



Natural Solutions: The Essential Neglected Opportunity for Addressing Climate Change

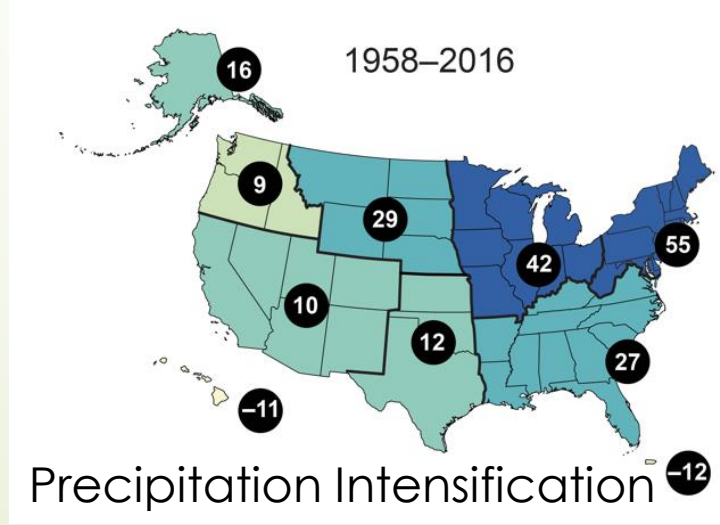
Massachusetts Environmental Health Association

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Visiting Scientist Woodwell Climate Research Center

The Climate Has Already Changed



Health consequences in a climate changed world

- India May 2022 extreme heat 113°F
- Over 20,000 die from heat stroke
- Night time temperatures exceed 100°F
- Body temperatures exceeding 108°F destroys protein and brain tissue



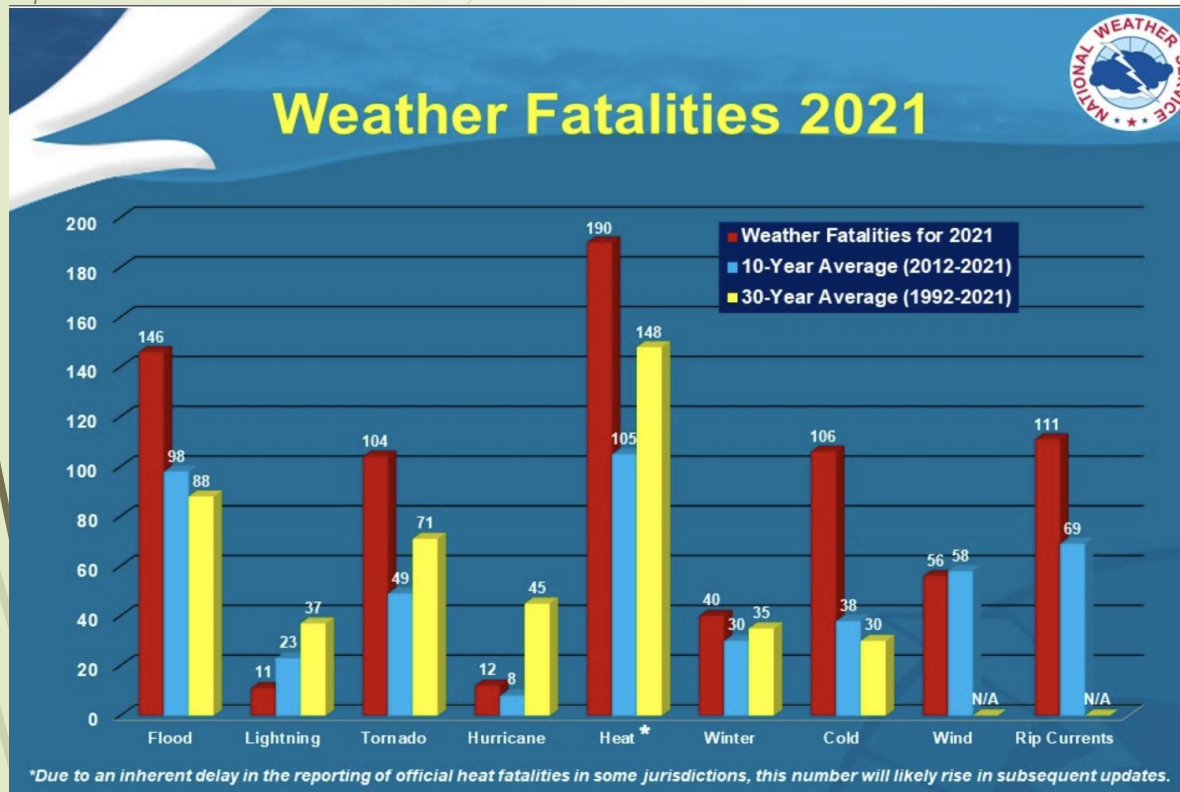
Diseases associated with warmer climates move to temperate climates

- Lyme and other tick borne diseases in North America
- Malaria moves into highlands of Kenya, and into southern Europe
- Poison ivy moves into northern US and southern Canada
- Allergies move North



