Welcome to this week's presentation and conversation
hosted by the
Canadian Association for the Club of Rome,
a Club dedicated to intelligent debate and action on global issues.

Agriculture in the Anthropocene.

Dr. Ralph Martin, plant scientist, started teaching at the Nova Scotia Ag College, in 1990. In 2001, he founded the Organic Ag Centre of Canada to coordinate research & education on organic systems, across Canada. In 2011, he became Professor and Loblaw Chair in Sustainable Food Production at U Guelph. In 2019, he retired & published *Food Security*.

The Holocene was unusually benign for ag and it must adapt in the Anthropocene. Since WWII, ag has tried to produce more food with population increases. Problems were legion: wasted food, excess livestock, unhealthy eating habits, concentration of land ownership, & pollution. Possibilities to balance production with consumption are to reduce wasted food, increase biodiversity, draw down CO_2 while improving soil health, address inequality, & reduce fertilizer use. We could learn when we have enough.

Dr. Martin's presentation will be followed by a conversation, questions, and observations from the participants.

CACOR acknowledges that we all benefit from sharing the traditional territories of local Indigenous peoples (First Nations, Métis, and Inuit in Canada) and their descendants.

2022 June 01

Agriculture in the Anthropocene

June 1, 2022

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Photo by Justin Hofman, Barcroft Media

"We are living in the Anthropocene, an epoch where everything of Earth's current matter and life… is being determined by the ruinous activities of just one soft-skinned, warm-blooded, short-lived pedestrian ape."

Tim Dee. *2018. Ground Work: Writings on Places and People*

Part 1: Problems

Photograph: Tayfun Salcı/Zuma Wire/Rex/Shutterstock. https://bit.ly/3eParmE

Basic Ag Premise; Growth Intro Ch.

- **7.9** bil people with 1.4 bil cars and 0.8 bil cats and dogs; by 2050 expect **9 - 10** billion people (<30 % increase)
- In developing countries, average incomes rise; consume more meat; thus by 2050, increase **food** production by 70 – 100%

Animal Ag Production

1 bil cattle, 0.7 bil pigs and 26 bil chickens require **feed** and release **methane** Ch 7

Photo: https://bit.ly/3wlOp22

Photo by K Lightburn

Biodiversity in Ag?

- 350,000 plant species, 195,000 flowering plants, most have edible parts useful to humans
- < 300 plant species for food; only 17 species provide 90% of human food
- Of 17 species, 3 (corn, rice and wheat) make up > 50% of all food crops

Ch 11

Land and Money

Photo by Terry Tindall

Smallholder farms produce 80% of world's food supply with only 12% of arable land. https://bit.ly/2BAMqzS Ch 10

1% of world's farms control 70% of world's farmlands.
Bill Gates is biggest private owner of farmland in US
https://bit.ly/3mtfKvn

“Ideas over inheritance in India follow gender lines. Women grow up to 80% of India’s food, but own 11% of its farmland.” https://bit.ly/3yjijrL

For over 90% of our existence, humans lived in egalitarian societies

…

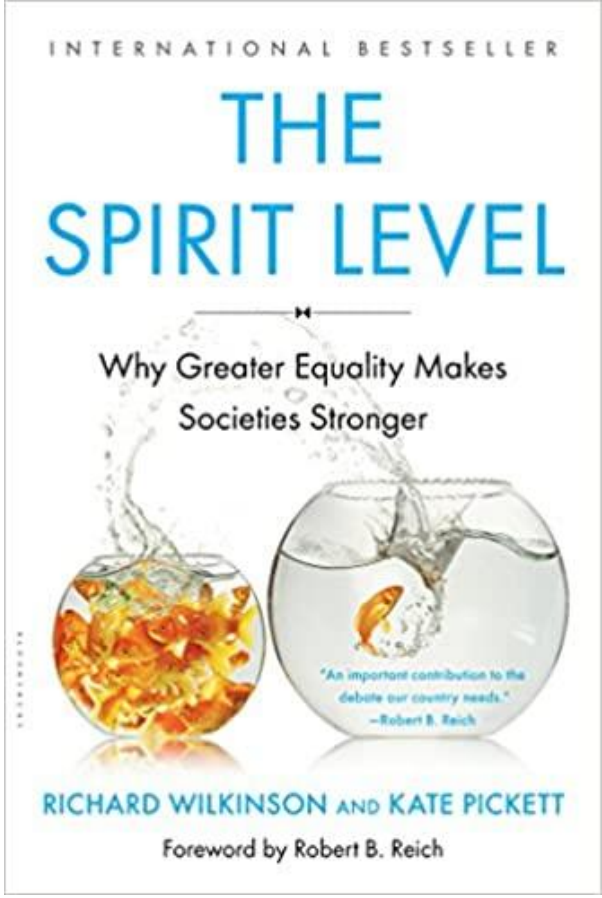
Modern inequality arose and spread with the development of agriculture

Ch 4

"I have it and you don't"

Photo of gannet in Guardian

https://bit.ly/3dCjzvi



Disasters occur when Hazards meet Vulnerability – Recognize human-made components of hazards and vulnerabilities (due to inequality)

https://go.nature.com/3feOSMT

We are what and how we eat Ch 5

- Two-thirds of health-care costs can now be attributed to chronic diseases associated with unhealthy eating

Dube et al. 2009. Building Convergence: Toward an Integrated Health & Agri-Food Strategy for Canada. https://bit.ly/3gouQB5

Advertisers and Kids with Drinking Problems

Heart and Stroke Fndn https://bit.ly/2oGnVWZ

Can of pop almost daily max of sugar. PHAC notes that 25% of children consume sugary drinks every day.

Canadian children & youth spend 8 hrs /d on screens and view > 25 million food and beverage ads; > 90% for unhealthy foods.

Industry should pick on someone its own age Ch 5

Annual Health Care Costs (AHCC)

in contrast to **Food-Secure Households**

Tarasuk et al. 2015. CMAJ. **DOI:10.1503 / cmaj.150234** Ch 5

- Marginal food insecurity, AHCC 23% higher
- Moderate food insecurity, AHCC 49% higher
- Severe food insecurity, AHCC 121% higher

Food insecurity is caused by **poverty**; not lack of food

Photo by M Kenny

U of Guelph Wasted Food Audit

http://dx.doi.org/10.1016/j.wasman.2014.09.019

- Unavoidable (36%) – not edible under normal circumstances (e.g. apple cores, melon rinds)
- Avoidable (53%) – thrown away prior to disposal and still edible (e.g. heel of bread, half a roast) + 11% possibly avoidable
- **$49.5 Billion** - value of wasted food (~ 58% overall) in Canada; about 32% of this, avoidable)

Gooch et al. 2019. https://bit.ly/2ZvPmaC Ch 6

On Ontario farmland:

1) SOM levels are now decreasing on 82% of fields

2) 54% fields have an erosion risk that is too high

3) Only 20% of cropland has very high cover (i.e. > 300 days covered). When bare ground is pounded by rain, it erodes and loses SOM.

