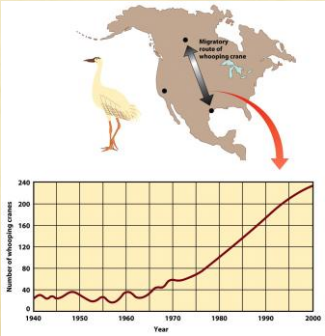
Sustaining Biodiversity: The Species Approach

Chapter 9

Whooping Cranes

- Endangered due to
  - Destruction of wetlands
  - Habitat loss due to urbanization
  - Agricultural modification of their flyways
  - All of these things caused the following:
    - Food web disruption. Loss of breeding grounds
    - Loss of nesting sites. Loss of migration habitat
  - Hunted for a variety of reasons
    - For goods: feathers, meat, skins, eggs, trophies etc.
    - For sport
  - Sometimes killed by accident

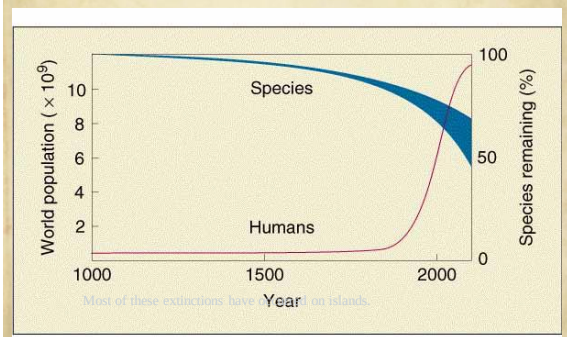
Whooping Crane Migration route and Change in Population from 1940 - 2000



9-1 What Role Do Humans Play in the Premature Extinction of Species?

- ***Concept 9-1A*** *We are degrading and destroying biodiversity in many parts of the world, and these threats are increasing [how?].*
- ***Concept 9-1B*** *Species are becoming extinct 100 to 1,000 times faster than they were before modern humans arrived on the earth (the background rate), and by the end of this century, the extinction rate is expected to be 10,000 times the background rate.*

Human Effect on Biodiversity



Most of these extinctions have occurred on islands.

Extinctions Are Natural but Sometimes They Increase Sharply

- **Background extinction (see concept 9-1B)**
- **Extinction rate (% or number of species going extinct in a given time period)**
- **Mass extinction (50-95%)**: causes?
- Levels of species extinction
  - Local extinction (extinct in local region only)
  - Ecological extinction (ecol role disappears)
  - Biological extinction (all gone forever)
  - Commercial extinction (Overharvest)

Animal Species Prematurely Extinct Due to Human Activities

Some Human Activities Cause Premature Extinctions; the Pace Is Speeding Up

- Conservative estimates of extinction = 0.01-0.1%
  - Growth of human population will increase this loss
  - Rates are higher where there are more endangered species
  - Tropical forests and coral reefs, wetlands and estuaries—sites of new species—being destroyed

The Sixth Extinction

There have been five previous mass extinctions on Earth.

- The last mass extinction 65 million years ago saw the end of the dinosaurs and most marine reptiles.
- The Sixth Extinction refers to the recent and apparently human-induced loss of much of the Earth's biodiversity.

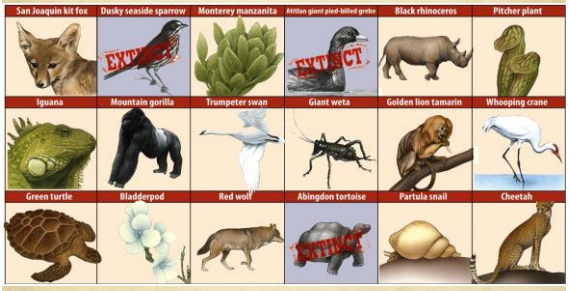
Organism	Total number of species (approx*)	Known extinctions (since ~ AD 1500)
Mammals	5487	87
Birds	9975	150
Reptiles	10,000	22
Amphibians	6700	39
Plants	300,000	114

Estimating Extinction Rates

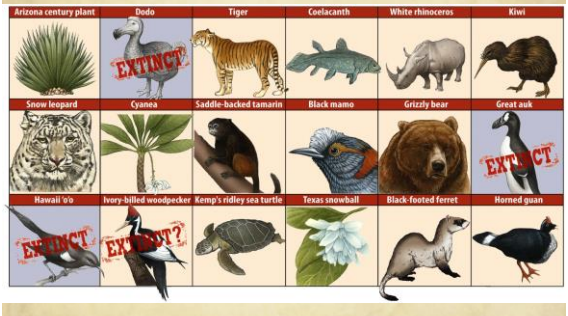
Estimates of the current extinction rate can be made by comparison to the **background extinction rate**.

