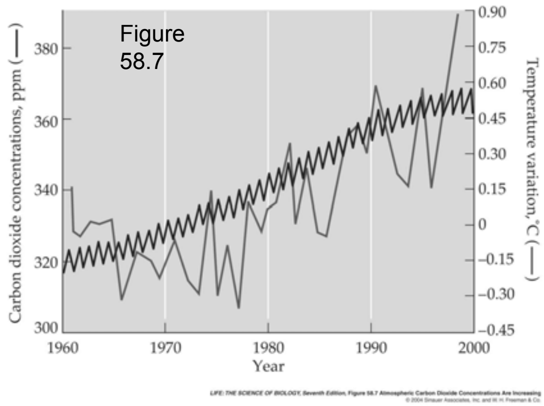
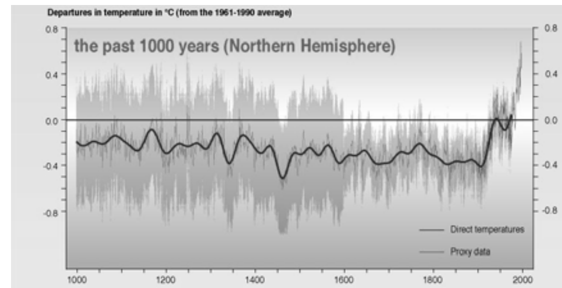


Temp normally fluctuates

Humans are forcing climate change



The Nitrogen Cycle

- Most Nitrogen gas (N_2) (78 %) is in the atmosphere
  - Can plants and animals use this directly?
  - How then?
- Nitrogen fixation by microbes
- **Denitrification -** returns mineral and organic N to the atmosphere (microbes too).

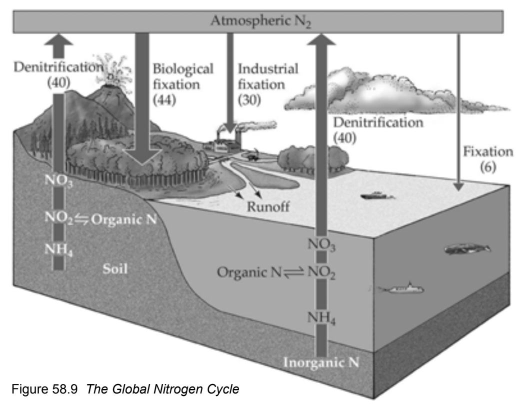


Figure 58.9 *The Global Nitrogen Cycle*

The Nitrogen Cycle

- Humans - N-based fertilizers and burning fossil fuels (which produces nitric oxide).
- Negative effects of changes:
  - contamination of groundwater by nitrate
  - increases in greenhouse gases (nitrous oxide and tropospheric ozone)
- The addition of nutrients to water bodies, called **eutrophication**

Eutrophication and Dead-zones

- Excess nutrients cause algae to rapidly grow
- This depletes the O_2 (as algae choke the water and dead algae decompose)

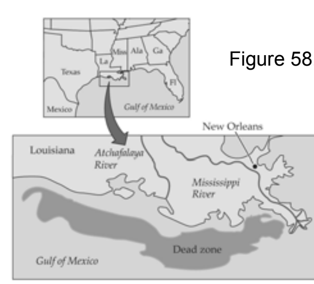
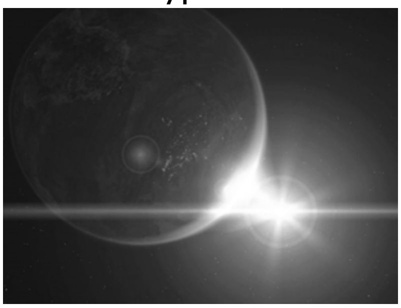


Figure 58.10

Biosphere Ecology
The Gaia Hypothesis



The Gaia Hypothesis – J. Lovelock

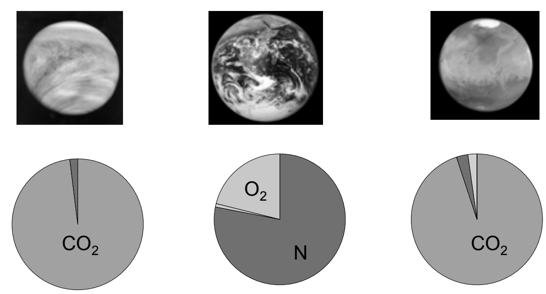
- The Biosphere itself is a **self-regulating system**
- Life functions as a system to regulate temperature, chemical composition, etc. of Earth
- This DOES NOT necessarily mean the Earth is a living organism

Evidence for the Gaia Hypothesis?

