Types of dispersers

Which are active versus passive?
For passive, what is mechanism of dispersal?

www.cees.no

www.pbase.com/antjes/image/33813044

eatourbrains.com/EoB/category/morgan-j-locke

www.rosssea.info

nationalzoo.si.edu

www.orgsites.com

www.mainedeer.com

Cattle egret: first, jump dispersal, then diffusion

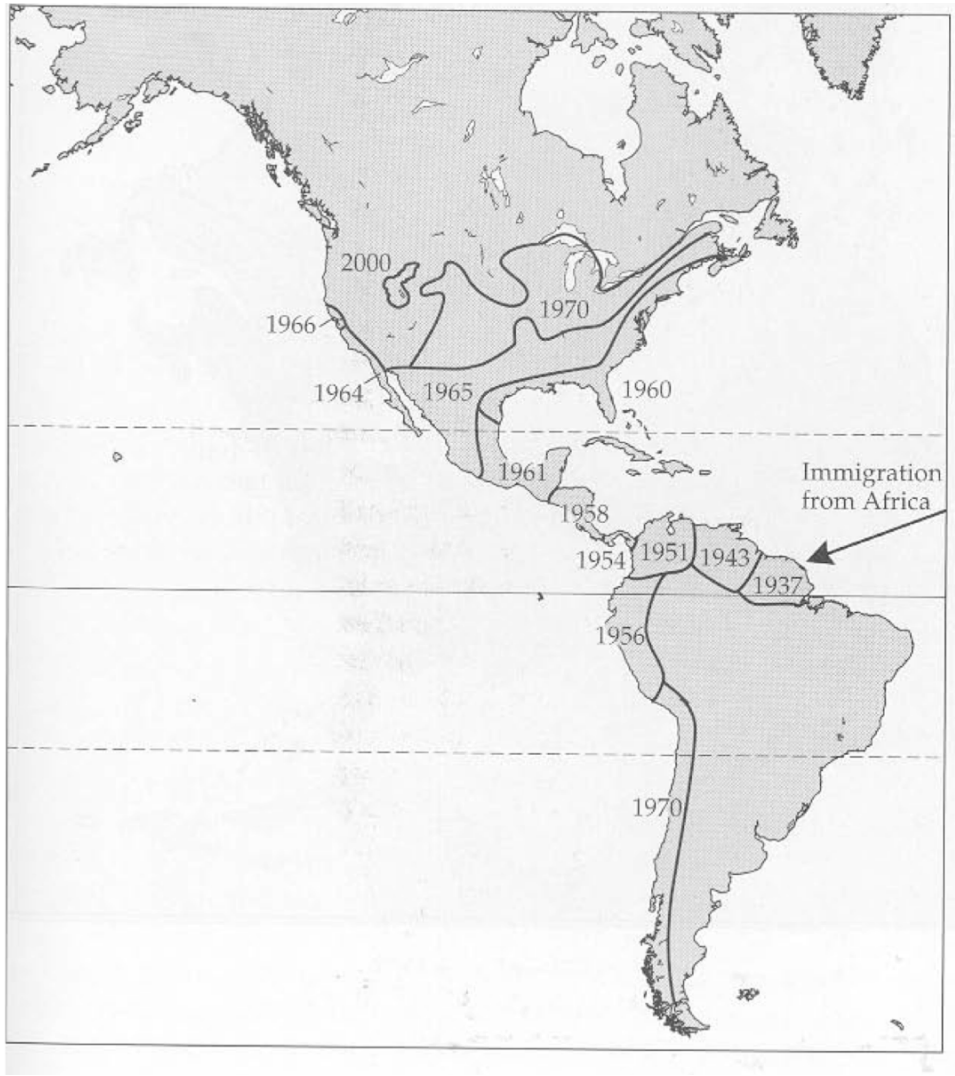
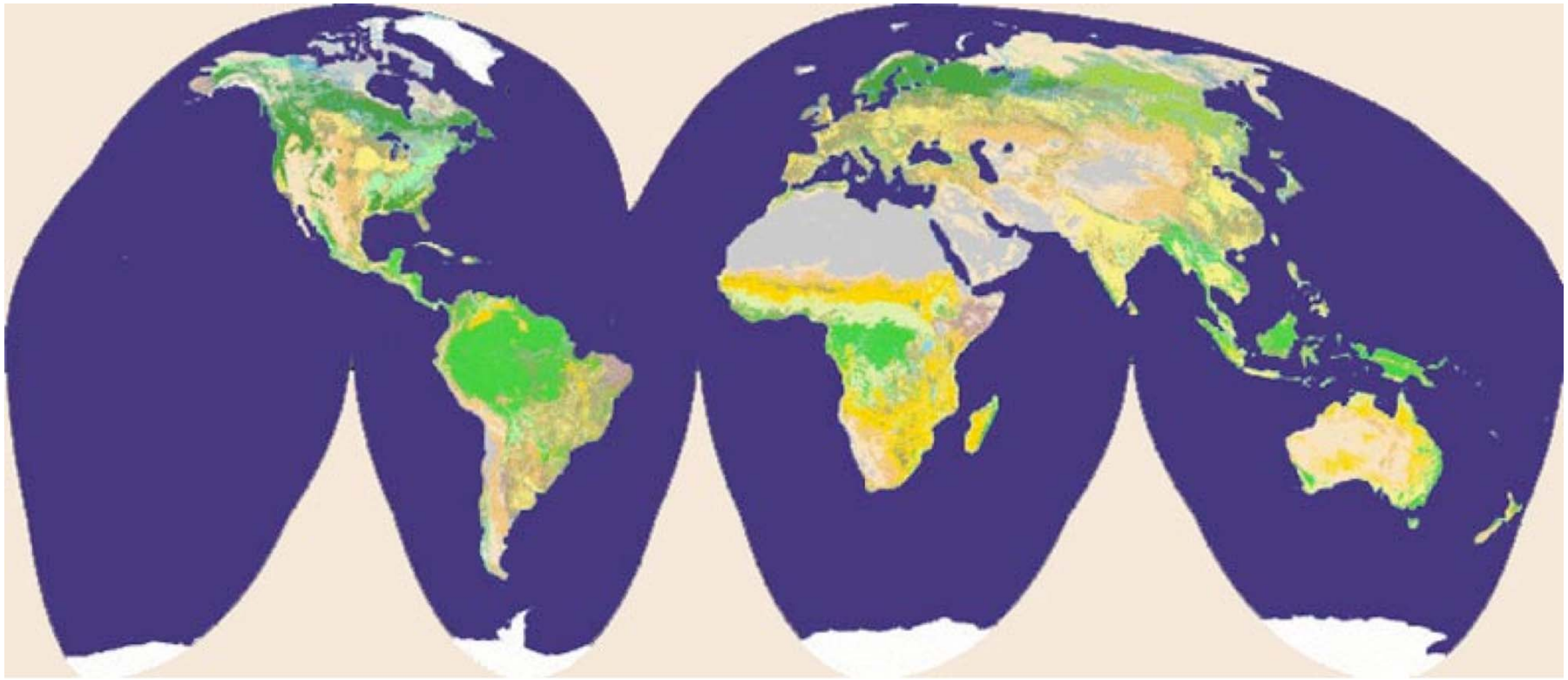