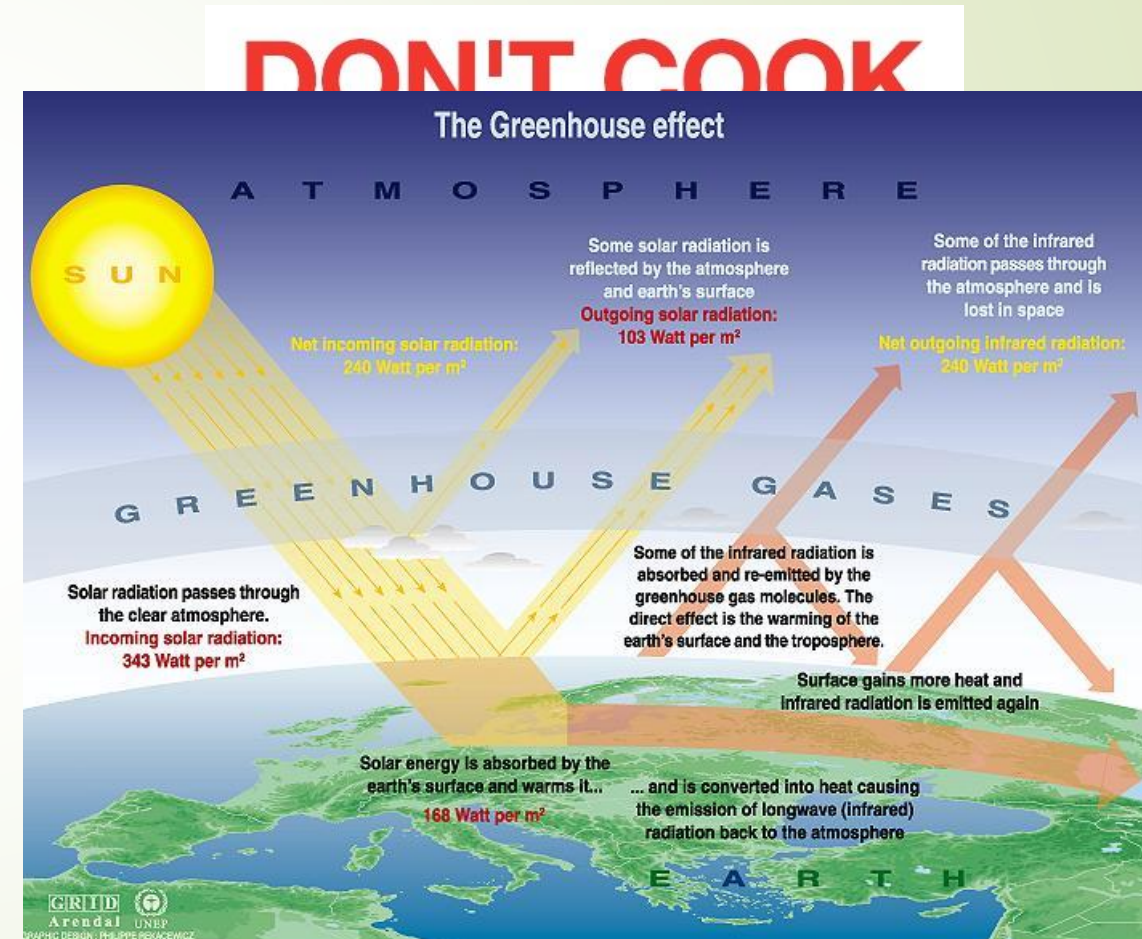
Lyme carrying ticks

Injury and death from intense storm damage



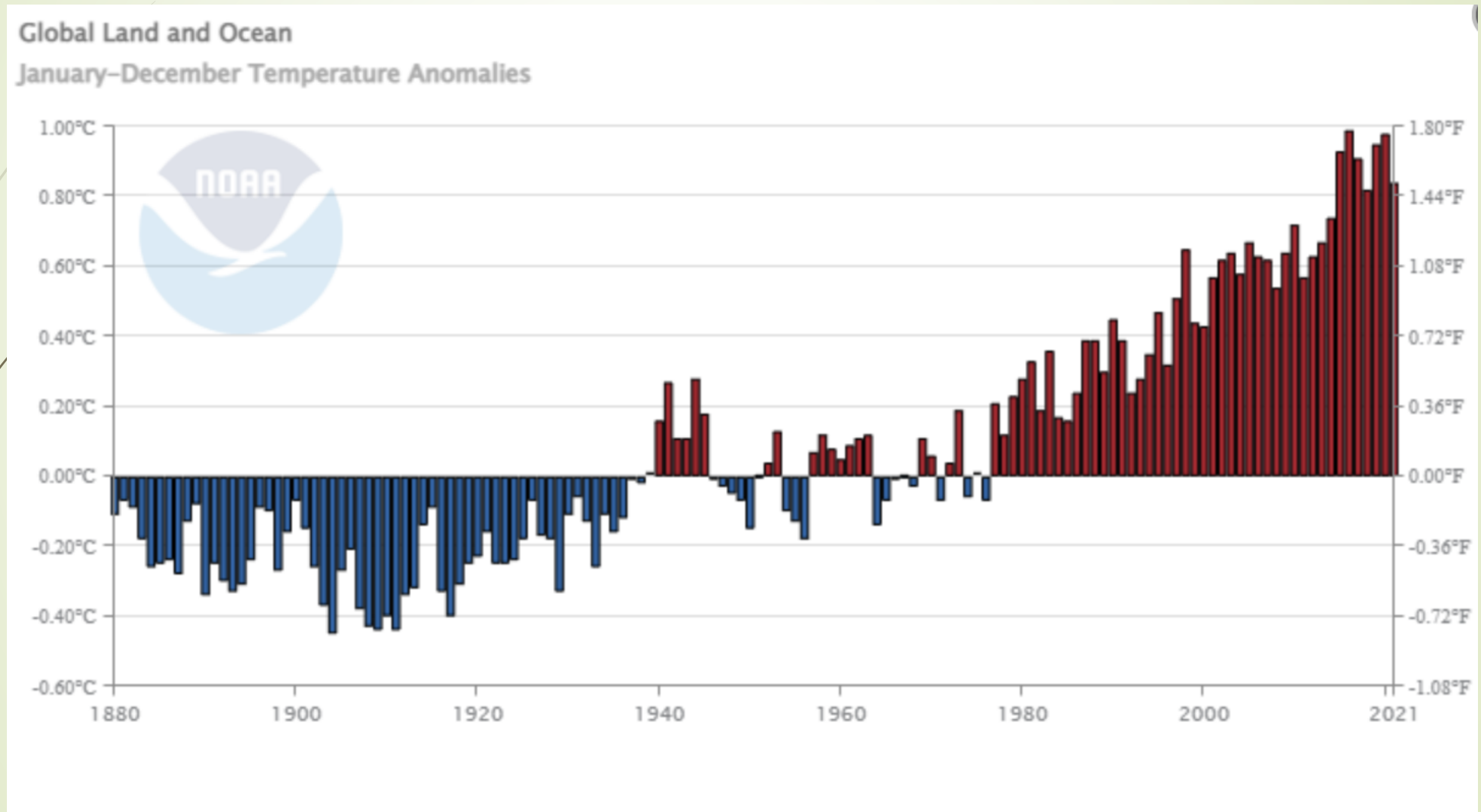
How are we changing the climate and creating weather extremes?

- Hypothesis that an atmospheric component allowed the sun's light to penetrate the atmosphere, but prevented the earth's radiant heat from leaving thereby keeping the earth warm – Fourier 1827
- He called it the greenhouse effect by analogy to the glass buildings in which plants are grown
- Today it would be called the "Hot Car Effect"

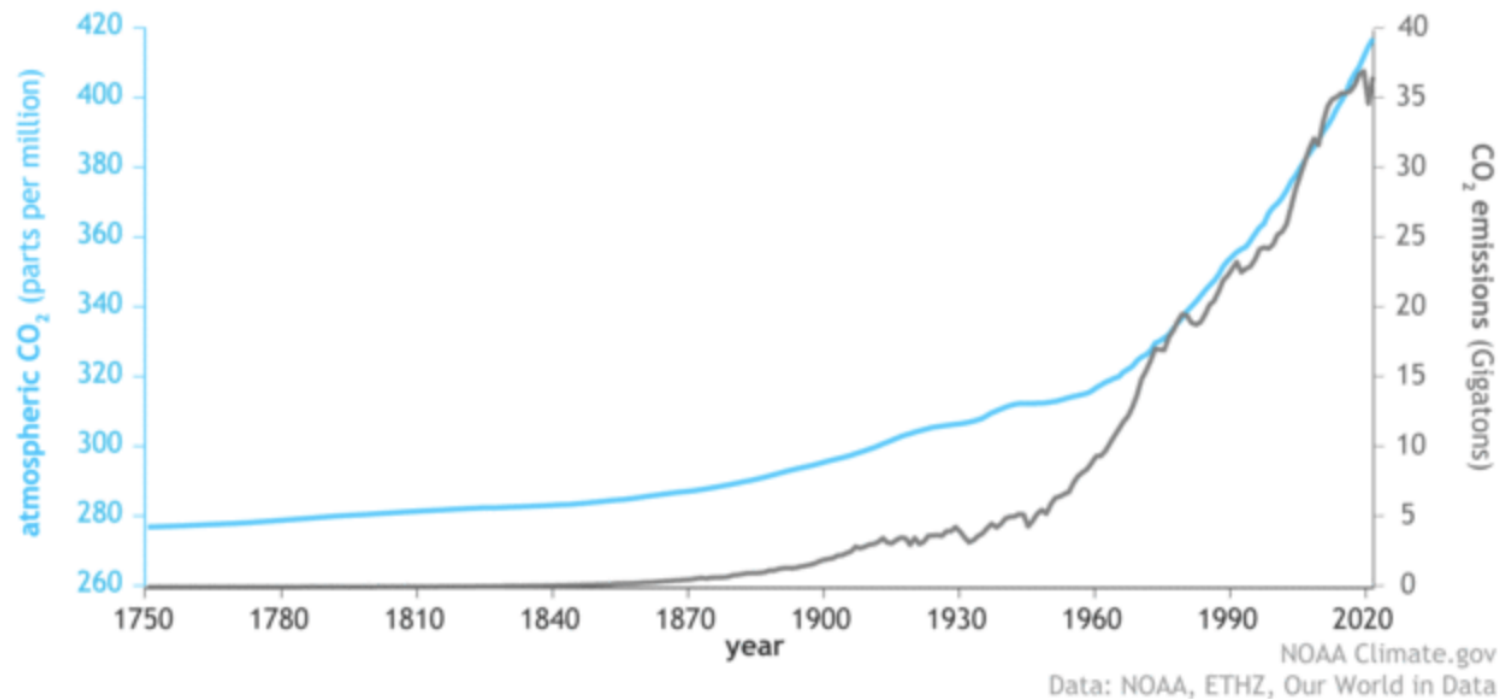


Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

The Changing Global Temperature is Changing the Weather!



