The Ecological Crisis and the Great Acceleration

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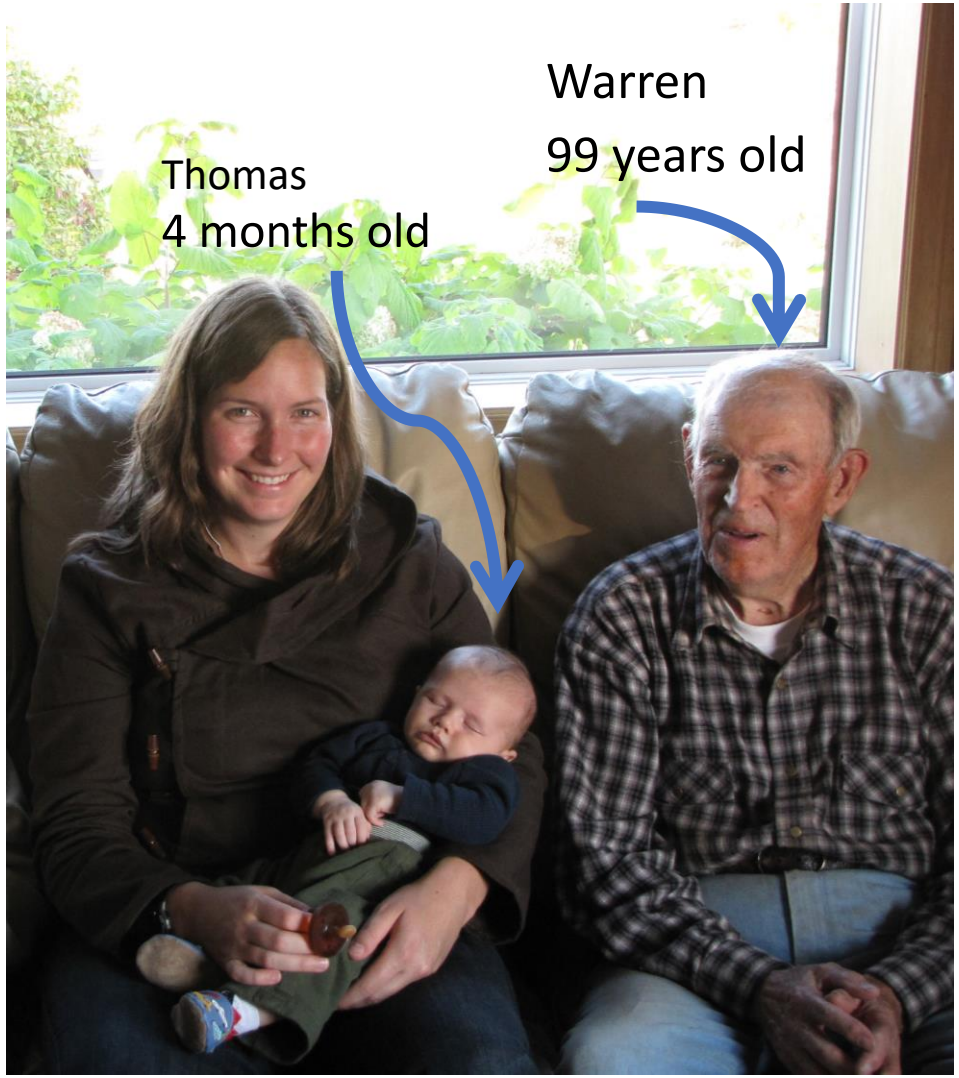
Humans are changing the world quickly and this level of change is relatively new.



When Warren was 4 months old

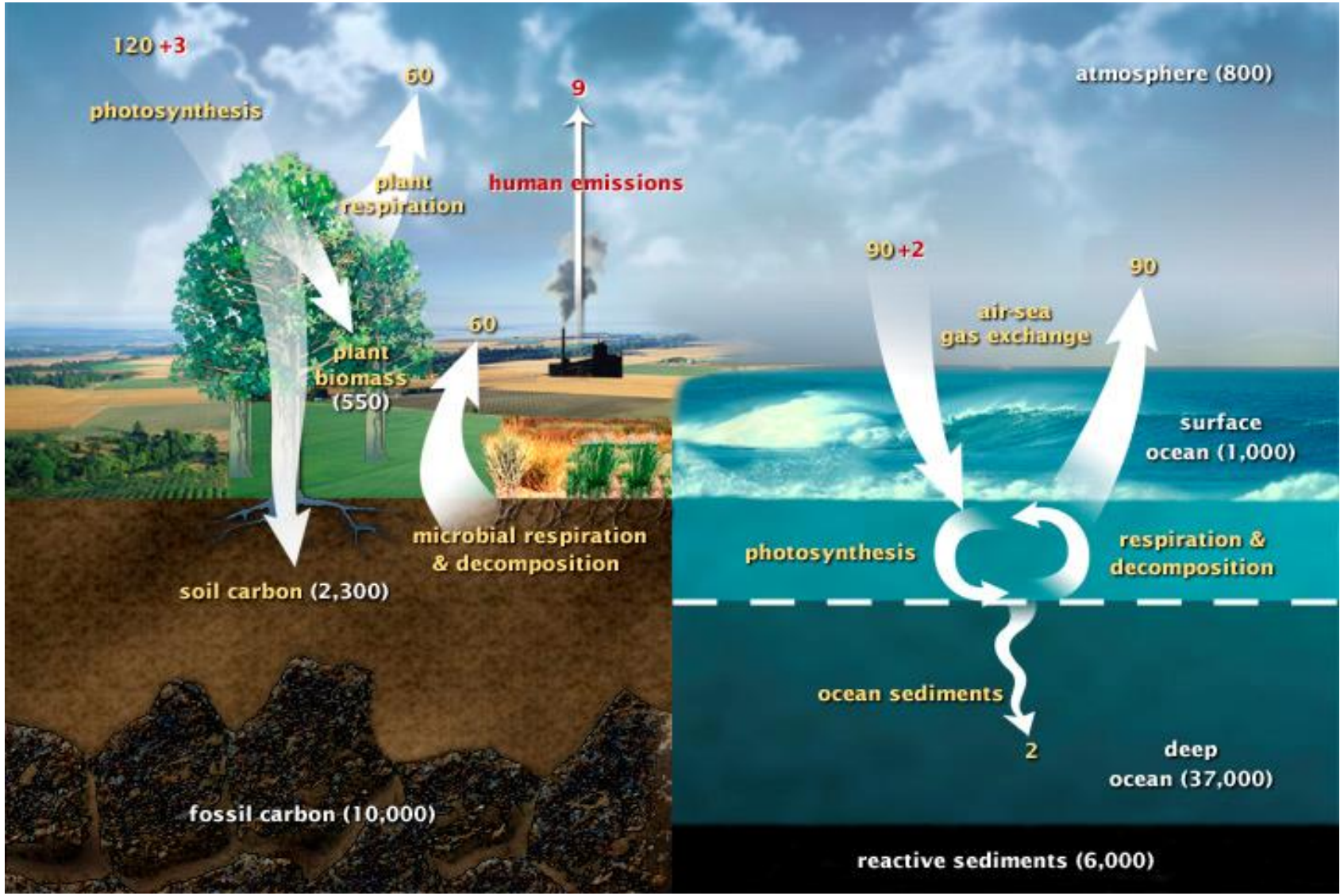
	1913	2012-2013
World population	1.8 billion	7 billion
Motor vehicles	1.1 million	> 1 billion
Commercial air travel	None (began in 1914)	Over 9 million flights in the US alone

Slater St. 1913 (Downtown Ottawa)

Slater St. 2013

Human disruption of the carbon cycle

Gigatons of carbon/year
Yellow = natural
Red = Anthropogenic emissions
White = stored carbon



https://earthobservatory.nasa.gov/features/CarbonCycle

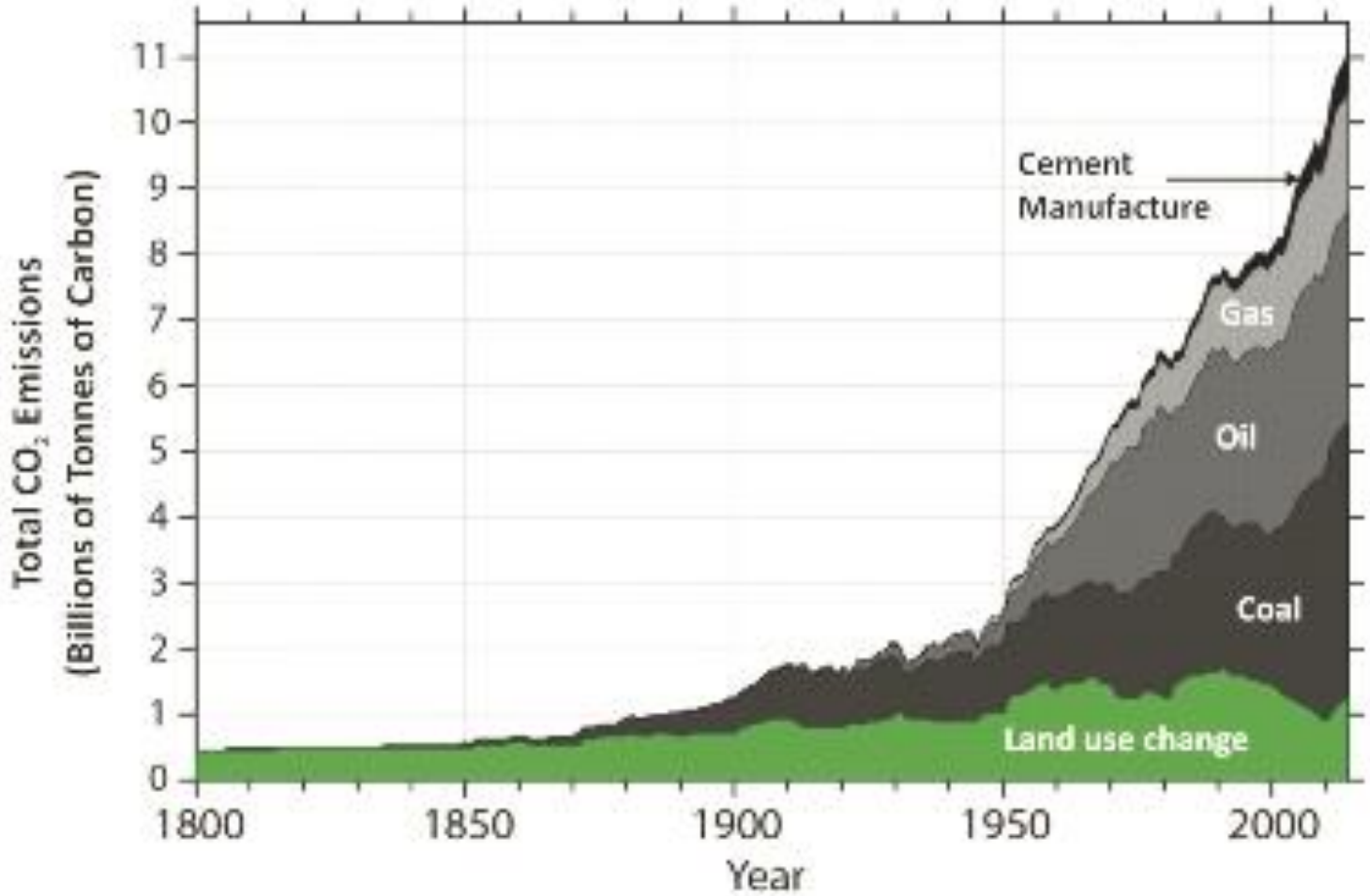
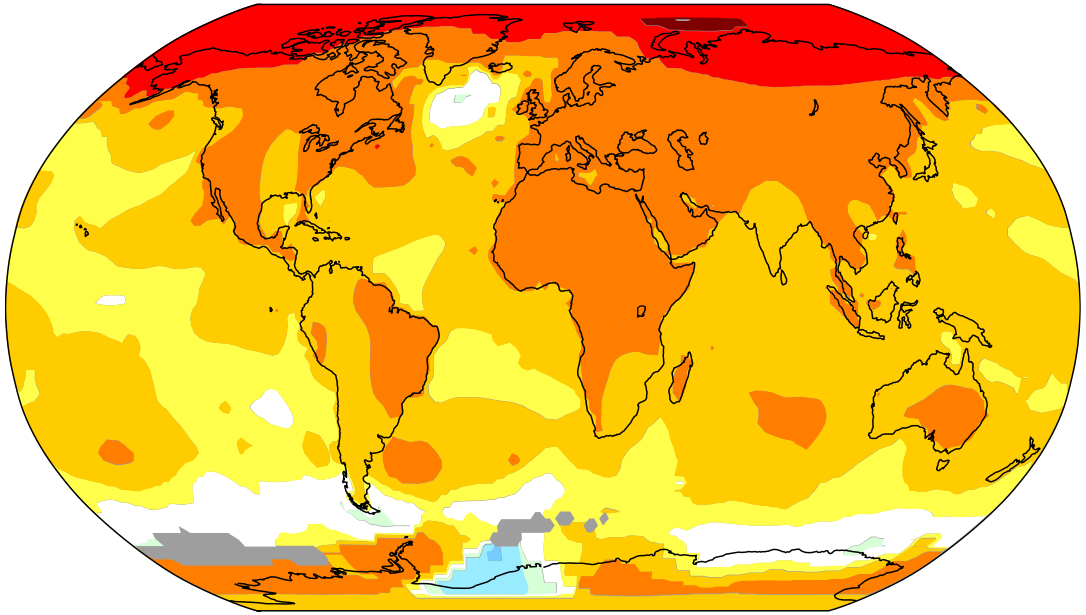


