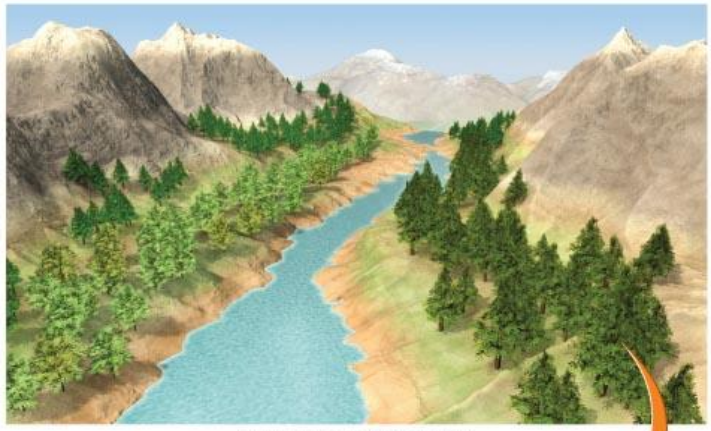
Ch. 8: Biodiversity

Biodiversity

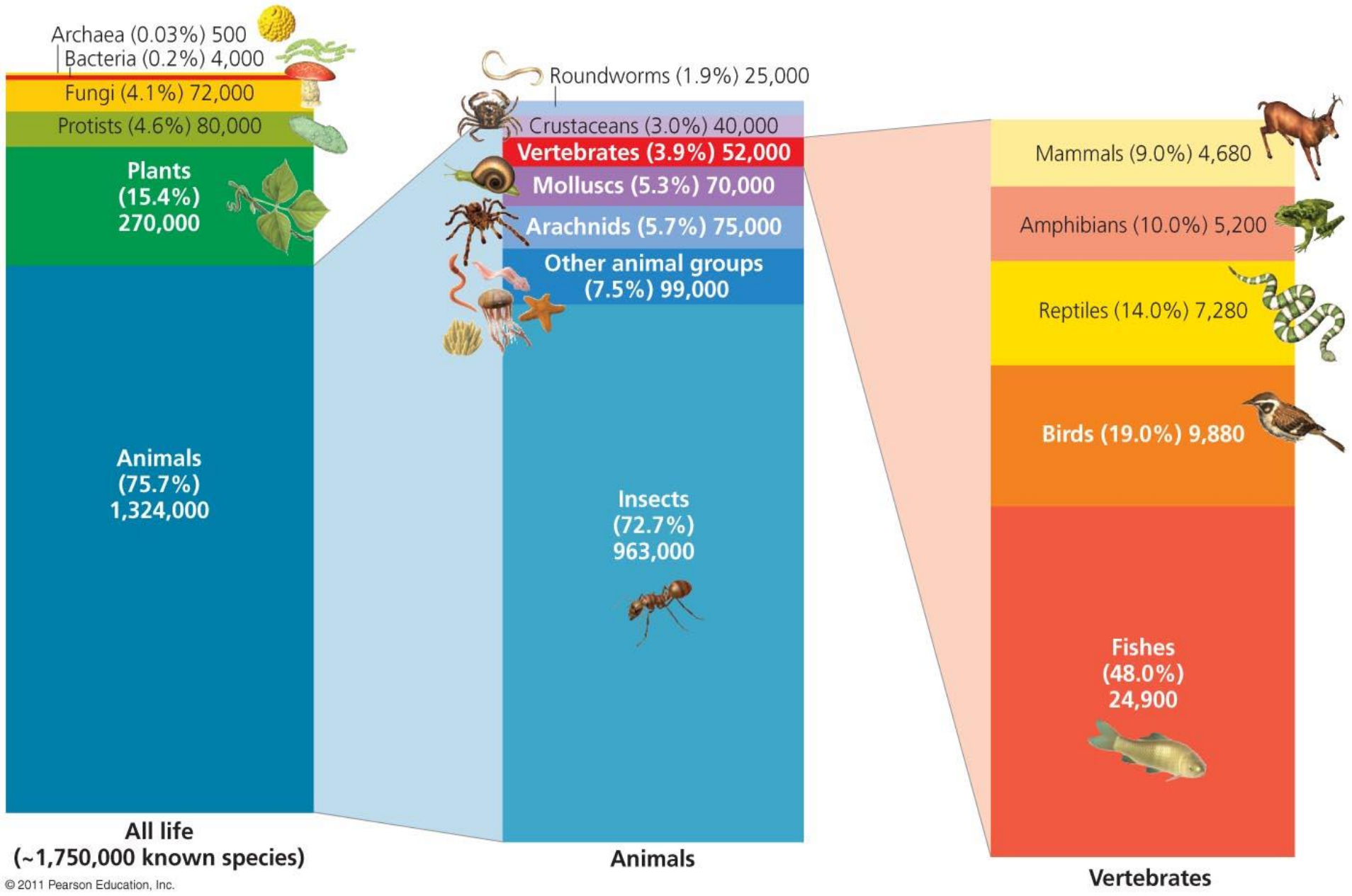
- **Variety of life at all levels of organization**
- **Types of Biodiversity**
  1. **Ecosystem diversity: Number & variety of ecosystems (including different communities & habitats) in an area**
  2. **Species diversity: number or variety of species in a particular region**
  3. **Genetic diversity: differences in DNA (traits) among individuals (coat color, speed, intelligence….)**
     - **Aids survival of population**



Ecosystem diversity

Species diversity

Insects outnumber all other species



Measuring biodiversity is not easy

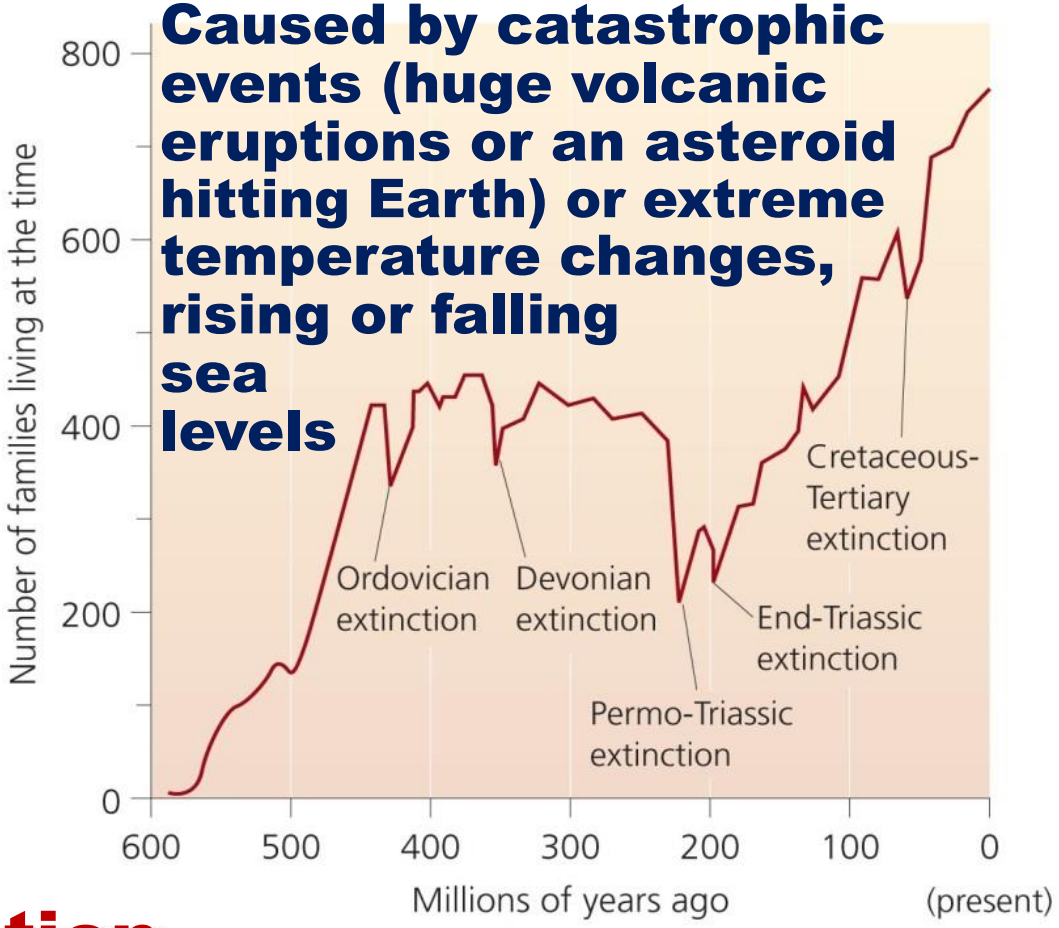
- 3–100 million species are estimated to live on Earth (14 million most accepted number)
- ~1.8 million species have been identified & described
  - Small organisms are easily overlooked
  - Many species look identical until thoroughly examined
  - Many remote spots on Earth remain unexplored (tropical rainforest, deep sea)

163 beetle species found on one rainforest tree!

