Chapter 7: The Extinction Process
Extinction as a normal process

• **Causes**
  – random catastrophic events
  – biological interactions
    • competition
    • disease
    • predation
  – chronic physical stress
  – frequent arbitrary disturbances
Vulnerability to extinction

• Why are some species rarer than others?
  – restricted to an uncommon type of habitat
    • vernal pool habitats
    • desert springs
  – confined to small ranges by geographic barriers
    • islands in the ocean or lakes surrounded by land
    • soil types (e.g., Amazonian plants)
  – occur at low population densities for other reasons (e.g., body size, behavior)
Figure 7.2. Three ways a species can be rare.

- **African cichlids**
- **Dwarf naupaka:** 4 populations on beach dunes of Maui
- **Hawaiian hawk** on island of Hawaii
- **Proboscis monkey** in Borneo mangrove swamps
- **Maned wolf**
- **Cave salamander and NE beach tiger beetle**
Extinction on islands

• **Natural extinction rates on islands > continents**
  – evolution on islands of fearless species without predators
  – evolution of flightless birds
Endemic species on islands

- Polynesian colonization of Hawaiian islands
  - 400-600 AD through present
  - effects on indigenous bird species
    - 68 species prior to Polynesian colonization
    - 24 now extinct
    - 29 endangered
    - 15 threatened

78% of all species that originally inhabited the islands
Endemic species on islands

- Hawaiian honeycreepers
  - 13 species have gone extinct
Endemic species on islands

- Hawaiian honeycreepers
  - 12 species are endangered
Endemic species on islands

• Hawaiian honeycreepers
  – only 1 species has healthy populations

Hawaiian Amakihi
Endemic species on islands

• Madagascar
  – over evolutionary period of 20 million years, native flora >10,000 taxa, 90% endemic
  – endemic lemurs
    • 14 species became extinct 1500 years ago with arrival of first aboriginal colonists
    • 15 species remain, all endangered
Extinction in small populations

• **Colonial species**
  – require critical density in order to survive and reproduce
  – habitat management can force population densities below critical sizes and although suitable habitat remains, there are not enough individuals to maintain reproduction → population dies out
Extinction in small populations

- Colonial species
  - example: passenger pigeon
Extinction in small populations

• **Demographic stochasticity**
  – random variation in mortality and survivorship due to chance accidents involving individuals
  
  – can eliminate small populations in a short period of time
  
  – example: population with too few breeding females that fail to reproduce or fail to produce viable young
Extinction in small populations

• **Environmental stochasticity**
  – *random variations in the environment that affect mortality and survival*
    • climate change
    • food / nutrient / water availability
    • cover
    • pollution
    • interactions with other organisms

  – can eliminate small populations in a short period of time
Extinction in small populations

- **Catastrophes**
  - dramatic events that occur at random intervals
    - droughts / floods
    - hurricanes
    - fires
  - can eliminate small populations almost instantaneously
Extinction in small populations

• Genetic stochasticity
  – random variations in the gene frequencies of a population resulting from genetic drift, bottlenecks, inbreeding or similar factors
  – examples
    • northern elephant seals
    • cheetahs
Extinction of the heath hen

Figure 7.12. A combination of factors drove the heath hen, once widespread in the eastern United States, into extinction, including environmental stochasticity (unusual weather events), demographic stochasticity (skewed sex ratios), genetic stochasticity (loss of genetic variation due to small population size), and catastrophes (fires). (Photo by Steven Holt/Aigrette Stockpix.)
Vulnerability to extinction

• **Species with small population sizes**

  – especially true for large-bodied animals with low reproductive potential

  – examples

    • mammals: whales, rhinoceros, great apes
    • birds: whooping crane, California condor
Vulnerability to extinction

• Species with small population sizes
  – dodo
Vulnerability to extinction

- Species with small population sizes
  - dodo and tambalacoque
Vulnerability to extinction