Atmospheric carbon dioxide amounts and annual emissions (1750-2021)

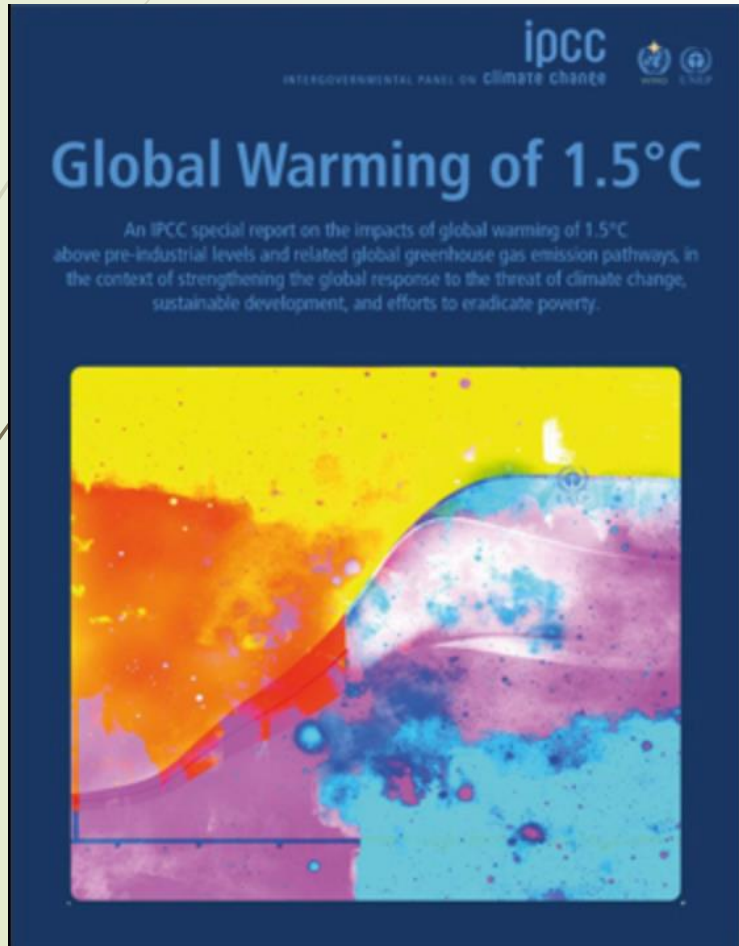


The amount of carbon dioxide in the atmosphere (blue line) has increased along with human emissions (gray line) since the start of the Industrial Revolution in 1750. Emissions rose slowly to about 5 billion tons per year in the mid-20th century before skyrocketing to more than 35 billion tons per year by the end of the century. NOAA Climate.gov graph, adapted from original by Dr. Howard Diamond (NOAA ARL). Atmospheric CO₂ data from [NOAA](#) and [ETHZ](#). CO₂ emissions data from [Our World in Data](#) and the [Global Carbon Project](#).

Today's Climate Goals

- ▶ 1992 – UN Framework Convention on Climate Change
 - ▶ *"The goal of this convention ... is to achieve ... **a concentration of greenhouse gases in the atmosphere** that will avoid dangerous anthropogenic interference in the climate system."*
- ▶ Paris Climate Agreement 2015
 - ▶ *"This Agreement ... aims to strengthen the global response to the threat of climate change ... by holding the increase in the global average temperature to well below 2°C (3.6°F) above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C (2.7°F) above pre-industrial levels." - Article 2*
 - ▶ *"Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases ... including forests." Article 5*
- ▶ **Global temperature has already risen by 1.2°C or 2.2°F**

Climate Change: How to meet the 1.5° C goal?



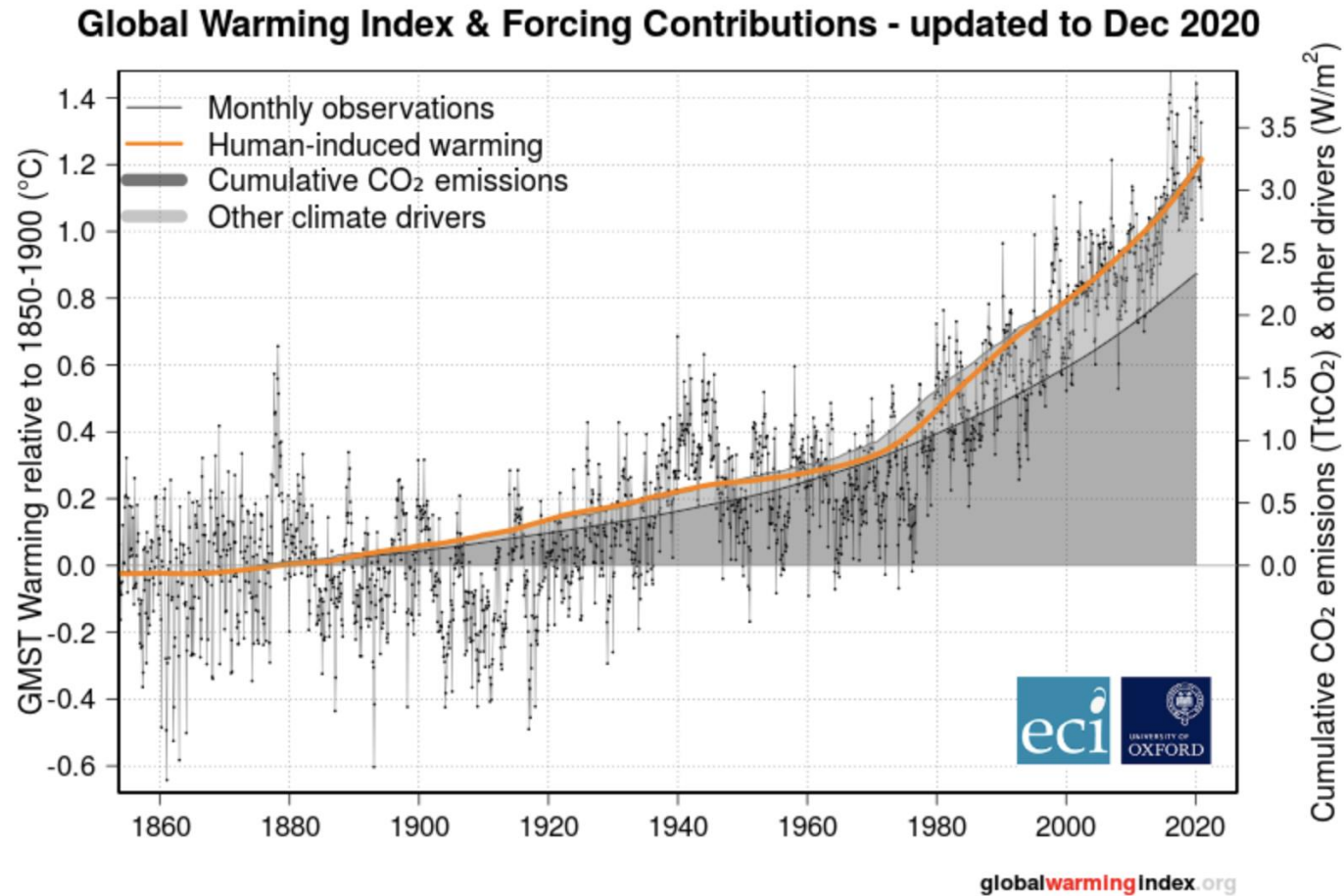
IPCC Special Report *Global Warming of 1.5°C (2.7°F)* 2018

To keep temperatures from rising excessively “... global **net** anthropogenic carbon dioxide emissions (must) decline by about 45% from 2005 levels by 2030 ... reaching **net** zero around 2050” ...and net negative beyond 2100

Must simultaneously reduce carbon dioxide emissions and increase its removal from the atmosphere