http://omafra.gov.on.ca/english/landuse/soil-strategy.htm Ch 10

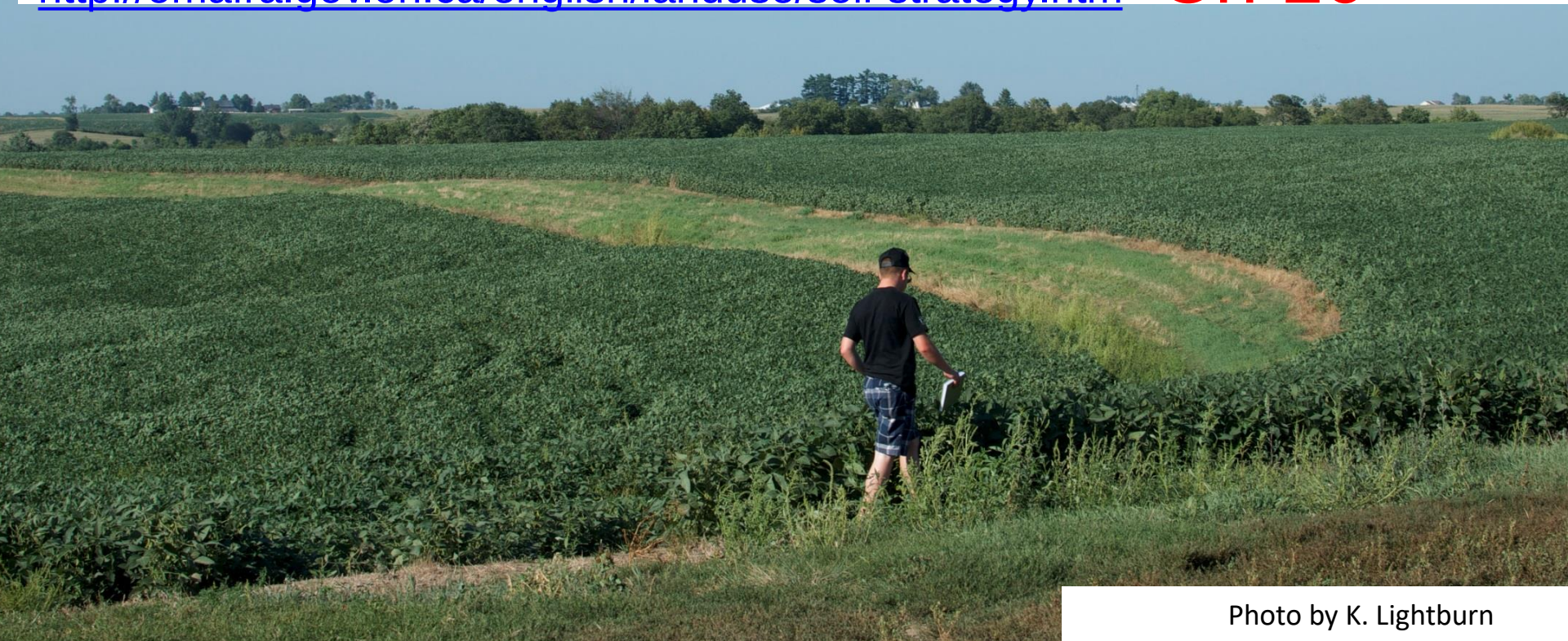
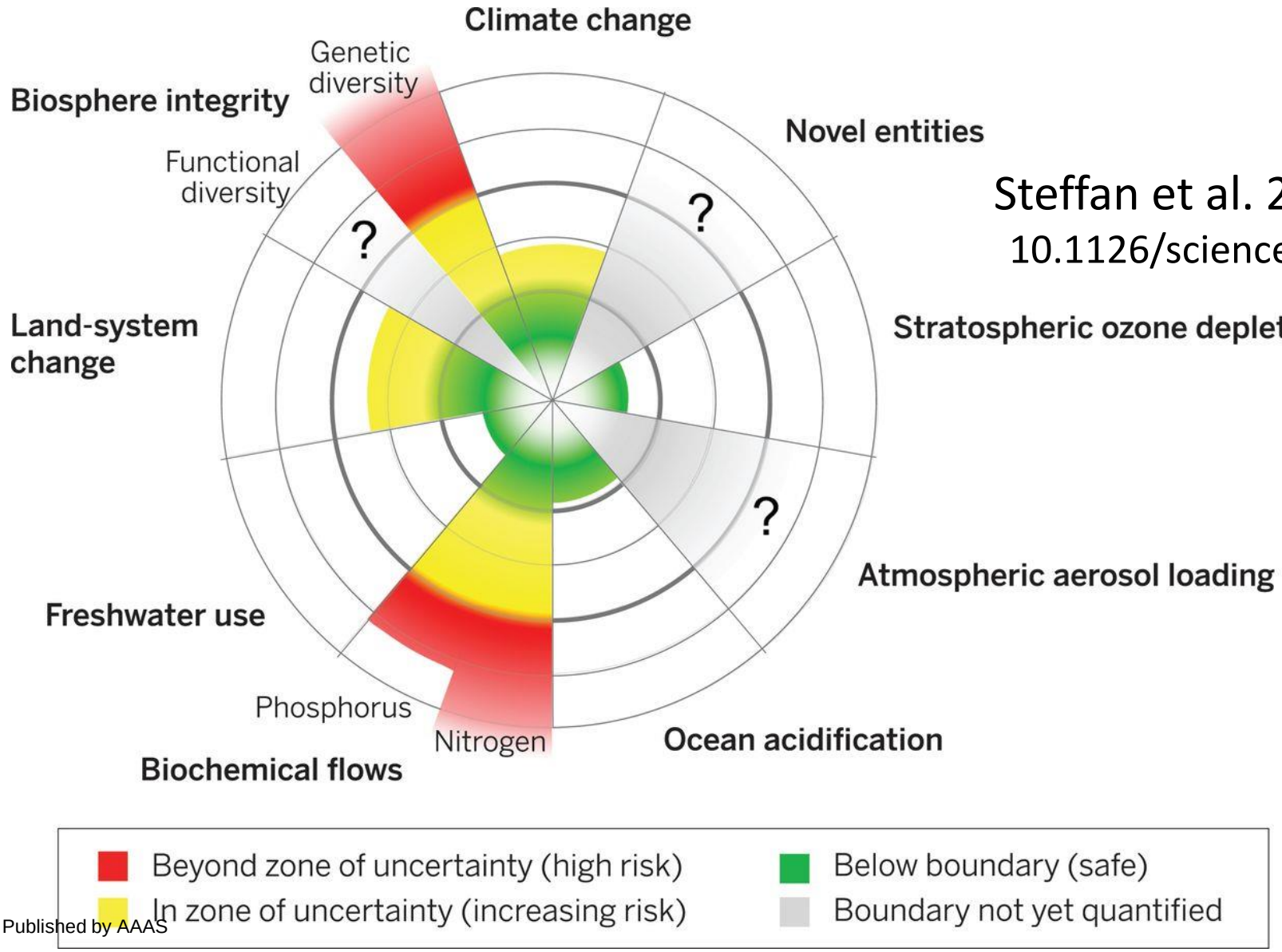