- Organisms do influence their environment
  - Ecosystem Engineers – modify the conditions of their environment

Modify their physical and chemical environment to better suit themselves

Evidence for the Gaia Hypothesis



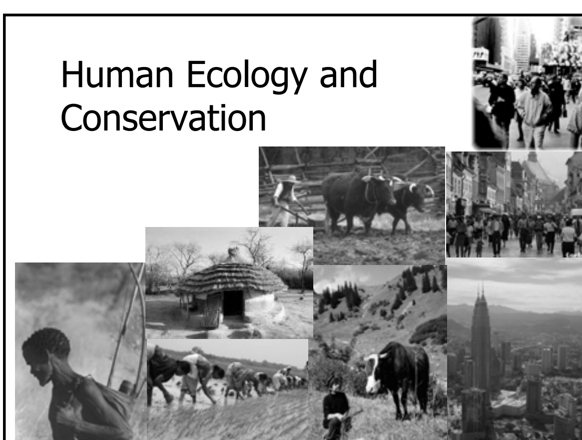
Venus and Mars – rich in CO_2, little N, no O_2 methane
Earth – rich in N, O, little CO_2, some methane

- The atmospheres of Mars and Venus are ‘lifeless’
  - Reflect the abundance of elements in the solar system
- Earth’s atmosphere is out of balance
  - Too much O & methane, too little CO_2
- Composition of Earth’s atmosphere reflects the influence of life:

Where’s all the oxygen from (and where did the CO_2 go?)

What produces methane?

Human Ecology and Conservation



Human Ecology

The study of the interactions between people and their environment

We can study these interactions

In the Past – archaeology, history

In the Present – current human groups/societies

Human Ecology

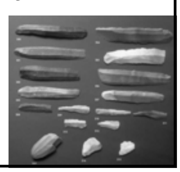
- Humans have **culture**
  Systems of knowledge, behavior and artifacts

Culture allows us to adapt to environments



Humans as predators
Mary Stiner (UA Archaeologist)

- Studies of Paleolithic diet (9k – 100k y ago): these are early humans (hunter-gatherers)
- Looking at remains to reconstruct diet and their interactions with environment

Humans as predators

Diet shift is observed –

Early on – lots of tortoise (slow, lots of meat)

More recent sites – little tortoise, but lots of hares, birds

The people shift to a resource that's harder to catch and has less meat!

Humans as predators

- Tortoises are K-selected
  - Slow population growth
- If human pop is small – not a problem – not enough hunting to affect tortoise populations
- BUT – in the late Paleolithic – human pop begins to grow

Humans as predators

- Human pop growth caused a heavy sustained predation on tortoises
- Tortoise pop decrease dramatically
- Humans then shift the species they are eating
- Despite being more difficult to hunt – hares are more abundant (r-selected)

Humans as predators

From the tortoise and the hare we can see:

(1) How humans as predators influence their prey

(2) The interaction of ecology and culture:

Shifting to a new resource was driven by ecological interactions, and required shifts in culture as well (norms, new tools, strategies, butchering, recipes, etc.)

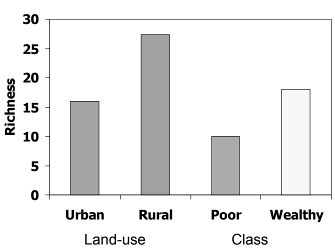
Urban ecology: studying human-environment interactions in and of cities

(1) Ecology in the city

See how organisms respond to urbanization (a disturbance)

Ecology in the city

E.g. How do bird communities respond to urbanization?



Lower bird diversity in the city

Lower diversity in poor neighborhood

Why do bird communities respond to urbanization?

- Urbanization alters bird **habitat**
- Wealthy areas have more parks and use more natural vegetation (more and better habitat)
- It is **decisions (culture)** that influence habitat and determine bird diversity

Urban ecology: studying human-environment interactions in and of cities

(1) Ecology in the city (disturbance)

(2) Ecology of the city

Treat the city as an ecosystem and study its dynamics

Ecology of the city – treat the city as an ecosystem

Study how materials and energy flow into, out of, and through the city

e.g. where does your food come from??