Human-induced warming: +1.258864476 °C

on Wed, 28 Sep 2022 21:09:40 GMT

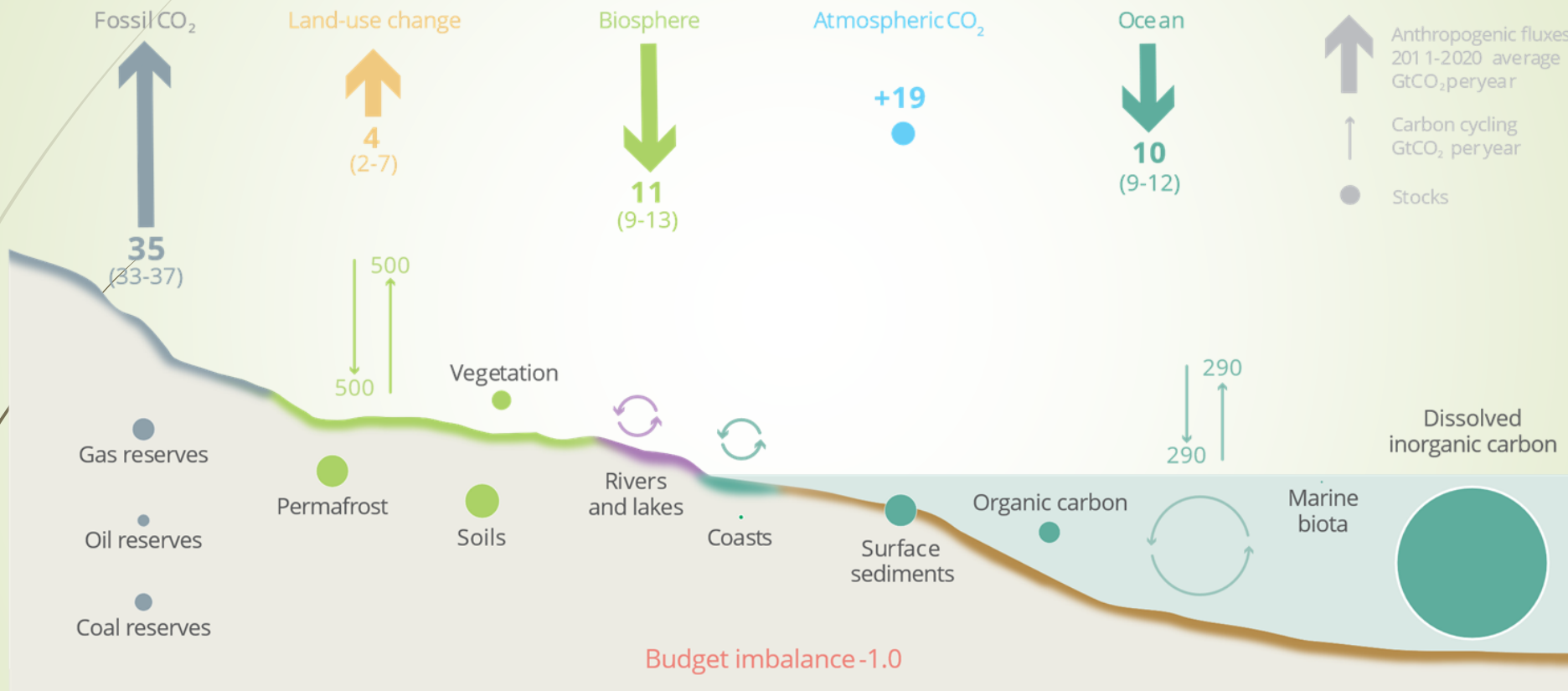


This graph shows how the main drivers are contributing to human-induced global warming.
The dark grey shows CO₂ emissions added up over time.

<https://www.globalwarmingindex.org>

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, global annual average for the decade 2011–2020 (GtCO₂/yr)

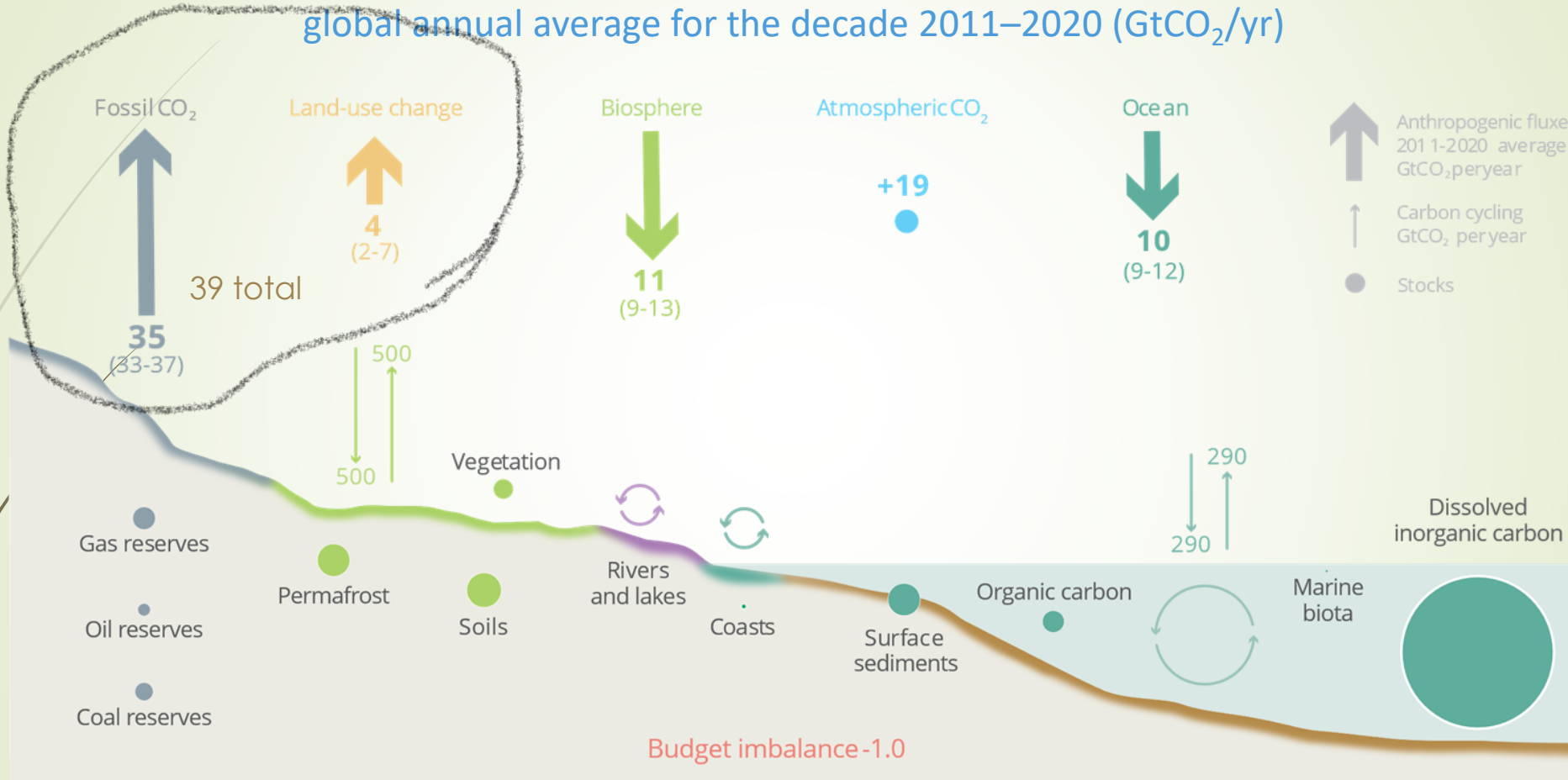


The budget imbalance is the difference between the estimated emissions and sinks.

Source: [NOAA-ESRL](#); [Friedlingstein et al 2021](#); [Canadell et al 2021 \(IPCC AR6 WG1 Chapter 5\)](#); [Global Carbon Project 2021](#)

