Lecture 12, 01 Oct 2009
Biodiversity Threats
Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2009
Kevin Bonine
Mary Jane Epps

506 meet in BSE129
9am Wed (07 Oct)

Meet & Greet
Jim Kenna
State Director, Arizona BLM
SNRE Faculty and Student
Please join us to meet Jim Kenna, State Director, for the Bureau of Land Management in Arizona BLM. Mr. Kenna was appointed as State Director in January 2009. As Arizona’s new BLM State Director, he would like to meet as many SNRE folks as possible. BLM is an important public land manager in Arizona. The School has a history of collaborative projects with BLM.

Kenna, a native of Colorado, began his career 36 years ago in Arizona as a wildland firefighter and has since served in numerous positions throughout the nation. Prior to his current position, Mr. Kenna was the associate state director for BLMs Oregon/Washington office, and he was the deputy assistant director for resources and planning at BLMs headquarters office in Washington, D.C. He also held a variety of management positions in Palm Springs, Calif., Burns, Ore., Prineville, Ore., and served as a recreation planner in Moab, Utah. He has a Bachelor of Arts degree in economics from Prescott College. As Arizona BLM State Director, Kenna oversees the management of BLM Arizona’s 12.2 million-acre surface area of public lands and another 17.5 million subsurface acres within the state. He is responsible for about 800 employees in nine offices.

October 7th, 2009
3:30-4:30pm
BSE Room 311

Q3
Due by 6am Friday 09 October to MJ as .DOC attachment.
Craft two letters, each a page in length, to one or more of your political representatives. The first letter should focus on the theme of externalities. Convince your representative(s) that more explicit consideration of externalities is good for people, the economy, and the environment. The second letter should be about invasive species. What do you want your representative(s) to know about invasive species and what do you want them to do with respect to invasive species? Although these are letters, we still want you to include one or more citations in each. The best letters will be organized, clear, and persuasive.

Threats to Biodiversity
(Primack Ch4)

Habitat Loss
destruction, fragmentation, degradation
Global Climate Change
Overexploitation
Invasives
Disease

Quiz, 01 October 2009
1. Name and Date (1 pt)
2. Give one example each of in-situ and ex-situ conservation strategies discussed by Ed Moll (2 pts)
3. What does it mean for an invasive species to have a certain threshold for cost-effective control? (3 pts)
4. Distinguish between continental and oceanic islands (2 pts)
5. Give an example from your Quammen (Song of the Dodo) reading of a taxa that is a poor disperser to islands (1 pt)
6. Define phenology (2 pts)
Biological Invasions

Modified from Kathy Gerst (2008)
Dept. of Ecology and Evolutionary Biology

Characteristics of invasive species
• Widespread distribution (AND high abundance)
• Great dispersal ability or migratory tendencies
• Great reproductive capability (~ r-selected)
  – Early maturation; short generation time
• Capacity for clonal/asexual reproduction?
• Small body size
• Edge species
• Affinity with humans (anthrophilic)

Characteristics of invaded habitats
• Disturbed
• Low diversity
• Absence of predators of invading species
• Absence of native species morphologically or ecologically similar to invader
• Absence of predators or grazers in evolutionary history (naive prey)

Zebra Mussels
• Fresh water mussels native to Black Sea
• Transported to Great Lakes via ballast water from a trans-oceanic vessel.
• Mussel discovered near Detroit in 1988.
• Down to Gulf of Mexico and into Connecticut
• Cover large areas of lakes & rivers, prevent establishment of native species, clog pipes.