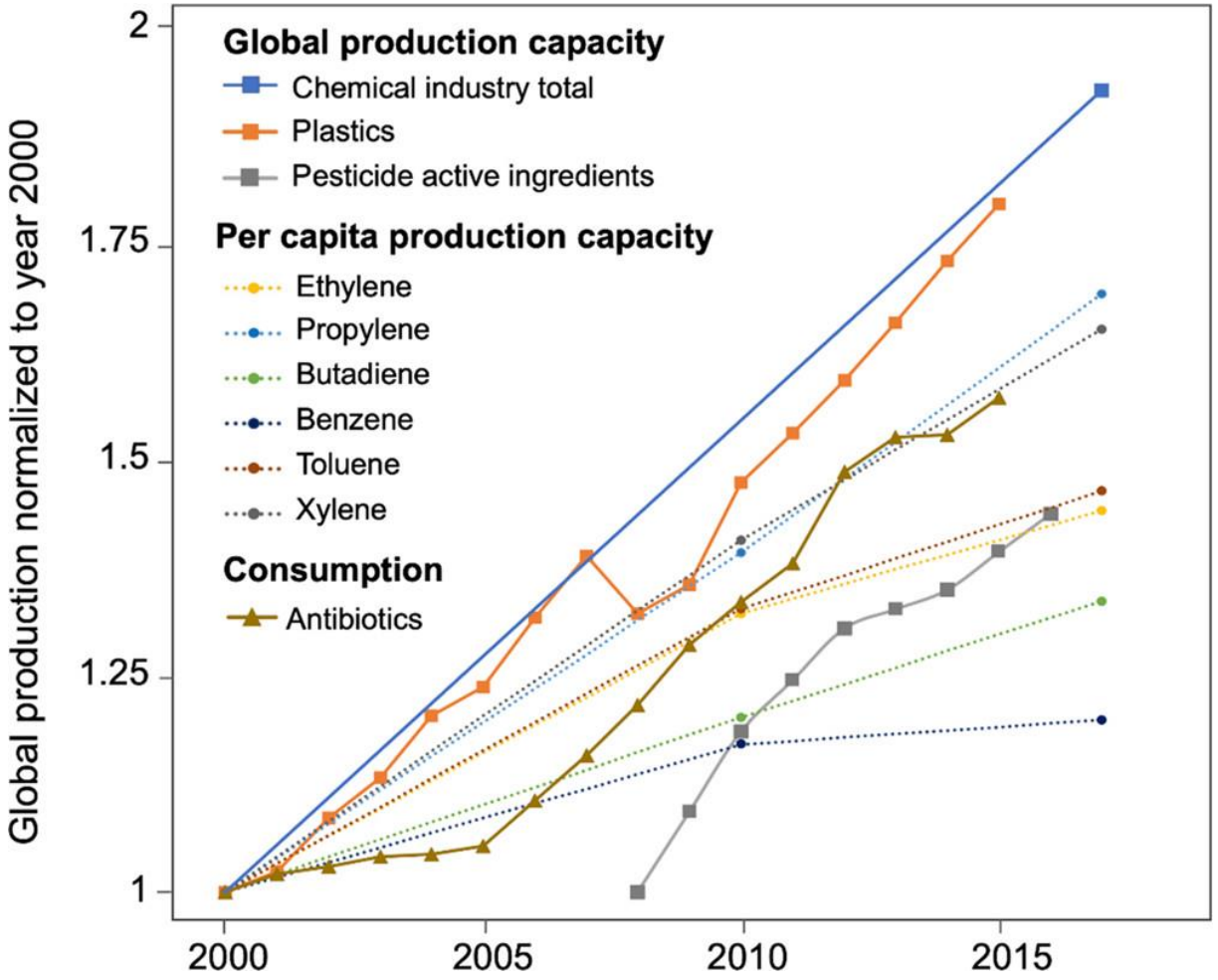
Photo by K. Lightburn

Planetary boundaries: Guiding human development on a changing planet Ch 9



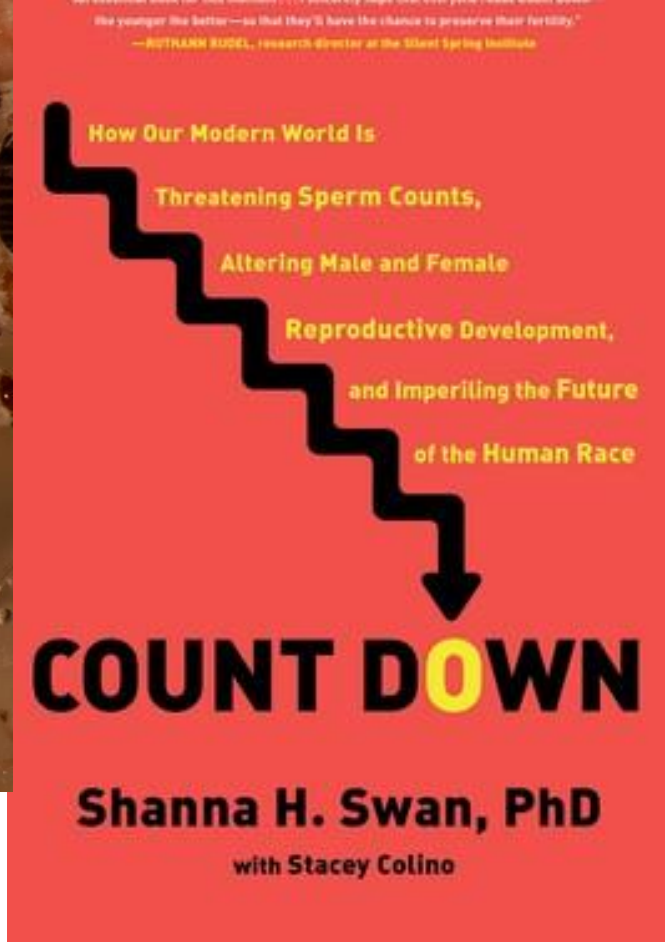
Steffan et al. 2015. DOI: 10.1126/science.1259855

Novel Entities are outside the Safe Operating Space of the Planetary Boundary. Annual production & releases are increasing at pace outstripping global capacity for assessment & monitoring.