Figure 7. Anthropogenic carbon emitted as CO_2 in billions of tonnes per year from land use change, fossil fuel consumption, and cement manufacturing, 1800–2014. Data from Boden et al. (2017), Houghton (2008), and Houghton and Nassikas (2017). Diagram after Stocker et al. (2013, figure TS.4).

Burn et al 2021

Temperature change in the last 50 years



2011-2021 average vs 1956-1976 baseline

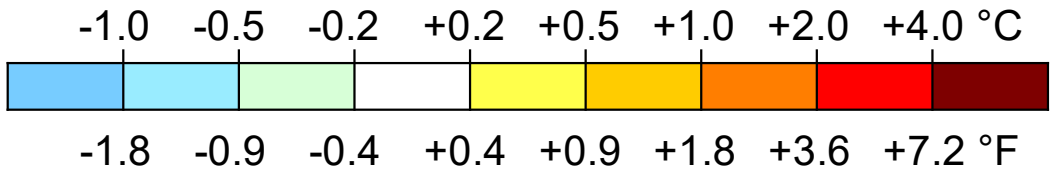
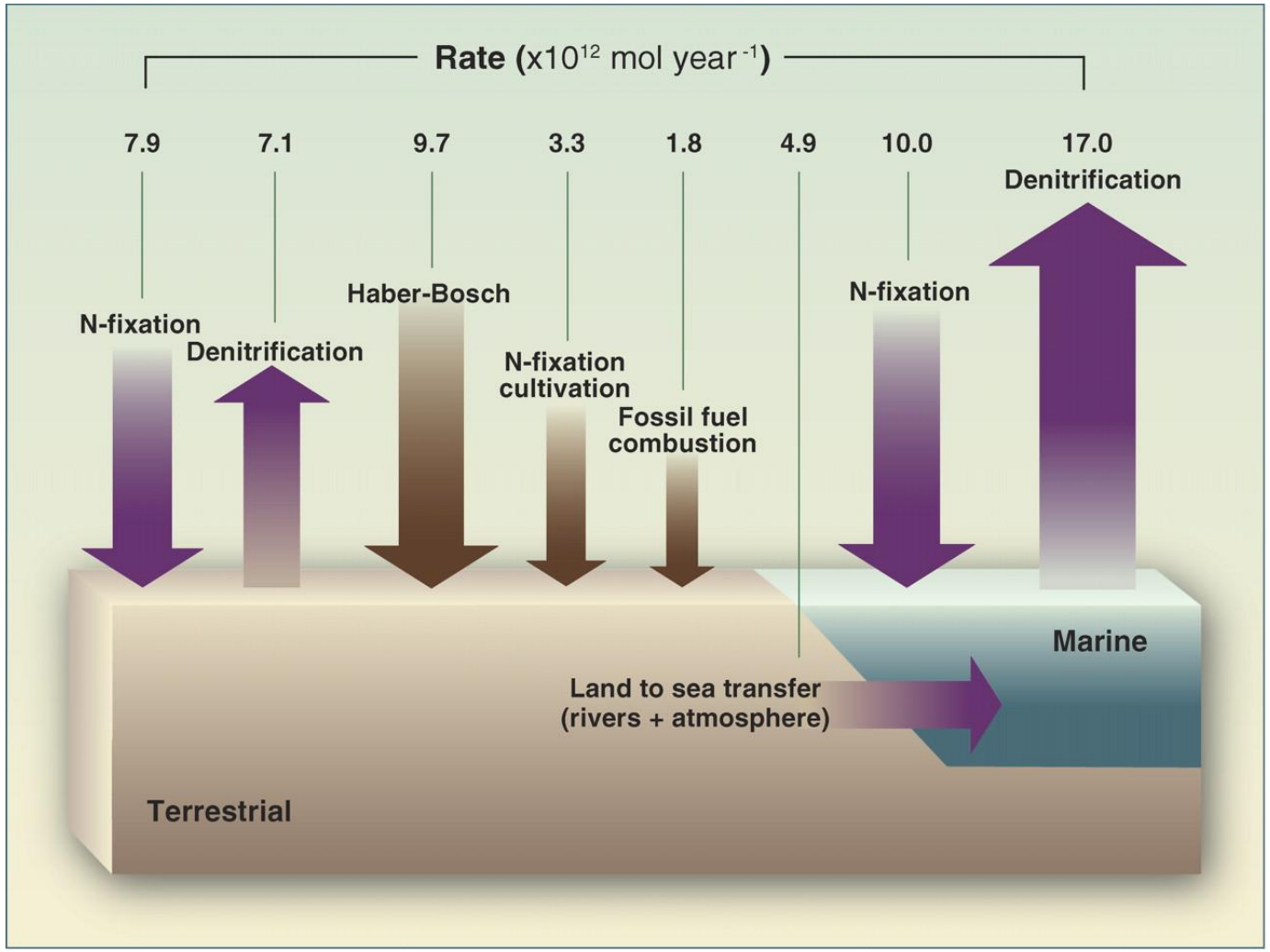


Fig. 4 Rates of nitrogen flux in the modern nitrogen cycle depend on the efficiency of the transformations between reservoirs.