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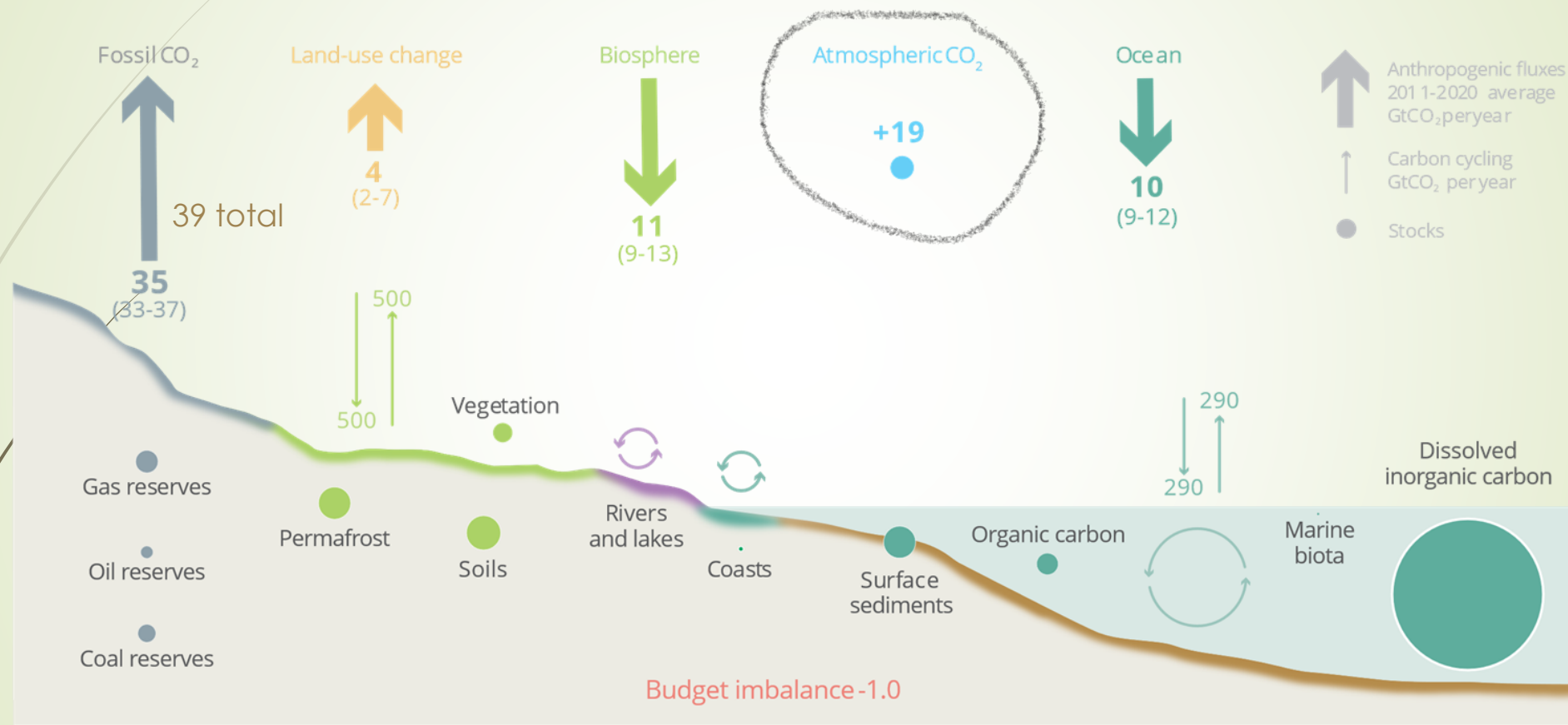


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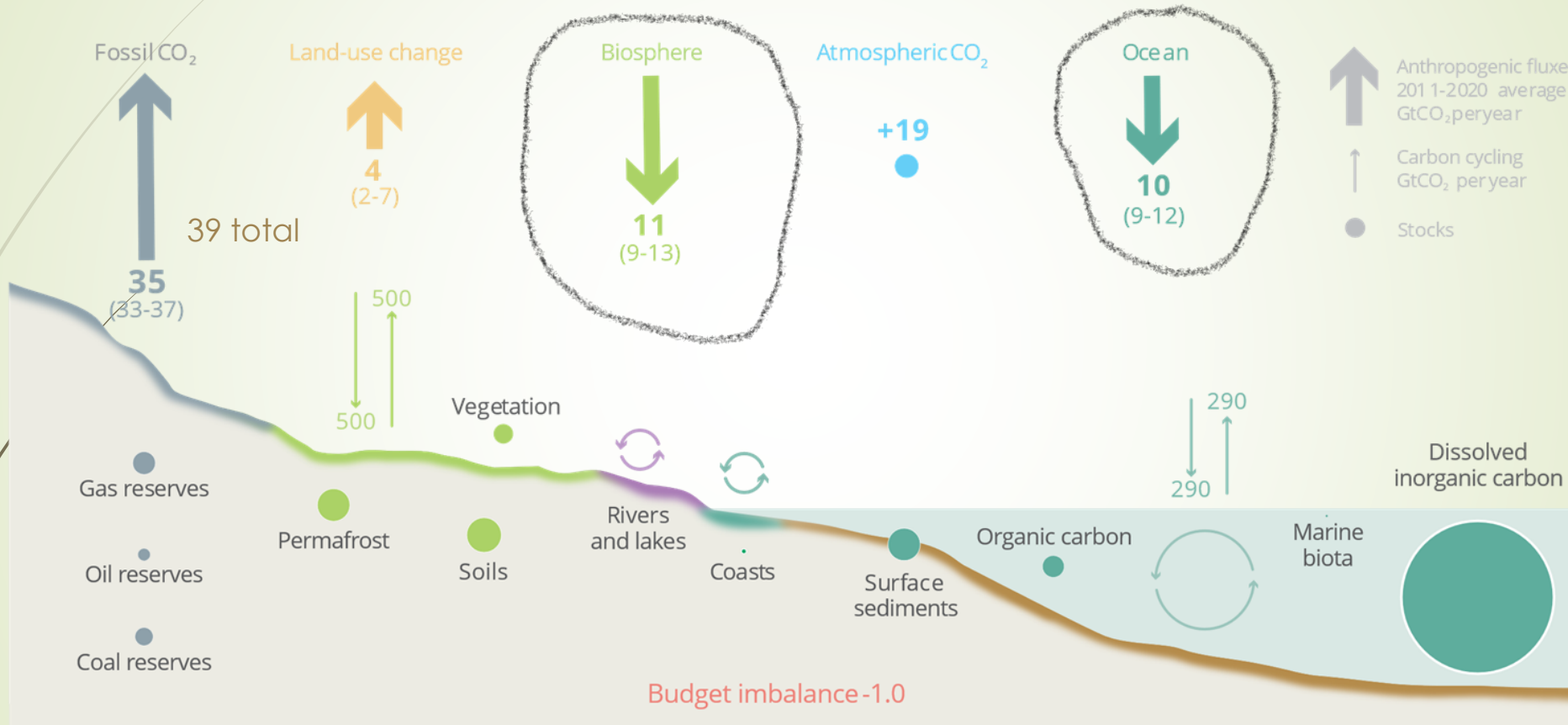


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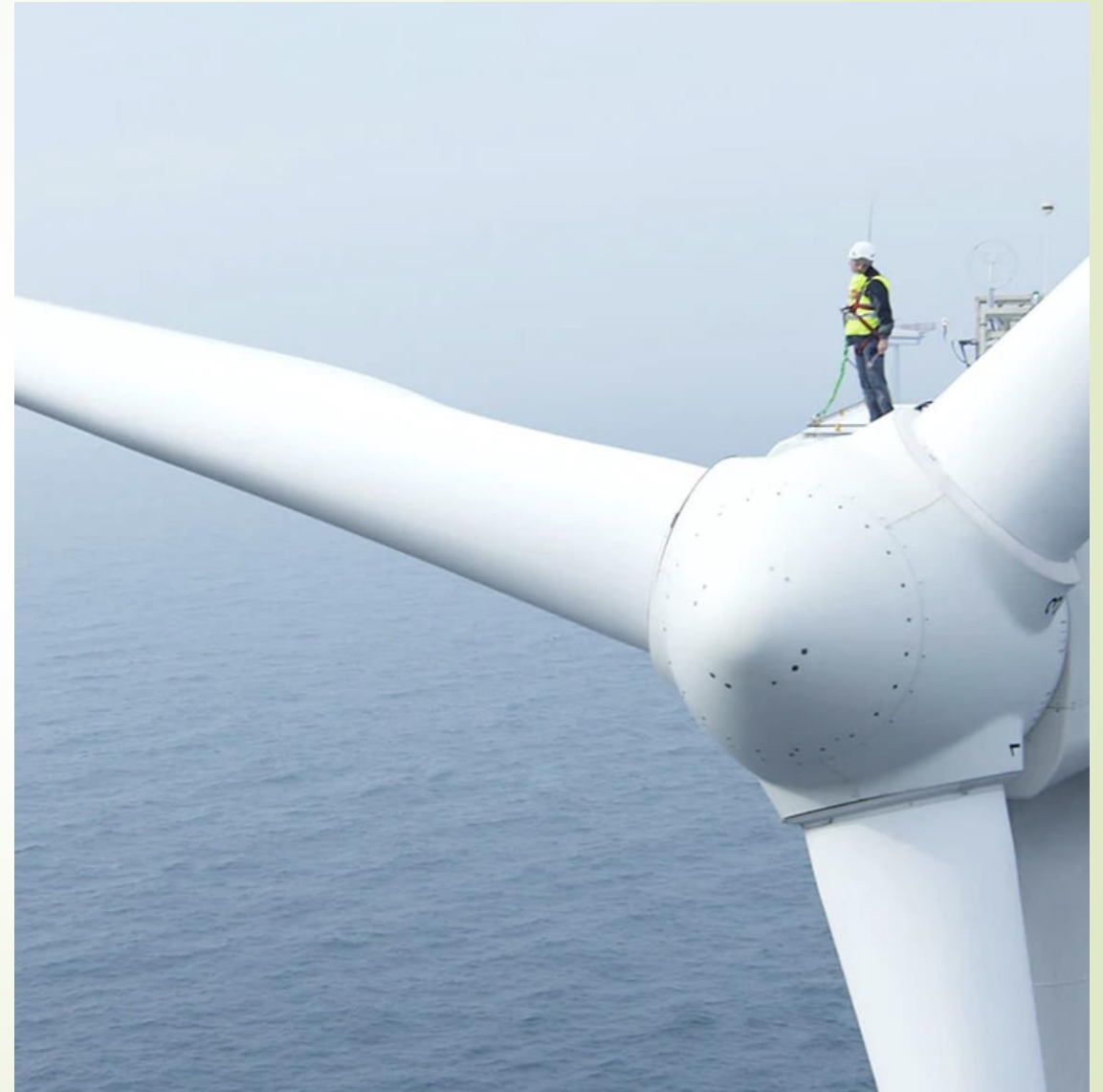