• Species with high economic value
  – whales
  – sea turtles
  – rhinoceros
  – elephants
  – large cats
  – great auk
Vulnerability to extinction

- Top carnivores at ends of long food chains
  - predatory birds, reptiles, large cats
  - at risk also because toxicants bioaccumulate and biomagnify up food chains
Vulnerability to extinction

• Island species

  – also local insular habitats

  – small scale disturbances have extremely large effects

  – examples

    • many toad and frog species, as well as other amphibians, especially in Texas

    • Hawaiian and Madagascar species
Vulnerability to extinction

• Specialist species
  – colonial species
  – food specialists
    • panda (bamboo)
    • black-footed ferret (prairie dogs)
  – habitat specialists
    • wetland species
    • birds
CITES

• Convention on International Trade in Endangered Species
  • International agreement among governments to ensure that international trade in wild organisms does not threaten their survival

• Voluntary
  – 175 nations at present
  – US was first to enter in 1975
  – Solomon Islands and Kyrgyzstan in 2007
  – Oman in 2008
  – Armenia, Bosnia and Herzegovina in 2009
How does CITES work?

• **Appendix I**
  – species threatened with extinction
  – trade permitted only in exceptional circumstances

• **Appendix II**
  – species not necessarily threatened with extinction
  – trade must be controlled in order to avoid overutilization

• **Appendix III**
  – species that are protected in at least one country
  – CITES members have been asked to assist in limiting trade
CITES financial support

• **CITES Trust Fund**
  – contributions from CITES member nations
  – UN scale of assessment
  – 2009 contributions = $5,164,613 for all member nations
    • U.S. = $1,135,359 (22%)
    • 38 nations contribute $49 each
    • lowest assessed contribution: Solomon Islands at $29
CITES financial support

- **External funding for projects**
  - population surveys, management plans, etc.
  - 2004
    - U.S. highest contributor at $161,708 (21%)
    - Great Britain second
  - 2007
    - Australia highest contributor at $269,532 (31% of $871K)
    - U.S. 8th at $27,200
  - 2008
    - Japan highest contributor at $108,083 (20% of $565K)
    - U.S. 8th at $15,000
    - two private foundations contributed $127K (22%)
Endangered Species Act (1973)

• **Purpose**: “to conserve the ecosystems upon which endangered and threatened species depend and to conserve and recover listed species”

• **Endangered species**: in danger of extinction throughout or in a significant portion of its range

• **Threatened species**: likely to become endangered within the foreseeable future
Endangered Species Act

• U.S. Fish and Wildlife Service and National Marine Fisheries Service

• partnerships with States

• partnerships with non-Federal landowners
Endangered Species Act

• **Listed species**
  – “best scientific and commercial data available”
  – made solely on species’ biological status and threats to their existence

• **Candidate species**
  – species with enough information to propose listing, but have not been listed as yet
  – conservation actions put in place to prevent need for listing
Endangered Species Act

• **Recovery**
  – ultimate goal of ESA
  – recovery plans to restore species to ecological health
  – involvement of public and interested stakeholders
  – e.g., bald eagle
Endangered Species Act

• **Critical habitat**
  – geographic areas with physical/biological features essential to the conservation of listed species
  – may require special management considerations or protection
  – may include areas not occupied by the species at the time of listing but that are essential to the conservation of the species
  – affects only federal agency actions or federally funded or permitted activities
### Threatened and Endangered Species in the U.S.

