

Biological Interactions

Stenophagy: common in plant-eating insects

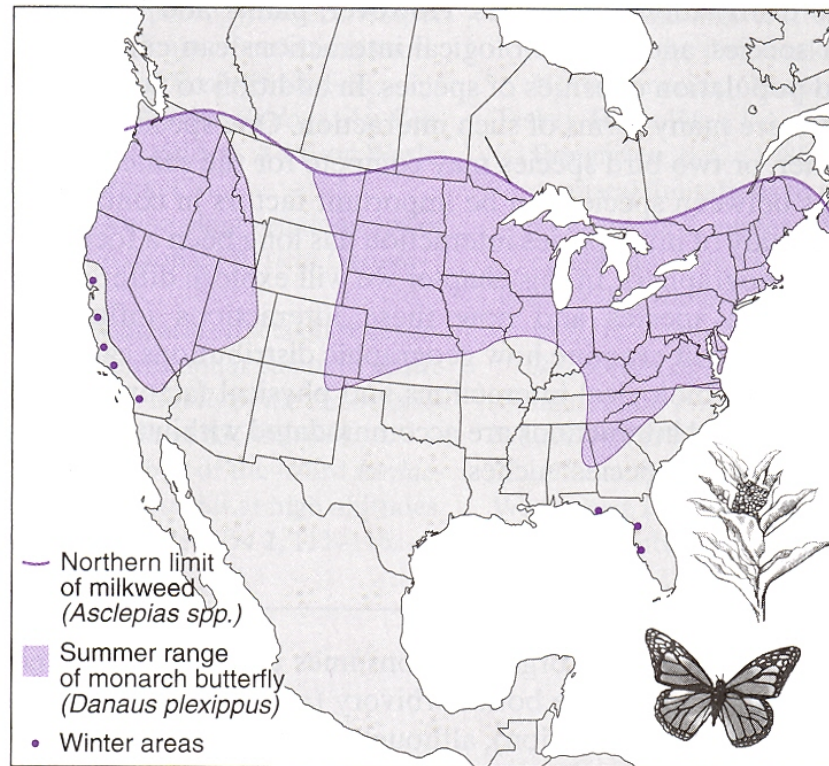


FIGURE 4.1 The correspondence between the northern range limits of the monarch butterfly (*Danaus plexippus*) and the northern range limits of its food plant, milkweed (*Asclepias* spp.) (after Brower and Malcolm, 1991).

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)



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*)

