

# Ecological Compensation Is Necessary To Avoid The Sixth Mass Extinction

Anthony D. Barnosky  
Stanford University  
Jasper Ridge Biological Preserve  
[@tonybarnosky](#)



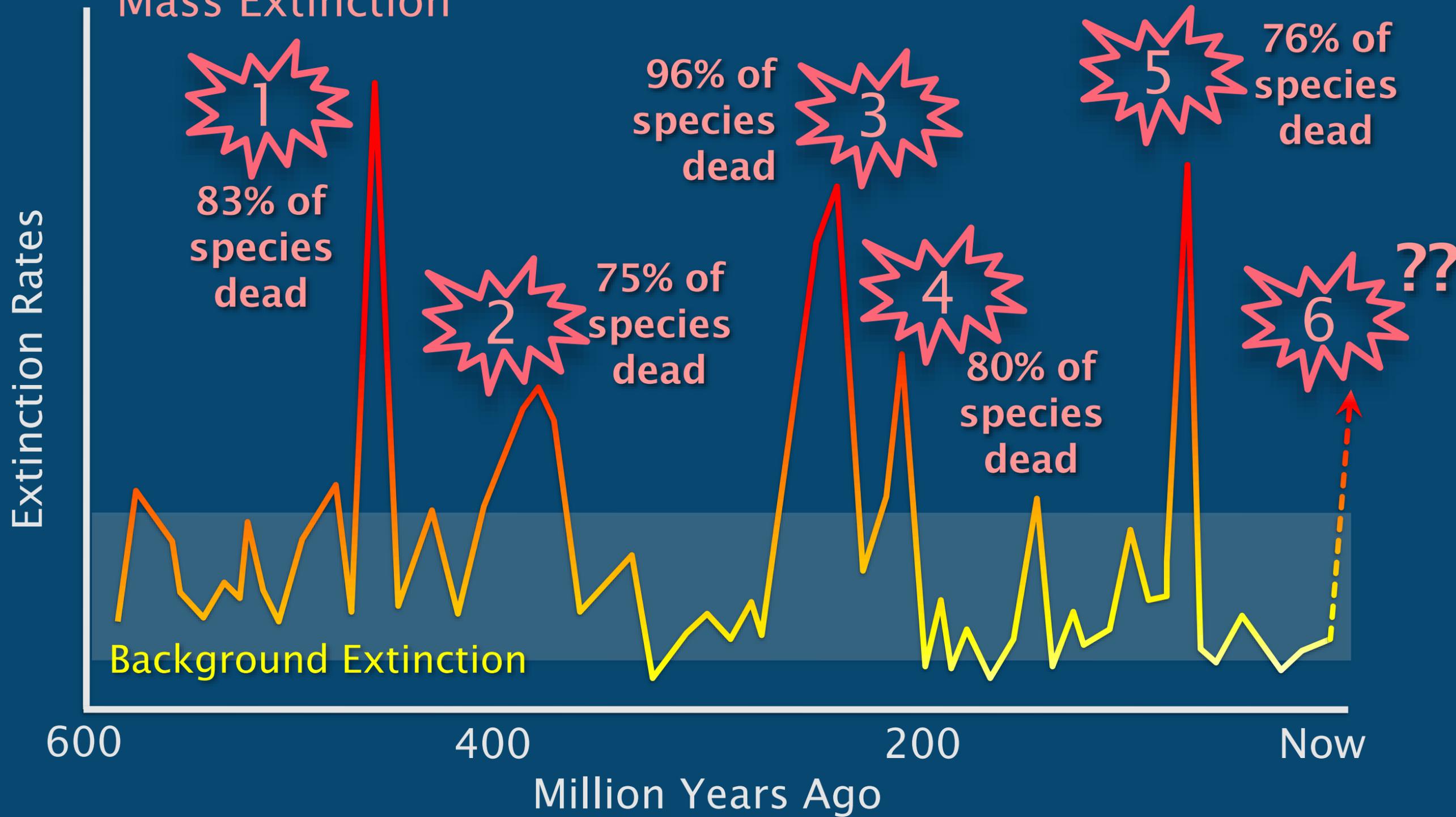
# We are killing species fast



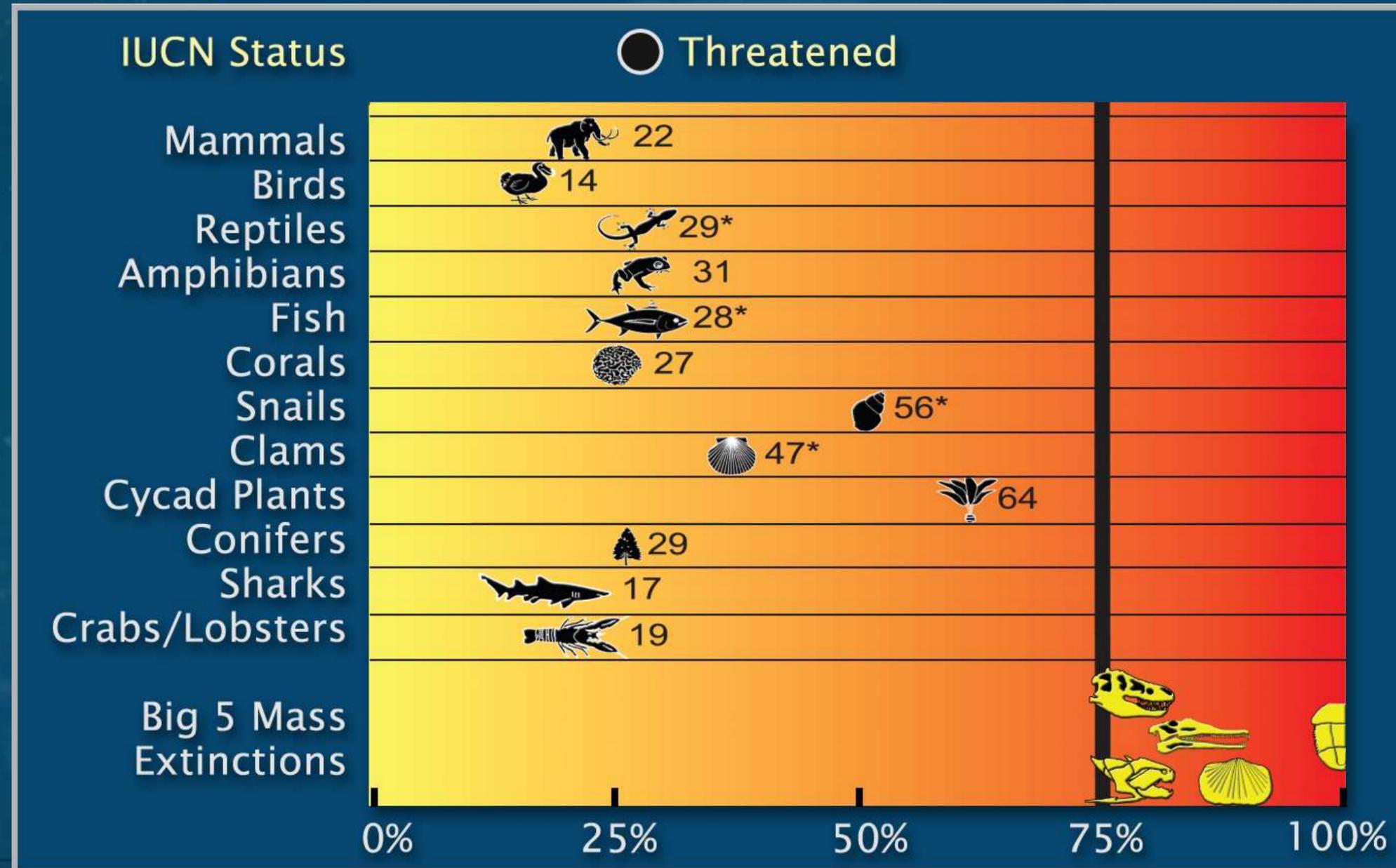
- Wiped out 50% of world's wildlife in the last 40 years
- >25,000 species known to be at risk