Cities are ecosystems with low primary productivity – they need to import most of it from surrounding areas

Ecology of the city – treat the city as an ecosystem

What controls the flow of energy and materials in an urban ecosystem?

People do – culture, society, economics

What buildings go where
What plants to plant
How much resources (water, food, power) is needed
What products are made there, imported

Culture interacts with organisms and the environment to determine how the ecosystem is going to function

Why Do We Care about Species Extinctions?

We would have a biology of conservation even without an extinction crisis.

1. Benefits from intact natural systems.
2. Ethical concern for species and ecosystems in danger of extinction.

Benefits from nature

- Plants and animals have always been a source of raw materials for humans (food, shelter, medicine).
- Today about half of medical prescriptions contain a natural plant or animal product.

Benefits from nature

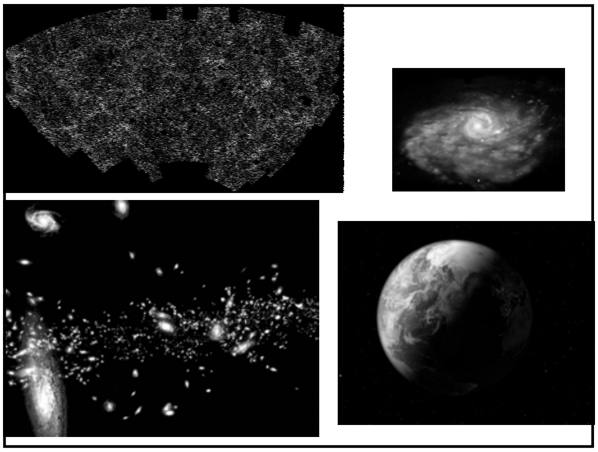
Ecosystem services - benefits from intact ecosystems:

- Maintenance of fertile soils.
- Prevention of soil erosion.
- Detoxification and recycling of waste.
- Regulation of water - reducing runoff, increasing ground water recharge, reducing flooding and erosion.
- Regulation of the composition of the air.
- Pollination.
- The list is long.

Aesthetic and ethical concerns

Biophilia - People evolved in close contact with nature - seem to derive pleasure from contact with nature (or at least "knowing it's there")

- People seem to feel **moral or ethical concern** about watching or causing extinction of species or degradation and loss of ecosystems.



Estimating Current Rates of Extinction

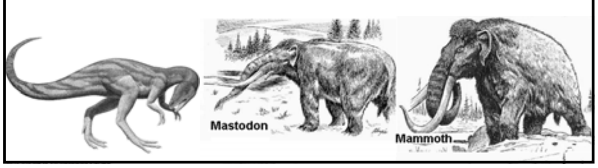
- So, people would want to conserve nature, even if it were not in crisis.
- But nature is in an extinction crisis.
- How bad is it?

Estimating Current Rates of Extinction

A quick and dirty estimate:

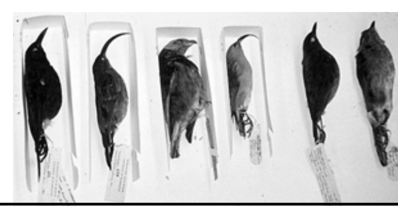
- Fossil evidence suggests average time to extinction for most species is 1-10 million years

$\frac{\text{1-10 mil yrs}}{\text{species}} \Rightarrow \frac{0.01\% - 0.001\% \text{ of species}}{\text{century}}$



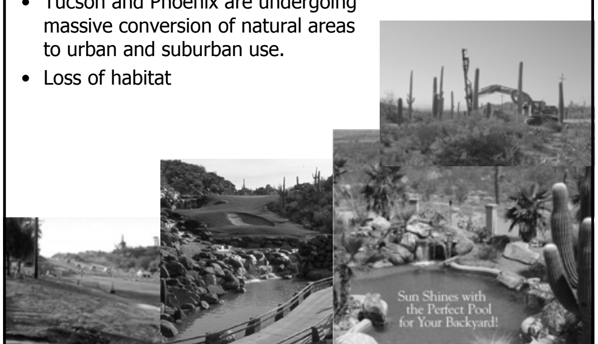
Current extinction rates are much greater than those ‘background’ rates

- 0.01% – 0.001% of all species/century.
- Rate for groups we know about (e.g. birds, mammals) is at about 1% in this past century, 100 - 1000 times the expectation



Estimating Current Rates of Extinction

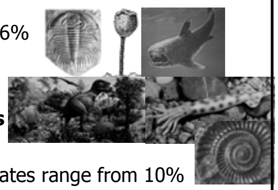
- Tucson and Phoenix are undergoing massive conversion of natural areas to urban and suburban use.
- Loss of habitat



Estimating Current Rates of Extinction

- Deforestation rates in the tropics are high and known.