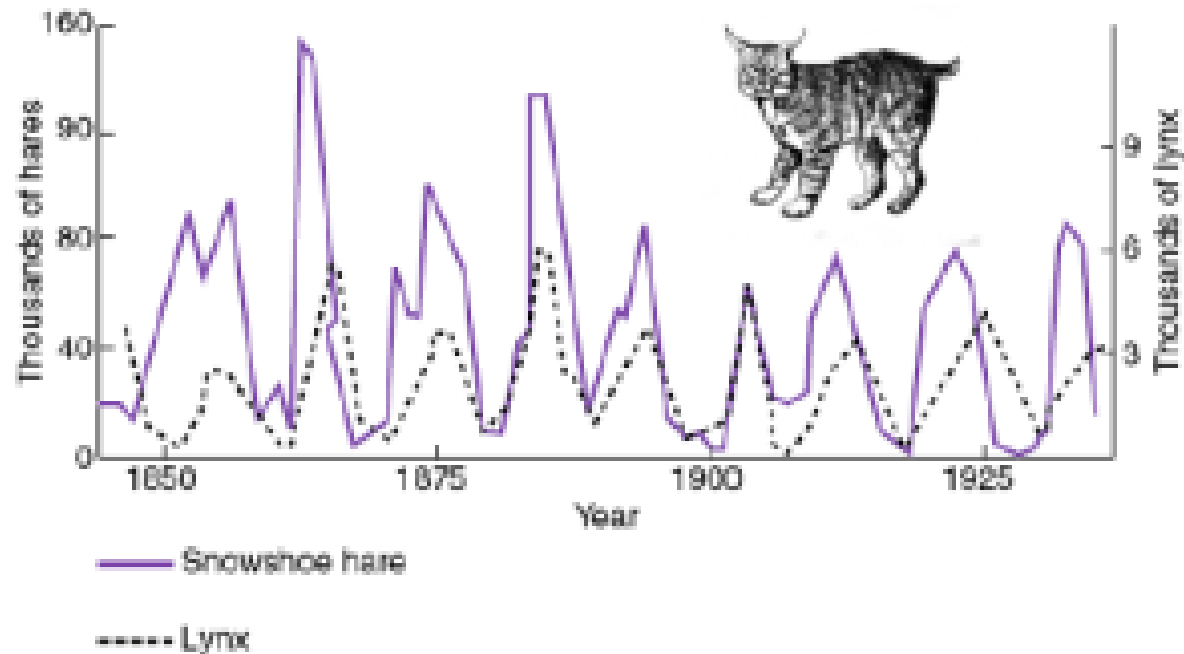


FIGURE 4.3 Historical cyclic variations in the population sizes of the snowshoe (*Lepus americanus*) and Canada lynx (*Lynx canadensis*) (after MacLulich, 1937; Begon et al., 1996).

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

Biological Interactions

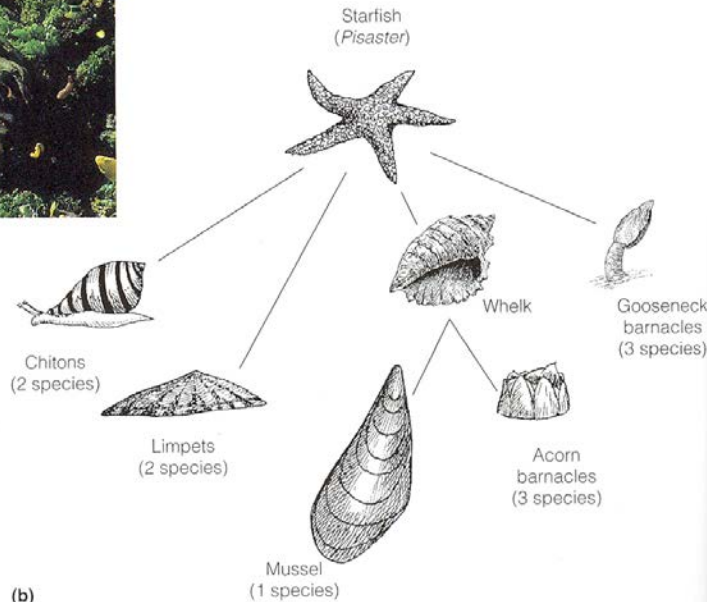
Evidence of predator controls on prey distribution

Artificial exclusion experiments:



(a)

Figure 17.4 | (a) The rocky intertidal zone of the Pacific Northwest coast is inhabited by a variety of species including starfish, barnacles, limpets, chitons, and mussels. (b) A food web of this community shows that the starfish *Pisaster* preys on a variety of invertebrate species. The experimental removal of *Pisaster* from the community reduced the diversity of prey species as a result of increased competition. (Adapted from Paine 1969.)



(b)

Prey species before: 15
Prey species after: 8

Smith and Smith, 2006

Biological Interactions

Predator controls on prey distribution

invasive generalist predator (euryphagous)

