

# Important Dates to Remember

First day of Class: January 7

Spring Break: Feb 14-22

Last lecture: Wed April 1

Quizzes and Exam:

- Friday February 6 (lectures 1-10)
- Friday March 13 (lectures 11-16)
- Wednesday April 1 (lectures 17-24)
- Exam April 20 (lectures 1-24)

Presentations (always on Wed):

- Group 0 (MacDougall) Jan 21<sup>nd</sup>
- Group 1 Jan 28<sup>th</sup>
- Group 2 Feb 4<sup>th</sup>
- Group 3 Feb 11<sup>th</sup>
- Group 4 Feb 25<sup>th</sup>
- Group 5 March 4<sup>th</sup>
- Group 6 March 11<sup>th</sup>
- Group 7 March 18<sup>th</sup>
- Group 8 March 25th

# Biology 3130

# Conservation Biology

# Winter 2026

- Professor Andrew MacDougall [asm@uoguelph.ca](mailto:asm@uoguelph.ca)
- Graduate Teaching Assistants:

Emily Heagney	<a href="mailto:eheagney@uoguelph.ca">eheagney@uoguelph.ca</a>
Eric Bonk	<a href="mailto:ebonk@uoguelph.ca">ebonk@uoguelph.ca</a>
Emily (Celeste) Landon	<a href="mailto:landone@uoguelph.ca">landone@uoguelph.ca</a>

\*we try our best to answer emails within the same week, and usually do

\*we do not answer emails after 5 pm or on weekends – PLAN AHEAD ☺

# Our Research



**Ecosystem services - farms  
(Ontario)**



**Climate change  
(Sweden, Yukon)**



**Invasion, fire, rarity  
(Vancouver Island)**



**Global change  
(everywhere)**

# **I. Course Overview**

# Course Objectives

- 1) Understand the mechanisms that create and maintain species diversity.
- 2) Familiarization with theoretical and applied perspectives on conservation biology, emphasizing the '**how**' (scientific-based approaches) and the '**why**' (the social and economic contexts of the discipline).
- 3) Understand the biological basis for the management of wild, living resources from both terrestrial and aquatic systems, especially in an era of global environmental change

# Course Objectives

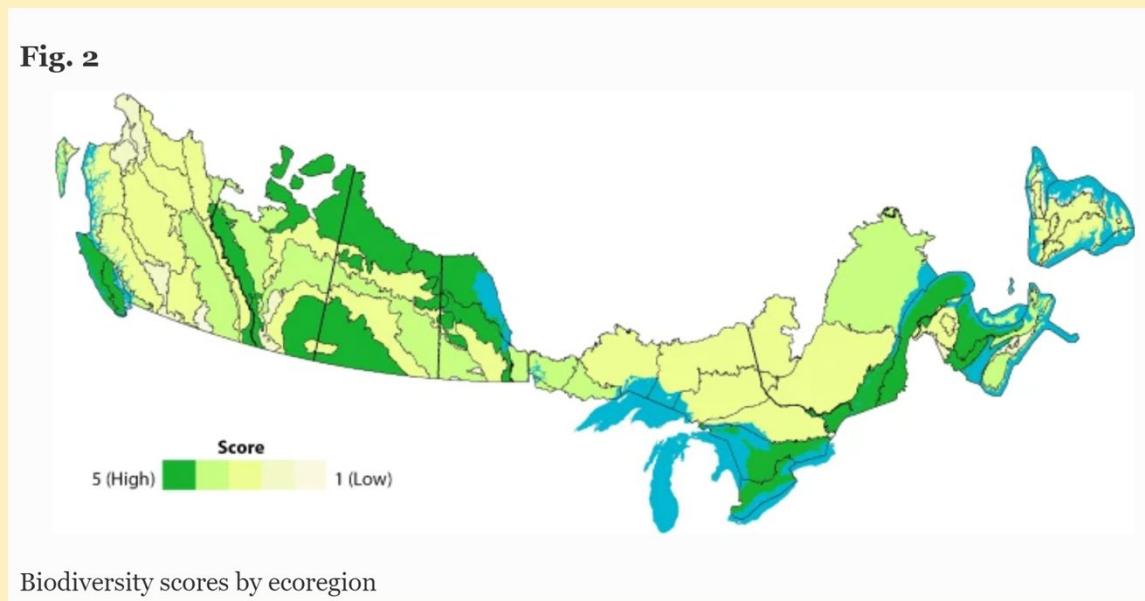
- The “**how**”?

Biodiversity:

- how it's created and maintained
- its value (science-based arguments)
- how it's being destroyed
- how it can be protected

# Course Objectives

- The “why”?
  - most Canadians don’t care, or they care but have limited understanding of the issues (i.e., social media...)
  - it’s difficult to conserve anything unless it can be conveyed **why** it’s important.
  - the new era (2026): Canada as a “**natural resources superpower**”....



# **The factors that create and maintain biological diversity on the planet**

## **(A) Large scale [spatial & temporal]**

- History
- Habitat heterogeneity
- Climatic and energetics
- Productivity
- Disturbance

## **(B) Local scale [species interactions]**

- Competition
- Predation

# The factors that drive the loss of biological diversity on the planet

## (A) Large scale [spatial & temporal]

- History (*unprecedented rates of change*)
- Habitat heterogeneity (*habitat loss, fragmentation*)
- Climatic and energetics (*climate change*)
- Productivity (*eutrophication*)
- Disturbance (*too much, too little*)

## (B) Local scale [species interactions]

- Competition (*invasion*)
- Predation (*added or subtracted predators*)

## **II. Course Details**

- **Always consult these slides if in doubt about assignments, tests, or lectures**
  - We NEVER answer emails on these details, especially later in the term – you are responsible for managing the class
  - When in doubt ('how do I structure my essay?') always consult these notes, which are posted on Courselink as of today (first class of the term)

# Lectures

- **Monday, Wednesday 1230-120**
- **Friday 1230-120:** tests, meetings with MacD, work time on papers: the classroom is here for you!
- Power-point slides, with discussion
- There MAY be the occasional zoom lecture....



# Office Hours

- Special sessions on some of the Friday class slots – to be announced periodically throughout the term
- **Best bet: see me before or after class**
- Sickness (missed class): lectures are posted online
- Sickness (first missed test or exam): marks reweighted pending discussion with me (do not assume it's ok)
- Sickness (second missed test or exam): marks lost except for exceptional circumstances
- General Absence (lecture material): you are responsible for making up for missed content

# Course Evaluation

- First quiz – **10% (multiple choice)**
- Second quiz – **15% (multiple choice)**
- Third quiz – **15% (multiple choice)**
- Exam – **30% (April 20<sup>th</sup> 1130 am-2 pm)**
- In-class presentation or essay – **30% (presentation OR a two-page essay)**
- **We NEVER reschedule quizzes, ever**
- **We will reweight your grade once, but only with permission from me**
  - Missing two quizzes is only permitted under extreme circumstances

# Course Evaluation

- This is an upper-level BIOL course, and evaluation expectations are high.
- A grade of **A** (80% or higher) is reserved for students that demonstrate **a mastery of the material**.
  - 1) knowledge of the concepts ('what is a metapopulation?')
  - 2) understanding the mechanistic underpinning of the concepts ('how do metapopulations function, and what limiting factors influence the persistence of metapopulations?')
  - 3) understanding their application ('why is metapopulation theory relevant for conservation management?')

# Use of AI

- Pretty good on the “what”, starts to struggle on the “how”, falls apart on the “why”....
- This class targets “critical analysis”: the mechanisms (biological, cultural, political) that explain and predict conservation outcomes...
  - These outcomes are complex and context-dependent
  - Your presentations and essays.....