Terrestrial plants and oceans remove ~60% of annual emissions

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Source: [NOAA-ESRL](#); [Friedlingstein et al 2021](#); [Canadell et al 2021 \(IPCC AR6 WG1 Chapter 5\)](#); [Global Carbon Project 2021](#)

Replace fossil fuel generation with renewables and storage





84% less energy for heat and hot water than code
Grid connected net electricity exported
Annual energy needs met by solar panels
No carbon dioxide emissions

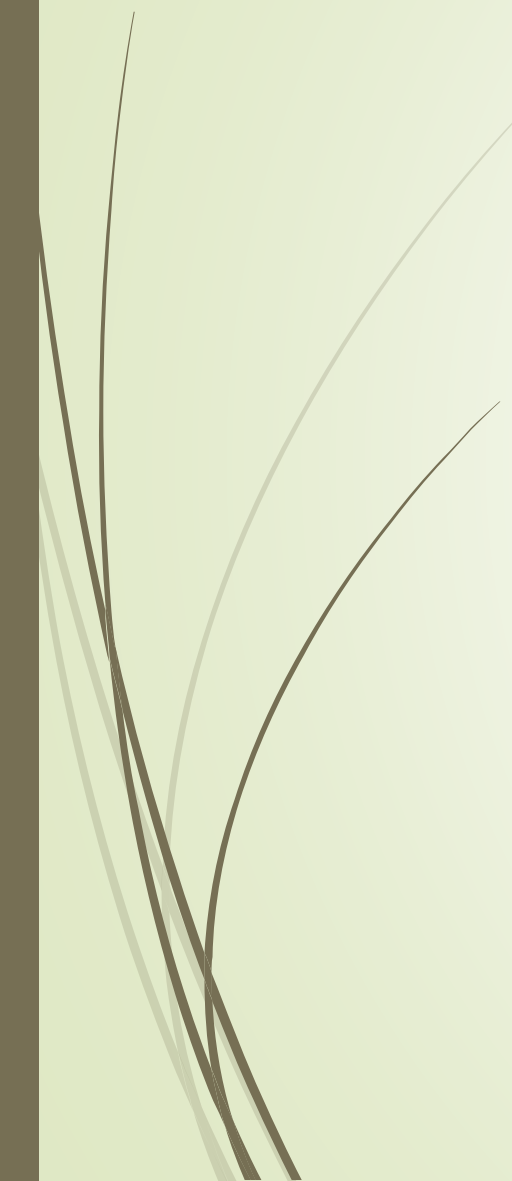
Natural Climate Solutions to Climate Change: A Forest Ecosystem Service

Keeping trees in the ground where they are already growing is an effective low-tech way to slow climate change

February 22, 2021 8:23am EST Updated February 23, 2021 6:12pm EST



Some facts about forests and climate

- ▶ Forests account for 92% of all land plant mass globally (Pan et al., 2013),
 - ▶ Forests store about 45% of the total organic carbon on land in their biomass and soils (Bonan, 2008)
 - ▶ Forests removed the equivalent of about 30% of fossil fuel emissions annually from 2009 to 2018, of which **44% was by temperate forests** (Friedlingstein et al., 2019).
 - ▶ Forests provide critical habitats to more than half of all known plant and animal species on Earth (Vié et al., 2009; Gibson et al., 2011)
 - ▶ **How do we increase removal of atmospheric carbon dioxide by Forests?**
- 

Increasing carbon accumulation by forests

- ▶ Altering forest management to let more trees grow would allow global **forests to accumulate twice as much carbon**

Erb et al 2018

- ▶ “...the **largest one percent of trees** in mature and older forests comprised 50 percent of forest biomass worldwide”
Lutz et al 2018





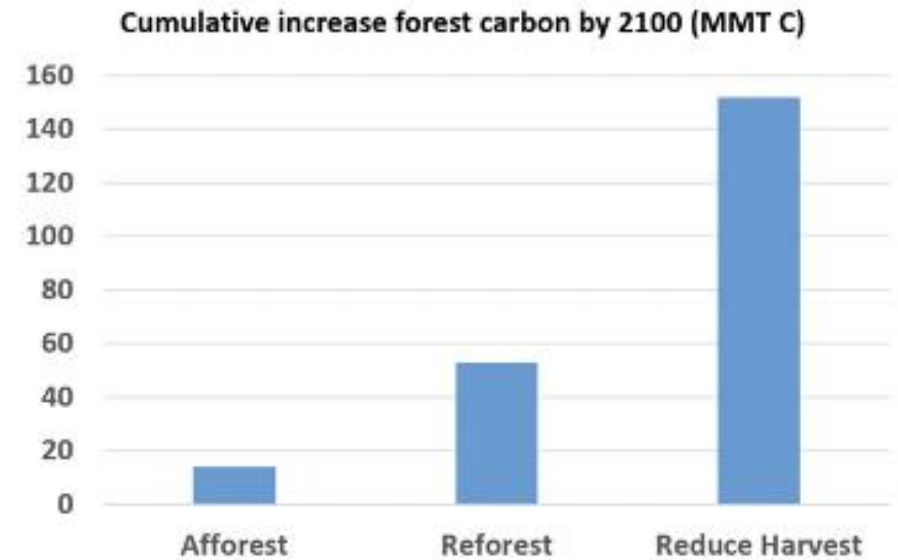
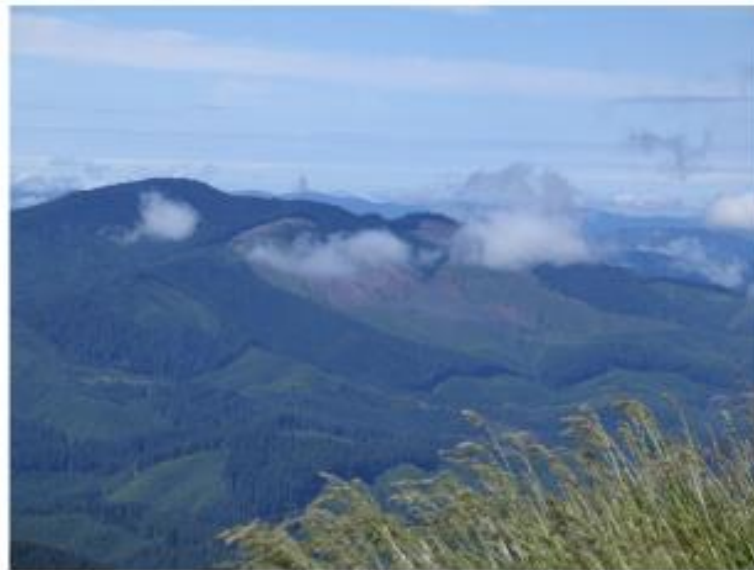
50% Carbon

How do we get big trees?
Let more of them grow!

