

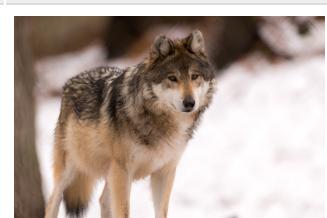
## What do these animals have in common?



*Elaphas maximus*



*Cavia tschudii*



*Canis lupus*



*Vicugna vicugna*

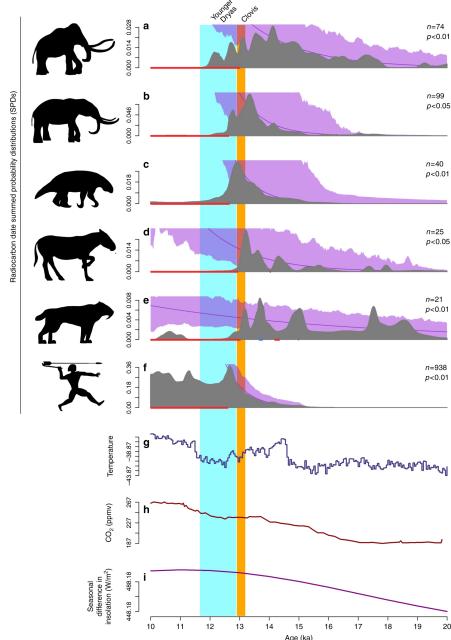


*Anas platyrhynchos*



*Cyprus mouflon*

# Recap: Human's first epic "management" fail.



*Homo* rapidly diversified and spread around the globe during the Pleistocene (2.7 mya) - a drier, colder period more dominated by large **herbivores** and **grasslands** and intermittent periods of **glaciation** ("Ice Ages")

To adapt, *Homo* increased meat protein intake, likely first via *scavenging*, then rapidly improving *hunting skills*

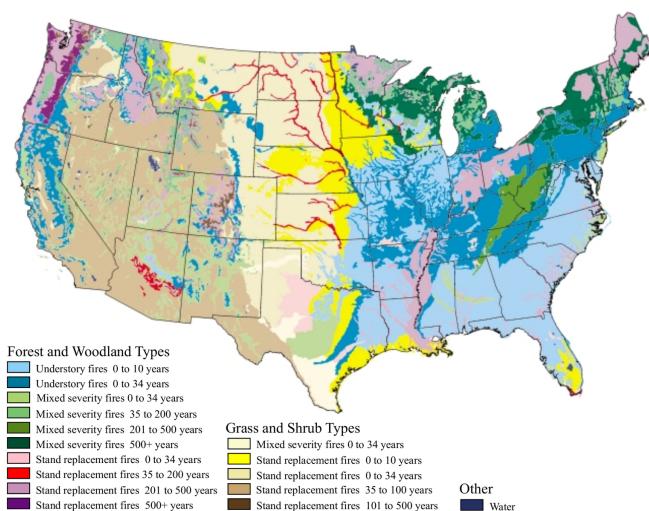
As *Homo* expanded around the globe and encountered naive megafauna, many species of megafauna went **extinct**.

(Broughton et al. 2018)

3 / 45

## Did forager-hunter-gatherers **manage** wildlife?

(aside from driving them to extinction)



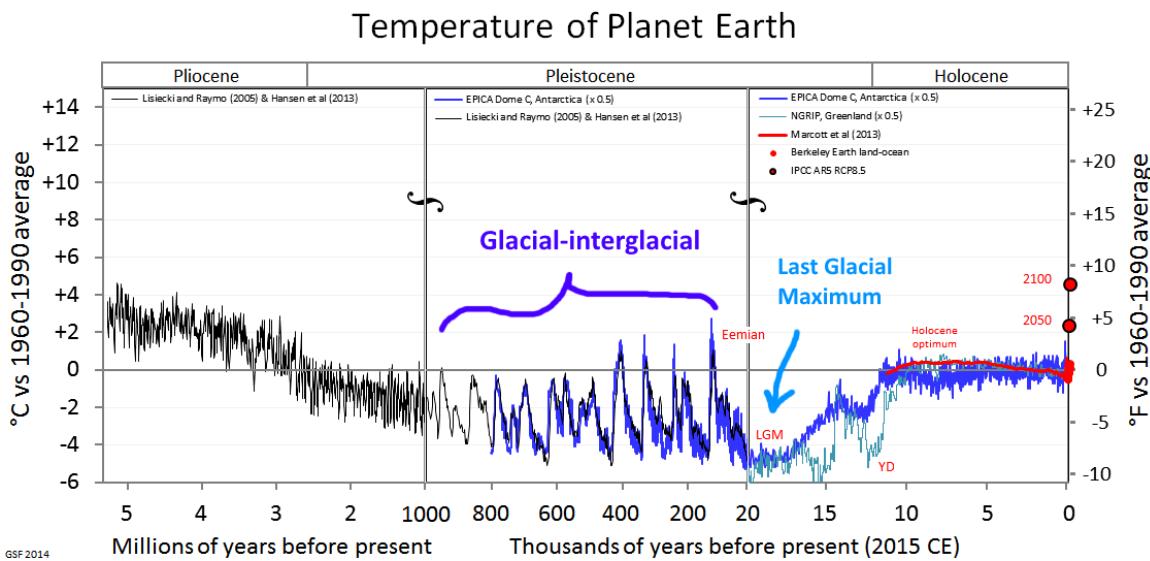
**Controlled (ritual) Fires** were widely used, in (large) part to create suitable habitat for large ungulate prey: deer, bison, elk, etc.

Large parts of the U.S. that is currently forested (or cultivated) was once grassland / savannah.