<table>
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<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Listed species of animals</td>
<td>517</td>
<td>518</td>
<td>566</td>
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<td>744</td>
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<td>Total</td>
<td>1260</td>
<td>1264</td>
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Summary of Listed Species
Listed Populations\(^1\) and Recovery Plans\(^2\) as of 10/23/2008

<table>
<thead>
<tr>
<th>Group</th>
<th>United States</th>
<th>Foreign</th>
<th>US Listings with active Recovery Plans(^3)</th>
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<tr>
<td></td>
<td>Endangered</td>
<td>Threatened</td>
<td>Total Listings</td>
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<tr>
<td>Mammals</td>
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<td>14</td>
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<tr>
<td>Birds</td>
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<td>90</td>
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<tr>
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<td>Amphibians</td>
<td>13</td>
<td>11</td>
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<td>Fishes</td>
<td>74</td>
<td>65</td>
<td>139</td>
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<td>Clams</td>
<td>62</td>
<td>8</td>
<td>70</td>
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<td>Snails</td>
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<td>Conifers and Cycads</td>
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<tr>
<td>Grand Total</td>
<td>1049</td>
<td>309</td>
<td>1358</td>
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</tbody>
</table>
Modern-day causes of extinction

Number 5: Wildlife trade

– New world monkeys

Black bearded saki

Golden lion tamarin
Modern-day causes of extinction

Number 5: Wildlife trade

– Amazon fish

Cardinal tetras  Black neon tetra  Tambaqui
Modern-day causes of extinction

Number 5: Wildlife trade

– Australian parrots
– Other neotropical birds

Australian king parrot
Modern-day causes of extinction

Number 4: Predator and pest control

– Large predators
  • Wolves
  • Bears
  • Large cats

Mexican gray wolf
Modern-day causes of extinction

Number 4: Predator and pest control

– Carolina parakeet
Modern-day causes of extinction

Number 3: Overexploitation

– major cause of extinction in 19th and early 20th centuries

– examples
Modern-day causes of extinction

Number 3: Overexploitation

– Dodo (will the Tambalacoque tree be next?)
Modern-day causes of extinction

Number 3: Overexploitation

– Great auk
Modern-day causes of extinction

Number 3: Overexploitation

– Passenger pigeon
Modern-day causes of extinction

Number 3: Overexploitation

– Marine mammals: Steller’s sea cow
Modern-day causes of extinction

Number 3: Overexploitation

– Marine mammals: Caribbean monk seal
Modern-day causes of extinction

Number 2: Introduction of exotic species

- animals
- plants
- feral domesticated species
- invasive species
Modern-day causes of extinction

Number 1: Habitat alteration / disruption

– Major cause of extinction since mid-20\textsuperscript{th} century

– Forms of habitat destruction

  • logging and deforestation
  • drainage of wetlands
  • damming of rivers
  • urban development
  • agriculture

– Examples
Modern-day causes of extinction

Number 1: Habitat alteration / disruption

– American ivory billed woodpecker

*may not be extinct after all!*
Modern-day causes of extinction

Number 1: Habitat alteration / disruption

– Dusky seaside sparrow
Modern-day causes of extinction

Number 1: Habitat alteration / disruption

– Black footed ferret
Habitat fragmentation

• Increases vulnerability to human activities
  – exposure to pesticides
  – air pollution
  – noise and light
  – intrusion disturbances
Habitat fragmentation

- **Edge effects** on small nature reserves of equal area but different shapes; circle has greater interior habitat
Habitat fragmentation

• Effects on migratory species
  – North American songbirds
    • nesting versus stopover versus wintering habitat
    • loss of these habitats?
    • increased nest predation?
Population decline of migrant and nonmigrant birds in Rock Creek State Park, MD

<table>
<thead>
<tr>
<th>Species</th>
<th>Mean number of pairs sighted</th>
<th>% change</th>
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<tbody>
<tr>
<td></td>
<td>1940s</td>
<td>1980s</td>
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<tr>
<td><strong>Migrants</strong></td>
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<tr>
<td>Red-eyed vireo</td>
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<td>Ovenbird</td>
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<td>3.5</td>
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<td>Yellow-throated vireo</td>
<td>6.0</td>
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<tr>
<td>Hooded warbler</td>
<td>5.0</td>
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<tr>
<td>Eastern wood peewee</td>
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<tr>
<td>Black-and-white warbler</td>
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<tr>
<td><strong>Nonmigrants</strong></td>
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<td>Carolina chickadee</td>
<td>5.0</td>
<td>4.3</td>
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<td>Tufted titmouse</td>
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<td>4.5</td>
</tr>
<tr>
<td>Downy woodpecker</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>White-breasted nuthatch</td>
<td>3.5</td>
<td>3.1</td>
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Habitat fragmentation