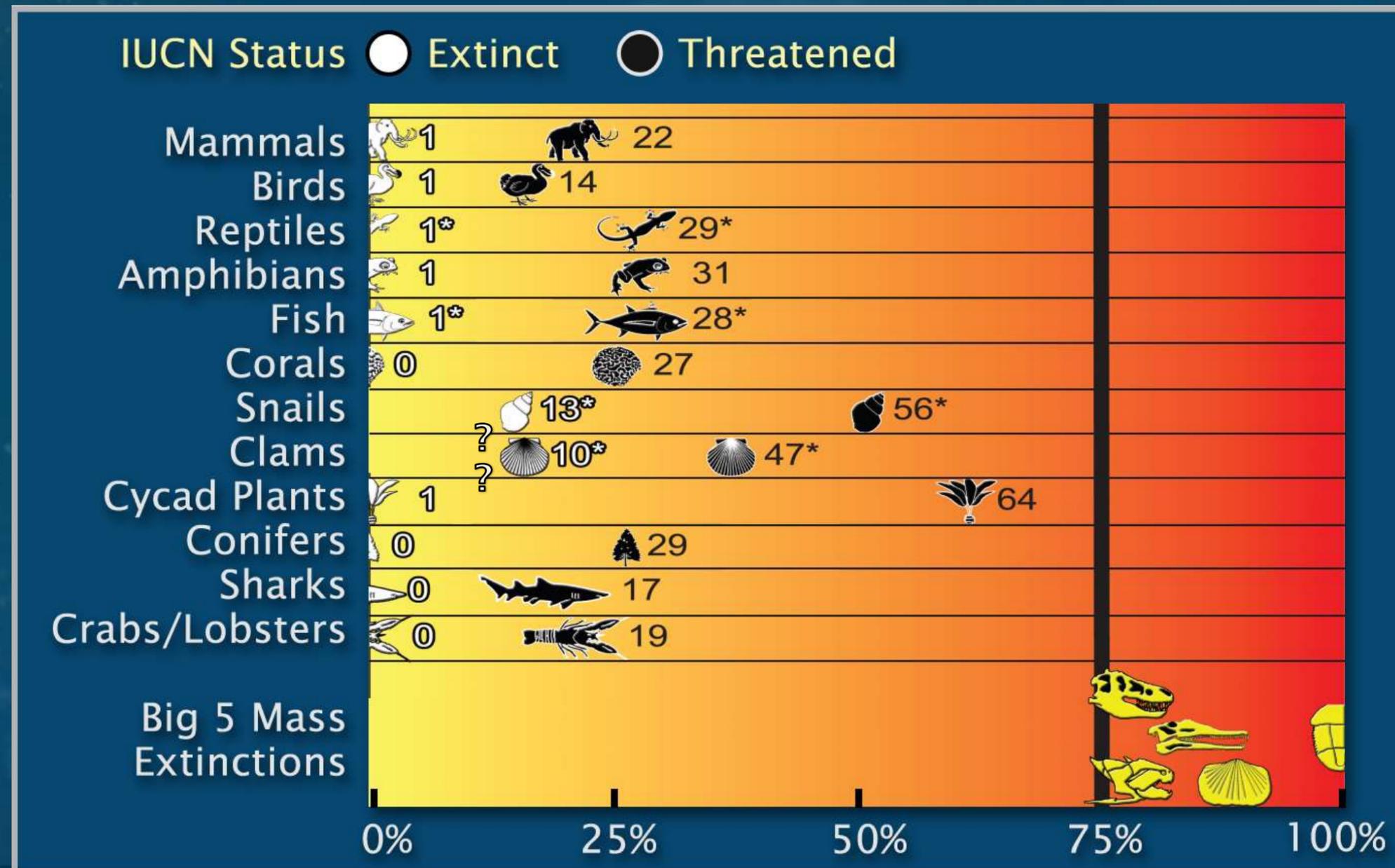
# Mass Extinction



# Mass extinction plausible within 2 to 3 human lifetimes



# Good news: Very few species actually extinct

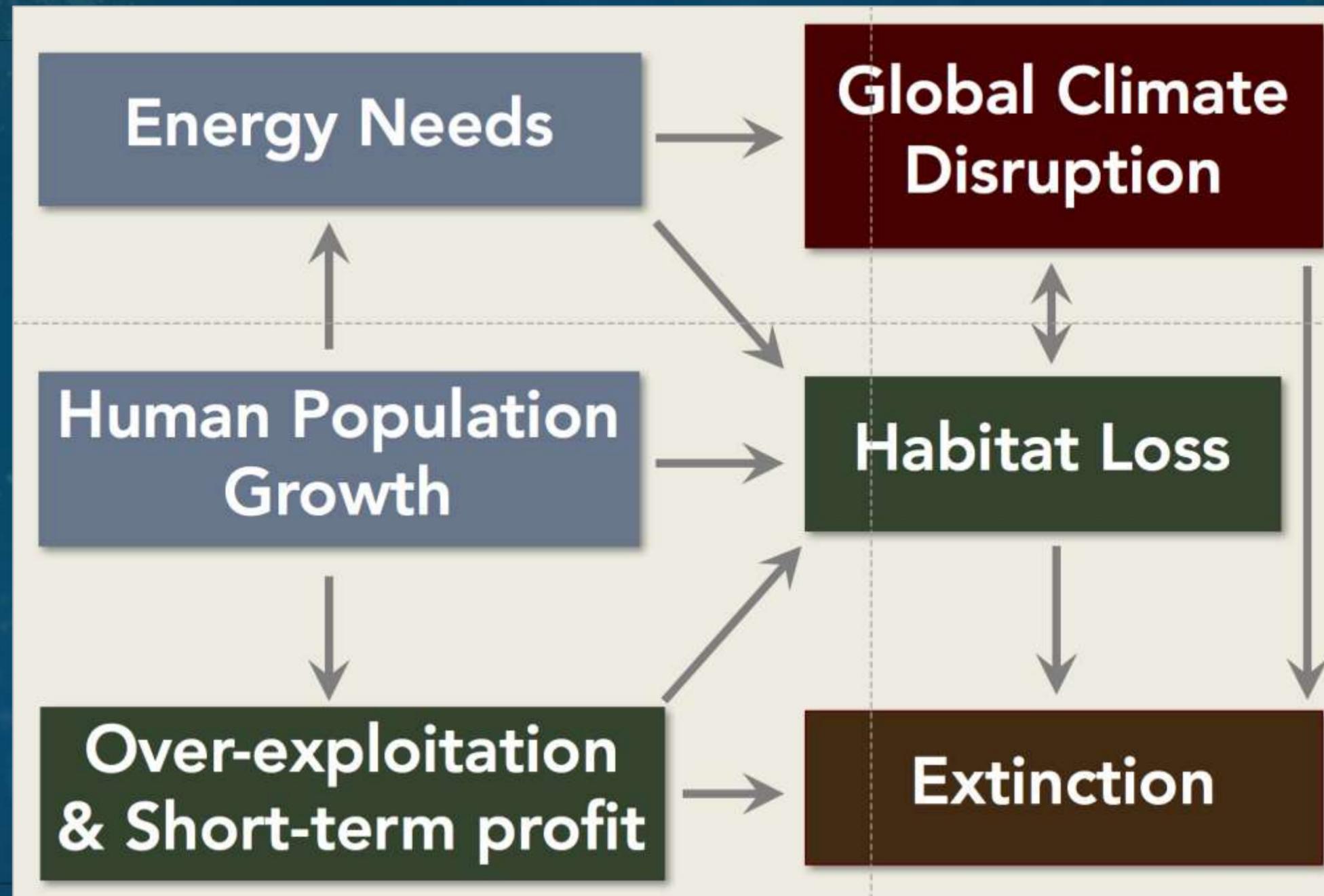


# Some success stories

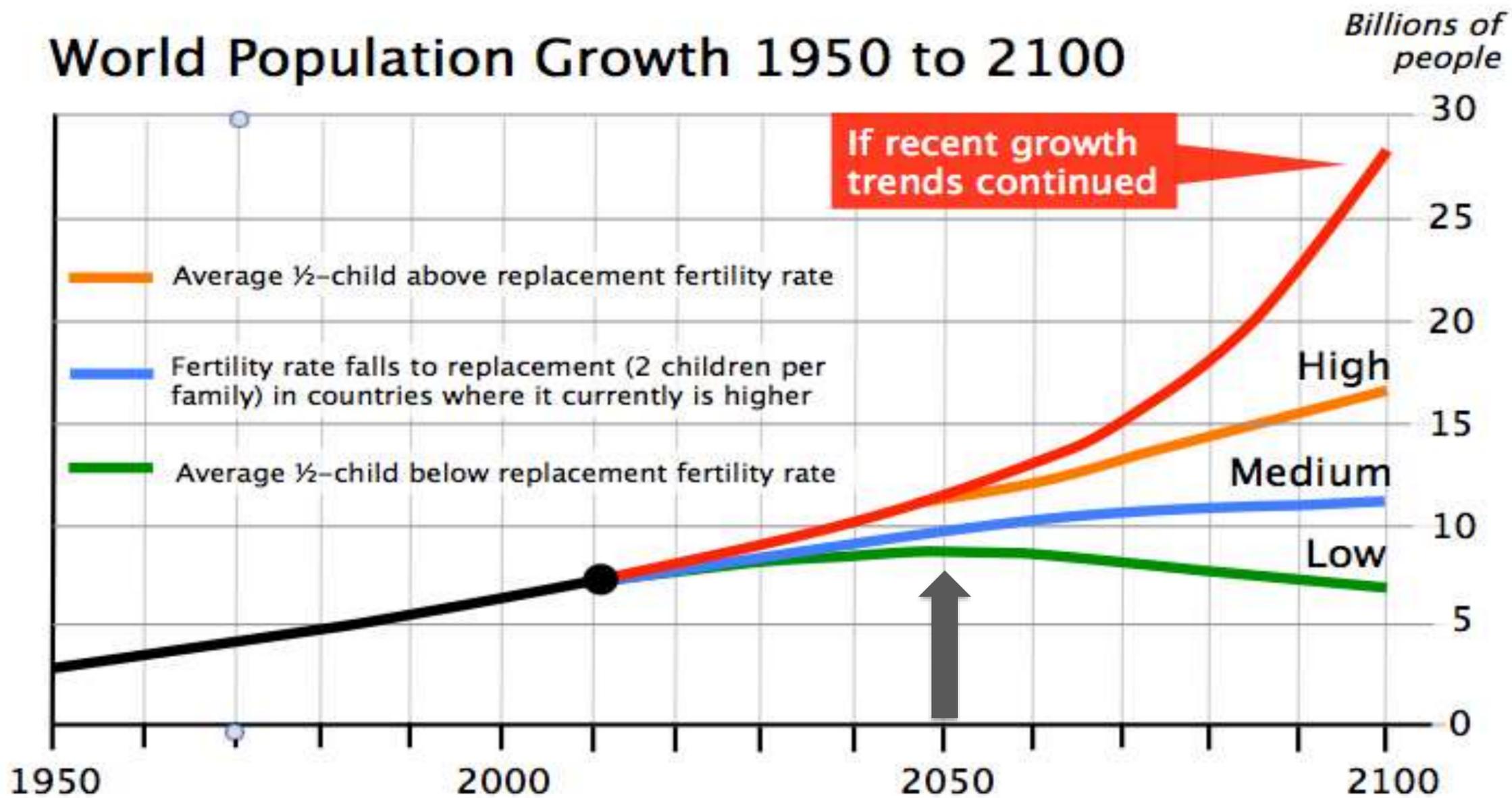
## Galapagos Tortoise



# Need to address the root causes of extinction

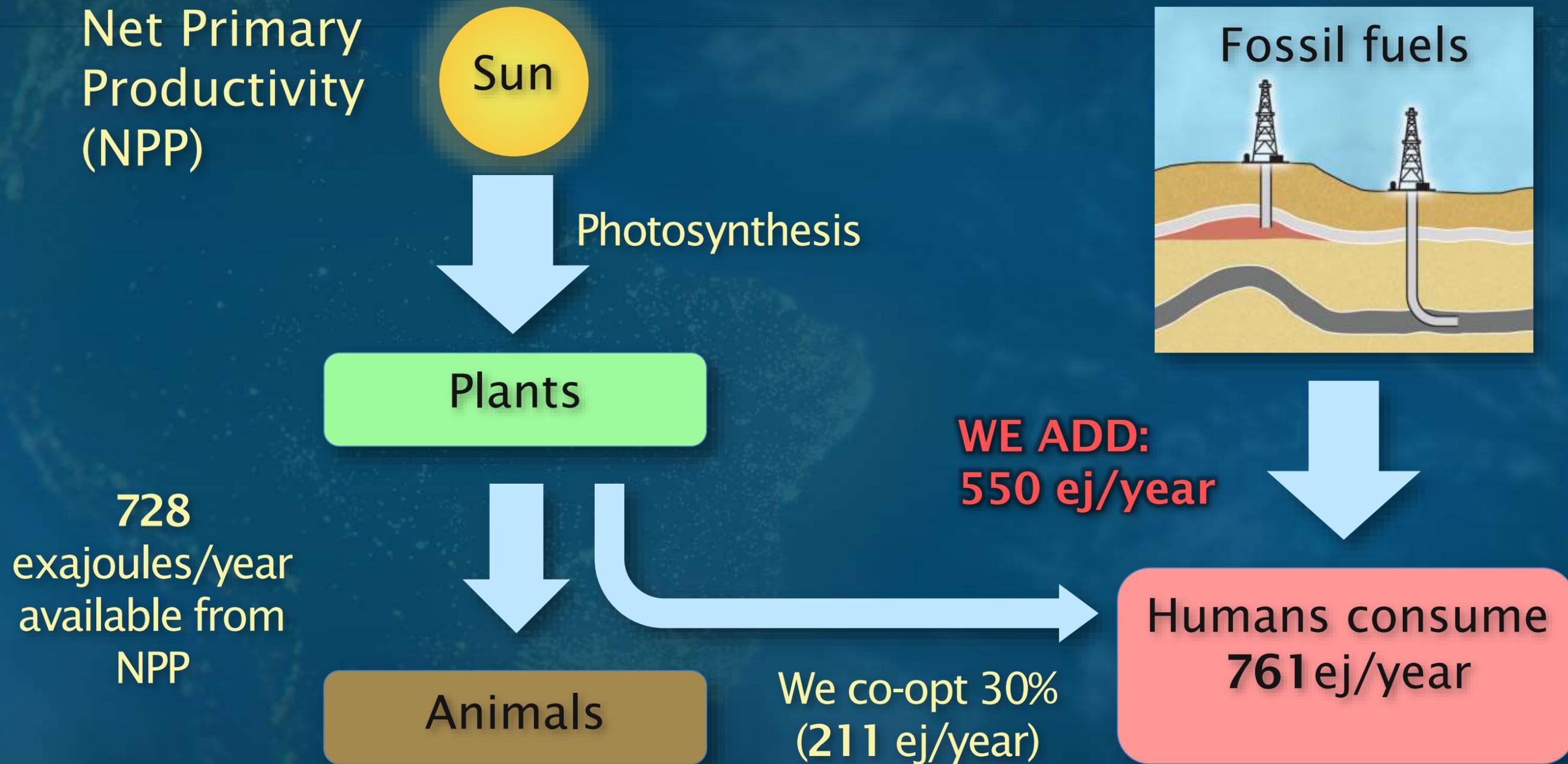


