## Biological Interactions

Stenophagy: common in plant-eating insects

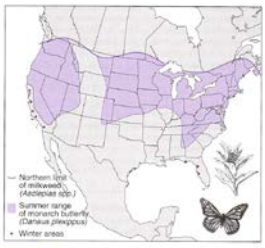



FIGURE 4.1 The correspondence between the northern range limits of the monarch butterfly (*Danaus plexippus*) and the northern range limits of its food plant, milkweed (*Asclepias* spp.) (after Brower and Malcolm, 1991).



## Biological Interactions

Edith's checkerspot butterfly is restricted to eating a plantain whose range is itself restricted to serpentine soils

so, the plant's distribution is controlled by abiotic (soil or edaphic) factors, but the butterfly's distribution is controlled by a biotic factor (where the plant grows)

Slide courtesy C. Still



## Biological Interactions

Stenophagy: examples in mammals

Giant panda (*Ailuropoda melanoleuca*)

www.trekearth.com/gallery/Asia/China/photo1084.htm

Koala (*Phascolartus cinereus*)

www.appleblossomart.net/Free/Koala-Wallpapers.htm

Abert's squirrel (*Sciurus aberti*)

www.enature.com/fieldguides/enlarged.asp?imageID=18865

## Biological Interactions

### Lotka-Volterra model

Classic study of Canada lynx (*Lynx canadensis*), snowshoe hare (*Lepus americanus*)

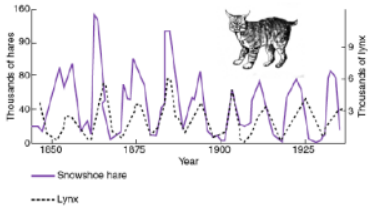



**FIGURE 4.3** Historical cyclic variations in the population sizes of the snowshoe *(Lepus americanus)* and Canada lynx *(Lynx canadensis)* (after MacLulick, 1937; Begon et al., 1996).

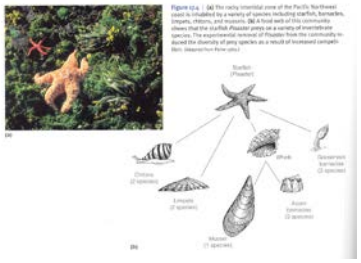
*Note: more recent studies show the influence of plant-hare cycles w/o lynx*



## Biological Interactions

### Evidence of predator controls on prey distribution

Artificial exclusion experiments:



Prey species before: 15
Prey species after: 8

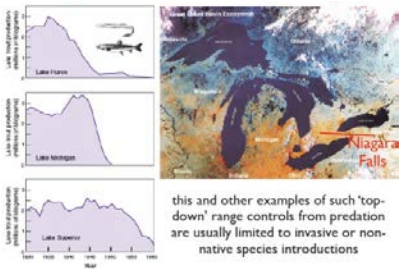
Smith and Smith, 2006



## Biological Interactions

Predator controls on prey distribution

invasive generalist predator (euryphagous)




this and other examples of such 'top-down' range controls from predation are usually limited to invasive or non-native species introductions

Figure 4.2, MacDonald

Slide courtesy C. Still

## Biological Interactions

## Competition

Allelopathy: chemical warfare

*Casuarina equisetifolia* litter completely suppresses germination of understory plants as shown here despite the relative openess of the canopy and ample rainfall (>120 cm/ yr) at the location

en.wikipedia.org/wiki/Allelopathy

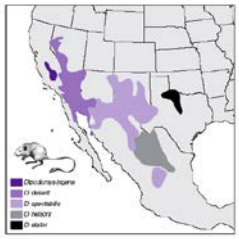
Toxins inhibit seed germination



## Biological Interactions

## Competition

Interspecific competition controlling species distributions



- similar, closely related species
- similar ecological niches
- no range overlap