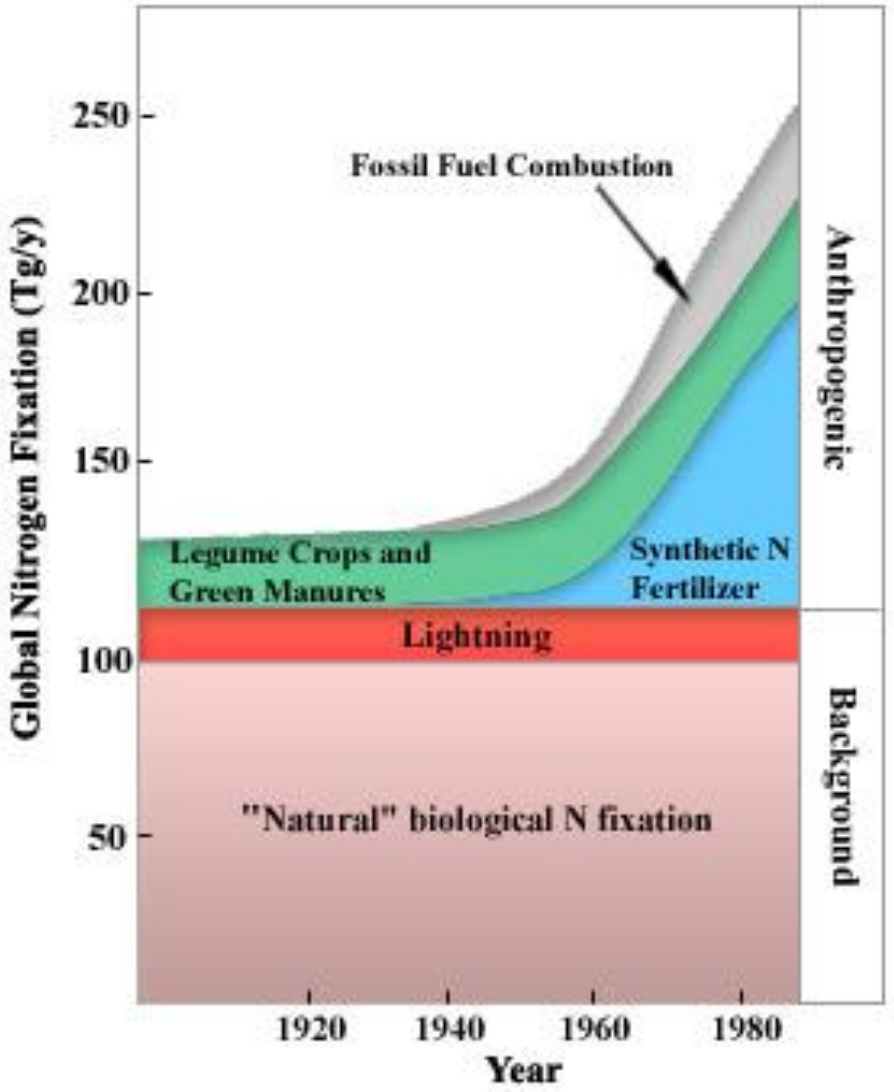


Donald E. Canfield et al. Science 2010;330:192-196

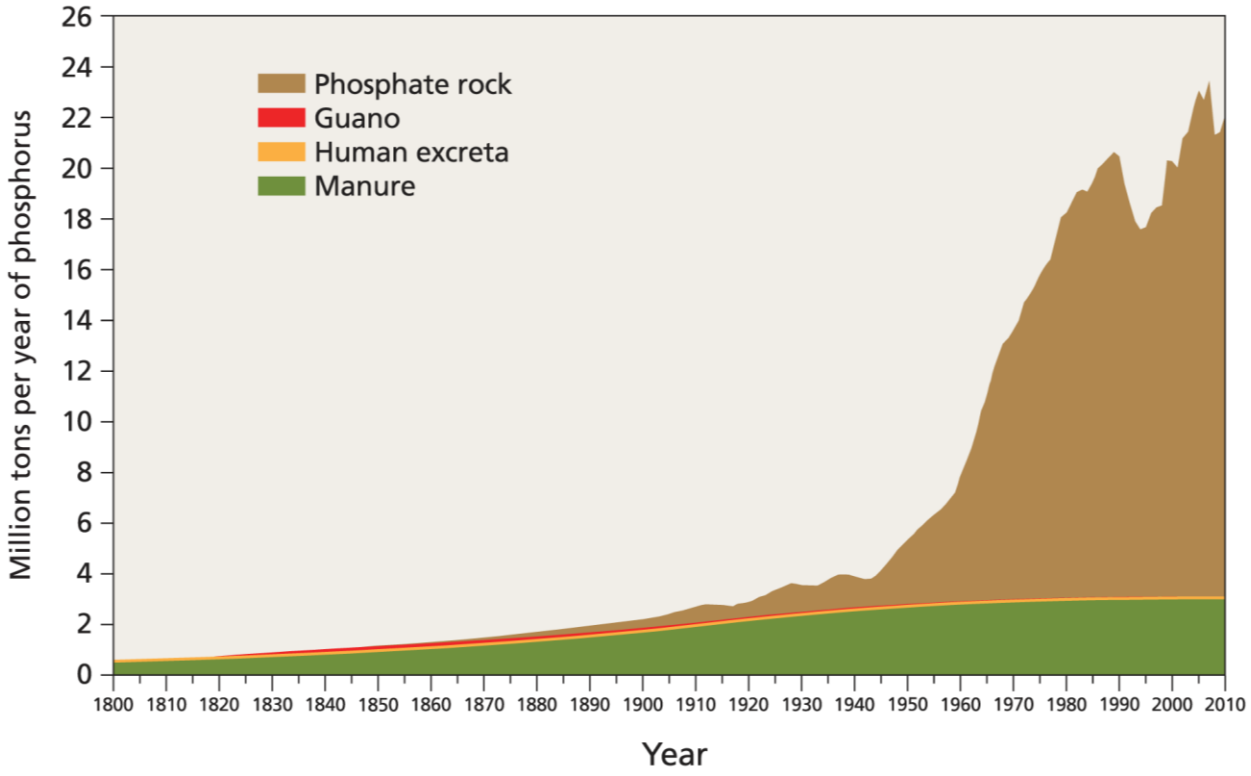
Published by AAAS

Nitrogen

- Humans have approximately doubled the rate of Nitrogen fixation



https://www.visionlearning.com/en/library/Earth-Science/6/The-Nitrogen-Cycle/98

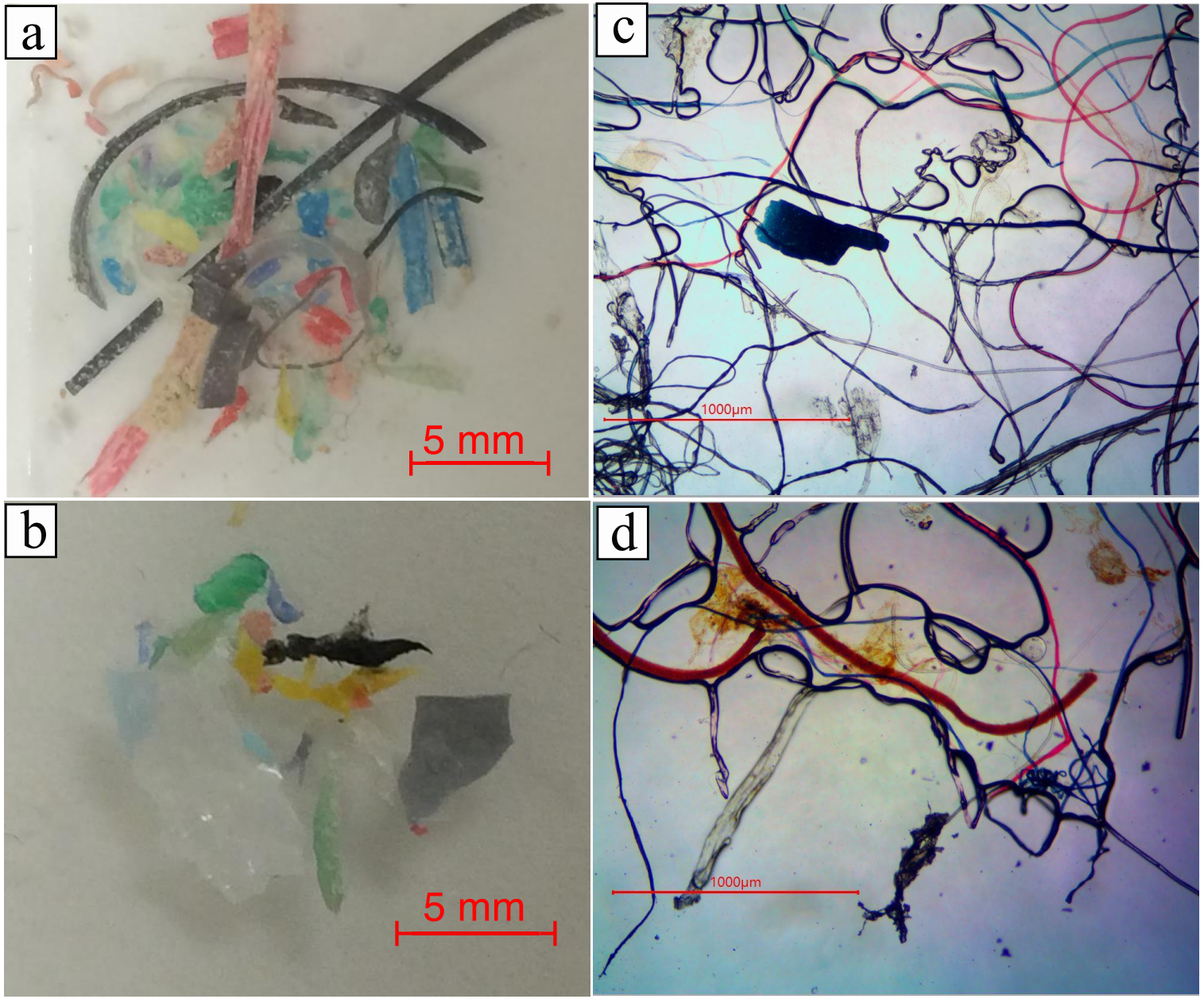


Phosphorus

- Human disruption of the phosphorus cycle

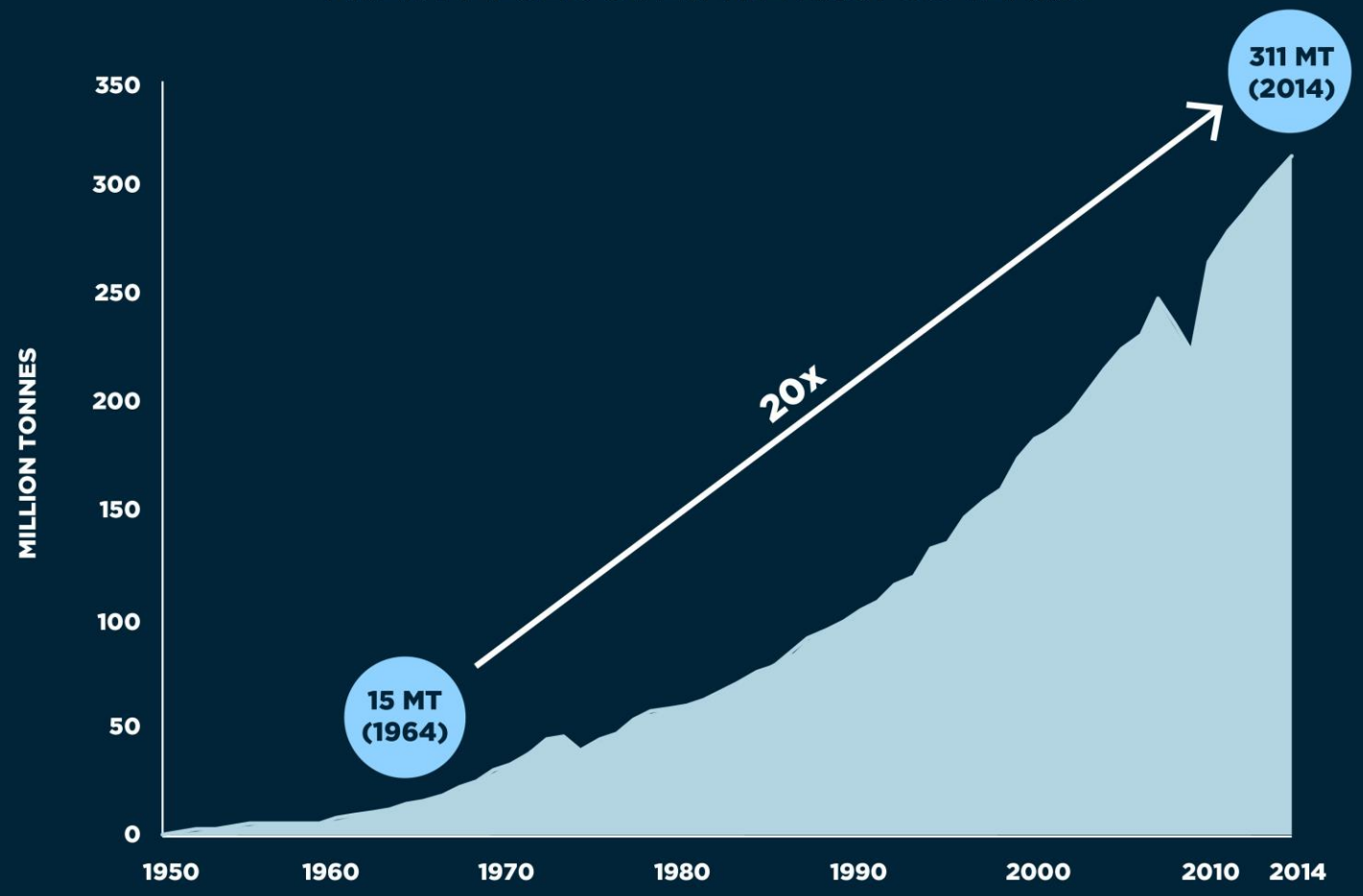
Eutrophication (increased algal production in lakes)

