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)

-Thank Ed Moll
-Robichaux Tues

Readings

Primack Ch4,5
Thomas and Reid 2007 Biocontrol
Harper et al. 2008 Habitat Loss
Quammen Excerpt (*Song of the Dodo*)
Walther et al. 2002 Phenology and Climate Change

Lab FRIDAY 02 October 1-8pm northwest corner BSE

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Meet & Greet

Jim Kenna

State Director, Arizona BLM

SNRE Faculty and Students:

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, Jim 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, Jim was the associate state director in BLMs Oregon/Washington office, and he was the deputy assistant director for resources and planning at BLMs headquarters office in Washington, D.C. He has also held a variety of management positions in Palm Springs, Calif., Burns, Ore., Prineville, Ore., and Lakeview, 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 Arizonas 12.2 million surface acres of public lands and another 17.5 million subsurface acres within the state. He is responsible for about 600 employees in nine offices.

October 7th 2009

3:30-4:30pm

BSE Room 311

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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.

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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)

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Threats to Biodiversity

(Primack Ch4)

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Threats to Biodiversity

Habitat Loss

destruction, fragmentation, degradation

Global Climate Change

Overexploitation

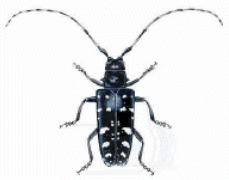
Invasives

Disease

SYNERGY

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)

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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)

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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

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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

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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

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Ecological impacts

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

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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.

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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

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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)

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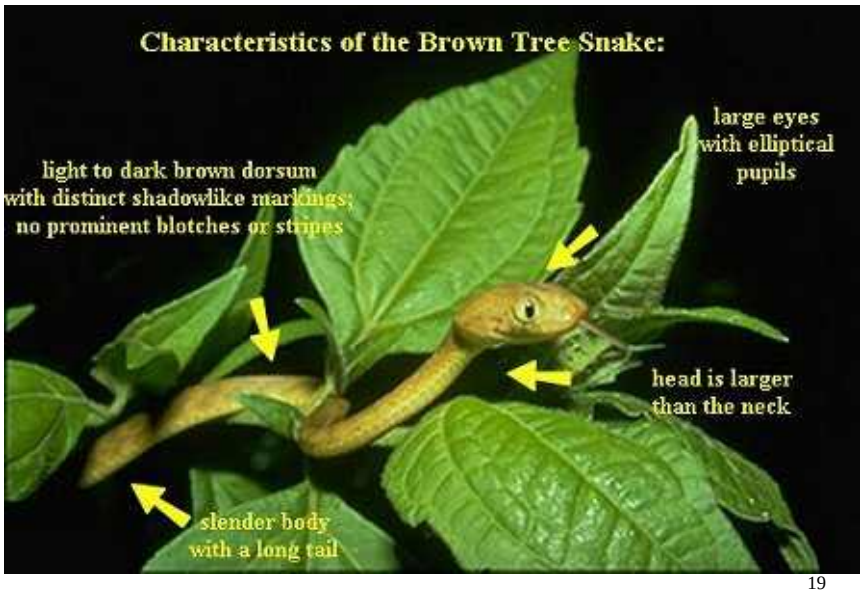
http://www.fort.usgs.gov/resources/education/bts/bts_home.asp



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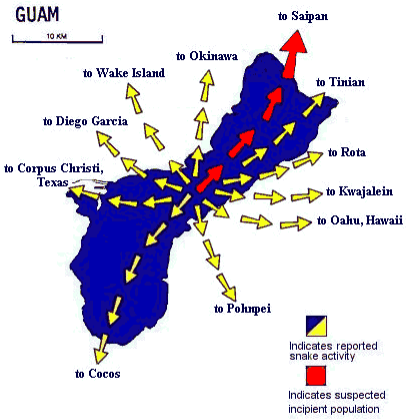
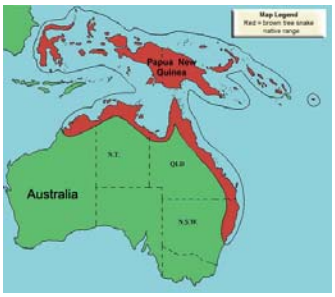
http://www.fort.usgs.gov/resources/education/bts/bts_home.asp