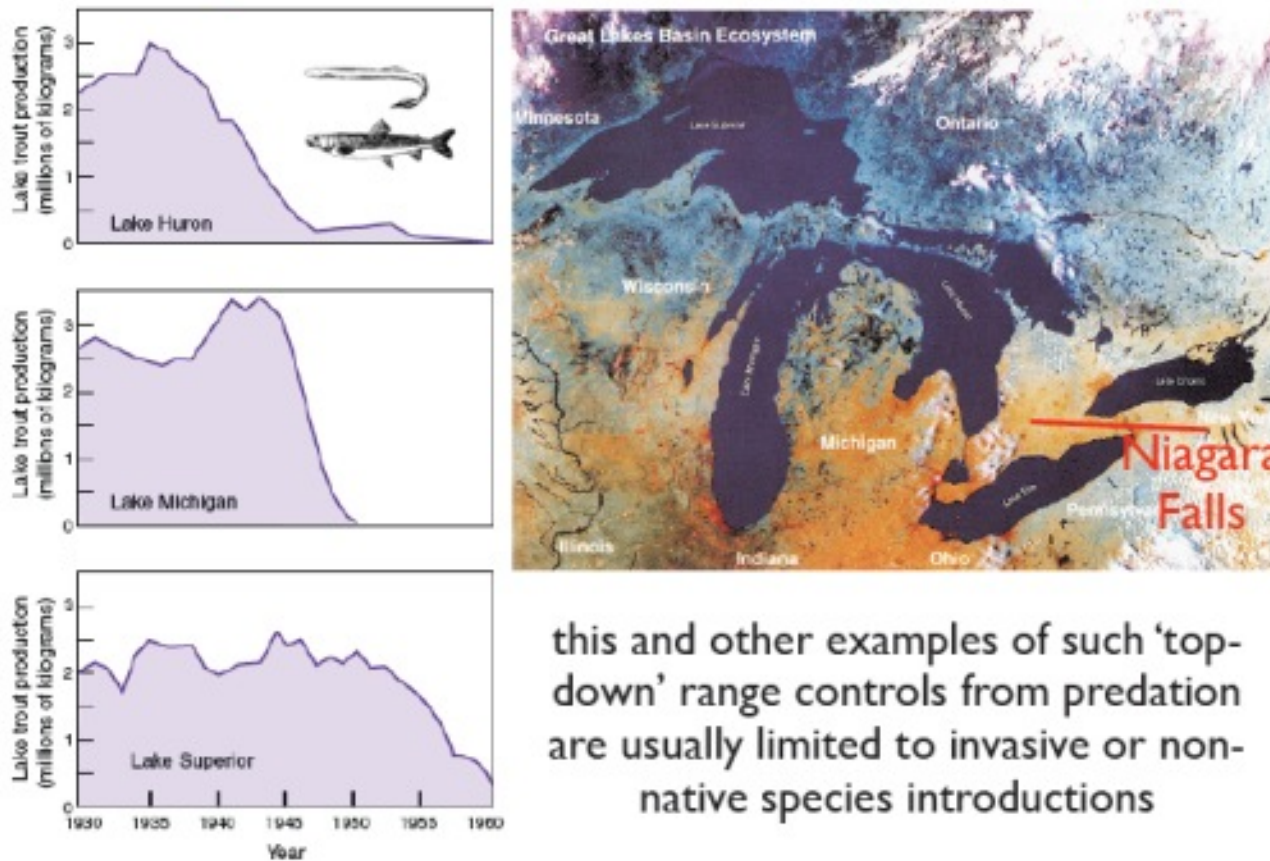


Figure 4.2, MacDonald

Biological Interactions

Competition

Allelopathy: chemical warfare



[Casuarina equisetifolia](#) litter completely suppresses germination of understory plants as shown here despite the relative openness 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

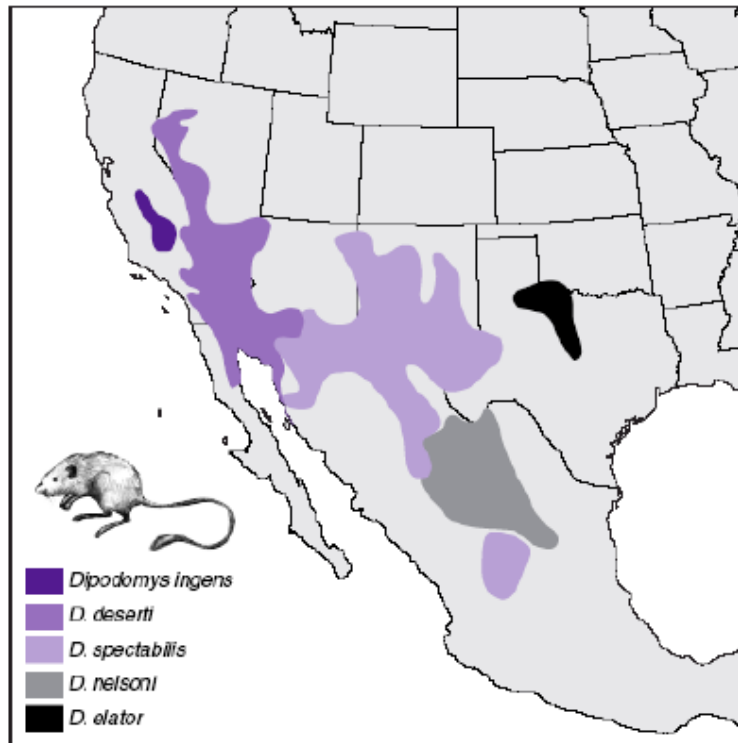


FIGURE 4.4 The distribution of kangaroo rat species in the southwestern United States and Mexico shows sharp range boundaries that suggest the importance of competition with other species in limiting the geographic ranges of each species (after Bowers and Brown, 1982 and Brown and Lomolino, 1998).