Biodiversity loss and species extinction

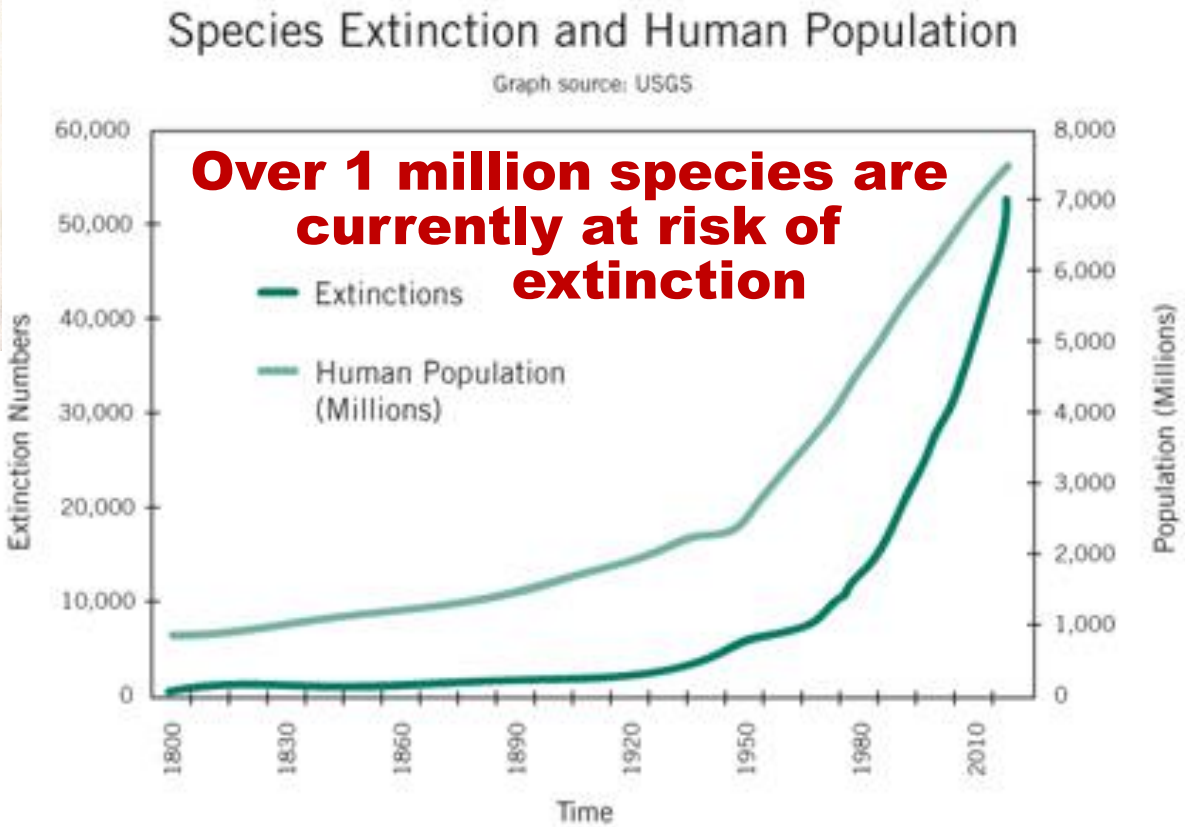
- **Extinction**: the last member of a species dies & the species ceases to exist on Earth
- Earth has had five **mass extinctions**
  - 75% of world's species lost in a short geological time period (< 2.8 million years
- **Extirpation**: disappearance of a population from a local area, but not the entire species globally
  - Can lead to extinction

Caused by catastrophic events (huge volcanic eruptions or an asteroid hitting Earth) or extreme temperature changes, rising or falling sea levels



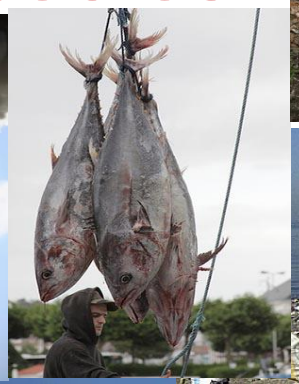
Humans are causing the 6th mass extinction

- The current extinction rate is 100-1,000 times greater than the natural, background rate
  - Will increase due to human population growth, resource consumption, & pollution
- Many species face high risks of extinction:
  - Mammal species (21%), bird species (12%)



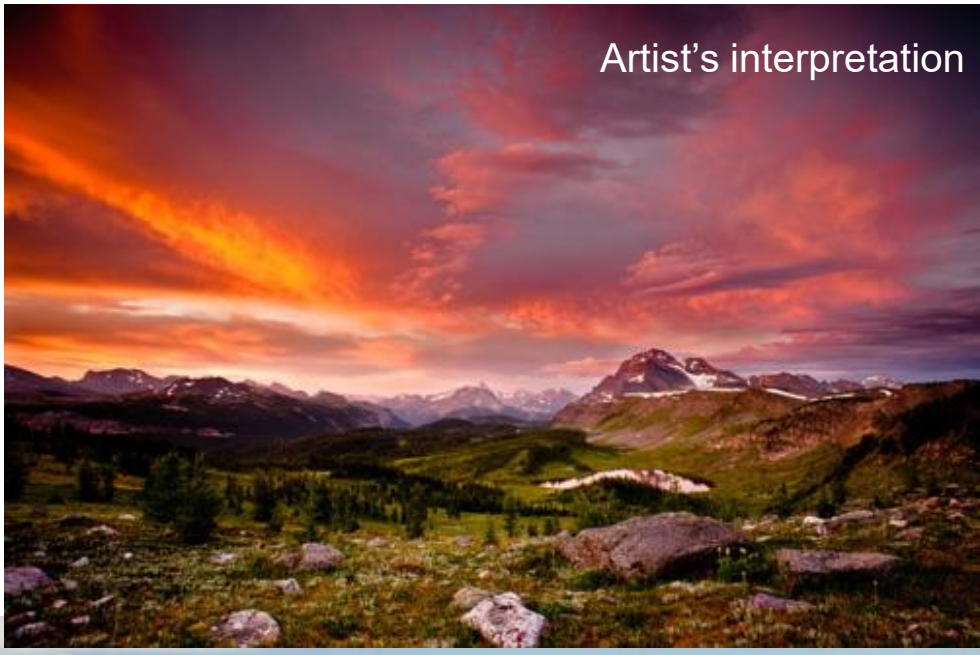
What is Causing this Human-Induced Mass Extinction Event?