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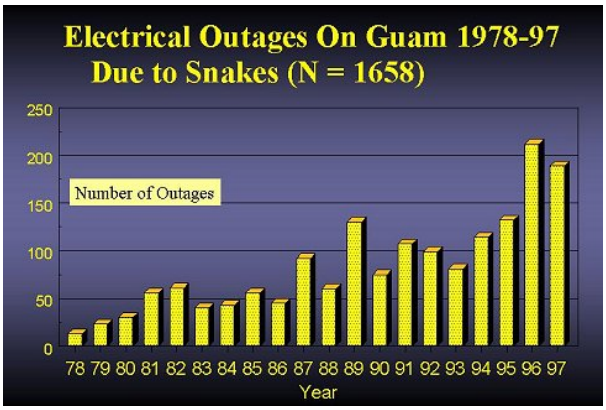

http://www.fort.usgs.gov/resources/education/bts/bts_home.asp

The hand of an infant with swelling, discoloration, and bleb formation.

Results of one night's captures by hand.

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Summary of Species' Status on Guam

Birds Lizards Mammals Species Status Summary

* Represents species that were affected by factors unrelated to the brown Treesnake.

Birds: Native		
Common Name	**Scientific Name**	**Status on Guam**
Wedge-tailed shearwater	*Puffinus pacificus*	extirpated *
White-tailed tropicbird	*Phaethon lepturus*	rare
Yellow bittern	*Ixobrychus sinensis*	common in suitable habitats
Pacific reef-heron	*Egretta sacra*	uncommon
Mallard	*Anas platyrhynchos*	extirpated *
Micronesian megapode	*Megapodius laperouse*	extirpated *
Guam rail	*Rallus owstoni*	extirpated (currently reintroduced in a wildlife enclosure)
White-browed rail	*Poliolimnas cinereus*	extirpated *
Common moorhen	*Gallinula chloropus*	rare
Brown noody	*Anous stolidus*	rare
White tern	*Gygis alba*	rare
White-throated ground-dove	*Gallicolumba xanthonura*	extirpated
Mariana fruit-dove	*Ptilinopus roseicapilla*	extirpated
Island swiftlet	*Aerodramus vanikorensis*	rare
Micronesian kingfisher	*Halcyon cinnamomina*	extirpated

The BTS on Guam (Home)
Biology of the BTS & Pacific Snakes
Invasion of a Predator
Impacts & Damages from the BTS
Control & Containment of the BTS
Frequently Asked Questions
Related Resources
Report Snake Sightings!
Table of Contents
Search FORT

Mariana crow	*Corvus kubaryi*	rare
Nightingale reed-warbler	*Acrocephalus luscinia*	extirpated
Guam flycatcher	*Myiagra freycineti*	extirpated
Rufous fantail	*Rhipidura rufifrons*	extirpated
Micronesian starling	*Aplonis opaca*	rare
Cardinal honeyeater	*Myzomela cardinalis*	extirpated
Bridled white-eye	*Zosterops conspicillatus*	extirpated
Birds: Introduced		
Common Name	**Scientific Name**	**Status on Guam**
Black francolin	*Francolinus francolinus*	common
Blue-breasted quail	*Coturnix chinensis*	common
Red junglefowl	*Gallus gallus*	rare
Rock dove	*Columba livia*	uncommon
Philippine turtle-dove	*Streptopelia bitorquata*	uncommon
Black drongo	*Dicrurus macrocercus*	uncommon
Eurasian tree-sparrow	*Passer montanus*	common
Chestnut mannikin	*Lonchura malacca*	rare

Judas Goats on Isabela, Galapagos

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http://www.darwinfoundation.org/en/our-work/featured-projects/project-isabela

Invasive Species Threaten Galapagos's Diversity, By Juliet Eilperin
Washington Post Staff Writer, Monday, February 27, 2006; A06

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.