## **IIa. Course Details: Quizzes**

# Quizzes

- **Objective:** To test your **understanding** the major concepts of Conservation Biology. Many test questions will ask you to think on your feet, solve problems, and apply concepts from lecture in new contexts.
- **Warning:** These quizzes are **extremely hard**, as expected in a third-year specialized course. It is open book, but do not let this deceive....
  - It is NOT enough to be able to understand what is being presented in lecture, although that helps
  - **In addition**, we expect you to independently study and understand the concepts presented, both what those concepts mean (e.g., definitions) and how they work to affect issues relevant to conservation.
  - MOST STUDENTS STRUGGLE on these quizzes, especially the first one – it's OK if you experience this: do not under-prepare
  - you have been warned ☺

# Quizzes

- Three quizzes (note: Courselink quizzes are done remotely OR in-class – your choice).
- Each of three sections of the course will be followed by a quiz ONLY on the material from that section – the quizzes are not cumulative.
- All occur within the 50-minute time period of class, start time is ONLY from 1230-1240 pm. After that you cannot get into the quiz.
- NOTE: If you locked out of your midterm, you need to call Courselink – there is nothing I can do (x56939)
- There will be no make-up quizzes – everyone must write the quizzes at the same time.

# LockDown Browser Requirement

This course requires the use of LockDown Browser for online exams. Watch this video to get a basic understanding of LockDown Browser: <https://www.respondus.com/products/lockdown-browser/student-movie.shtml>

## Download Instructions

- Select the quiz in the course
- Under Quiz Requirements you will see "To take this quiz you must use the Respondus LockDown Browser"
- Below this will appear: "You can use the button below if you have not already downloaded LockDown Browser". Click the button to go to the download page and then follow the instructions
- Use the link to download Respondus LockDown Browser to your computer; follow the installation instructions
- Return to the Quiz page in Brightspace (it may still be open in another tab) and select the quiz
- Select "Launch LockDown Browser"
- The quiz will now start
- Note: LockDown Browser only needs to be installed once to a computer or device. It will start automatically from that point forward when a quiz requires it.

## Guidelines

When taking an online exam follow these guidelines:

- [If testing is to occur at a designated location, such as a testing center, add those instructions here.]
- [If applicable] Select a location where you won't be interrupted
- Before starting the test, know how much time is available for it, and also that you've allotted sufficient time to complete it
- Turn off all mobile devices, phones, etc. and don't have them within reach
- Clear your area of all external materials - books, papers, other computers, or devices
- Remain at your desk or workstation for the duration of the test
- LockDown Browser will prevent you from accessing other websites or applications; you will be unable to exit the test until all questions are completed and submitted

## Getting Help

Several resources are available if you encounter problems with LockDown Browser:

- The Windows and Mac versions of LockDown Browser have a "Help Center" button located on the toolbar. Use the "System & Network Check" to troubleshoot issues. If an exam requires you to use a webcam, also run the "Webcam Check" from this area
- [As applicable, insert information about your institution's help desk, including details about how to contact them. Some help desks want students to run the "System & Network Check" and the "Webcam Check" before they are contacted - and even, to forward the results of these checks at the time of opening a ticket.]
- Respondus has a Knowledge Base available from support.respondus.com. Select "LockDown Browser & Respondus Monitor" as the product to view helpful articles.
- If you're still unable to resolve a technical issue with LockDown Browser, go to support.respondus.com and select "Submit a Ticket". Provide detailed information about your problem and what steps you took to resolve it

# **IIb. Course Details: Presentations**

# Presentations

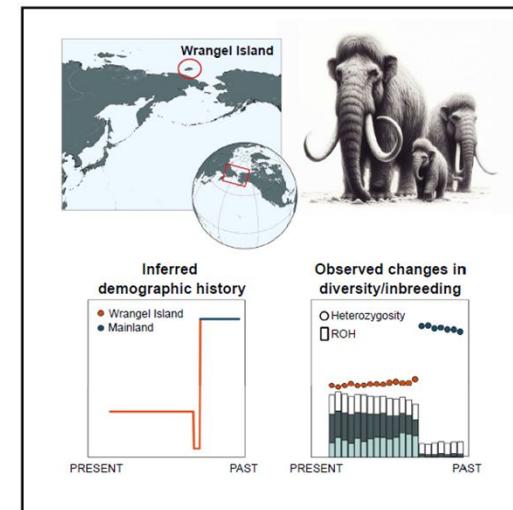
- All of our topics of interest are on the front line of today's major conservation issues
- We will read 8 papers over the term, which will be the subject of group work including presentations
- Three major topics 1. general conservation issues on biodiversity 2. drivers of diversity 3. human impacts and solutions to global change
- Humans are rapidly transforming the planet, in ways never seen before (Anthropocene) – much of this starts with agriculture
  - 40% of the earth's land surface supports cropping
  - 75% of all grain production goes to livestock
  - 50% increase in food needed by 2050 – clean air, water, soil
  - farming has largely been unsustainable: environment
  - today's situation reflects centuries of land use decisions

## Article

# Cell

## Temporal dynamics of woolly mammoth genome erosion prior to extinction

### Graphical abstract



### Authors

Marianne Dehasque, Hernán E. Morales, David Diez-del-Molino, ..., Tom van der Valk, Sergey Vartanyan, Love Dalén

### Correspondence

marianne.dehasque@gmail.com (M.D.), love.dalen@zoologi.su.se (L.D.)

### In brief

The analysis of 21 high-coverage woolly mammoth genomes allowed for the investigation of the genomic changes that led to the extinction of the species' last surviving population on Wrangel Island. Despite the population quickly recovering from a founder event bottleneck in the early Holocene, the results show that they suffered from inbreeding depression, with ensuing purging of deleterious mutations for thousands of years after the recovery.

### Highlights

- Analysis of long-term genomic changes using 21 high-coverage woolly mammoth genomes
- Severe bottleneck of the last surviving population when Wrangel Island was isolated
- The population partially recovered within a few generations and then remained stable
- Inbreeding depression and purging persisted for thousands of years after the recovery

- GROUP 0 - SPECIES CONCEPT A MESS
- GROUP 0 - Grey Zone of Speciation PLoS BIOL
- GROUP 1 - Wooly Mammoth
- GROUP 2 - Watson
- GROUP 3 - Dawson
- GROUP 4 - Chase
- GROUP 5 - Paustian Nature
- GROUP 6 - NET ZERO C
- GROUP 7 - Wollburg
- GROUP 8 - Indigenous Conservation

# Presentations

- The class has been divided into 8 groups of ~45 students each (posted on Courselink tomorrow)
- there will be **four** tasks per group:
  - 2 or 3 members of each group will volunteer to construct the powerpoint presentation and lead the discussion in front of the class;
  - Each remaining group member (excluding the leaders) posts comments on courselink, that can be used by the presenters when preparing the presentation **48 hrs prior to the start of the presentation**
  - Each remaining group member (excluding the leaders) must hand in a TWO PAGE summary to the **Courselink Dropbox**
  - Each remaining group member (excluding the leaders) must help facilitate discussion in the class, although discussion in the class is not restricted to the group members.

# Presentations

Both (i) the presentation and (ii) the two-page single-spaced 12 pt font essay must focus on the following three issues, for each chapter:

- **Synopsis:** the main issues of the paper
- **Critical analysis** of content including methods, findings, core hypotheses, conclusions, errors
- **Reflection** on the current relevance and interest: ecological, personal, economic, social, political, anything. **Note, these form the basis of questions to be discussed in class**

**GROUPS MUST COORDINATE AMONG THEMSELVES – USING COURSELINK – TO DETERMINE WHO WILL VOLUNTEER TO LEAD THE PRESENTATION**

# Presentations

## **Posting comments online (Courselink)**

-comments must be posted on-line **two FULL days prior to the presentation** (all posting are automatically time-stamped on course link)

-for example, if the presentation is Wed Jan 28<sup>th</sup> at 1230 pm, comments **MUST** be posted before Mon Jan 26<sup>th</sup> at 1230 pm

**-failure to do so will result in a mark of 0**

# Presentations

- I. **Presentation:** care and effort, demonstration of critical thinking, engaging questions (up to 30/30 for the presenters)

OR

- IIa. **Essay:** care and effort, demonstration of critical thinking, engaging questions...(up to 25/30 –

**no AI cut-and-paste writing = plagiarism [remember- there's 40 or so group members writing similar essays....]**

- IIb. **Online Participation:** care and effort, demonstration of critical thinking, engaging questions...DO NOT SIMPLY POST YOUR ESSAY (up to 5/30)