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

Suggestion: interspecific competition controlling species distributions

Biological Interactions

Competition

Invasive species are, by definition, superior competitors

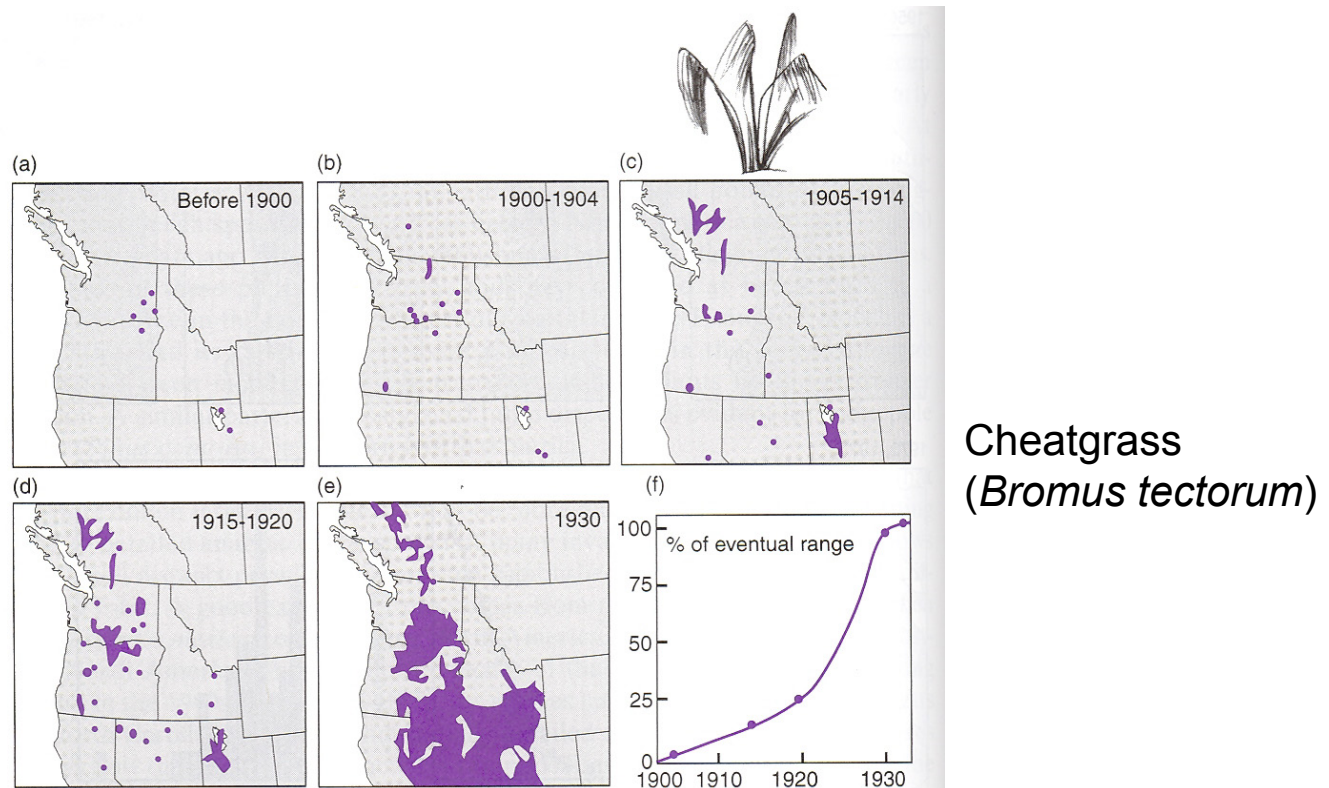


FIGURE 8.9 The logistic expansion of invading species spreading by either diffusion or jump dispersal as displayed by cheat grass (*Bromus tectorum*) expansion in western North America (after Mack, 1981; Shigesada and Kawasaki, 1997).