- Naturally, extinction occurs over long periods, allowing nature to slowly replace what has been lost, but humans have sped up this process to a dangerous rate
- Human population growth & development
- Destruction of natural habitats
- Hunting & harvesting of species
- Introduction of non-native species
- Pollution (including climate change)
- Life will need millions of years to recover



Biodiversity loss has many causes

- **Five primary causes of population decline:**
  1. **Habitat alteration**
     - **Destruction & Fragmentation**
  2. **Invasive species**
  3. **Pollution**
  4. **Overharvesting**
  5. **Global climate change**



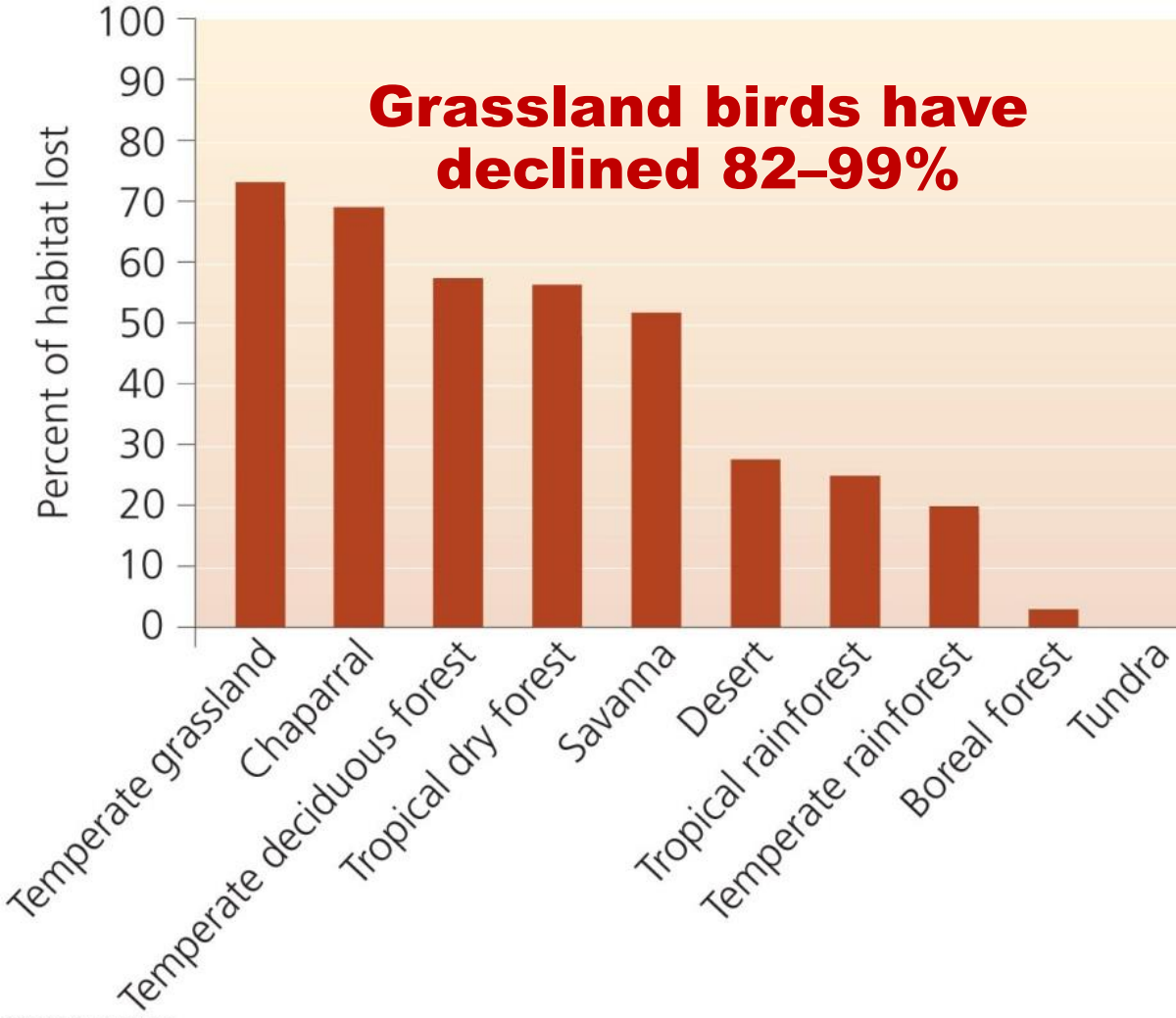
Los Angeles before & after human alteration

1. Habitat alteration

- Greatest cause of biodiversity loss
- Habitats destroyed, fragmented, & degraded
  - Farming replaces & simplifies communities
  - Grazing modifies grassland structure & composition
  - Clearing forests removes resources organisms need
  - Hydroelectric dams turn rivers into reservoirs
  - Suburban sprawl replaces natural communities

Habitat loss occurs in every biome

- Responsible for declines for 83% of mammals & 85% of birds
- 99% of U.S. prairies have been converted to agriculture
- 50% of wetlands in U.S. destroyed in past 200 years
  - 90% in California

