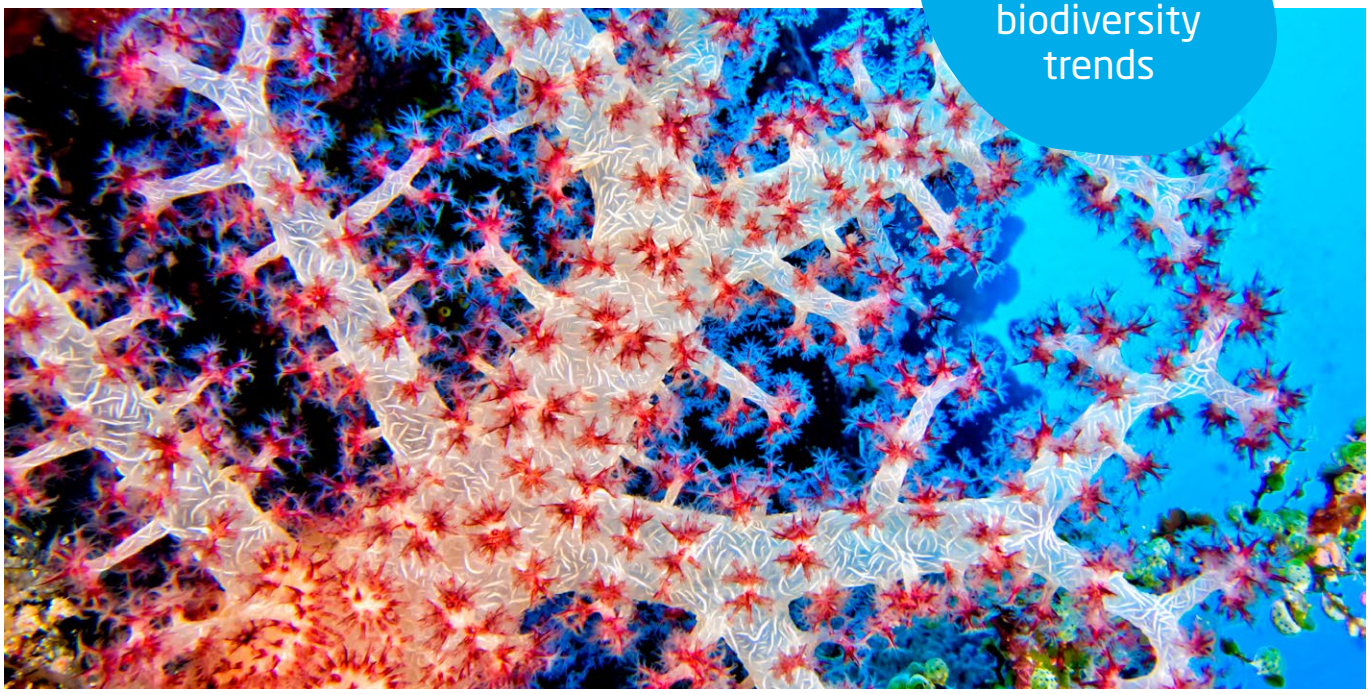
HIFMB FACT SHEET

Transfer Office for
Marine Biodiversity Change

Interpreting biodiversity trends



Biodiversity trends, their interpretation and implications

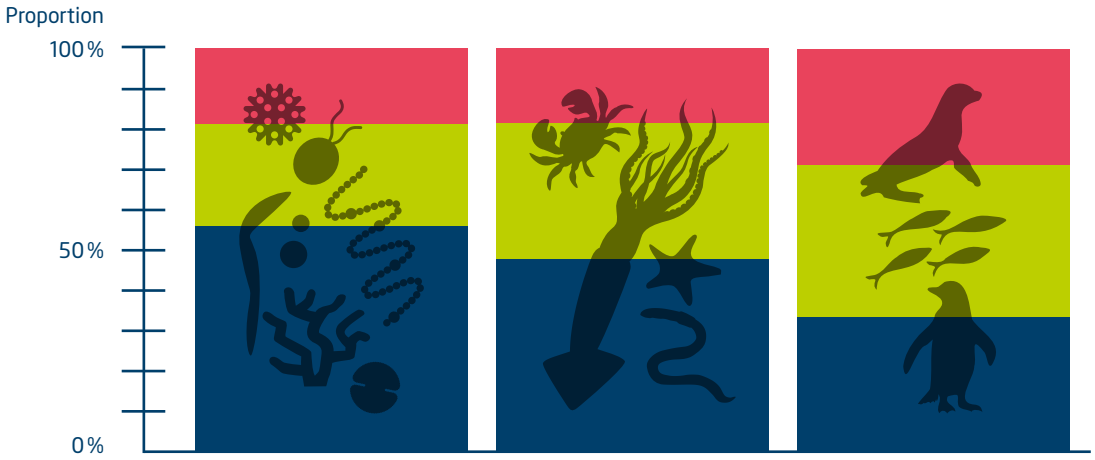
Unlike climate change, where temperature serves as a primary indicator, changes in biodiversity cannot be captured by a single metric. As a result, there are various indicators that each reflect different aspects of biodiversity change. These indicators must be interpreted together in order to form a complete understanding of how biodiversity is evolving.

