Bridging the Gap between Biodiversity Metrics

Webinar June 5th 2023

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PRé

Queen Mary University of London

Your panel for today

Mark Goedkoop

Founder of PRé Sustainability

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Theoretical Ecologist
Queen Mary University of London

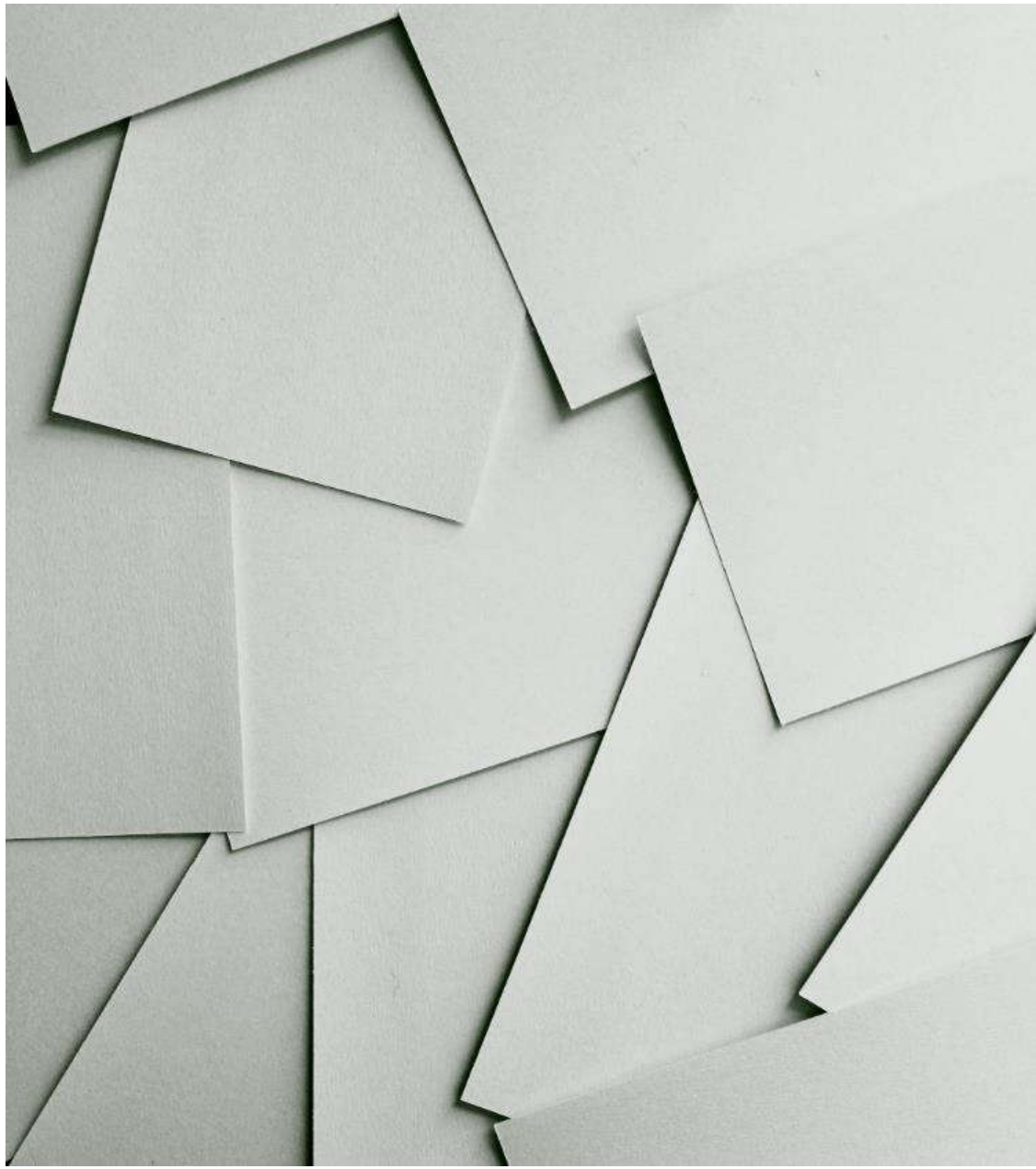
Marina Dumont

Analyst at PRé

Agenda

- Introduction and objectives
- Understanding State Indicator Metrics (Axel)
  - *Q&A*
- Understanding Footprint Metrics (Mark)
  - *Q&A*
- Bridging the Gap; LPI, PDF (Mark)
  - *Q&A*
- Managing extinction risk: BIC, BSC, UD, RSR, STAR (Axel)
  - *Q&A*
- Closure

All background information is available on www.biodiversity-metrics.org



Objectives

Clarify how leading metrics work

Clarify what leading metrics represent

Do they measure (global) extinction risks?

Do they measure Ecosystem Functioning (and indirectly ecosystem services)

Clarifying the State Indicator perspective and the Footprint perspective

State indicator metrics for policy development

Biodiversity Footprinting for business

Bridging the apparent Gap between State and Footprint indicators

Corporate Biodiversity Footprint Metrics can be linked to State Indicator Metrics (and thus policy)

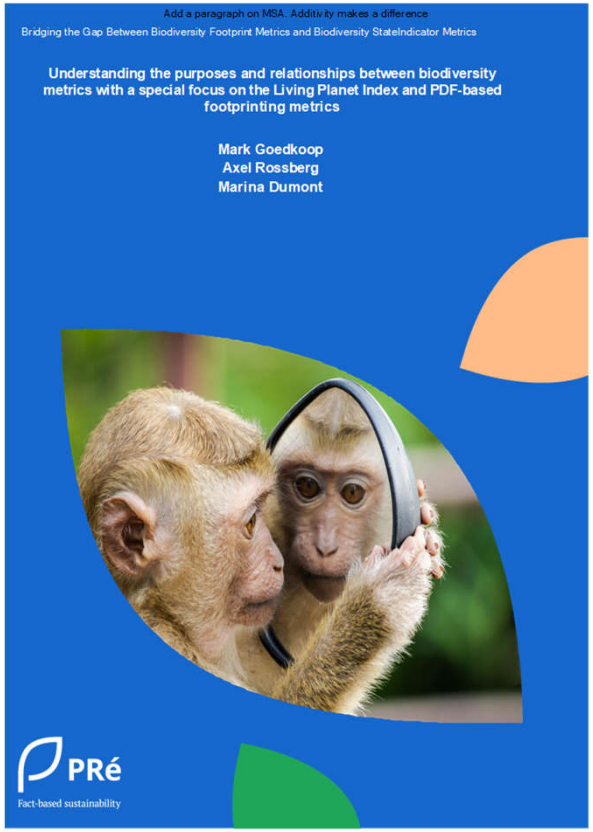
What does this tell us about possible remediation options

If reducing extinction risk is the objective, how can we compensate residual impacts using this thinking

All background information is available on www.biodiversity-metrics.org

The scientific basis

- Axel Rossberg made a math based link between various biodiversity metrics
- Main conclusion: a PDF based footprint is a very good proxy for the global extinction risk
- Axel approached us: Help me… nobody is going to read my paper
- The whitepaper is available via www.biodiversity-metrics.org *(metrics and methods -> understanding biodiversity metrics)*



All background information is available on www.biodiversity-metrics.org

- Please use the Q&A section for questions and comments
- You can see all questions and up-vote them
- We will try to address the most popular after each section

The slides and recordings will be sent afterwards, and on www.biodiversity-metrics.org

All background information is available on www.biodiversity-metrics.org

Understanding State Indicators

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State Indicator Metrics

Track biodiversity STATE for policy makers

Basis: Compare present system state with past, through observations

Options:

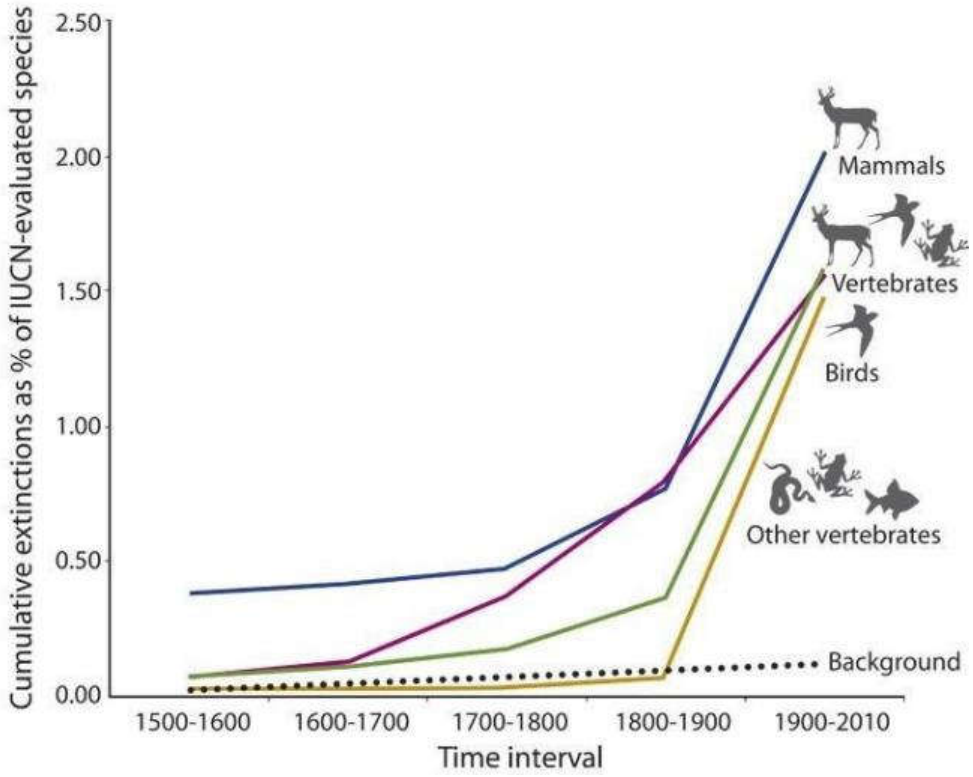
Focus on species extinction risk

Focus on ecosystem intactness, extent (and services)

All background information is available on www.biodiversity-metrics.org

Moving towards the 6th mass extinction

- We are in a the midst of an "extinction crisis"
- Extinctions difficult to measure
- Instead, measure *extinction risk*



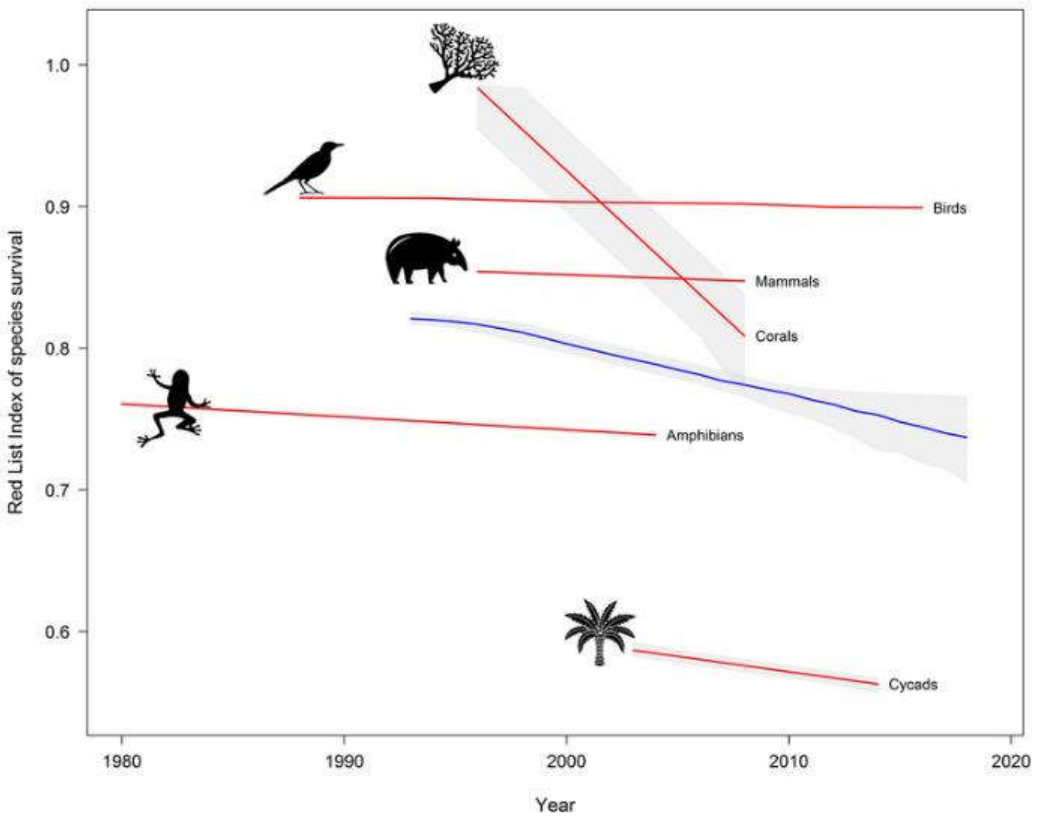
Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M., Palmer, T.M., 2015. Accelerated modern human–induced species losses: Entering the sixth mass extinction. Science Advances 1, e1400253. https://doi.org/10.1126/sciadv.1400253

See also: Cowie, R.H., Bouchet, P., Fontaine, B., 2022. The Sixth Mass Extinction: fact, fiction or speculation? Biological Reviews 97, 640–663. https://doi.org/10.1111/brv.12816

State indicator: Red List Index

Species Red List Category	Score
Least Concern	1.0
Near Threatened	0.8
Vulnerable	0.6
Endangered	0.4
Critically Endangered	0.2
Extinct	0.0

→ average over all species = RLI



https://www.iucnredlist.org/assessment/red-list-index

All background information is available on www.biodiversity-metrics.org

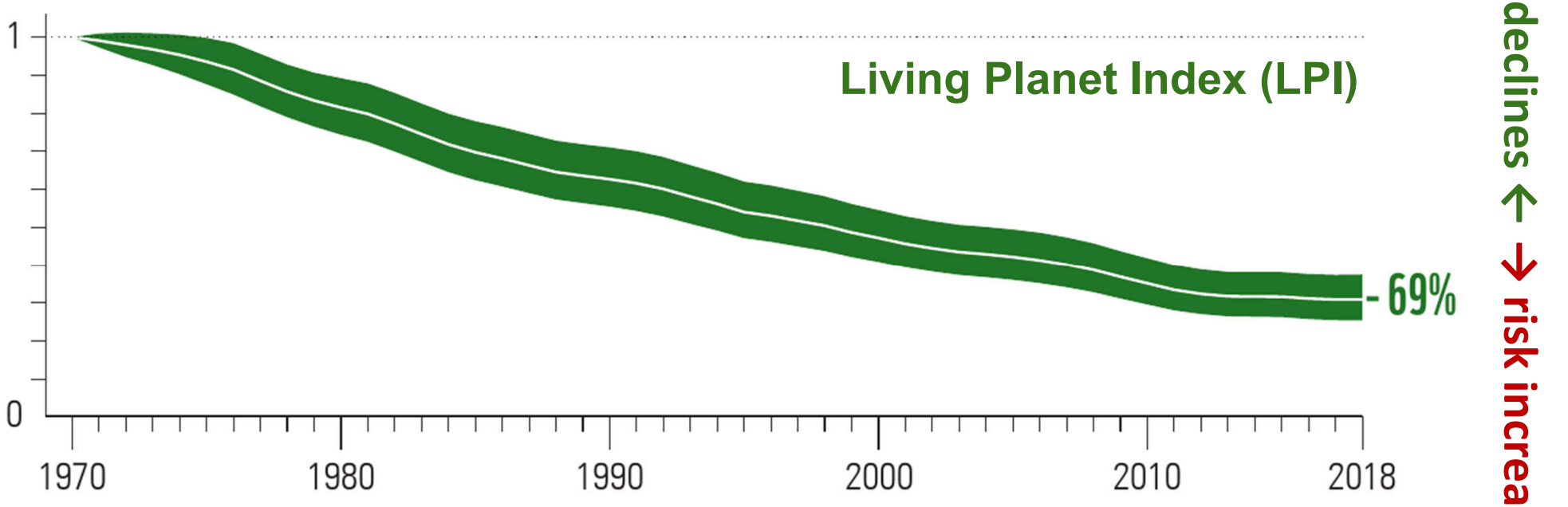
State indicator: Living Planet Index (LPI)

- Computed from changes in population sizes of species
- The
- Refl

risk declines ← → risk increases

State indicator: Living Planet Index (LPI)

- Computed from changes in population sizes of species
- The “Dow Jones Index of biodiversity” - highlight cited in media
- Reflects changes in **mean global species extinction risk** (https://doi.org/10.48550/arXiv.2111.03867)