- **Effects on migratory species**
  - migratory fish species (e.g., Pacific salmon)

- Chinook
- Chum
- Sockeye
- Coho
- Pink
- Steelhead
Endangered and threatened species in Texas: examples

- Whooping crane
- Attwater’s prairie chicken
- Houston toad
- Kemp’s Ridley sea turtle
Whooping crane

- *Grus americana*
- listed as endangered since 1970
- tallest North American bird
- flies with neck and legs fully extended
- bugle-like trumpet call
- similar in appearance to sandhill crane
Whooping crane

• **Historical range**
  – Arctic coast to central Mexico
  – Utah to New Jersey

• **Historical breeding range**
  – central Illinois through Iowa and North Dakota to Alberta
  – disappeared from most of this range by 1890s
Whooping crane

- **Historical population sizes**
  - 500-1400 in 1870
  - declined rapidly in late 19\textsuperscript{th} century
  - by 1937 only two small breeding populations
    - nonmigratory population in SW Louisiana
    - migratory population wintering on Aransas NWR and nesting in unknown location (discovered in 1954 in what is now known as Wood Buffalo National Park in Canada NW Territories)
Whooping crane
Whooping crane

• Habitat
  – nesting
    • poorly drained wetlands interspersed with potholes
    • nests in rushes, sedges of marshes and sloughs
  – migration
    • croplands used for feeding
    • large wetland areas used for roosting and feeding
  – wintering
    • 22,500 acres of marshes and salt flats on Aransas NWR
Whooping crane

• Life history
  – mate for life at 3-4 years of age
  – can live 22-24 years in wild, 30-40 years in captivity
  – leave Aransas NWR in late March; arrive Wood Buffalo NP in late April
  – nests of 2 eggs hatch May-June
  – feed on large insect nymphs or larvae, frogs, rodents, small birds, fish and berries
Whooping crane

• **Life history**
  – migrate to Aransas beginning in September as single, pair, family group or small flock
  – arrive Aransas late October and set up territories
  – feed on blue crabs, clams, wolfberry fruits
Whooping crane

• **Threats and reasons for decline**
  – agriculture in Great Plains of U.S. and Canada
  – human disturbance
  – Gulf Intracoastal Waterway: petrochemical products
  – hunting and/or poaching
  – biological factors
    • delayed sexual maturity and small clutch sizes
    • drought during breeding season
    • diseases
    • migration hazards
Whooping crane

• **Status**
  – 1938-1939: 14 adults and 9 juveniles
  – 1995: 133 total (43 nesting pairs); >200 at present

• **Efforts toward recovery**
  – legal protection, habitat protection and research at Aransas and Wood Buffalo
  – monitoring programs
  – habitat management: prescribed burning
  – ecotourism
Attwater’s prairie chicken

- *Tympanuchus cupido attwateri*
- Listed as endangered since 1967
Attwater’s prairie chicken

- Grouse family
- Found only in the coastal prairie of Texas
- Requires mixture of native grasses at different heights
  -短草覆盖：求偶，觅食，避免降雨
  -中草覆盖：栖息，觅食
  -高草覆盖：筑巢，闲逛，觅食，逃生覆盖
Attwater’s prairie chicken

• Preferred habitat
  – tallgrass prairie dominated by bunchgrasses: little bluestem, indiangrass, switchgrass, big bluestem
  – flowering plants: *Ruellia*, yellow falsegarlic, ragweed
  – open prairies without any woody cover: avoid areas with >25% shrub cover
Attwater’s prairie chicken