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Carl von Ossietzky
Universität
Oldenburg

Coastal and marine biodiversity trends in Germany

An analysis of over 1600 biodiversity trends (across different biodiversity metrics, e.g. number of species, amount of biomass) from coastal and marine ecosystems in Germany extracted from raw data and literature on plants and phytoplankton, invertebrates (macrozoobenthos, arthropods, zooplankton) and vertebrates (birds, marine mammals, fish) gave a differentiated picture. (Hodapp et al. 2024)



Proportions of positive (green), neutral (darkblue) and negative (red) trends in biodiversity monitoring time series for marine plants and phytoplankton, invertebrates and vertebrates.

Plants and phytoplankton
Over half of all trends (56 %) were stable, while the data indicate on average more positive (25.3 %) than negative (18.7 %) trends, although the numbers varied between the different biodiversity metrics.

Invertebrates
Almost half of the time series (47.7 %) showed no trend, but considerably more negative (33.8 %) than positive (18.5 %) trends across all biodiversity metrics.

Vertebrates
One third of all trends (33.4 %) were stable, while positive trends (37.9 %) prevailed over negative trends (28.7 %).

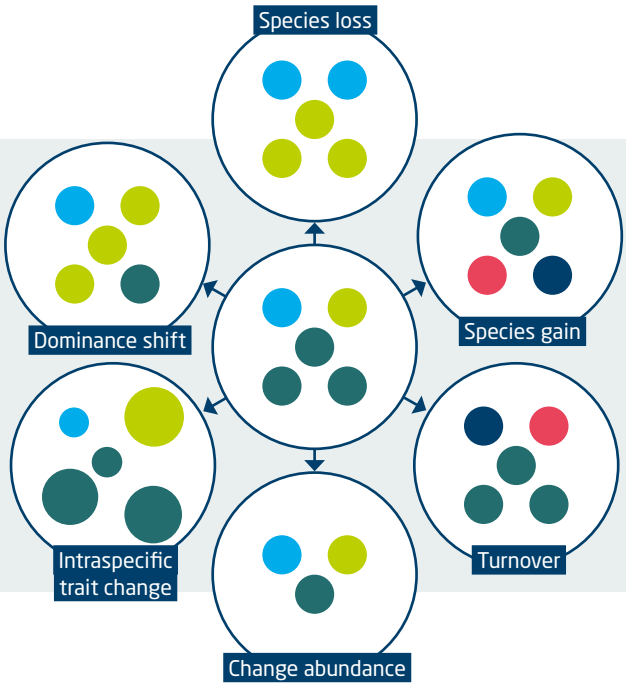
These time series depict an overall rather balanced development in biodiversity trends and seem almost contradictory to the alarming results of Red List Indices or the IPBES Global Assessment on Biodiversity and Ecosystem Services (IPBES 2019). This seeming incoherence between different biodiversity change measures is resolved though when biodiversity trends and metrics are interprted correctly.

1 Monitoring biodiversity can only take place where diverse communities still exist

Monitoring biodiversity usually takes place in protected areas, i.e. in places where we expect to find rather diverse or natural communities. At the same time, healthy habitats are decreasing in area and connectivity under the intensifying use of natural systems by humans, e. g. settlements, traffic, agriculture. Loss of intact habitat always results in loss of biodiversity, but will stay unnoticed or unrecorded by most biodiversity monitoring time series (Hodapp et al. 2024).

2 No trend in species numbers does not imply no change

Assessing changes in species numbers over time can only capture one facet of biodiversity change. Studies have shown that the number of species can stay exactly the same, while up to all species in a community are replaced due to e. g. environmental change. Whether the new species fulfill the same functions or represent the same diversity in species traits as the former community can vary greatly. Thus, species numbers are only one aspect of many to be considered when assessing biodiversity change (Hillebrand et al. 2018).