FIGURE 6.2 Colonization of the New World by the cattle egret, (*Bubulcus ibis*). This heron crossed the South Atlantic from Africa under its own power, becoming established in northeastern South America by the late 1800s. From there it dispersed rapidly, and it is now one of the most widespread and abundant herons in the New World. (After Smith 1974.)

Lomolino et al. 2006

Barriers and corridors



landcover.usgs.gov/landcoverdata.php

What are some examples?

Tropical mountains are greater barriers than temperate mountains

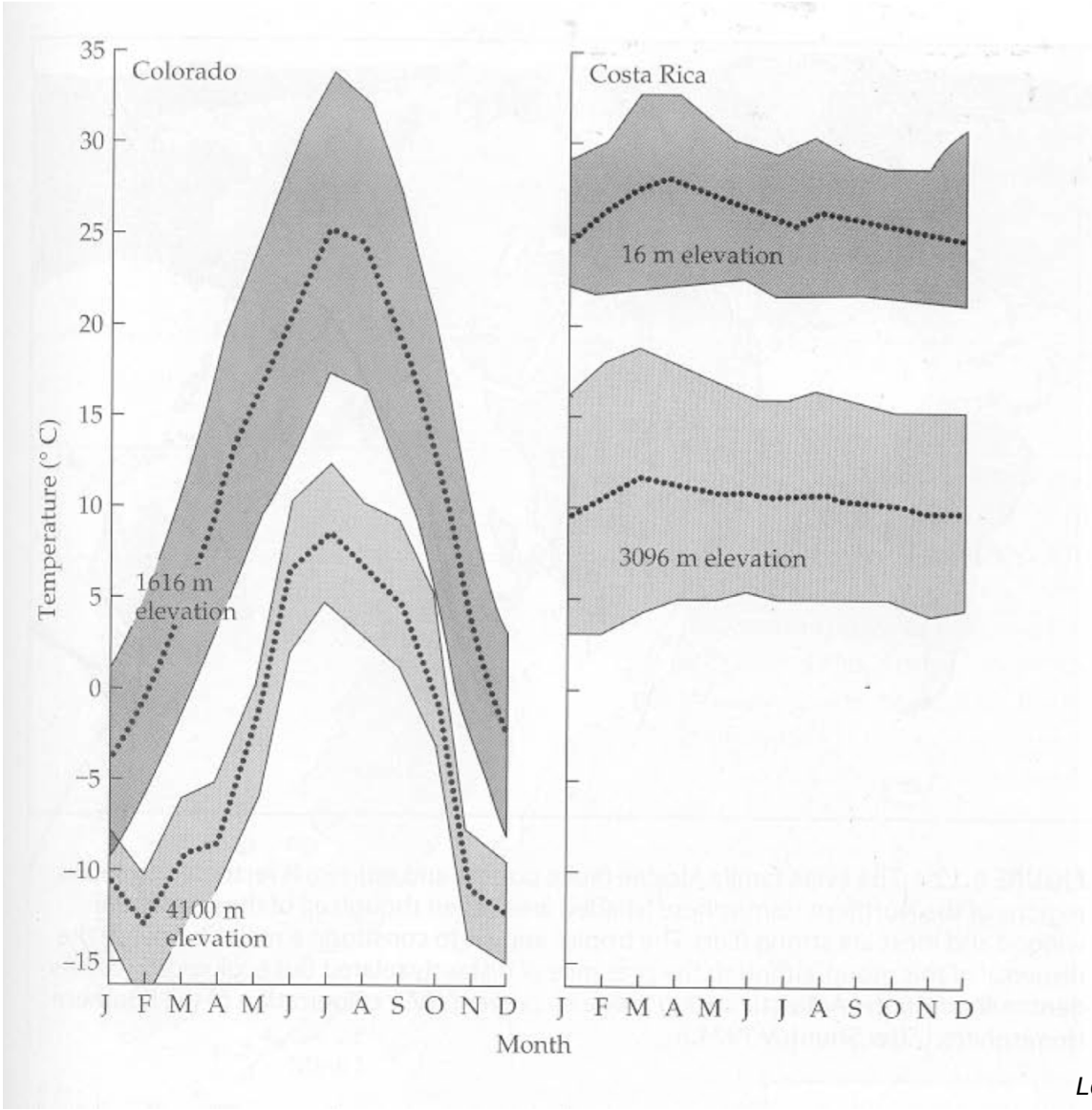


FIGURE 6.11 A given change in elevation tends to be a greater barrier to dispersal in the tropics than at higher latitudes, as shown by these temperature profiles. In tropical regions, sites separated by several thousand meters of elevation usually experience no overlap in temperature, whereas in the temperate zone, winter temperatures at low elevations broadly overlap summer temperatures at much higher sites. (After Janzen 1967.)

Lomolino et al. 2006

Island chains as (two-way) filters

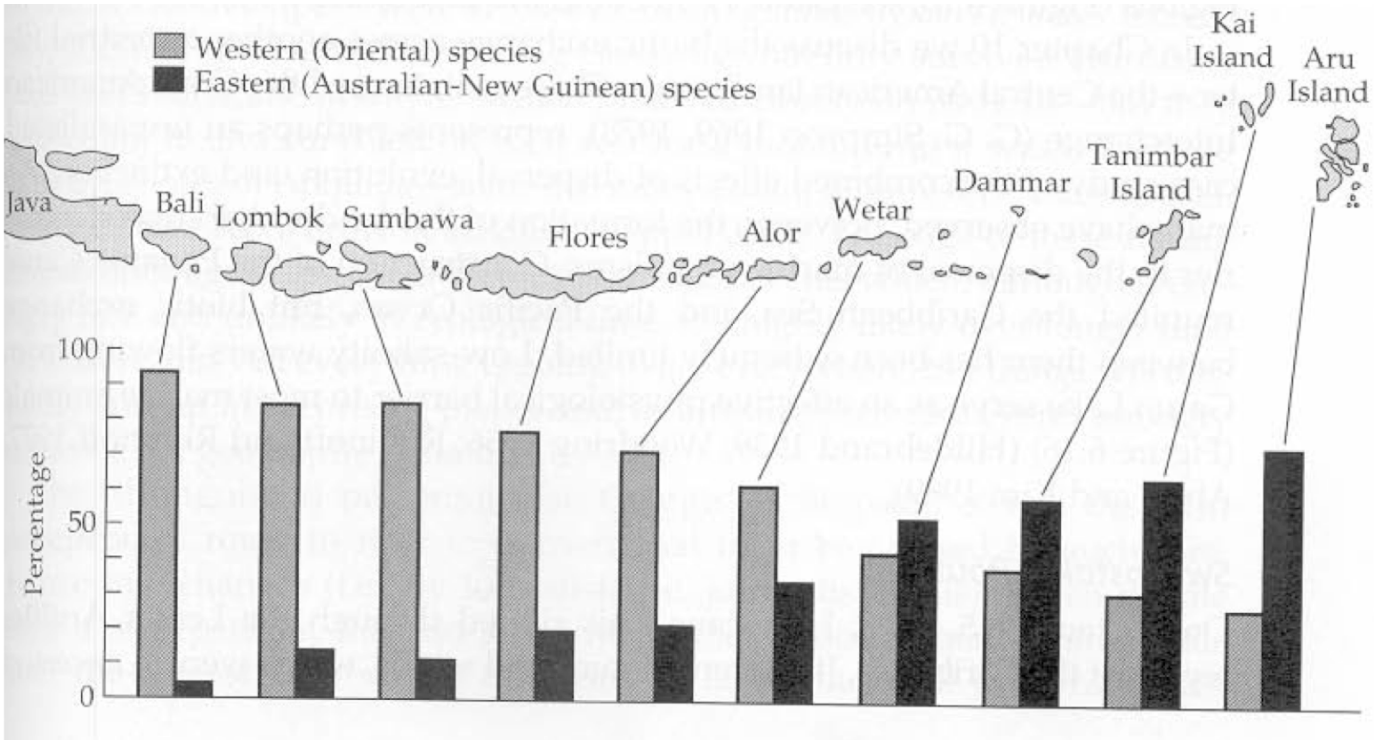


FIGURE 6.14 The Lesser Sunda Islands between Java and New Guinea serve as a two-way filter for the reptilian faunas of southeastern Asia and Australia. Bars quantify the decline in Oriental species and the increase in Australian species going from west to east down the island chain. (After Carlquist 1965.)