- David Schindler ELA Research



Vermaire et al FACETS 2017

PLASTICS PRODUCTION INCREASED TWENTY-FOLD OVER THE LAST 50 YEARS

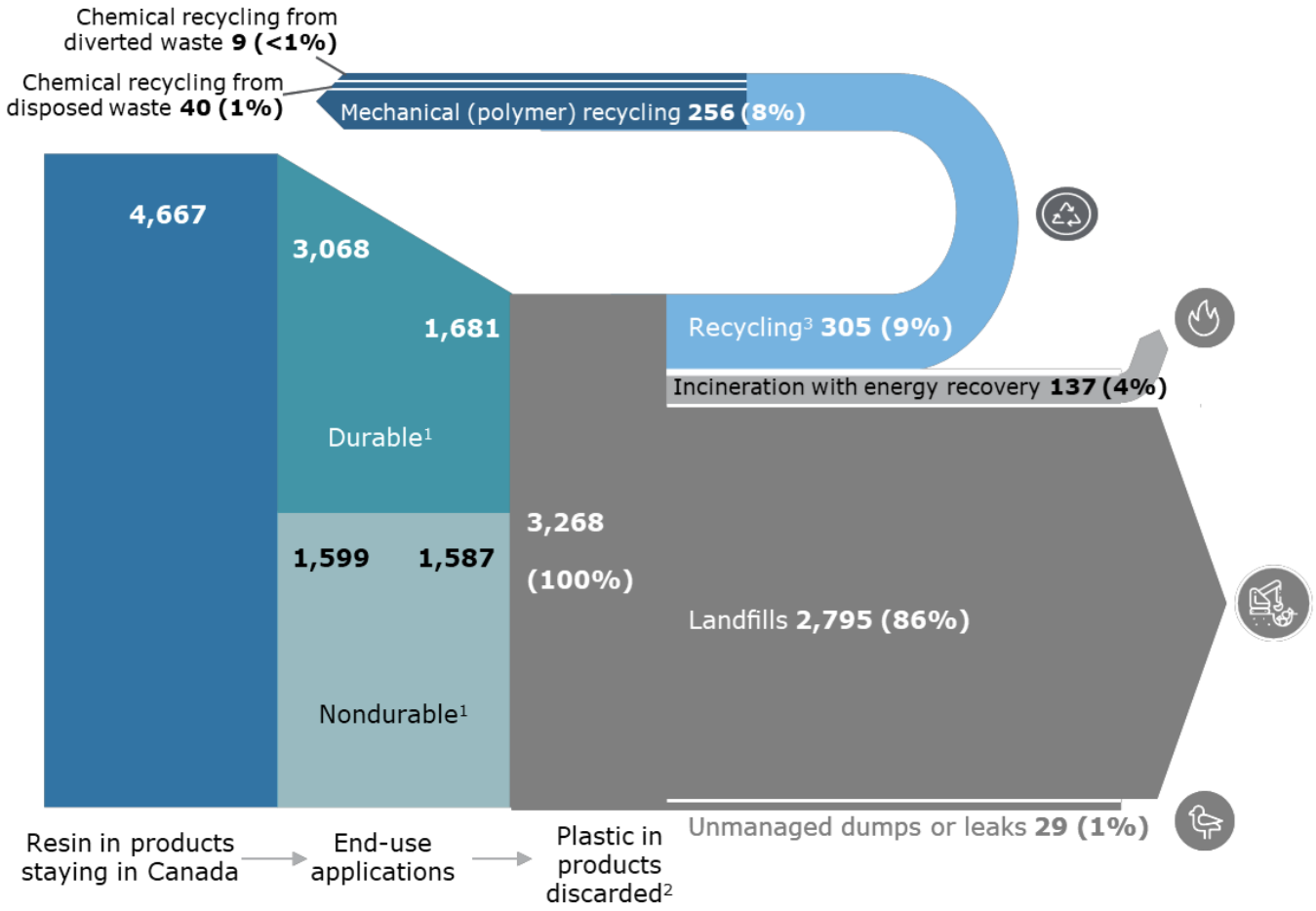


WORLD ECONOMIC FORUM, ELLEN MACARTHUR FOUNDATION, MCKINSEY & COMPANY,
A NEW PLASTICS ECONOMY: RETHINKING THE FUTURE OF PLASTICS (2016)
ELLENMACARTHURFOUNDATION.ORG/PUBLICATIONS

NOTE: Production from virgin petroleum-based feedstock only (does not include bio-based, greenhouse gas-based or recycled feedstock)
SOURCE: PlasticsEurope, Plastics – the Facts 2013 (2013); PlasticsEurope, Plastics – the Facts 2015 (2015).

ELLEN MACARTHUR FOUNDATION

Canadian resin flows in thousands of tonnes per annum, 2016

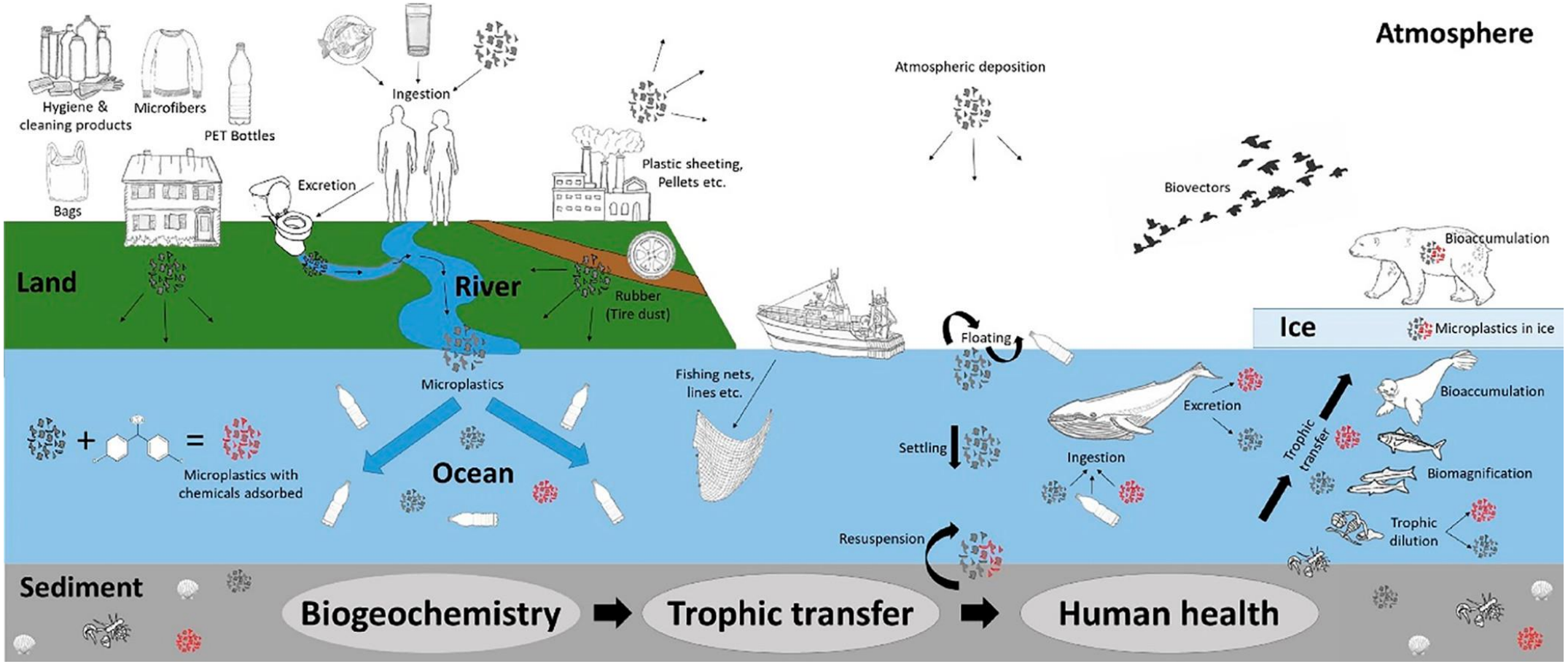


[1] Durable applications with an average lifetime >1 year will end up as waste only in later years; given market growth and increase share of plastics in durable applications (e.g., construction, cars) plastics waste generated today is less than what is being put in the market that same year. On the contrary nondurable applications go almost straight to waste.

[2] 1,587 thousand metric tons of mixed plastic waste from nondurable applications plus 1,681 thousand metric tons of mixed plastic waste from production in previous years.

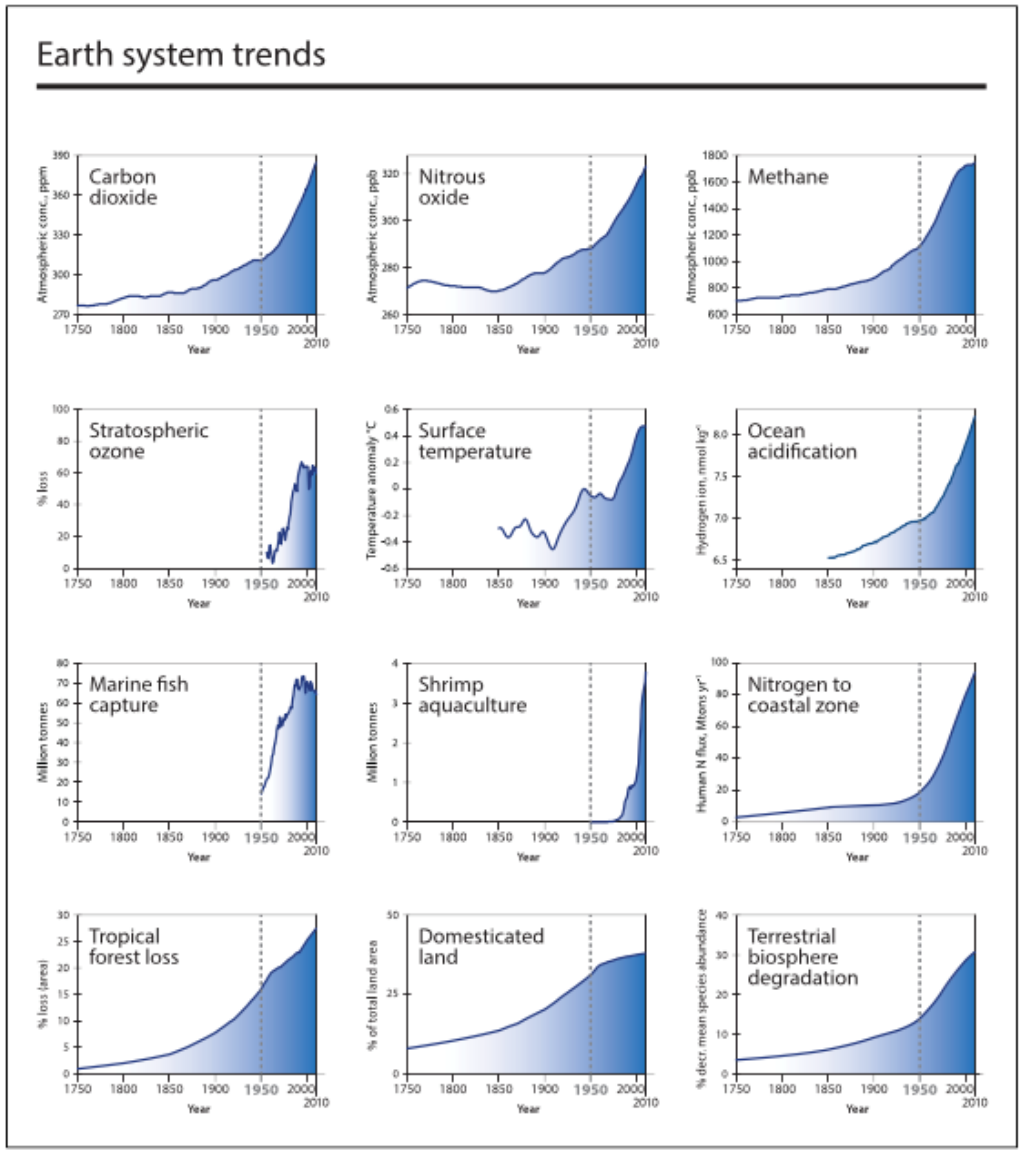
[3] Output recycling rate, after taking into account process losses.