Persson et al. 2022 DOI: 10.1021/acs.est.1c04158

Photo: https://bit.ly/33ZZWb1

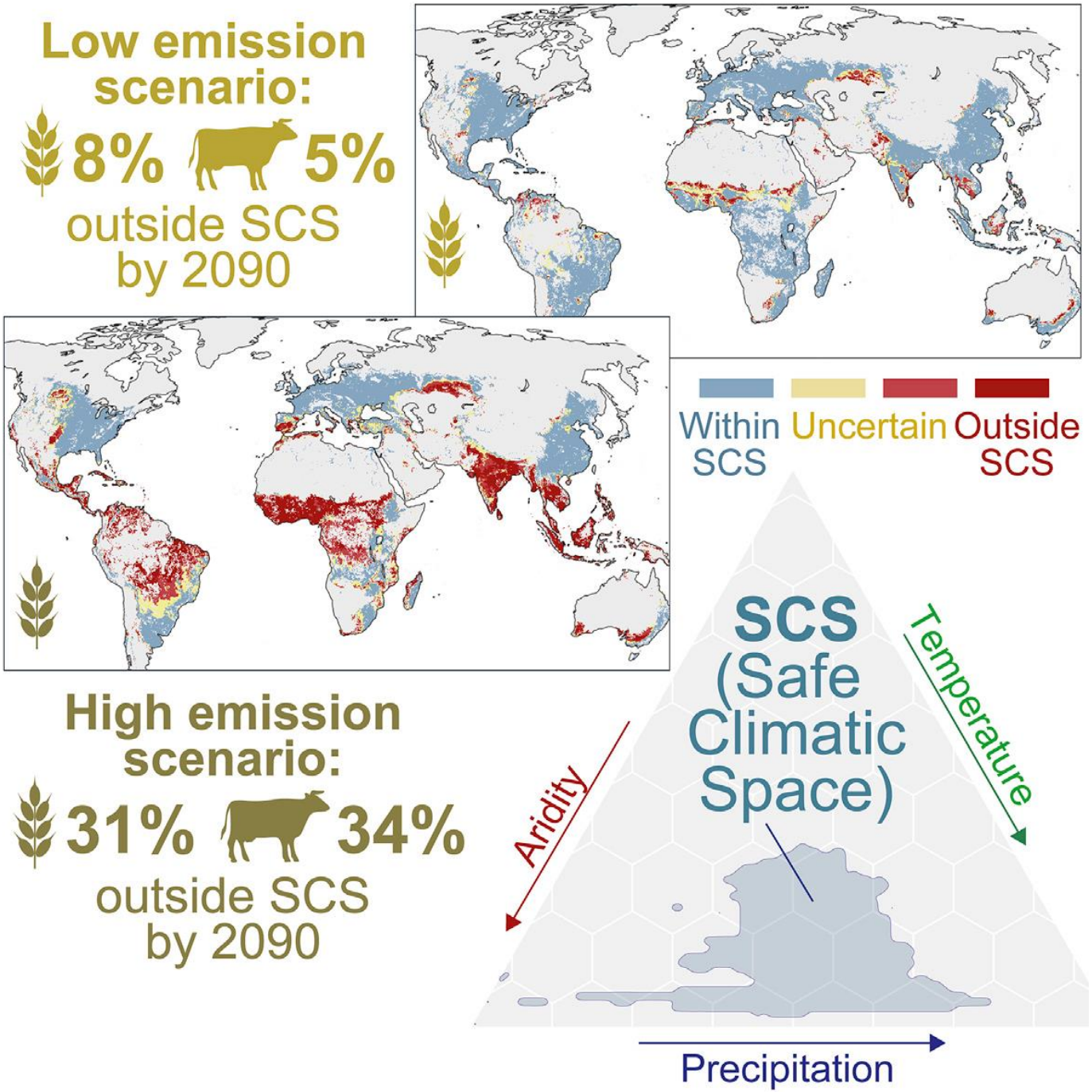


Pesticides of all types pose a clear hazard to soil invertebrates. Hyland et al. 2019. https://doi.org/10.1016/j.envres.2019.01.024 Ch 10 and 11

By 2045 median human sperm count may be zero, given BPAs, other chemicals. https://bit.ly/2Pwudu2

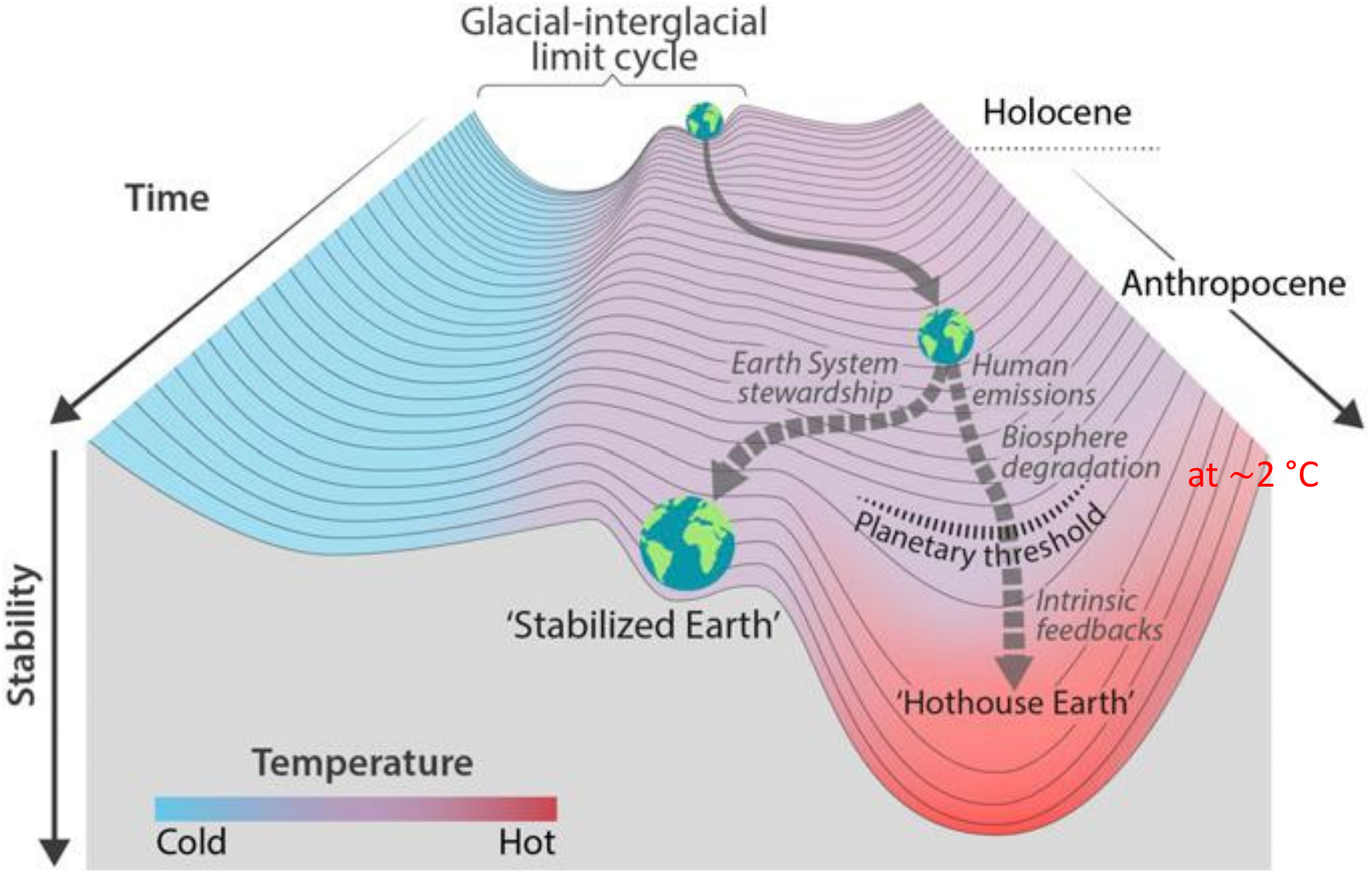
Green water planetary boundary (% ice-free land area on which root-zone soil moisture deviates from Holocene variability for any month of the year) is already transgressed. Wang-Erlandsson et al. 2022. www.nature.com/articles/s43017-022-00287-8