# World Population Growth 1950 to 2100

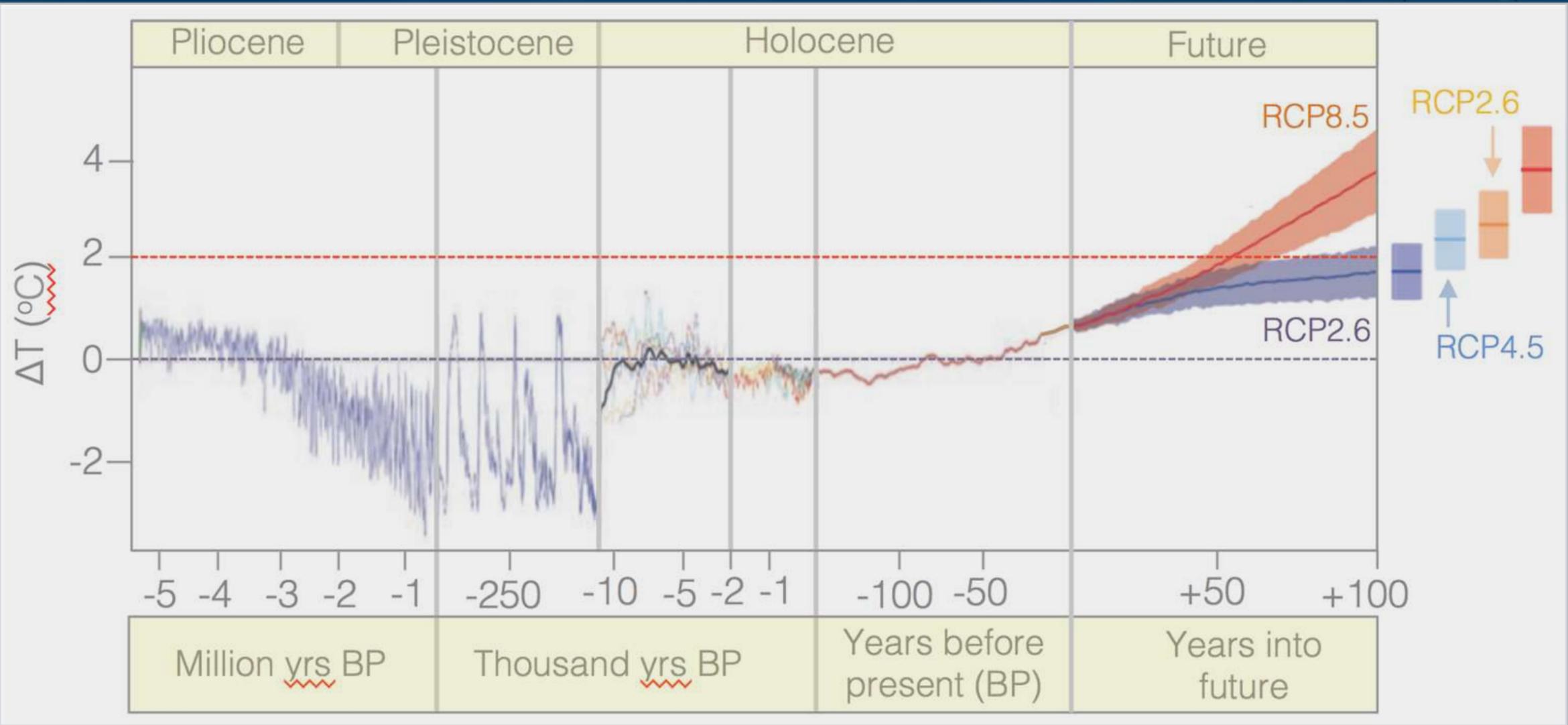


Data and projections from Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat

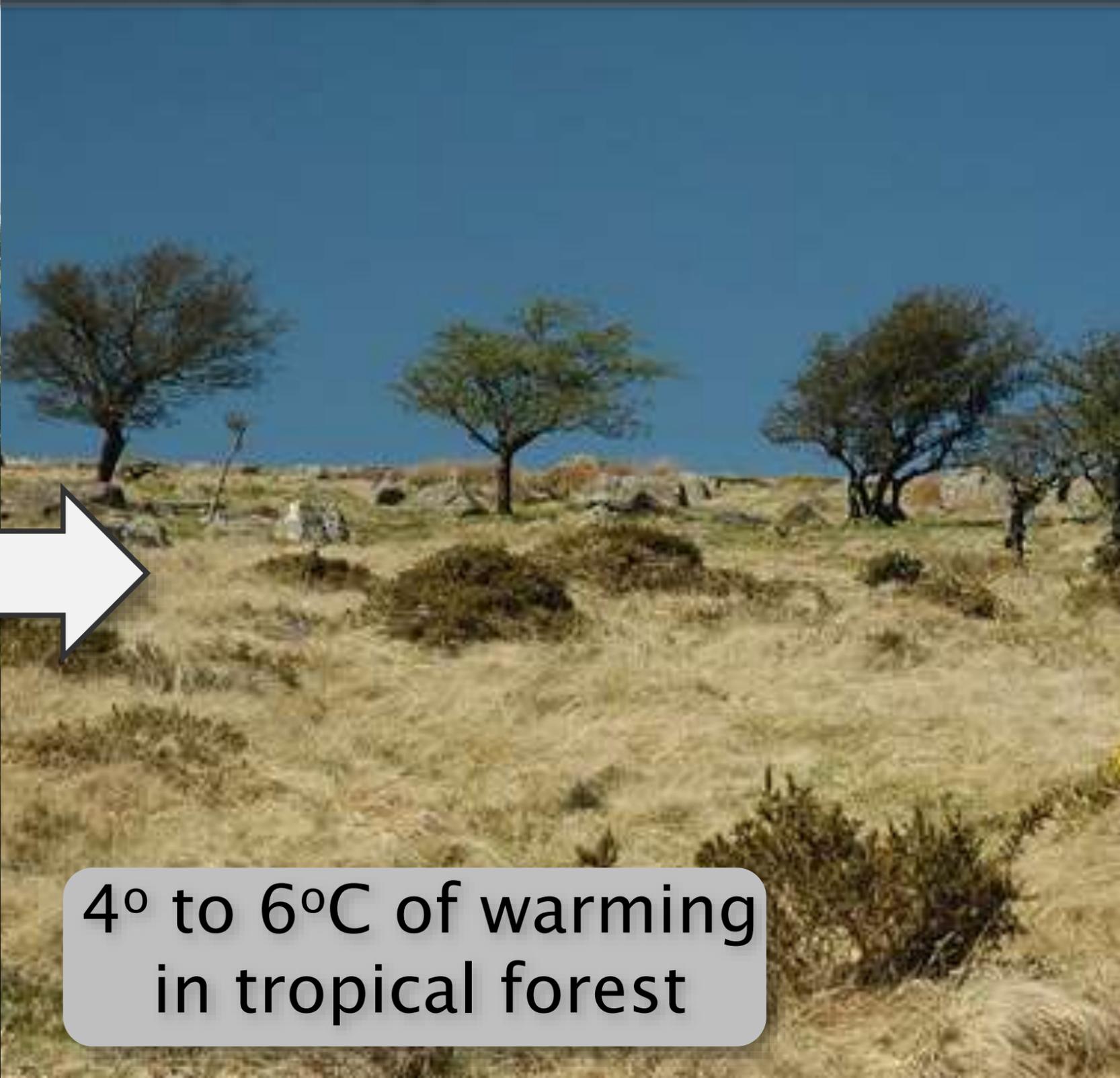
# We have to produce lots of energy



# Greenhouse gases heating up the planet at warp speed



How much would continuing current greenhouse warming change landscapes by 2100?



