



## Biological Invasions

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## What is an invasive species?

- a species of plant, animal, or other organism that was introduced (usually by man) to a non-native ecosystem, where it became harmful to the natural environment or to human health.

## What is an invasive species?

- organism not native to a region
- Introduced accidentally or intentionally
- Out-compete native species for available resources, reproduce prolifically, and dominate regions and ecosystems.
- Difficult to control w/o native predators
- *Remember: not all invasive species are exotic, and not all exotic species are invasive!*



## Historical context in North America

- Originally viewed as welcome additions to landscape!
- Domesticated plants and animals
- Ornamental plants and animals to remind settlers of home

## Current state

- More than 6,500 species of established, self-sustaining populations of non-native species in the U.S.
- result from: increased movements of people, transportation of products, and reduced travel time between destinations



## How serious of a problem?

- Costs due to invasive spp. in U.S. is \$125-140 billion / year.
- 25% of US agriculture GNP lost to foreign pests
- Nearly 1/2 of species listed as threatened or endangered under the E.S.A. are at risk due to competition with or predation by non-native species
- Considered by biologists to be the second greatest threat to biodiversity!

## Not all introduced species are successful

### The "Tens Rule":

- 10% of non-native species become established
- 10% of those become ecological problems (invasives!!)

## Characteristics of invasive species

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

## Characteristics of invaded habitats

- Disturbance
- 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)

## 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



## 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.



## Escaped Introductions

- Agricultural species
- Ornamental species

aquarium fish,  
residential trees,  
European birds



## Intentional Introductions

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



*Arundo donax*: Giant Reed

## 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
- Costs \$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



## 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



## 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)

## 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

## Ecological impacts

### 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.

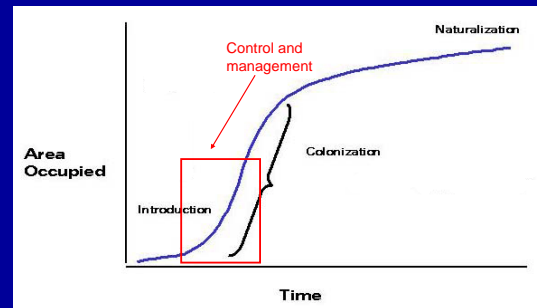
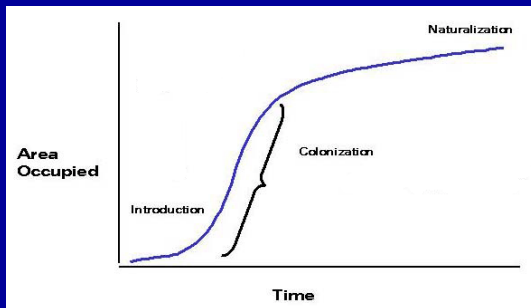


## Invasives on islands Example: Hawaii

- 50% of flora considered invasive. Prior to human colonization over 90% of flora was endemic
- All reptiles and amphibians are introduced.
- Over 100 species of birds introduced.
- Mass extinctions of native flora and fauna are in progress due to destruction of habitat and invasion of new species.

## Control and management options

- **Inspection/restrictions** on travel and trade
- **Genetic breeding**
- **Eradication**: physically remove plants/animals
- **Herbicides**: chemically kill (plants)
- **Exotic pests**: bring in biological control agent



## 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



Moab, Utah  
-increased bird, spider diversity with beetle introduction

## 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*
- Rosy Wolfsnail in Hawaii: introduced to control Giant African Snail. Prefers small native spp. (15-20 native snails extinct)



## 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

## 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**