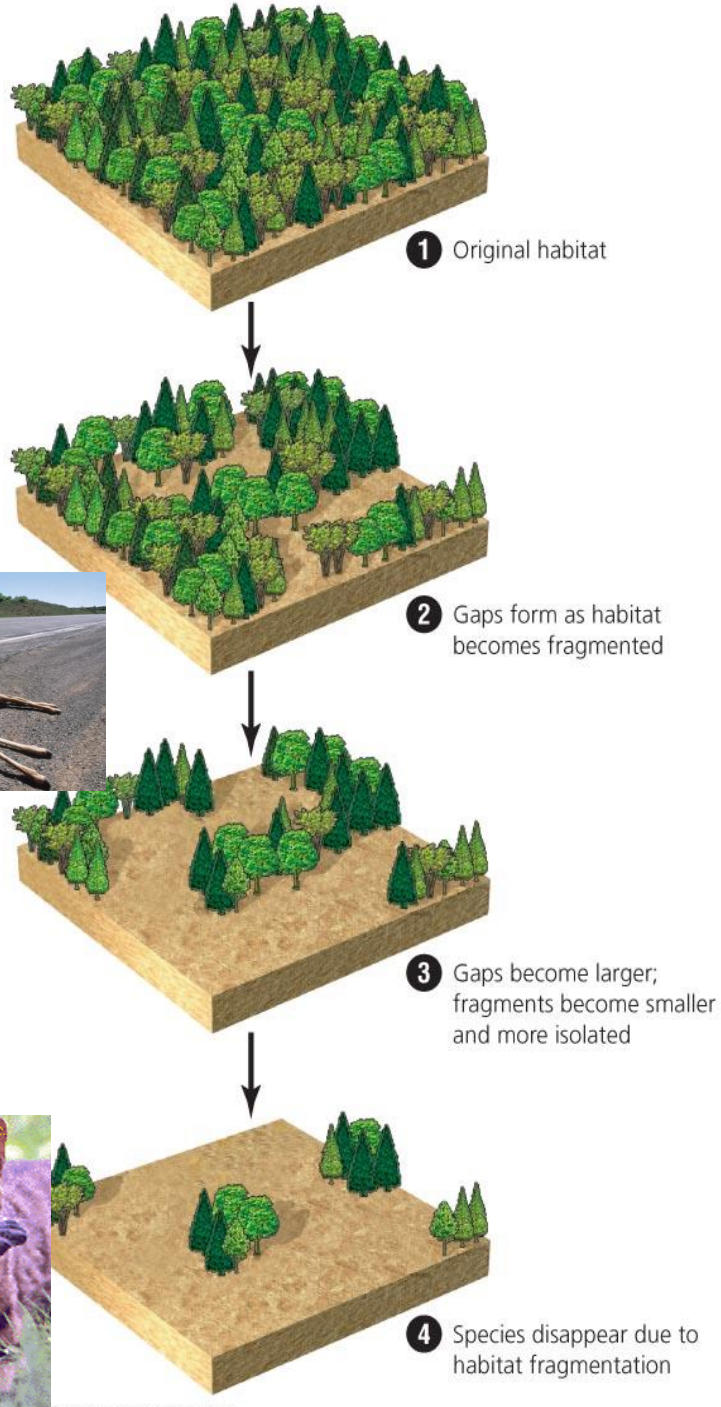


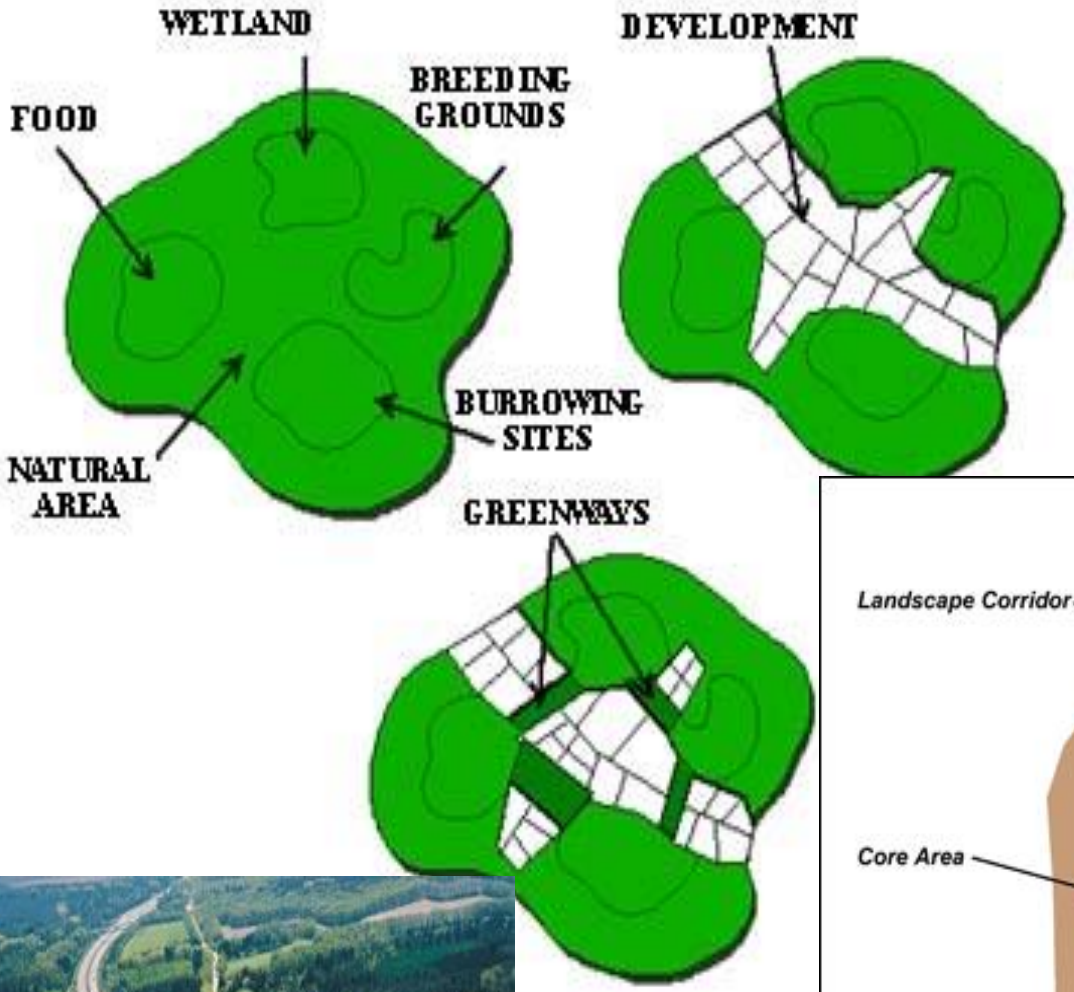

Only the Brazil nut trees, protected by national law, were left standing after farmers cleared this parcel of Amazon rain forest to grow corn. Despite progress in slowing deforestation, this northern state of Pará saw a 37% spike over one year.

Habitat fragmentation

- **Gradual, piecemeal degradation of habitat into small, isolated patches**
  - **Farming, roads, logging, housing, urbanization……**
- **↓ Resources & mating**

- **Produce subpopulations (vulnerable to inbreeding & extinction)**
- **Edge Effects: increases exposure to human areas**
  - **Noise, light, weeds, pet predators (Cat, Dogs)**

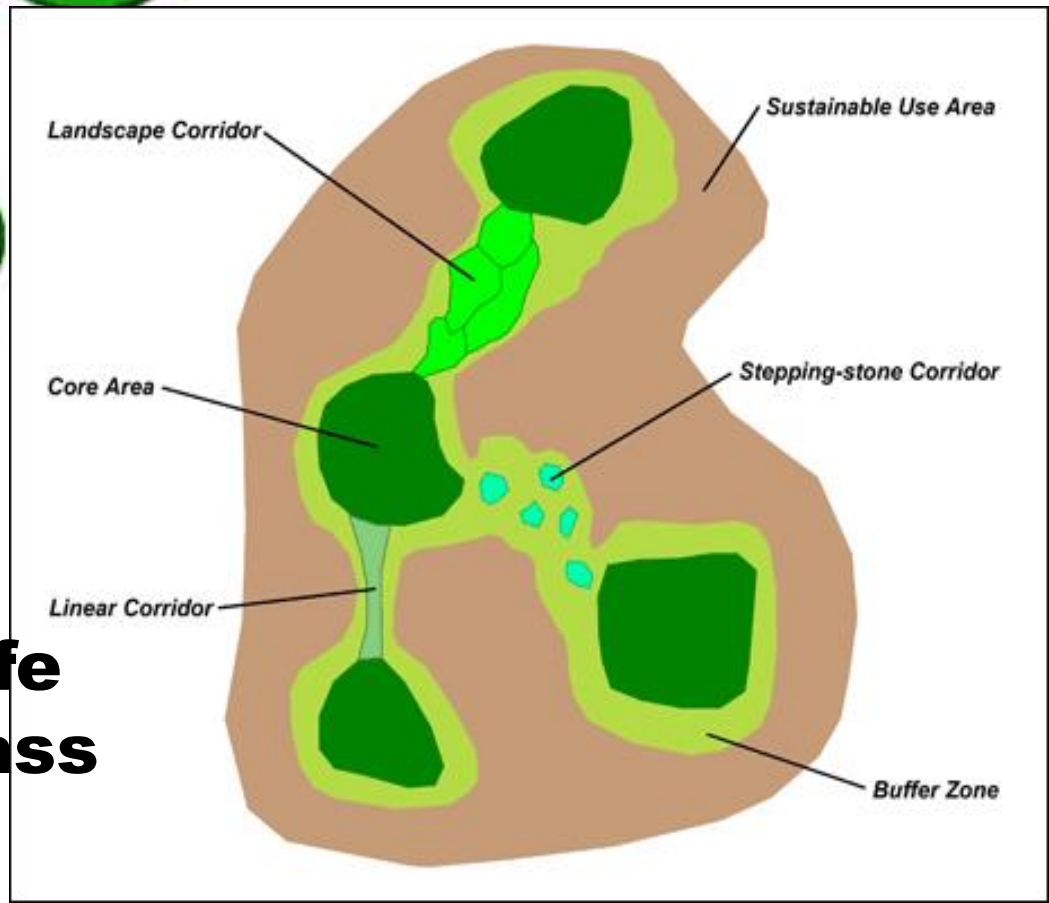




Solution:

