Biodiversité & agriculture : situation actuelle & perspectives

J-L. Hemptinne

Octobre 2023

1. Biodiversité : une érosion très rapide
2. Inverser les tendances
3. Éducation et politique

Biodiversité ?

Diversité de la vie à tous les niveaux d'organisation biologiques (gènes, individus, espèces, biomes)

(Gaston & Spicer (2004). Biodiversity. An introduction. Blackwell Publishing)

« La diversité biologique désigne la variabilité entre les organismes vivants de toutes les sources, y compris, entre autres, les écosystèmes terrestres, marins et autres écosystèmes aquatiques et les complexes écologiques dont ils font partie; cela comprend la diversité au sein des espèces, entre les espèces et des écosystèmes. »

Convention on Biological Diversity

Rio de Janeiro, 1992

Biodiversité ?

Combien ?

Biodiversité ?

Combien ?

< 2.10^6 décrites

3 à 100.10^6 ?

May, R. M. (1988) Science, 241, 1441-1449
Mora et al. (2011), PloS Biology, 9, e1001124

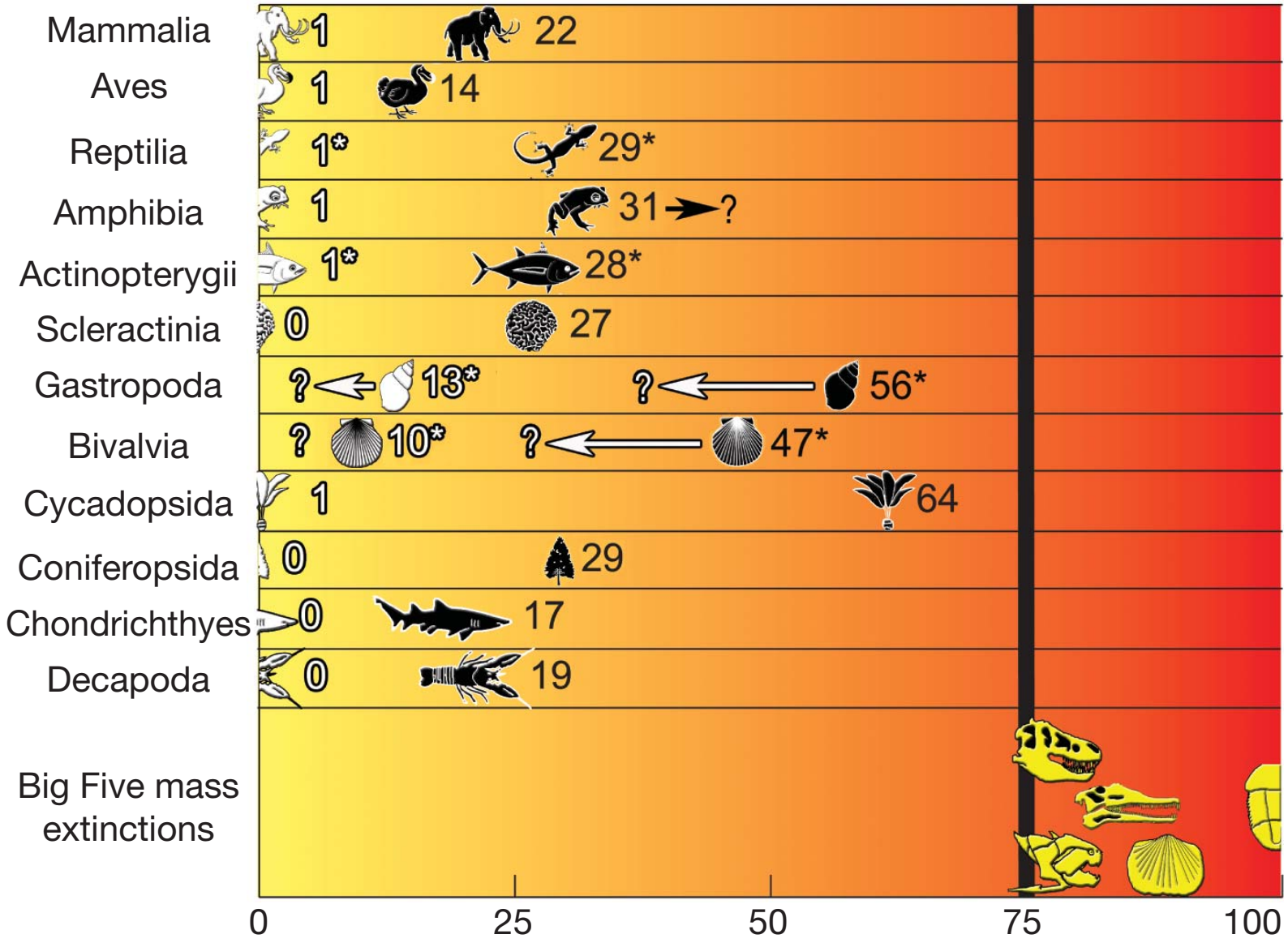
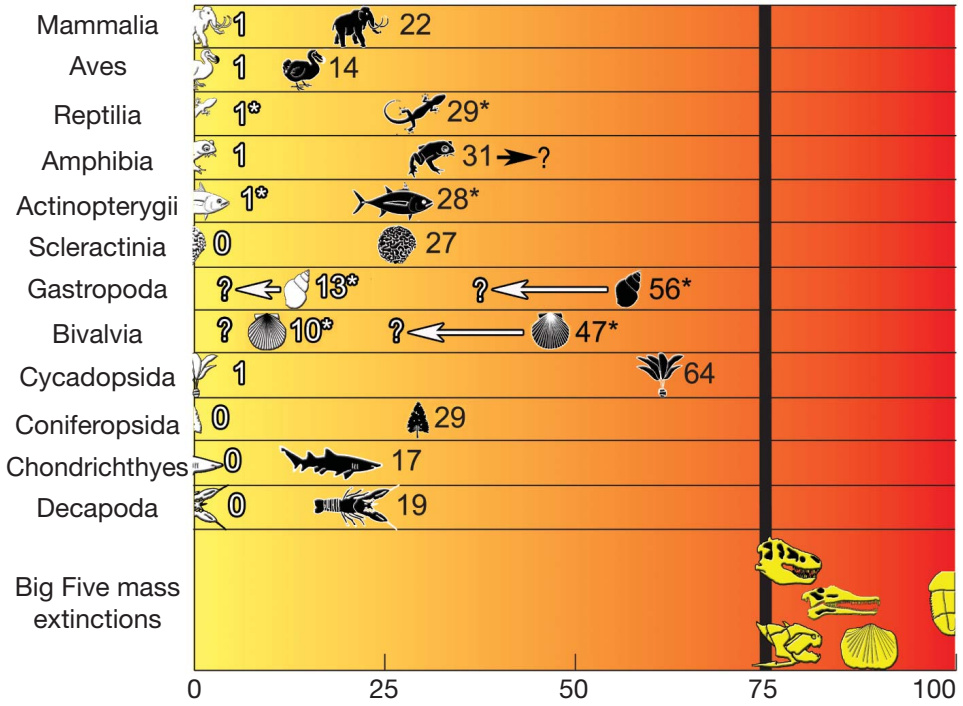


Figure 2 | Extinction magnitudes of IUCN-assessed taxa[6] in comparison to the 75% mass-extinction benchmark. Numbers next to each icon indicate percentage of species. White icons indicate species 'extinct' and 'extinct in the wild' over the past 500 years. Black icons add currently 'threatened' species to those already 'extinct' or 'extinct in the wild'; the amphibian percentage may be as high as 43% (ref. 19). Yellow icons indicate the Big Five species losses: Cretaceous + Devonian, Triassic, Ordovician and Permian (from left to right). Asterisks indicate taxa for which very few species (less than 3% for gastropods and bivalves) have been assessed; white arrows show where extinction percentages are probably inflated (because species perceived to be in peril are often assessed first). The number of species known or assessed for each of the groups listed is: Mammalia 5,490/5,490; Aves (birds) 10,027/10,027; Reptilia 8,855/1,677; Amphibia 6,285/6,285, Actinopterygii 24,000/5,826, Scleractinia (corals) 837/837; Gastropoda 85,000/2,319; Bivalvia 30,000/310, Cycadopsida 307/307; Coniferopsida 618/618; Chondrichthyes 1,044/1,044; and Decapoda 1,867/1,867.

Barnosky et al. (2011), Nature, 471, 51-57

Taux d'extinction

Taux de spéciation



Importance de l'extinction
% espèces éteintes ou en voie d'extinction

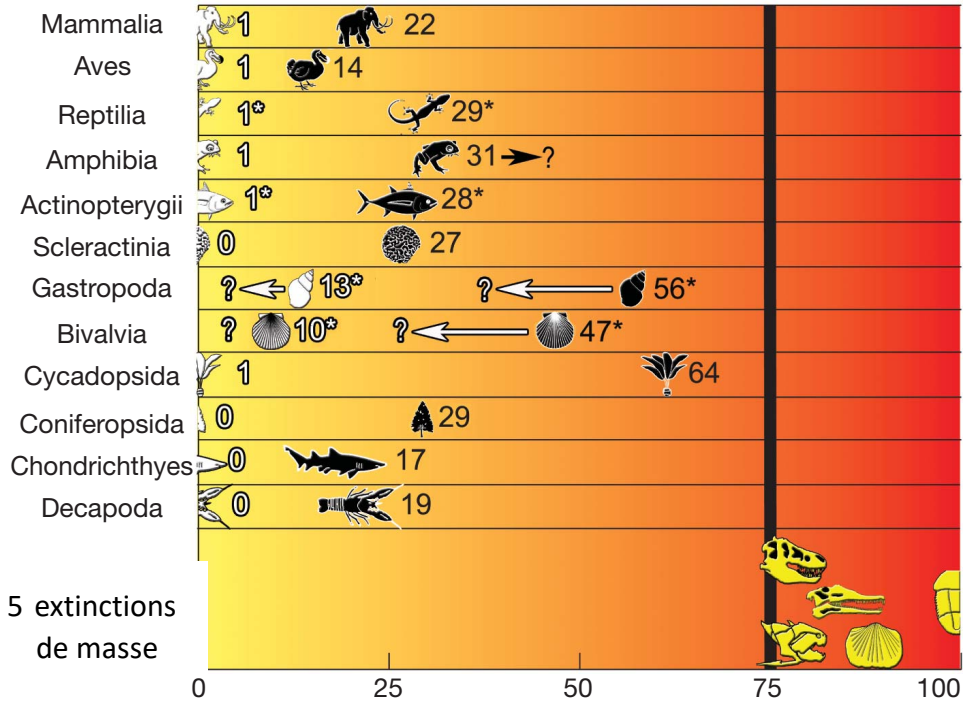
Ordre de grandeur du taux de spéciation : 0,1 /million d'espèces.année

Taux d'extinction : valeurs de 0 à 0,09 (Arthropodes) /million d'espèces.année

Barnosky et al. (2011), Nature, 471, 51-57
De Vos et al. (2014), Cons. Biology, 29, 452-462