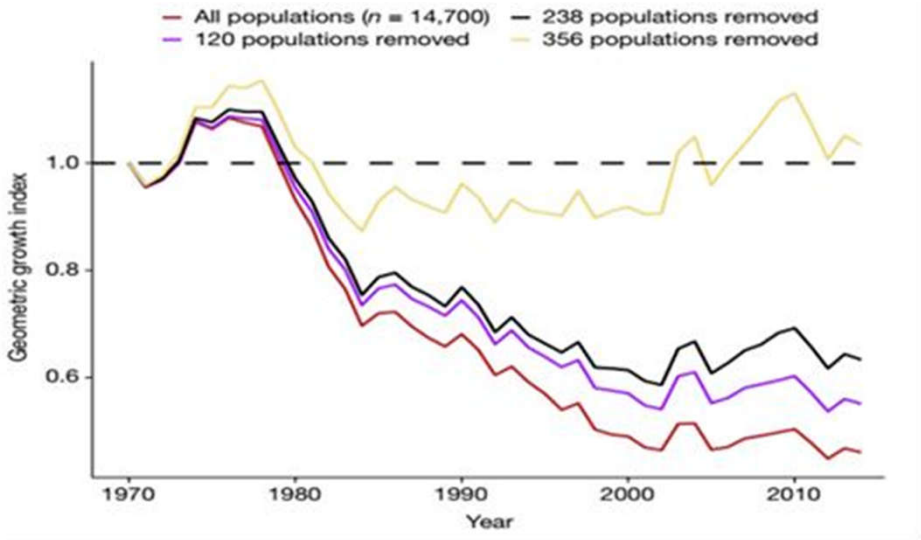
State indicator: Living Planet Index (LPI)

- Population sizes x_i relative to baseline are multiplied and then the root is taken:

  $$\sqrt[n]{x_1 * x_2 * \ldots * x_n} = \text{LPI}$$

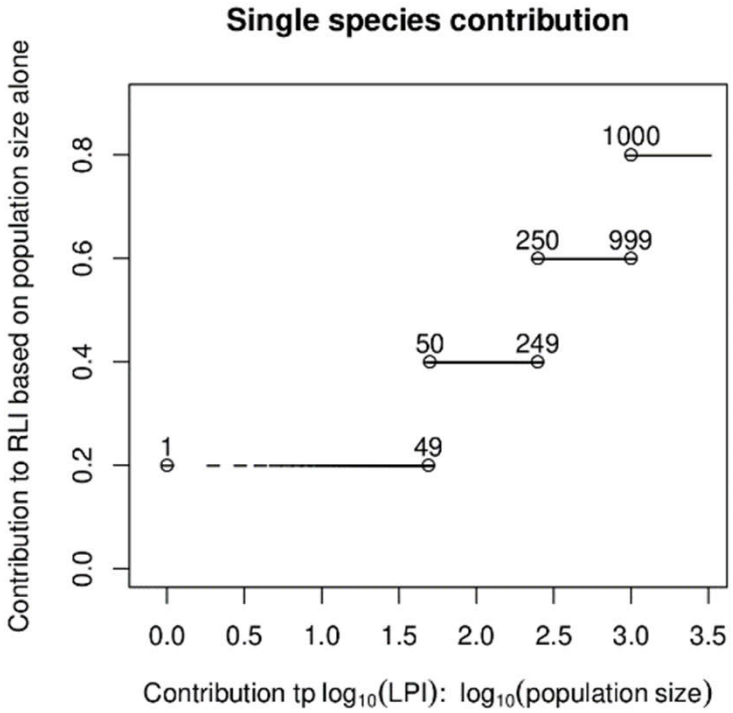
  → geometric mean

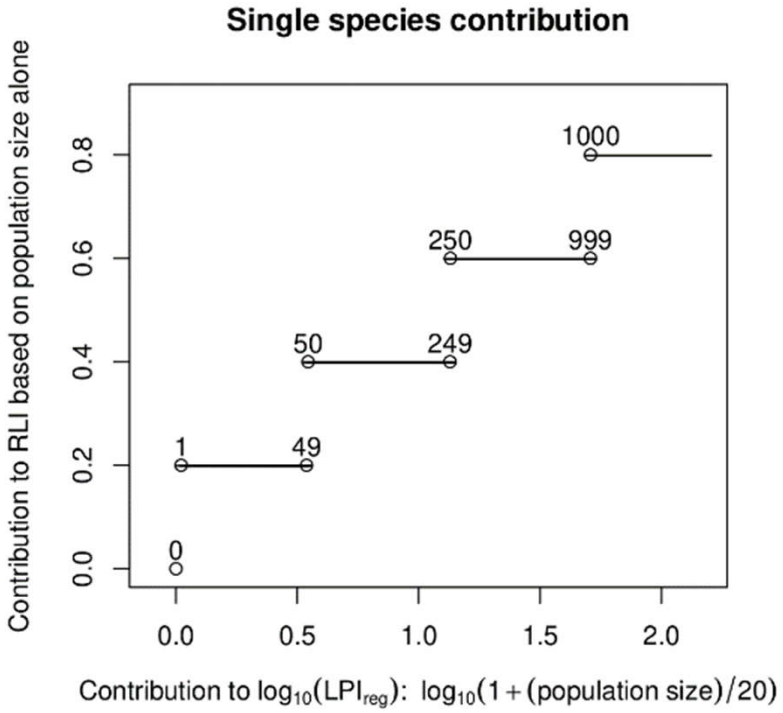
- The multiplication makes the metric very sensitive for fast declining populations



Leung, B., Hargreaves, A.L., Greenberg, D.A., McGill, B., Dornelas, M., Freeman, R., 2020. Clustered versus catastrophic global vertebrate declines. Nature 588, 267–271. https://doi.org/10.1038/s41586-020-2920-6

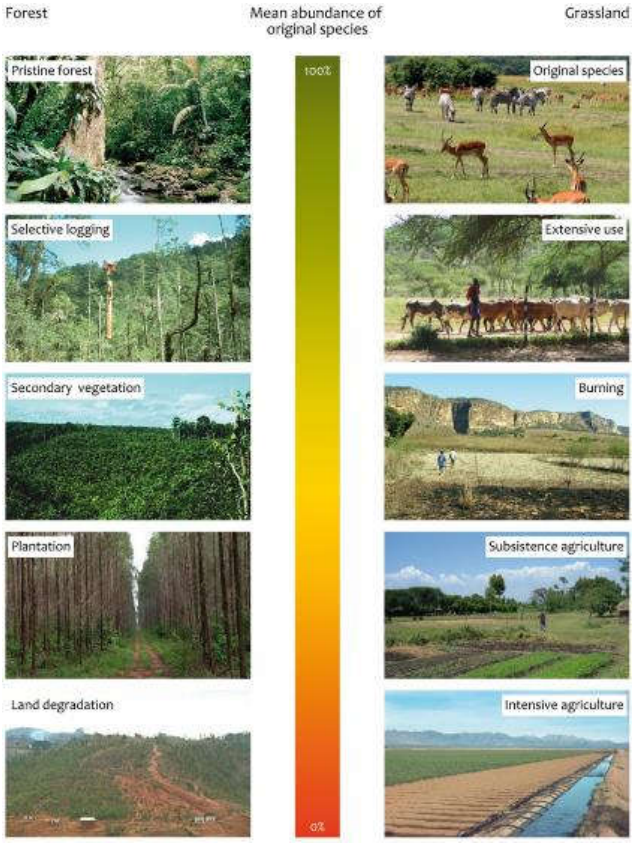
Technical aside:
Are RLI and LPI fundamentally different?