Lomolino et al. 2006

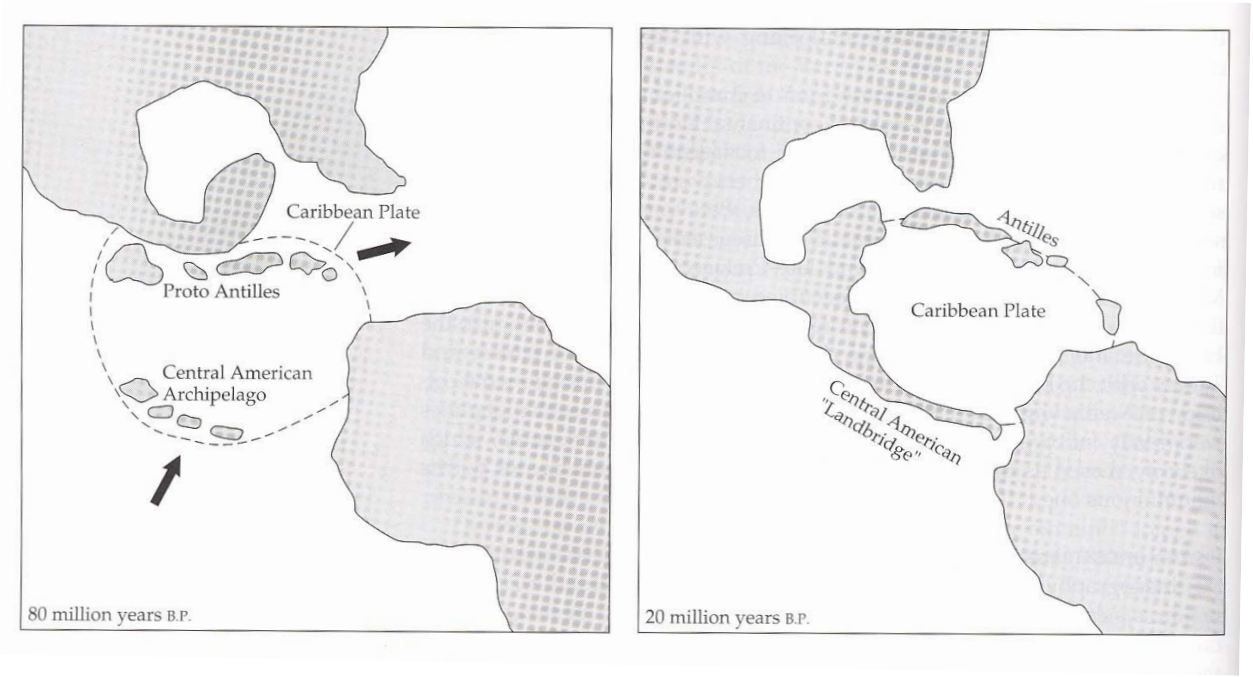
Hawaiian Islands colonization

- jump dispersal, not diffuse
- sweepstakes (low probability)
- wind or water dispersal types

http://www.faqs.org/docs/factbook/print/zn.html

Great American Exchange

- 16-3 Mya: NA, SA in current geographic position
  - but separated by sea: barrier for animals, flightless birds
- mammals in SA evolved in isolation (marsupials)
- mammals in NA evolved together with Eurasia (placentals)
- 3 Mya: formation of isthmus