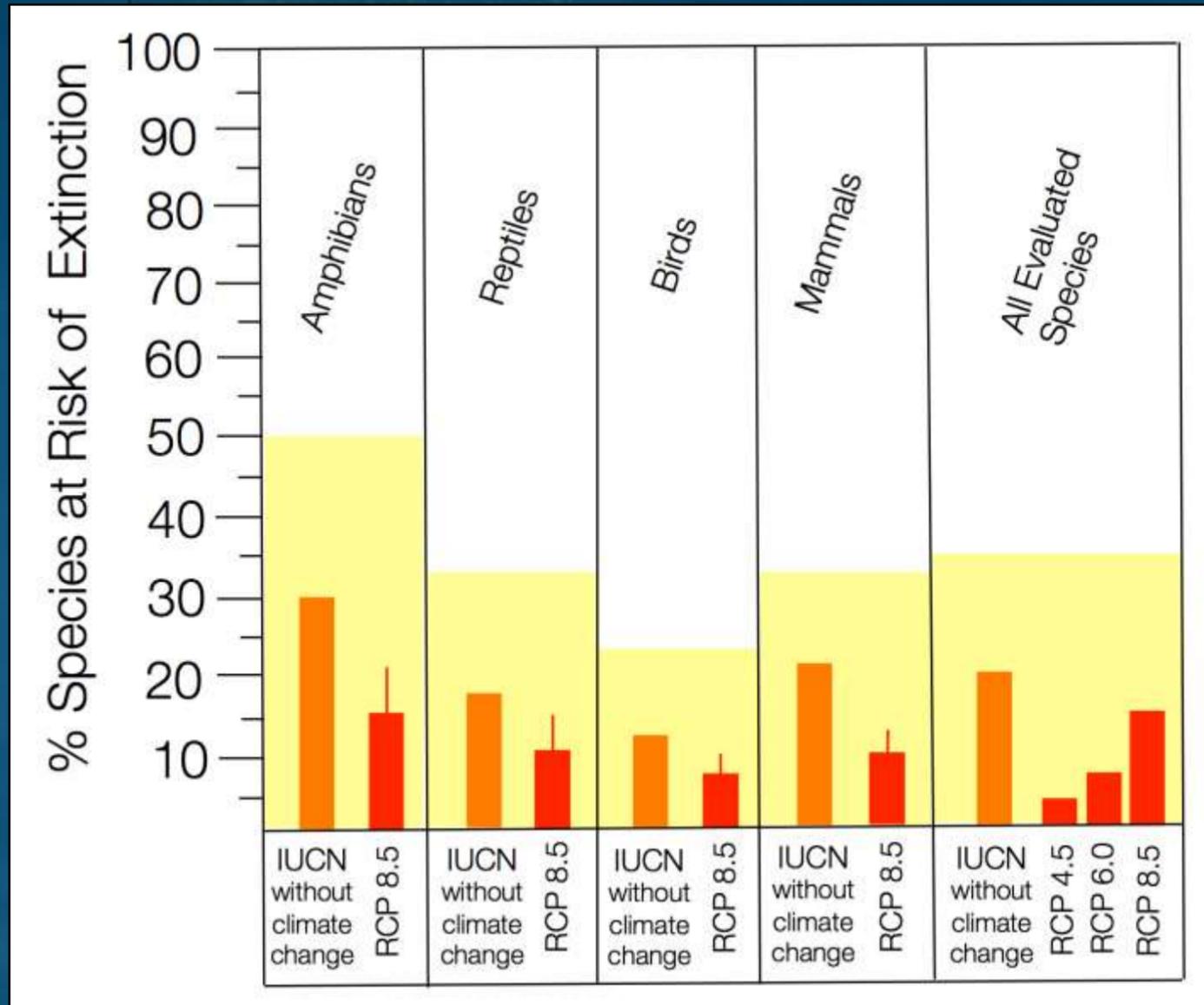
4° to 6°C of warming  
in tropical forest