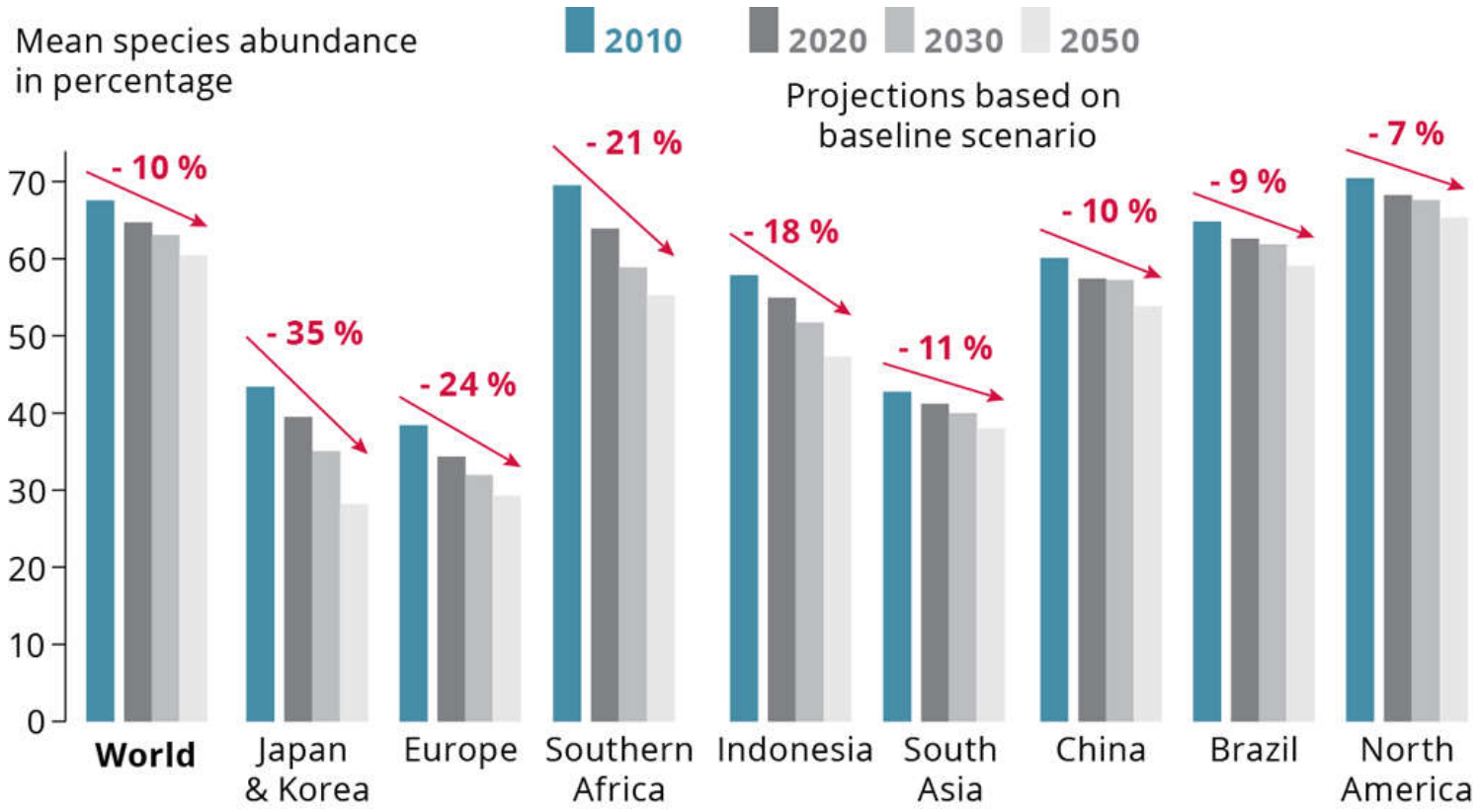




State indicator: Mean Species Abundance

Quantifies the intactness/integrity/condition of ecosystems





https://www.eea.europa.eu/soer/data-and-maps/figures/terrestrial-mean-species-abundance-globally

State indicator: Mean Species Abundance (MSA)

- MSA based on <u>local</u> population sizes x_i relative to baseline
- Changes are not multiplied but added, and then divided by the number of populations
  $(x_1 + x_2 + \cdots + x_n)/n$ = MSA
  → arithmetic mean
- …then average MSA over space.
- Several variants of the metric are used; we focused on the GLOBIO version developed by PBL.

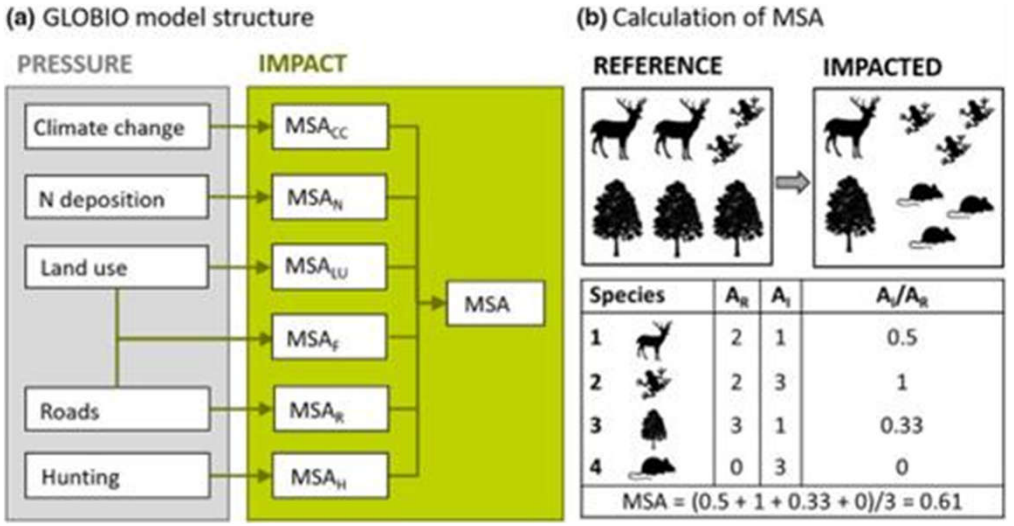
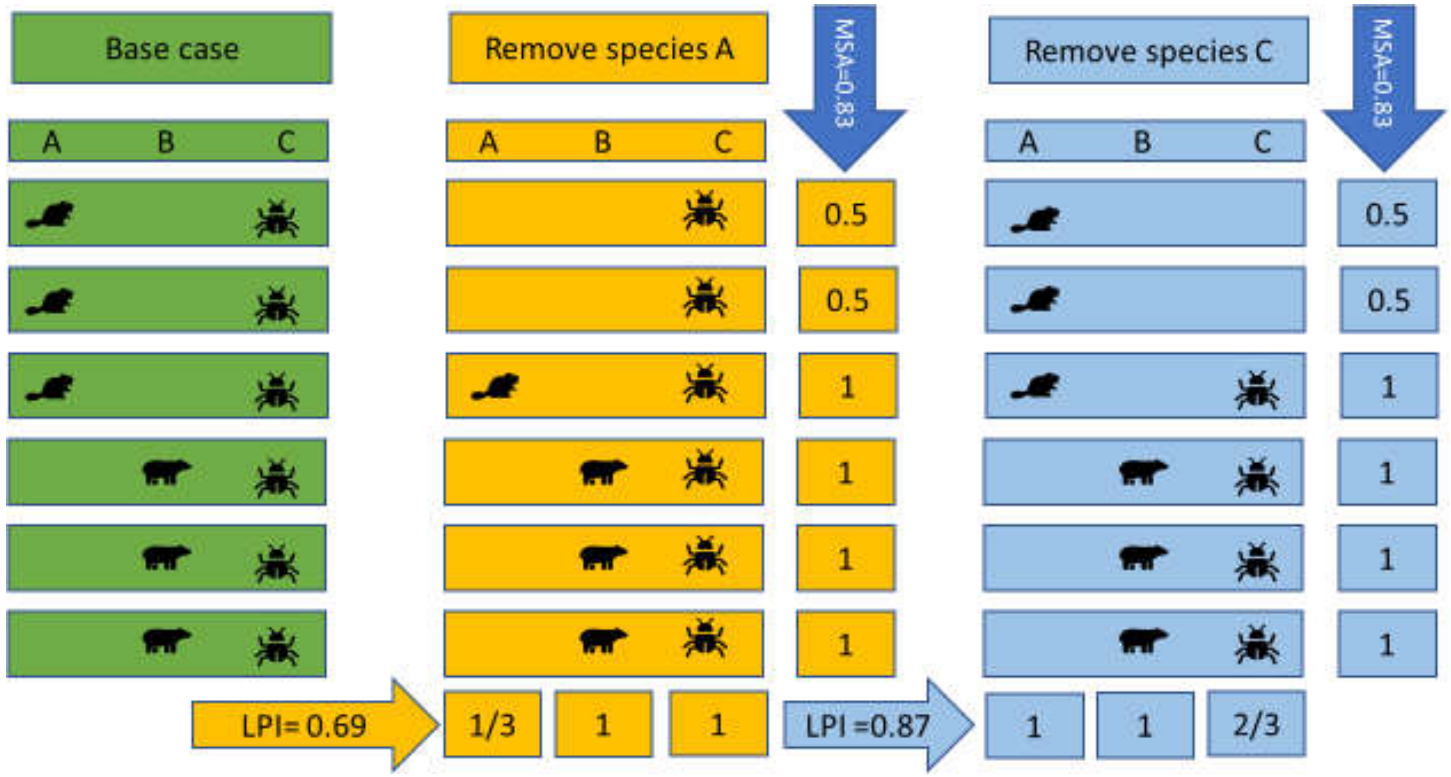