Corridors between fragments may allow viable populations

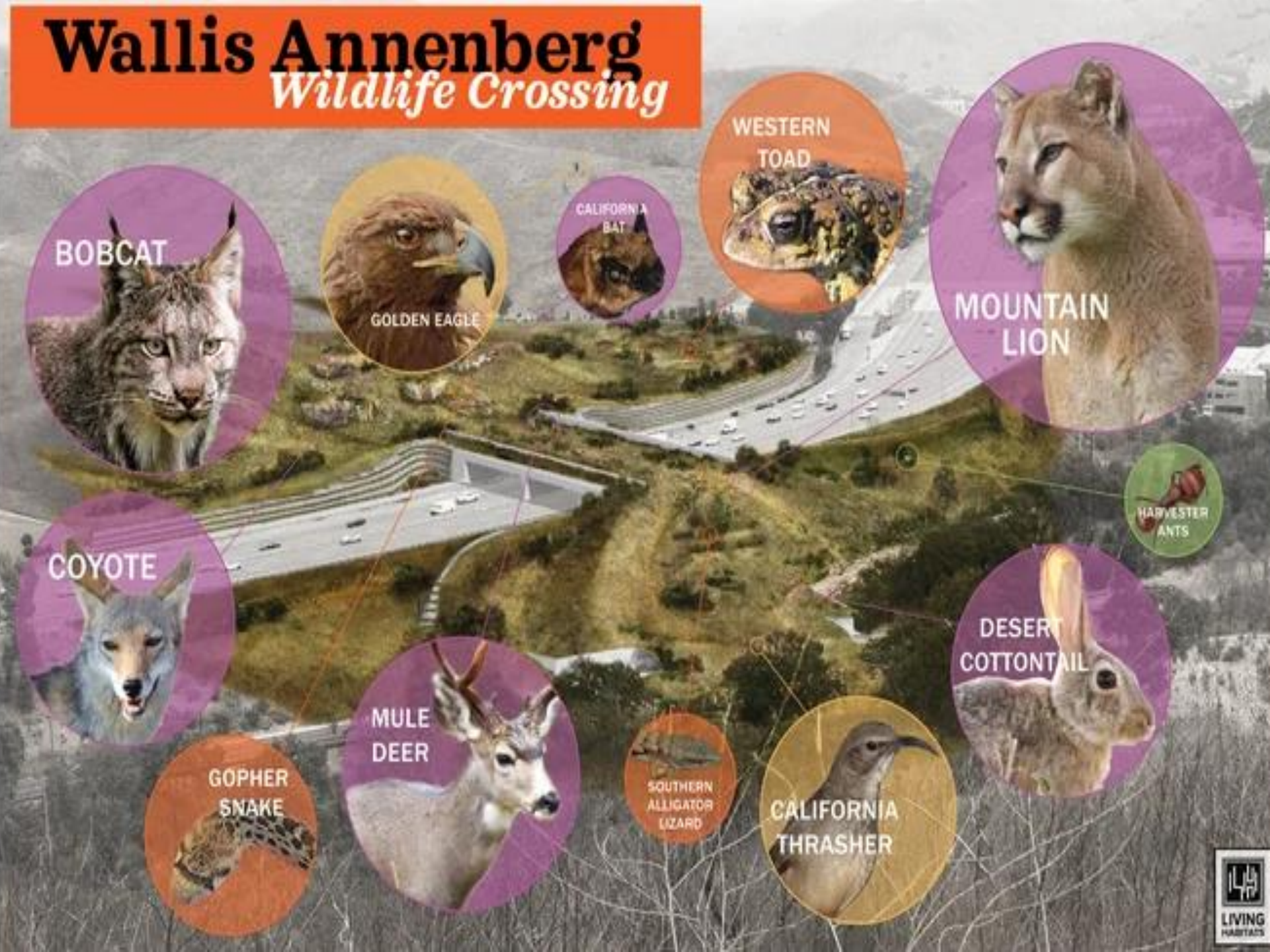
Wildlife Overpass



OC Great Park's wildlife corridor could link Cleveland National Forest with Laguna Coast Wilderness Park, Crystal Cove State Park, & Pacific Ocean

In Nov. 2013, Irvine planned 178-acre wildlife corridor

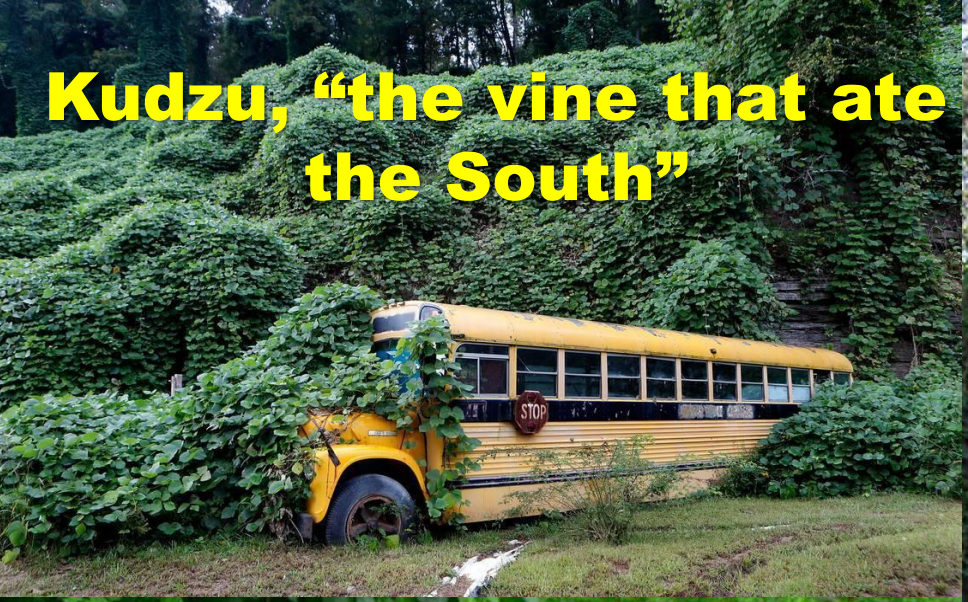
Wallis Annenberg *Wildlife Crossing*



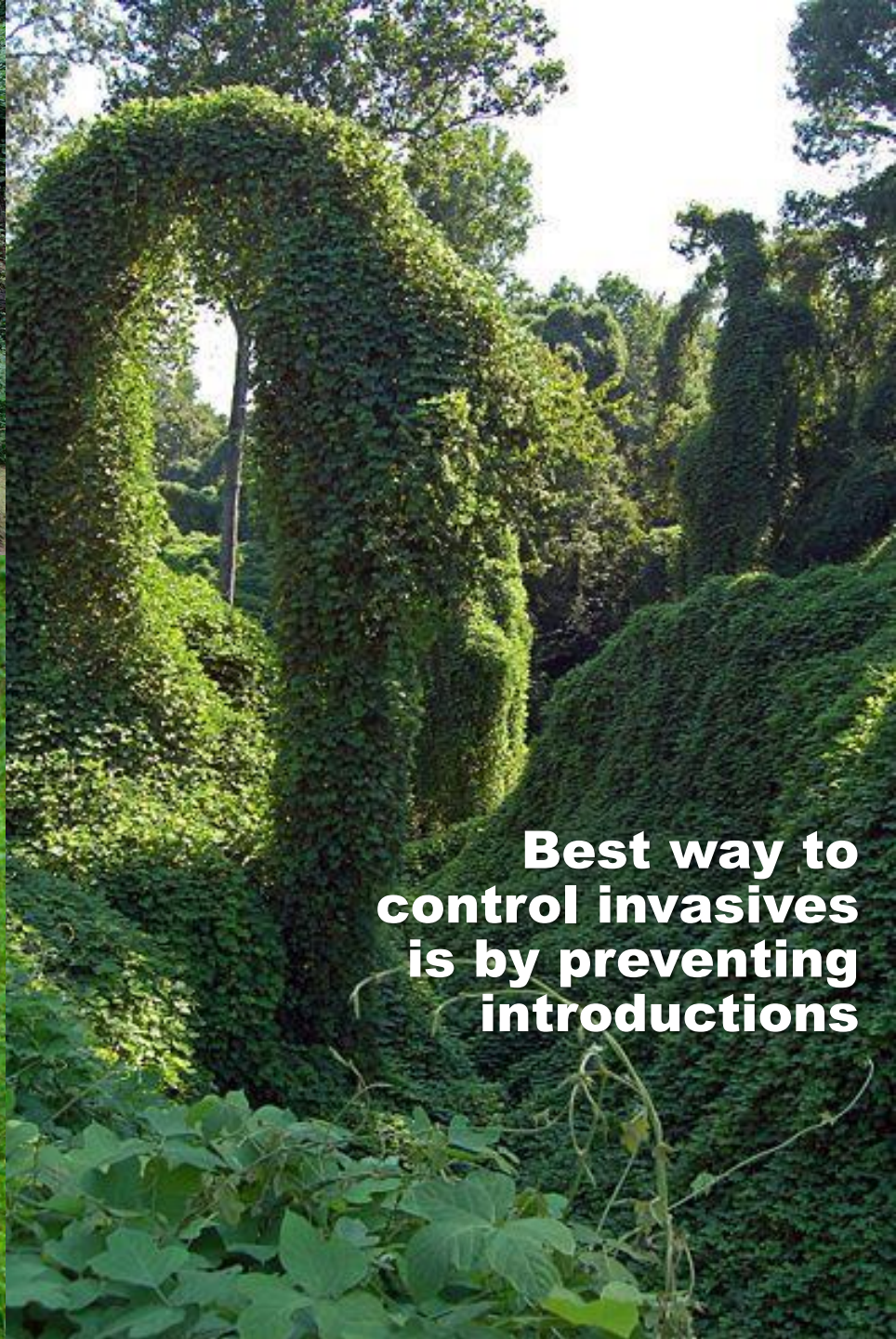
2. Invasive species

- Introduction of non-native species to new areas
  - Accidental: fire ants, weeds, aquatic species
  - Intentional: food crops, exotic pets, ornamental plants
- Invaders lack their natural predators, competitors, parasites, or climatic conditions (freezing temp)
- Invaders out compete, prey upon or infect native species

Invaders cost billions of dollars in damage each year


Kudzu, “the vine that ate the South”
STOP


Introduced from Asia, Kudzu can be controlled with biocontrol using goats


Best way to control invasives is by preventing introductions

3. Pollution harms air, water, soil, & organisms

- **Air pollution degrades forest ecosystems, sickens wildlife & humans**
- **Water pollution impairs fish and amphibians**
- **Agricultural chemicals harm terrestrial & aquatic species**
- **Toxins, garbage, oil, & chemicals impact organisms**
- **Damage to wildlife & ecosystems caused by pollution can be severe**