- make your suggestions **short and concise**, to help the presenters  
-point form is preferred
- this is 5% of your course grade; make sure to post your comments on time  
these comments are critical to help the presenters create their short and concise presentation

# Presentations

**The Presentations – 15 minutes MAX plus 10 minutes for class discussion**

**Title Slide:** Names of group leaders

- **Slide 2: Synopsis:** the main issues of the paper
- **Slide 3: Critical analysis** of content including methods, findings, core hypotheses, conclusions
- **Slide 4: Reflection:** current relevance and interest: ecological, personal, economic, social, political, anything
- GROUP LEADERS MUST POST THEIR PRESENTATIONS ON DROPBOX 30 MINUTES BEFORE CLASS

# Presentations

**The Essay – 2 pages single-spaced with 12 point font, due in dropbox at 1230 pm the day of your presentation**

No title page – get to the point immediately

No references needed – citing other work is fine, but optional

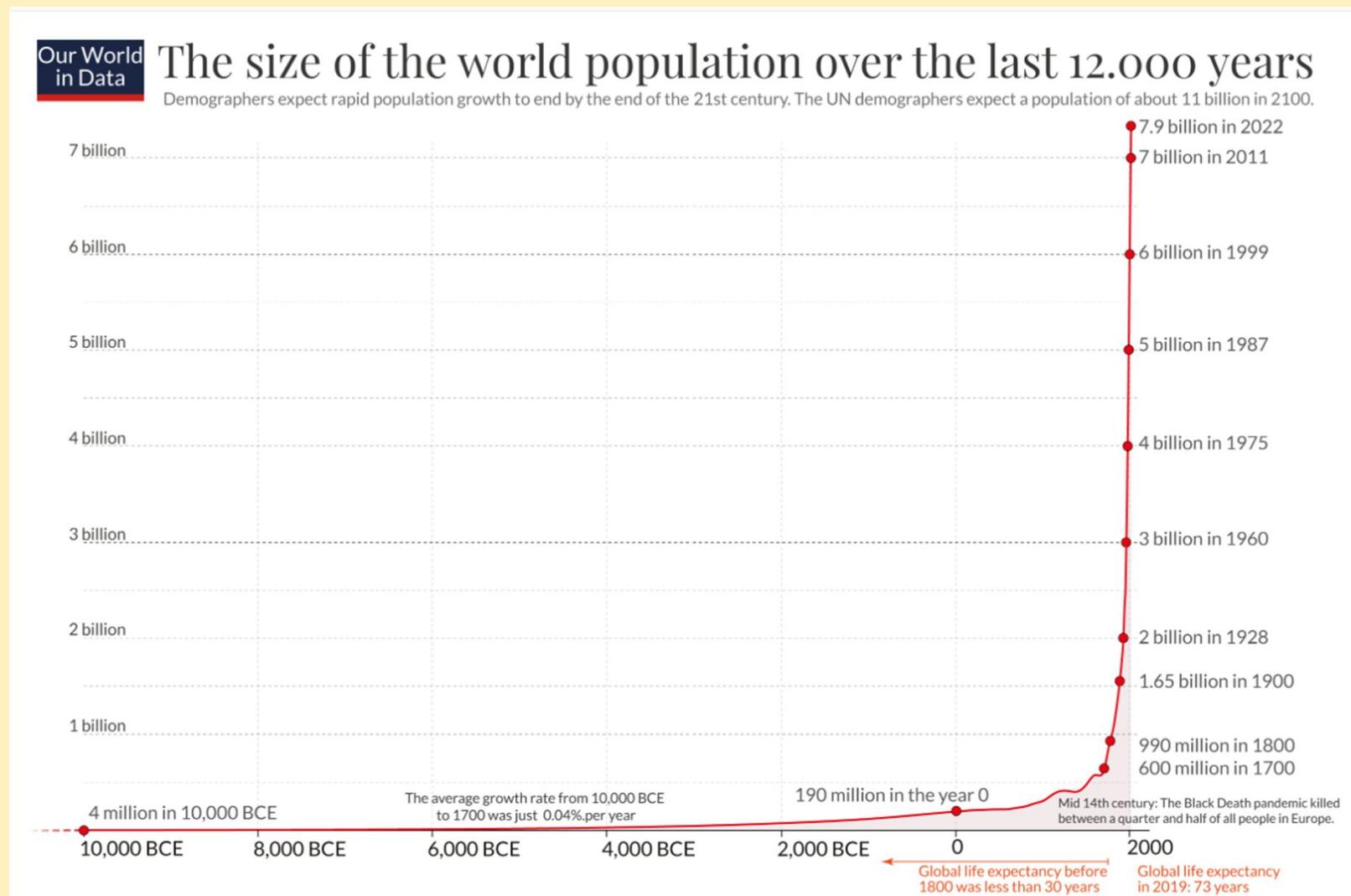
for example, if the presentation is Wed Jan 28<sup>th</sup> at 1230 pm, then your essay MUST be posted by 1230 pm on Wed Jan 28<sup>th</sup>

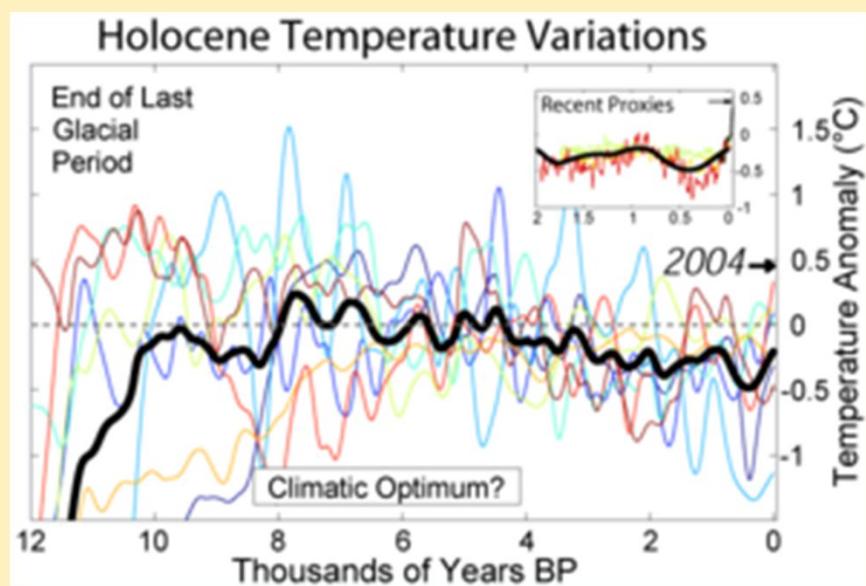
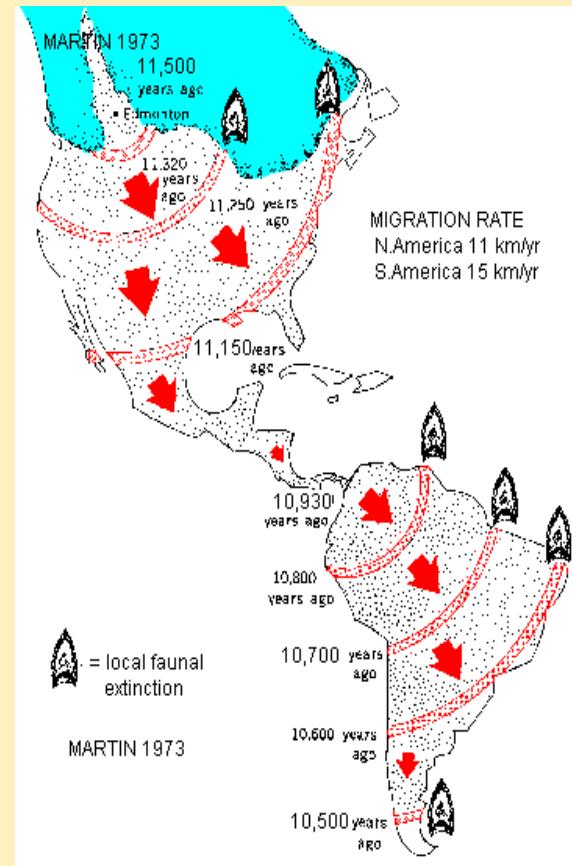
# Courselink