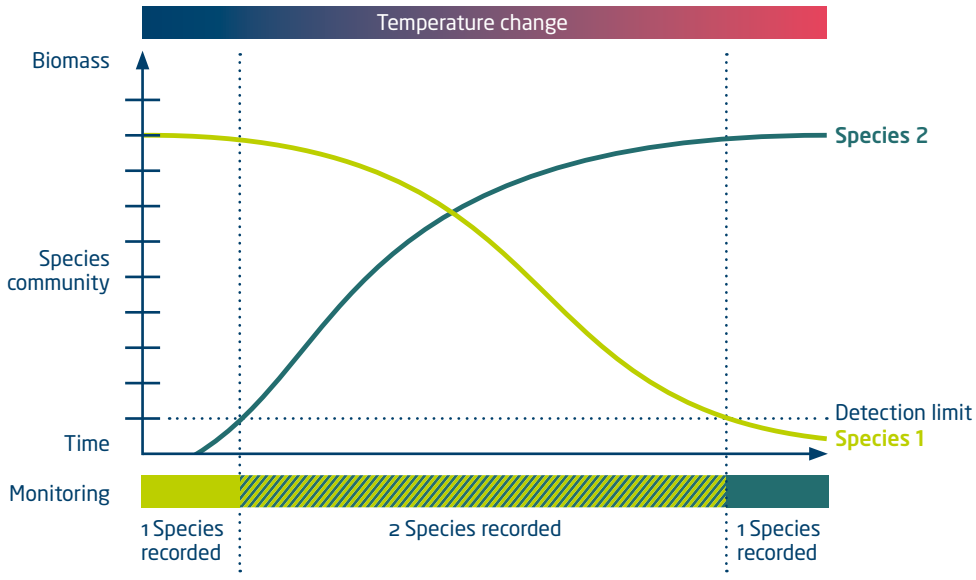


Aspects of biodiversity change. The central circle describes the current species community. Each of the surrounding circles depicts a species community where one biodiversity aspect of the original community has been changed.

Colours depict different species. Different shapes indicate differing functional traits.

3 No trend in species numbers does not imply no loss

When environmental conditions change (e.g., rising temperatures), they typically become less favorable for some species that prefer previous conditions (e.g., cooler temperatures), while they may become more suitable for species that were previously absent, due to their different tolerance levels (e.g., temperature tolerance). This shift leads to changes in the species community: the establishment of new species and, in most cases, the local extinction of others as their ranges shift. These processes occur simultaneously, but on different time scales. The extinction of a species can take a long time, continuing until the last individual disappears, whereas the establishment of new species tends to happen much more quickly once conditions become suitable. As a result, monitoring time series of species numbers should indicate slightly positive trends, because they also record the species that have not yet fully gone extinct.This imbalance can take decades or even longer to resolve and therefore still takes place long after a period of environmental change has ended (Strack et al. 2022; Kuczynski et al. 2023). Thus, the current neutral trends often observed in species richness over time likely reflect a long-term decline in species numbers, rather than a stable biodiversity.



Biomass dynamics of one cold adapted (species 1) and one warm adapted (species 2) species in a warming environment. The dashed line indicates the detection limit, below which a species cannot be recorded in monitoring programmes. The monitoring bar indicates the time interval, in which one or both species are recorded and therefore count towards the monitored local species richness.

Take-home messages

1

The balanced picture of positive, neutral and negative biodiversity trends is not contradictory to the alarming reports based on Red List indices and estimated numbers of global species loss.

2

Every development with regard to biodiversity has to take into account the massive time lag related to biodiversity dynamics as a result of the different time scales relevant to species gains and losses as response to environmental change. This is also true for changes in response to management actions. Biodiversity change takes time!

3

Biodiversity monitoring has to include several aspects of biodiversity change: changes in the amount of habitat, species numbers, and biomass as well as the functional composition of communities. All aspects are necessary in order to obtain acomprehensive picture of biodiversity change.

Original Publications

Kuczynski L, Ontiveros VJ & Hillebrand H. (2023). Biodiversity time series are biased towards increasing species richness in changing environments. Nat Ecol Evol 7: 994–1001. https://doi.org/10.1038/s41559-023-02078-w

Hillebrand H, Blasius B, Borer ET et al. (2018). Biodiversity change is uncoupled from species richness trends: Consequences for conservation and monitoring. J Appl Ecol 55: 169–184. https://doi.org/10.1111/1365-2664.12959

Strack T, Jonkers LC, Rillo M et al. (2022). Plankton response to global warming is characterized by non-uniform shifts in assemblage composition since the last ice age. Nat Ecol Evol 6: 1871–1880. https://doi.org/10.1038/s41559-022-01888-8

Hodapp D, Buschbaum C, Dutz J et al. (2024). Küste und Küstenschutz. In: Faktencheck Artenvielfalt – Bestandsaufnahme und Perspektiven für den Erhalt der biologischen Vielfalt in Deutschland. ed. by Wirth C, Bruelheide H, Farwig N et al. oekom, München: 647–785. ISBN 978-3-98726-095-7. https://doi.org/10.14512/9783987263361

IPBES. (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Version 1). Zenodo. https://doi.org/10.5281/zenodo.6417333

HIFMB Transfer Office
for Marine Biodiversity Change

Author
Dr. Dorothee Hodapp, Dr. Ute Jacob

Publisher
Transfer Office for Marine Biodiversity Change
Helmholtz Institute for Functional Marine Biodiversity at the University of Oldenburg (HIFMB)
Im Technologiepark 5 / 26129 Oldenburg / Germany / T +49 471 4831 2511
marine.biodiv@hifmb.de / hifmb.de/transfer-office

Editorial design and infographic design
утро Design