Illustration of MSA truncation rules (see frog example)

LPI and MSA provide different information

- Assume a toy world with just three species populations and 6 plots
- If 2 out of 3 populations A disappear, LPI = 0.69
- If 2 out of 6 populations C disappear, LPI = 0.87
- In both cases MSA is the same: MSA = 0.83
- LPI is sensitive to increase in extinction risk.
- MSA is not.
- <u>We should use both kinds of metrics.</u>



Your Questions On State Indicator Metrics

All background information is available on www.biodiversity-metrics.org

Understanding Footprint Metrics

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Footprinting Metrics

Companies can determine their anual emissions, water and land-use and assess the expected (Future) impact on biodiversity

Basis: Assess the full scope 1, 2 and 3, as is done in Life Cycle Assessment

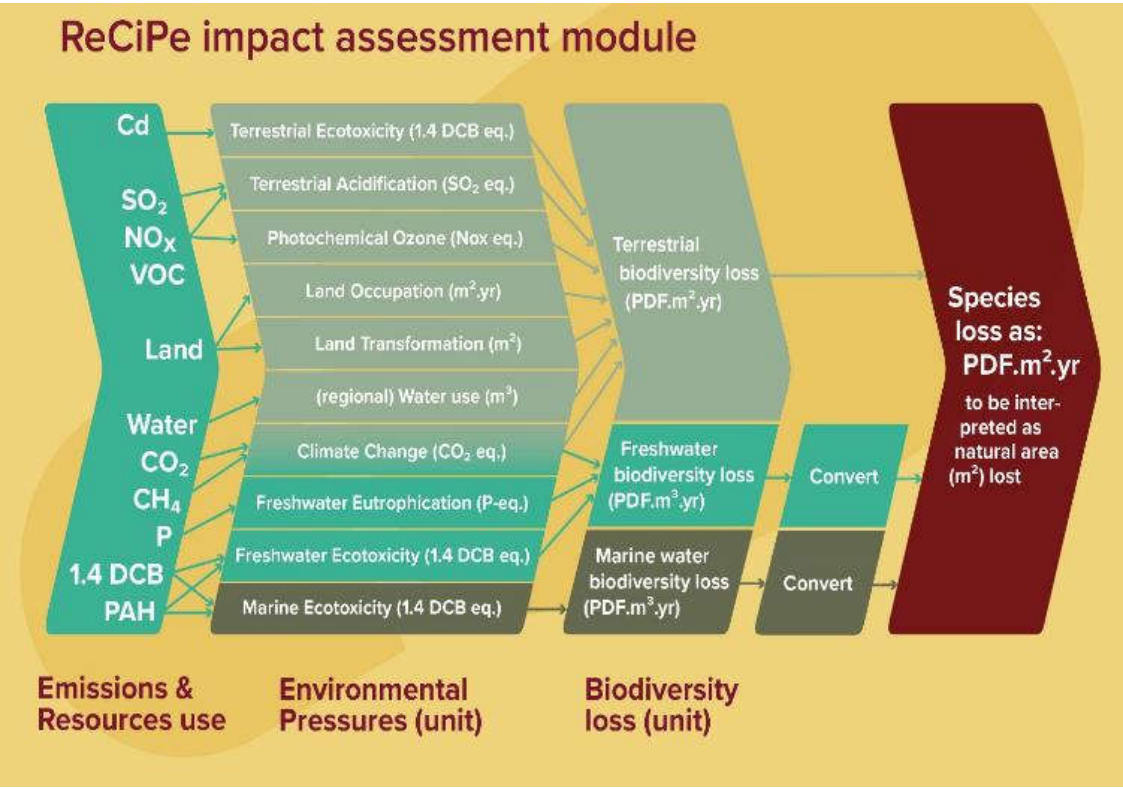
Options:

- Asses the potential disappearance of species
- Assess the impact on species abundancy

All background information is available on www.biodiversity-metrics.org

Focus on Potentially Disappearance of Species

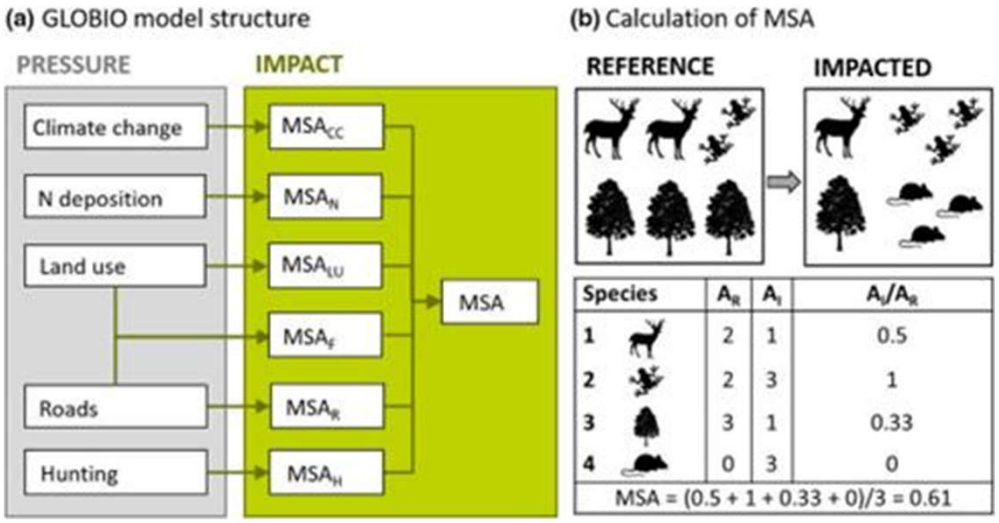
- The ReCiPe methodology was developed for LCA,
- Metric: Potentially Disappeared Fraction of Species (PDF) in and area during a time interval:
  - PDF is a percentage
  - Year, because An emission will have an impact during a limited time periods
  - Area or Volume, because: Land and water use will have a regional impact, emissions dilute over an area or volume, hence the m^2 or m^3.
- The unit is PDF.m2.yr for terrestrial impacts and PDF.m^3.yr for aquatic impacts. To align surface and volume, we can multiply with the species density, so the unit becomes Species.yr



All background information is available on www.biodiversity-metrics.org

Focus on Species Abundance

- The GLOBIO methodology was developed as State indicator but is also used for Footprinting.
- Unit: MSA.m2.yr



PDF = 1
MSA=0

PDF = 0
MSA=1

All background information is available on www.biodiversity-metrics.org

PDF and MSA Footprints are based on models

- All impact pathways are based on environmental cause effect mechanism, such as Fate, Exposure, Impact and Damage models
- All are based on publicly available peer reviewed science.
- For Land use and water use modelling species counts under different pressures are used.
- Focus on Vascular plants and lower organisms

All background information is available on www.biodiversity-metrics.org

www.bioscope.info: free biodiversity screening tool

The question:
What is the biodiversity impact of an investment, a company or a sector?

Input data
Enter the spending data of all purchased goods for your production processes

Results
BioScope calculates the biodiversity footprint for your investment or your company.

The Benefits
- Easy to use
- Low time investment
- Free access
- Open-source models
- Download results and visual representation

The **BioScope model** includes the EXIOBASE environmentally extended input-output database & the ReCiPe impact assessment method

Your Questions on Footprint Metrics

All background information is available on www.biodiversity-metrics.org

Bridging the Gap between metrics

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Why it is interesting to bridge the gap?

In climate the state indicator and the footprint are connected (CO2 equivalents); we can relate company footprints to for instance, the Paris goals

The Biodiversity Footprint Metrics seem unconnected to the State Indicator Metrics, especially with the focus on extinction risk

The MSA State Indicator Metric can be relatively easily linked to the MSA Footprint, but MSA is not very sensitive to extinction risk

If Extinction Risk is the focus (see GBF), it is more interesting to focus on the LPI.