Accidental introductions
• Seeds on livestock
• Disease on agricultural and forestry plants
• Aquatic organisms in ship ballast waters from international shipping
• Canals that connect formerly disconnected oceans, seas, and lakes

Escaped Introductions
• Agricultural species
• Ornamental species
  aquarium fish, residential trees, European birds
Intentional Introductions

- Planted for erosion control, forage, forestry
- Introduced for hunting, fishing

Ecological impacts of invasive species

1. Direct interactions with native species:
   - Competition
   - Predation
2. Impact ecosystem function
3. Spread of disease
4. Hybridization with natives

Ecological impacts

1. Direct interactions with native species: 
   **Competition and Predation**
   - Compete for light, space, nutrients, pollinators, etc.
   - Community has evolved without defense mechanisms to non-native predators

Purple Loosestrife

- Aggressive wetland invader
- Produce up to 2.7 million seeds per plant yearly
- Spreads across approximately 480,000 additional hectares of wetlands each year
- Local fauna do NOT eat plant
- Did not become invasive for first 100 years in U.S.

Kudzu Vine

- Fast-growing vine introduced to prevent soil erosion
- Major pest in the southern US.
- Grows up to 1 foot/day
- >$50 million/year in lost farm & timber production

Brown Tree Snake

- Originating in the South Pacific and Australia
- Extirpated 10 of 13 native bird species, 6 of 12 native lizard species, and 2 of 3 bat species on the island of Guam
- Now found on Hawaii (islands and invasives)
The eight-year battle to remove wild goats, donkeys and pigs from Santiago, Pinta and northern Isabela islands has cost at least $5.2 million and is still just shy of completion. The United Nations covered three-quarters of the cost.

The assault against feral goats -- along with an ongoing campaign against wild dogs, cats, pigs, donkeys and an array of invasive plants and insects -- demonstrates the challenge conservationists face in preserving this hotbed of genetic diversity. Alan Tye, interim director of sciences at the Charles Darwin Research Station on the island of Santa Cruz, said his institute focuses on just two things: "threats and threatened things." Although 95 percent of the species that were here when humans first arrived still exist in the Galapagos, the International Union for Conservation of Nature and Natural Resources lists dozens on its "red list" of threatened species. These include the Galapagos hawk and the Galapagos fur seal, along with 57 species of Bulimulus snails.

Other species, including plants and insects, are harder to eradicate. At this point, the 720 introduced plants growing in the Galapagos outnumber the islands' 500 original plant species. Blackberry bushes, planted by farmers, have spread widely, along with quinine trees. Newer residents are bringing in ornamental shrubs such as lantana, nicknamed "the curse of India" because it drives out other plants, and other garden plants to the Galapagos.

Ecological Impacts

2. Change to ecosystem function
- Biogeochemistry (ex: change in soil type)
- Biophysical processes (water uptake and transpiration)
- Trophic structure (food webs)
- Disturbance regime (ex: fire)

Domestic Cats
- Originated from wild cats in the middle east
- Hunt native birds, lizards, small mammals
- Carry infectious diseases that can be transferred to native animals, domestic livestock, and humans
- VERY significant impact on islands where native birds have not evolved to fear predators

Grasses in the Sonoran Desert
- Buffel grass from Africa is the most rapidly spreading invasive plant in Arizona
- Promotes fire and re-sprout easily
- Decreases water filtration into the soil
- Fire is NOT a natural part of the saguaro-palo verde plant communities
- Kills tortoises too 😞
- Invasion facilitated by open space in desert: entire structure of communities changes
Ecological impacts

3. Disease: invasive species may carry diseases to which native species are not adapted.

- Avian malaria
- Chestnut blight
- Dutch Elm disease
- Small pox...?

Chestnut Blight

- Deciduous forests of eastern NA
- Made up to 40% of overstory trees
- In early 1900s fungal disease noticed
- Fungus originated in nursery stock from Asia where it is native
- Many animal species depend on chestnuts; 7 spp. of moths and butterflies now extinct

4. Hybridization

- introduced species may not be genetically separated from a native species, and can proceed to hybridize. Ex: introduced trout.
  → may mean the end of a genetically unique local population.