The cuts in global emissions currently planned by 2030 were way off track to keep the peak below 1.5C. That is the global goal, but currently there is **less than a 10% chance of hitting 1.5C target**. https://bit.ly/3NlZrMY



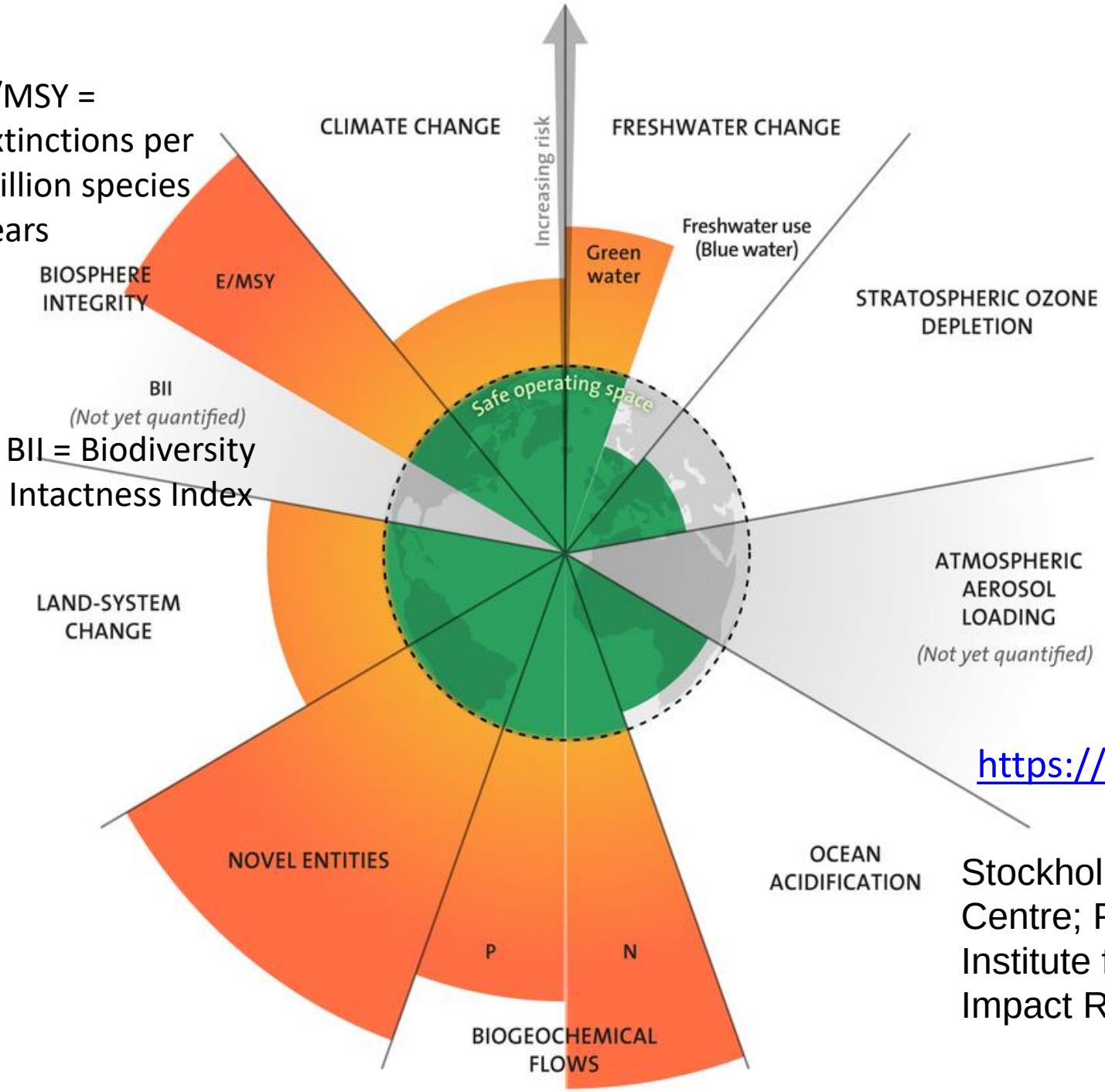
Kummu et al. 2021. https://doi.org/10.1016/j.oneear.2021.04.017

Areas of food production with highest risk of falling beyond the SCS also projected to increase their population, during this century.



Ch 9. Steffen et al. 2018. Trajectories of the Earth System in the Anthropocene. https://doi.org/10.1073/pnas.1810141115

E/MSY = extinctions per million species years



BII = Biodiversity Intactness Index

https://bit.ly/37YsYxd

Stockholm Resilience Centre; Potsdam Institute for Climate Impact Research

Part 2: Possibilities

Photograph of a grey squirrel: Robin Morrison/2021 MPOYI
https://bit.ly/3wfjxQK

Reimagining Ag Premise of Growth

- Improved education for girls and women Ch 6
- **Reduce** wasted food (now > 50% in Canada) Ch 6
- Eat less meat (higher quality), more pulses and edible insects Ch 7

Pulses in Jinja Market, Uganda

Spicy cricket fritters

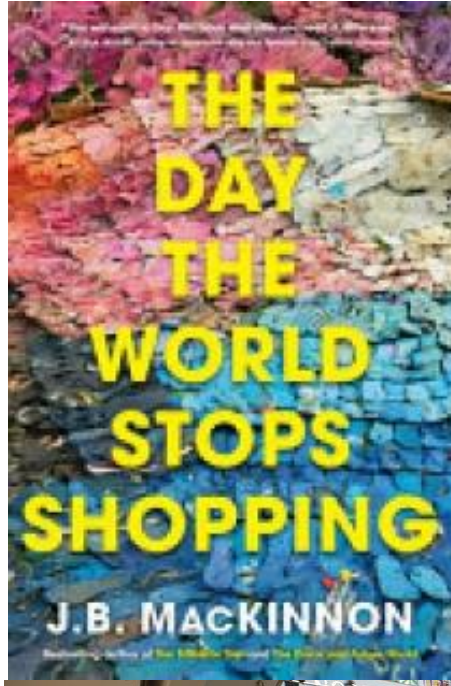
Consume Less

UN panel – Overconsumption surpassed overpopulation as the greatest driver of our eco-crises, about 2000.