- Lectures (PDFs)
- Discussion and class announcements.
- Folders for each of the 8 groups – to coordinate work tasks, and to submit materials to the presenters 48 hours PRIOR to the presentation.
- Dropbox – submitting your two-page essays
- Dropbox – Submitting your presentation 30 mins before class

# **III. Why Conservation Biology?**

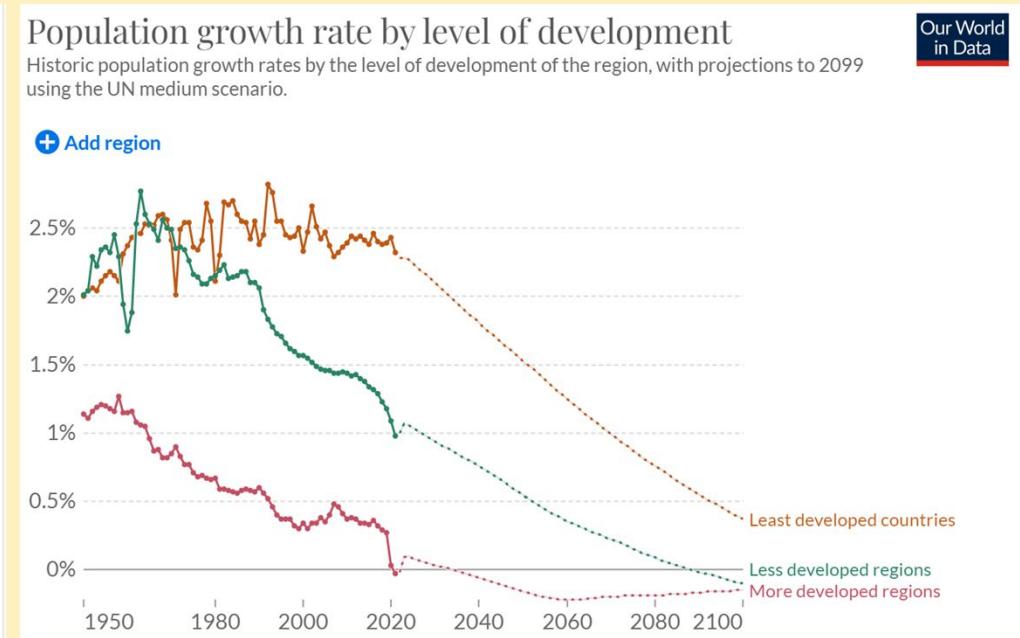
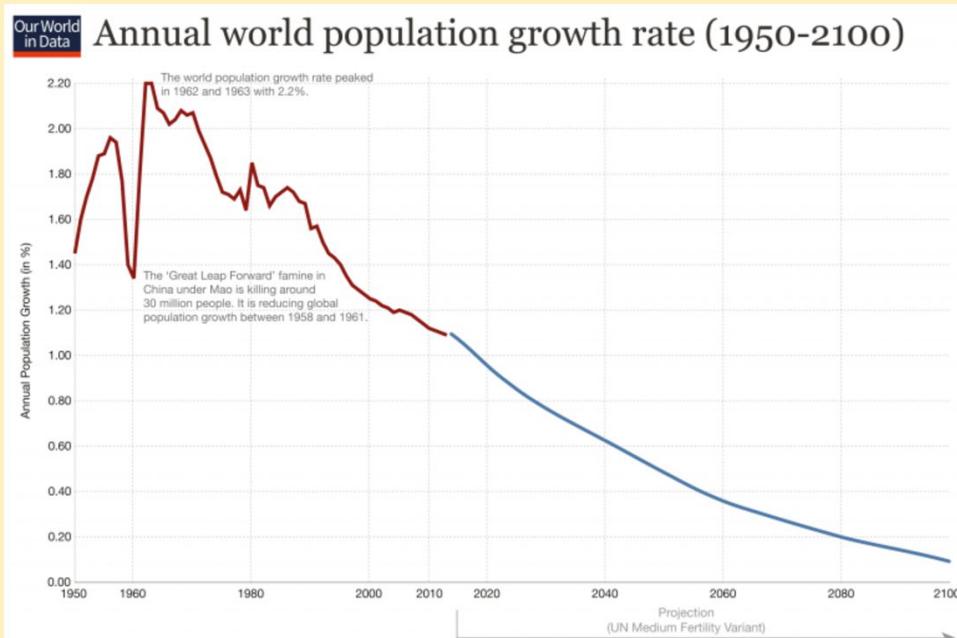
- Expanding human demands...
- Every natural ecosystem has been changed, most changed profoundly ...
- Extinctions, altered functioning of ecosystems, reduced availability of resources, soil erosion...
- Cause? 8+ billion people





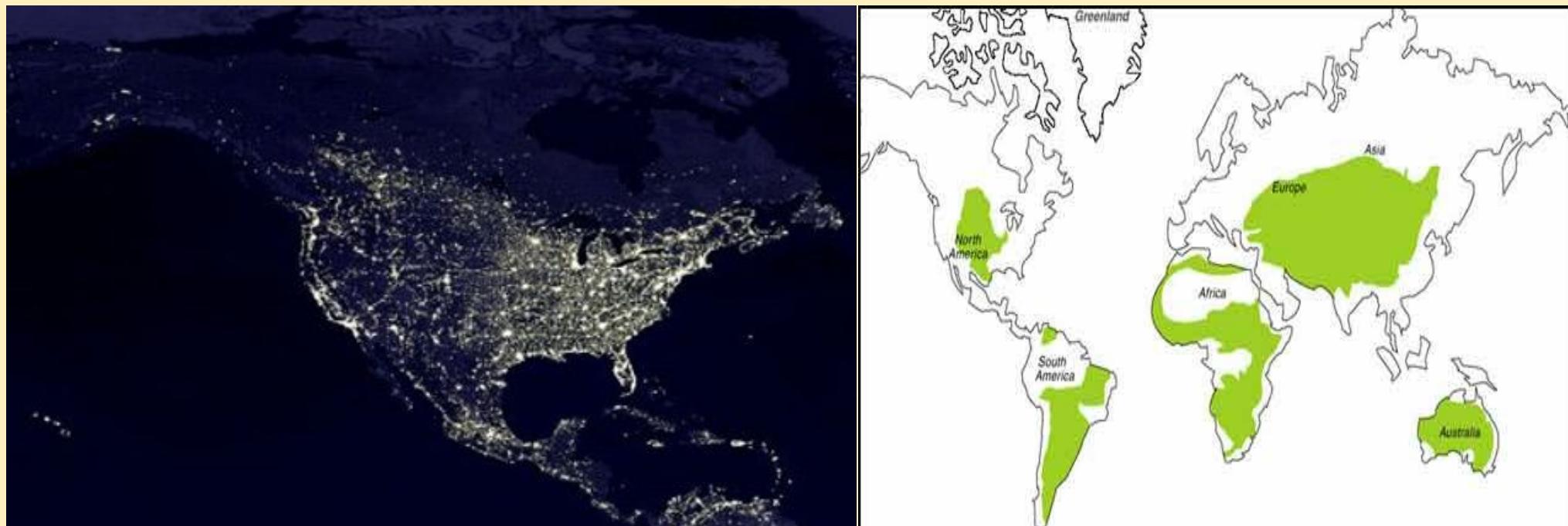
# But never like today...

- **The Anthropocene**
- We now consume a large fraction of the planet's resources
- We now consume 20-40% of the planet's annual net primary productivity (energy from the sun transformed to plant biomass)
  - 35% of the net primary production from oceanic shelves.
  - We also consume 60% of freshwater runoff (irrigation, drinking water) – 70% of this 60% = agriculture (irrigation)
- Consumption is highly unequal
  - Global North: 10% of the world's population but 50% oil consumption.



# Ecological footprint

- 83+% of the earth' land surface shows evidence of our direct impacts...
  - Agriculture
  - Urbanity, suburban sprawl, roads
- Fertile grasslands = 98% transformed
- Indirect “downwind” change: climate, nutrient pollution – impacts are now ~100% (nowhere to run or hide, including our biggest parks....)