Control and management options

- Inspection/restrictions on travel and trade
- Eradication: physically remove plants/animals
- Herbicides: chemically kill (plants)
- Exotic pests: bring in biological control agent
But invasives…
may have different patterns of impact

And…

Salt Cedar (Tamarisk)
- Introduced as an ornamental and for windbreaks
- Invades riparian areas
- Accumulates salts in tissues which alters soil composition
- Uses lots of water!
- Provides poor wildlife habitat?
- Forms monocultures
- Decreases biodiversity

Management of Salt Cedar
- Manual removal
  - Costly and takes a LONG time
- Chemical/herbicide
- Restore flood regime
- Biological control
  - Use of natural enemies to reduce damage caused by pest population
  - Possible more effective and less costly solution???

Biological Control
- Used successfully in the U.S. since 1889
- About 420 invasive spp. have been controlled “successfully” with biocontrol
- Benefit/cost ratio can be very high: the derived benefit of controlling a pest divided by the total cost of the biological control project.

Why introduce insect herbivores?
- Salt cedar has little/no natural enemies in new habitat
- This gives it a competitive advantage over native species
- Introduction of herbivores from native habitat will help control it and slow reproduction
**Diorhabda elongata**

- Beetle co-evolved with salt cedar in China.
- Salt cedar is only plant insect feeds or reproduces on.
- Has special adaptations to be a specialist on salt cedar.

**Salt Cedar defoliation: NV**

**The Big Question: What if the biocontrol agent itself becomes invasive??**

- Beetle was tested for 13 years in quarantine before release to be sure it was not going to feed on native plants.
- The very small risk of beetle changing hosts are outweighed by benefits.
- Tamarisk has no close relatives in N.A.

**Biocontrol Success Stories**

- Prickly Pear Cactus and moth borer in Australia (1926).
- Vedalia Beetle in California; saved citrus industry from scales: 1890s.
- Cassava mealybug in Africa with a wasp from South America (1980s).

**Biocontrol Horror Stories**

- Cane Toads in Australia: introduced to control Cane grub.
  *Cane Toads: An Unnatural History 1987*
Biocontrol mistakes

• Take home message:
  • Control agent must be a specialist on target!
  • Generalist vertebrates = bad biocontrol

• Some of worst invaders today were originally introduced for control of other invasive species

• What works in one site, won’t work in others

Additional issues with biocontrol

• Not enough quantitative evaluation of success
• Studies focus on affects of biocontrol agent on individual plants but not necessarily the whole population, community and ecosystem

Invasives: Conclusion

• Invasive species are a **THREAT** to human health, biodiversity and ecosystem functions

• Need to put an **ECONOMIC** value on loss of species, habitats, and ecosystem functions as a result of invasive species impact?

• Most important solution is early detection and **PREVENTION**

Exploitation and Ecosystem Modification...
Fishing down the marine food web. After the large fish at the top of the food web are fished out, fisheries go after smaller fish and invertebrates at lower levels in the food web while their trawling destroys animals and plants on the sea floor. Time increases toward the right along the blue arrow.


"Trawling is a method of dragging nets, with rollers attached to the front of the nets, along the seabed. The motion of the rollers rotating stirs up the seabed having the effect of making the shrimps jump into the nets."
Italy: The Manzo family of Sicily
Food expenditure for one week: 214.36 Euros or $260.11

Germany: The Melander family of Bargteheide
Food expenditure for one week: 375.39 Euros or $500.07
United States: The Revis family of North Carolina
Food expenditure for one week: $341.98

Mexico: The Casales family of Cuernavaca
Food expenditure for one week: 1,862.78 Mexican Pesos or $189.09

Poland: The Sobczynscy family of Konstancin-Jeziorna
Food expenditure for one week: 582.48 Zlotys or $151.27

Egypt: The Ahmed family of Cairo
Food expenditure for one week: 387.85 Egyptian Pounds or $68.53

Ecuador: The Ayme family of Tingo
Food expenditure for one week: $31.55

Bhutan: The Namgay family of Shingkhey Village
Food expenditure for one week: 224.93 ngultrum or $5.03
Chad: The Aboubakar family of Breidjing Camp
Food expenditure for one week: 685 CFA Francs or $1.23