- It is estimated that one species per million species per year becomes extinct.
- Birds provide the best example of the current rate of extinction because extinctions of various species have been relatively well documented since AD 1500.
- Current extinction rate of birds is **30 times higher** than the expected rate

Extinct Species



Extinct Species



Endangered & Threatened Species

Endangered Species

- Species that faces threats that may cause it to become extinct within a short period

Threatened Species

- Species whose population has declined to the point that it may be at risk of extinction

Extinct – no mas!! Ever!! (except the wooly Mammoth… we are bringing it back!!)

Extinct in the Wild – extinct in the wild but still exists in captivity

Extant – Still living

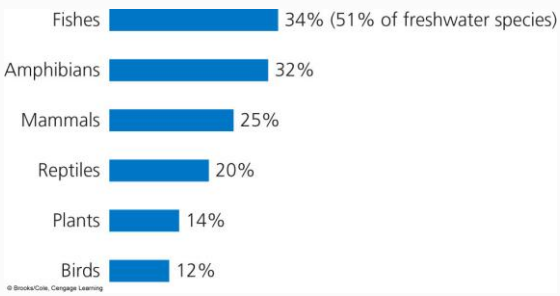
Endangered and Threatened Species Are Ecological Smoke Alarms

- **Endangered species (few survivors, nearly extinct)**
- **Threatened species**, vulnerable species
  - Characteristics of such species
    - Are they tasty?
    - Are they big and/or slow?
    - Do they have valuable body parts?
    - Are they otherwise desirable?

Endangered Natural Capital: Species Threatened with Premature Extinction

Characteristics of Species That Are Prone to Ecological and Biological Extinction

Percentage of Various Species Threatened with Premature Extinction



9-2 Why Should We Care about Preventing Premature Species Extinction?

- ***Concept 9-2*** *We should prevent the premature extinction of wild species because of the economic and ecological services they provide and because they have a right to exist regardless of their usefulness to us.*

Justifications for Preserving Endangered Species

Utilitarian
- How species are useful to HUMANS

Ecological
- How species are necessary to maintain the functions of ECOSYSTEMS, and the BIOSPHERE

Aesthetic
- Enhances our lives by their BEAUTY

Cultural
- Many indigenous people rely on certain organisms for their very survival.

Moral
- All species have a RIGHT to exist

Conservation Biology

Scientific study of how humans impact organisms and the development of ways to protect biodiversity

- Involves:
  - Protecting habitats
  - Restoring damaged or destroyed habitats
  - Zoos, aquaria, botanical gardens
  - Seed banks

Classic Cases of Wildlife Management

- The American Grizzly Bear
  - Endangered due to hunting & habitat destruction
- The American Bison
  - Hunted for their hides
  - Killed in war against native Americans
  - Recovering due in part to ranchers raising them for profit
- A common goal in wildlife conservation is to “restore” the abundance of a species
- Adequate information of the abundance of a species is very rare

Conservation

In 1992 the **Convention on Biological Diversity** was adopted in Rio de Janeiro.

- It is an international treaty that aims to conserve biodiversity, use biodiversity in a sustainable way, and ensure that the benefits of genetic resources are shared equally.

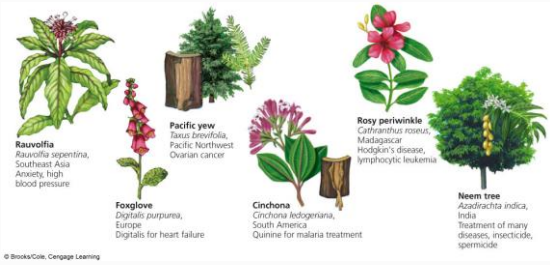
Ex-situ conservation includes using zoos for breeding programs and education.