Avg person in a rich country now consumes **13x** as much as avg person in poor country

Need **more than four Earths** if everyone lived like avg Canadian.

www.theglobeandmail.com/opinion/article-were-ready-to-spend-again-but-there-are-profound-costs-to-consumption/



From Animal Ag Production To Animal Ag Synergies

i) maximize forages as feed,
ii) integrate crop and livestock systems
iii) use co-products or '***unavoidably wasted food***' for feed. Wyngaarden et al. 2020. https://doi.org/10.1080/21683565.2019.1633455

Photos by J. Duynisveld

Ontario could reduce arable land for **feed** production by 40% while maintaining sufficient animal protein for an adequate diet.

Ch. 7 - Food for People, Feed for Livestock

Biodiversity in Ag Ch 11

Grow diverse crop species, spread risk as **climate changes** and improve health

Achieve greater biodiversity and ecological resilience with **incentive payments** to farmers to:
a) reserve at least 3% of natural habitat per farm
b) improve natural habitat

African Orphan Crops Consortium

Healthy Africa through nutritious, diverse and local food crops http://africanorphancrops.org/

Spider plant - annual wildflower native to Africa; widespread in tropical areas; leaves and flowers are both edible

Reduce Poverty to Reduce Food Insecurity

Most food insecure households do not use food banks and there is no evidence that food charity is a durable solution.

Photo by A Hammermeister

Governments need to act on food insecurity through **income-based interventions**.

Tarasuk and McIntyre. 2020.

www.thecanadianencyclopedia.ca/en/article/food-insecurity-in-canada Ch 3

Dr. Noralou Roos
Dr. Evelyn Forget
Fraser Institute Ch 5

- Guaranteed Annual Income (GAI) $17 billion (as in Dauphin, in 2015 $) to luxury GAI of $58 billion
  Total cost of Canada's current income support system (payout plus admin. costs) was $185 billion in 2013.
  https://tgam.ca/3eY0UuP
- GAI can support low income consumers **and** farmers
  Bootstraps Need Boots by Hugh Segal (2019)

JK to 12 curriculum of **food skills** and **food literacy** in each school. Is this really beyond implementation? Ch 4 and 5

Photo from Screaming Avocado website

Reducing Wasted Food

www.guelphfoodwaste.com

1 billion extra people could be fed if we globally applied the best **current** methods to reduce wasted food.

Kummu et al. 2012. Sci. of the Total Environ. 438: 477-489

People with more food awareness, waste less food

https://doi.org/10.1016/j.wasman.2014.09.019

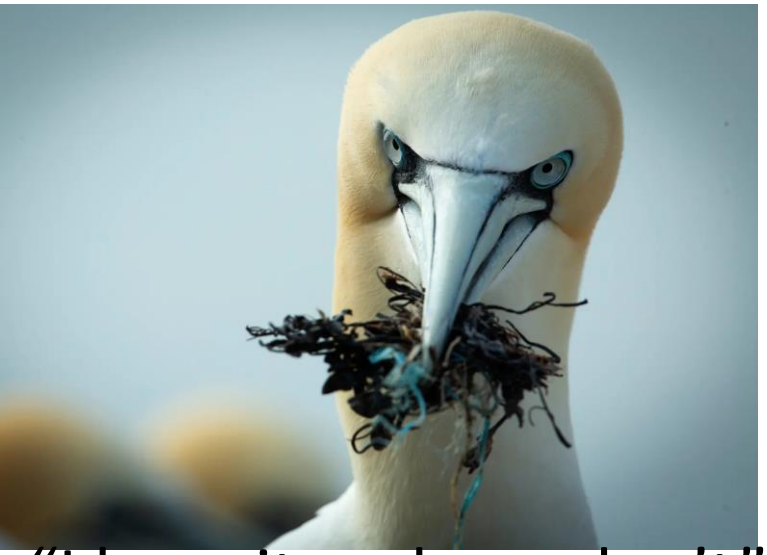
Ch 6

Principles of Addressing Wasted Food

1) **Reduce, Reduce, Reduce**
2) Recover and upscale for people
3) Feed pets, livestock (incl insects)
4) Anaerobic digestion (energy and nutrients)
5) Bio-diesel (energy) or compost (nutrients)
6) Divert from Landfill (after all else)

Jurisdictions with more equal income distributions have better mental and physical health **(for <u>everyone</u> and not just those who have less).**

Ch 4



"I have it and you don't"

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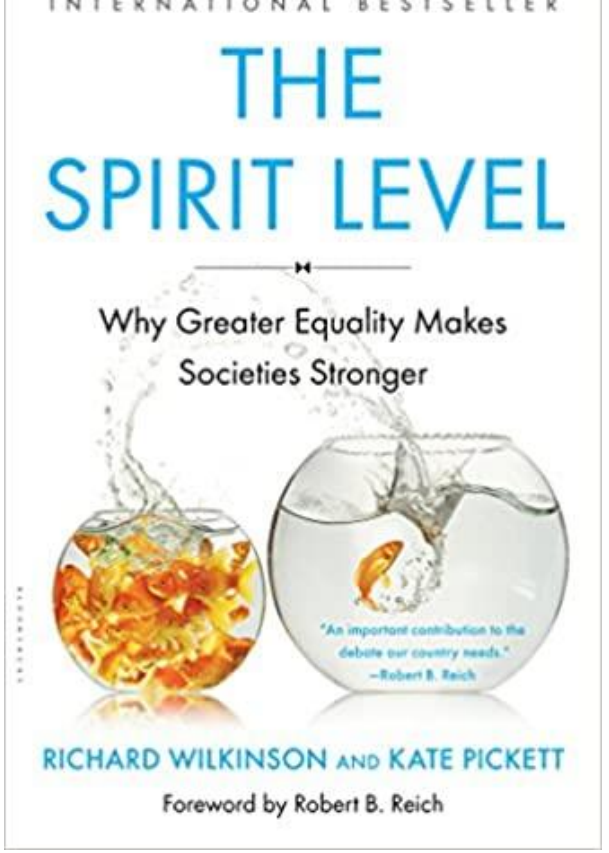


https://patrioticmillionaires.org/

Recently millionaires joined Davos protests, demanding 'tax us now' https://bit.ly/3PAidCl

Classes 1, 2 and 3 – prime (dependable) ag land needed for stable yields, especially as **climate changes**
Classes 4, 5, 6 and 7 – constraints for ag and lower yields

