has also been carried out that could be used as a baseline for future evaluation of large-scale nature-based solution change in forestry management https://www.forestintegrity.com/. Details of methods used are presented in the Grantham et al. (2020) publication pre-print.
Scale of measurement	Landscape scale assigning Intactness scores to large land parcels. This indicator is typically used across rural landscapes rather than in small urban land parcels.
Data source	
Required data	Multiple remote sensed datasets are combined to create an index of ecological integrity. Data sources depend upon methodology. See Faber-Langendoen et al. (2012a; 2012b) for a standard methodology

Data input type	Quantitative Spatial data on a range habitat characteristics.
Data collection frequency	Evaluation frequency would typically be carried out to correspond with update of the various datasets required for the consolidated assessment. Ideally this would be an annual process, but update over periods of up to five years may also be feasible. Longer-time frames than this may miss critical tipping points in terms of habitat change.
Level of expertise required	This evaluation indicator requires expertise in both remote sensing methodologies and ecological understanding.
Synergies with other indicators	Strong synergies with other biodiversity indicators, particularly as some of the component datasets for this indicator might also be relevant across several biodiversity indicators. Also, synergies with greenspace mapping indicators.
Connection with SDGs	Strongest link to SDG 15. However there are links to all SDGs except 1 and 5: Biodiversity underpins food production; Links between biodiversity and health & wellbeing benefits; Links to environmental education; Links between biodiversity and water quality; Links between biodiversity and clean energy (biosolar, biofuel); Job creation; Improved green infrastructure and industry associated with biodiversity (potential disservices also); Social equality in relation to access to nature; Sustainable urban development; Biodiversity a good indicator of responsible consumption; Climate change adaptation; More sustainable water management; Biodiversity benefits; Environmental Justice in relation to biodiversity; Opportunities for collaborative working.
Opportunities for participatory data collection	Low opportunity for participatory involvement in the Evaluation Indicator itself. However, several of the component spatial datasets provide opportunity for citizen-science type opportunities in relation to data generation and/or ground-truthing of datasets. Similarly, output Ecological Integrity maps can also be ground-truthed through participatory processes.
Additional information	
References	Beyer, HL, Venter, O, Grantham, HS and Watson, JEM (2020) Substantial losses in ecoregion intactness highlight urgency of globally coordinated action. Conservation Letters 13(2), e12692, https://doi.org/10.1111/conl.12692. Brown, E.D., Williams, B.K. (2016) Ecological integrity assessment as a metric of biodiversity: are we measuring what we say we are?. Biodiversity Conservation 25, 1011–1035.

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10.7 Proportion of protected areas

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Author/s and affiliations: Stuart Connop

Sustainability Research Institute, University of East London, UK

Proportion of protected areas	Biodiversity
Description and justification	Proportion of a specific area (typically a Formal Urban Area) which fall under special protection by the Natura 2000 directive, and this includes a variety of different biodiversity-rich and sensitive habitats. This represents a proxy measure for the contribution that an area is making to biodiversity conservation strategies.
Definition	There are a range of restrictions to agricultural and forestry related activities within these areas which contribute to foster the development and recovery of rare species.
Strengths and weaknesses	A key indicator related to the biodiversity value of spaces. Relatively straightforward, but does not consider any sites that do not fall under the Natura 2000 directive. This can, therefore, miss many sites of value to nature conservation including designated sites, particularly in urban areas.
Measurement procedure and tool	Proportion (%) of a designated area (e.g., Formal Urban Area) belonging to Natura 2000 network per grid cell. Typically, using a GIS programme (e.g.ArcGIS, QGIS) a Natura 2000 shapefile is clipped to a target area polygon,