Biological Interactions

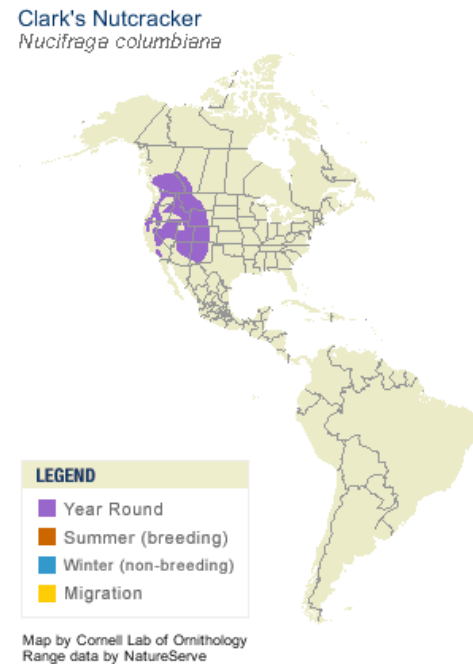
Introduction to the -isms

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

Biological Interactions

Symbiotic mutualism example

Clark's nutcracker (*Nucifraga columbiana*)



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

Biological Interactions

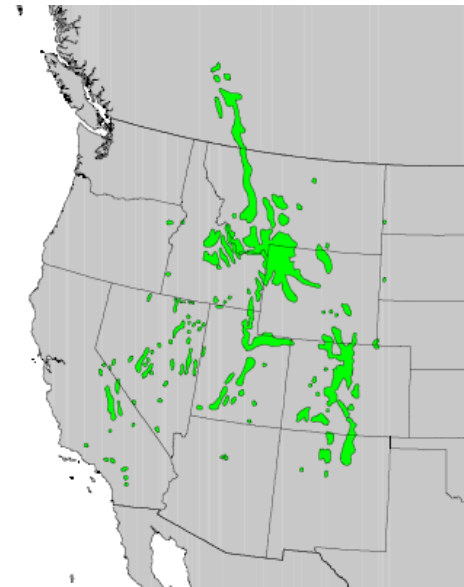
Five-needle pines

- 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



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

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



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

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

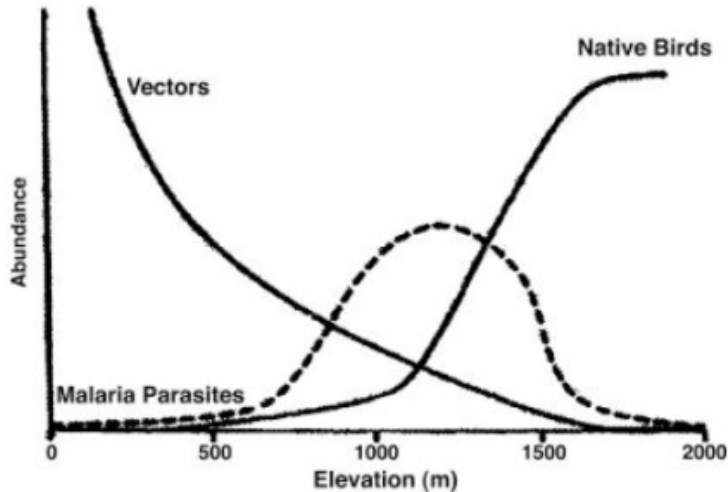
- Clownfish are impervious to anemone's poison => protection for clownfish
- Some clownfish are anemone-specific
- Clownfish may attract predators, which serve as prey for anemone => mutualism



www.sherrysknowledgequest.com/clownfish.htm

Biological Interactions

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



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
 - limited in elevation extent by temperature