4. Overharvesting

- Exploitation of wildlife through hunting & trading has caused once abundant wildlife to decline severely, driving extinction

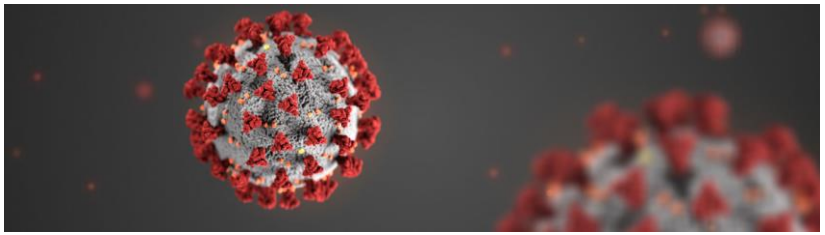
- Species that are few in number, long-lived, & have few young over lifetime are especially at risk
- Powerful economic incentives increase poaching & illegal black market trade
  - Illegal trade pays a higher wage than most jobs
  - Many terrorist organizations (LRA, ISIS, etc.) now poach animals to fund their activities
- Many species are affected: Whales, sharks, gorillas, rhinos, elephants, macaws, pangolins
  - The oceans contain only 10% of the large animals they once did due to over-fishing

4. Overharvesting

- Hunting & Fishing
  - We harvest species from the wild faster than populations can recover
- Commercial products
  - Timber (clear-cut forests)
- Rare & Exotic species trade
  - Traditional medicine
  - Pets, gardens
  - Aphrodisiacs & prestige display
- Predator & Pest Control (mostly to protect livestock)

Global Wildlife Trade Causes Pandemics

- Trade in wild animals can drive extinction & spread diseases to humans like Corona virus
- Wild animals are consumed as food, used in traditional medicine, or kept as pets
- Use of wild animals, especially mammals, that carry diseases that can cross the species barrier, poses a threat to human health
- Many are taken from the wild illegally & smuggled over borders



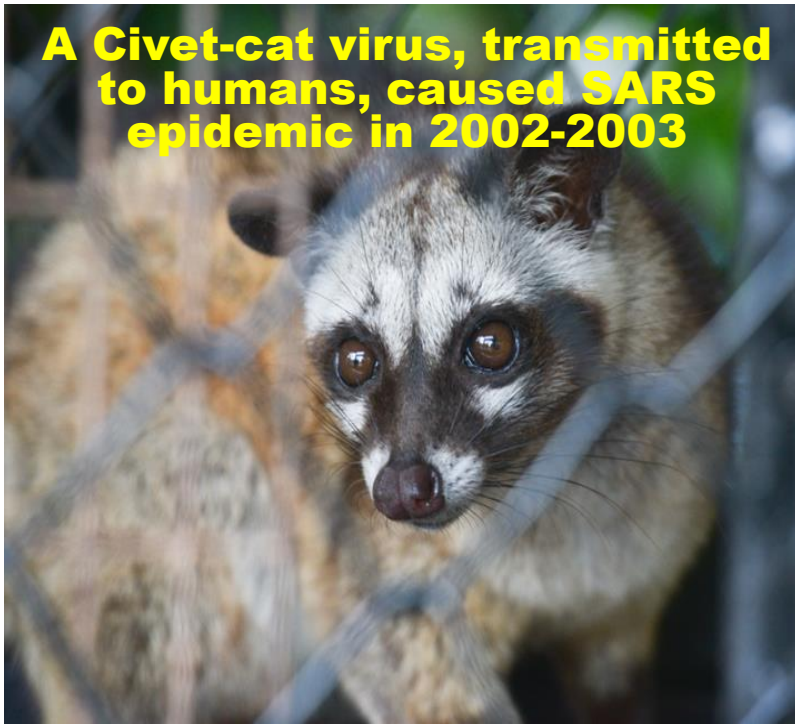
- Human diseases: Covid-19 (Corona Virus), Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), & Ebola ALL originated in wild animals

Wet Markets & Forest Destruction

- Food markets offering fresh meat, produce, & cooked food are common worldwide
- But, some markets also sell rare, wild animals or their parts that allow diseases to jump between species (humans too) that would never come together naturally
- Destruction of forests & road building into forests allows people to exploit & hunt animals they could not normally access

A World Wide Ban in Wild Animal Trade is Needed to Stop Disease Pandemics

- Close contact with wild animals through hunting, trade, or habitat loss puts the world at increased risk of new disease outbreaks
- As natural habitat is diminished, wildlife comes into closer contact with people
- A world ban would protect habitats & species from extinction & people from global disease pandemics



5. Climate change

- Human manipulation of Earth's climate system has global impacts on biodiversity
- Emission of greenhouse gases (CO_2, methane, NO_2, ...), mostly from burning fossil fuels (coal, petroleum, natural gas), warms temperatures
  - Modifying global weather patterns
- Frequency of extreme weather events increases
  - Droughts, heavy storms, fires, etc.

- Increased stress forces organisms to shift their geographic ranges (some can't migrate)
  - Most animals & plants will not be able to adapt quickly enough
  - 20–30% of species are at increased risk of extinction

Warming has been the greatest in the Arctic

- Because of melting ice, polar bears can't hunt seals
- Can't migrate further North since they live at the top of the world
  - Added to the endangered species list in 2008
    - First species listed due to climate change

Biodiversity provides free ecosystem services

- Provides food, fuel, fiber, & shelter
- Purifies air & water
- Detoxifies wastes

The value of 17 ecosystem services = $46 trillion per year

- Stabilizes climate, moderates floods, droughts, wind, temperature

- Cycles nutrients, renews soil fertility
- Pollinates plants, controls pests & disease

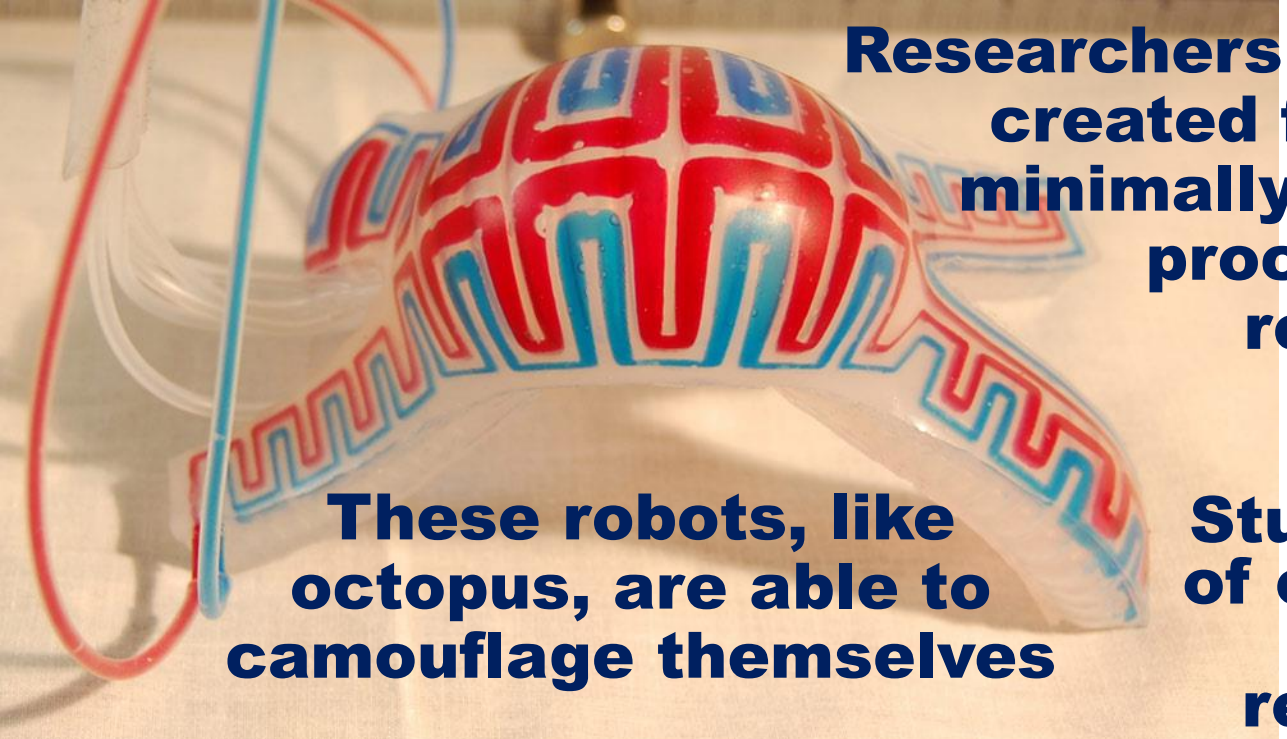
- Maintains genetic diversity of crops
- Provides cultural & aesthetic benefits