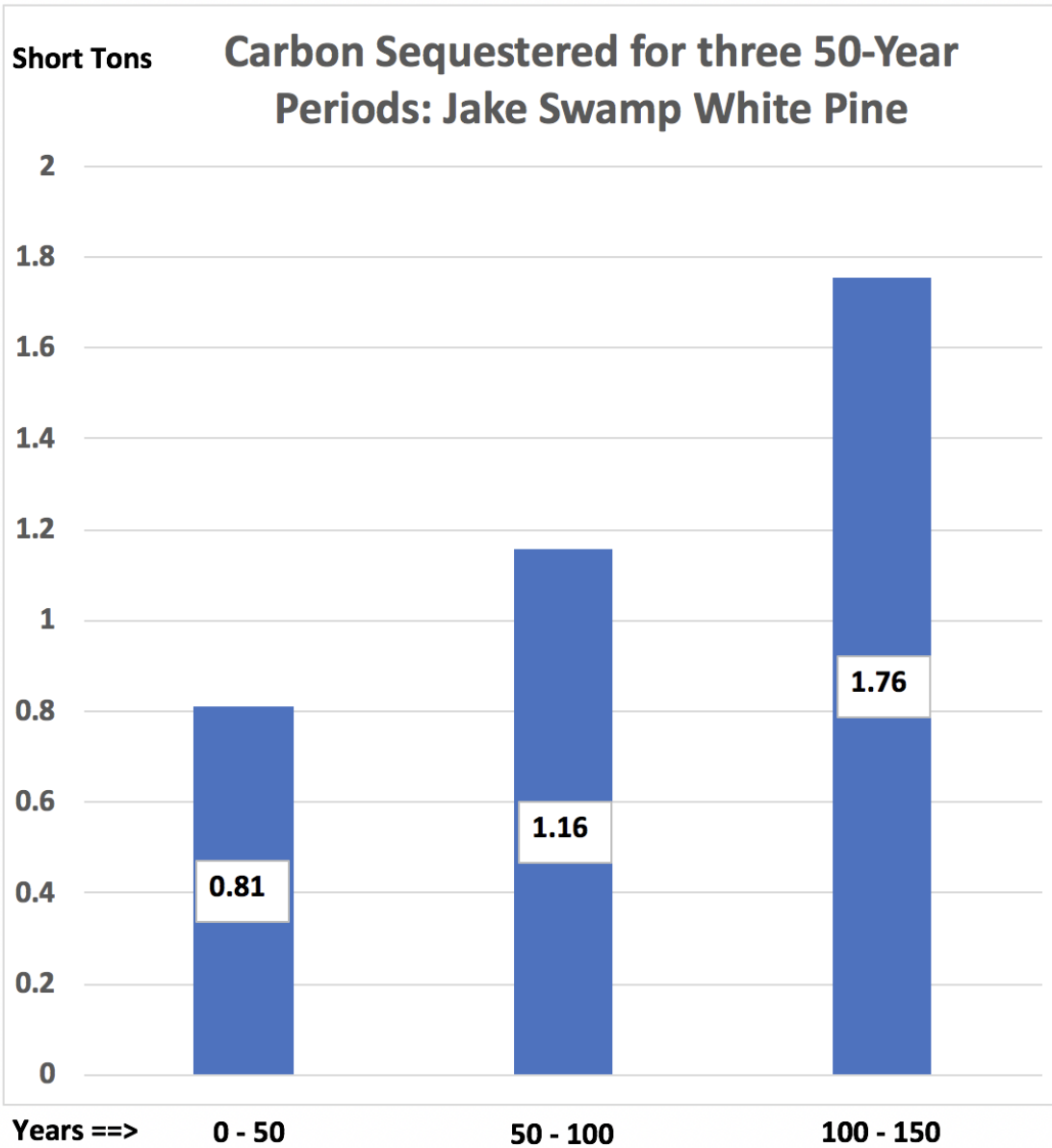
Proforestation Management
growing forests without
harvest **to reach their**
potential for biodiversity and
carbon accumulation in
trees and soils

Larger trees in older and
growing forests accumulate
the most atmospheric
carbon over time, and store
it in the wood of their trunk
and limbs and in soils

Accumulated carbon stocks in mature and old forests is the most effective forest-related climate mitigation strategy



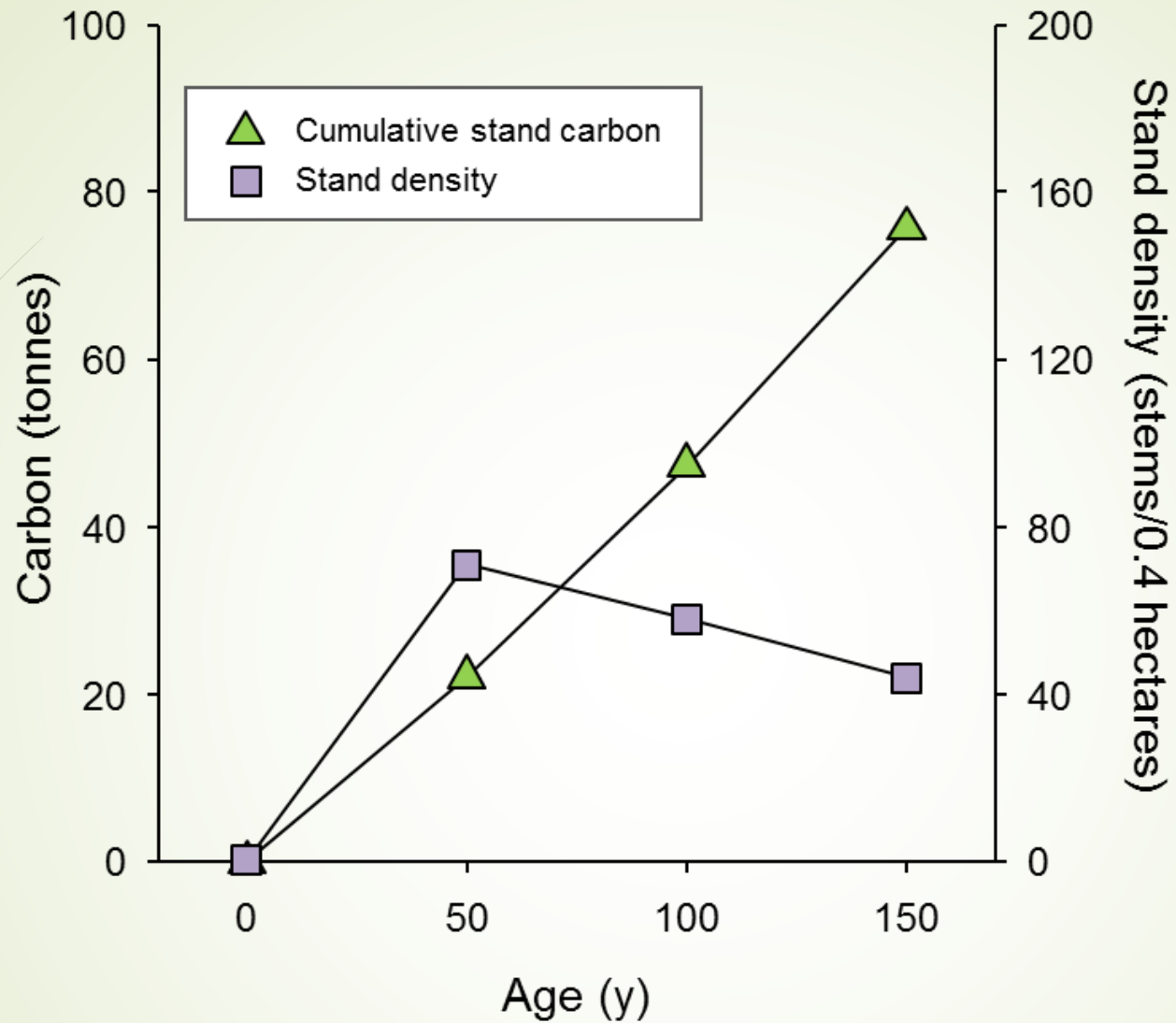
Restricting harvest to half of current rates on public lands and lengthening harvest cycles contributes the most to increasing carbon accumulation compared with business-as-usual management (Law et al. *Proc. Nat. Acad. Sci.* 2018, Luyssaert et al. *Nature* 2008)



Total Carbon Sequestered for 1st 150 years
3.7 short tons or 3.4 metric tons
(Currently 4.17 Tons at 160 Years)

Tallest tree in Northeast US
Located in Western Massachusetts

176+ feet high Measurements by
Bob Leverett 2018



Cumulative carbon and number of trees in a stand of white pine (Leverett et al. 2021)

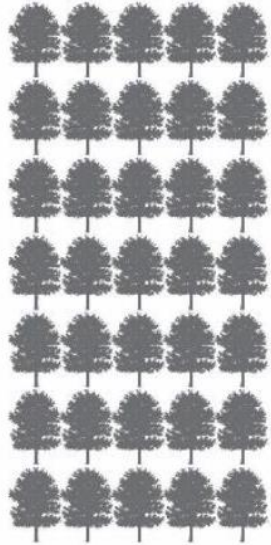
CARBON ROCK STARS: LARGE, OLDER TREES AND FORESTS

How many oak trees does it take to store 8 tons of carbon?