Suggestion: interspecific competition controlling species distributions

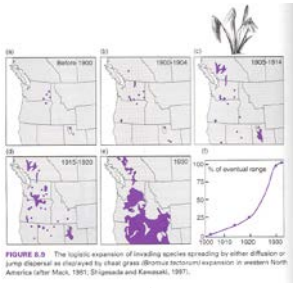
Slide courtesy C. Still



## Biological Interactions

## Competition

Invasive species are, by definition, superior competitors



Cheatgrass (*Bromus tectorum*)

## Biological Interactions

### Introduction to the -isms

| Type of -ism | Effect on species 1 | Effect on species 2 |
|---|---|---|
| mutualism | + | + |
| commensalism | + | neutral |
| parasitism | + | - |

Slide courtesy C. Still



## Biological Interactions

### Symbiotic mutualism example

Clark's nutcracker (*Nucifraga columbiana*)

www.birds.cornell.edu/AllAboutBirds/BirdGuide/Clarks_Nutcracker_dtl.html



## Biological Interactions

Five-needle pines

- large (nutritious), wingless (not dispersed by wind) seeds
- high fat, high-energy food source

Whitebark pine (*Pinus albicaulis*)

Limber pine (*Pinus flexilis*)

esp.cr.usgs.gov/data/atlas/little/

## Biological Interactions


en.wikipedia.org/wiki/Clark%27s_Nutcracker

Caches thousands of pine seeds each year

Has a tremendous memory:

- can remember where to find most of the seeds it hides
- 6 months later, under 3' of snow



## Biological Interactions

www.cudenver.edu/Academics/Colleges/CLAS/Biology/Biology+Faculty/Dr.+Diana+Tomback.htm

Caches by nutcracker (and squirrels) result in multiple stems in close proximity ("cache-mates")



## Biological Interactions

Whitebark pine is a keystone species

Reliance on whitebark pine by animal species

Key is the mutualistic relationship with the nutcracker

## Biological Interactions

### Symbiosis: 2. Commensalism

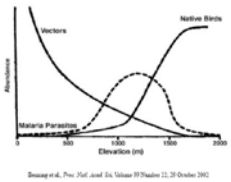
- Clownfish are impervious to anenome's poison => protection for clownfish
- Some clownfish are anenome-specific
- Clownfish may attract predators, which serve as prey for anemone => mutualism

www.sherrysknowledgequest.com/clownfish.htm



## Biological Interactions

Example of controls of parasites on host geographic distribution: invasive species




- 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
  - limited in elevation extent by temperature



## Biological Interactions

### Example of combined physical, biological controls

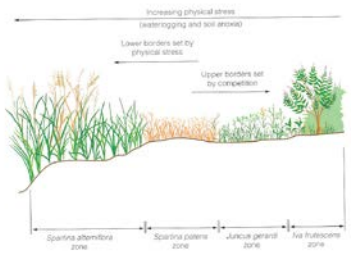



Figure 13.10 | Zonation of the dominant perennial plant species in a New England salt-marsh community. The upper borders of species distribution are a function of competition, whereas the lower boundaries are a function of the ability of the species to tolerate the physical stress associated with salinity, waterlogging, and low oxygen concentrations in the sediments. (Adapted from Emery et al. 2001.)

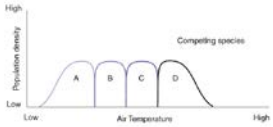
Smith and Smith, 2006

## Biological Interactions

### Biological interactions and gradients

Method of determining impact of competition: examine abundance of different species along environmental gradient

*Danger: inferred, not determined*



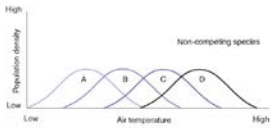




FIGURE 4.8 Hypothetical gradient distribution of four competing species and four noncompeting species.



## Biological Interactions

### Biological interactions and niches

Concepts of niches in presence of competition

*fundament niches = circles*

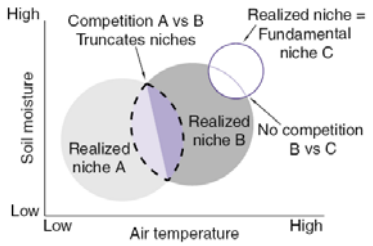



FIGURE 4.9 The realized and potential niches of three hypothetical plant species.