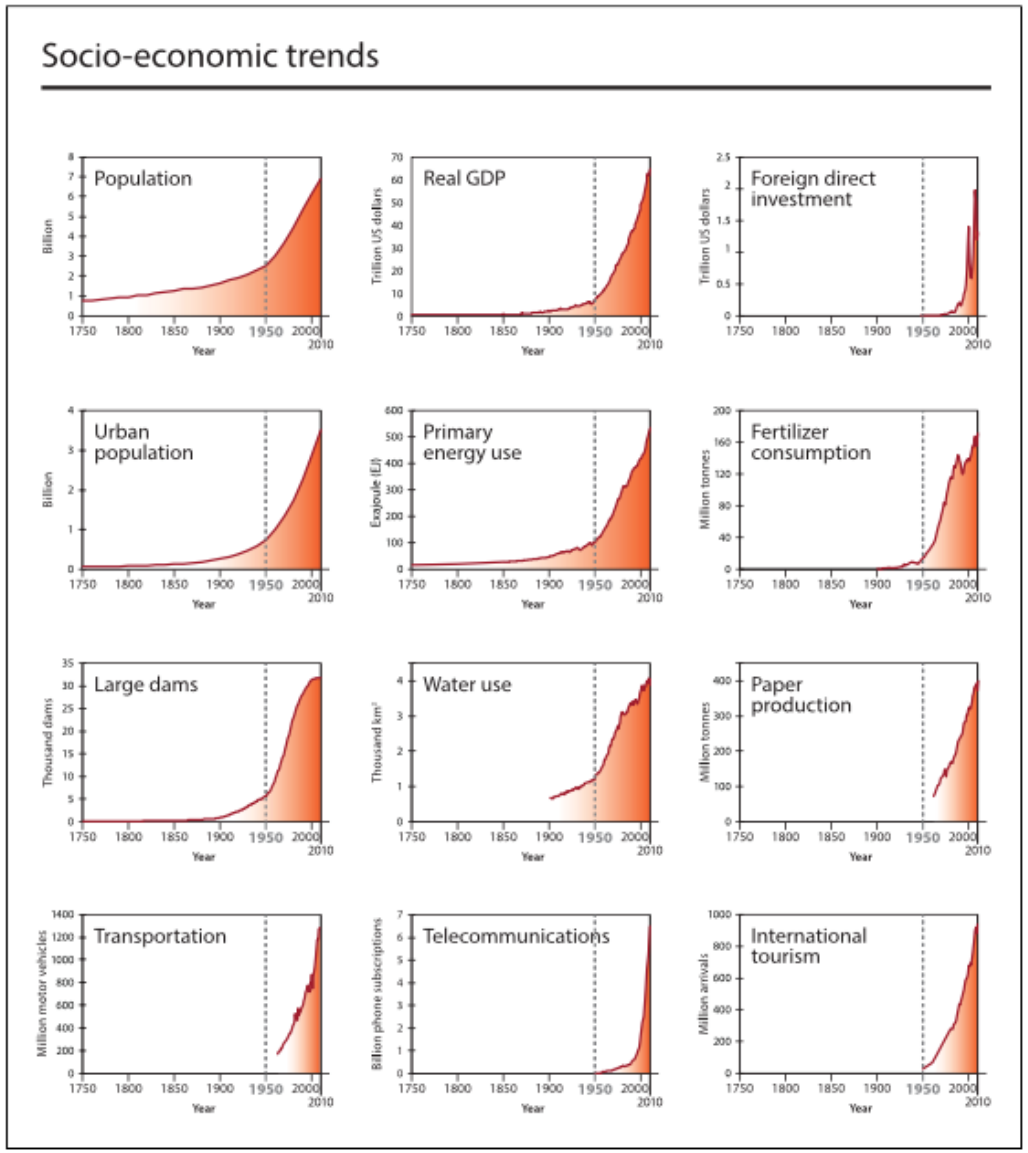
Environment and Climate Change Canada 2019



Conceptual model of the plastic pollution cycle and the interactions between biogeochemistry, trophic transfer, and human health and exposure.
Note that arrows and artwork are not to scale and are for descriptive purposes only. Expanded, adapted, and redrawn, in part, from Rochman et al. (2019) with permission.

DOI: (10.1021/acs.est.9b02942)



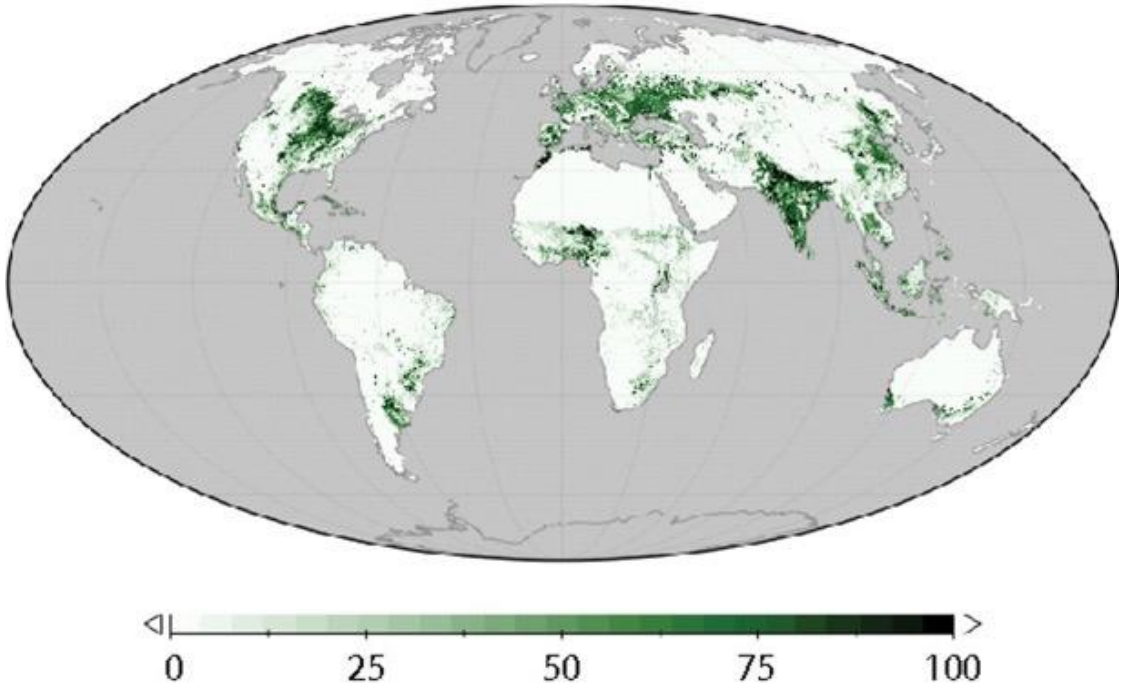


Steffen et al. 2015

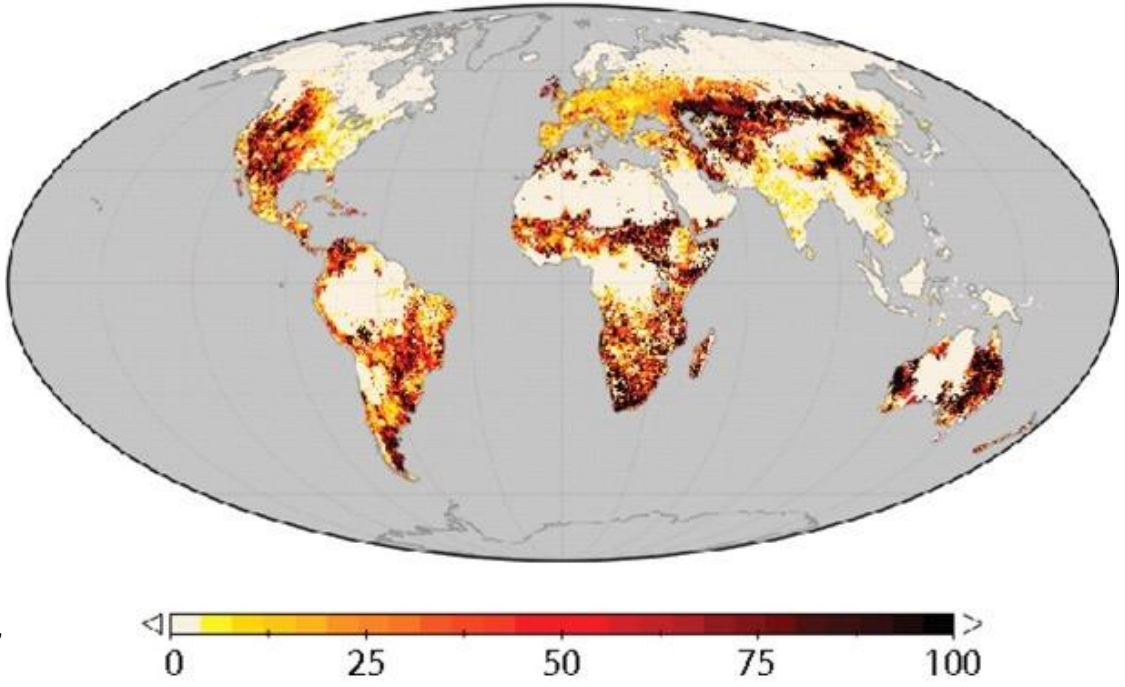
Agriculture is the largest ecosystem on the planet