# Ocean acidification

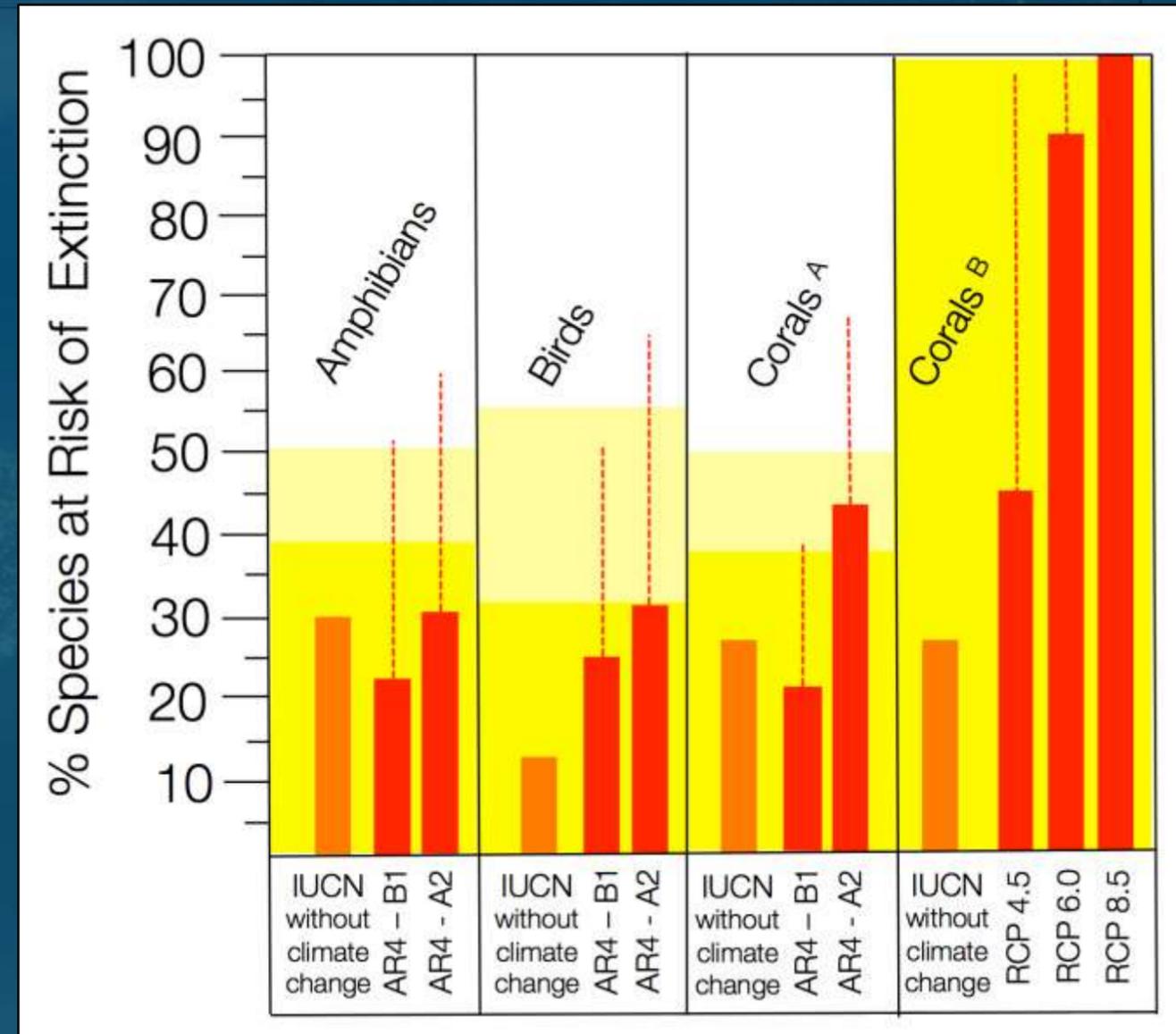
By 2070



# Quantifying increased risk of extinction due to climate change

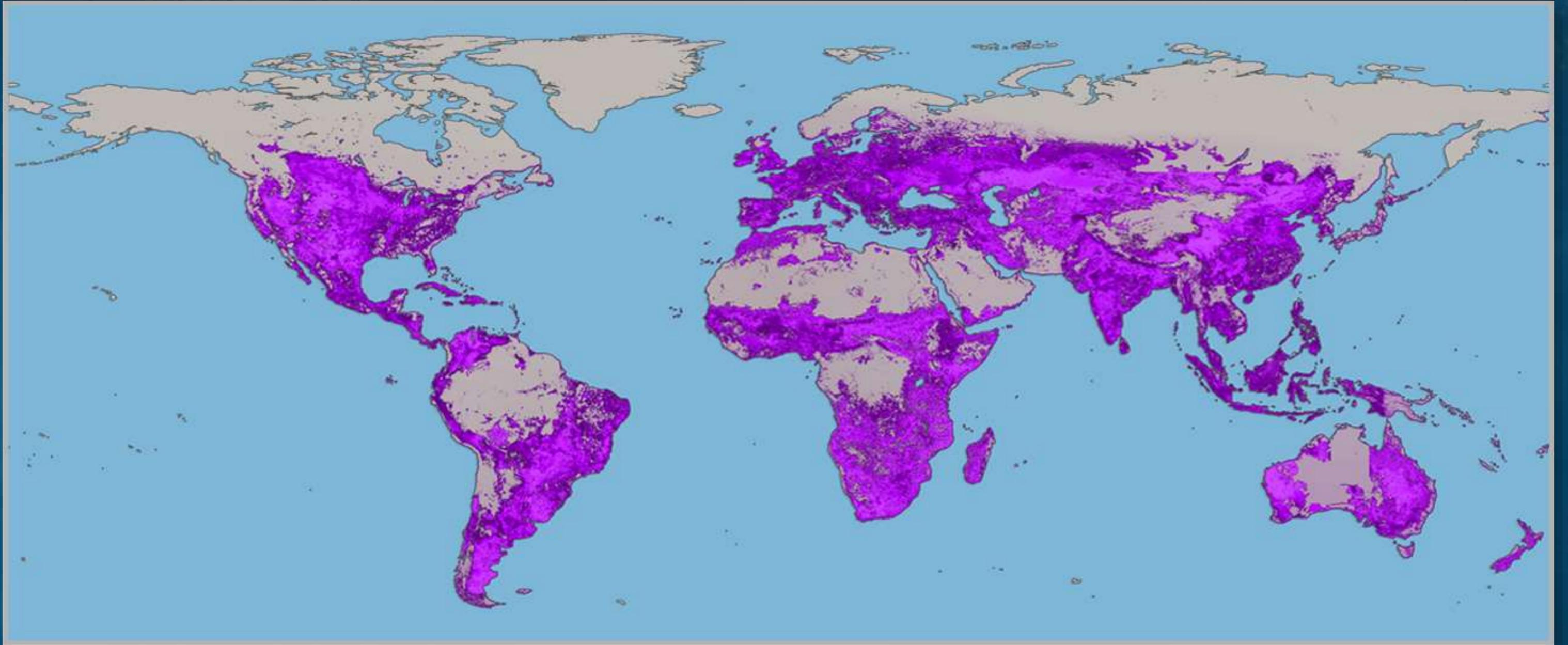


Urban 2015, Science 348 :571 – 573



Foden et al. 2013, PLOS ONE; Ricke et al. 2013, Environ. Res. Lett. 8

# Habitat loss



~ 51 % of land area has been converted for humans

# Over-exploitation

## Agriculture



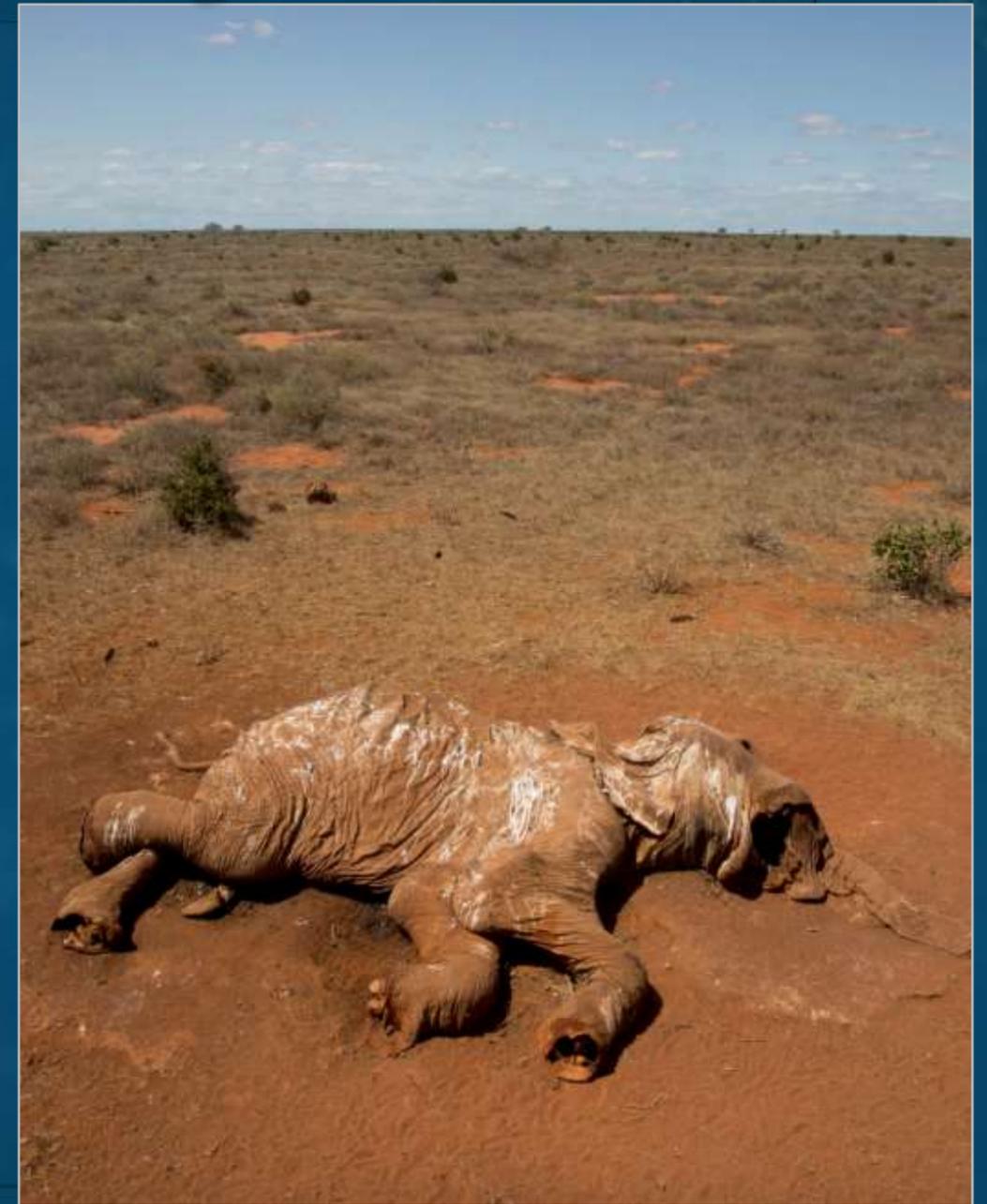
<https://s-media-cache-ak0.pinimg.com/736x/ed/5c/14/ed5c14bb46f7fb4e79f0887abd0ba039.jpg>

## Deforestation



[https://steven.doig.com.au/files/2013/06/15-forest-types\\_1200.jpg](https://steven.doig.com.au/files/2013/06/15-forest-types_1200.jpg)

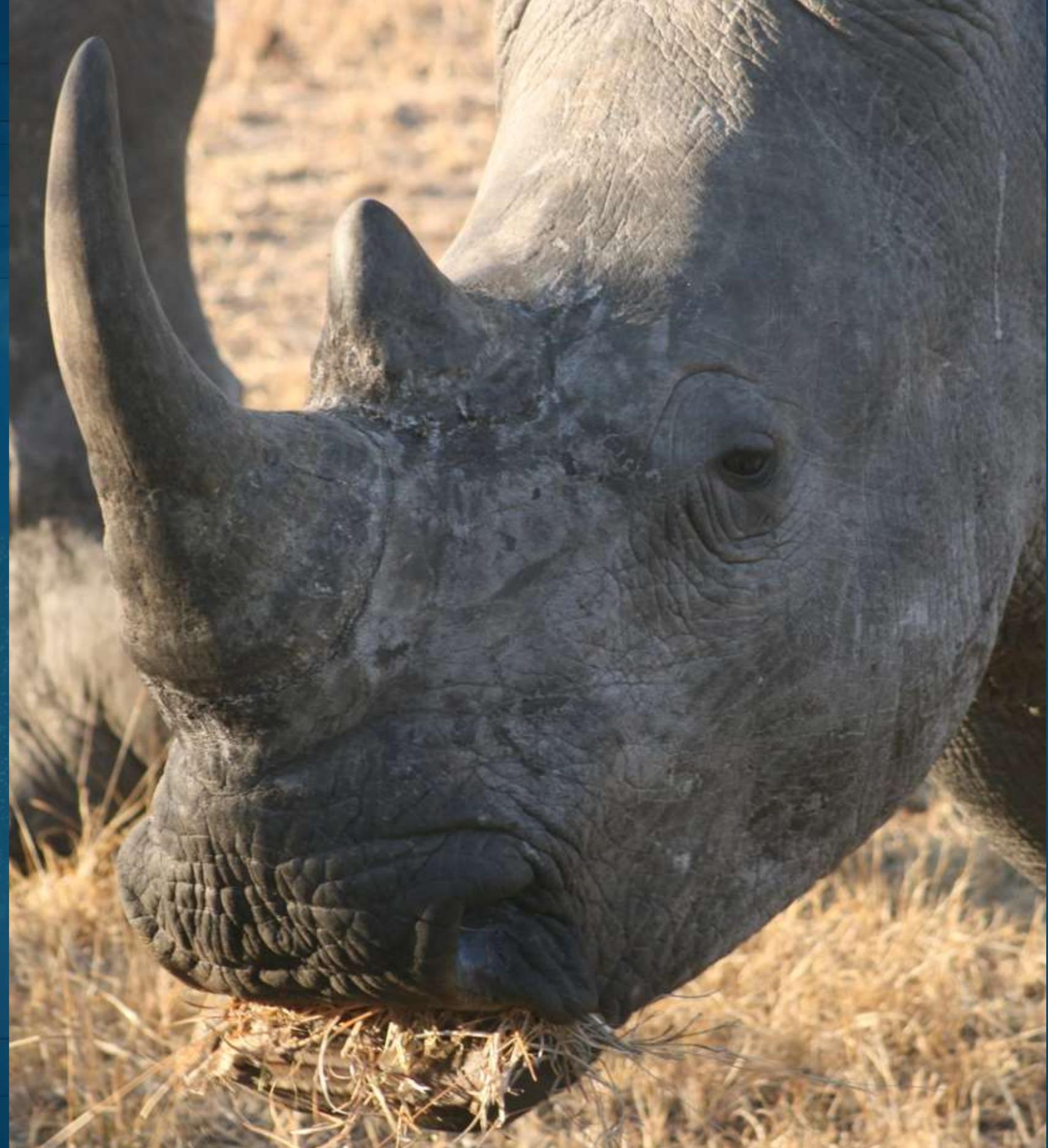
## Illegal Wildlife Trade



<http://news.nationalgeographic.com/content/dam/news/2015/07/15/poachingconf.jpg>

**Solutions?**

People already taking  
some extreme  
measures



# A need for ecological compensation

SEMINAR ON 9TH OF JUNE IN TURKU, FINLAND.

## **ECOLOGICAL COMPENSATION**

– GREENWASHING  
OR WASHING-  
PROOF GREEN?

