Sensitivity of the Red List of Ecosystem indicators

The Red List Index of ecosystems (RLIE) summarises the status and trends in the risk of ecosystem collapse, using data from the IUCN Red List of Ecosystems. The RLIE reports on proportion of ecosystems in each Red List category, is applicable to all ecosystems (marine, terrestrial and freshwater), and complements the widely used Red List Index (RLI) of species.

A key question for indicators is how sensitive they are to biodiversity change, and to biodiversity responses to policy. Our tests of RLIE sensitivity found that:

1) RLIE can clearly differentiate between low and high threat levels
2) RLIE responds quickly (within 5 years) to changes in threat levels, both increases in threats (e.g. climate change) and decreases (e.g., due to effective conservation policy).
3) RLIE detects change in both in area and ecosystem integrity (Figure 1, methods below).

These findings are supported by empirical analyses from Norway, where the impacts of alternative policy scenarios could be detected through the RLIE (Figure 2).

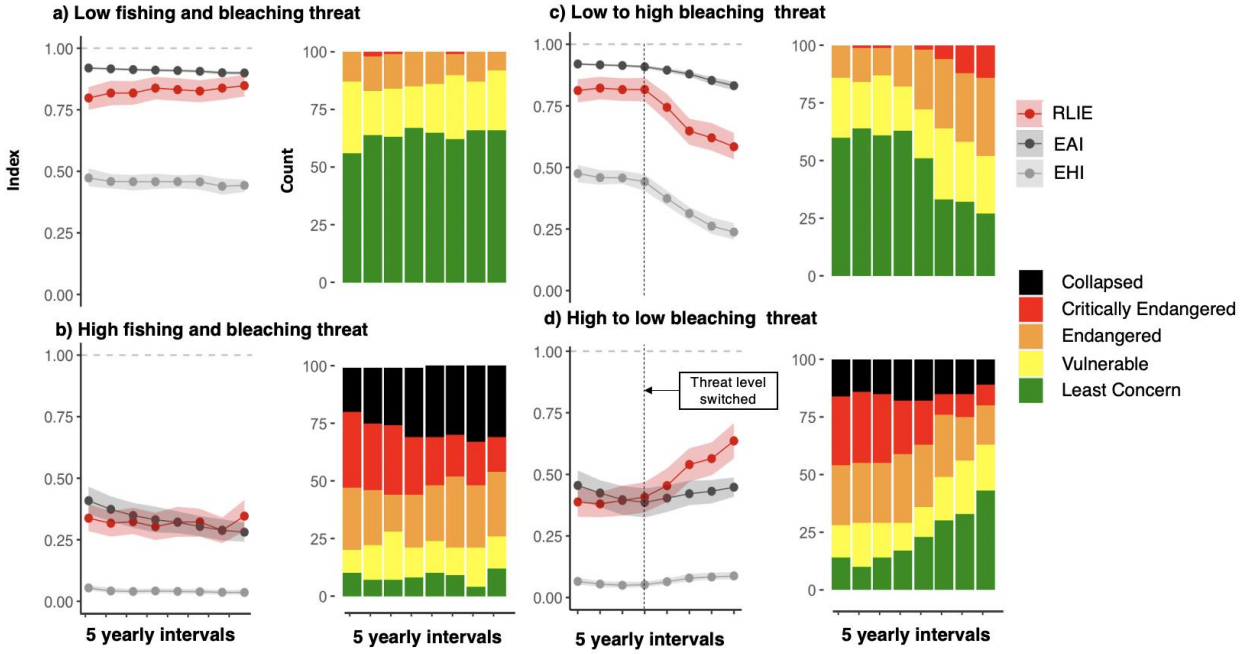

Figure 1. The Red List Index of ecosystems (RLIE, red lines) differentiates between low (a) and high (b) threat scenarios, and detects changes in threats from both low to high (c, e.g., increasing climate change) and high to low (d, e.g., effective policy). The RLIE responds to change in both ecosystem area (summarised by the Ecosystem Area index EAI, black lines) and ecosystem integrity (Ecosystem Health Index EHI, grey lines). The RLIE summarises the proportion of ecosystems in each Red List risk category (show in the right-hand panels for each plot).