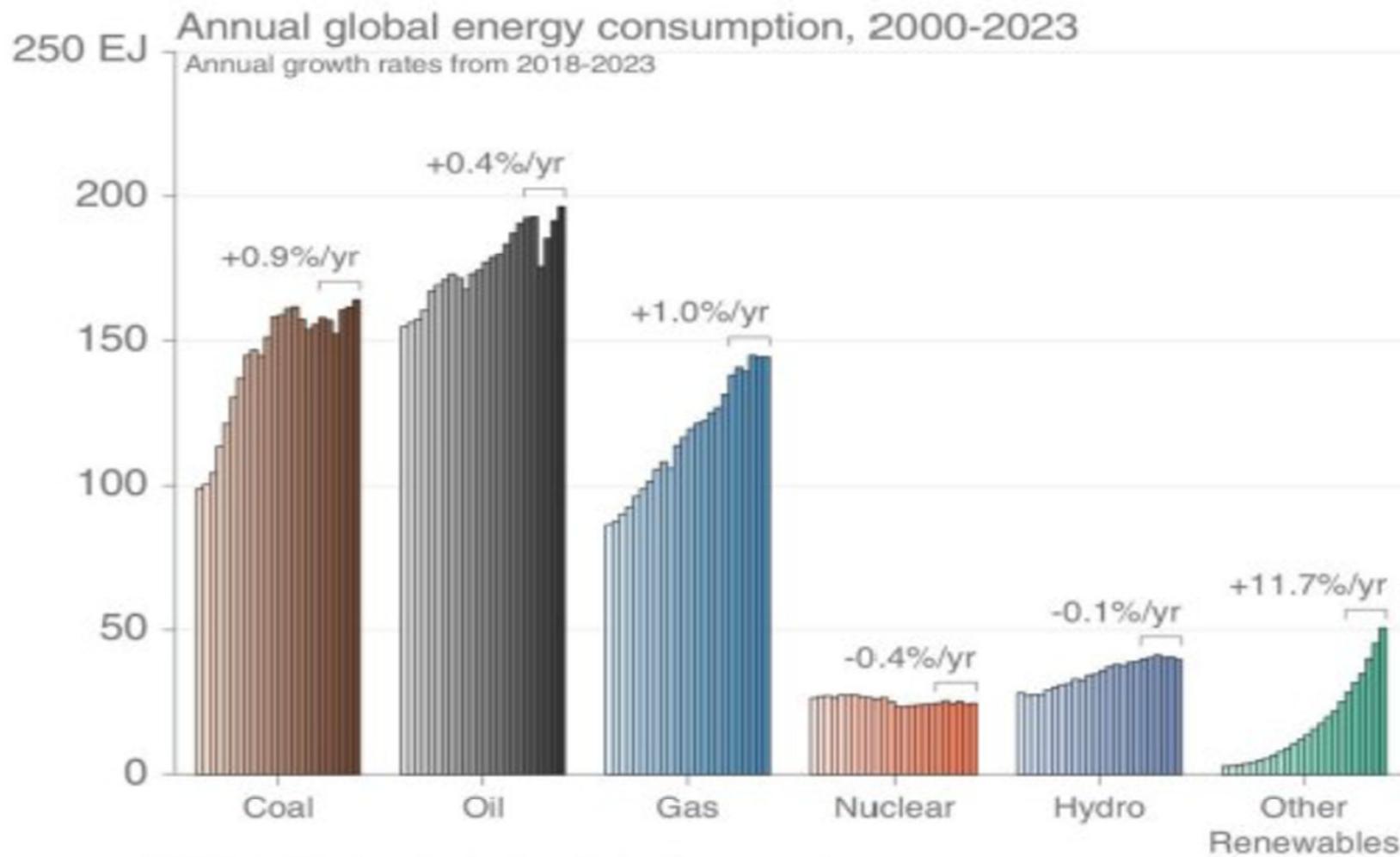


# Room for optimism? Sure!

- Humans as ‘rational’ beings – we have the potential to change our consumption patterns...
  - Challenges: inertia and fear
    - “The economy will tank if we reduce consumption”
    - “Our natural resource industries will tank if we set constraints on harvest...”
    - We must become a “natural resources superpower”....
  - Overcoming the challenges: sustainable development, alternative thinking, crisis management, etc.
  - Conservation Biology...

# Energy use by source

Energy consumption by fuel source from 2000 to 2023, with growth rates indicated for the more recent period of 2018 to 2023



Fossil fuel use keeps growing...but coal has leveled off, while renewables are growing exponentially

AAAS

# Science

2025  
SPECIAL ISSUE

BREAKTHROUGH OF THE YEAR

18 DECEMBER 2025

**COVER:** Qianjiadong Reservoir in southern Hunan, China, produces a double harvest: solar energy and yellow carp. The solar farm produces up to 80 megawatts of power while the fish forage beneath the panels. With a massive scale-up of solar and wind at home and cheap exports of the technology, China is driving a worldwide surge of renewable energy—*Science's* 2025 Breakthrough of the Year. See page 1208.



## THE GREEN GIANT

Images of China's clean energy infrastructure reveal a transformation of unmatched scale and speed

Photography by GEORGE STEINMETZ

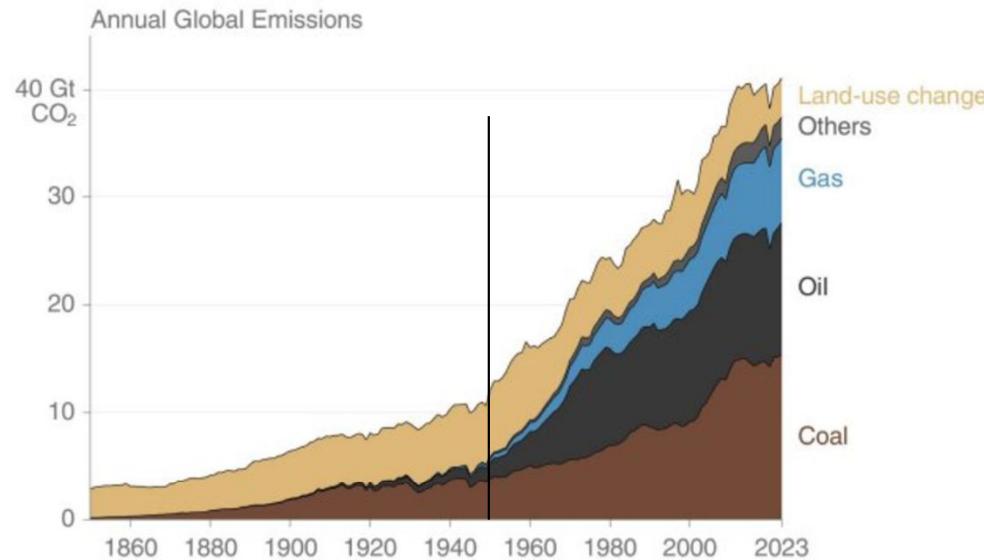
**C**hina's turn to green energy dwarfs any other country's, as a parade of astonishing numbers attests. In 2024 alone it installed new solar and wind generation equivalent to roughly 100 nuclear power plants, and the pace quickened early this year. Dozens of new, ultrahigh-voltage power lines are marching thousands of kilometers from western deserts where much of the solar energy is generated to the eastern cities where it is used. Hungry awaiting the bounty of clean energy are millions of electric cars and a sprawling network of high-speed electric trains that can zip between cities 1000 kilometers apart in a morning.

China's landscape reflects this metamorphosis. The vistas of smog, smokestacks, and coal heaps still exist, but glinting silicon panels now cover hills, deserts, and lakes. One solar farm on the Tibetan Plateau spans more than 400 square kilometers, an area more than twice the size of Washington, D.C. Wind turbines grow ever bigger; one meant for use offshore has blades 150 meters long. Arrays of house-size lithium batteries stockpile excess energy, and more is stored in mountaintop reservoirs, pumped full of water when energy is abundant and tapped as needed by allowing the water to cascade through turbines to a lower lake. The factories that produce the solar panels, turbines, batteries, and cars have added new industrial sprawl—but often without the smokestacks because they are electrified.