We found there is a good link between PDF based Footprints and the LPI

All background information is available on www.biodiversity-metrics.org

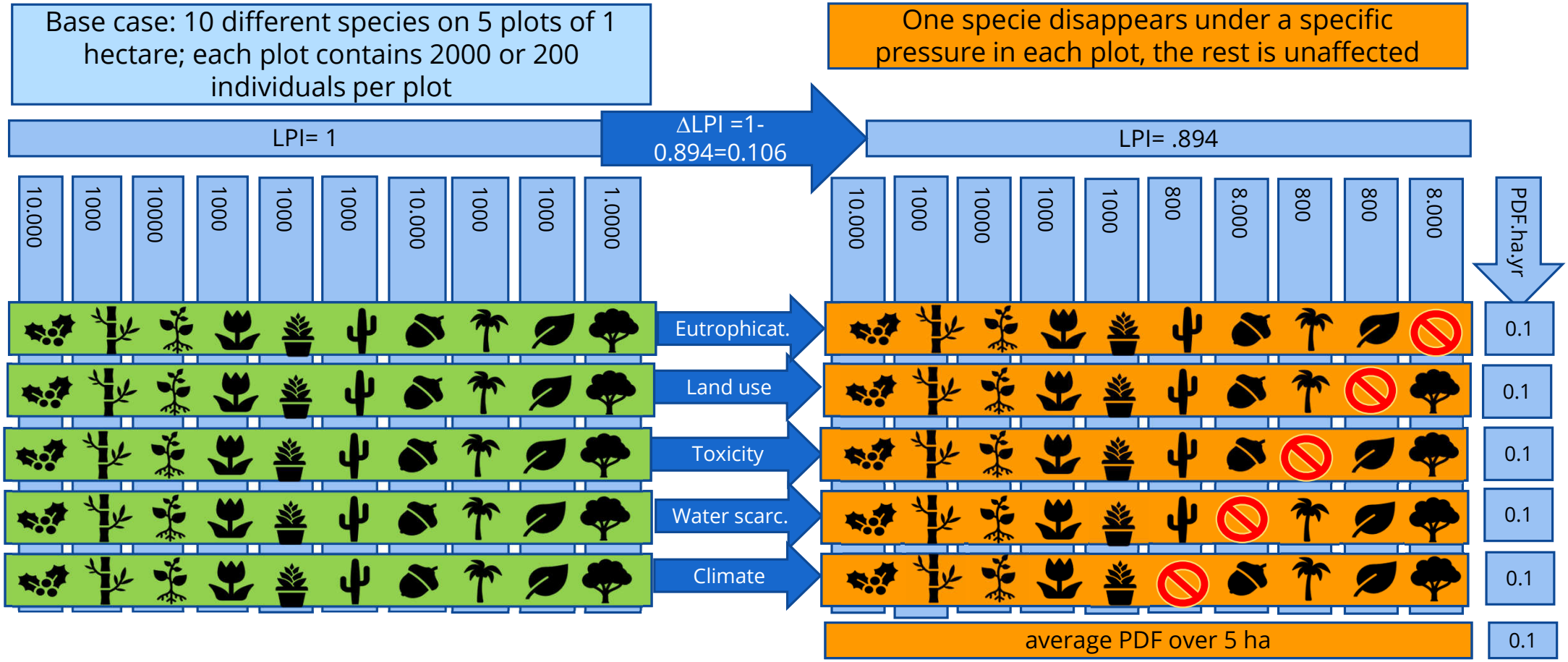
Linking LPI to PDF based Footprint results

- The detailed analysis from Axel Rossberg shows the mathematical relationship:

$$\Delta LPI \approx - PDF \cdot LPI$$

  - ΔLPI denotes the change in LPI
  - PDF denotes the potentially Disappeared Fraction of Species calculated in a Footprint
  - LPI denotes the pre-existing LPI
- Suppose we have 10 species in 6 plots. Populations are either 200 or 2000 individuals per species per plot.
- An intervention causes the disappearance of one different species (PDF=10%)

Linking PDF to LPI



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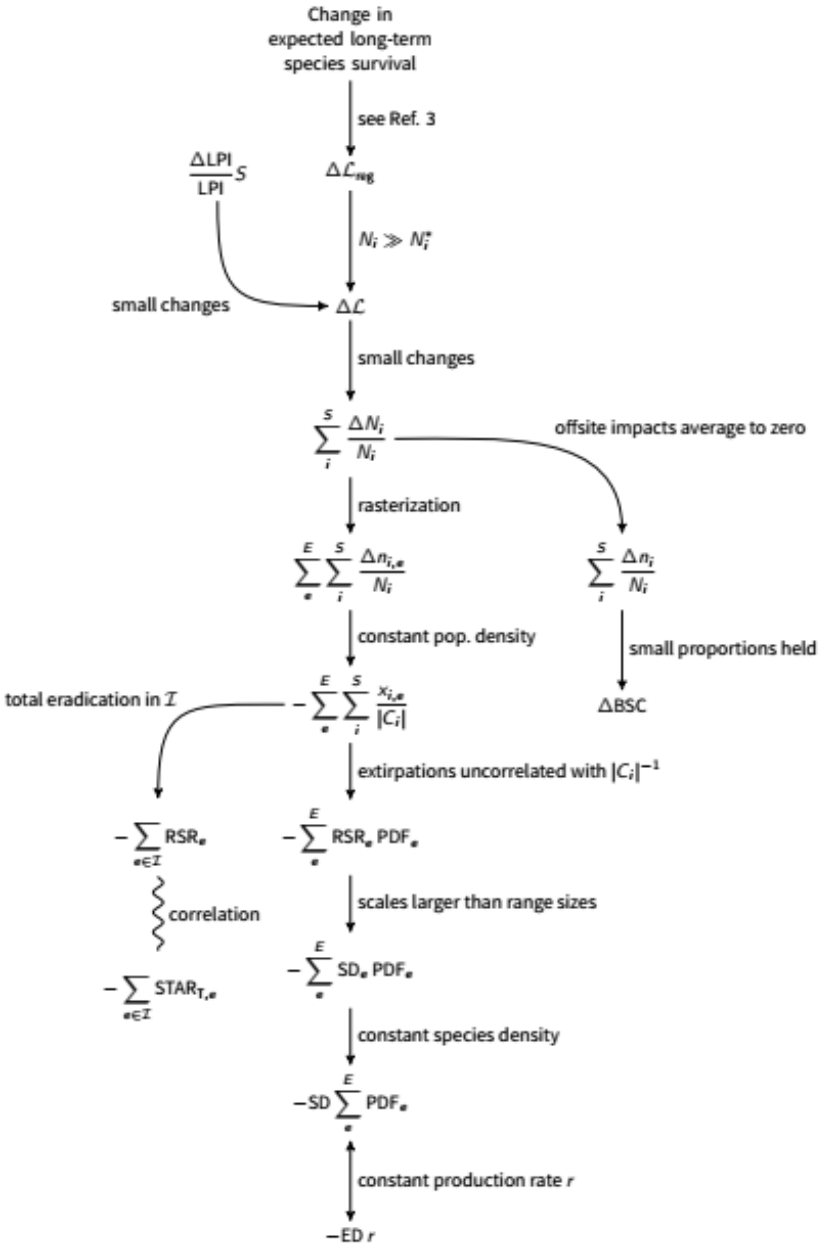
Assumptions

- The example only works because different species disappear in each plot. If the same species would disappear in all plots the LPI would be zero, so no match…
- Generally, companies cause emissions along a long and geographical distributed supply line, so impacts will be widespread.
- In case large areas of land are used or converted; the link may not work