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Goats

No Goats

http://www.darwinfoundation.org/en/our-work/featured-projects/project-isabela

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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

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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)

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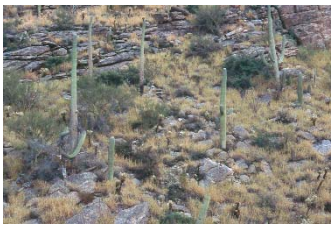
Grasses in the Sonoran Desert

•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

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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… ?

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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

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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.

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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

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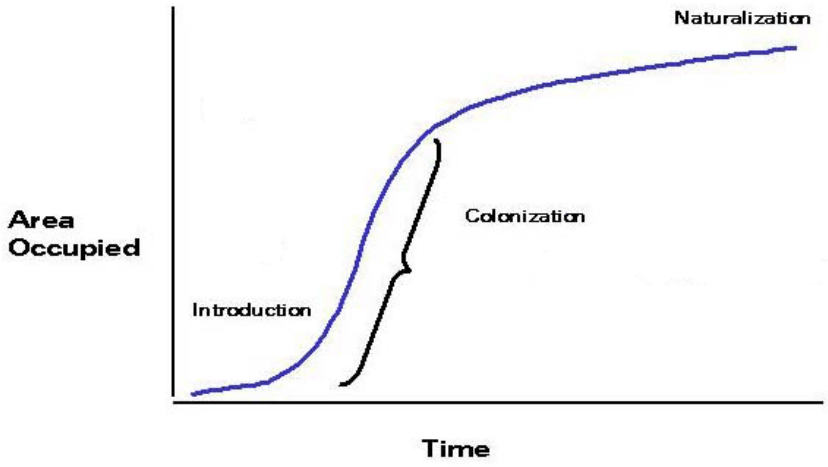
Naturalization
Area
Occupied
Colonization
Introduction
Time

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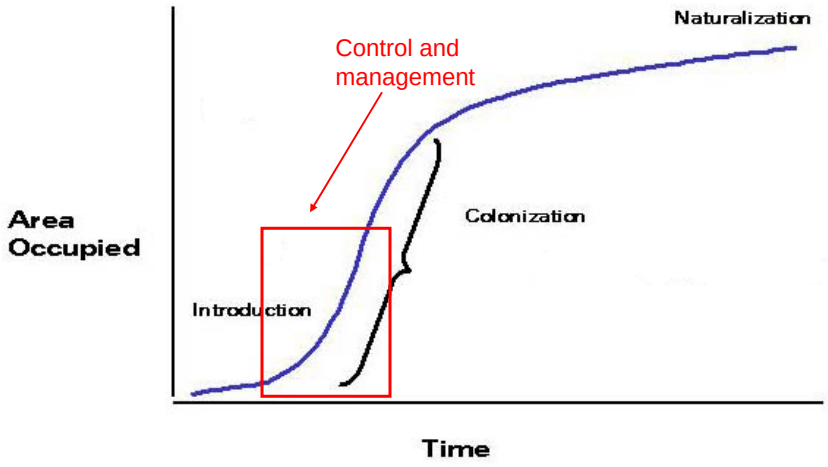
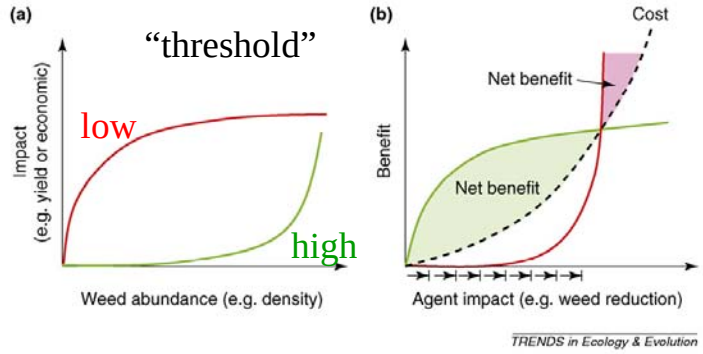