Lomolino et al., 2006

Great American Exchange

Initially, net migration was symmetrical…

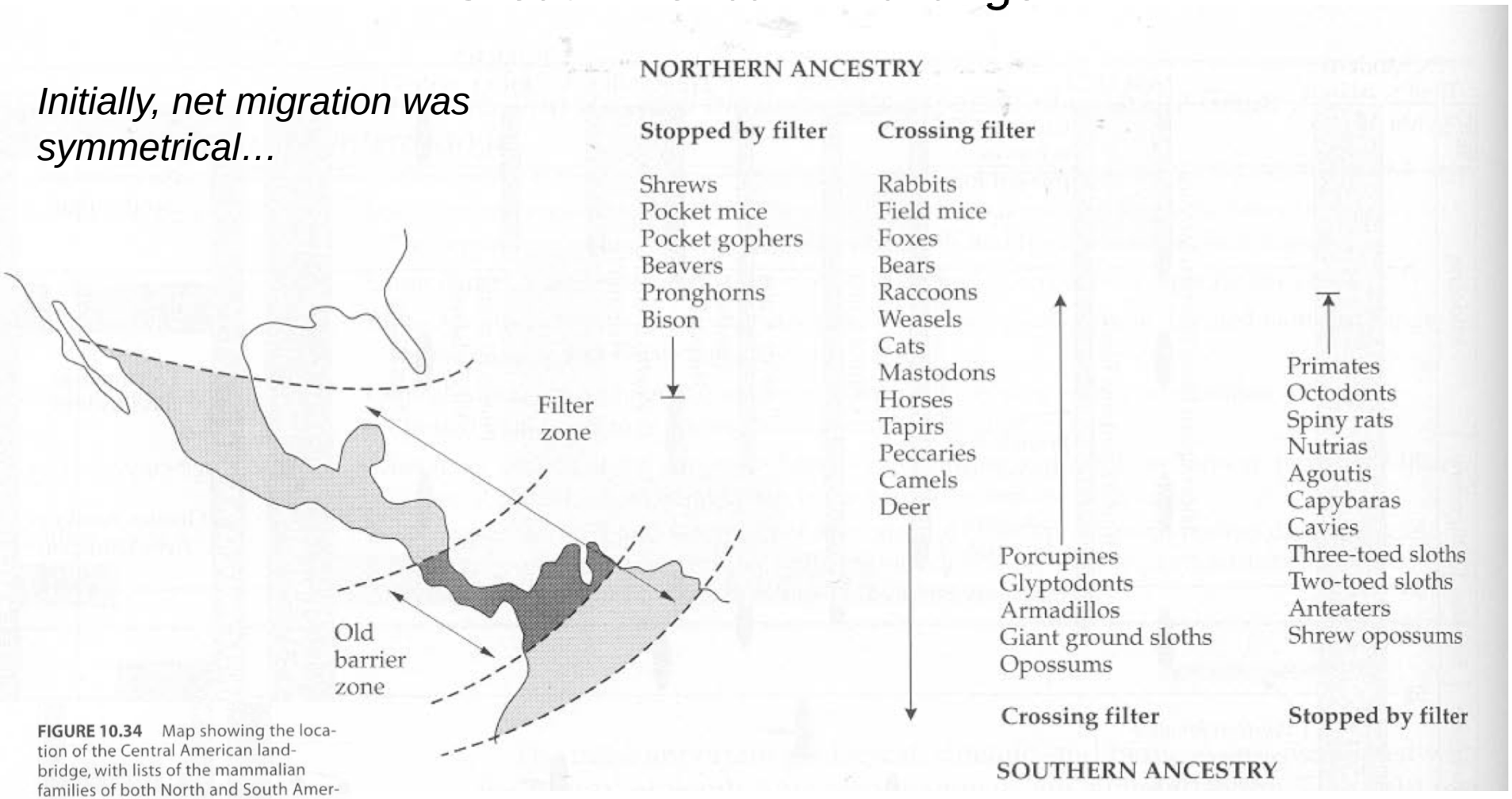


FIGURE 10.34 Map showing the location of the Central American landbridge, with lists of the mammalian families of both North and South American origin that either crossed through the filter of tropical lowland habitats in Central America during the Great American Interchange to colonize temperate regions of the other continent, or were stopped in or near the filter. Note the asymmetry, with more groups of North American origin passing through the filter and more families of South American origin stopped by the filter.

- *50% of modern S.A. mammals are of N.A. origin*
- *10% of modern N.A. mammals are of S.A. origin*
- *many S.A. extinctions due to N.A. invaders*
- *no evidence of N.A. extinctions due to S.A. invaders*

Lomolino et al. 2006

Great American Exchange

Why did N.A. species replace many S.A. species but not the reverse?

1. N.A. species were superior competitors
   - S.A. species evolved in relative isolation
   - N.A. species evolved with connections to Eurasia and Africa, 6 times the land area
     - products of a larger and more competitive arena
     - faster evolution
     - these processes led to more intelligent, efficient, faster species

2. Different physical environments in N.A. versus S.A.
   - southward migrating species from N.A. encountered similar habitat throughout much of S.A.
   - northward migrating species from S.A. encountered arid/ semiarid conditions in Mexico, a barrier to species adapted to moist tropical conditions in the isthmus

Lomolino et al. 2006, http://en.wikipedia.org/wiki/Great_american_interchange

Invasive Species

- 50,000 nonindigenous species in US
  - includes beneficial species (crops, sport, pets, …)
  - other species are not beneficial
- Major environmental damage: losses of $137 billion per year
- 79 exotic species causes $97 billion during 1906-1991 (OTA 1993)