- Preferred habitat
Attwater’s prairie chicken

• **Life history**
  – **leks**: booming grounds
  – mating
  – nests: clutch sizes 4-15 eggs
  – causes of nest failures
    • predators
    • heavy or frequent rainfall
  – feed on green foliage, seeds, insects
Attwater’s prairie chicken

• Threats and reasons for decline
  – habitat loss and alteration
  – introduced grasses: coastal bermuda grass
  – invasion of woody species: Chinese tallow and *Baccharis*

  – urbanization and industrial expansion
Attwater’s prairie chicken

• **Status**
  – in serious decline
  – <30 birds remain in wild
  – two populations: Attwater’s Prairie Chicken NWR; Texas City Preserve
  – 2007 attempt to establish a new population on a private ranch in
Attwater’s prairie chicken

- Attwater Prairie Chicken National Wildlife Refuge
- Nature Conservancy Texas Prairie Preserve
- Private ranch, Goliad

Source: U.S. Fish and Wildlife Service
Attwater’s prairie chicken

• **Efforts toward recovery**
  – grazing management
  – prescribed burning
  – brush management
Houston toad

- *Bufo houstonensis*
- Listed as endangered since 1970
- Light brown to purplish gray; 2-3.5” long
Houston toad

• **Habitat requirements**
  
  – deep (>40”), sandy soils within Post Oak Savannah vegetational area of east central Texas
  
  – still or slow-moving water that persists for ≥30 days; without predatory fish
Houston toad

• Threats and reasons for decline
  – habitat loss and alteration
    • loss of wetlands (conversion to land or open water)
    • clearing of native vegetation near breeding ponds and nearby uplands
    • high traffic roads
    • continuous grazing and fire suppression
  – drought
  – red imported fire ant
  – pesticides and organic chemicals
Houston toad

• **Status**
  – populations are extremely fragmented; most habitat permanently destroyed
  – extirpated from Harris, Galveston, Brazoria counties
  – largest population in Bastrop State Park

• **Efforts towards recovery**
  – research into life history and habitat requirements
  – landowner cooperation
Kemp’s Ridley sea turtle

- *Lepidochelys kempii*
- Listed as endangered since 1970
Kemp’s Ridley sea turtle

- Smallest sea turtle (28” and 75-100 lbs)
- Generally found only in Gulf of Mexico
- Prefer shallow waters, feed at bottom
- Hatchlings: surface drifters (pelagic phase)
- Adults: depth related to body size
Kemp’s Ridley sea turtle

• Life history
  – nesting beach at Rancho Nuevo, on Gulf of Mexico coast in state of Tamaulipas, Mexico (100 miles north of Tampico)
Kemp’s Ridley sea turtle

• **Life history**
  – feed on crabs, shrimp, snails, sea urchins, jellyfish, fish
  – females nest in large groups (arribazones) over a period of hours or days
Kemp’s Ridley sea turtle

• **Life history**
  – Nest mainly during the day; lay 1-3 clutches per season; 100 eggs per clutch
Kemp’s Ridley sea turtle

- **Life history**
  - incubation of 50-55 days; warm temperatures produce primarily females and cool temperatures males; eggs hatch, juveniles imprint and head for the water
  - sexual maturity may require 10-20 years
Kemp’s Ridley sea turtle

• Threats and reasons for decline
  – egg harvest
  – shrimp trawl nets
  – trash discarded at sea
  – dredging
  – entanglement in drift nets
  – pollution

Population crash between 1947 and 1970s probably result of these two factors
Kemp’s Ridley sea turtle

• **Status**
  – up to 1960s was a very abundant species in Gulf of Mexico; 40,000 females nested in 1961
  – 1000 females nest today

• **Efforts toward recovery**
  – U.S. FWS assistance at Rancho Nuevo beach since 1978
  – Turtle Excluder Devices (TEDs) since 1990
  – “Head-Start Program”
Kemp’s Ridley Padre Island release