Naturalization
Control and
management
Area
Occupied
Colonization
Introduction
Time

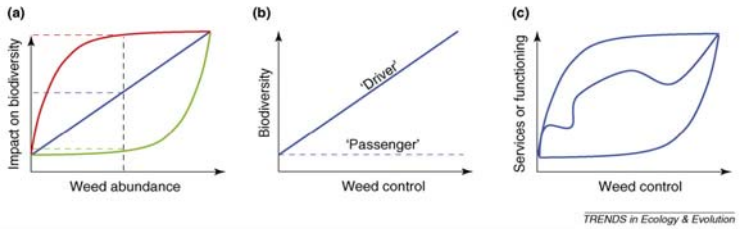
36

But invasives…
may have different patterns of impact



And…

Thomas and Reid, 2007. *TREE.*



Control may have different levels of benefits for biodiversity depending on the nature of the invasive spp and the circumstances of invasion.

- Invasive as Driver vs. Passenger

- Invasive Species Treadmill

- Functional Restoration vs. Biodiversity

Thomas and Reid, 2007

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???

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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.

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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

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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

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Salt Cedar defoliation: NV

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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.

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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)

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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)

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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

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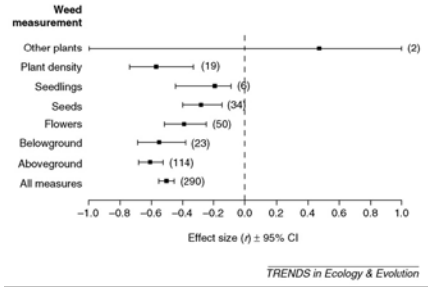
Additional issues with biocontrol

- 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



50

Thomas and Reid, 2007. *TREE.*

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**

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Exploitation and Ecosystem Modification…

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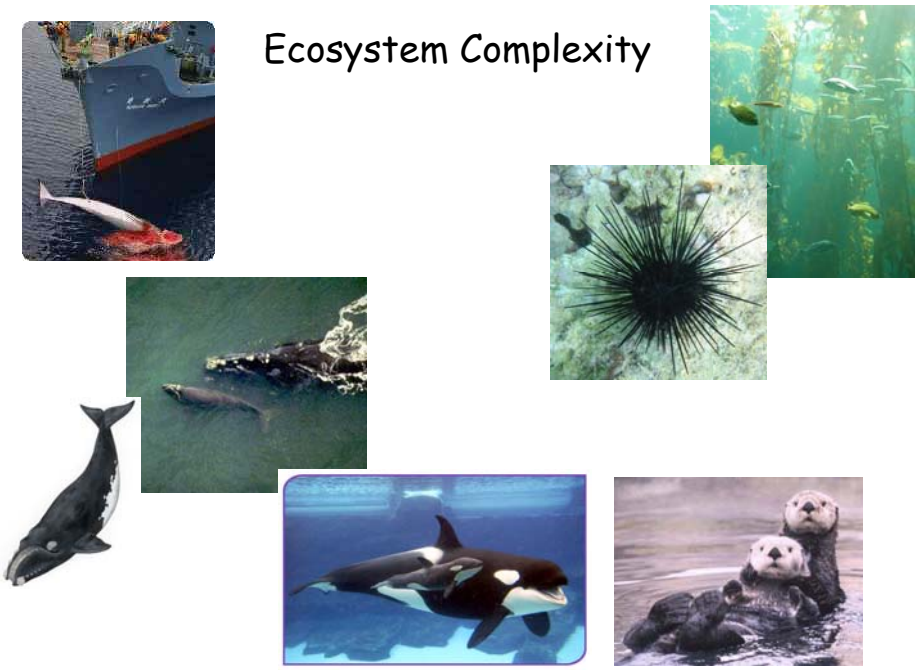