SCIENTIFIC, SOCIETAL AND CULTURAL APPROACHES  
TO BIODIVERSITY OFFSETTING

[www.koneensaatio.fi/en/tapahtuma/ecological-compensation/](http://www.koneensaatio.fi/en/tapahtuma/ecological-compensation/)

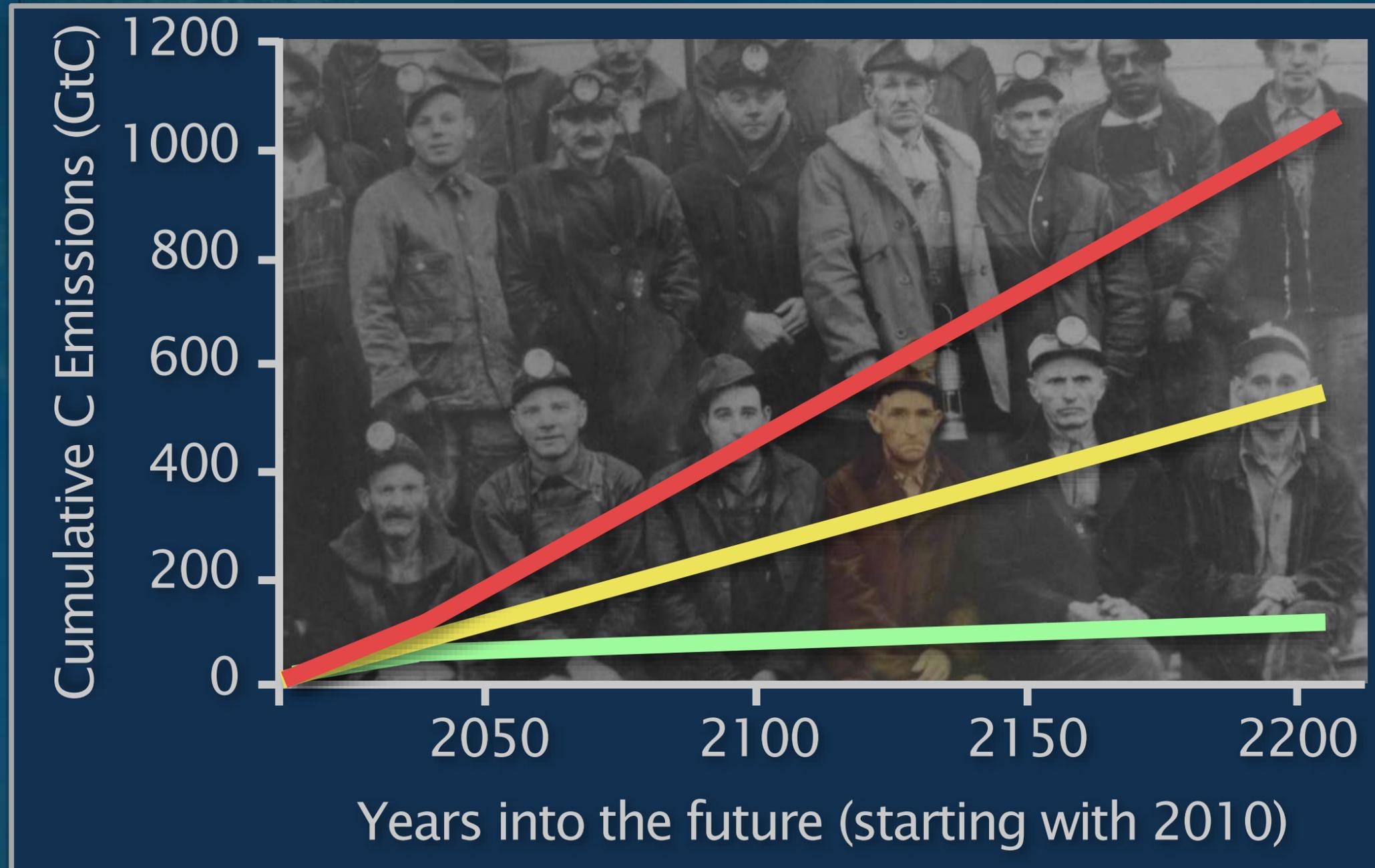


## Three scales important

- Global
- Inter-regional alliances
- Local

# Global :

To minimize climate change, we must quit using fossil fuels



No reductions in coal emissions

Replace all coal with natural gas by 2030

Lower emissions 5.1% per year for 50 years

# Carbon neutral energy feasible globally by 2050

Solar



Wind



Water



Tides/Waves



Electric Vehicles



Algal Biofuels



# Developing world: Leapfrog past fossil fuels through technology transfer

Pasang Lhamu-Nicolle Niquille Hospital, Nepal



K. Das Shrestha, 2013, Sustainable Nepal

**The richest billion produce 60% of greenhouse gases**

Unsustainable Consumption of Coal, Oil, and Gas



# The cost of fixing the climate problem

- US\$ 750 billion to US\$ 1000 billion per year of investment and spending for ~50 years
- For the richest 1 billion that is only:  
US \$750 – US \$1000 per person per year

# Inter-regional alliances

## Governors' Climate & Forests Task Force



<http://www.gcftaskforce.org/>

“Protects tropical forests, reduces emissions from deforestation, promotes realistic pathways to forest-maintaining and rural development” (REDD+)

- USA (California & Illinois)
- Mexico
- Peru
- Brazil
- Spain
- Ivory Coast
- Nigeria
- Indonesia
- 32% of global tropical forests

# Local: Stanford University Habitat Conservation Plan



# Stanford University lands



8,180 acres

30% densely developed

- Campus buildings
- Shopping mall
- Commercial real estate
- Faculty and student housing

70% lightly / moderately developed

- Cattle grazing and equestrians
- Green space with hiking trails
- Jasper Ridge Biological Biological Preserve

# High biodiversity

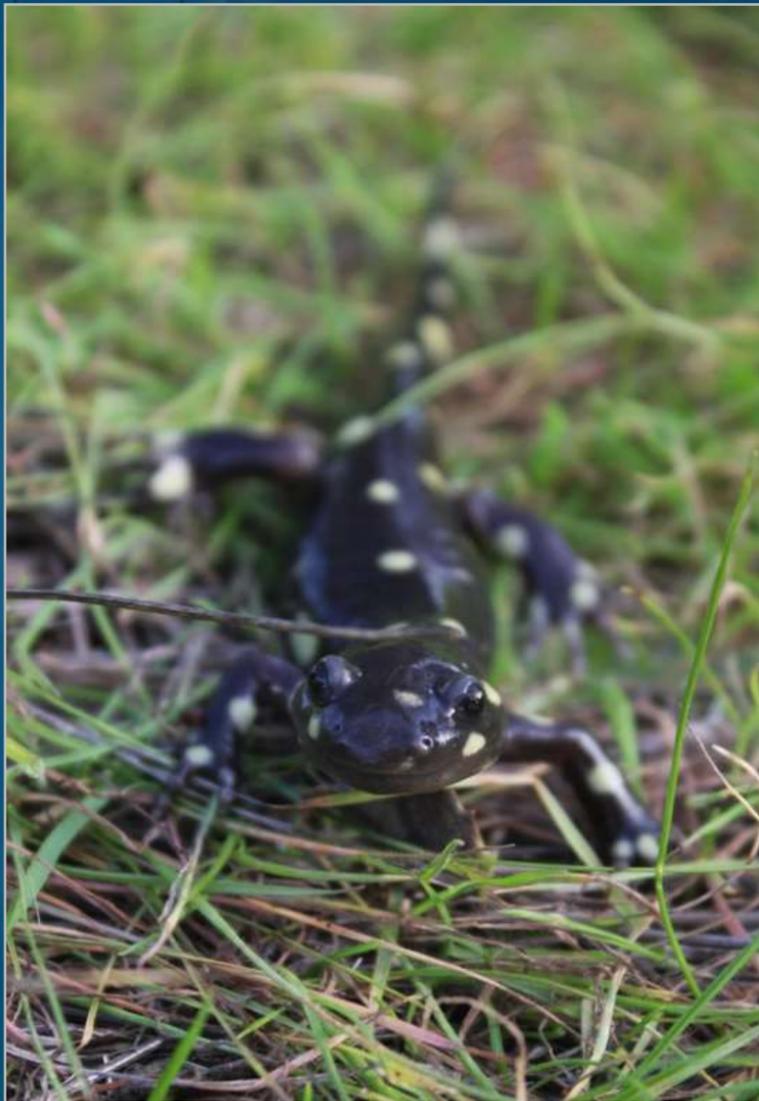


## Native Species

- >50 species of mammals
- >175 species of birds
- ~20 species of reptiles
- ~12 species of amphibians
- ~10 species of freshwater fishes
- ~650 species of plants
- nearly countless species of invertebrates