~ 1/3 of ice-free terrestrial system is under some form of Agriculture

cropland



rangeland



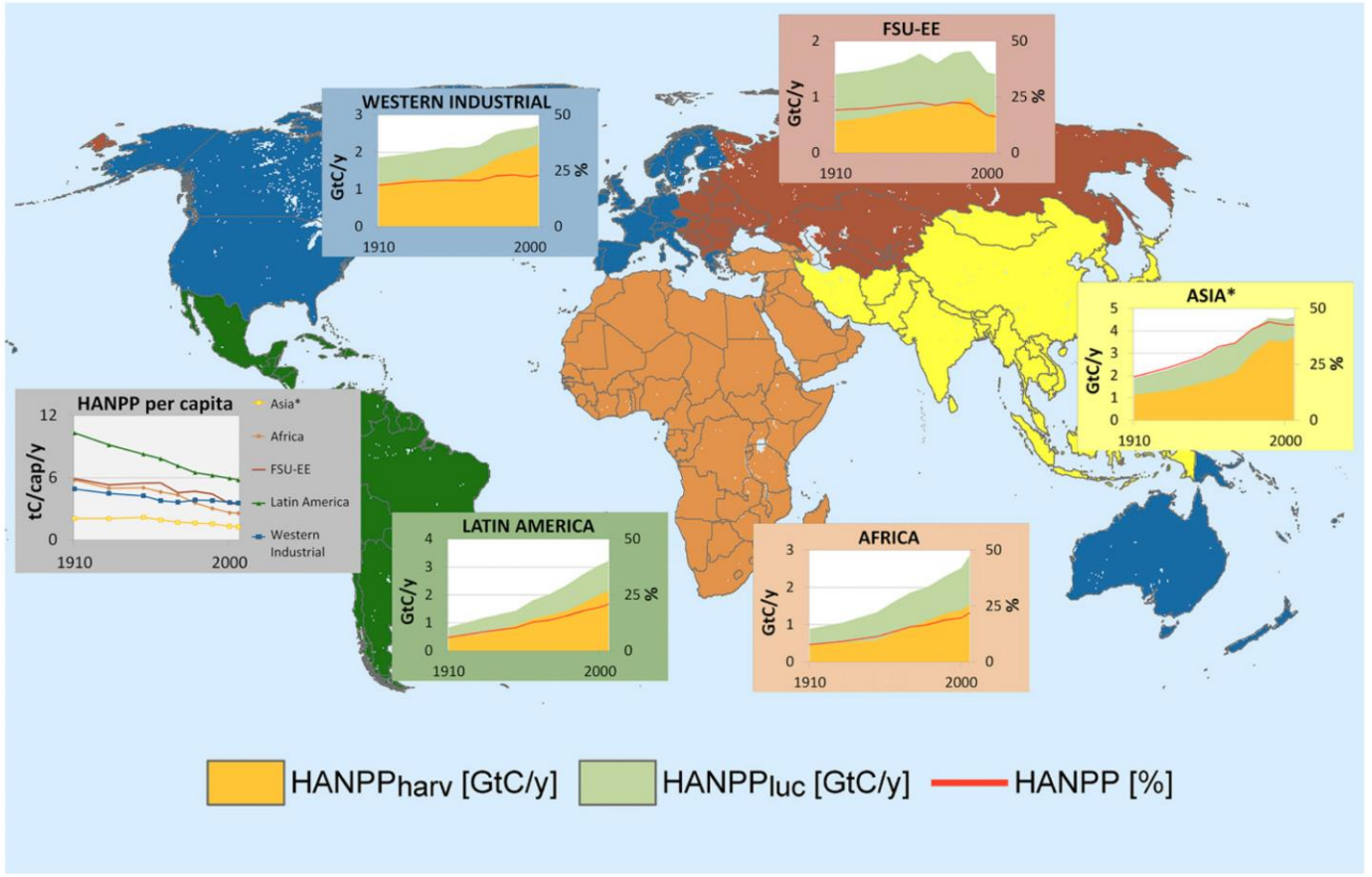
Foley et al. 2017

Humans are taking a large share of net primary production

From 1910 to 2005 HANPP went from 13% to 25% of net primary production of potential vegetation

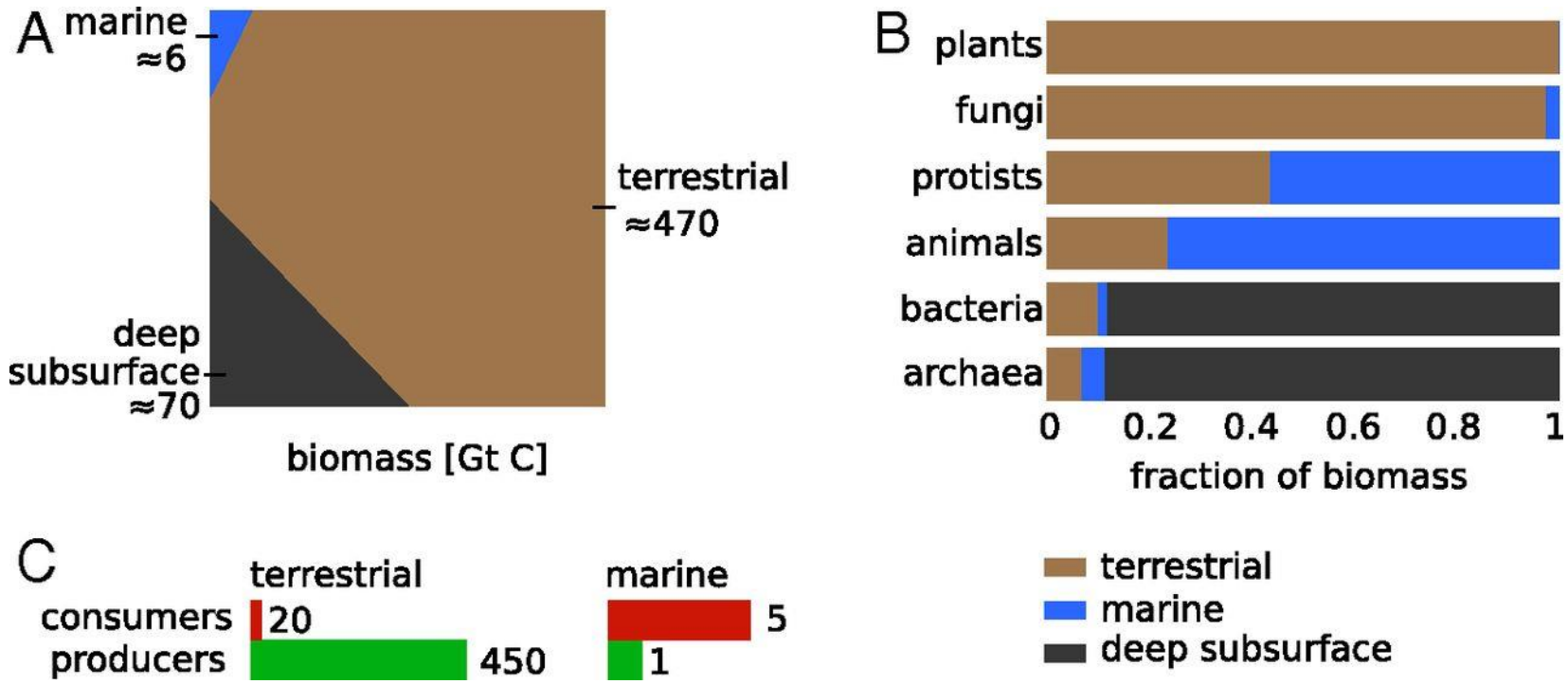
$HANPP_{harv}$ = Human Appropriated Net Primary Production by harvest

$HANPP_{luc}$ = Human Appropriated Net Primary Production by land-use change



Krausmann et al. 2013 PNAS

Biomass distributions across different environments and trophic modes.



Yinon M. Bar-On et al. PNAS 2018;115:25:6506-6511

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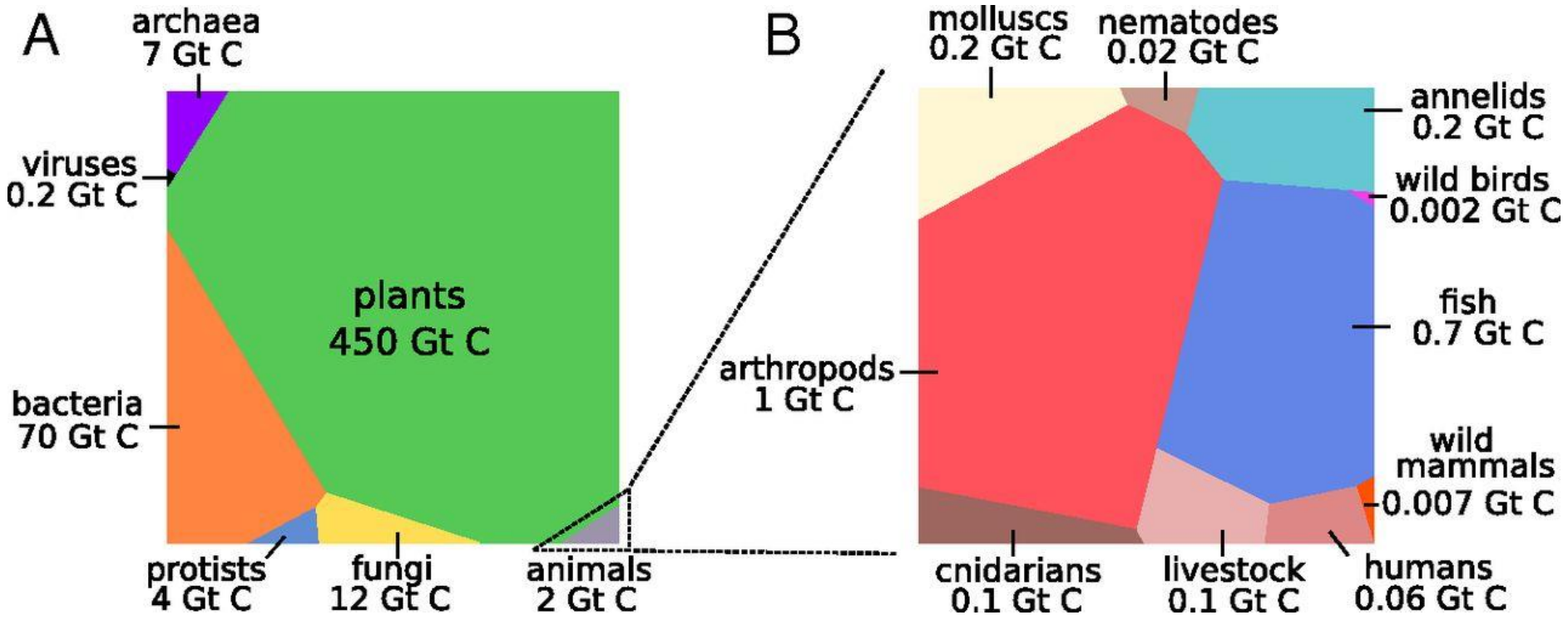
Graphical representation of the global biomass distribution by taxa.