These days, the containers in China's busy ports are packed with new wares: electric cars, solar cells, wind turbine blades. In building up its own green energy system, China has also created an export industry worth nearly \$180 billion in 2024, putting low-cost renewable energy within reach for much of the rest of the world (see story, p. 1208). The revolution these images document is now going global. —Tim Appenzeller

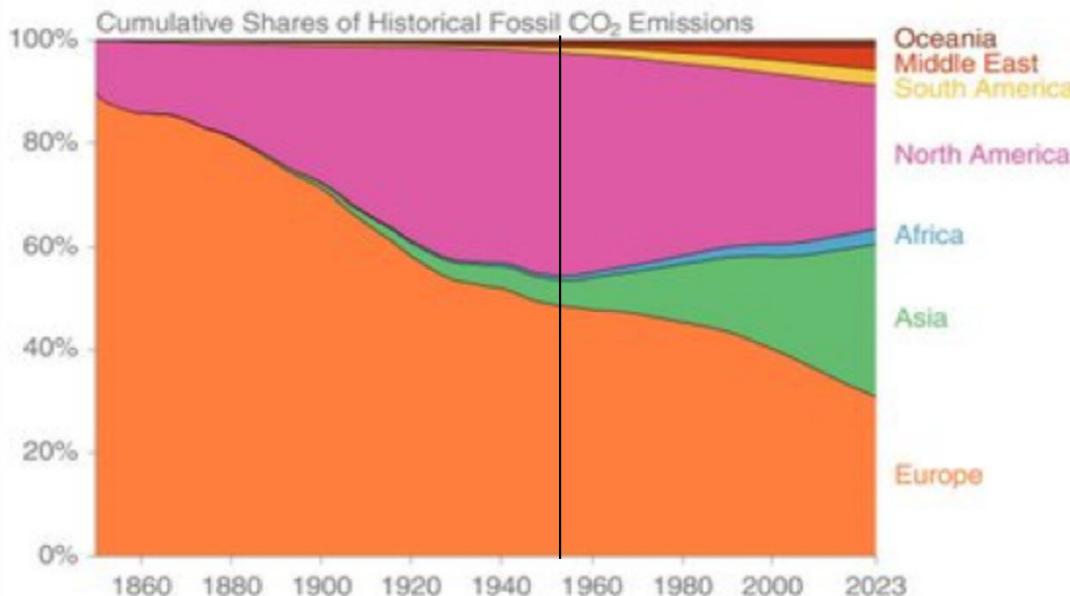
George Steinmetz's photography regularly appears in *National*

Land-use change was the dominant source of annual CO<sub>2</sub> emissions until around 1950.  
Fossil CO<sub>2</sub> emissions now dominate global changes.



### Historical cumulative emissions by continent

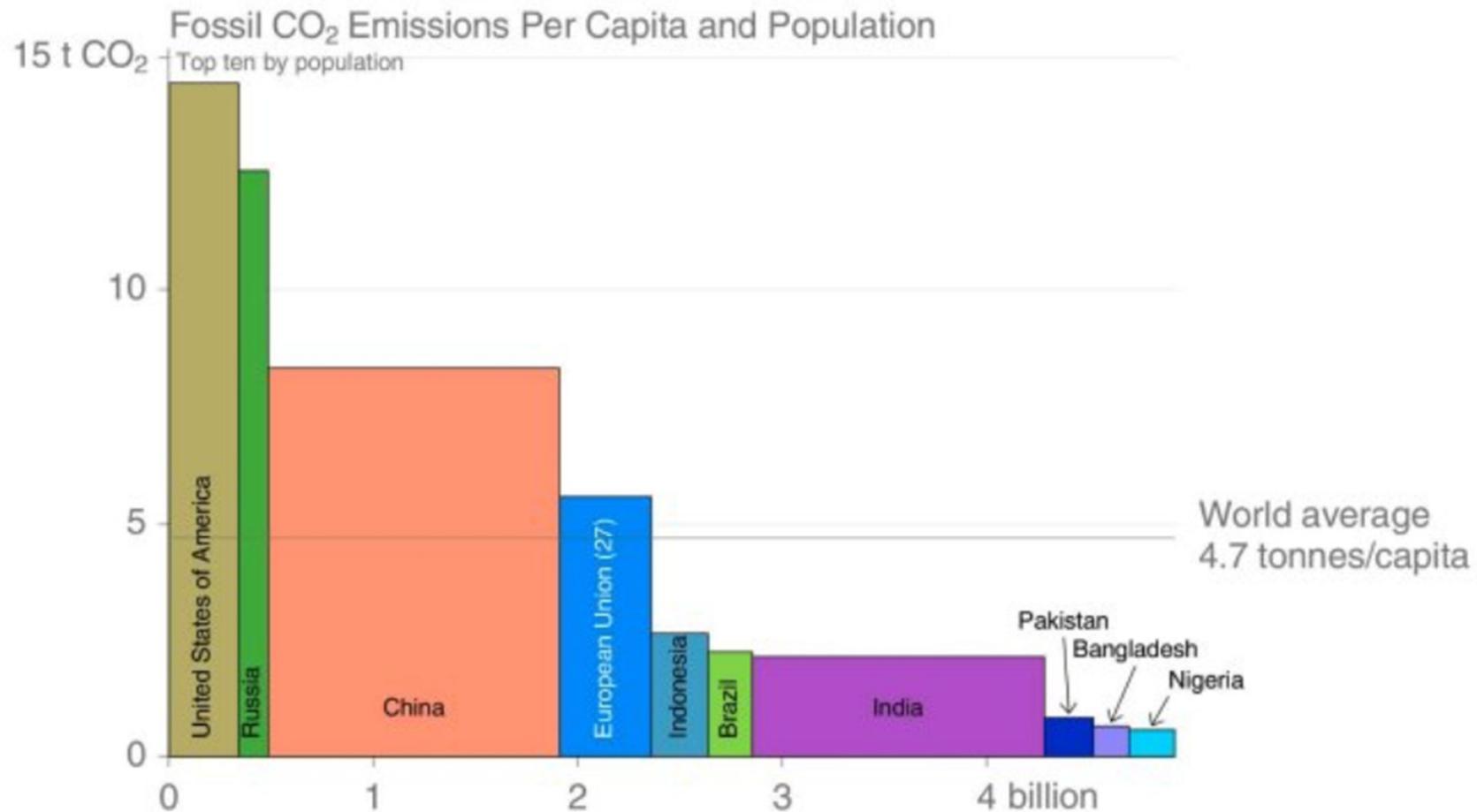
Cumulative fossil CO<sub>2</sub> emissions (1850–2023). North America and Europe have contributed the most cumulative emissions, but Asia is growing fast



**Historically, land use was the main source of CO<sub>2</sub> until about 1950, and remained relatively large until 1980...**

**Land use change = soil cultivation releases massive amounts of carbon to the atmosphere (group 5!)**

The 10 most populous countries span a wide range of development and emissions per capita