Taux d'extinction

Taux de spéciation



Importance de l'extinction
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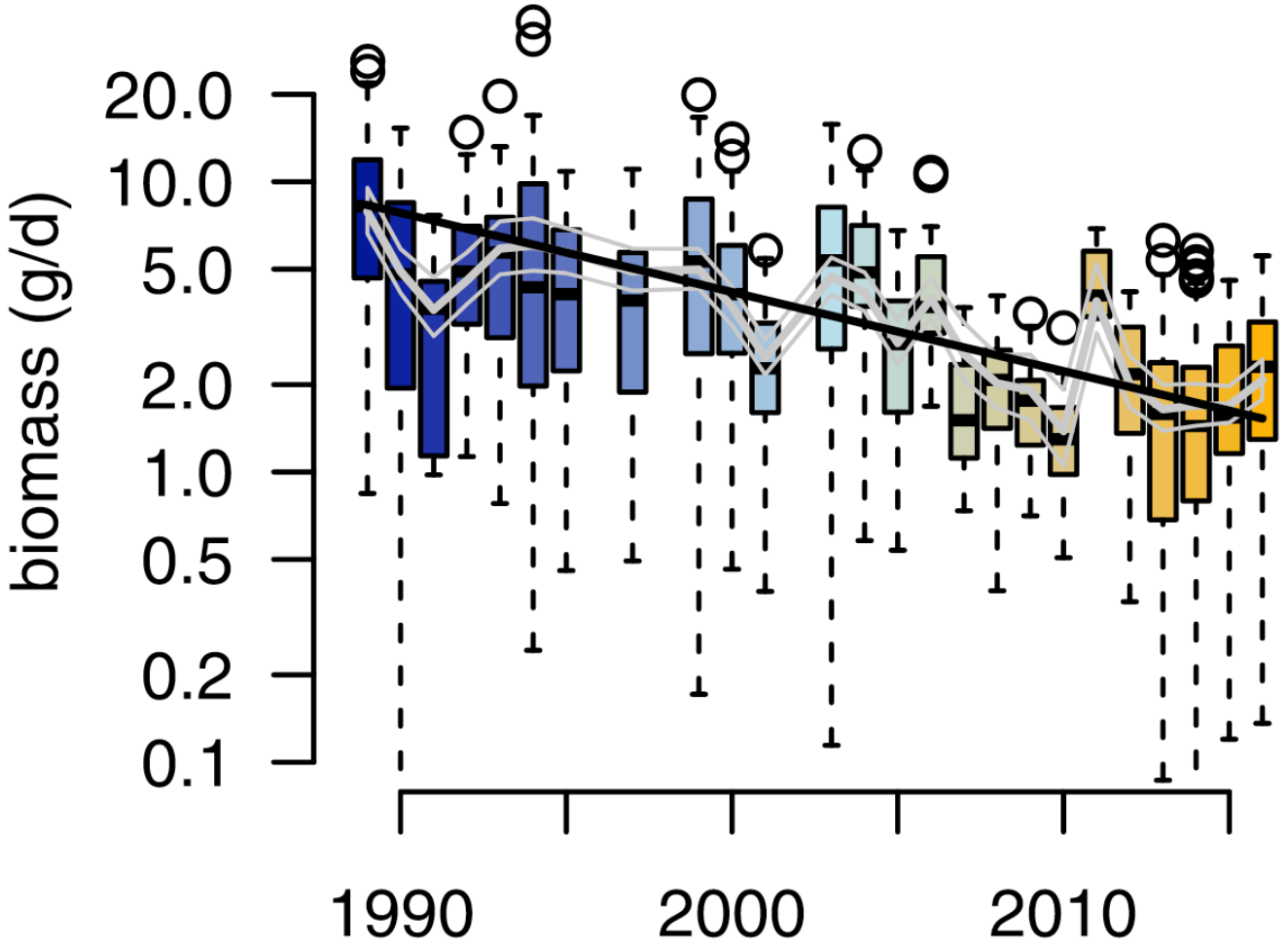
Taux d'extinction : valeurs de 0 à 0,09 (Arthropodes) /million d'espèces.année

Maintenant : x 100 ou x 1000 !

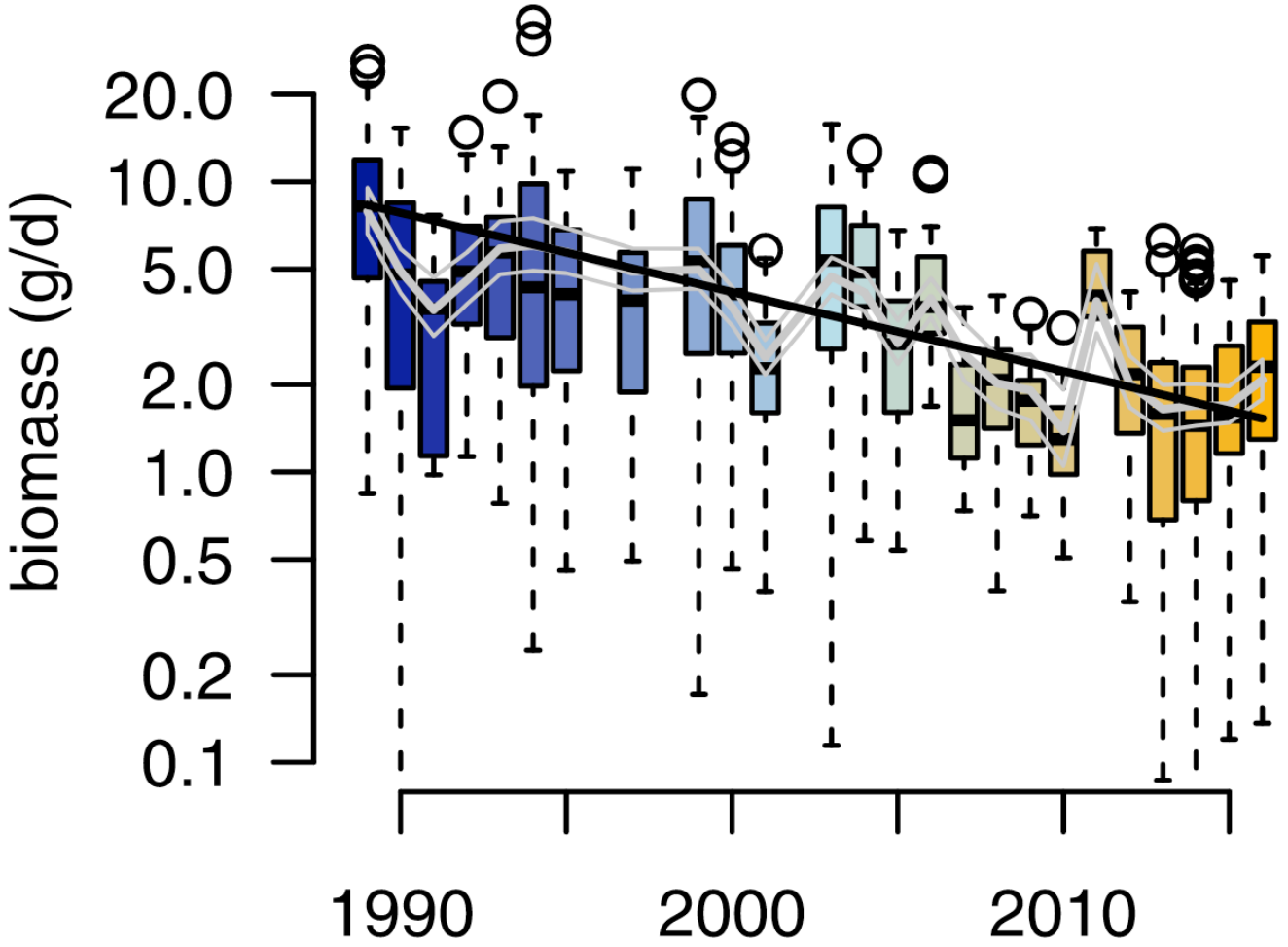
Barnosky et al. (2011), Nature, 471, 51-57
De Vos et al. (2014), Cons. Biology, 29, 452-462

1. Etat des lieux

Hallman, C. A. et al.. (2017), PloS One, 12, 10



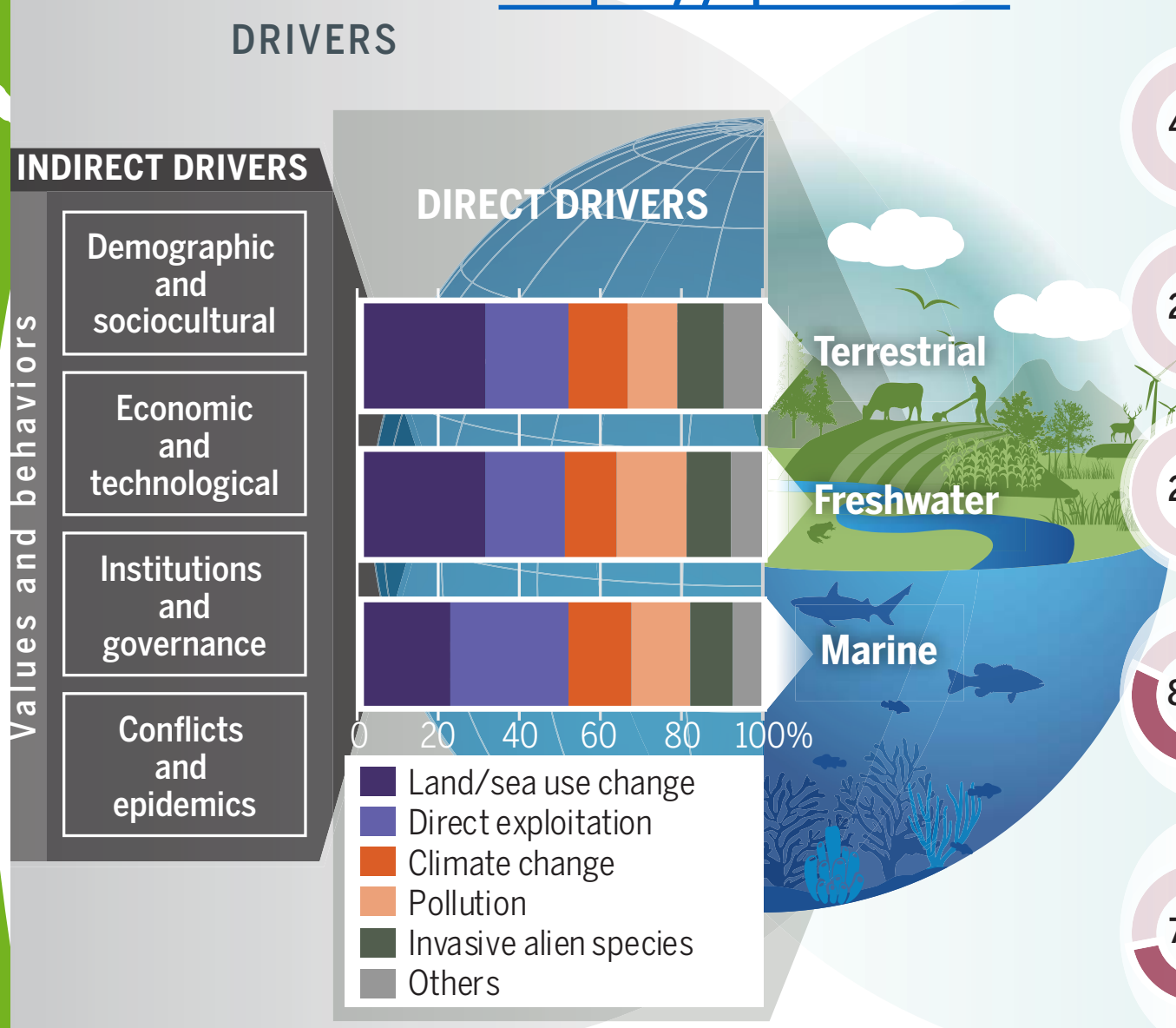
Hallman, C. A. et al.. (2017), PloS One, 12, 10



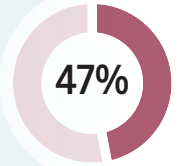
Impact sur la diversité des oiseaux

Rigal, S. et al. (2023), PNAS, 120, 21, e2216573120

https://ipbes.net

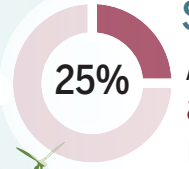


EXAMPLES OF DECLINES IN NATURE



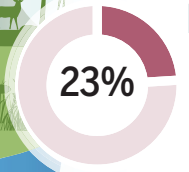
ECOSYSTEM EXTENT AND CONDITION

Natural ecosystems have **declined by 47 per cent** on average, relative to their earliest estimated states.