Yinon M. Bar-On et al. PNAS 2018;115:25:6506-6511

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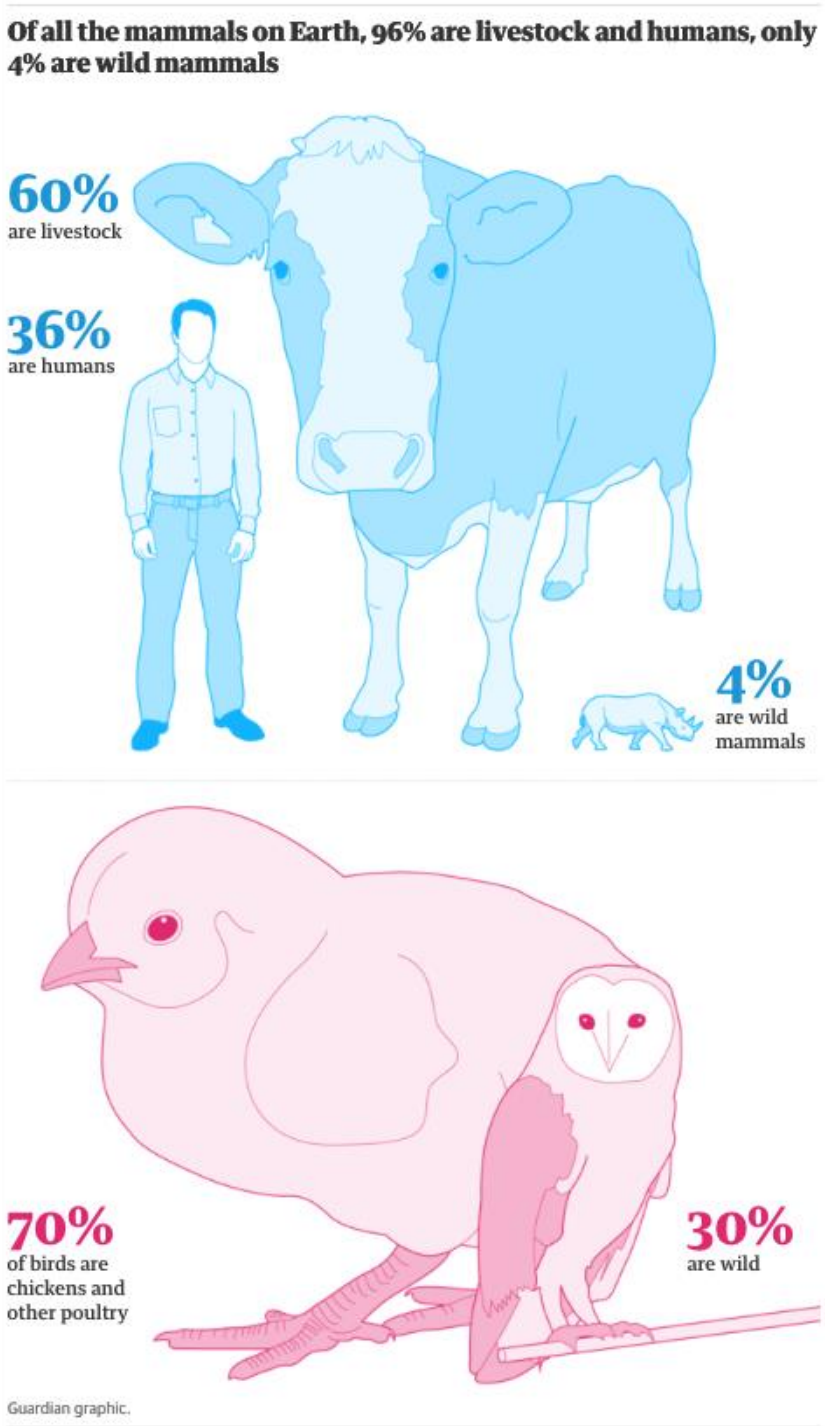
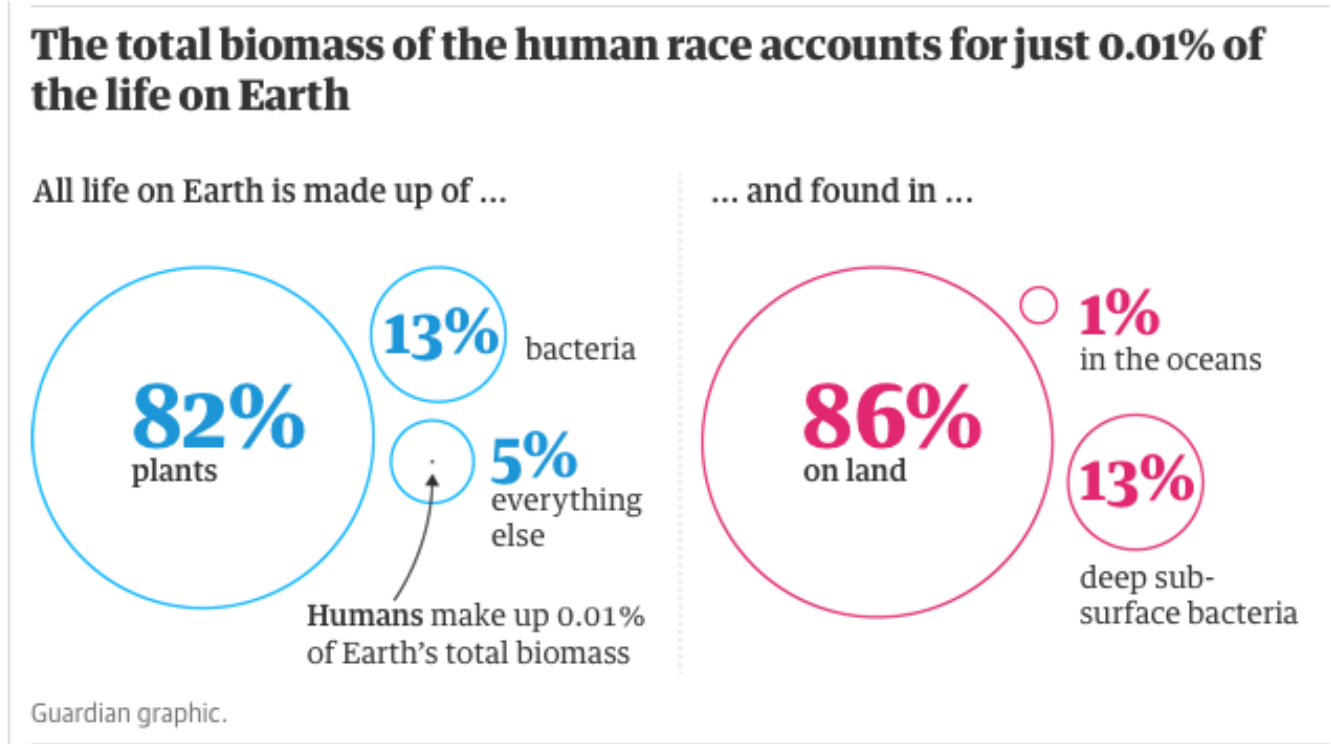
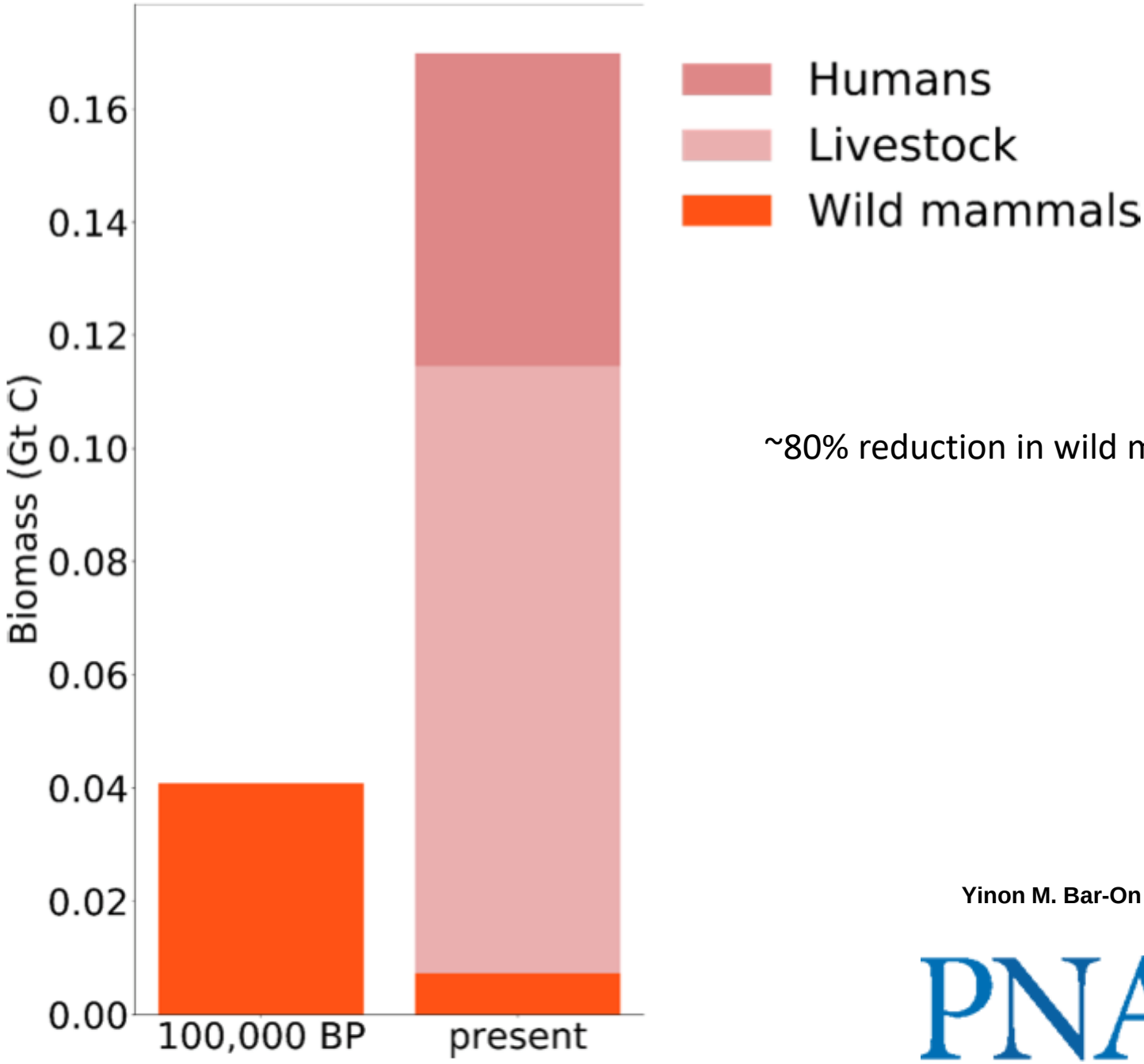


- Percentages in Gt of carbon



The Guardian



~80% reduction in wild mammal biomass (Gt C)