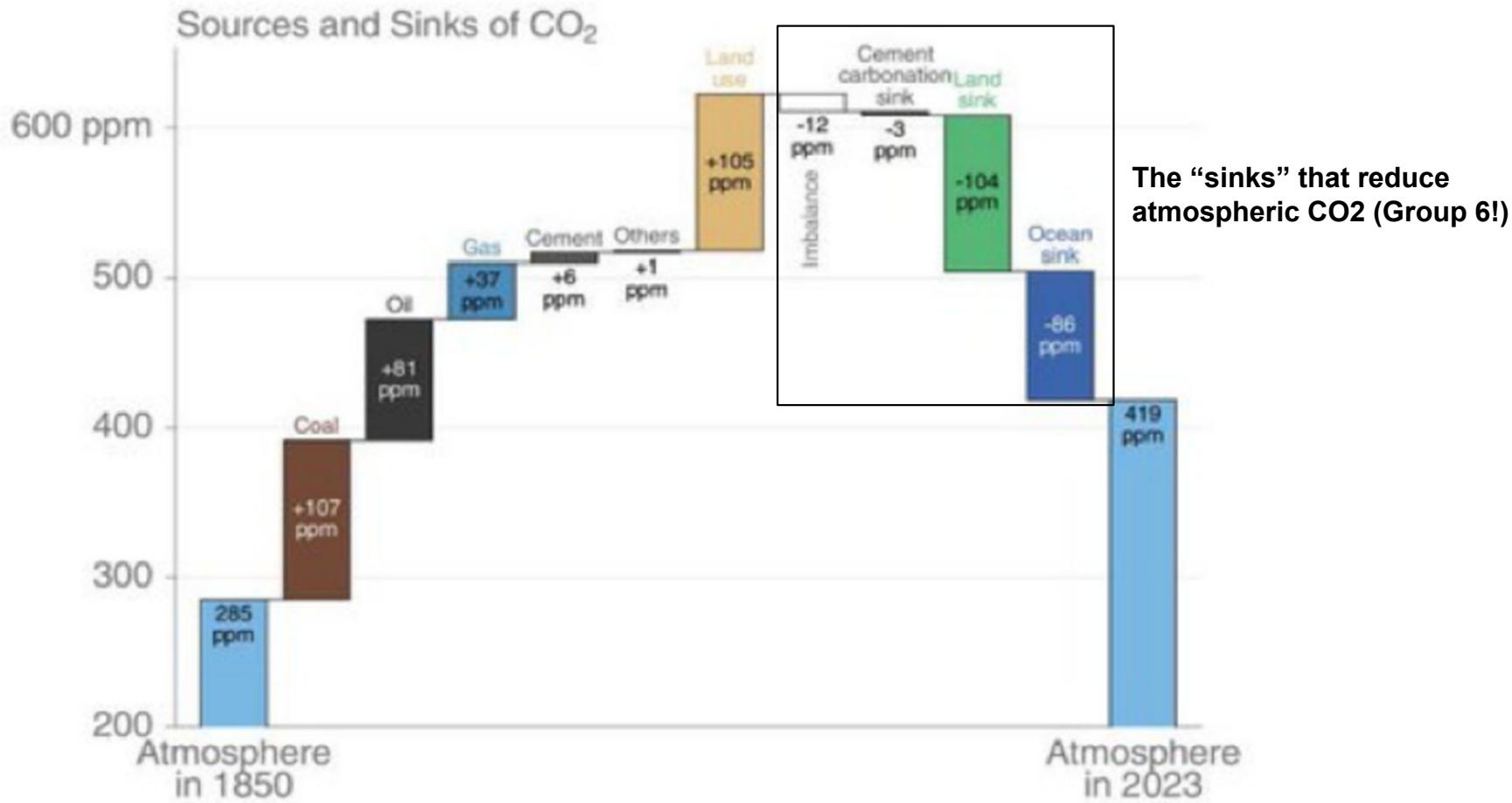


**It is NOT about over-population; it is about consumption...  
(Group 7!)**

## Global carbon budget

The cumulative contributions to the global carbon budget from 1850

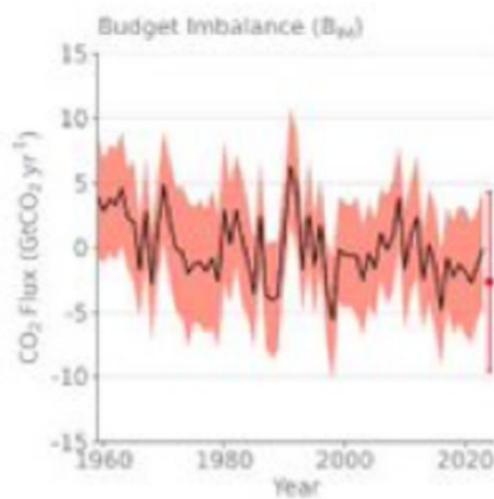
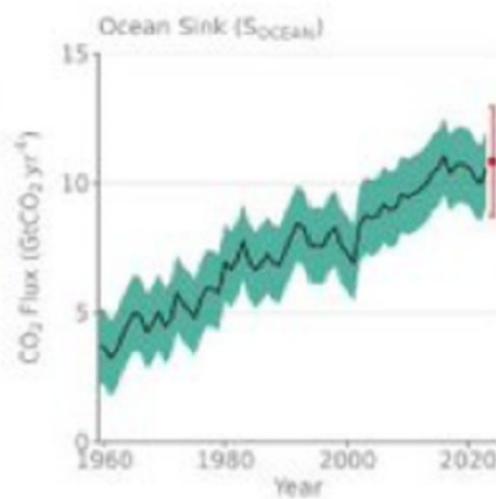
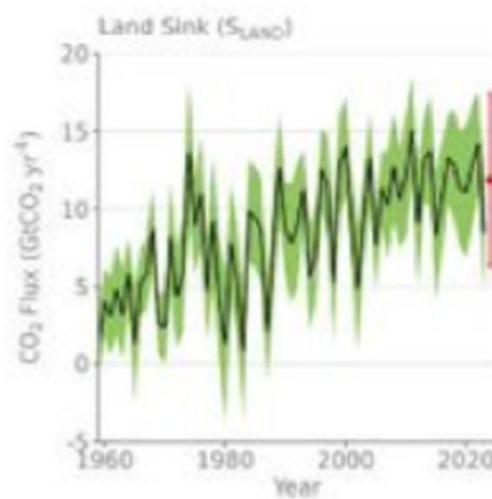
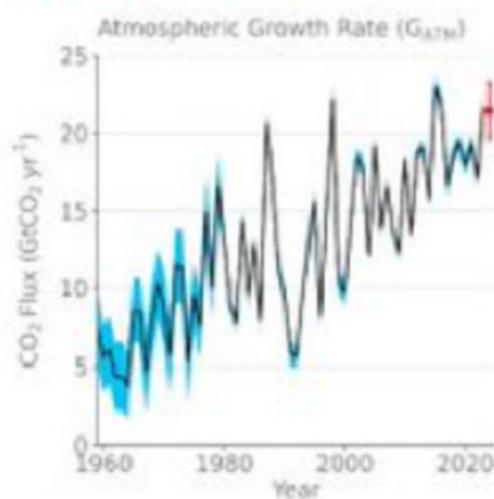
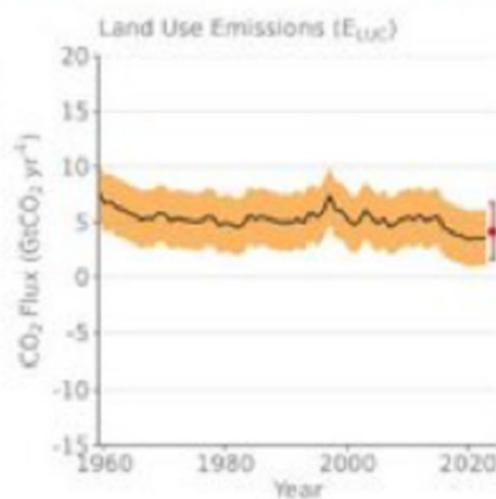
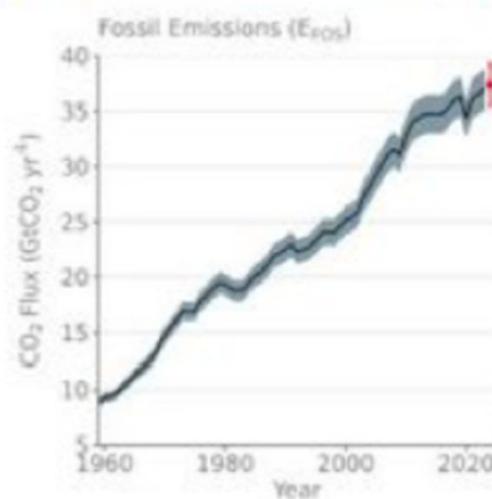
The carbon imbalance represents the gap in our current understanding of sources & sinks



We **MUST** reduce emissions – we cannot just plant trees...  
But the earth “sinks” are nonetheless substantive

## Changes in the budget over time

The sinks have continued to grow with increasing emissions, but climate change will affect carbon cycle processes in a way that will exacerbate the increase of CO<sub>2</sub> in the atmosphere