Pimentel et al., 2000

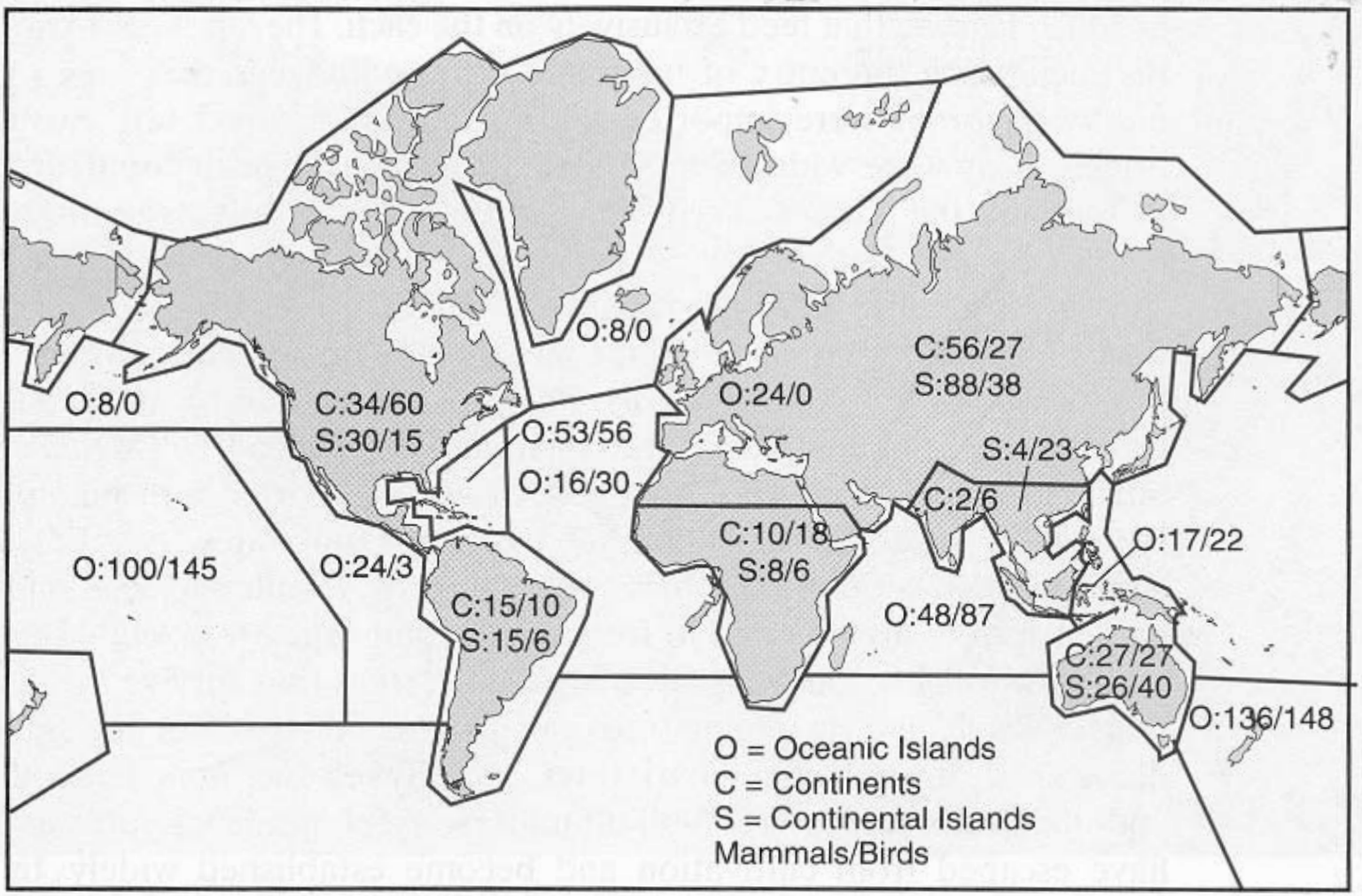


FIGURE 8.11 Introduced mammal/bird species for the continents, coastal islands, and offshore islands of the earth (after Ebenhard, 1988).

Economic costs of invasive species in US

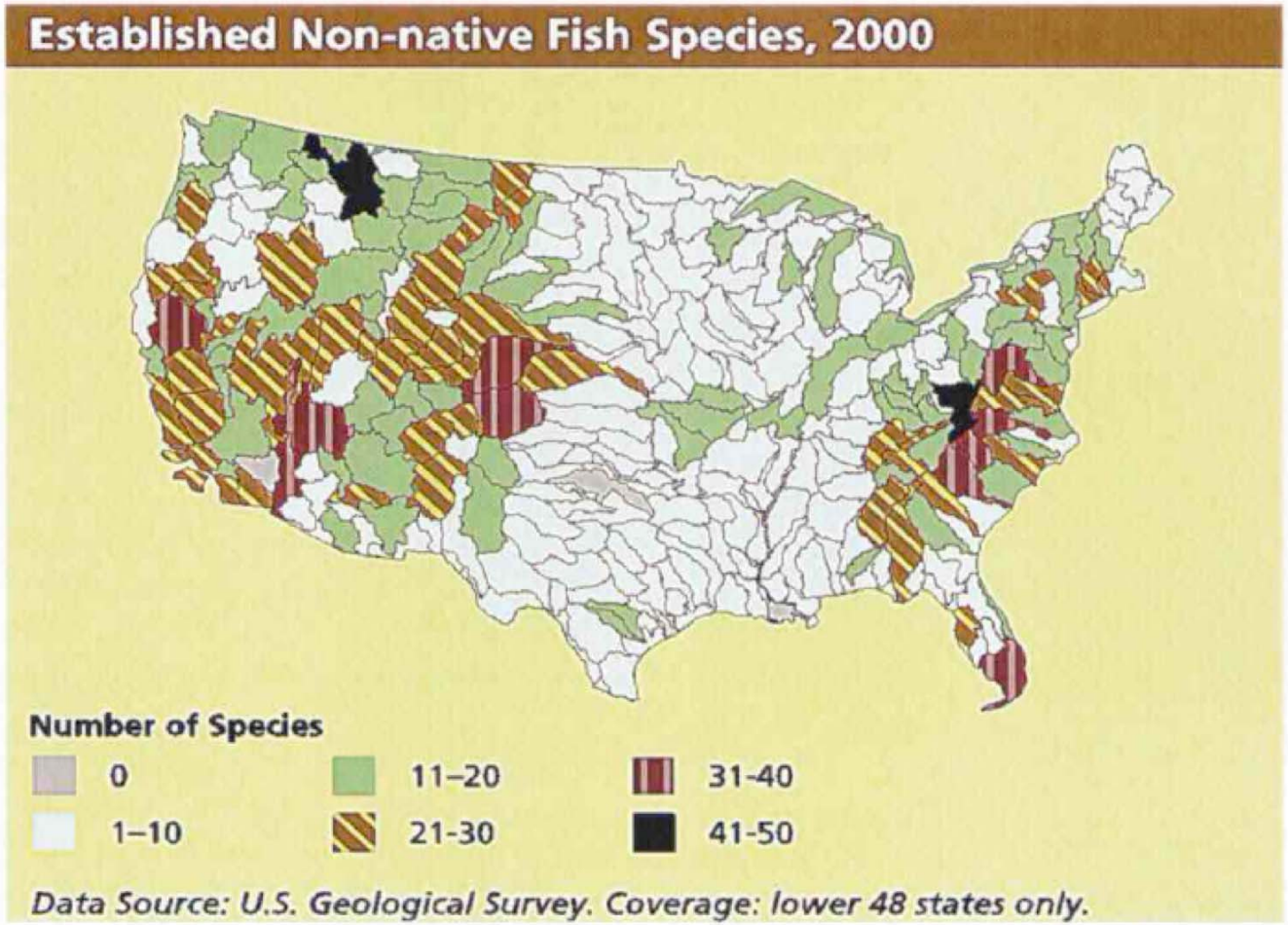
Type of organism	Losses and damages (× $1 million)	Control costs (× $1 million)	Total costs (× $1 million)
Plants			
Purple loosestrife	NA[a]	45	45
Aquatic weeds	10	100	110
Melaleuca tree	NA	3–6	3–6
Crop weeds	23,400	3,000	26,400
Weeds in pastures	1,000	5,000	6,000
Weeds in lawns, gardens, golf courses	NA	1,500	1,500
Mammals			
Wild horses and burros	5	NA	5
Feral pigs	800	0.5	800.5
Mongooses	50	NA	50
Rats	19,000	NA	19,000
Cats	17,000	NA	17,000
Dogs	250	NA	250
Birds			
Pigeons	1,100	NA	1,100
Starlings	800	NA	800
Reptiles and amphibians			
Brown tree snake	1	4.6	5.6
Fishes	1,000	NA	1,000
Arthropods			
Imported fire ant	600	400	1,000
Formosan termite	1,000	NA	1,000
Green crab	44	NA	44
Gypsy moth	NA	11	11
Crop pests	13,900	500	14,400
Pests in lawns, gardens, golf courses	NA	1,500	1,500
Forest pests	2,100	NA	2,100
Mollusks			
Zebra mussel	NA	NA	100
Asian clam	1,000	NA	1,000
Shipworm	205	NA	205
Microbes			
Crop plant pathogens	21,000	500	21,500
Plant pathogens in lawns, gardens, golf courses	NA	2,000	2,000
Forest plant pathogens	2,100	NA	2,100
Dutch elm disease	NA	100	100
Livestock diseases	9,000	NA	9,000
Human diseases	NA	6,500	6,500
All organisms			136,630