*Fire Management Today* - 2000 - vol 60. No 3

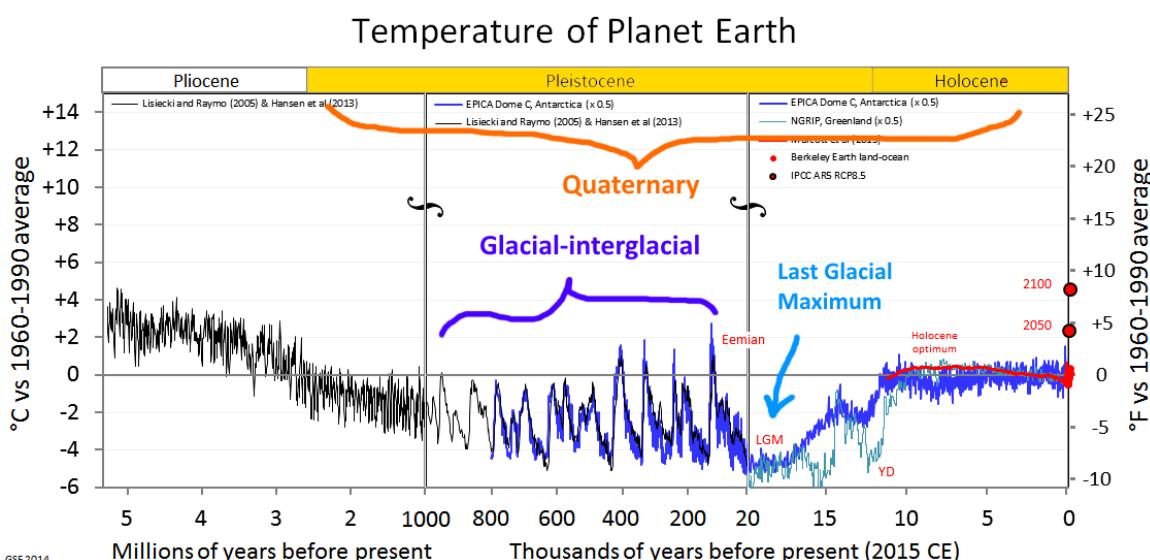
4 / 45

# Pleistocene - Holocene transition 11.6 kya



5 / 45

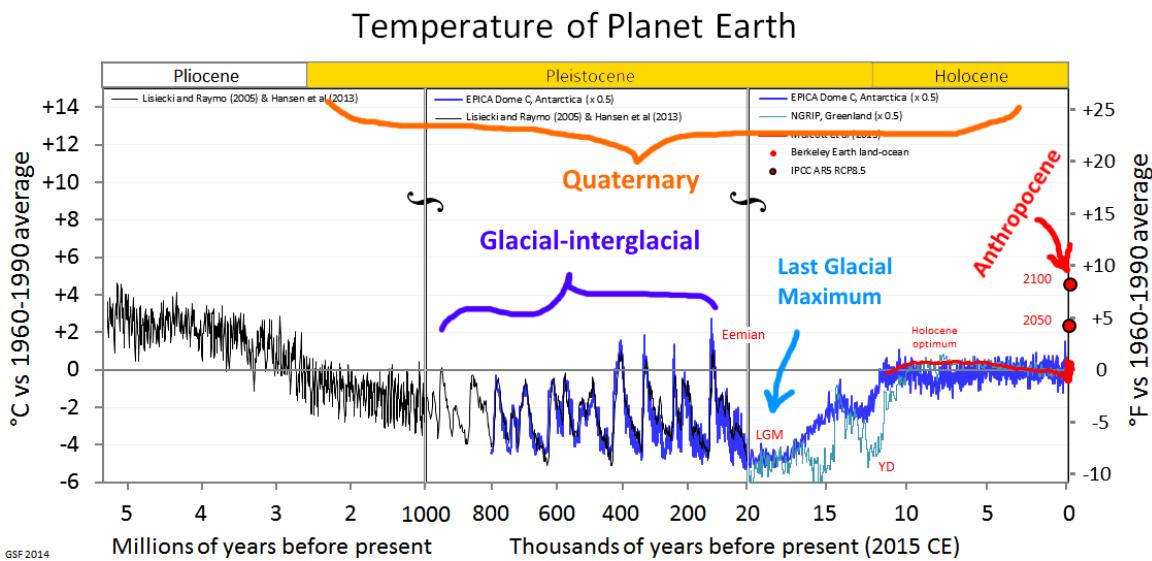
# Pleistocene - Holocene transition 11.6 kya



warm(er)! and stable!

6 / 45

# Holocene to Anthropocene (1950 - ...)

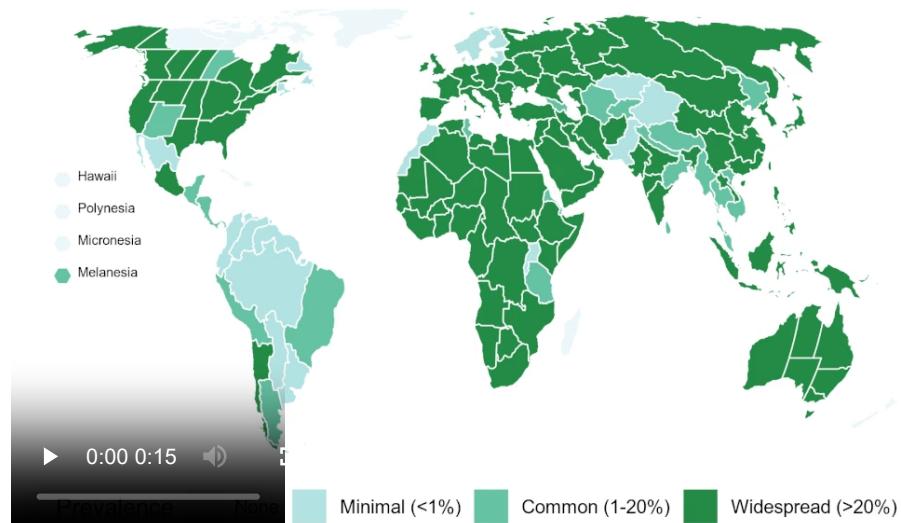


Note - scale and speed of current temperature change

7 / 45

Start of Holocene all humans are foragers

Foraging/Hunting/Gathering  
10000 years ago

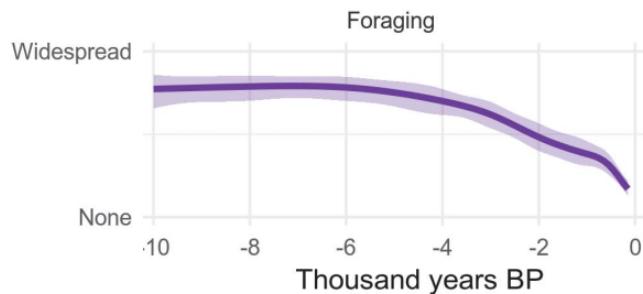


End of Holocene, not so much

8 / 45

# Foraging / hunting / gathering / fishing

Subsistence economies and land-use practices that generally exhibit lower amounts of direct human alteration of ecosystems and control of plant and animal life cycles. (Stephens et al. 2019)