How Does the Current Mass Extinction Compare to Others?



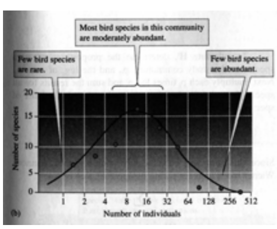
- Late Permian Mass Extinction: 96% of all species became extinct.
- Late Cretaceous: 76%
- **These occurred over millions years.**
- Estimates of current extinction rates range from 10% during the next 20 years to 50% over the next 50 years.
- Our current **rate** of extinction is much higher than the biggies.
- If continued long enough we can surpass the big mass extinctions in total number very fast.

Good News and Bad

- Good News: The earth will recover from the current mass extinction – it always does.
- Bad News: No one you know (or who looks remotely like modern Homo sapiens) will be around to see it!
- It will take 10's of millions of years.

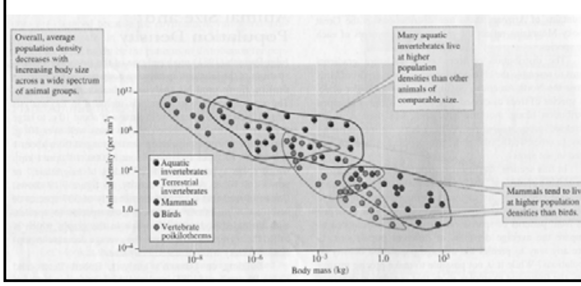
Who Goes Extinct?

- Most species are moderately abundant.
- A few species are rare.
- A few are superabundant.
- **The rare are usually the first to go.**



Who Is Rare?

- Big organisms tend to be the most rare.
- So big organisms tend to go extinct first (gorillas, tigers, condors, whales, elephants, rhinos).



What Is Rarity?

There are seven types of rarity, based on:

1. Geographic range: restricted vs. extensive
2. Habitat tolerance: narrow vs. broad
3. Local population size: small vs. large

There are 8 combinations of these 3 factors (2x2x2=8)

What Is Rarity?

- Species with extensive ranges, broad habitat tolerance and large local populations **are not rare** (starlings, house sparrows, rats, deer mice, dandelions).
- These will inherit the earth.

What Is Rarity?

The other 7 combinations constitute the 7 types of rarity.

(1) Extensive Range, Broad Habitat Tolerance, but Small Local Populations.

E.g., **Peregrine falcon**:

- Range circles the Northern hemisphere in the New and Old World.
- Broad habitat tolerance.
- But, uncommon everywhere: in 1942 there were 350 breeding pairs east of the Mississippi River.

What Is Rarity?

(2) Extensive Range, Broad Habitat Tolerance, but Small Local Populations.

E.g., **tigers**:

- Range once extended from Turkey to eastern Siberia, Java, and Bali.
- Broad habitat tolerance: boreal forest to tropical rain forest.
- But, **uncommon everywhere**.
- Now only found in a series of **fragmented** populations.
- May only survive in zoos (e.g., Siberian tiger).

What Is Rarity?

(3) Extensive Range, Large Populations, but Narrow Habitat Tolerance.

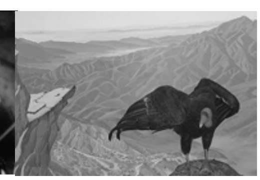
E.g., **passenger pigeon**:

- Range all of eastern US and lower Canada.
- Billions of birds.
- Only nested in huge aggregations in **virgin forests.**
- The forests were cut and commercial hunters exploited remaining nest sites
- Would not breed in captivity.
- Martha died in 1914 in the Cincinnati Zoo.

Total Losers

(4) Restricted Range, Small Populations, and Narrow Habitat Tolerance.

- E.g., mountain gorilla, giant panda, California condor, many island species.



So what's the answer?