Biodiversity and Extinction

• Species, Biodiversity
• Patterns and processes
• Threats to biodiversity
• Extinction
• What’s being done
What is a species?

- **Biological Species Concept**: species are groups of actually or potentially interbreeding natural populations that are reproductively isolated from other such groups.  
  - Ernst Mayr

- Asexual organisms?
- Great Dane and Chihuahua?
- Many other species concepts (phylogenetic, recognition, cohesion, evolutionary, ecological, internodal…)

What is biodiversity?

The number and variety of organisms found within a specified geographic region.
How many species on earth?
1.4 million known…estimates as high as 50-100 million

What factors correlated with high diversity?

- Energy
- Precipitation
- Temperature
- Area
- Stable environment
- Moderate disturbance level

Which of these are we influencing?
Threats to biodiversity – habitat loss

- Long-leaf pine – 90 million acres in the southeast
- 153,200 acres w/ 5,000 old growth
- 0.00005% left
- Red-cockaded woodpecker
- Elgin Air Force Base – 200,000 acres
Threats to biodiversity – biological invasions

• Hawai`i used to sustain at least 140 species of native birds.

• 70 of those species are extinct. Of the 70 surviving, 30 are endangered.

Threats to biodiversity – biological invasions

• Guam: Believed to have been introduced via cargo transported by U.S. military ships during World War II.

• Abundance: Up to 13,000 snakes per square mile on Guam.

• Has virtually wiped out the native forest birds of Guam, including the flightless rail. Twelve species of bird unique to the island have disappeared as a direct result of brown tree snake predation.
Cost of biological invasions?

Pimentel et al. (2000) estimate that invasive species cause economic losses in the U.S. of over $122 billion per year.

http://www.unk.edu/acad/biology/hoback/escape/

Extinction

- Over 99% of all species that have ever existed are now extinct.

- So what’s the big deal?
Extinction Rates

• Current extinction rates are thought to be 1,000 to 10,000 times higher than background extinction rates

What does a given species need to survive?
• **Minimum Viable Population** - for any given species in any given habitat is the smallest isolated population having a 99% chance of remaining extant for 1000 years despite the foreseeable effects of *demographic, environmental and genetic stochasticity, and natural catastrophes.*”
  Schaffer – 1981

• **Minimum Dynamic Area** – the area of suitable habitat necessary for maintaining the minimum viable population.

---

**Effective Population Size**

• \[ N_e = \frac{4N_mN_f}{N_m+N_f} \]

• Eg: a population of seals with 6 females and 150 males?

• \[ N_e = \frac{4\times6\times150}{6+150} = 23 \]
6\textsuperscript{th} Mass Extinction

• Right here, right now.

• Over the past 500 years, scientists have recorded about 250 species extinctions among mammals, birds, amphibians, reptiles, and conifers.
http://www.well.com/user/davidu/extinction.html

http://www.glrc.org/mp3/1999/06/28/graham.mp3
What are we losing?

www.redlist.org/

Mammals
Birds
Reptiles
Amphibians
Insects
Molluscs
Plants

Amphibian Decline

1/3 of world’s 6000 amphibian species face extinction

Climate Change Drives Amphibian Extinctions, Scientists Say
http://usinfo.state.gov/utils/printpage.html

The Frog Man of the Sonoran Desert
• Vaquita, or Gulf of California harbor porpoise (*Phocoena sinus*)

• Total remaining: only about 500

• North Pacific Right Whale (*Eubalaena japonica*)

• Population in the hundreds?
• Javan Rhino
  \textit{(Rhinoceros sondaicus annamiticus)}

• Total remaining: about 70

Losing 60 Million Years of Evolution?
• Mountain gorilla
  (Gorilla gorilla)
• Shares 96% of its DNA with Homo sapiens.
• About 650 left.