In-situ conservation involves restoring ecosystems and protecting wildlife populations.

Species Are a Vital Part of the Earth's Natural Capital

- **Instrumental value**
  - **Use value**
    - **Ecotourism**: wildlife tourism (examples?)
    - Genetic information
  - **Nonuse value**
    - Existence value
    - Aesthetic value
- **Ecological value (larger picture?)**

Natural Capital: Nature's Pharmacy



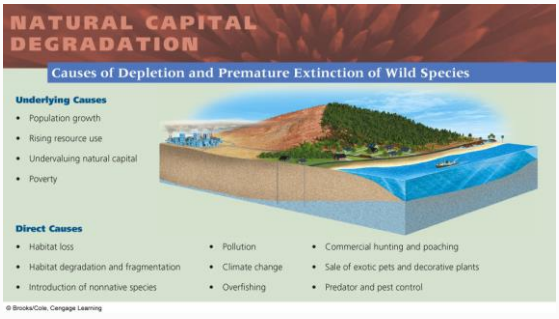
Are We Ethically Obligated to Prevent Premature Extinction?

- **Intrinsic value**: existence value
- Edward O. Wilson: **biophilia** phenomenon
- **Biophobia**

9-3 How do Humans Accelerate Species Extinction?

- ***Concept 9-3*** *The greatest threats to any species are (in order) loss or degradation of its habitat, harmful invasive species, human population growth, pollution, climate change, and overexploitation. (see Fig 9-10)*

Causes of Depletion and Premature Extinction of World Species



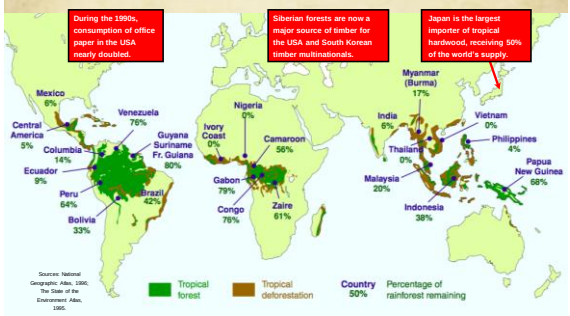
Six major causes of species decline and premature extinction

HIPPCO:

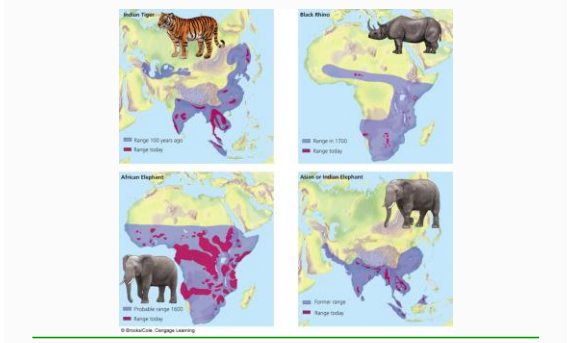
1. **Habitat destruction**
2. **Invasive Species**
3. **Pollution**
4. **Population – Human Population growth**
5. **Climate Change**
6. **Overexploitation – over-consumption of animal's resources and/or over-hunting**

1. Habitat Destruction

Almost half of the world's **rainforests** are in just three countries: Brazil in South America, Zaire in Africa, and Indonesia in SE Asia.



Natural Capital Degradation: Reduction in the Ranges of Four Wildlife Species



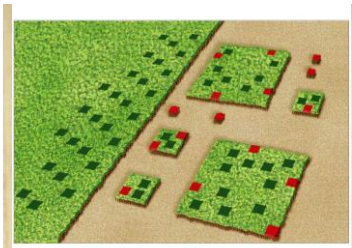
1. Habitat Destruction

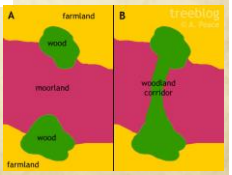
1a. Habitat Loss

- The **largest** threat
- The Giant Panda is a prime example

1b. Habitat Fragmentation

- Separation of wilderness areas from other wilderness areas
  - Increased **extinction** of local species
  - **Disruption** of ecological processes
  - New opportunities for invasions by introduced or **exotic species**
  - Increased risk of **fire**
  - **Changes** in local **climate**
- Smaller fragments mean **less biodiversity**
- Geographic isolation leads to **genetic isolation**
- Some organisms need large areas for **hunting** & **reproduction**





2. Invasive Species

Also called **introduced** or **exotic** species.