# Widening global variability in grassland biomass since the 1980s

Received: 5 December 2023

A list of authors and their affiliations appears at the end of the paper

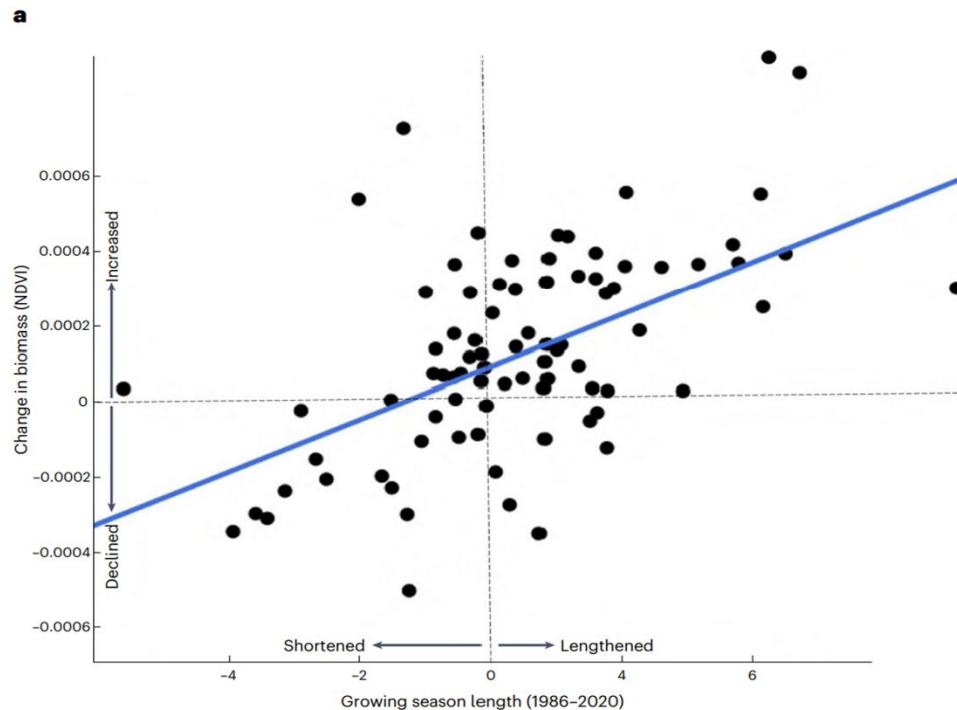
Accepted: 9 July 2024

Published online: 5 August 2024

Check for updates

Global change is associated with variable shifts in the annual production of aboveground plant biomass, suggesting localized sensitivities with unclear causal origins. Combining remotely sensed normalized difference vegetation index data since the 1980s with contemporary field data from 84 grasslands on 6 continents, we show a widening divergence in site-level biomass ranging from +51% to -34% globally. Biomass generally increased in warmer, wetter and species-rich sites with longer growing seasons and declined in species-poor arid areas. Phenological changes were widespread, revealing substantive transitions in grassland seasonal cycling. Grazing, nitrogen deposition and plant invasion were prevalent in some regions but did not predict overall trends. Grasslands are undergoing sizable changes in production, with implications for food security, biodiversity and carbon storage especially in arid regions where declines are accelerating.

Andrew S. MacDougall <sup>1,2</sup>, Ellen Esch<sup>1</sup>, Qingqing Chen <sup>3</sup>, Oliver Carroll <sup>1</sup>, Colin Bonner <sup>1</sup>, Timothy Ohlert<sup>4</sup>, Matthias Siewert <sup>2</sup>, John Sulik <sup>5</sup>, Anna K. Schweiger <sup>6</sup>, Elizabeth T. Borer <sup>7</sup>, Dilip Naidu <sup>8</sup>, Sumanta Bagchi <sup>8</sup>,



## Message:

- (1) The land sink is growing....
- (2) But not everywhere: the direct (83%) and indirect (~100%) impacts of people do not unfold similarly by region, or always in ways that we might intuitively predict...

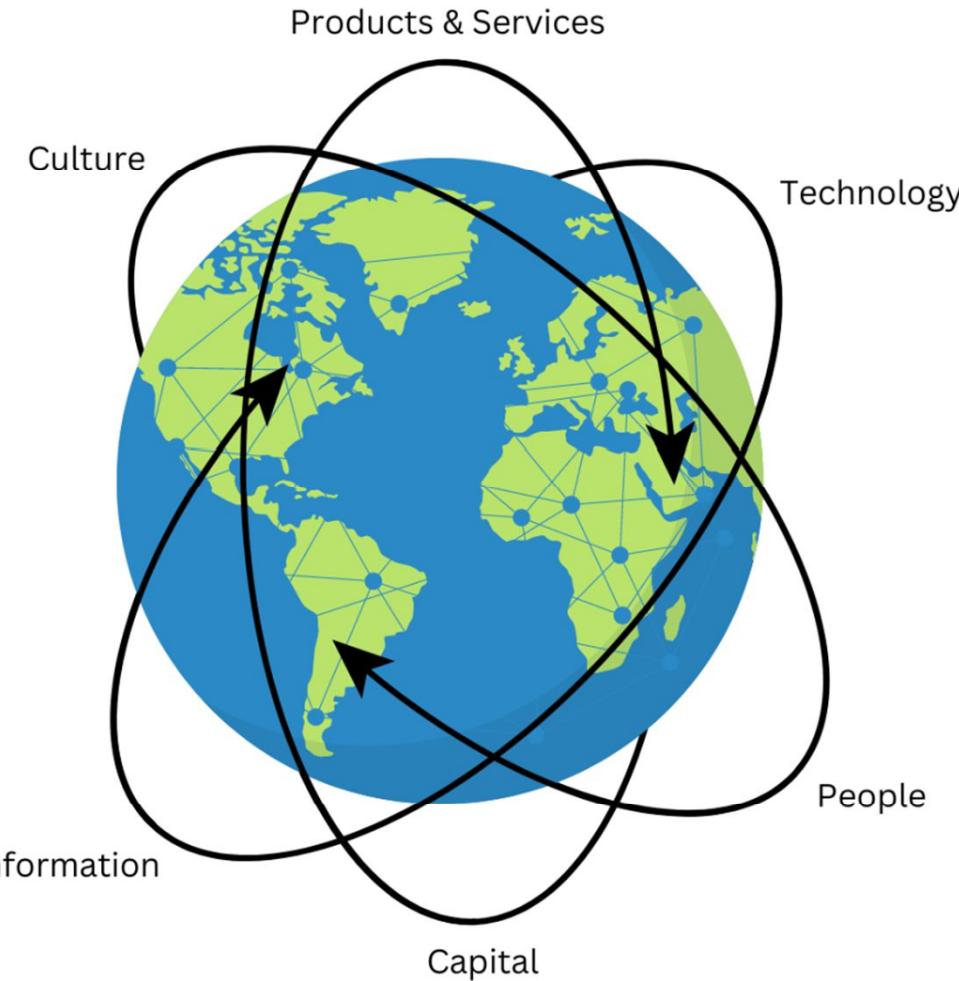
# SUSTAINABLE DEVELOPMENT GOALS



Many of the UN SDGs are connected to the environment, and relate to the direct (83%) and indirect (~100%) impacts of humans. As with the previous slide, they cannot be achieved similarly by region, or always in ways that we might intuitively predict...

**"policy competition"** SDG 1 vs SDG 2, 6, 7, 13, 14, 15....

# Globalization



Solving/achieving many of the UN SDGs centers on the benefits of “globalization” – the free-exchange of...everything....which has been the prevalent global model since the 1980s, but

- (1) has largely depended on cheap and endlessly available fossil fuels, and
- (2) has arguably accelerated global environmental challenges....

# **IV. Core Features of Conservation Biology?**

# What is Conservation Biology?

- **Conservation biology** is the scientific study of the nature and status of earth's biological diversity with the aim of protecting species, habitats, and ecosystems from excessive extinction rates that are linked to the modern human enterprise (Wikipedia).

# Extinct species in Canada