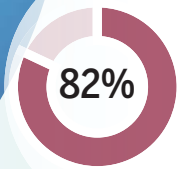
SPECIES EXTINCTION RISK

Approximately **25 per cent of species are already threatened with extinction** in most animal and plant groups studied.



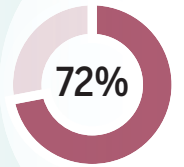
ECOLOGICAL COMMUNITIES

Biotic integrity—the abundance of naturally-present species—has **declined by 23 per cent** on average in terrestrial communities.*



BIOMASS AND SPECIES ABUNDANCE

The global biomass of wild mammals has **fallen by 82 per cent**.* Indicators of vertebrate abundance have declined rapidly since 1970



NATURE FOR INDIGENOUS PEOPLES AND LOCAL COMMUNITIES

72 per cent of indicators developed by Indigenous Peoples and local communities show **ongoing deterioration** of elements of nature important to them

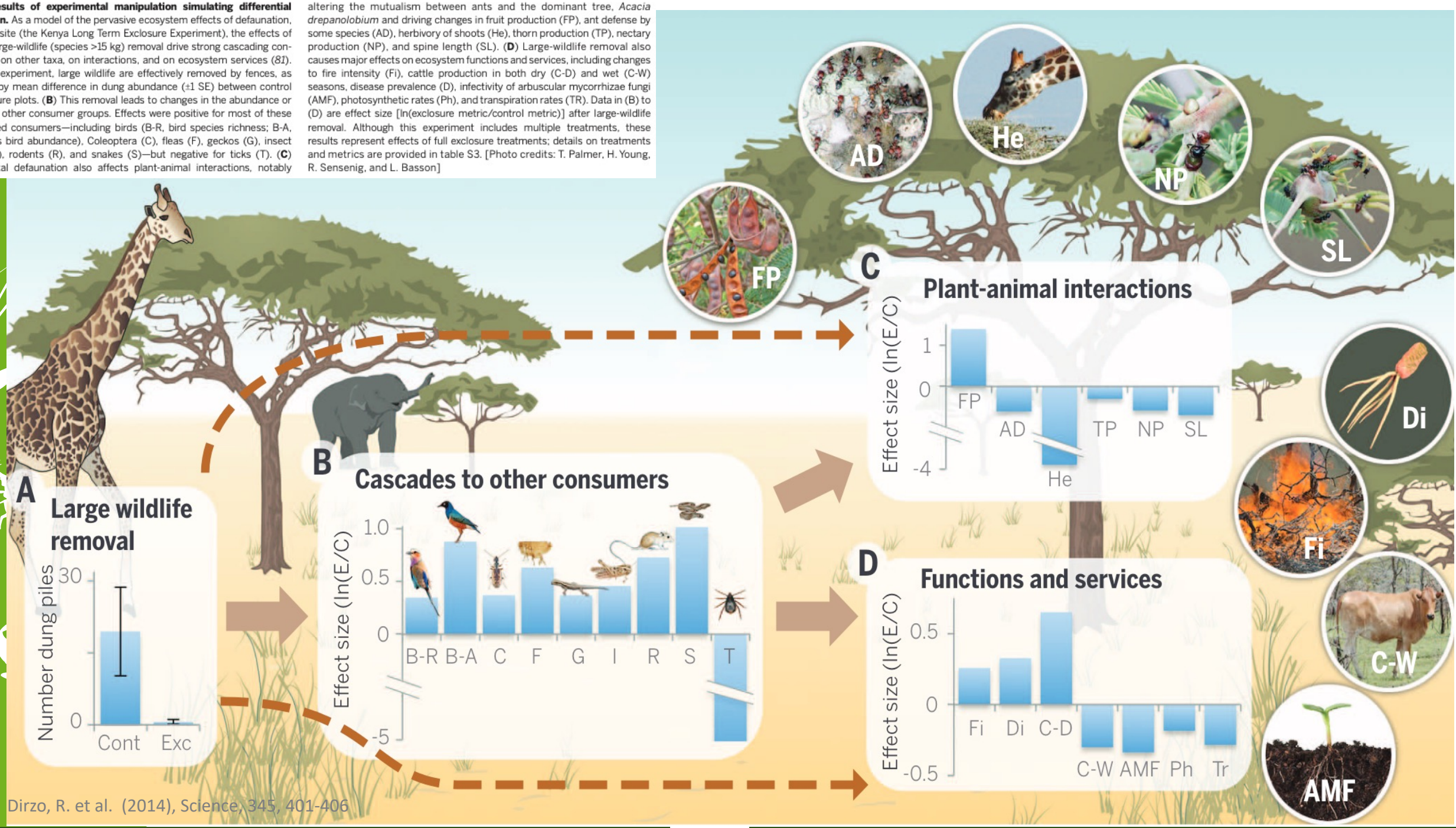
Díaz, S. et al. (2019) Science, 366, eaax3100

* Since prehistory

Perte de biodiversité ?

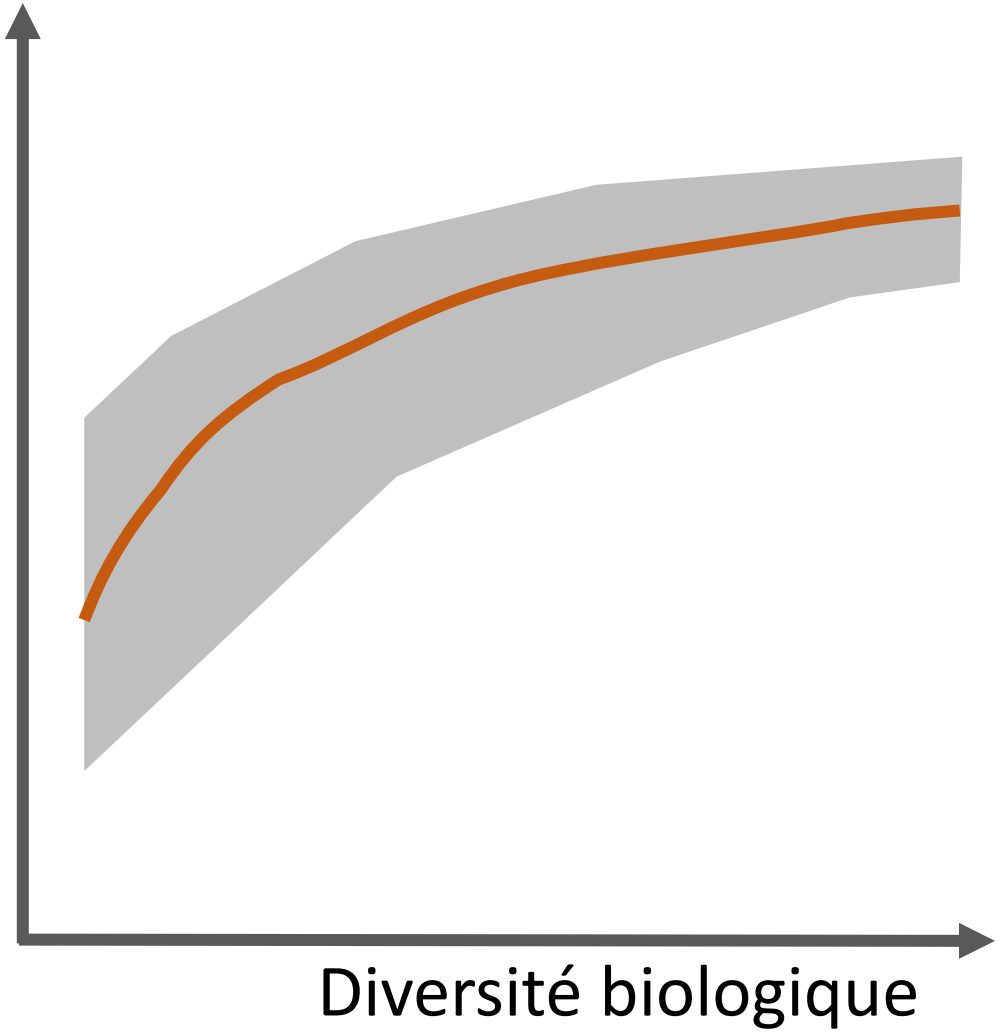
Comprendre l'importance de la perdre

Fig. 4. Results of experimental manipulation simulating differential defaunation. As a model of the pervasive ecosystem effects of defaunation, in just one site (the Kenya Long Term Exclosure Experiment), the effects of selective large-wildlife (species >15 kg) removal drive strong cascading consequences on other taxa, on interactions, and on ecosystem services (*81*). (**A**) In this experiment, large wildlife are effectively removed by fences, as evidenced by mean difference in dung abundance (±1 SE) between control and exclosure plots. (**B**) This removal leads to changes in the abundance or diversity of other consumer groups. Effects were positive for most of these small-bodied consumers—including birds (B-R, bird species richness; B-A, granivorous bird abundance), Coleoptera (C), fleas (F), geckos (G), insect biomass (I), rodents (R), and snakes (S)—but negative for ticks (T). (**C**) Experimental defaunation also affects plant-animal interactions, notably altering the mutualism between ants and the dominant tree, *Acacia drepanolobium* and driving changes in fruit production (FP), ant defense by some species (AD), herbivory of shoots (He), thorn production (TP), nectary production (NP), and spine length (SL). (**D**) Large-wildlife removal also causes major effects on ecosystem functions and services, including changes to fire intensity (Fi), cattle production in both dry (C-D) and wet (C-W) seasons, disease prevalence (D), infectivity of arbuscular mycorrhizae fungi (AMF), photosynthetic rates (Ph), and transpiration rates (TR). Data in (B) to (D) are effect size [ln(exclosure metric/control metric)] after large-wildlife removal. Although this experiment includes multiple treatments, these results represent effects of full exclosure treatments; details on treatments and metrics are provided in table S3. [Photo credits: T. Palmer, H. Young, R. Sensenig, and L. Basson]