Those that have evolved in one place and been transported by humans, either **intentionally** or **unintentionally**, to a new region.

- Introductions may be useful, e.g. crop plants and livestock.
- Other introductions may be directly harmful to the environment. Examples include:
  - Kudzu in southeastern USA
  - Cane toads in Australia
  - Rats in New Zealand

Sheep are a common and useful introduced species.

Rats found homes on sailing ships and moved around the world with humans.

Some Deliberately Introduced Species Can Disrupt Ecosystems

- Most species introductions are beneficial
  - Food
  - Shelter
  - Medicine
  - Aesthetic enjoyment
- Nonnative species may have no natural
  - Predators
  - Competitors
  - Parasites
  - Pathogens

Kudzu

Kudzu (*Pueraria lobata)* is a climbing vine native to south-east Asia.

- It spreads by vegetative reproduction and is a serious invasive pest in the southeastern United States.
- Kudzu was first introduced to the USA in the 1800s as an ornamental plant, and was also widely used as a high protein cattle fodder and to prevent erosion.
- It was listed as a weed in 1970.
- It is estimated that Kudzu covers 3 million hectares (7.4 million acres) of land in southeastern USA.

Kudzu distribution in the USA

Kudzu Taking Over an Abandoned House in Mississippi, U.S.

Red Imported Fire Ant

Red fire ants (*Solenopsis invicta*) were accidentally introduced into the USA from South America in the 1920s.

- They are now resident in 14 US states where they displace native ground-nesting wildlife.
- They also damage crops and can inflict a nasty sting.
- They have thrived in disturbed habitats in North America where they lack a natural control agent.

Spread of red fire ants from South America to North America.

Some Harmful Nonnative Species in the United States

Some Accidentally Introduced Species Can Also Disrupt Ecosystems

- Red Lionfish (Pterois volitans/ miles) in the Atlantic Ocean

- Burmese python (Python bivittatus) in the Florida Everglades

Prevention Is the Best Way to Reduce Threats from Invasive Species

- Prevent them from becoming established
- Learn the characteristics of the species
- Set up research programs
- Try to find natural ways to control them

Characteristics of Invader Species and Ecosystems Vulnerable to Invading Species

Characteristics of Successful Invader Species	Characteristics of Ecosystems Vulnerable to Invader Species
High reproductive rate, short generation time (r-selected species)	Climate similar to habitat of invader
Pioneer species	Absence of predators on invading species
Long lived	Early successional systems
High dispersal rate	Low diversity of native species
Generalists	Absence of fire
High genetic variability	Disturbed by human activities

3. Pollution

Examples: Acid rain, ozone depletion, climate warming, excessive fertilizer, industrial wastes

Endocrine Disrupters

- Interfere with normal hormone action
- Can interfere with animal development
- Are often connected to cancer
- Can interfere with sexual activity (alligators)
- Are found in plastics and some pesticides
- Known endocrine disruptors: dioxin and dioxin-like compounds, polychlorinated biphenyls (PCBs), DDT, and some other pesticides.

FRONTLINE "Poisoned Waters" "Intersex" (3:52)
http://youtu.be/Wl6p_6bqrnM

Indicator / Bellweather Species

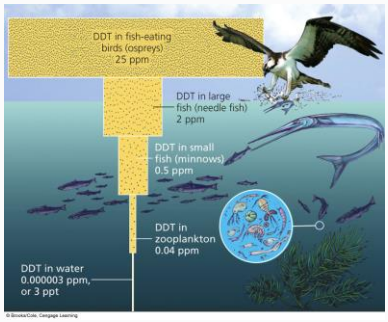
- Amphibians are indicator species
  - In US 38% of amphibian species are declining
  - No single cause has been identified
- Deformities have also been identified (right)

The American Pika: A climate indicator species? (4:20)
http://youtu.be/t31rFXQSUno

Other Causes of Species Extinction (2)