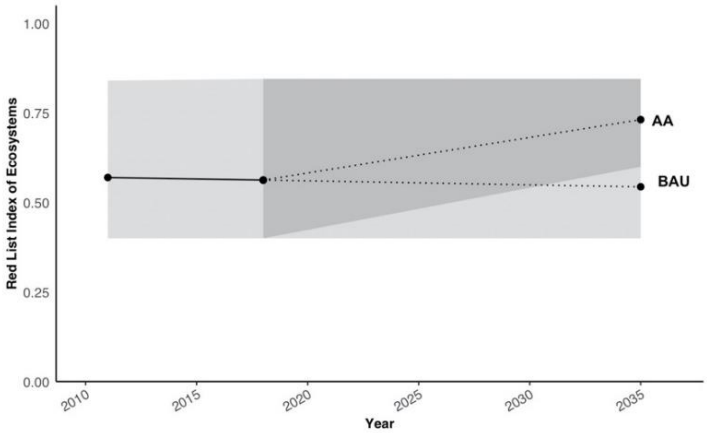

Figure 2. The Red List Index of ecosystems (RLIE) differentiates between 'adjusted ambition' (AA) and business-as-usual (BAU) policy pathways in Norway for a selected set of ecosystems; Norway has undertaken two Red List of Ecosystems assessments (2011 and 2018), and project the impact of policy pathways on ecosystem risk status (presented in Kyrkjeeide et al. 2021). The intervals were calculated using the 25th and 75th percentiles to represent the middle 50% of the data at each timepoint.

Details on indicators:

We tested the three indices (Figure 1) developed to monitor past and likely future changes across marine, freshwater, and terrestrial ecosystems. The indices use data on the spatial distribution and integrity of ecosystems from IUCN Red List of Ecosystems assessments:

1. The **Red List Index of Ecosystems (RLIE)** summarises the status and trends in the risk of ecosystem collapse. It is based on the proportion of ecosystems in each Red List category in each year and complements the widely used Red List Index of species survival.
2. The **Ecosystem Area Index (EAI)** measures change in ecosystem extent.
3. The **Ecosystem Health Index (EHI)** measures ecosystem degradation, including changes in ecological processes and functions of both the biological and physical components of ecosystems. Based on ecosystem-specific variables, it measures the average trends of degradation or recovery.

Performance testing approach

We used a stochastic ecosystem model of the Meso-American coral reef to test how well and how rapidly the indices represent the status of ecosystems. We created four scenarios with differing levels of threat from fishing and mass coral bleaching (Fig 3). For each scenario, we simulated 100 reef futures over 200 years and calculated the indices at 5-yearly intervals.

We tested the:

1. **Sensitivity** – can the indices differentiate between high and low levels of threat?
2. **Responsiveness** – how quickly can the indices detect changes in ecosystems? This can allow for rapid actions to stop declines or signal that changes in policy or conservation actions have been effective.

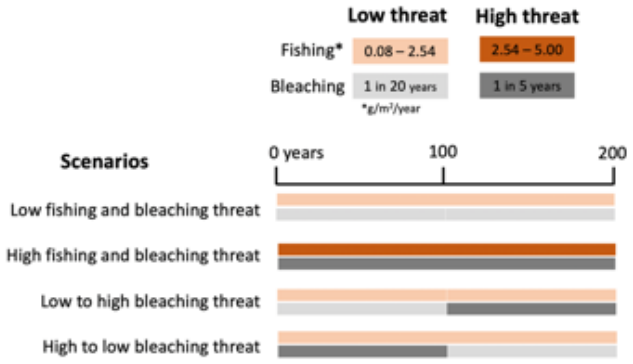

Figure 3. Four threat scenarios and values for the level of threat.

Key findings

The ecosystem indices are sensitive, responsive and offer complementary information on changes in ecosystems. Several key insights included:

- All indices differentiated between the high and low threat scenarios and responded to changes in threat level within 1-10 years.
- The RLIE was less sensitive than the EHI, as the RLIE is calculated using course risk categories rather than fine-scale data on change. The EHI was the most sensitive as it detects fine-scale degradation, declining the fastest and most to the onset of high threats.
- The RLIE is sensitive to ecosystem degradation, as the RLIE can change when the area of the ecosystems remains stable but the condition is degrading. In contrast, measuring only area, as in the EAI, can underestimate ecosystem status as it will only change when the area increases or parts of the ecosystem become locally collapsed (e.g., from land clearing).

Sources

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*Rowland JA, Lee CKF, Bland LM, Nicholson E. 2020. Testing the performance of ecosystem indices for biodiversity monitoring. Ecological Indicators **116**:106453. Elsevier. Available from https://doi.org/10.1016/j.ecolind.2020.106453.*

*Kyrkjeeide MO, Pedersen B, Evju M, Magnussen K, Mair L, Bolam FC, Mcgowan PJK, Vestergaard KM, Braa J, Rusch G. 2021. Bending the curve: Operationalizing national Red Lists to customize conservation actions to reduce extinction risk. Biological Conservation **261**. https://doi.org/10.1016/j.biocon.2021.109227*