Dirzo, R. et al. (2014), Science, 345, 401-406

Fonction de l'écosystème *

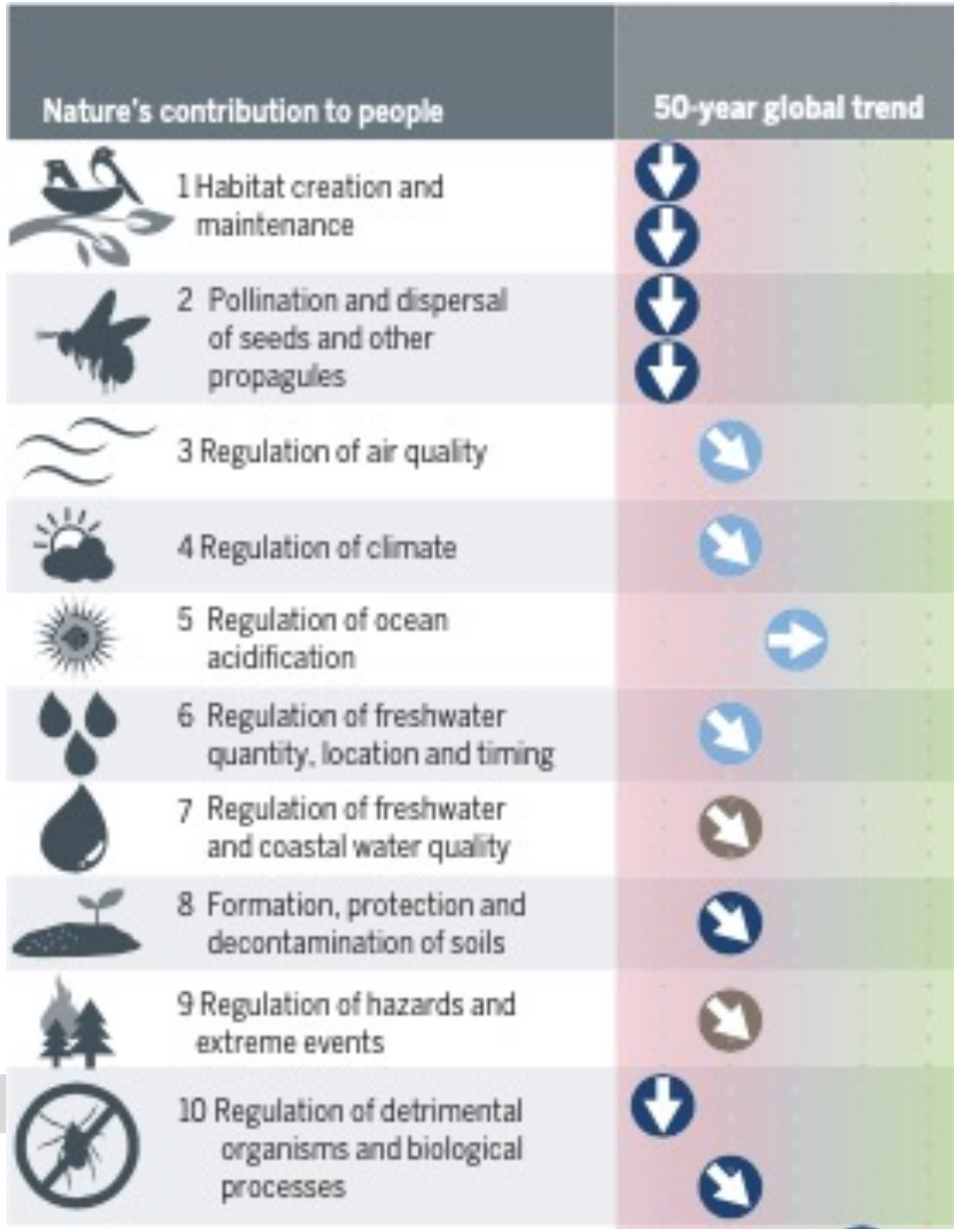


* Production de biomasse, décomposition, cycles des éléments et de l'eau,…

Cardinale, B. J. et al., (2012), Nature, 7401, 59-67.

Loreau, M. & de Mazancourt, C. (2013). Ecol. Letters, 16, 106-115.
Pennekamp, F. et al. (2018). Nature, https://doi.org/10.1038/s41586-018-0627-8
Kéfi, S. et al. (2019). Ecol. Letters, doi: 10.1111/ele.13340.
Gonzalez, A. et al. (2020). Ecol. Letters, 23,757-776 .

Des fonctions des écosystèmes aux services écosystémiques

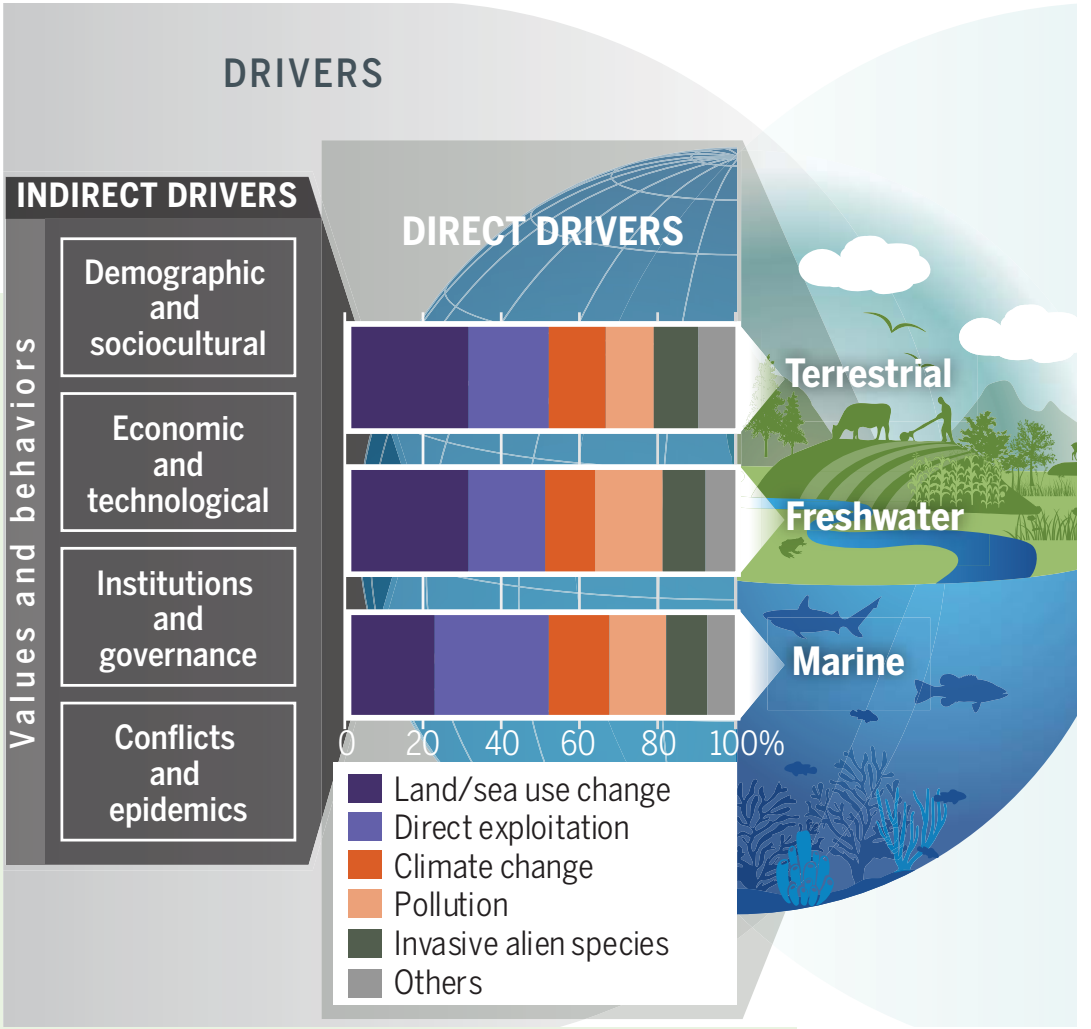


Díaz, S. et al. (2019) Science, 366, eaax3100

https://ipbes.net

1. Affectation des sols

Déforestation pour agriculture, urbanisation,…
Mise en réserve (30 % min; COP 15;
Kunming-Montréal, 7-19/12/2022)



2. Exploitation

Agriculture favorisant la biodiversité
Efforts de conservation des ressources (sols, quota & régulation de pêche, …)

Quelques sources :
Tilman et al. 2017 (Nature 546);
Crist et al. 2017 (Science 356);
Springmann et al. 2018 (Nature 562);
Willett et al. 2019 (The Lancet; site of the EAT Foundation : https://eatforum.org/eat-lancet-commission/)

Mettre en œuvre des stratégies agricoles favorisant la biodiversité

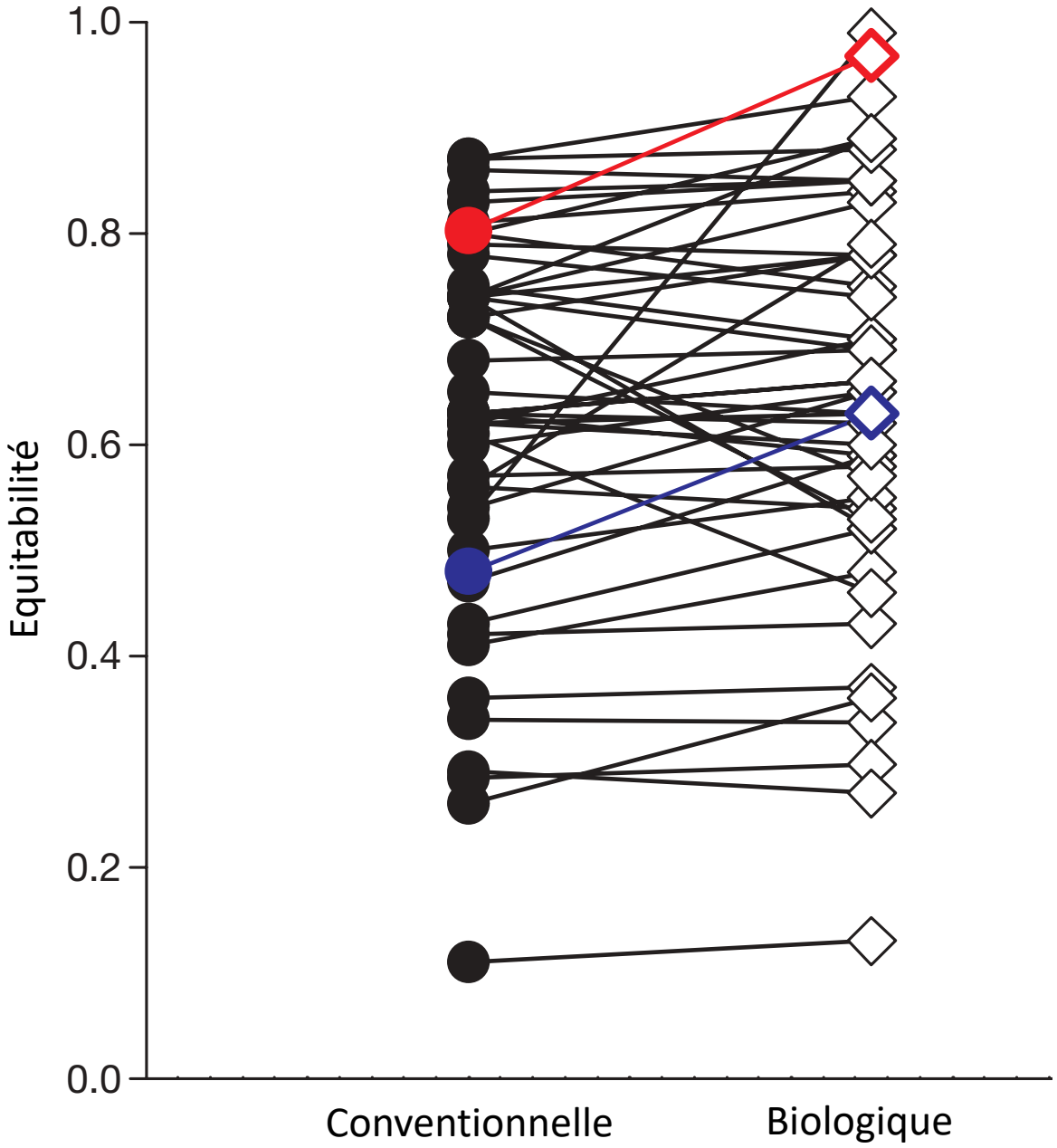
- ***Réduction des menaces directes :***
  Pesticides de synthèse
  Engrais minéraux