- Pesticides
  - DDT: Banned in the U.S. in 1972
- **Bioaccumulation**
- **Biomagnification**

Bioaccumulation and Biomagnification



4. Population

- Destruction, fragmentation or degradation of habitats
- Little habitat remains for many endangered species

5. Climate Change

Case Study: Polar Bears and Global Warming

- Environmental impact on polar bears
  - Less summer sea ice
  - PCBs and DDT
- 2008: ESA list as “threatened”
- Currently “Vulnerable” = high risk of endangerment in the wild

6. Overexploitation

Its ok to gasp in horror at this picture…

Illegal Killing, Capturing, and Selling of Wild Species Threatens Biodiversity

- Poaching and smuggling of animals and plants
  - Animal parts
  - Pets
  - Plants for landscaping and enjoyment
- Prevention: research and education

Rising Demand for Bush Meat Threatens Some African Species

- Indigenous people sustained by **bush meat**
- More hunters leading to local extinction of some wild animals

The Ivory Trade

- From 1975 to 1989 **the ivory trade** was regulated under **CITES** (the Convention on International Trade in Endangered Species), and permits were required for international trading.

Confiscated Ivory

In response to the **1989** world wide ban on trade in ivory, the Kenyan government publicly burnt 12 tons of **confiscated ivory**. With the increased awareness of the issue, the USA and several European countries banned ivory imports.

Wardens weighing confiscated ivory

Rhinoceros Horn

Black rhinoceros (*Diceros bicornis*) were once plentiful throughout sub-Saharan, southern, and eastern Africa.

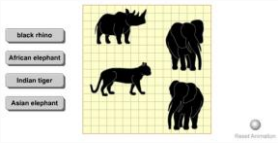
Remnant populations are now only found in Kenya, Tanzania, the Central Republic, Zimbabwe and South Africa.

Kenya has lost 98% of its black rhino population in 17 years.

Animation: Humans affect biodiversity

PLAY

Active Figure: Habitat loss and fragmentation



PLAY

9-4 How Can We Protect Wild Species from Premature Extinction? (1)

- ***Concept 9-4A*** *We can use existing environmental laws and treaties and work to enact new laws designed to prevent species extinction and protect overall biodiversity.*
- ***Concept 9-4B*** *We can help to prevent species extinction by creating and maintaining wildlife refuges, gene banks, botanical gardens, zoos, and aquariums.*

9-4 How Can We Protect Wild Species from Premature Extinction? (2)

- ***Concept 9-4C*** *According to the* ***precautionary principle****, we should take measures to prevent or reduce harm to the environment and to human health, even if some of the cause-and-effect relationships have not been fully established, scientifically.*

International Treaties Help to Protect Species

- 1975: Convention on International Trade in Endangered Species (CITES)
  - Signed by 172 countries
- 1993: Convention on Biological Diversity (CBD)
  - Focuses on ecosystems
  - Ratified by 190 countries (not the U.S.)

Case Study: The U.S. Endangered Species Act (1)

- Endangered Species Act (ESA): 1973 and later amended in 1982, 1983, and 1985; FWS, NMFS
- Identify and protect endangered species in the U.S. and abroad

Confiscated Products Made from Endangered Species

We Can Establish Wildlife Refuges and Other Protected Areas

- 1903: Theodore Roosevelt – credited with establishing five national parks (e.g., Crater Lake)
- Wildlife refuges (e.g., Ding Darling NWR; 10,000 Islands NWR)
  - Most are wetland sanctuaries
  - More needed for endangered plants
  - Could abandoned military lands be used for wildlife habitats?

Gene Banks, Botanical Gardens, and Wildlife Farms Can Help Protect Species

- Gene or seed banks (e.g., Spitzbergen, Norway)
  - Preserve genetic material of endangered plants
- Botanical gardens and arboreta
  - Living plants
- Farms to raise organisms for commercial sale

Zoos and Aquariums Can Protect Some Species

- Techniques for preserving endangered terrestrial species
  - Egg pulling
  - Captive breeding
  - Artificial insemination
  - Embryo transfer
  - Use of incubators
  - Cross-fostering
- But – space and funding limited
- Are these “prisons” for wildlife?

What Can You Do? Protecting Species