[a]NA, not available.

Table 1. Estimated annual costs associated with some nonindigenous species introduced to the United States, in millions of dollars (see text for details and sources).

Pimentel et al., 2000

Invasive species example: Freshwater fish



The number and distribution of nonnative fish species in US watersheds, as well as other indicators of nonnative species, are reported in The State of the Nation's Ecosystems *(The Heinz Center, 2002;* www.heinzcenter.org/publications.htm*). Recently proposed revisions to these indicators, encompassing plants, vertebrates, invertebrates, and pathogens for the six major US biomes, will increase the consistency of reporting on nonnatives and improve comparability across regions and research and monitoring programs. Reprinted courtesy of The Heinz Center.*

Dybas, 2004

Invasive species example: Lake trout

- Introduced into Yellowstone Lake in 1994 by angler
- Decline of native cutthroat trout
- Park Service removed 80,000 lake trout since 1995
- Problem not likely to go away; rather, in maintenance mode

lake trout

pond.dnr.cornell.edu

cutthroat trout

www.fs.fed.us/r4/btnf/recreation/webpics/FishWebpage

Invasive species example: Buffelgrass as a disrupter of Southwest desert ecosystems

- modifications to disturbance regimes
- elimination of native species
- control by
  - education
  - mechanical removal

http://www.npr.org/templates/story/story.php?storyId=5295379

Invasive species example: Cheatgrass in the West

Consequences

- spreads by fire: promotion of fire => loss of native shrublands => loss of habitat for native animals
- weed in agricultural fields
- little or no nutritional value for cattle ("cheatgrass")