Organisms provide drugs, medicines, & new technology

- Wild species produce $150 billion/year of drugs
- Every species that goes extinct is a lost opportunity to cure disease
- Engineers study organisms to develop new products, medical devices, technologies, & to improve infrastructure
- We're good at mimicking nature

Medicines and Biodiversity: Natural sources of pharmaceuticals

Plant	Drug	Medical application
Pineapple (*Ananas comosus*) 	Bromelain	Controls tissue inflammation
Autumn crocus (*Colchicum autumnale*) 	Colchicine	Anticancer agent
Yellow cinchona (*Cinchona ledgeriana*) 	Quinine	Antimalarial
Common thyme (*Thymus vulgaris*) 	Thymol	Cures fungal infection
Pacific yew (*Taxus brevifolia*) 	Taxol	Anticancer (especially ovarian cancer)
Velvet bean (*Mucuna deeringiana*) 	L-Dopa	Parkinson's disease suppressant
Common foxglove (*Digitalis purpurea*) 	Digitoxin	Cardiac stimulant



Researchers study Octopus to created flexible robots for minimally invasive medical procedures, search & rescue, & defense.

These robots, like octopus, are able to camouflage themselves

Studying the ability of echinoderms like sea stars to regenerate body parts may aid in curing spinal cord injuries

Studying Spider webs help to design strong & lightweight bridges & buildings

Biodiversity generates income through ecotourism

- Especially in developing countries
- Costa Rican rainforests, Australia's Great Barrier Reef, Belize (reefs, caves, & rainforests), Tanzania's savanna wildlife…..

- Powerful, monetary incentive to preserve natural areas
  - Reduce impacts on the landscape & species

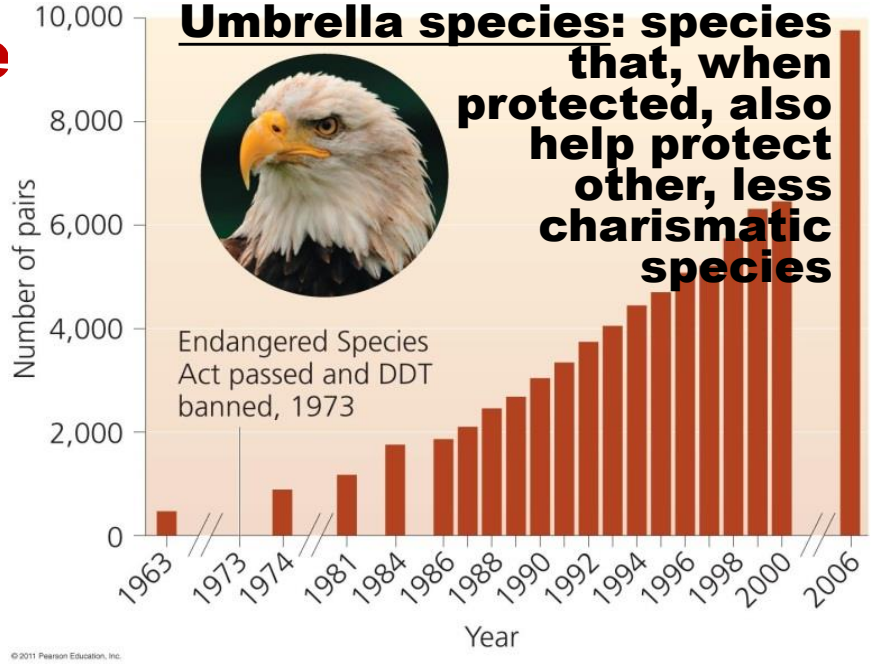
- Care must be taken or too many visitors can degrade habitats & disturb wildlife

People value & seek out nature

- We have an affinity for parks & wildlife
- We relax & enjoy vacations in natural places
- We value real estate with views of natural land
- Scientific studies show that spending time in nature improves our health:
  - Reduces stress (lowers cortisol levels), anxiety, & depression; lowers pulse rate & blood pressure; increases immune function
- Plants give off compounds called phytoncides into air (smell of pine or grass) that increase white blood cell production – may help fight cancer & other illnesses

Conservation of species

- **Endangered Species Act (ESA) (1973): primary U.S. legislation for protecting biodiversity**
- **Forbids government & citizens from actions that destroy endangered species & their habitats**
  - **Or trade in products made from endangered species**
- **Aims to prevent extinction by stabilizing declining populations & enabling them to recover**
  - **Restore habitats, remove pollutants & invasive species, captive breeding & release**
- **99% of species on list have avoided extinction. 1,274 endangered (Nov 2018**



International conservation efforts

- **UN Convention on International Trade in Endangered Species (1973)**
  - **CITES protects endangered species by banning international transport of live specimens or their body parts; funds research, law enforcement**

- **UN Environment Program (Ecosystem Management)**
- **Convention on Biological Diversity (1992)**
  - **Assesses human impacts, funds critical activities, promotes education & scientific cooperation**

- **By 2018, 196 nations had signed the Convention**
  - **Only the Vatican & U.S.A haven't joined**

CITES Helps, but Poaching is Hard to Stop

- 30,000 elephants still killed per year. Kenya has lost 85% of their elephants, Ethiopia 90%
- 1989 global ivory ban – greatly reduced sales in US, Japan, & Europe (80% of market then)
- Now illegal poaching is worth $10 billion/yr. – China now buys most ivory (Thailand, Hong Kong, Taiwan)

Nearly all ivory is carved into decorative or religious objects

Ethiopia arrested >700 traffickers from 2010-2015, destroyed 6 tons of seized ivory

Militias & terrorist groups seeking to fund their activities through ivory sales, hunt elephants, often inside national parks, loot communities, enslave people, & kill park rangers & soldiers

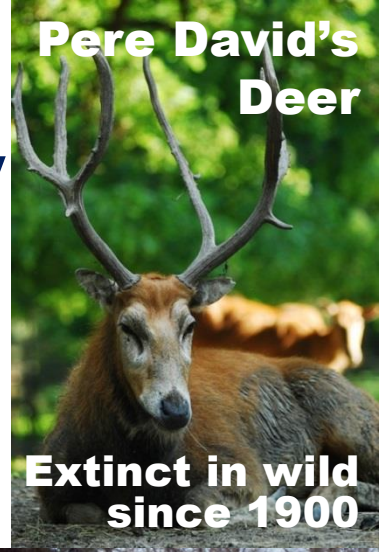
Togolese miltary police seize & guard a shipment of tusks headed to Vietnam

A pair of ivory chopsticks sell for $1,000 & a carved tusk sells for hundreds of thousands of dollars


Ivory Looks Better
on Elephants!