Preserve wetlands and prime ag land for ag, regardless of location in Ontario
Ontario loses 175 acres of farmland and productive ag soil every day https://ontariofarmlandtrust.ca/ Ch. 9

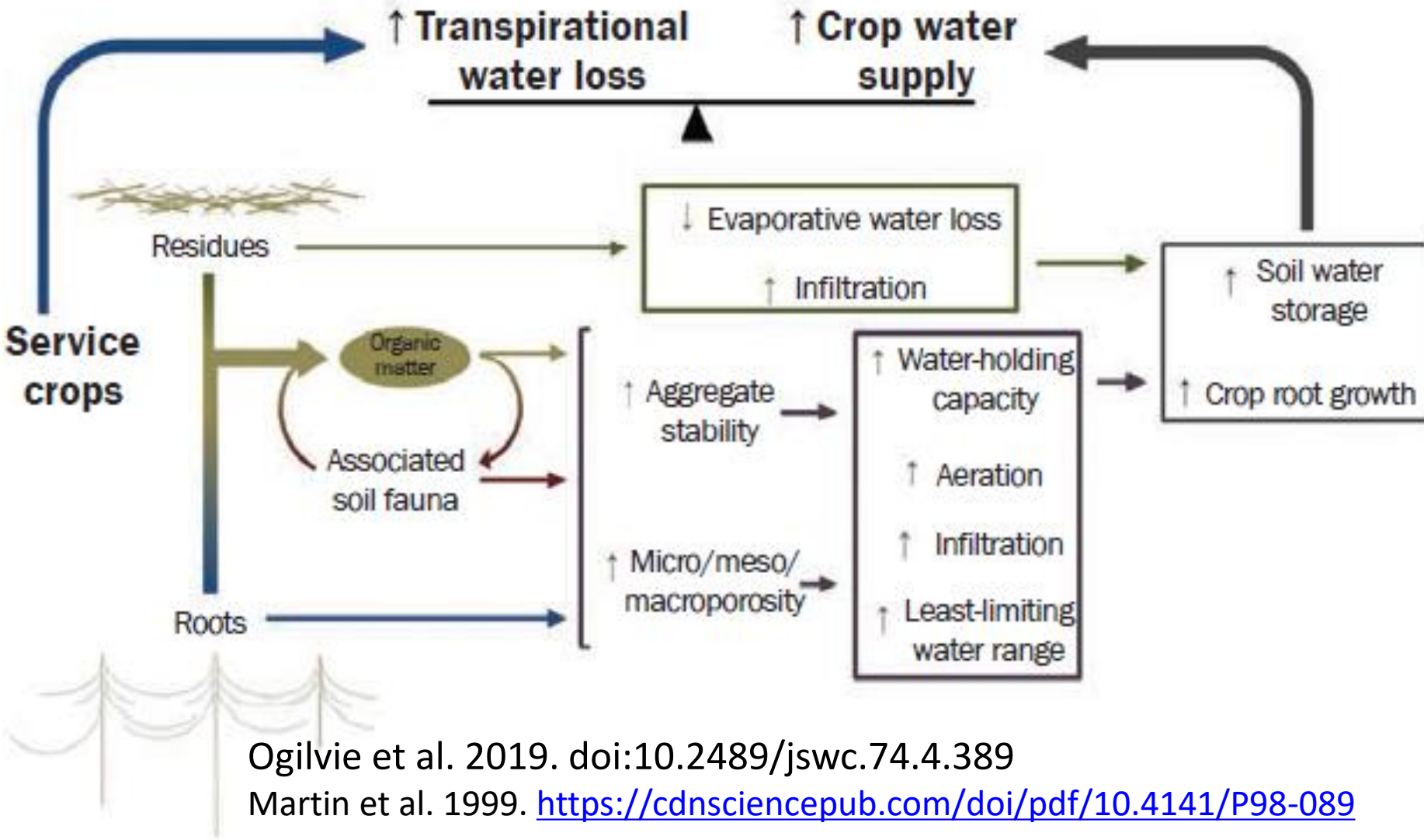
Advance food security and carbon dioxide **drawdown** with financial incentives to maintain or increase outcomes of **soil organic matter** levels, in ag fields.

Measure in a consistent scientific protocol. Ch 10

Photo by K. Lightburn

Figure 1

Summary of potential service crop impacts on agroecosystem elements that alter the crop water supply–transpirational water loss balance.



Ogilvie et al. 2019. doi:10.2489/jswc.74.4.389

Martin et al. 1999. https://cdnsciencepub.com/doi/pdf/10.4141/P98-089

Reducing N and P Fertilizer Dependency

- Legumes for N
- Organic farming
- Crops to enhance P availability
- Feed livestock feed, not food
- 4 Rs of Fertilizer Appl'n
- Reduce wasted food
- MSW, manure, **sewage**

Ch 8

Photo by A Hammermeister

In wastewater management, “ozonation” helps remove contaminants (e.g. pharmaceuticals and pesticides).
https://bit.ly/3vsyvFb

Effectively recycle MSW, manure, **sewage** (manage pathogens, pharmaceuticals, plastics, chemicals (e.g. PFAS)

Photo: https://bit.ly/2I045zM

Extract struvite as P source from sewage
http://crystalgreen.com/

Is Fertilizer Canada Crying Wolf? 2021. Daniel Schuurmann, Alfons Weersink https://bit.ly/3HHtiNY

- 20% reduction in fertilizer use within a given year would reduce yields of these crops by < 5% (avg).
- Cost-savings to farmers from reduced input costs.

Farmers may adjust cropping systems with:
i) Less high N feeding crops; more legume cover crops
ii) Split application of N
iii) Nitrification inhibitors