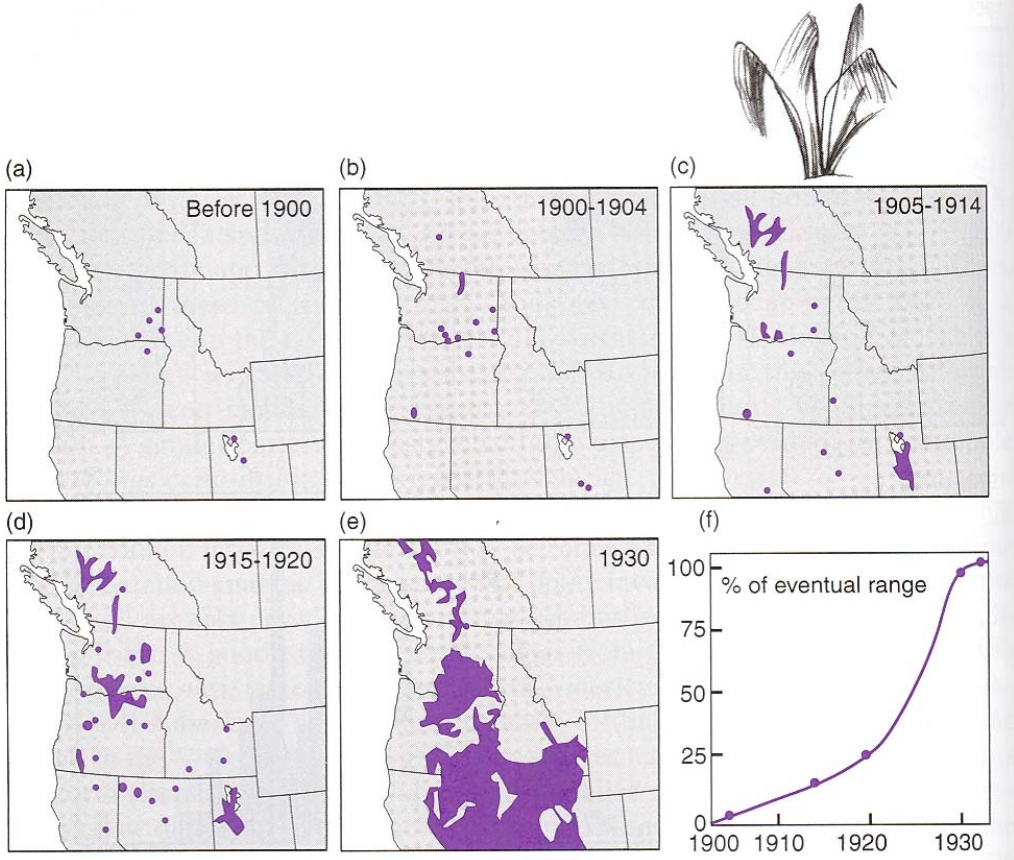


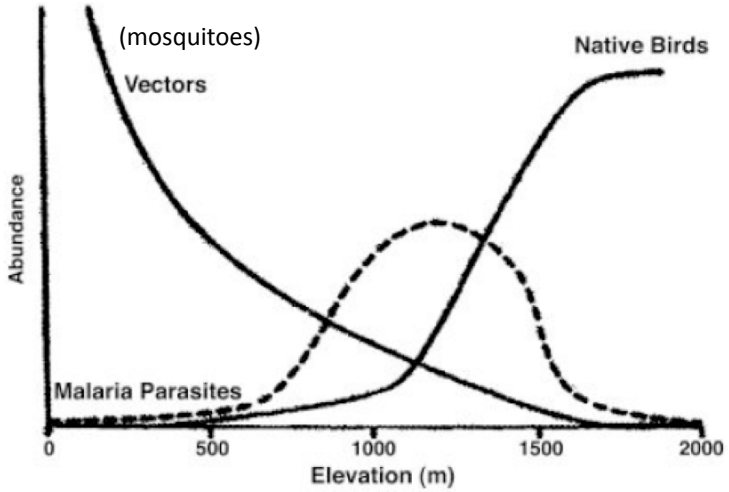
FIGURE 8.9 The logistic expansion of invading species spreading by either diffusion or jump dispersal as displayed by cheat grass *(Bromus tectorum)* expansion in western North America (after Mack, 1981; Shigesada and Kawasaki, 1997).

Invasive species example: Nutria in Louisiana

Figure 10 - Nutria have caused extensive habitat damage in southern Louisiana, sometimes leading to complete loss of marsh with conversion to open water. Ariel photo shows the results of vegetative change eight months into a four year study conducted by Lori Randall and Lee Foote through the USGS National Wetlands Research Center in Lafayette, LA. Experimental exclosures protected marsh vegetation from a 80-90% reduction in standing biomass from nutria (dotted white perimeter demarcates unfenced control area grazed by nutria). Such loss of plant biomass leads to a reduction in sediment accumulation and the eventual loss of marsh habitat.

Mack et al., 1997

Invasive species example: Malaria in Hawaiian Islands caused extinction in bird species



Benning et al., *Proc. Natl. Acad. Sci.* Volume 99 Number 22, 29 October 2002

- 30 species of Hawaiian honeycreepers (*Drepanididae*)
  - endemic to Hawaiian islands
- on Oahu, 6 species extinct by 1900
  - declines in lower elevation species but not higher elevation
- tied to introduction of *Culex* mosquitoes in 1820s by Europeans
  - carriers of avian malaria
  - lack of evolution in presence of mosquitoes => lack of defense in honeycreepers
  - <u>limited in elevation extent by temperature</u>

How are global change issues facilitating invasions?

Table 1. Possible general impacts of global change elements on the prevalence of invasive alien species[a]

Element of global change	Prevalence of invaders[b]
Increased atmospheric CO_2 concentration	+/−
Climate change	+
Increased nitrogen deposition	+
Altered disturbance regimes	+
Increased habitat fragmentation	+

[a]Although these predictions are speculative, they are based on observations that are mentioned or cited in the text.
[b]Key: +/−, might increase prevalence of some invaders and reduce prevalence of others; +, expected to increase prevalence of invaders in many affected regions.

Dukes and Mooney, 1999

Climate change facilitates some invasions

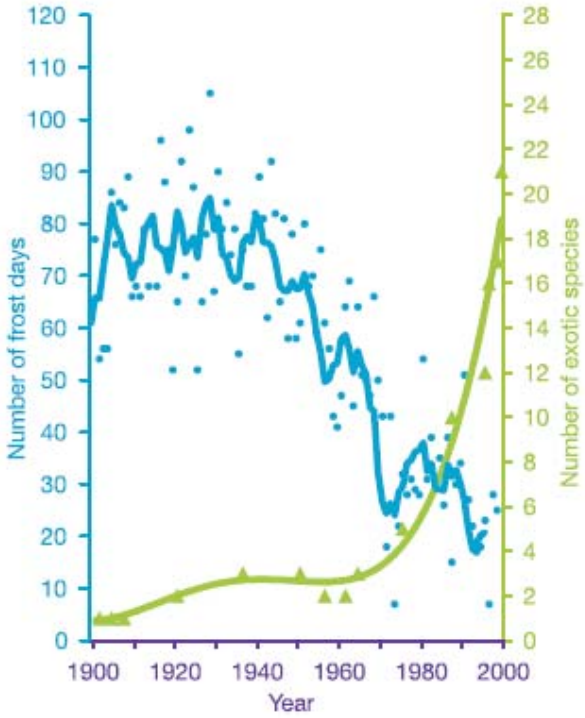


Figure 3 Vegetation shift from indigenous deciduous to exotic evergreen broad-leaved vegetation in southern Switzerland. The shrub layer is dominated by the growing number of spreading exotic evergreen broad-leaved species (see illustration) that appear to profit from milder winter conditions, indicated here by the decreasing number of days with frost per year (the smoothed curve gives five year averages for the number of frost days per year)[29].

Walther et al., 2002