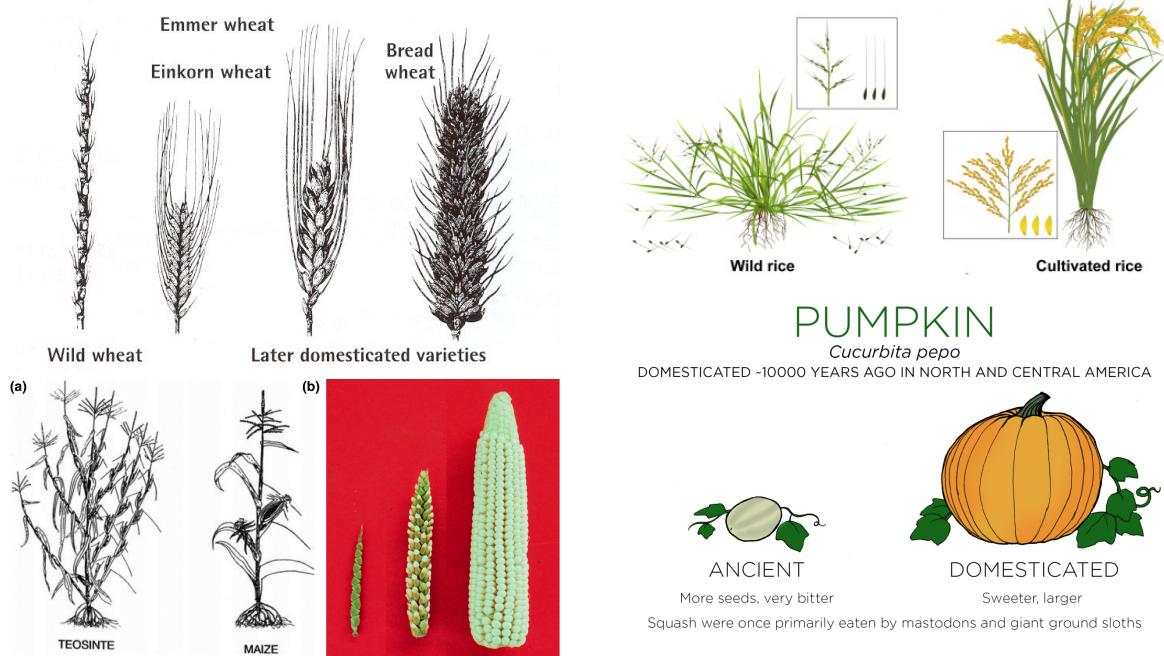


For at least 97% [of our 300,000 year existence] our hunter-gatherer ancestors lived as many other large predators do, in small groups within the confines of local ecosystems (Gowdy 2020)

What happened?

9 / 45

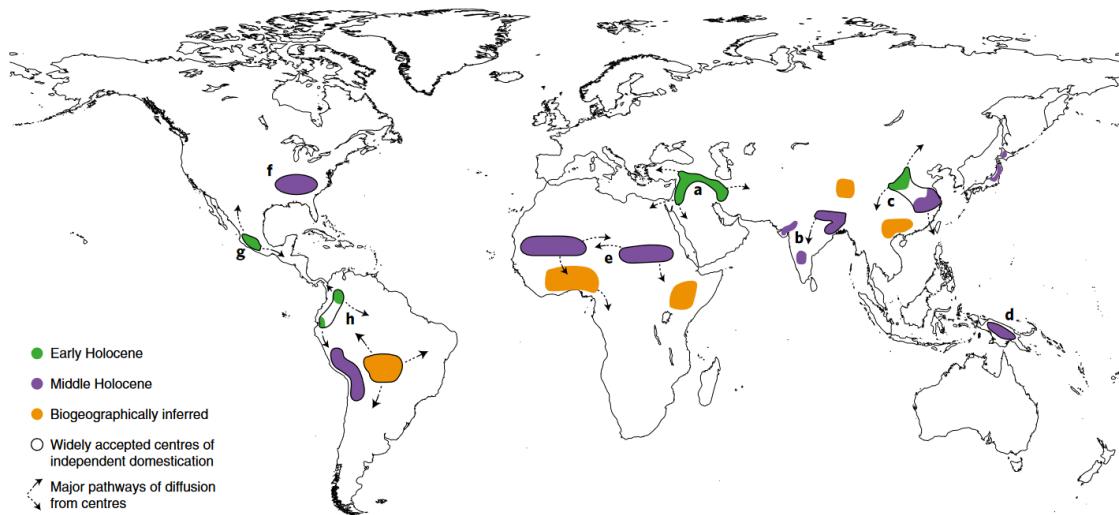
## Neolithic revolution: Agriculture



aka Plant domestication

10 / 45

developed independently in multiple locations...



- a. Southwest Asia (wheat, barley, lentil, pea, chickpea); b. India (rice (indica), millets, mungbean); c. China (broomcorn millet, foxtail millet, rice (japonica), soybean, melon); d. New Guinea (banana, taro, yam); e. Africa (date palm, sorghum, pearl millet, African rice, oil palm); f. Eastern North America (acorn and spaghetti squash, sunflower, sumpweed, goosefoot); g. Mexico (maize, pumpkin squash, common and lima beans, avocado, chilli pepper); h. South America (chilli peppers, peanut, cotton, squashes (butternut and Hubbard), common and lima beans, manioc, sweet potato, white potato, yam, quinoa).