- ***Paysage plus complexe :***
  Habitats de reproduction, abris pour les mauvaises saisons, de nourriture, …

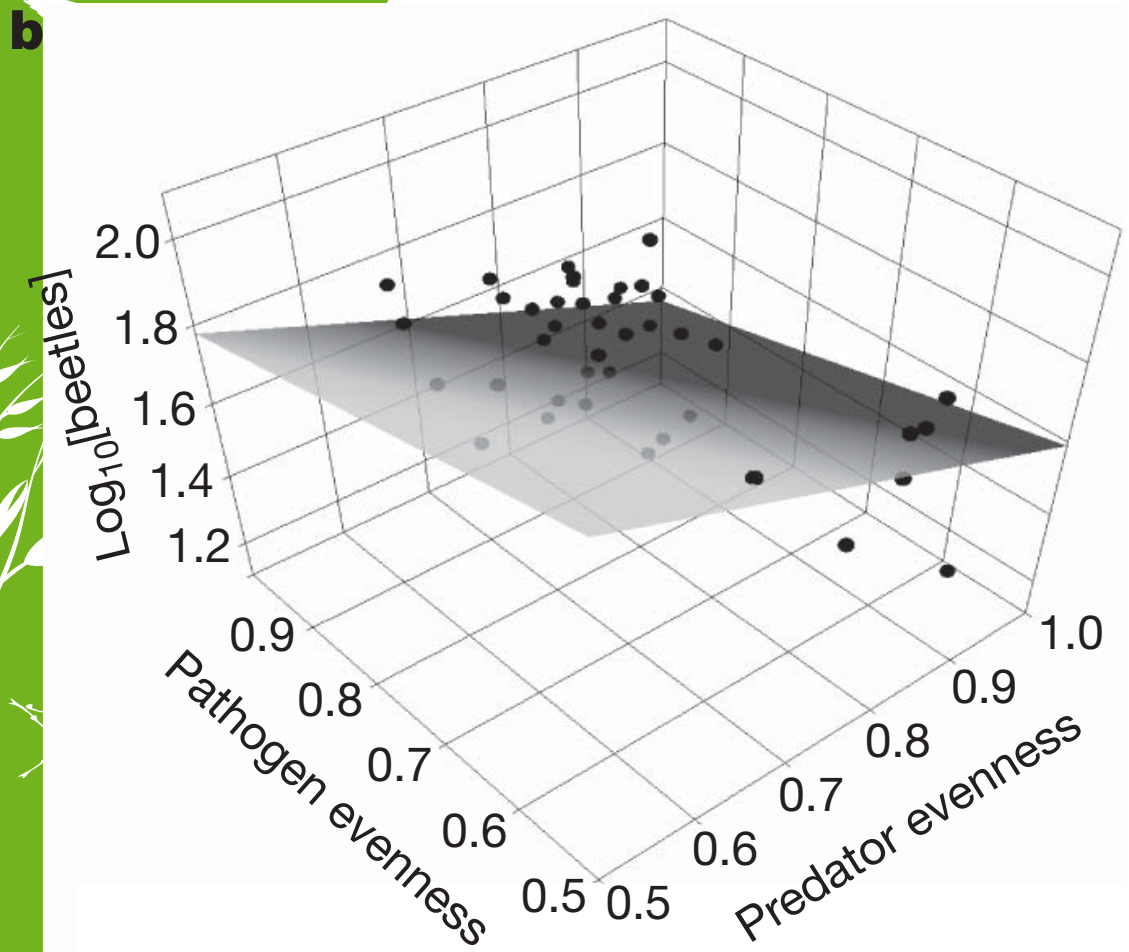
Muller, A. et al. (2017), Nature Communications, 8:1290

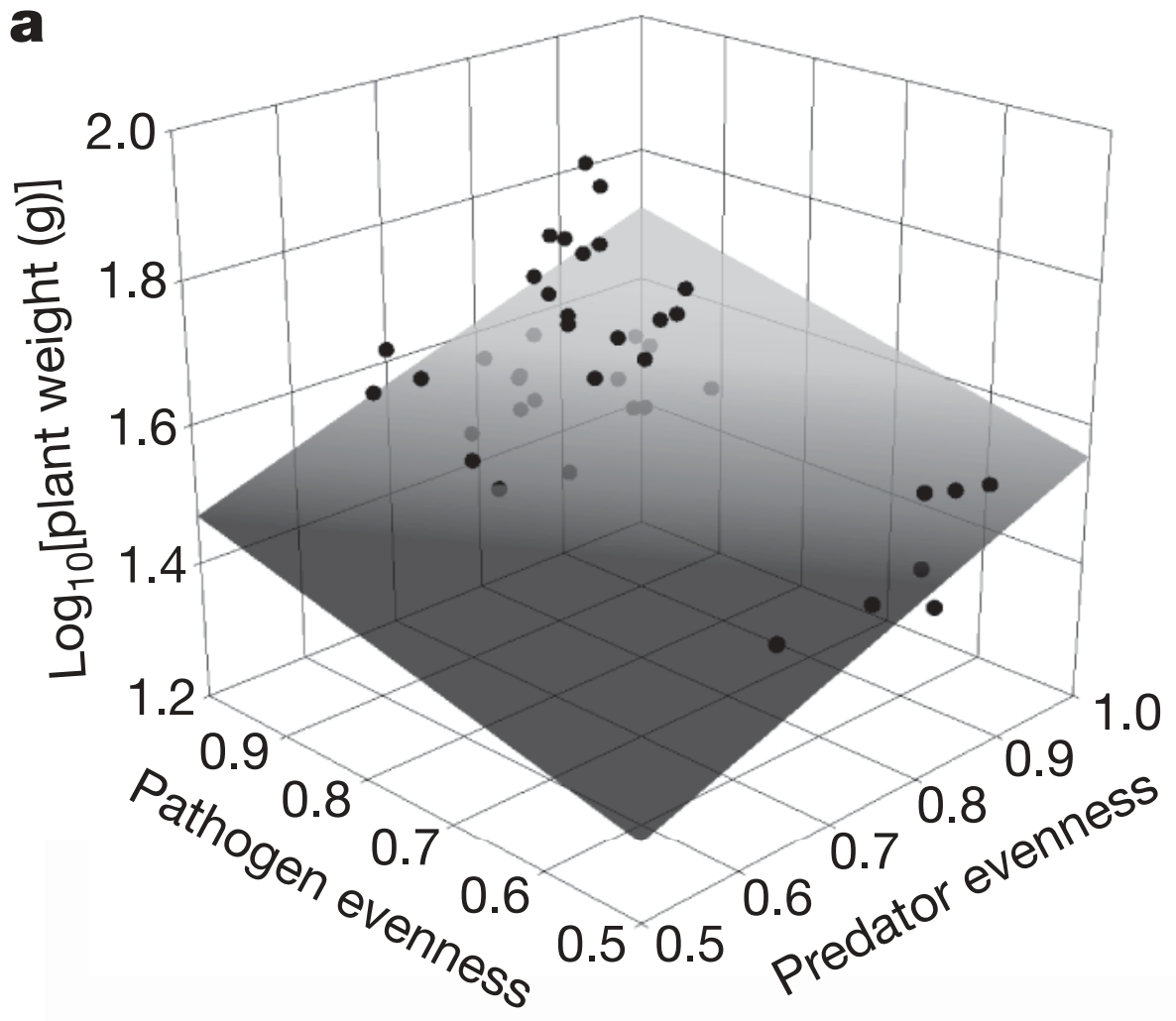
2. Que faire ?

Prédateurs : bleu
Pathogènes : rouge



Crowder, D.A. et al. 2010. Organic agriculture promotes evenness and natural pest control. Nature, 466, 109-112





Crowder, D.A. et al. (2010).