Captive breeding & Reintroduction

- **Individuals are bred & raised so they can be reintroduced into the wild**
  - **65 plant & animal species exist *only* in captivity**
  - **Zoos & botanical gardens**
- **Reintroductions of predators can be controversial**
  - **Wolves in Yellowstone & Western States**
- **Fragmented habitat must be improved before releasing animals**

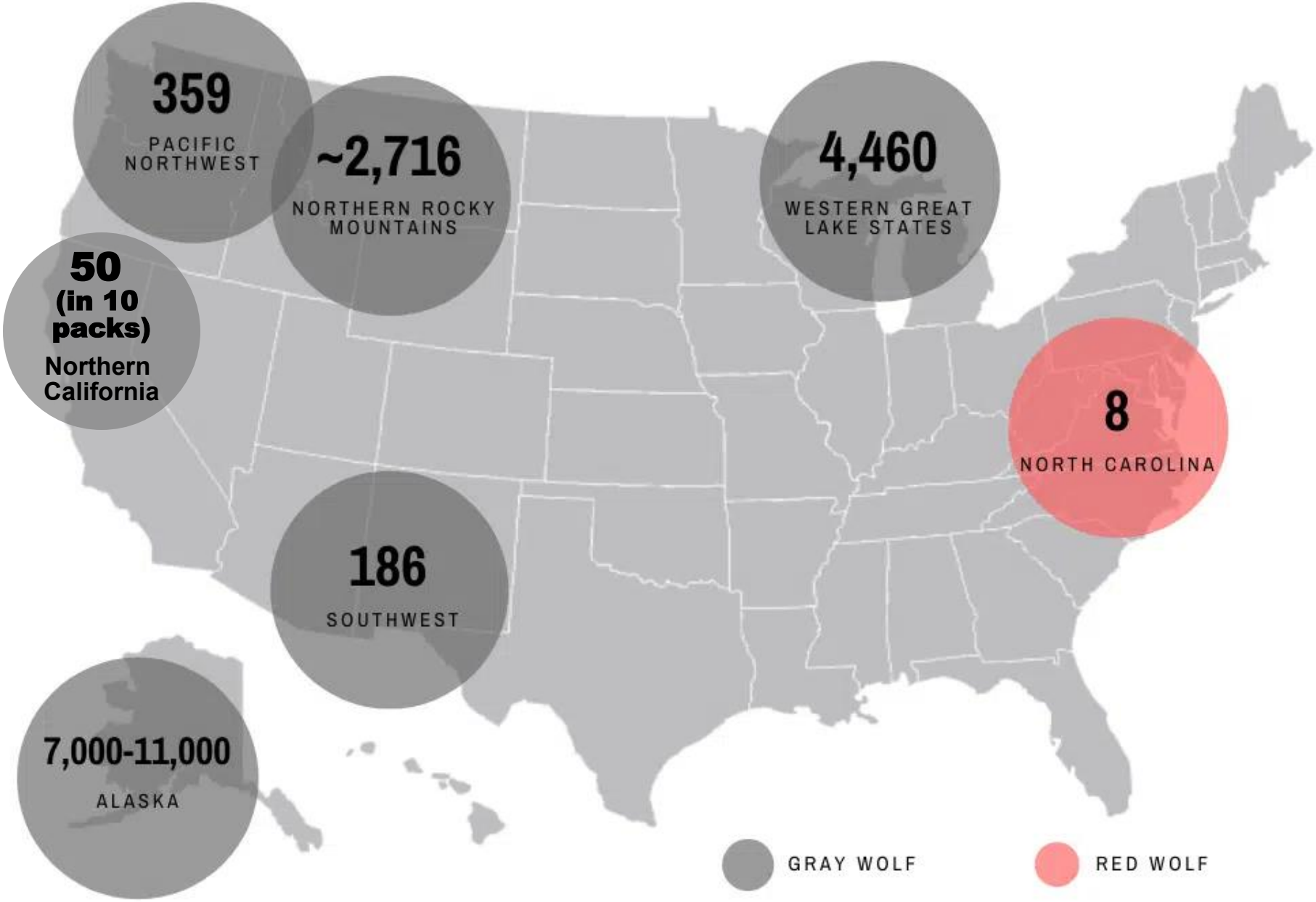


~5,500 wolves in USA lower 48 states now

San Diego Zoo's Center for Reproduction of Endangered Species

Biologists raise condor chicks in captivity with hand puppets that look like heads of adult condors

Estimated number of Wolves in United States



Parks & protected areas

- Setting aside land in parks & preserves, protects habitats, ecosystems, communities, & species
  - –Only 12% of world's land area is in parks, wilderness, reserves, etc., ~7.5% of ocean protected
  - –UN 2020 goal of 10% of ocean protected was not met

- Preserved by Federal, State & county governments; Non-profit groups (Nature Conservancy, Audubon)
- Not all managed for biodiversity, some used for recreation, water protection, etc.

- –Many too small to preserve whole systems

See All National Parks in One Minute

https://www.youtube.com/watch?v=Iva1m8cl9-Q


Redwood National & State Parks
38,982 acres established in 1968
Also a UNESCO World Heritage Site


Spirit Mountain National Monument
500,000 acres, designated March 2023


Crystal Cove State Park of California
3,936-acres established in 1979

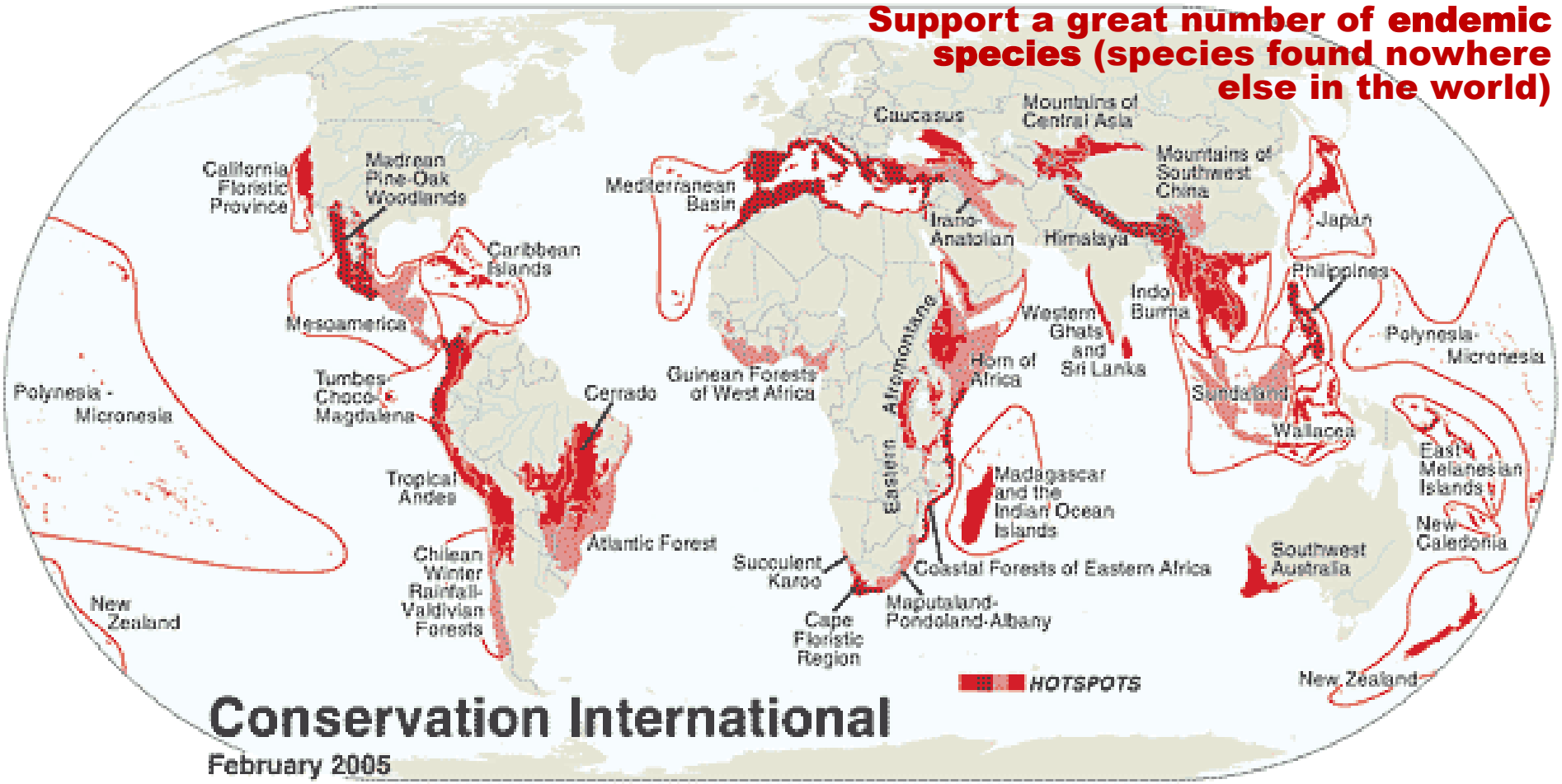

Laguna Coast Wilderness Park
7,000 acres, owned by Orange County Parks

34 global biodiversity hotspots

Most important global areas for conservation

2.3% of the planet's land surface contains 50% of the world's plant species and 42% of all terrestrial vertebrates

Support a great number of endemic species (species found nowhere else in the world)




I’m an umbrella species!
Protect me & you can save far more species & vast forest habitat!