POLICY BRIEF

ADVANCED BIODIVERSITY IMPACT ASSESSMENT FOR EVIDENCE-BASED DECISION-MAKING

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Main messages

- Ecosystem impacts from biomass supply chains extend across terrestrial, freshwater, and marine realms, but current assessment tools often fail to cover all realms.
- The BAMBOO project developed models for four complementary ecosystem metrics that provide a more comprehensive understanding of ecological impacts and trade-offs.
- Improved ecosystem metrics can strengthen evidence-based policymaking, supporting implementation of the Global Biodiversity Framework and more sustainable biomass governance.

Context

The adoption of the Kunming-Montreal Global Biodiversity Framework in 2022 marked a major milestone in global biodiversity governance, establishing ambitious targets to halt and reverse biodiversity loss by 2030. However, the fact that the preceding Aichi Biodiversity Targets were not fully achieved highlights persistent challenges in translating biodiversity commitments into effective action.

One important challenge is measurement. Existing biodiversity impact assessment approaches often rely on only one dimension of ecological change. This makes it difficult to identify ecological trade-offs across pressures, ecosystems, and supply chains, and can limit the effective integration of biodiversity into policy and planning, as called for under Global Biodiversity Framework Target 14.

This challenge is particularly relevant for biomass value chains, such as cotton, wood, or livestock feed, which can generate biodiversity impacts across terrestrial, freshwater, and marine ecosystems. Improving biodiversity impact assessment is therefore essential for evidence-based policymaking and for designing more sustainable biomass strategies.

In the BAMBOO project, we developed new impact assessment models, using four metrics covering different dimensions of nature - species richness, mean species abundance, functional diversity, and ecosystem services. It directly supports implementation of Target 14 of the Global Biodiversity Framework.

Key results

1. Species richness indicators improve assessment of marine biodiversity pressures.

Species richness indicators measure how human pressures affect the number of species present in ecosystems. BAMBOO developed new impact assessment models for three important marine pressures: ocean acidification, seabed damage, and overexploitation. These pressures are often missing in conventional biodiversity footprint tools. Ocean acidification, driven by carbon emissions, alters seawater chemistry and threatens calcifying organisms such as corals and molluscs. Seabed damage, caused for example by bottom trawling or dredging, destroys benthic habitats. Overexploitation reduces species populations and may disrupt marine food webs.

Improved representation of these pressures allows to better account for biodiversity impacts associated with supply chains linked to biomass inputs from marine systems.

2. Mean species abundance captures ecosystem condition beyond species loss.

Mean species abundance measures the average abundance of native species relative to undisturbed ecosystems. This metric helps assess ecosystem integrity, not just species presence.

Building on the GLOBIO model, BAMBOO developed new impact indicators for five environmental pressures: CO_2 emissions, NH_3 emissions, NO_x emissions, land use, and roads.

A key advantage is that mean species abundance captures ecological degradation even when species have not disappeared completely.

3. Functional diversity reveals risks to ecosystem functioning.

Species numbers alone do not show whether ecosystems retain ecosystem functioning. Functional diversity measures variation in species' traits that support ecosystem functioning.

BAMBOO assessed impacts of three environmental pressures across multiple realms: climate change, eutrophication (i.e., nutrient pollution), and