Biological Interactions

Example of combined physical, biological controls

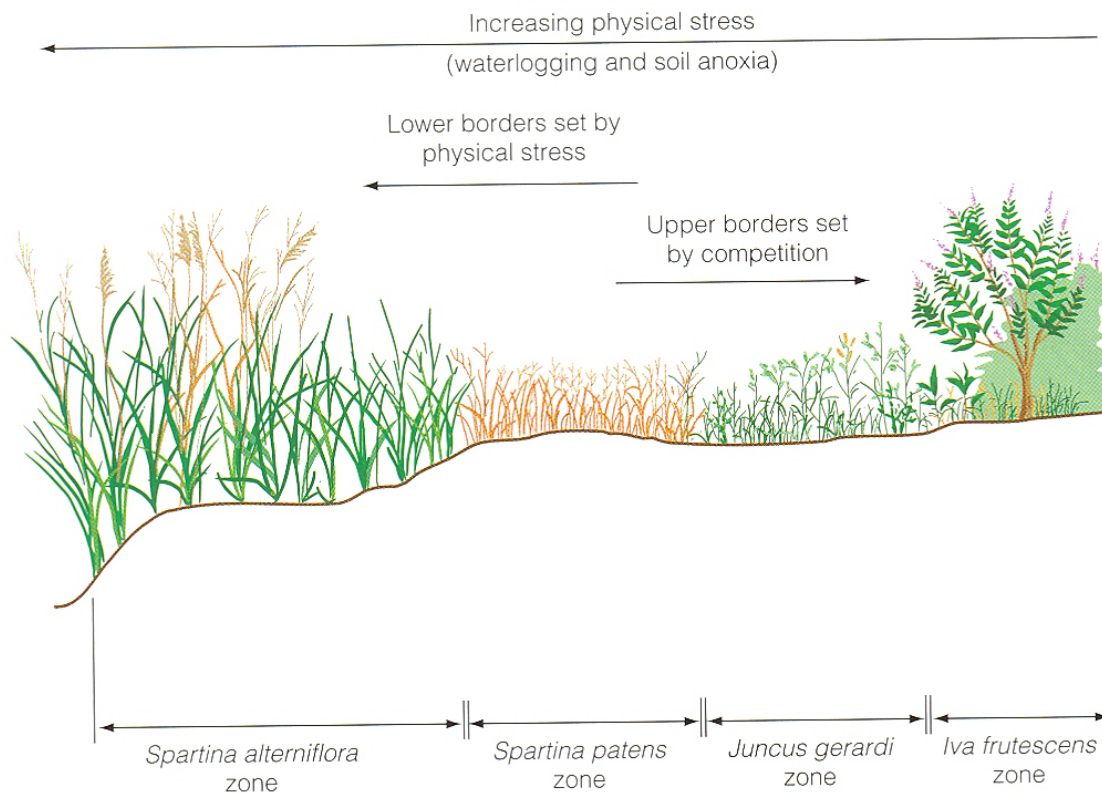


Figure 13.10 | Zonation of the dominant perennial plant species in a New England salt-marsh community. The upper borders of species distribution are a function of competition, whereas the lower boundaries are a function of the ability of the species to tolerate the physical stress associated with salinity, 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