# Endangered species: Federal and / or state laws prohibit harming them

California tiger salamander



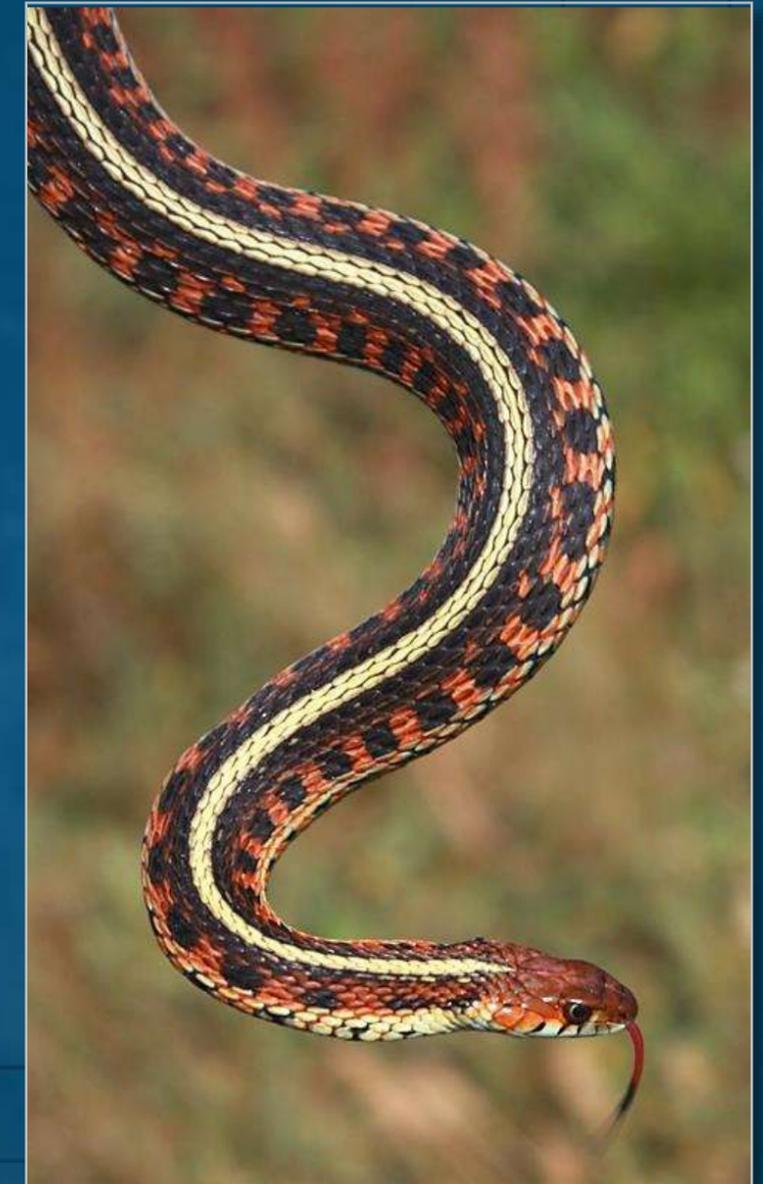
Steelhead



Western pond turtle



San Francisco garter snake



California red-legged frog



Dusky-footed wood rat

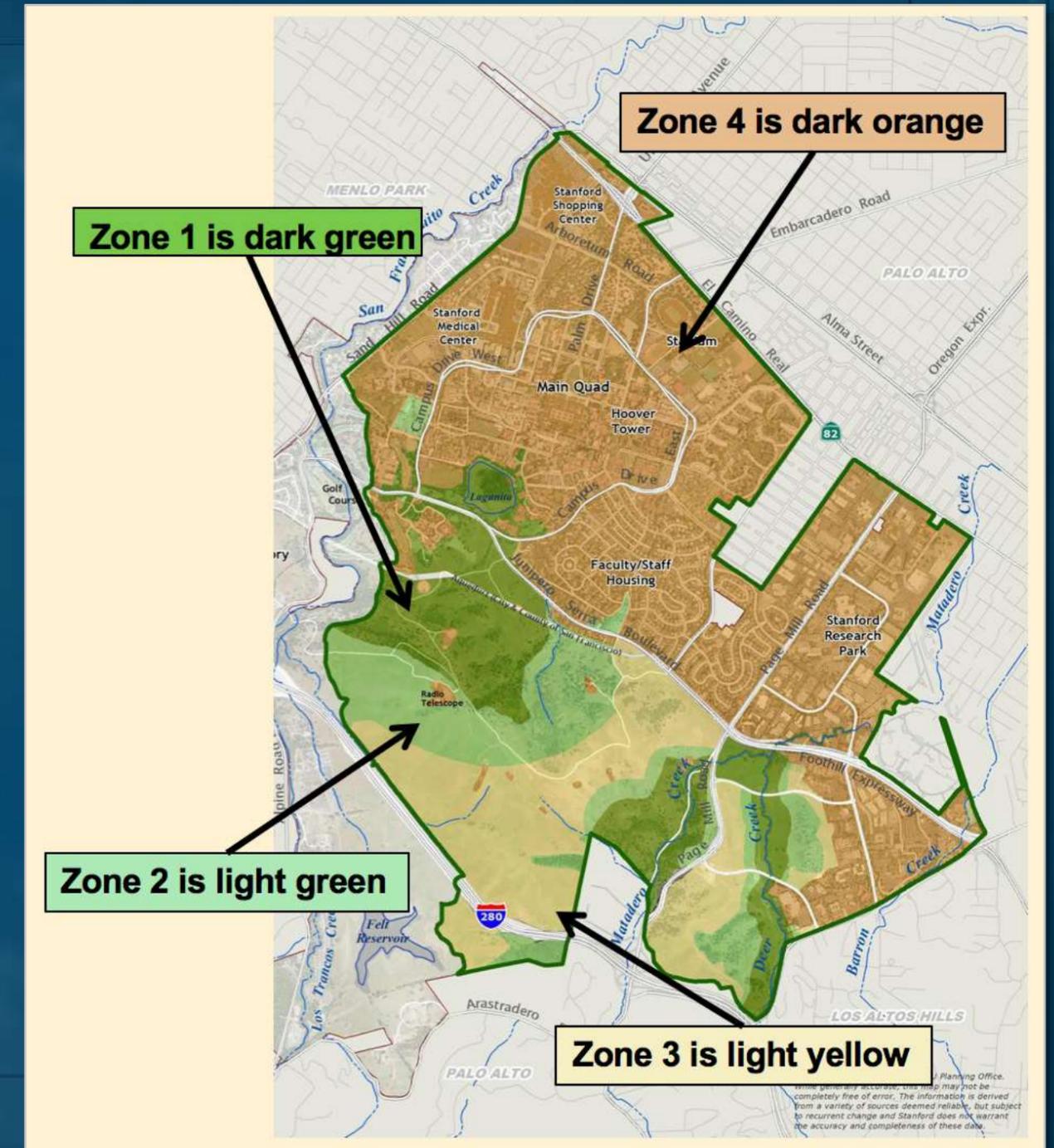


# Ecological compensation practiced for a long time



# Stanford Habitat Conservation Plan formalized in 2013

- 50 year plan/permit in accordance with U.S. Fish and Wildlife Service and California regulations
- Establishes a comprehensive conservation program
- Designed to provide a net environmental benefit
- Includes 4,372 acres of campus
- Management zones are based on the value of the land to the endangered species



# Much of the 50-year conservation program of the Stanford HCP will occur prior to new impacts

- No-build zone in lower foothills, in place at least 50 years
- 315 acres of uplands and 8 seasonal ponds (more to be built)
- Sites of future easements (to be dedicated when future impacts occur)
- Extensive management and future wetland construction