(Kavanagh et al. 2018)

11 / 45

## Why/how did agriculture emerge?

**H1. Surplus hypothesis** - improving environmental conditions, increased resource availability and growing human population densities

**H2. Necessity hypothesis** - worse environmental conditions led to innovation

**H3. Regional uniqueness hypothesis** - distinct, local processes independently drive the different geographic origins of domestication

12 / 45

# Why/how did agriculture emerge?

**H1. Surplus hypothesis -**  
improving environmental conditions, increased resource availability and growing human population densities

Agriculture appears to consistently appear *after* (potential) increase in human densities.

nature  
human behaviour

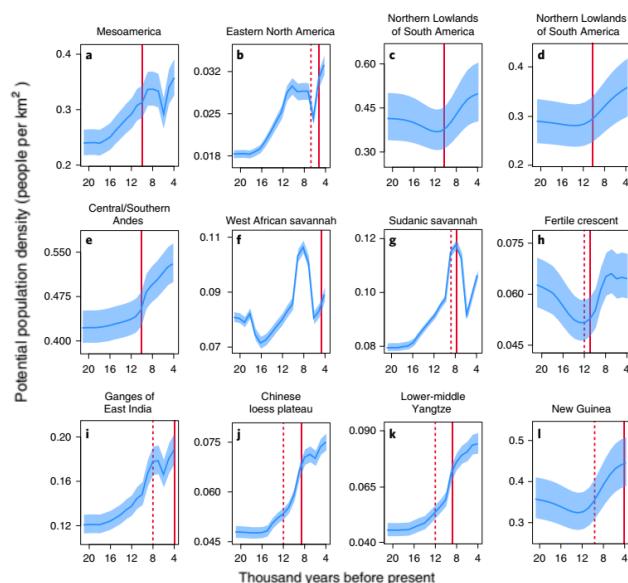
LETTERS

<https://doi.org/10.1038/s41562-018-0038-4>

Hindcasting global population densities reveals forces enabling the origin of agriculture

Patrick H. Kavanagh<sup>1,2\*</sup>, Bruno Vilela<sup>3,4</sup>, Hannah J. Haynie<sup>1</sup>, Ty Tuff<sup>1</sup>, Matheus Lima-Ribeiro<sup>2</sup>, Russell D. Gray<sup>4</sup>, Carlos A. Botero<sup>5</sup> and Michael C. Gavin<sup>1</sup>

Evidence for impact of improved / milder / more stable climate



13 / 45

Kavanagh et al. 2018

## Consequences of agriculture

settlement and aggregation

- cities
- wealth
- food surplus

social hierarchies / complex society / armies / technology

civilization

population EXPLOSION

- ~ 4 million 11,600 kya
- ~ 200 million in 1900 AD
- ~ 7.7 billion in 2020 AD



14 / 45

# Neolithic revolution ... good or bad?

The adoption of agriculture made the average person **worse off for millennia**. Physical health declined dramatically and most of the world's people were born into **rigid caste systems** and lived as **virtual or actual slaves** ...

After agriculture, humans became **shorter and less robust** and they suffered from more **debilitating diseases**, from leprosy to arthritis to tooth decay, than their hunter-gatherer counterparts ... Only in the last 150 years or so has the longevity, health, and well-being of the average person once again reached that of the Upper Pleistocene. The average **human life span in 1900 was about 30 years**, and for **Upper Pleistocene hunter-gatherers it was about 33 years**.

Gowdy 2020

15 / 45

## Consequences for wildlife



Note: **dogs** are our only Pleistocene Pets.

16 / 45

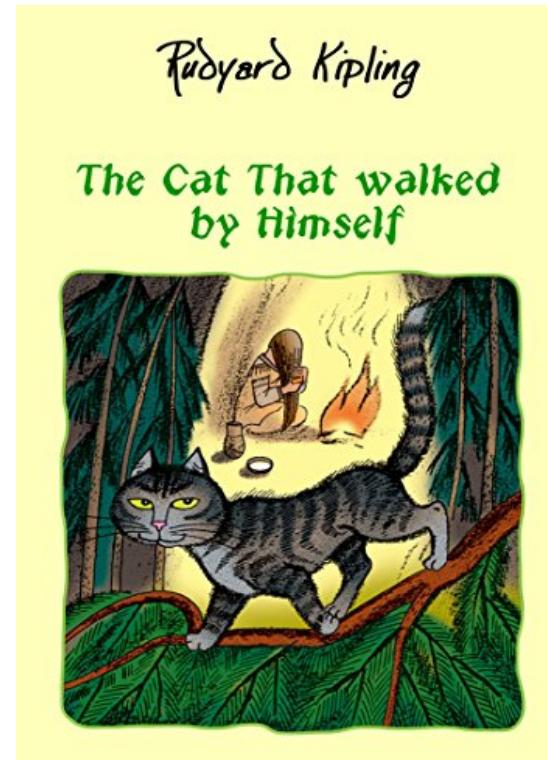
# Three pathways: 1. Commensal domestication

Framework of Melinda Zeder (2012)

Animal hangs out near humans.  
Ends up staying with humans.