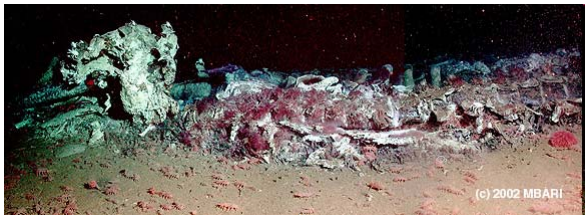

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***PRIMER OF CONSERVATION BIOLOGY 4e*, Figure 4.15**

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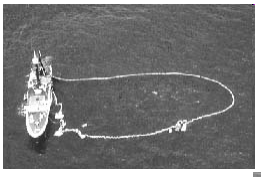

Modern boats use helicopters to find dolphins in the open ocean. Photo: NOAA

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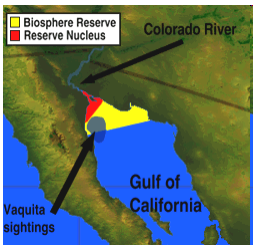
Vaquita
world's smallest cetacean



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OverExploitation
fisheries etc.

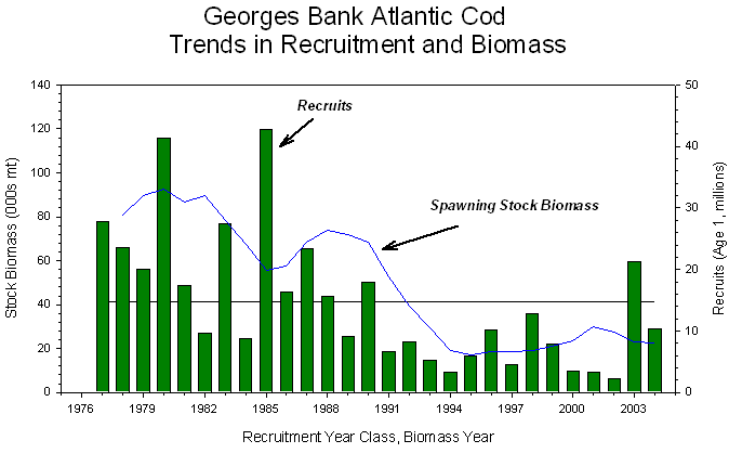

Figure 1.16 Trends in recruitment and biomass for Georges Bank Atlantic cod, 1978-2004. Horizontal line is the average recruitment for the time series.

http://www.nefsc.noaa.gov/sos/spsyn/pg/cod/

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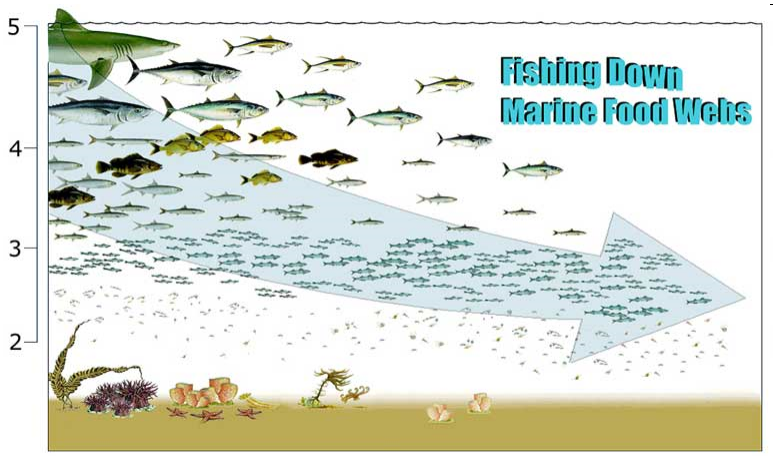


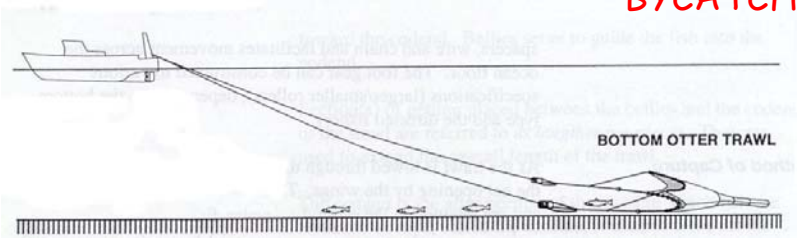
Fishing down the marine food web. After the large fish at the top of the food web are fished out, fisheries go after smaller fish and invertebrates at lower levels in the food web while their trawling destroys animals and plants on the sea floor. Time increases toward the right along the blue arrow.