Yinon M. Bar-On et al. PNAS 2018;115:25:6506-6511

PNAS

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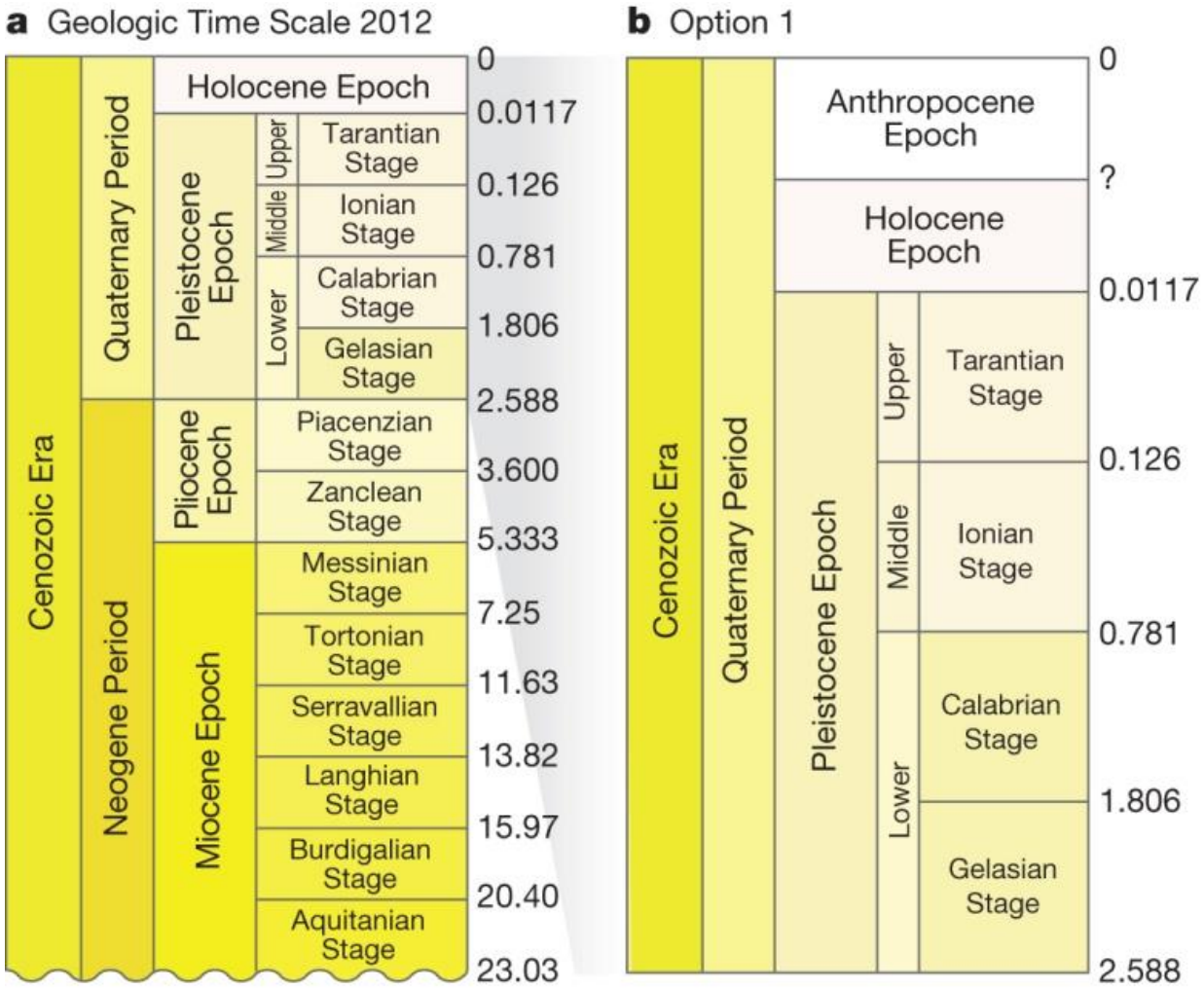
Anthropocene: A proposed geological time period where earth system processes have been altered by humans

Anthropo = human cene = geological suffix related to Cenozoic period “new”

Comparison of the current Geologic Time Scale[10] (GTS2012), with an alternative.



nature

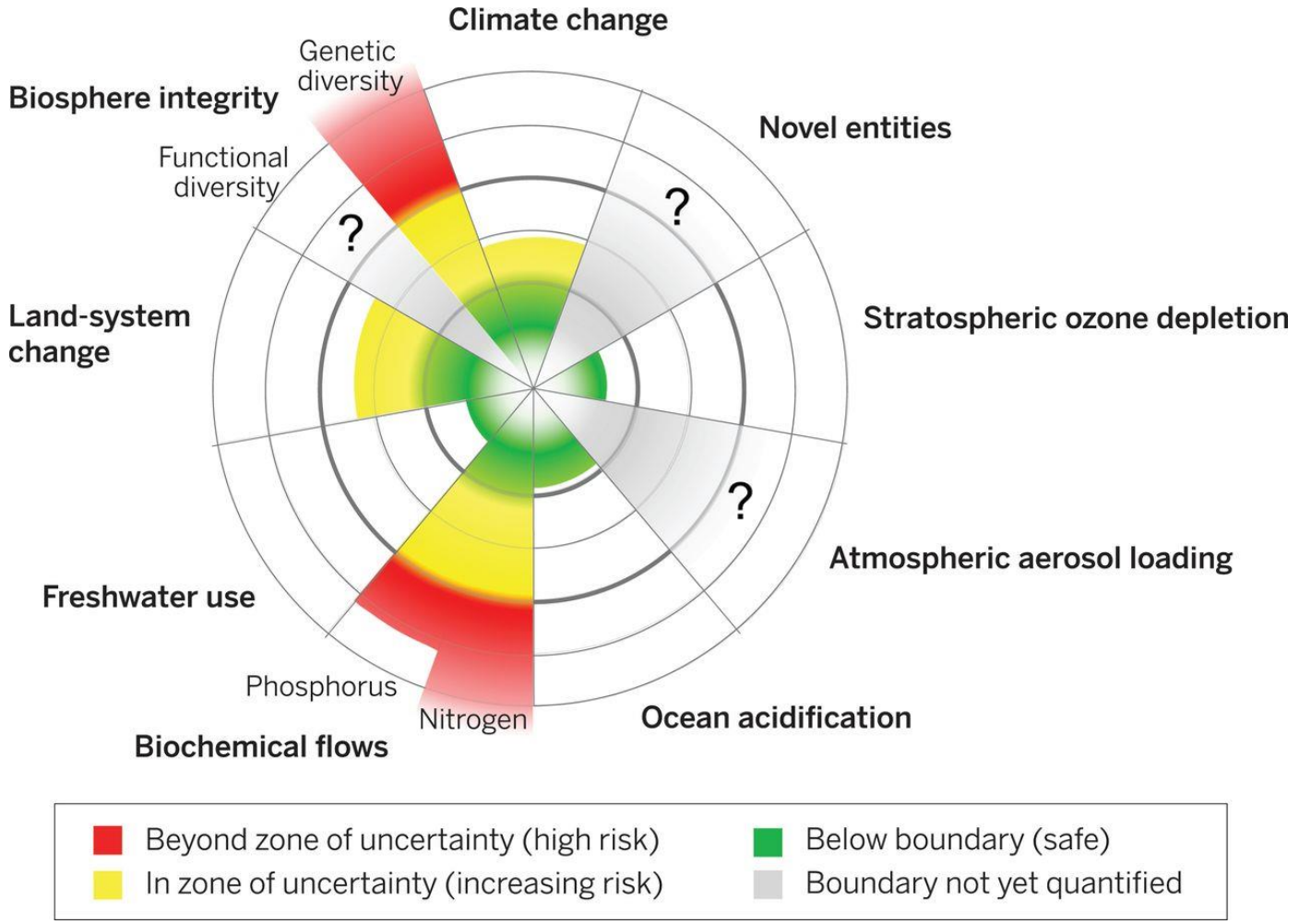
SL Lewis & MA Maslin *Nature* **519**, 171-180 (2015) doi:10.1038/nature14258

Crawford Lake

Photo credit: Tim Patterson

global boundary stratotype section and point (GSSP), or ‘golden spike’

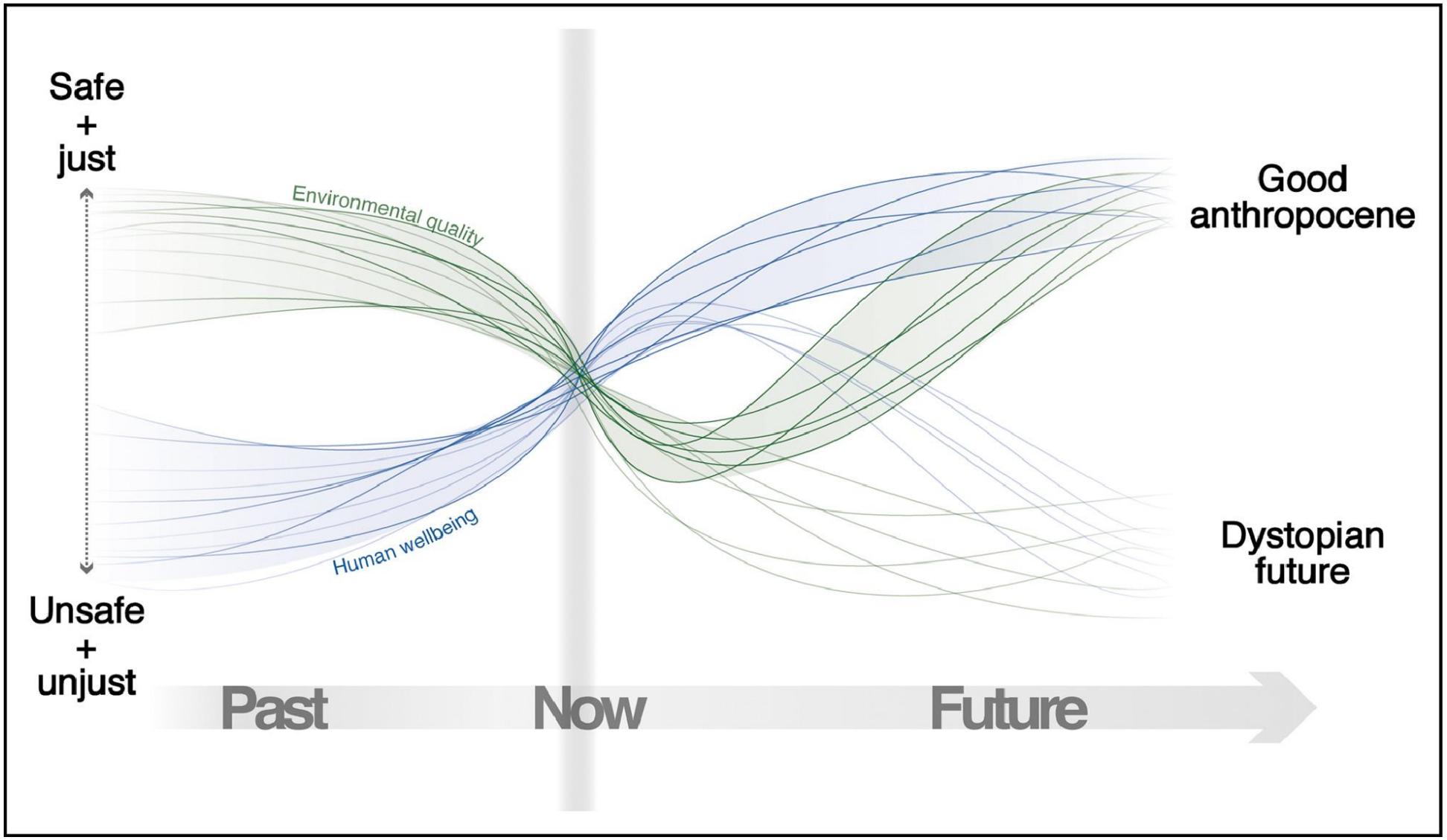
Current status of the control variables for seven of the planetary boundaries.The green zone is the safe operating space, the yellow represents the zone of uncertainty (increasing risk), and the red is a high-risk zone.



Will Steffen et al. Science 2015;347:1259855

Published by AAAS

Bright spots: seeds of a good Anthropocene



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