## Commensal Domesticates

Dogs (*Canis familiaris*)  
Cats (*Felis catus*)?  
Pig (*Sus scrofa*)?  
Guinea pig (*Cavia porcellus*)  
Golden hamster (*Mesocricetus auratus*)?  
Chicken (*Gallus domesticus*)  
Muscovy duck (*Cairina moschata*)  
Turkey (*Meleagris gallopavo*)



17 / 45

# Three pathways: 2. Prey domestication

- Most major livestock species.
- Humans developed hunting strategies designed to increase prey availability.
- Gradually transformed to **herd management**

## Prey Domesticates

Goat (*Capra hircus*)  
Sheep (*Ovis aries*)  
Cattle (*Bos taurus*)  
Zebu cattle (*Bos indicus*)  
Pig (*Sus scrofa*)?  
Water buffalo (*Bubalus bubalis*)  
Mithan (*Bos frontalis*)?  
Bali cattle (*Bos javanicus*)?  
Yak (*Bos grunniens*)  
Llama (*Lama glama*)  
Alpaca (*Lama pacos*)  
Reindeer (*Rangifer tarandus*)



*Capra aegagrus* (bezoar ibex)

*Capra hircus* (domestic goat)



*Bos primigenius* (aurochs)

*Bos taurus* (domestic taurine bull)



*Capra mouflon* (mouflon)

*Ovis aries* (domestic sheep)



*Vicugna vicugna* (vicuña)

*Lama pacos* (alpaca)

18 / 45

## Three pathways: 3. Directed domestication

- Regenerative (non-prey) secondary animal resources
- Mainly: labor, transport, draft, hides, furs

### Directed Domesticates

Horse (*Equus caballus*)  
Donkey (*Equus asinus*)  
Dromedary (*Camelus dromedarius*)  
Bactrian camel (*Camelus bactrianus*)  
Buffalo (*Bison bison*)  
Ferret (*Mustela furo*)  
Mink (*Mustela vison*)  
Silver fox (*Urocyon cinereoargenteus*)  
Chinchilla (*Chinchilla lanigera*)  
Emu (*Dromaius novaehollandiae*)  
Ostrich (*Struthio camelus*)  
Recent aquatic domesticates

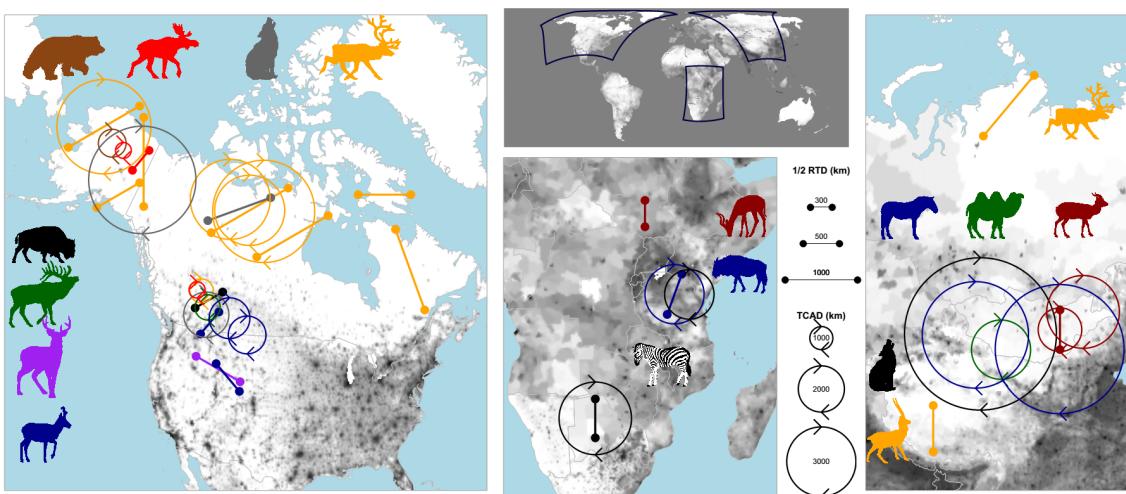
### Bactrian camel



19 / 45

## Brief aside on Bactrian camel

Joly, Gurarie et al. 2020, Longest terrestrial migrations and movements around the world, *Scientific reports*

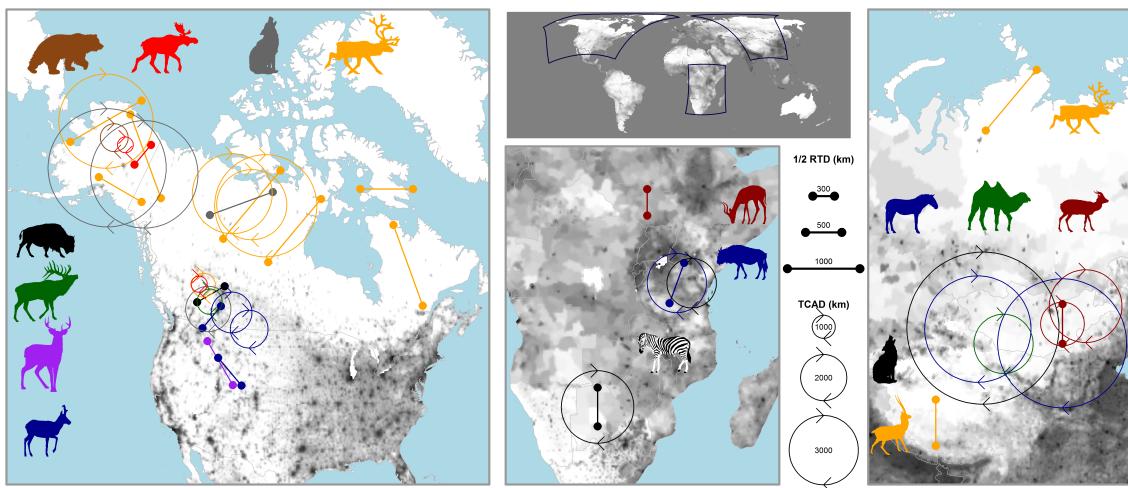


Just one comment is maybe we need to change the camel picture on Fig 1 because this picture looks like domestic camels not look like Wild camels. I have attached here real and beautiful Wild camels photograph and we can use it. - Dr. Adiya Yadamsuren