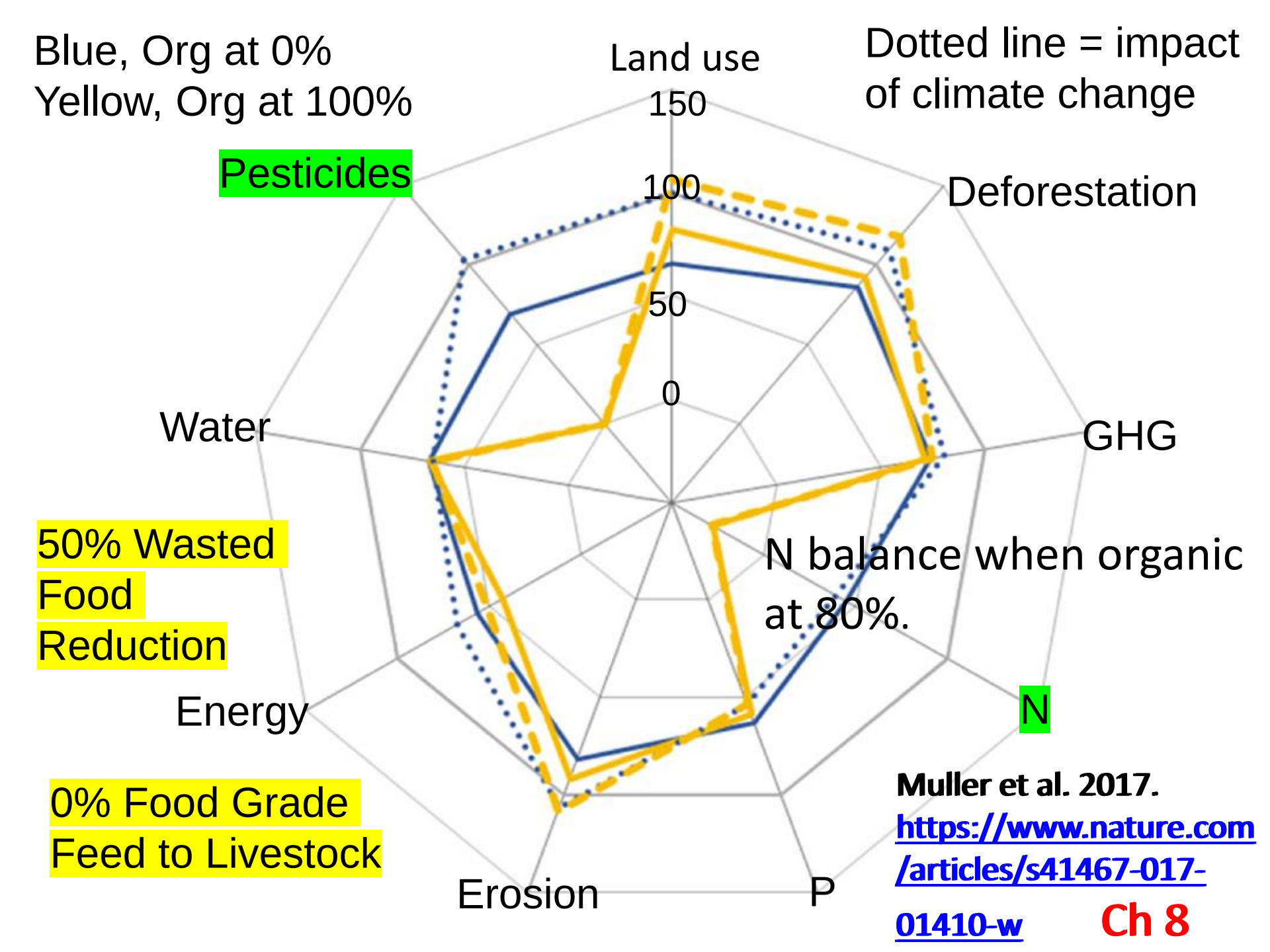
Reducing Pesticides with Organic Ag

Concentrations of organophosphate metabolites were 9 times lower in the urine of children, aged 2 – 4, with Organic rather than non-Organic diets

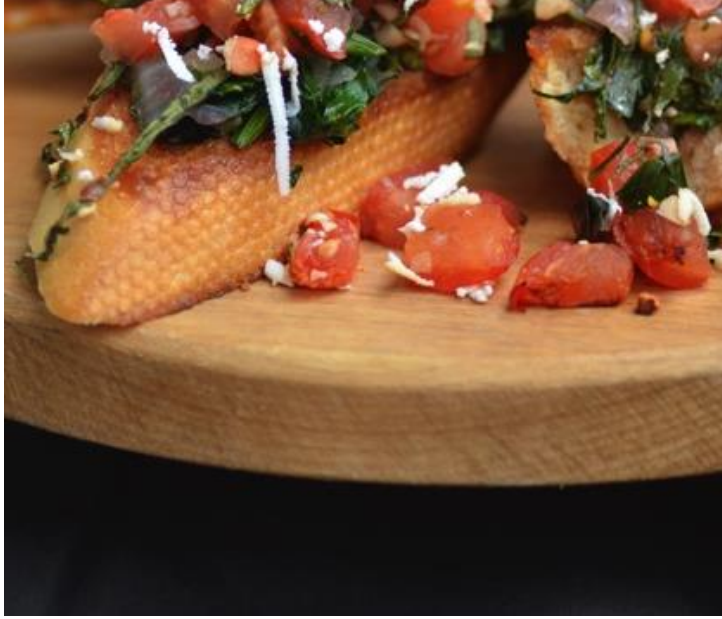
Curl et al. 2002.
doi: 10.1289/ehp.5754

Organic diet intervention significantly reduces urinary pesticide levels in U.S. children and adults. Hyland et al. 2019. https://doi.org/10.1016/j.envres.2019.01.024

Ch 8 and 11


Blue, Org at 0%
Yellow, Org at 100%
Dotted line = impact of climate change
Pesticides
Land use
150
100
50
0
Deforestation
GHG
N
P
Erosion
Energy
Water
50% Wasted Food Reduction
N balance when organic at 80%.
0% Food Grade Feed to Livestock
Muller et al. 2017.
https://www.nature.com/articles/s41467-017-01410-w
Ch 8

Balancing Production and Consumption Ch 4



What if mainstream agriculture had evolved differently, and we produced high quality food, with yields about 25% lower than now?

(Seufert and Ramankutty, 2017 http://advances.sciencemag.org/content/3/3/e1602638)

What if wasted food was 15% and not >40% as now?

Would we aspire to produce 25% more food, so that we could waste 40% or more?

Photos by M. Arseneault


Photo by Peter Caton/Action Against Hunger
https://bit.ly/3tDZni0
Part 3: Probabilities?

Photo: Journey of the Universe Project

We are children of Mother Earth, inheriting a 4.5 billion year reverie of grace. Only recently, in our evolution as self aware creatures, have we known Earth's full length story of stunning beauty and exquisite functioning.

Will we choose to continue acting as participants in the unfolding drama?

Earth Systems provided a gentle warning with the pandemic. Will we now be more motivated to appropriately adapt?

Risks:

1) excess pessimism may sabotage appropriate action

2) excess optimism may sabotage appropriate action

“Whatever you do will be insignificant, but it is very important that you do it.” Mahatma Gandhi

Svalbard Global Seed Bank. “Doomsday vault” or “Noah’s ark of seeds” https://bit.ly/3MxHdrZ

"Of all the dangers we face, from climate chaos to nuclear war, none is so great as the deadening of our response."

Joanna Macy

www.joannamacy.net

Sort ‘Wants’ from ‘Needs’ to Live Well, Within Planetary Boundaries

Pierre Dansereau, (1911 – 2011) urged humans to curb their appetites and voluntarily cut back.
“Be happily frugal.”
Intro Ch

I am on the ancestral lands of the Attawandaron, Anishinaabe, and Haudenosaunee peoples and the treaty lands of the Mississaugas of the Credit.

So far settlers have lived on this land for centuries. Indigenous peoples lived here in relationships, including with Mother Earth, for millennia.

Ch 1

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