http://www.animalinfo.org/rarest.htm

• Baiji (Yangtze River Dolphin) (*P) - ...only a few tens of individuals... (Reeves et al. 2000)
• Vancouver Island Marmot (*P) - ...at least 24... (Bryant 2002)
• Seychelles Sheath-tailed Bat (*P) - ...fewer than 50 individuals... (IUCN cited in Nowak 1999)
• Javan Rhino (*P) - ...fewer than 30... (Intl. Rhino Found. 2002)
• Great Palaearctic Hare (Assam Rabbit) (*P) - ...110... (Kavitha 2001)
• Northern Hairy-nosed Wombat (*P) - ...113... (Queensland Parks Wildl. Serv. 2003)
• Tamaraw (Dwarf Water Buffalo) (*P) - ...the total population is thought to be about 30... (IUCN 2002)
• Dwarf Blue Sheep (*P) - ...approximately 200... (Wang et al. 2000)
• Tonkin Snub-nosed Monkey (*P) - ...about 200... (Cons. Intl. 2000)
• Yellow-tailed Woolly Monkey (*P) - ...fewer than 250... (IUCN 2002)
• Kouprey (Cambodian Forest Ox) (*P) - ...generally assumed to be less than 250... (IUCN 2002)
• Malabar Large Spotted Civet (*P) - ...fewer than 250 mature individuals are thought to survive... (Nowak 1999)
• Sumatran Rhino (*P) - ...fewer than 300... (Intl. Rhino Found. 2002)
• Iberian Lynx (*P) - ...150 - 300... (Cat News 2003)
• Visayan Spotted Deer (*P) - ...a few hundred... (Heaney and Regalado 1998)
• Indus River Dolphin (*P) - ...hundreds... (Reeves et al. 2000)
• Saola (Vv Quang Dz) (*P) - ...estimated at several hundred... (WCWC/WWF 1997)
• Hirola (Hunter's Hartebeest) (*P) - ...by 1995 numbers were down to 300... (Kingston 1997)
• African Wild Ass (*P) - ...possibly only a few hundred... (WCWC/WWF 1997)
• Addax (*P) - ...may not exceed a few hundred... (Malton & Kingswood 2001)
• Black-faced Lion Tamarin (*P) - ...as few as 400... (Ballou & van Roode 2002)
• Ethiopian Wolf (*P) - ...442 - 487... (Marino 2003)
• Vaquita (*P) - ...about 500... (Focus 2002a)
• Arabian Oryx (*P) - ...approximately 500 animals in the wild... (re-introduced) (AZA 1998)
• Mediterranean Monk Seal (*P) - ...only 600 monk seals survive in the Mediterranean... (Oryx 1999)
• Hairless Deer Lemur (*P) - ...estimated to number between 100 - 1000... (IUCN 2002)
• Riverine Rabbit (*P) - ...the actual population is probably well below 1000 animals... (Stuart & Stuart 1996)
• Muriqil (Woolly Spider Monkey) (*P) - ...700 - 1000... (Emmons & Feer 1997)
• Giant Panda (*P) - ...about 1000... (Starbridge 2000)
• Golden Lion Tamarin (*P) - ...1000... (Stuart 2003)
• Golden Bamboo Lemur (*P) - ...about 1000 individuals... (IUCN 2002)
• Golden-rumped Lion Tamarin (*P) - ...1000... (Ballou & van Roode 2002)
• Greater Bamboo Lemur (*P) - ...1000 individuals... (IUCN 2002)
Is the current extinction crisis limited to the 20\textsuperscript{th}/21\textsuperscript{st} centuries?

Well, no.
Megafaunal Extinction

What’s being done?
Endangered Species Act

• Made law 1973
• “...provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and to provide a program for the conservation of such species.”

I.U.C.N.
(world conservation union)
http://www.iucn.org/

• Its members from some 140 countries include over 70 States, 100 government agencies, and 750-plus NGOs.

• The IUCN Red List is the world's most comprehensive inventory of the global conservation status of plant and animal species.
C.I.T.E.S.

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora, is an international agreement between Governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.
- 164 countries
- www.cites.org

CRES
(The Center for Reproduction of Endangered Species)

In November 1999, the Center produced the world's first interspecies transfer using an embryo that had been frozen and thawed. "Cayenne," a domestic house cat, gave birth to "Jazz," an African wildcat (Felis silvestris).
Some NGO’s

- www.conservation.org
- www.zerorevolution.org
- www.worldwildlife.org
- www.nature.org
- www.sierraclub.org
- www.friendsofearth.org

Priorities?
Biodiversity hotspots

The 25 biodiversity hotspots contain 44 percent of all plant species and 35 percent of all terrestrial vertebrate species in only 1.4 percent of the planet's land area.

Whoa… I’m like pretty depressed now.

But wait….
Success stories – Black footed ferret

- Thought extinct in the wild till a small population found in Wyoming in 1981.
- FWS captive breeding program has brought their numbers from 18 up to >1000.

Success stories – Guam Rail

- Introduction of Brown Tree Snake in Guam reduced population to 21 birds
- Through captive breeding biologists were able to release 267 birds
- Also reintroduced to Guam
Success stories – Bald Eagle

• Recently downlisted as threatened, the bald eagle is beginning to make a comeback in Maine, New York, New Jersey, New Hampshire, Massachusetts, Vermont and Connecticut.

• Although banning DDT had a positive impact on this species, habitat loss has been a major cause of its decline.

Success stories - ESA

• To date, eight species have been removed from the endangered species list and more than 25 are approaching recovery goals. Approximately forty percent of all species now on the list are either stable or improving.
What can you do?