20 / 45

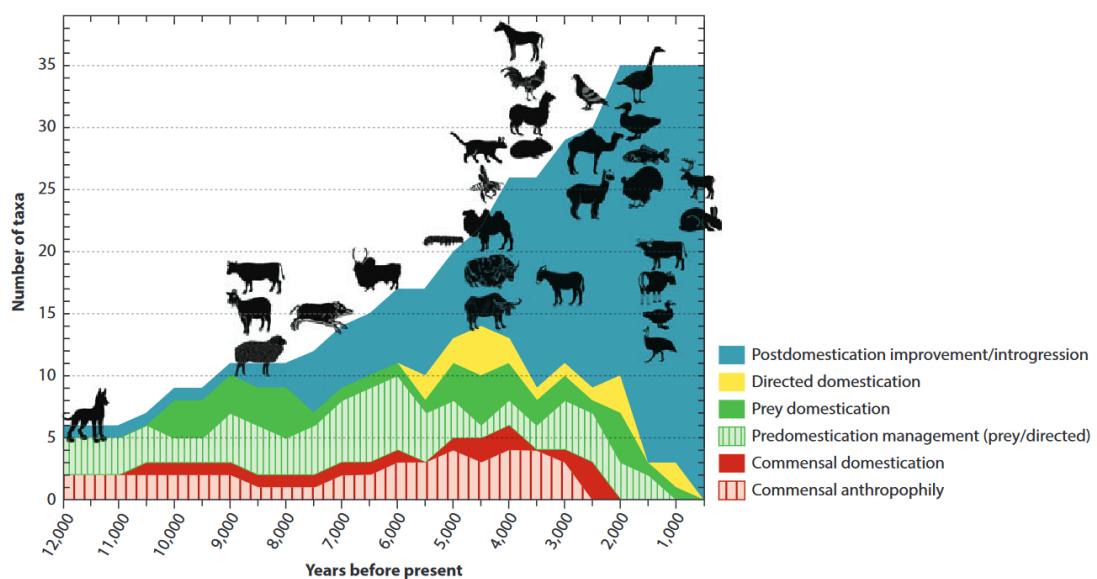
# Bactrian camel fixed!

Joly, Gurarie et al. 2020, Longest terrestrial migrations and movements around the world, *Scientific reports*



21 / 45

## Domestication of wildlife ... selective breeding



Larson and Fuller, 2014

22 / 45

# Domestication: Rise of Pastoralism

**Domesticated animals** released onto **open pastures** for grazing, usually by **nomadic people** who move around with their herds.

**Species:** cattle, camels, goats, yaks, llamas, reindeer, horses and sheep.

**Where:** around the world ... where land is "marginal", i.e. too unpredictable / unproductive for intensive agriculture. Usually **open** and **arid** land.



Thomson Reuters Foundation/Aleksandr Gulyaev  
23/45

## Pastoralism

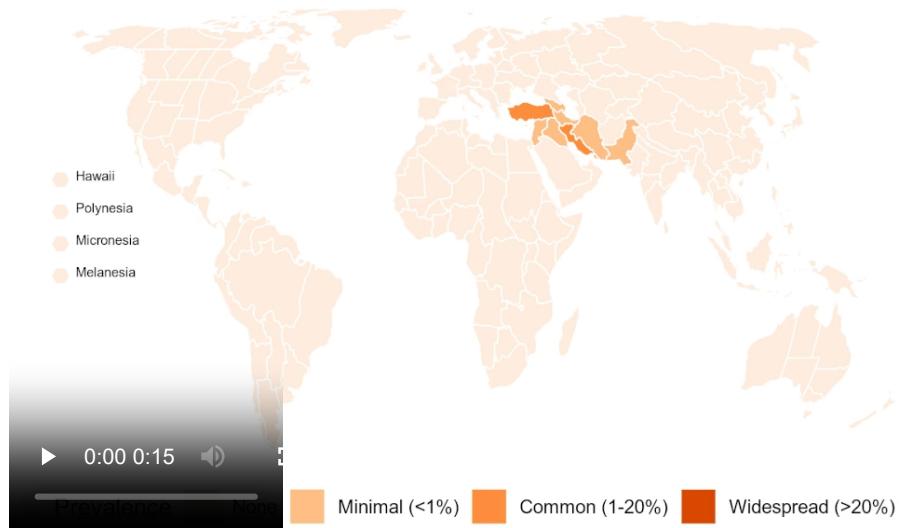
- Occupies ~20%-40% of the world's land surface, 2 billion animals
- Often in conflict with **agricultural / industrial** society
- Debates: is **pastoralism** equilibrium or **non-equilibrium** ecology?
- Debates: is **ranching pastoralism**?



# Pastoralism over time

## Pastoralism

10000 years ago



25 / 45

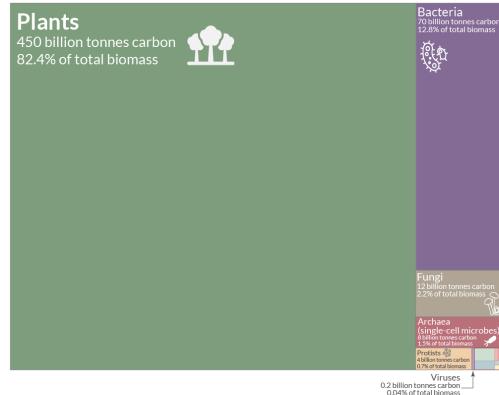
# Global biomass ....

## Life on Earth: the distribution of all global biomass

Biomass is measured in tonnes of carbon. The global distribution of Earth's biomass is shown by group of organism (taxa).

Our World  
in Data

Global biomass: 546 billion tonnes of carbon



Data source: Bar-On, Y.M., Phillips, R., & Milo, R. (2018). The biomass distribution on Earth. *Proceedings of the National Academy of Sciences*. Icons from Noun Project.  
OurWorldInData.org – Research and data to make progress against the world's largest problems.

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Where is the wildlife!?

26 / 45

# Global biomass ....

## Life on Earth: the distribution of all global biomass

Biomass is measured in tonnes of carbon. The global distribution of Earth's biomass is shown by group of organism (taxa).