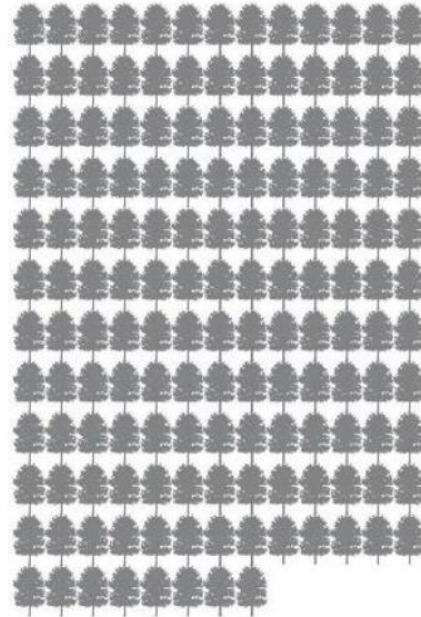
Robert Leverett 2021



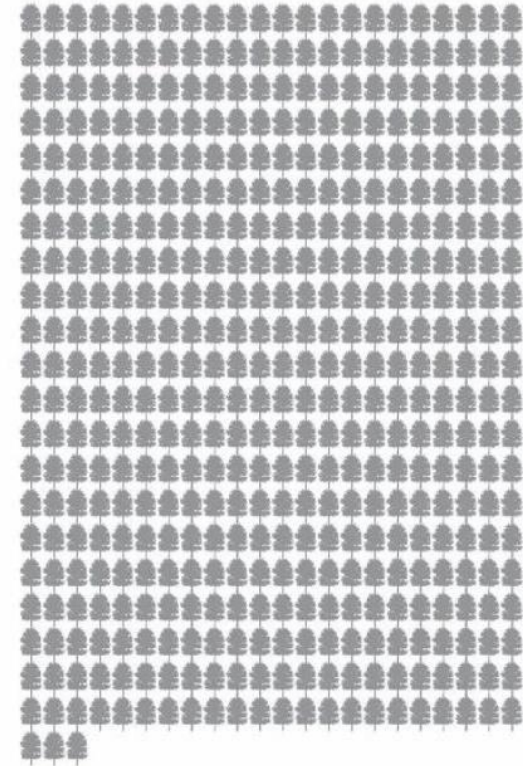
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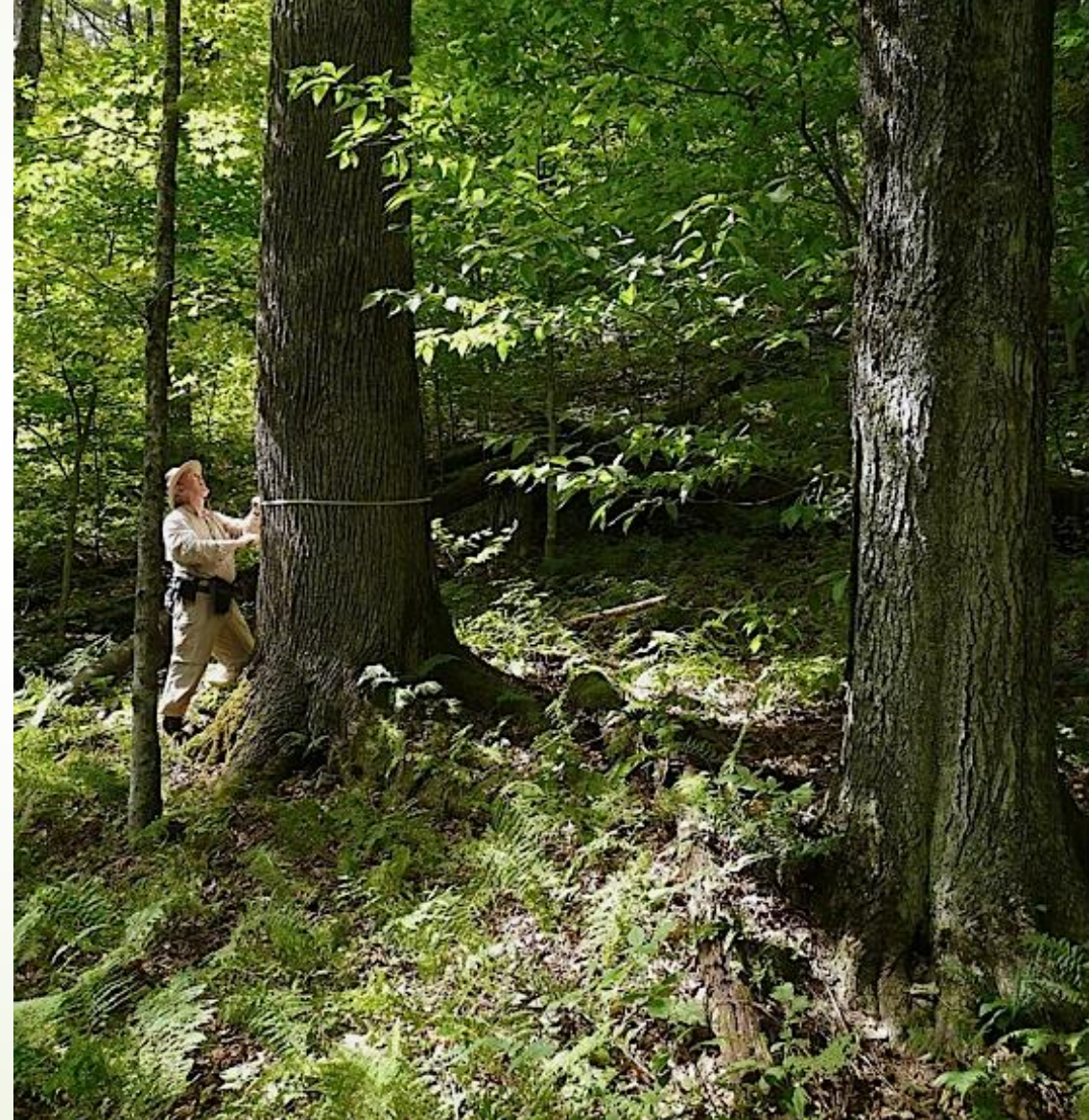
1
Mature
Canopy Tree
100' tall x 54" dia


35
Young
Canopy Trees
50' tall x 12" dia

151
Typical
Street Trees
40' tall x 6" dia

465
New Large
Landscape Trees
25' tall x 4" dia

Older forests of larger trees in Massachusetts reserves





Intergovernmental Panel on Climate Change 2022

- ▶ *“Safeguarding biodiversity and ecosystems is fundamental to climate resilient development, in light of the threats climate change poses to them and their roles in adaptation and mitigation (very high confidence).”*
- ▶ *“Recent analyses ... suggest that maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth’s land, freshwater and ocean areas, including currently near-natural ecosystems (high confidence).”*

<https://www.ipcc.ch/report/ar6/wg2/>



Nature Needs Half™

Protecting and interconnecting at least half of the planet's land and water is necessary to sustain the health, function, and diversity of all life.

E.O. Wilson co-founder of biodiversity science
10 June 1929- 26 December 2021

Strategies for closing the carbon gap and preventing catastrophic feedback heating

- Prevent deforestation, the draining of wetlands and soil carbon loss
- Restore degraded ecosystems
- **Proforestation** management is far more effective than “planting a trillion trees” and is among the least costly options for removing and storing additional carbon dioxide out of the atmosphere
- **Create Climate and Biodiversity Strategic Reserves** (Law et al 2022)



Establish two types of forests:



Strategic Climate and Biodiversity Reserves



Industrial production forests

A photograph of a forest floor. In the center, a large, vibrant red maple leaf with several holes is the focal point. To its left and right are two small, green, five-lobed plants. The ground is covered with dark soil, brown pine needles, small rocks, and other fallen leaves. The text "Thank you" is overlaid in white on the red leaf.

Thank you