Pauly, Daniel (2003). Ecosystem impacts of the world's marine fisheries. Global Change Newsletter, 55, page 21.

OverExploitation

SHRIMP TRAWLING

BYCATCH



"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." 64

Bycatch

(approx 10:1)

65

A seafloor community before (left) and after a trawling net crashed through.

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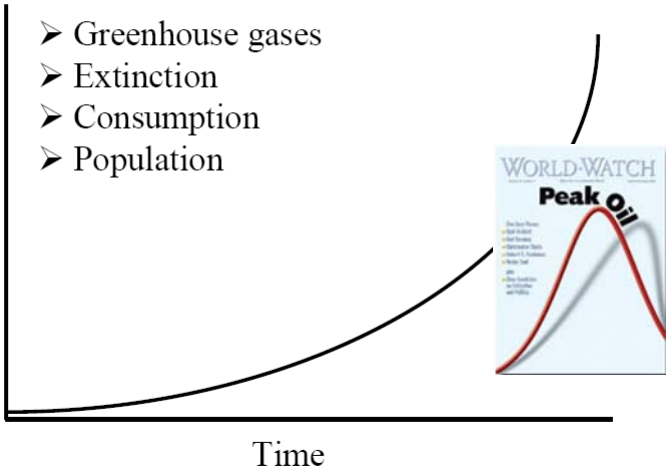
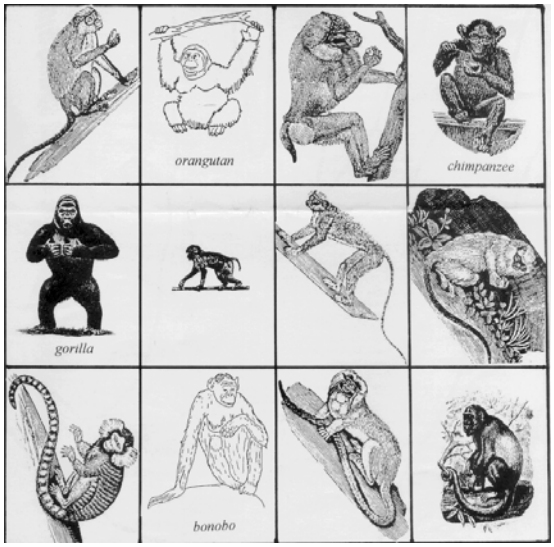
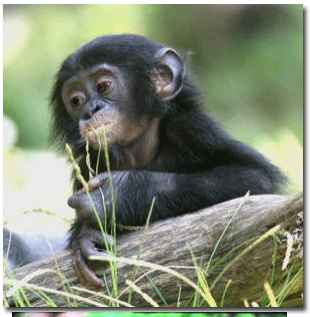
Four spikes*

- Greenhouse gases
- Extinction
- Consumption
- Population



*Ed Ayres (1999, *God's Last Offer*)





Italy: The Manzo family of Sicily
Food expenditure for one week: 214.36 Euros or $260.11

71

Germany: The Melander family of Bargteheide
Food expenditure for one week: 375.39 Euros or $500.07

72

United States: The Revis family of North Carolina Food expenditure for one week $341.98

73

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

74

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

75

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

76

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

77

Bhutan: The Namgay family of Shingkhey Village
Food expenditure for one week: 224.93 ngultrum or $5.03

78

Chad: The Aboubakar family of Breidjing Camp
Food expenditure for one week: 685 CFA Francs or
$1.23

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