All background information is available on www.biodiversity-metrics.org

Your Questions on Bridging the Gap

All background information is available on www.biodiversity-metrics.org

Compensating for extinction risk

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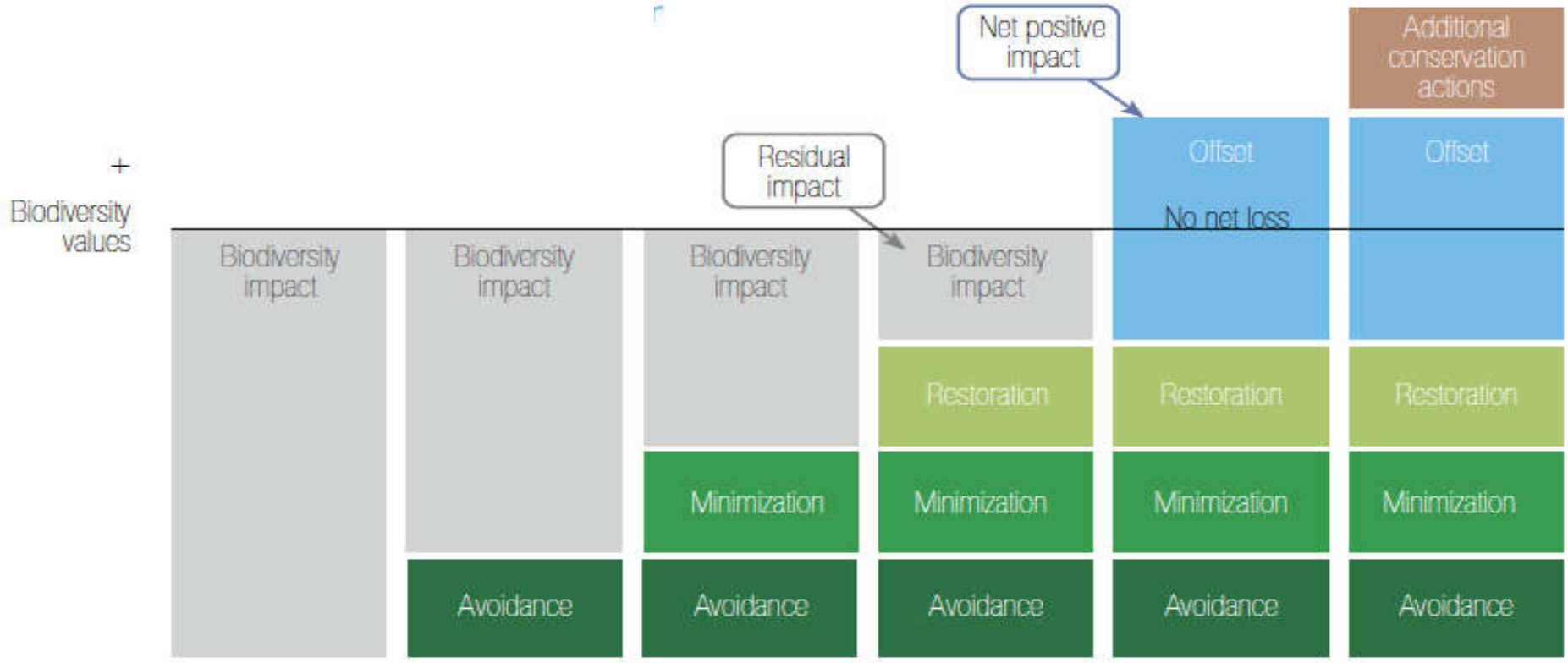
Mitigation Hierarchy: Compensate for Residual Impact



Credit Metrics

Companies and on their own or in partnership with others can make targeted interventions to reduce or compensate their footprint.

Quantitative changes resulting from local interventions

Options:

Reduce mean global species extinction risk

(Improve extent and intactness of local ecosystems)

Metrics of impact on extinction risk

Range Size Rarity (RSR) = $\frac{\text{local range}}{\text{species' global range}}$ ...summed over all species.

Consider change ΔRSR.

(Howard, 1991; Williams *et al.*, 1996)

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$$\text{Range Size Rarity (RSR)} = \frac{\text{local range}}{\text{species' global range}}$$

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Consider change ΔSTAR (?)

(Mair *et al.*, 2021)

$$\text{Units of Global Distribution (UD)} = \frac{\text{change in population caused}}{\text{species' previous global population}}$$

(Temple, *et al.*, 2012)

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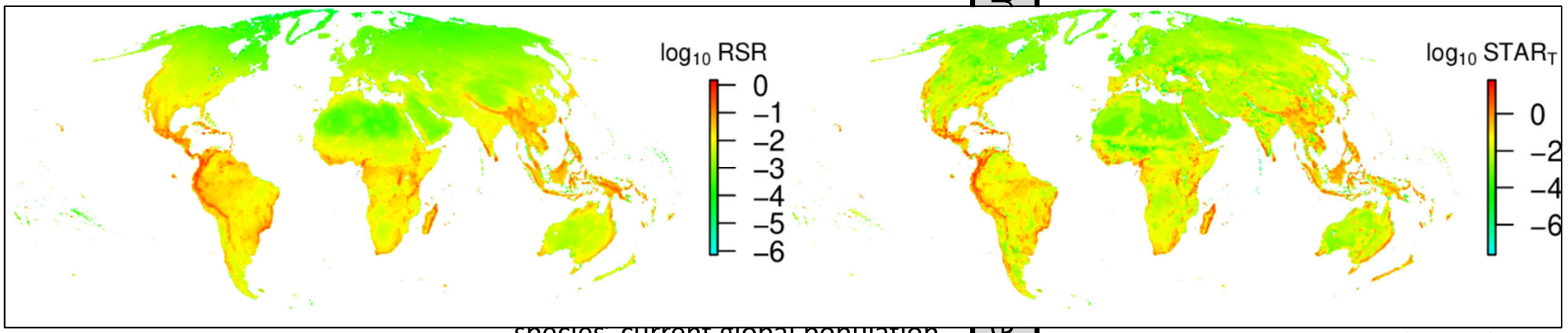
...summ...



species' current global population

(Rossberg, *et al.*, 2023)

...as.

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Consider change ΔBSC.

(Rossberg, *et al.*, 2023)

...summed over all species.

Link to State Indicator metrics:

$$\Delta LPI \approx \Delta BSC \cdot LPI / S$$

$$\Delta LPI \approx - PDF \cdot LPI$$

$$\Delta LPI \approx (\Delta BSC - PDF \cdot S) \cdot LPI / S$$

Link to State Indicator metrics:

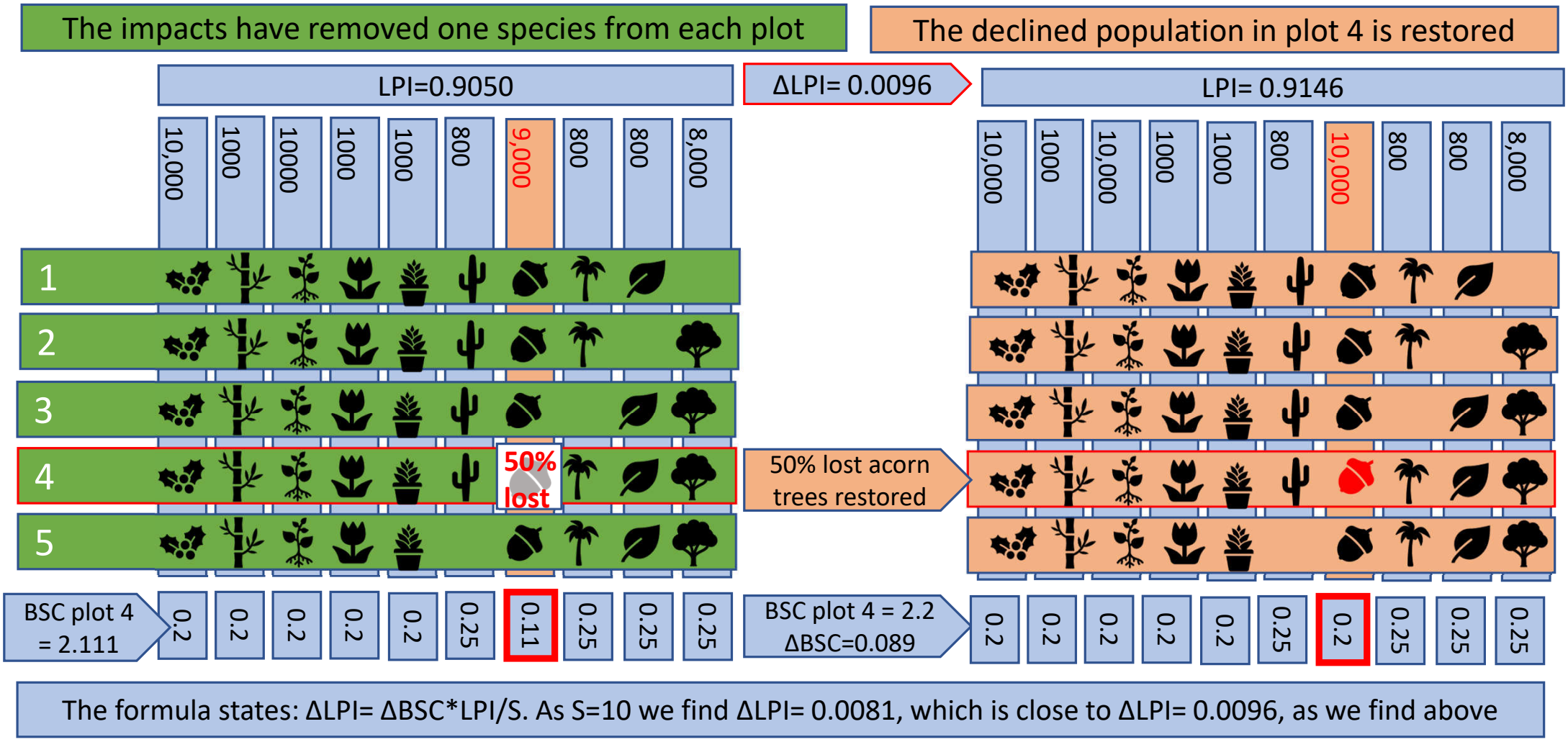
$$\Delta LPI \approx \Delta BSC \cdot LPI / S$$

$$\Delta LPI \approx - PDF \cdot LPI$$

$$\Delta LPI \approx (\Delta BSC - PDF \cdot S) \cdot LPI / S$$

→ LPI increases and extinction risk declines if:

$$\underbrace{\Delta BSC}_{\text{compensation}} - \underbrace{PDF \cdot S}_{\substack{\text{yearly} \\ \text{footprint in} \\ \text{species.yr}}} > 0$$