Our World  
in Data

Global biomass: 546 billion tonnes of carbon

**Plants**  
450 billion tonnes carbon  
82.4% of total biomass



**Animal biomass: 2 billion tonnes of carbon (0.4% of total biomass)**

**Arthropods**  
1 billion tonnes carbon  
42% of animal biomass



**Fish**  
0.7 billion tonnes carbon  
29% of animal biomass



**Annelids**  
0.2 billion tonnes  
8% animal biomass



**Molluscs**  
0.2 billion tonnes  
8% animal biomass



**Humans**  
0.04 billion tonnes carbon  
2.0% of animal biomass  
0.01% of total biomass



**Cnidarians**  
0.1 billion tonnes carbon  
4% of animal biomass



**Livestock**  
0.1 billion tonnes carbon  
4% of animal biomass



**Wild mammals**  
0.007 billion tonnes carbon  
0.3% of animal biomass



**Wild birds**  
0.002 billion tonnes carbon  
0.08% of animal biomass



**Nematodes**  
0.02 billion tonnes carbon  
0.8% of animal biomass

Data source: Bar-On, Y. M., Phillips, R., & Milo, R. (2018). The biomass distribution on Earth. *Proceedings of the National Academy of Sciences*. Icons from Noun Project.

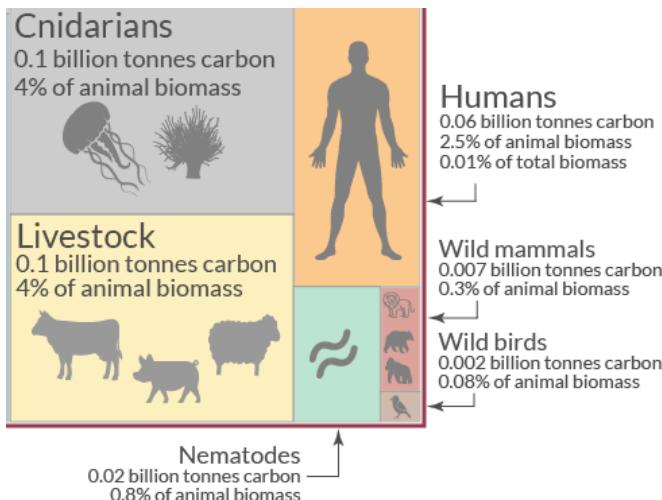
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Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

## Where are the animals!?

27 / 45

## Domesticated vs. wildlife vs. humans



**1 x Livestock =**

**1.6 x Humans =**

**14 x Wild Mammals =**

**50 x Wild birds**

Who really inherits the Earth?

Is wildlife important to **global ecology**?

(Bar-On et al. 2018)

28 / 45

# Consequence for wildlife

In settled, structured, agricultural societies - **hunting** becomes optional.

Transforms from **existential entwined essential experience** to .... *sport* (mainly for *elites*).

Often closely linked to **military** training.



*Egyptian nobleman hunting fowl in marshes (1350 BCE)*

29 / 45

## This cuts across cultures



*Livre de la Chasse* (France, 1327)



Qing dynasty China

30 / 45

# Early example of management

**Genghis Khan (1180? - 1227)** - an early 'father' of wildlife management.

Established wildlife protected areas and hunting season (winter) and restrictions



painting: Vadim Gorbato

**Grandson Kublai Khan (1215-1294)**

assigned keepers of the forest to plant food plots of millet and other favored foods for partridges and quail and provided feeding stations.

Guaranteed abundant game for 3-month annual court hunt.

31 / 45



32 / 45

# In (feudal) Europe

Wild-lands were rapidly cultivated and developed.

Feudal system preserved remaining wilderness as strictly **property of the king**, with especial claim on "higher game", esp. **deer, boar**.

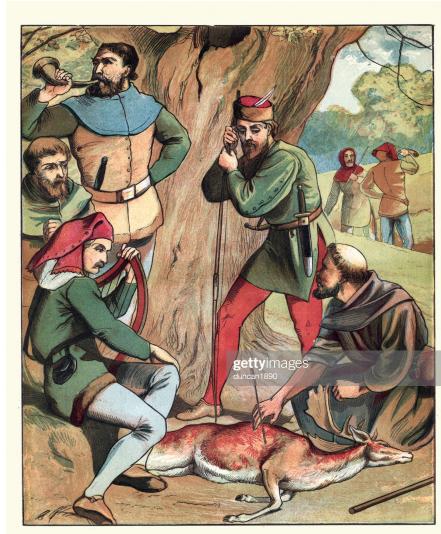
**Poaching** strongly deterred (hanging / blinding / maiming / etc.)

This conflicted with common-use of land, though small game (rabbit snaring, bird netting) remained legal.

**Game Laws of England** (~1400) made wealth was a **legal prerequisite** to hunt.

Motivated several peasant rebellions.

## Robin Hood



*Understandable strong appeal of rebel commoner myth.*

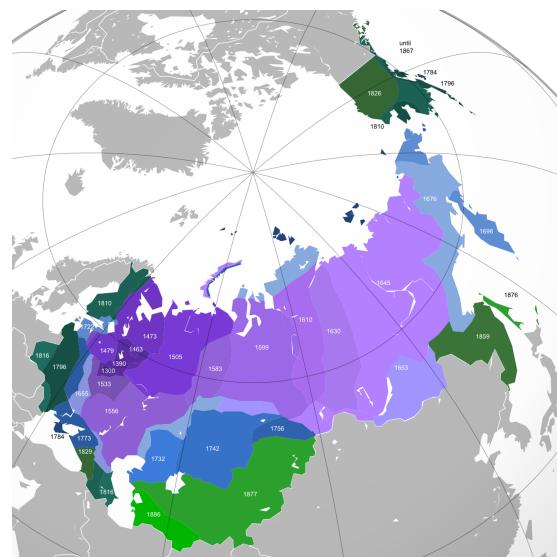
33 / 45

## Wildlife as globally traded commodity

Export of **furs** almost entirely funded the rise, wealth and expansion of **Russian Empire** across Siberia and into Alaska (1300-1850).

**Key species:** Beaver, mink, sable, fox, squirrel.

**Expansion to N. America:** Pursuit of sea otters and fur seals

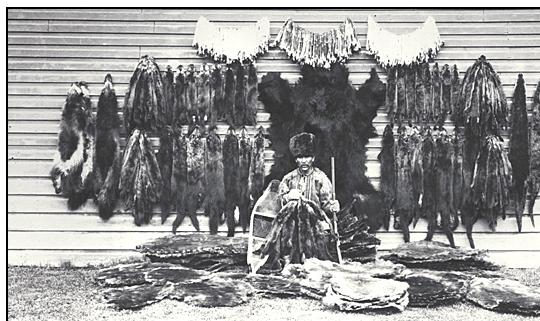


34 / 45

# Wildlife as globally traded commodity

Fur trade drove expansion and colonization across North America, especially Canada.