Building California tiger salamander reserves

Before



Pond #3 being built in 2003

After



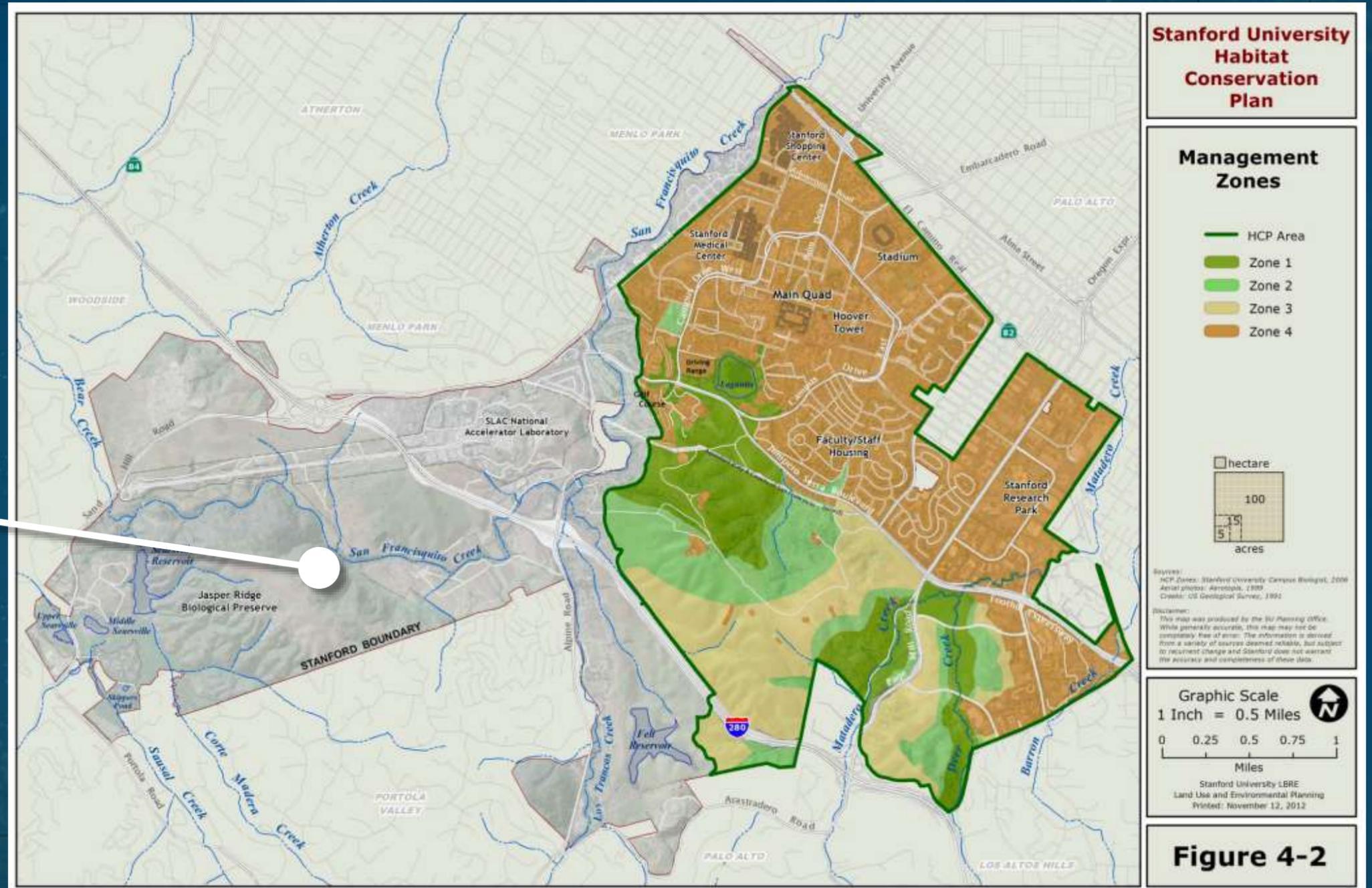
Pond #3 2007

# Danger of ecological compensation: Irreplaceable habitats

## Serpentine Grassland



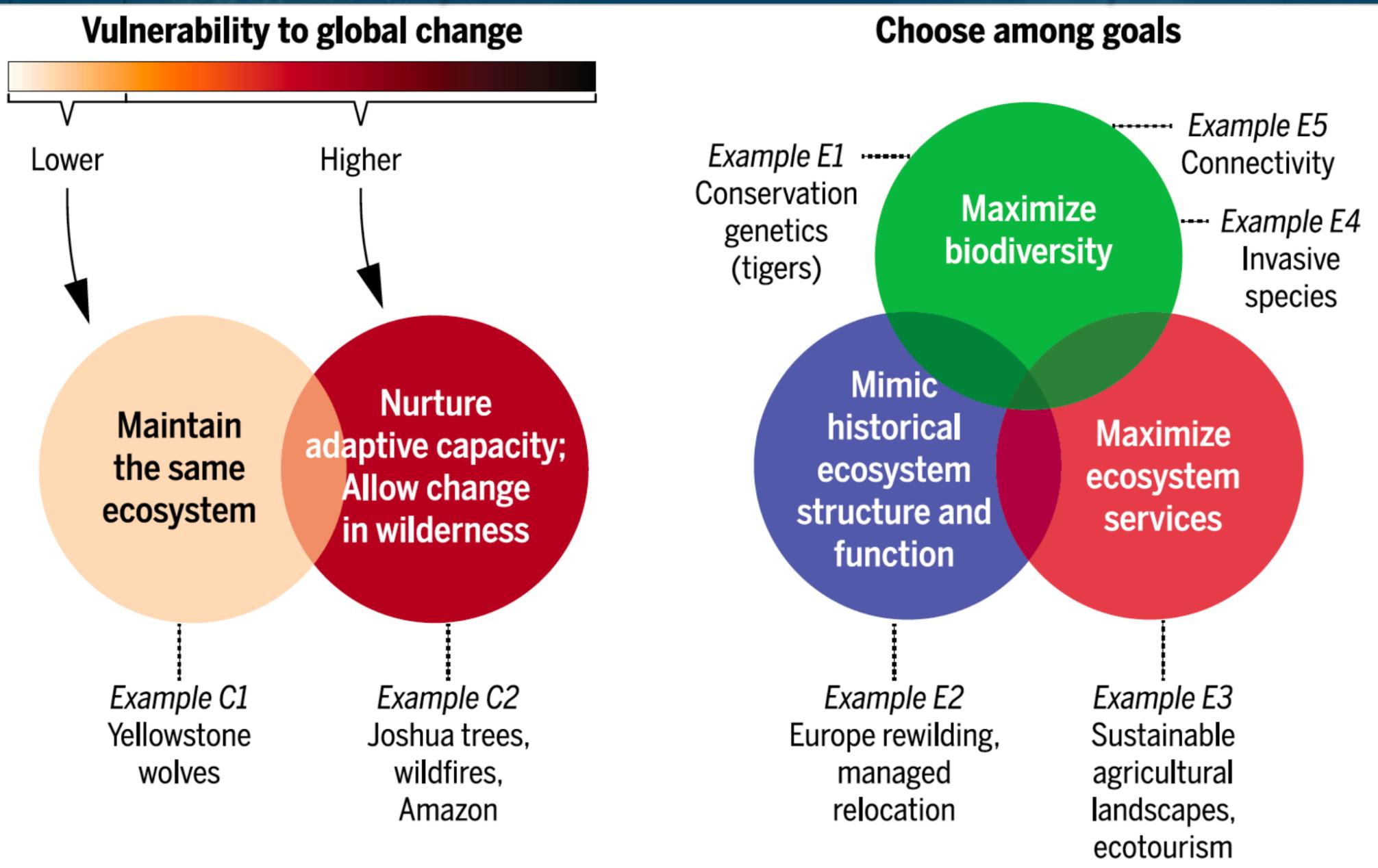
Jasper Ridge Biological Preserve



# Danger of ecological compensation

## Historical Ecosystems

## Novel Ecosystems



## Global Change

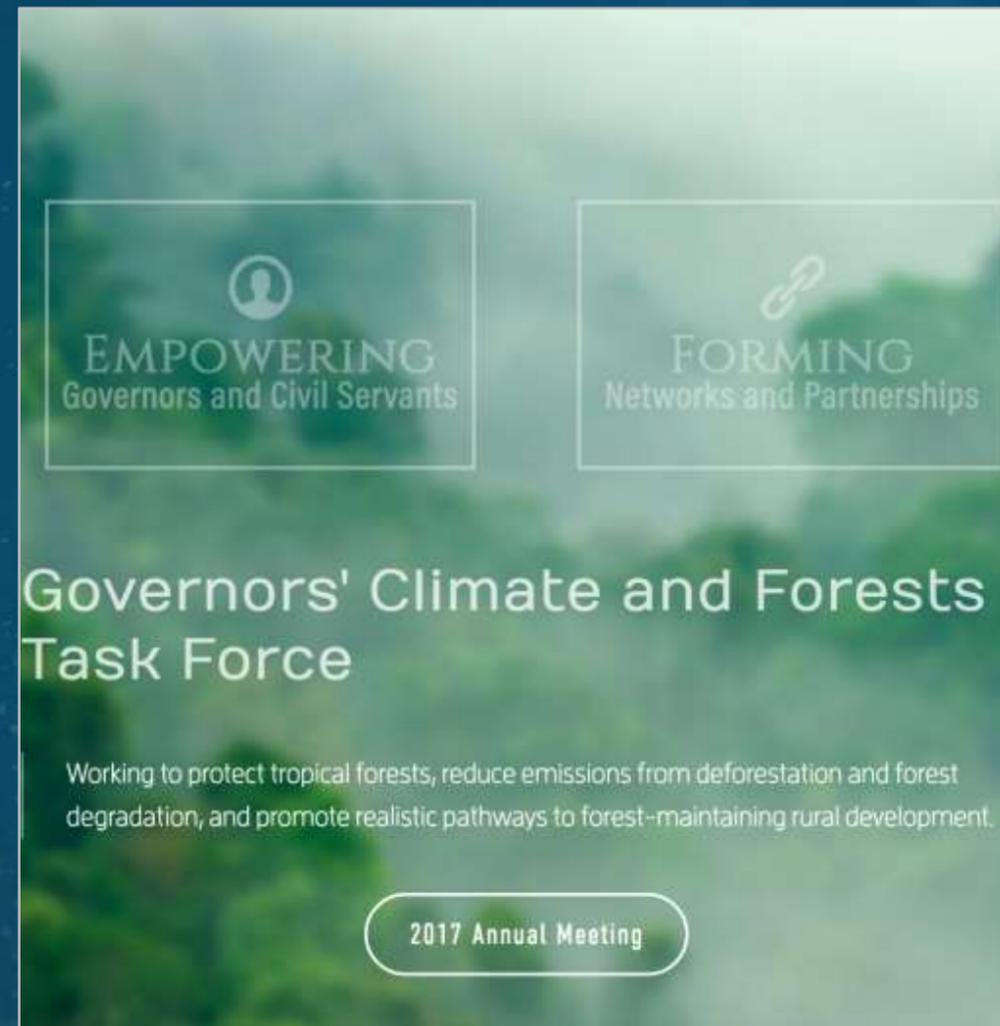
- The ecosystems we design to compensate for lost ones will never be exact duplicates
- Must build in adaptive capacity to withstand rapid global change
- Must take thousand-year baselines into account for success

# To sum up

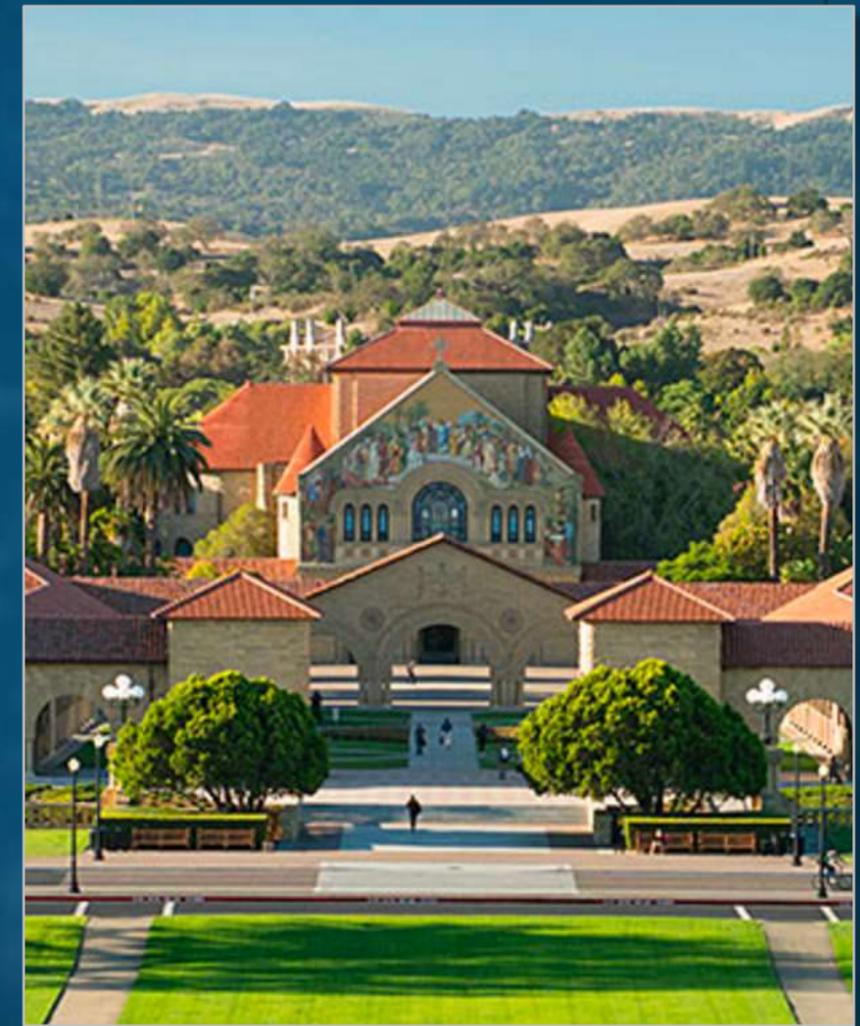
Avoiding the Sixth Mass Extinction will require ecological compensation at three scales



**Global**



**Inter-regional Alliances**



**Local**

**But ecological compensation alone will not be enough.**

**Must also:**

Preserve irreplaceable ecosystems

Address root causes:

- Human population growth
- Climate change
- Over-consumption of goods
- Over-exploitation of species





**Will we succeed?**

A landscape photograph showing a mix of green and brown trees and shrubs. The foreground is dominated by tall, dry, yellowish-brown grasses. The background features a dense line of trees, some with vibrant green leaves and others that are bare or have sparse, brownish foliage. The sky is overcast with soft, grey clouds. The image is framed by dark blue vertical bars on the left and right sides.

**In preventing the Sixth Extinction?**

**Maybe. But only if we start today.**

**Questions?**

@tonybarnosky



**end**