Une méta-analyse de 235 études

Confirmée en 2019

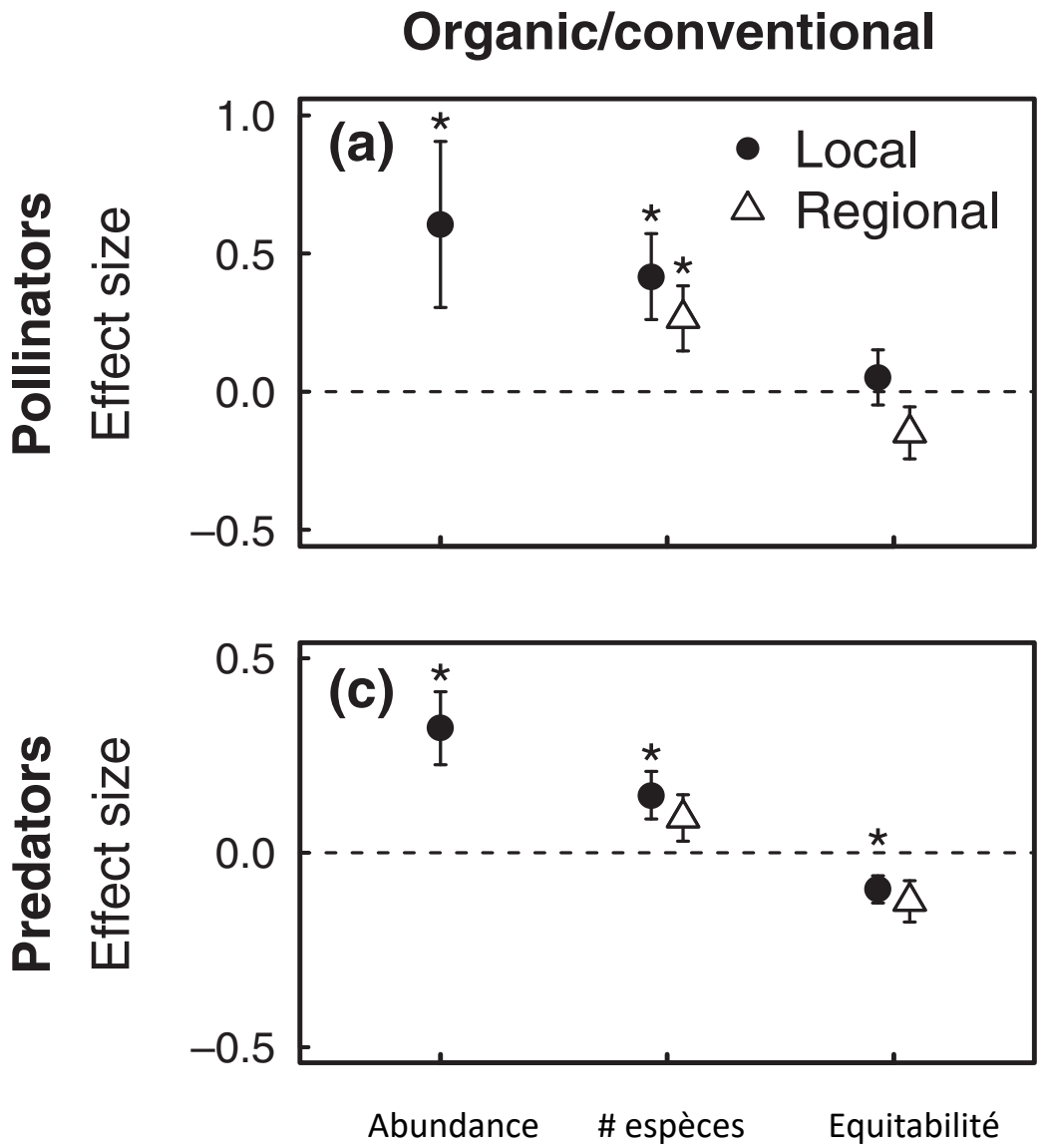


FIGURE 1 Effects of farm management schemes on arthropod abundance, local diversity, and regional diversity. Values shown are for the entire arthropod community, and indicate the mean log-response ratio (±*SE*) of (a) adopting organic farming and (b) promoting in-field plant diversity on abundance, richness, and evenness. A "*" above a mean effect size denotes a significant difference from zero (determined via one-sample *t*-tests; $\alpha = 0.1$; statistical details in Tables S8), while one below a pair of means indicates a significant difference between local and regional diversity (determined via linear mixed models; $\alpha = 0.1$; Tables S9–S12)

Lichtenberg, A.M. et al. 2017. A global synthesis of the effects of diversified farming systems on arthropod diversity within fields and across agricultural landscapes. Global Change Biology, 23, 4946-4957.

Dainese et al. 2019. A global synthesis reveals biodiversity-mediated benefits for crop production. Sci. Adv., 5 : eaax0121