British, French, Dutch, Spanish traders traded in furs **heavily** with Indigenous people of North America, fought **wars** over fur resources and land.



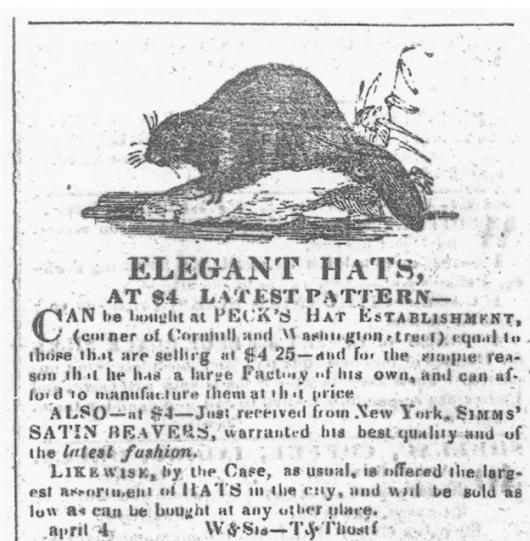
Canadian fur-trader

35 / 45

## ... especially beaver.

*A continent was explored, an indigenous race of people degraded and its culture crushed, and many people died - in part because beaver fur produced better felt than any other fur hat.*

Taber and Payne, 2003



from Boston Commercial Gazette, April 5, 1832

36 / 45

# Beaver Wars (1609–1701) [Tsianì kayonkwere]

What Were The Beaver Wars?



After **beaver** crashes (because silk, and scarcity) in 1840 top fur by value in US is **raccoon** followed by **muskrat**.

37 / 45

Commodities tend to get over-exploited

## Industrial whaling

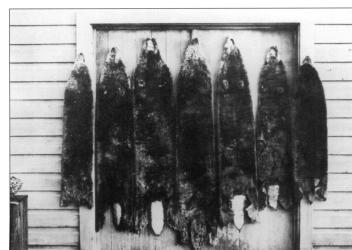
(in contrast to subsistence whaling)

Nearly drove many (most) large whale species to extinction.



## Maritime fur trade

Especially **fur seals** and **sea otters**



38 / 45



39 / 45

## Age of over-exploitation (1850-1899)

### N.A. extinctions

- Great Auk (1852)
- Sea mink (1852)
- Eastern elk (1867)
- Passenger Pigeon (1914)
- Carolina Parakeet (1917)

### Some major depletions

- Bison
- White-tailed deer
- Grizzly bears
- Wolves
- Mountain lions

40 / 45

# 20th century developments

## changes in attitudes

- Conservation Ethos (Theodore Roosevelt & friends)
- Land Ethic (Aldo Leopold)
- Game Management Science
- Environmental movement
- Legal frameworks for conservation and protection
- Rise of North American Model of Wildlife Management
- Recovery of many species

## but also certainly

- Rapid climate change
- Biodiversity crises
- Population growth
- More extinctions
- Human-wildlife conflicts
- Global perspectives

Rise (in a short period) of the science of **Wildlife Ecology, Conservation Biology**. Technological and analytical tools and theoretical frameworks.

41 / 45

# 21st century questions

Will we be remembered as the **Era of Conservation Science** or the **Era of Extinction?**

What's the role of **Science**?

What's the role of **Management**?

What's the role of **Traditional Knowledge**?

42 / 45

# Summaries (11,500 - 100 ya)

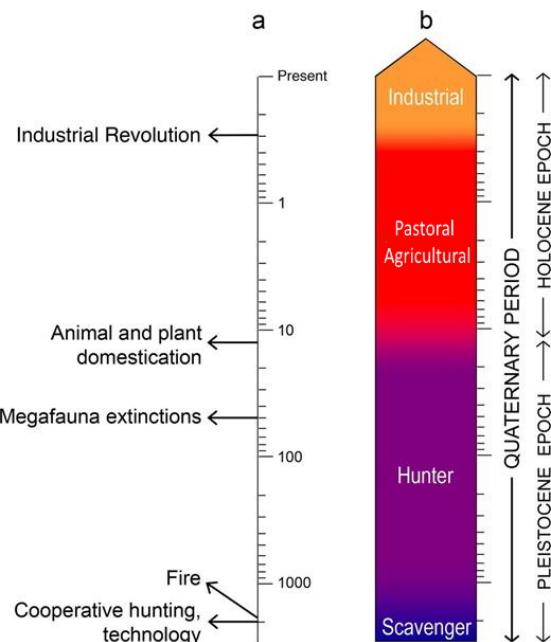
The **Holocene** has been warm and extraordinarily stable.

Allowed for **domestication** of plants and animals.

New modes of subsistence: **agriculture** and **pastoralism**.

**Wildlife** - basically - suffered from:

- competition with livestock
- competition with agriculture
- habitat loss
- decrease in **human** value
- increase in **commercial** value



43 / 45

## Back to the deep past future

Without climate stability ... it is unlikely that agriculture will be possible in the 21st century and beyond. Civilization will either collapse or gradually disappear over the coming centuries...

In the long run, the vision of **returning to a hunting and gathering way of life is wildly optimistic** ... Every characteristic that defines us as a species — compassion for unrelated others, intelligence, foresight and curiosity — evolved in the Pleistocene. **We became human as hunters and gatherers and we can regain our humanity when we return to that way of life.**



Essays

Futures  
journal homepage: [www.elsevier.com/locate/futures](http://www.elsevier.com/locate/futures)

Our hunter-gatherer future: Climate change, agriculture and uncivilization\*

ELSEVIER

John Gowdy\* Professor of Economics Emeritus, Rensselaer Polytechnic Institute, Troy, NY, USA



44 / 45

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