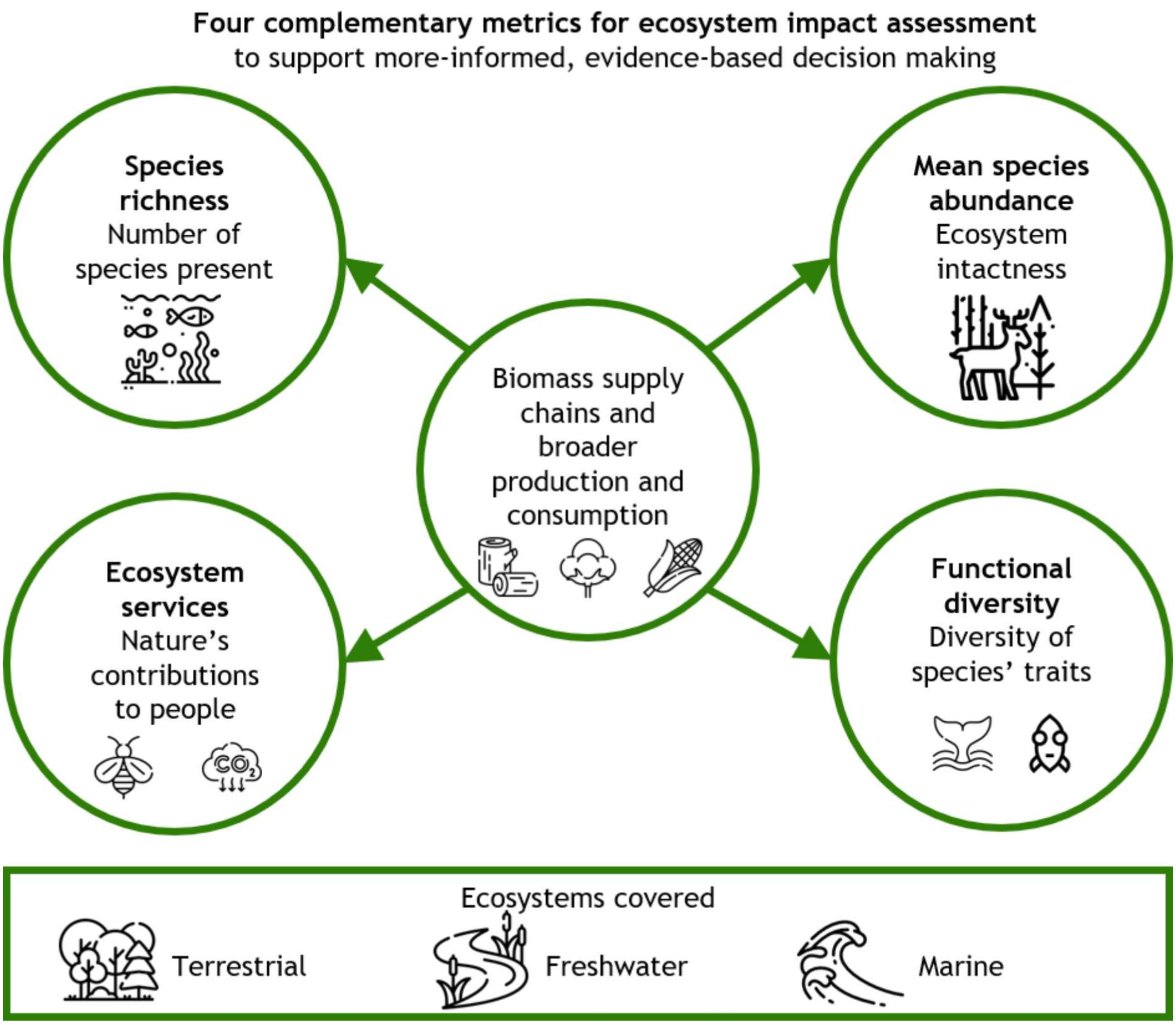

Figure 1: Overview of ecosystem metrics. Icons from Freepik at Flaticon.com.

overexploitation.

Depending on whether a lost species is functional rare or functional redundant, functional diversity loss can be stronger or weaker than species loss alone suggests.

4. **Ecosystem service models quantify land-use impacts on nature's contributions to people.**

Ecosystem service indicators show how land-use decisions influence nature's contributions to people.

Building on the GLOBIO-ES model, BAMBOO also assessed impacts on ecosystem services driven by land use. Four ecosystem services were assessed: pollination, pest control, erosion control, and carbon storage.

This strengthens policy analysis by linking biomass production systems directly to ecosystem service outcomes affecting human societies.

Recommendations

1. **Expand ecosystem assessments beyond single metrics.**

Policymakers should use multiple complementary metrics when assessing ecosystem impacts of policies and biomass supply chains. Using several metrics improves visibility of ecological trade-offs and reduces blind spots.

2. **Better integrate marine and freshwater pressures into ecosystem policy tools.**

Existing ecosystem impact assessment frameworks often prioritise terrestrial impacts. Integrating pressures such as ocean acidification, overexploitation, and eutrophication will improve ecosystem-wide policy alignment and strengthen cross-sector decision-making.

3. **Use ecosystem impact models to guide sustainable biomass strategies.**

As biomass demand grows for materials, energy, and feed, ecosystem-aware planning becomes increasingly important. Advanced impact assessment tools can support, for example, strategic land- and sea-use planning, as well as sustainability criteria for biomass sourcing. This can help align agricultural and forestry policy objectives with those for ecosystems.

Further resources

The BAMBOO impact assessment models are compiled on Zenodo:
https://doi.org/10.5281/zenodo.22102421

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