Des connaissances écologiques pour designer de nouveaux agrosystèmes

Rotation : > 4.8 ans; idéal : 7 ans

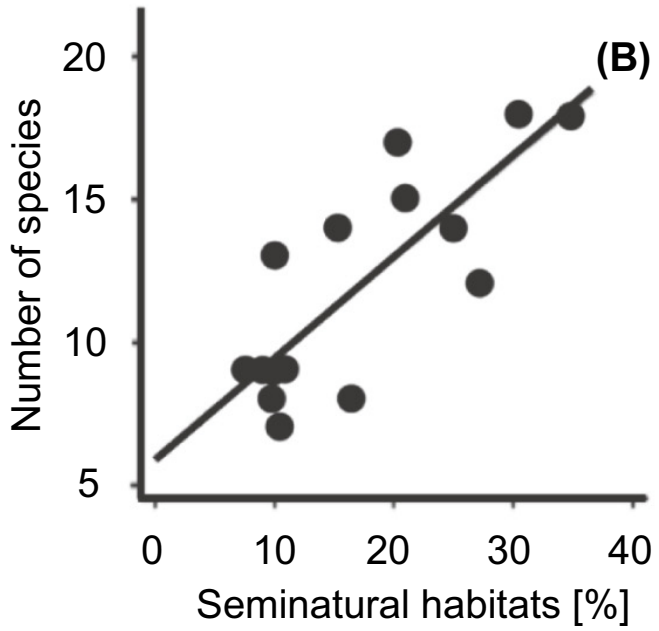
Ferme ≥ 20% habitats naturels

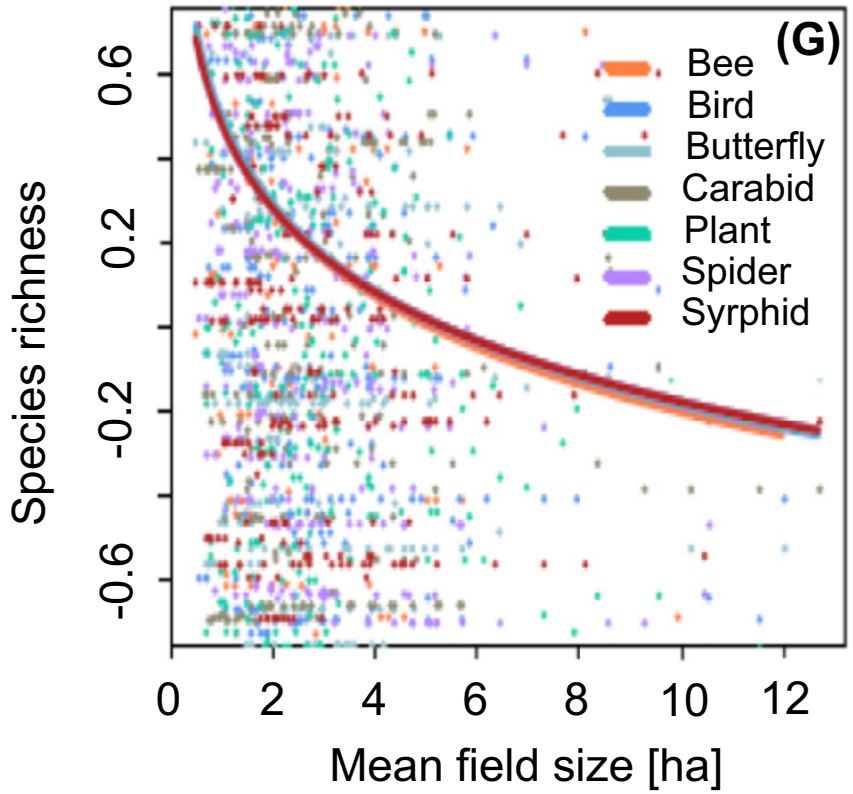
Parcelles ≈ 6 ha; longues & étroites

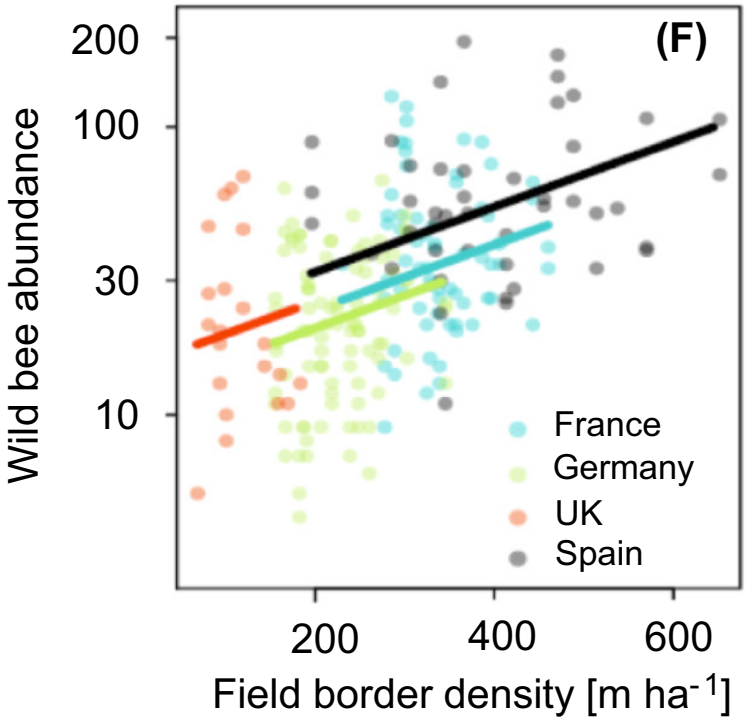
Bordures : ≥ 600 m/ha

Tscharntke T. et al. (2021). Trends in Ecology & Evolution, 36, 919-930

Connaissances écologiques & conception de nouveaux agrosystèmes

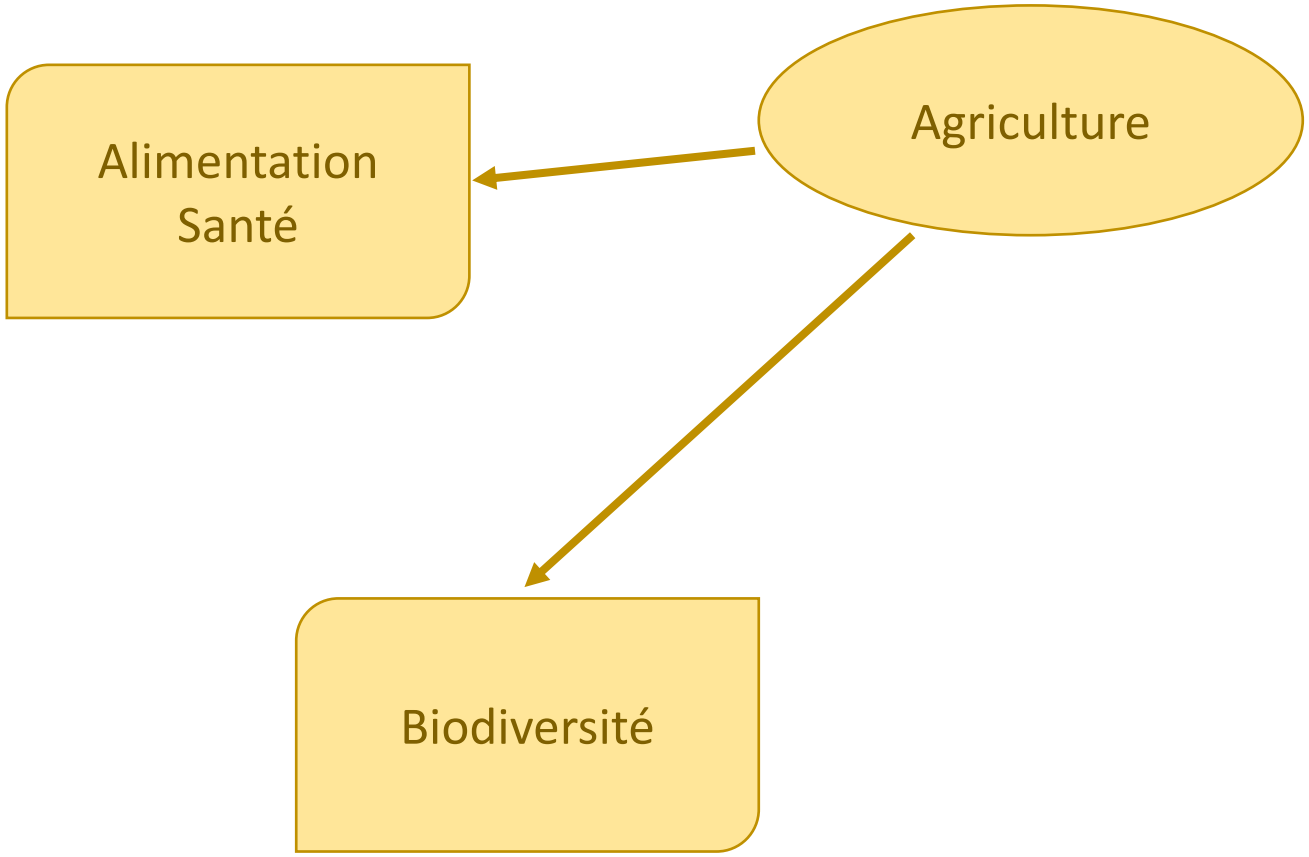


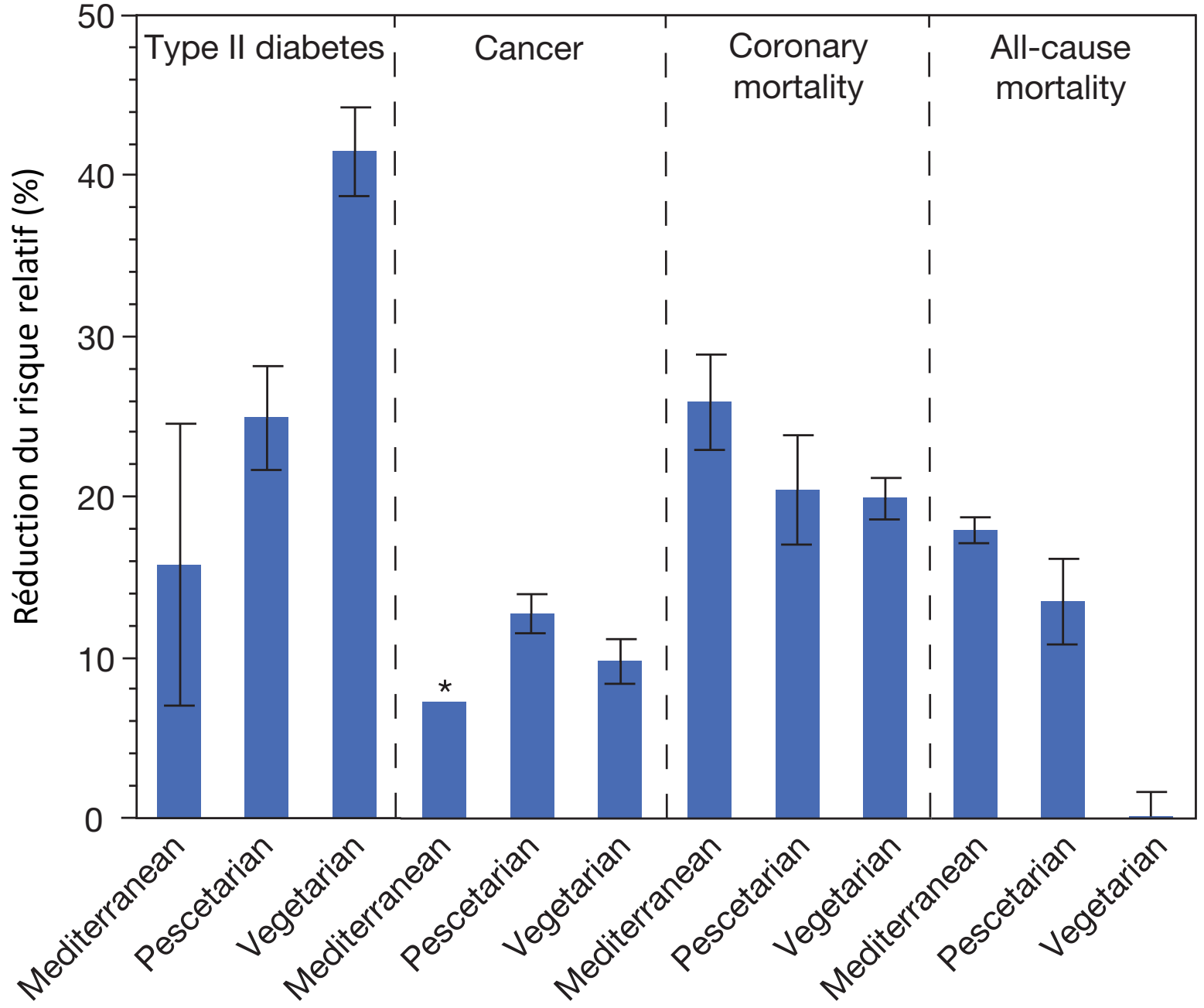




Tscharntke T. et al. (2021).
Trends in Ecology & Evolution, 36, 919-930

2. Que faire ?





Global diets link environmental sustainability and human health

David Tilman[1,2] & Michael Clark[1]

Nature (2014), 515,518-522

Willett et al. 2019 (The Lancet; site of the EAT Foundation : https://eatforum.org/eat-lancet-commission/

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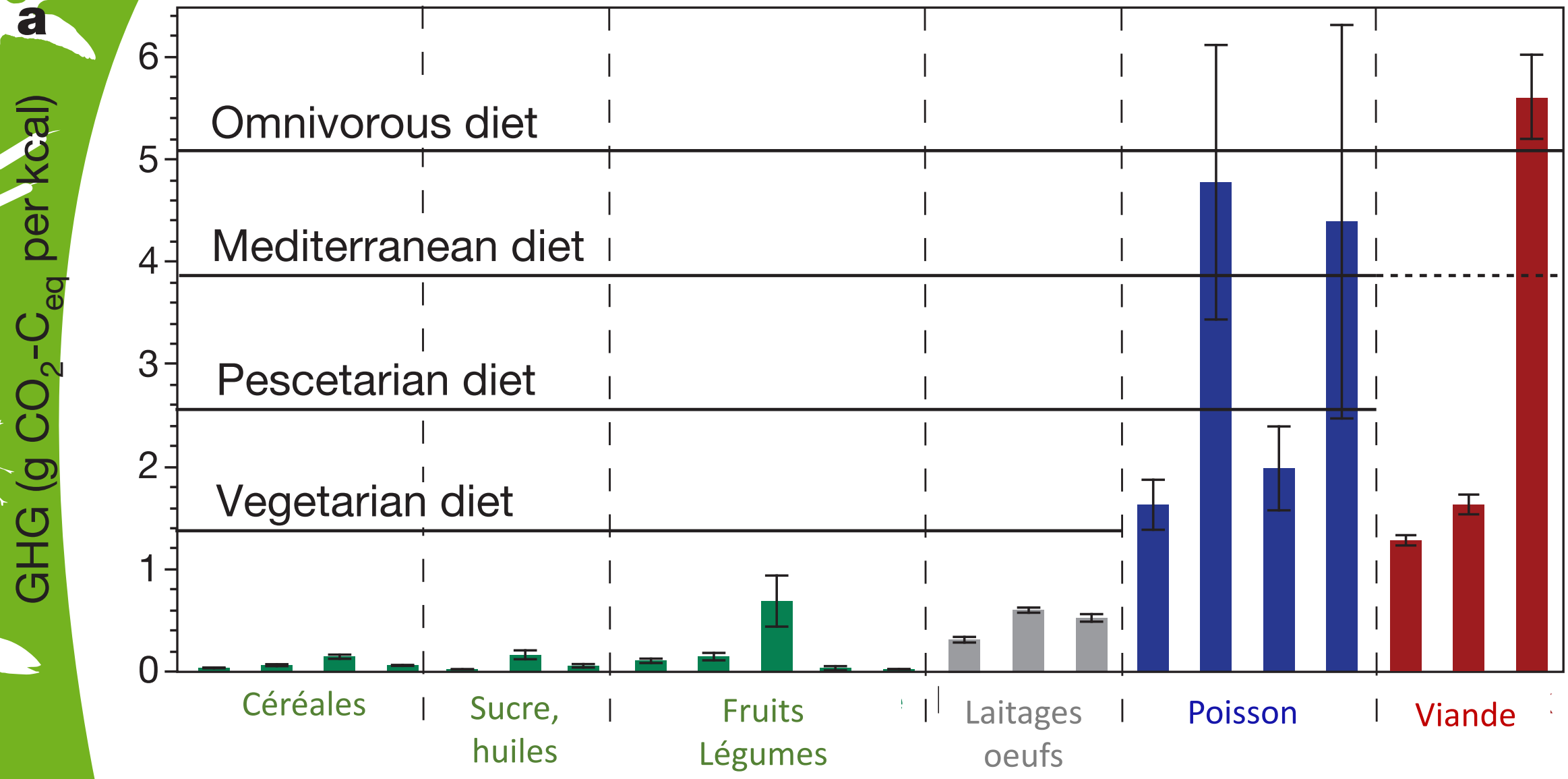