The impacts have removed one species from each plot
The declined population in plot 4 is restored
LPI=0.9050
ΔLPI= 0.0096
LPI= 0.9146
10,000
1000
10000
1000
1000
800
9,000
800
800
8,000
10,000
1000
10,000
1000
1000
800
10,000
800
800
8,000
1
2
3
4
5
50% lost
50% lost acorn trees restored
BSC plot 4 = 2.111
0.2
0.2
0.2
0.2
0.2
0.25
0.11
0.25
0.25
0.25
BSC plot 4 = 2.2
ΔBSC=0.089
0.2
0.2
0.2
0.2
0.2
0.25
0.2
0.25
0.25
0.25
The formula states: ΔLPI= ΔBSC*LPI/S. As S=10 we find ΔLPI= 0.0081, which is close to ΔLPI= 0.0096, as we find above

Earning Biodiversity Impact Credits

Recovering the population…

$$BIC = \frac{\text{change in population caused}}{\text{species' current global population}}$$

…of a species near extinction…

e.g. with treeconservationfund.org

… earns you ≈ 1 BIC. You can:

- Compensate your Biodiversity Footprint
- Contribute to increasing LPI
- Reduce mean global species extinction risk

Your Questions on Compensating residual Impact (and others)

All background information is available on www.biodiversity-metrics.org

Thank you

Please stay on to answer the quick feedback form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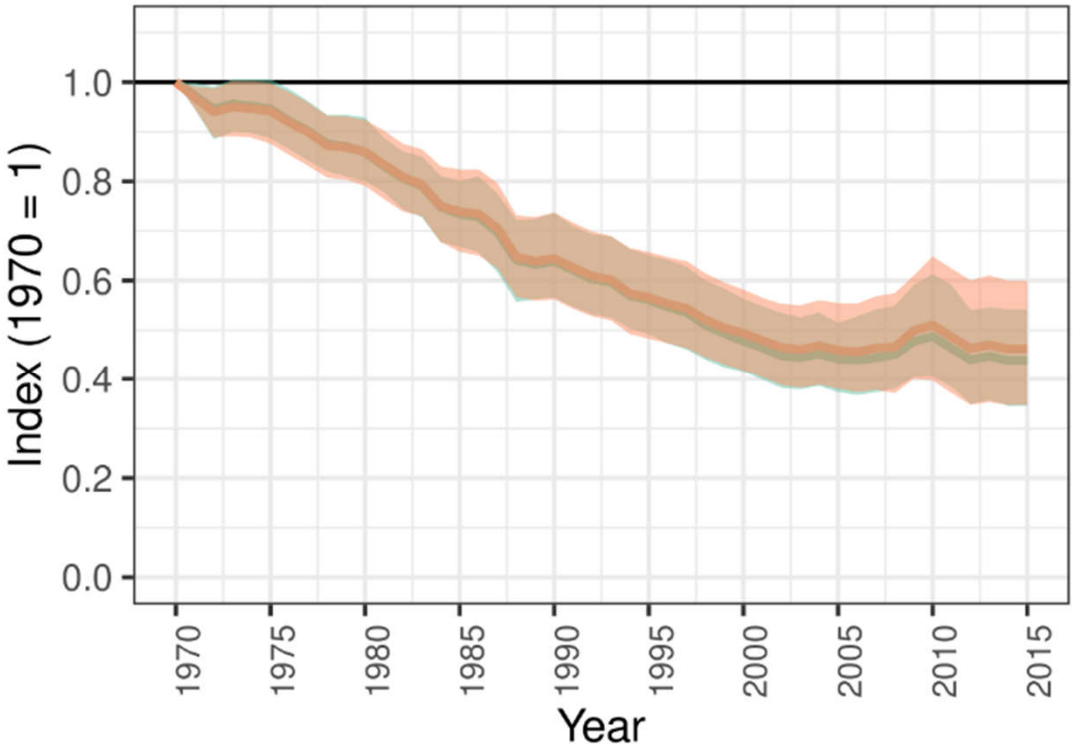
Background documents are available via: www.biodiversity-metrics.org

PRé Fact-based sustainability

Queen Mary University of London

Technical aside:
Does LPI describe local or global population trends??

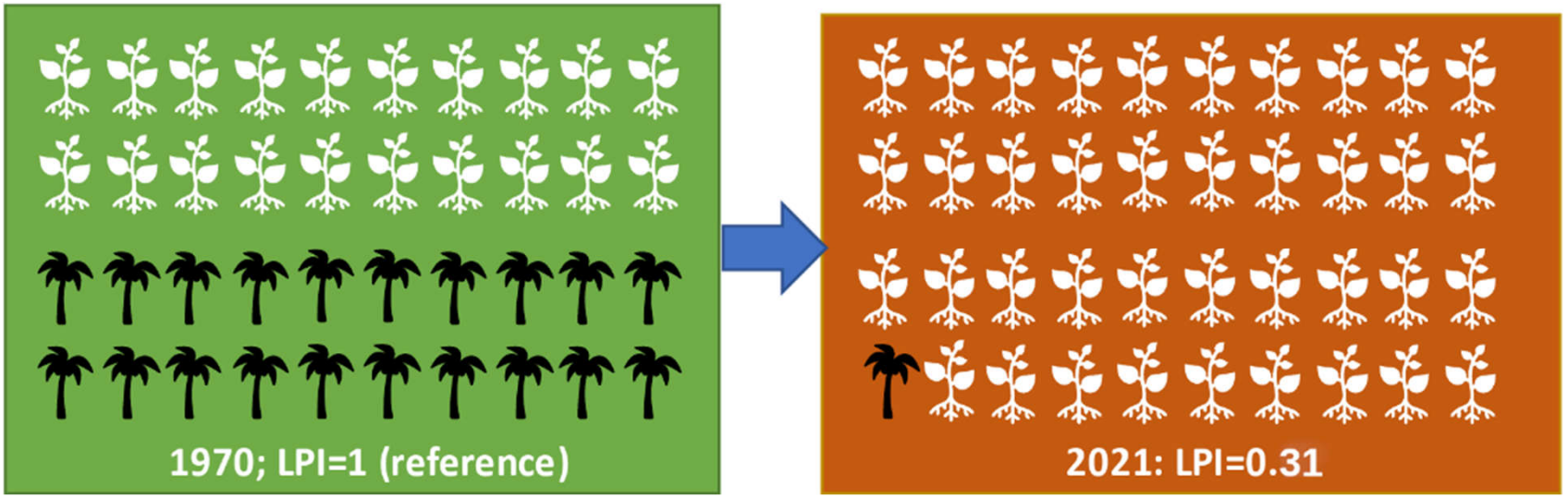


Standard method: represents global species abundance trends by trends of the **geometric mean** of available local population time series.

Modified method: represents global species abundance trends by trends of the **sum** of available local population time series.

Rossberg, A.G., O'Sullivan, J.D., Malysheva, S., Shnerb, N.M., 2023. A metric for tradable biodiversity credits linked to the Living Planet Index and global species conservation. https://doi.org/10.48550/arXiv.2111.03867

MSA and LPI are not the same



LPI = sqrt[(39 / 20) * (1 / 20)] = sqrt[1.95 * 0.05] = 0.31

A decline by 69%

MSA = [(39 / 20) + (1 / 20)] / 2 = [1.95 + 0.05] / 2 = 1 (no truncation)

MSA = [(20 / 20) + (1 / 20)] / 2 = [1.00 + 0.05] / 2 = 0.55

Sustainable development

"Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs."

Brundtland Report (1987)