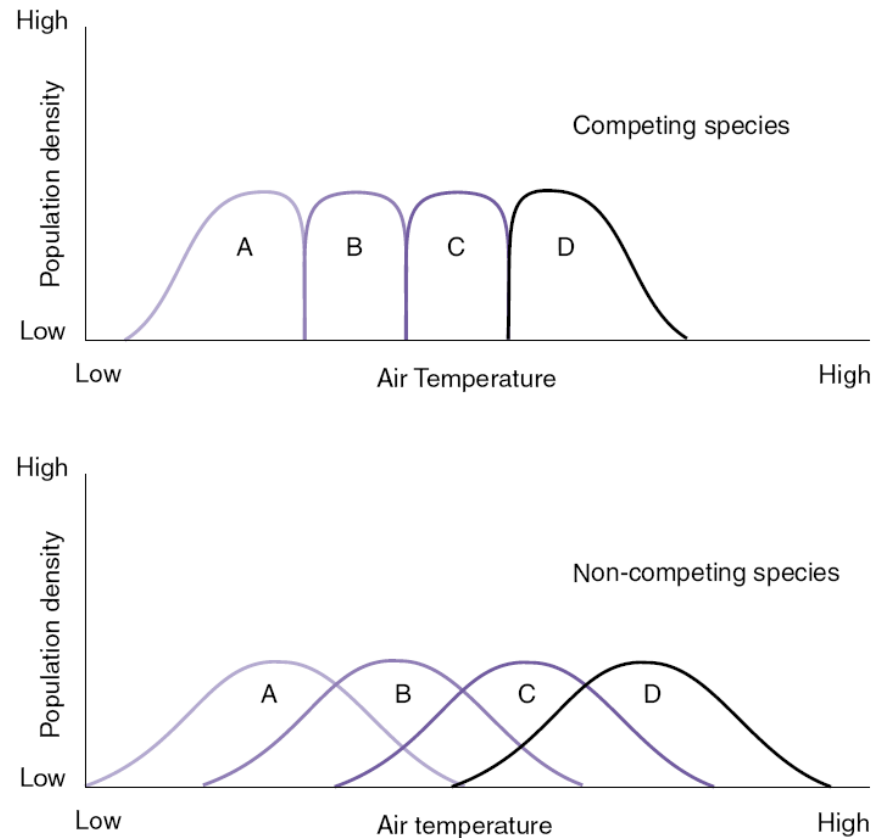


FIGURE 4.8 Hypothetical gradient distribution of four competing species and four noncompeting species.

Biological Interactions

Biological interactions and niches

Concepts of niches in presence of competition

fundament niches = circles

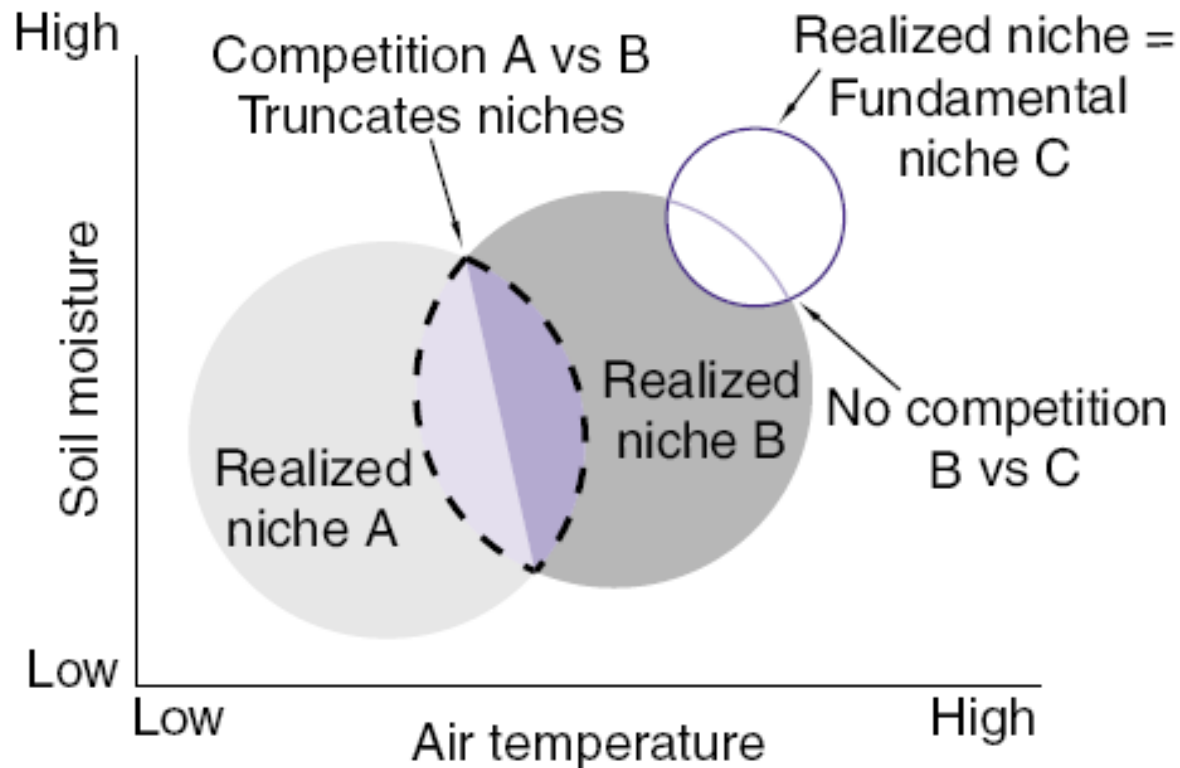


FIGURE 4.9 The realized and potential niches of three hypothetical plant species.