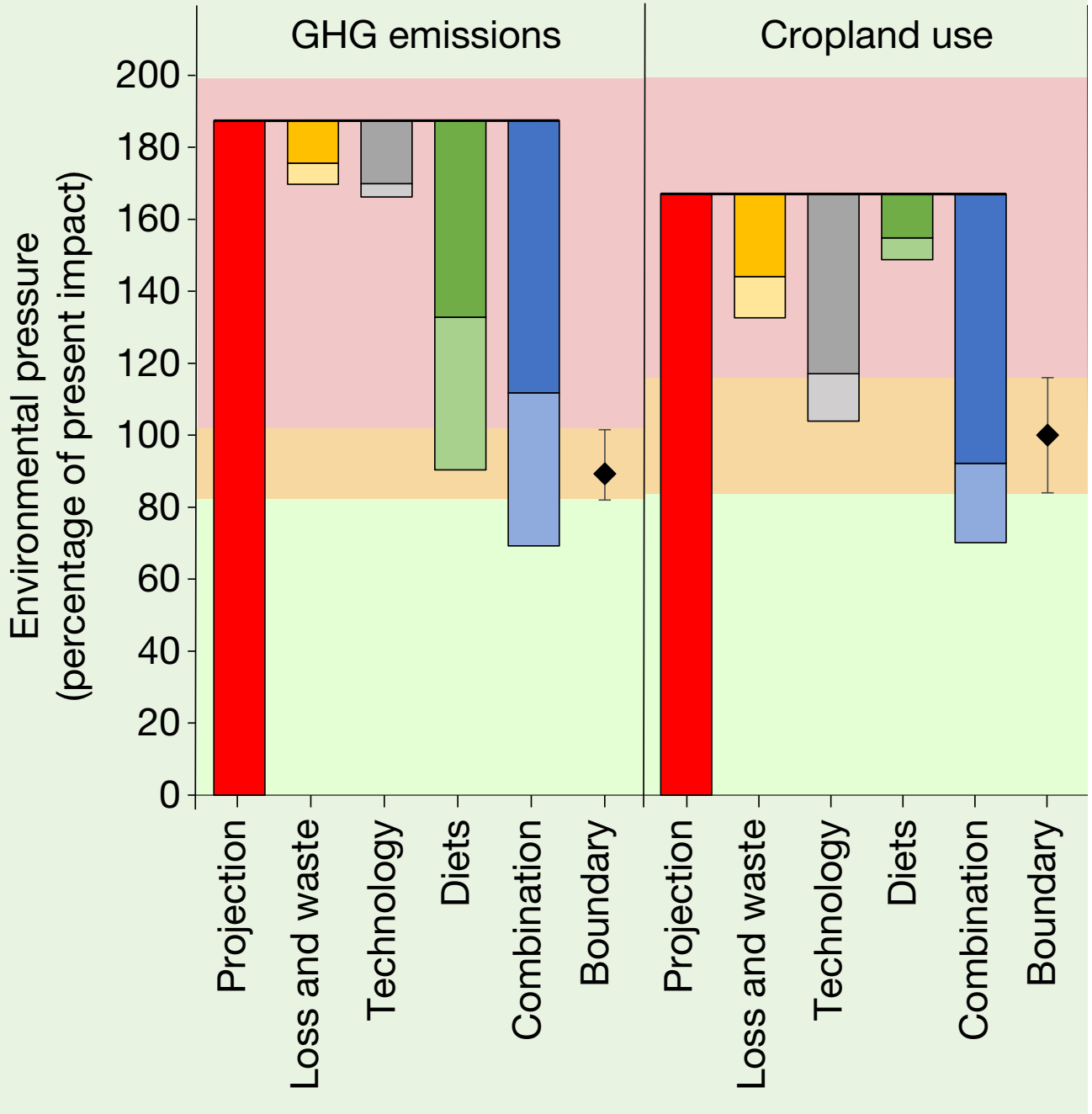
Tilman & Clark, 2014

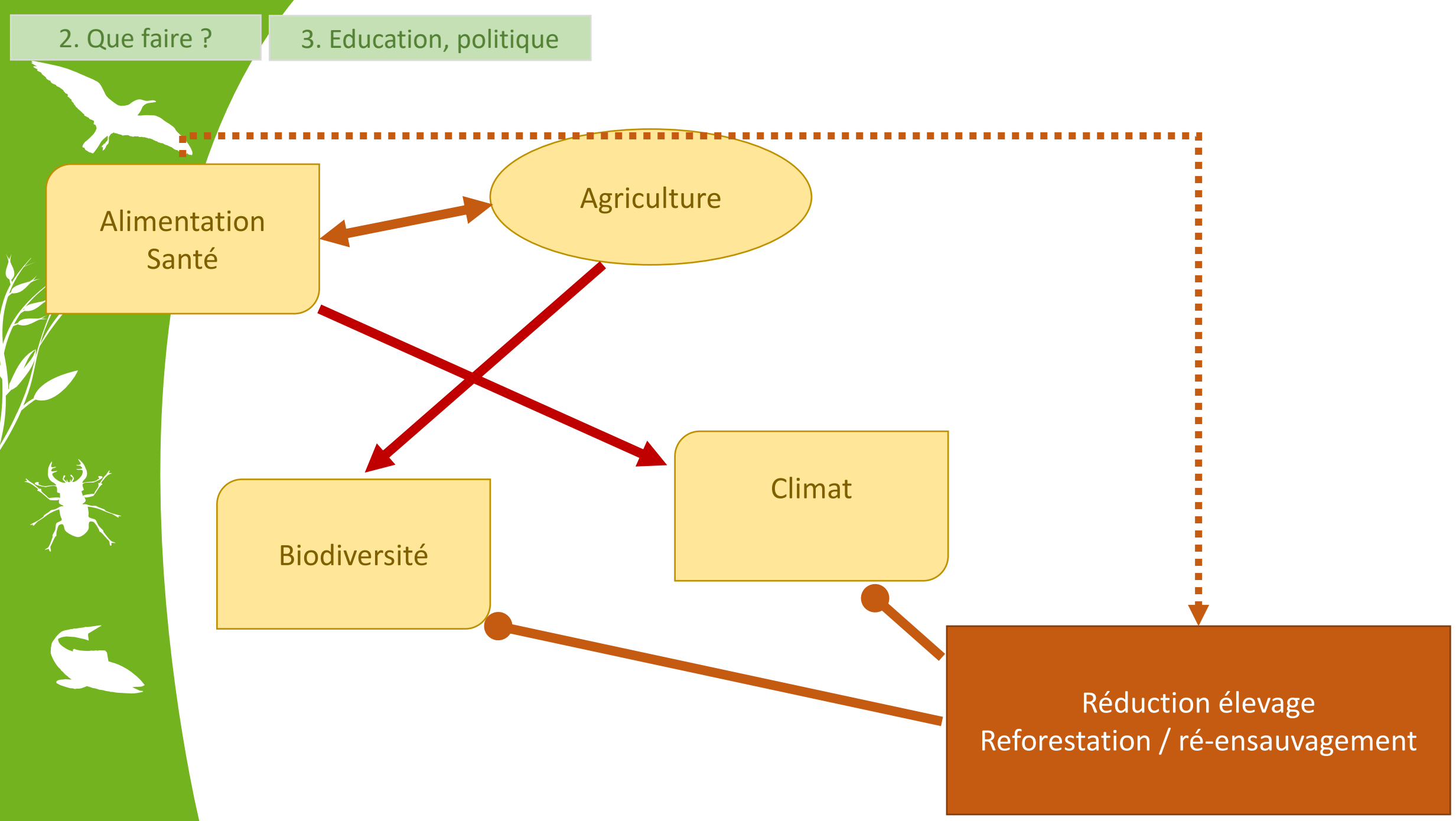
Horizon 2050

Fig. 2 | Impacts of reductions in food loss and waste, technological change, and dietary changes on global environmental pressures in 2050. These projections of environmental pressures in 2050 are baseline projections without dedicated mitigation measures for a middle-of-the-road development pathway, and are expressed as percentages of present impacts (see Fig. 1). The different measures of change and their combination are depicted as reductions from the baseline projections for the different environmental domains (for example, the 'diets' bar that ends at 90% of present impacts of GHG emissions indicates that ambitious dietary changes (flexitarian) can reduce the projected increase of GHG emissions from 187% of present impacts to 90%, which represents a reduction of 52% or 97 percentage points; and dietary changes of medium ambition (guidelines), which in the figure end at the split line of the 'diets' bar, can reduce GHG emissions from 187% of present impacts to 133%, which represents a reduction of 29% or 54 percentage points).

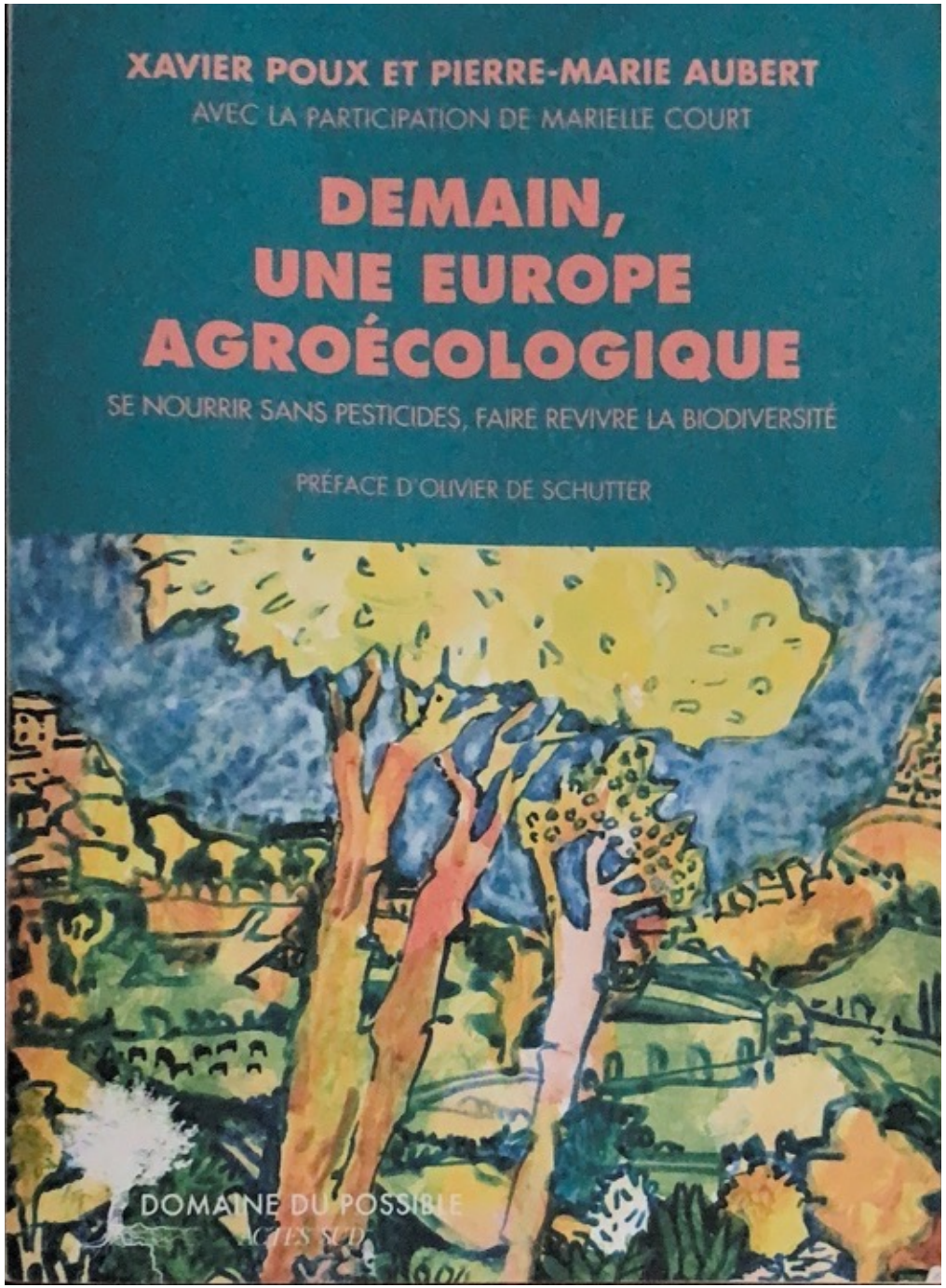
The loss and waste scenarios include reducing food loss and waste by half (waste/2) and by 75% (waste/4). The technology scenarios include medium-ambition technological changes up to 2050 (tech) and more ambitious technological changes (tech+). The diet scenarios include diets aligned with global dietary guidelines (guidelines), and more plant-based flexitarian diets (flexitarian) that are reflective of present evidence on healthy eating. The scenario combinations include all measures of medium ambition (comb(med): waste/2, tech, guidelines) and all measures of high ambition (comb(high): waste/4, tech+, flexitarian), the latter including an optimistic socioeconomic development pathway with higher income and lower population growth. The diamonds indicate mean planetary-boundary values (boundary), each associated with uncertainty intervals highlighted by colour (light green, below the mean value; light orange, between minimum and maximum values; light red, above maximum values).

Springmann et al. (2018)




Alimentation
Santé
Agriculture
Biodiversité
Climat
Réduction élevage
Reforestation / ré-ensauvagement

Demain, en Europe …



Actes Sud, Domaine du Possible, 2021, 320 p
ISBN : 978-2-330-15368-7

https://www.asca-net.com/tyfa-un-scenario-pour-une-europe-agroecologique-en-2050/

https://www.iddri.org/fr/publications-et-evenements/billet-de-blog/une-europe-agroecologique-en-2050-un-scenario-credible-un

Agissez sur le pas de votre porte, communiquez !

- ***Urbanisation*** **: 2ème après agriculture pour pertes de biodiversité**
- ***Chaque m² compte !***

(Soanes et al. 2019. Conservation Biology, 33)

Merci pour votre écoute.

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