Quiz

A Zero Net Growth Isocline (ZNGI) is

a) A stable equilibrium
b) The set of population sizes at which one species in a pair is unchanging
c) A path to extinction
d) An artifact of sampling

Interspecific Competition

Key concepts

- Classification of species interactions
- Interference competition (shore crabs)
  - Lotka-Volterra Theory
  - Zeroi net-growth isocline
  - Coexistence conditions
  - Alternative stable states

Classes of Interspecific Interactions

(Species 1/Species 2)	Interaction
(-/-)	Competitive
(+/+)	Mutualistic
(+/-)	Antagonistic Plant-Herbivore Predator-Prey Host-Parasite

Interference Competition

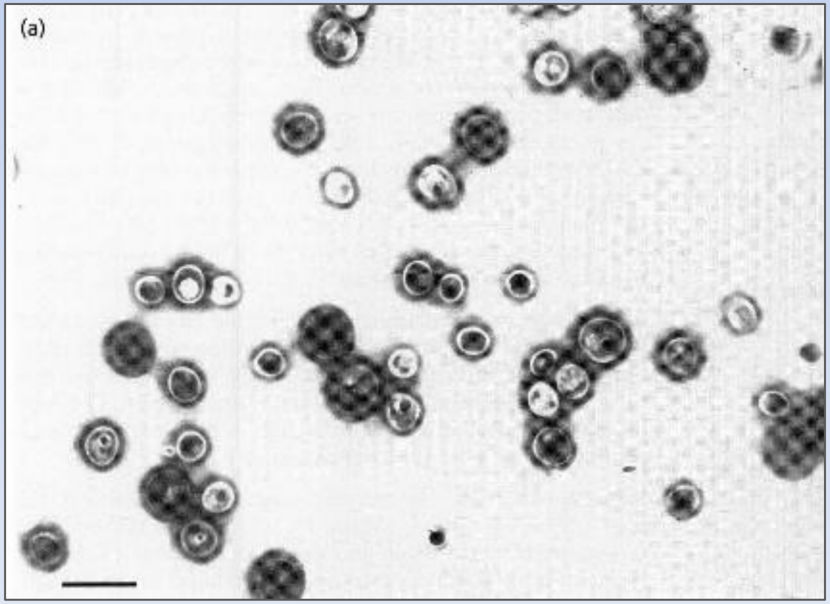
Interference competition. An interaction between organisms in which one species prevents another species from accessing resources in a way that diminishes fitness beyond the costs of resource competition.

Allelopathy in Garlic mustard *Alliaria petiolata*

Interference competition in seasonal anurans

Common frog, *Rana temporaria*

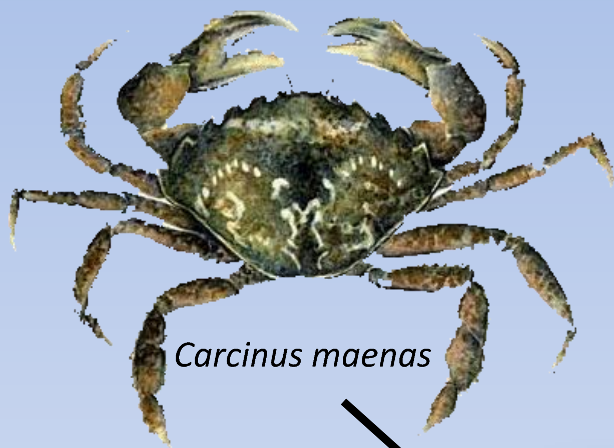
Natterjack toad, *Bufo calamita*



Phase-contrast microscopic image of protist pathogen *Anurofeca richardsi*

Image: Baker *et al.* (1999) Microbiology 145:1777-1784

Competition in invasive shore crabs



Carcinus maenas

Hemigrapsus sanguineus

Mytilus edulis

General (Lotka-Volterra) Competition Theory

$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1}{K_1} \right) \qquad \frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - N_2}{K_1} \right)$$

$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha_{12} N_2}{K_1} \right)$$

10 individuals of Species 2 = 1 individual of species 1

Total effect on Species 1 = ($N1$ + $N2$ * 1/10)

↑

Competition coefficient α_{12}

General (Lotka-Volterra) Competition Theory

$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha_{12} N_2}{K_1} \right)$$

$$\frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 - \alpha_{21} N_1}{K_2} \right)$$

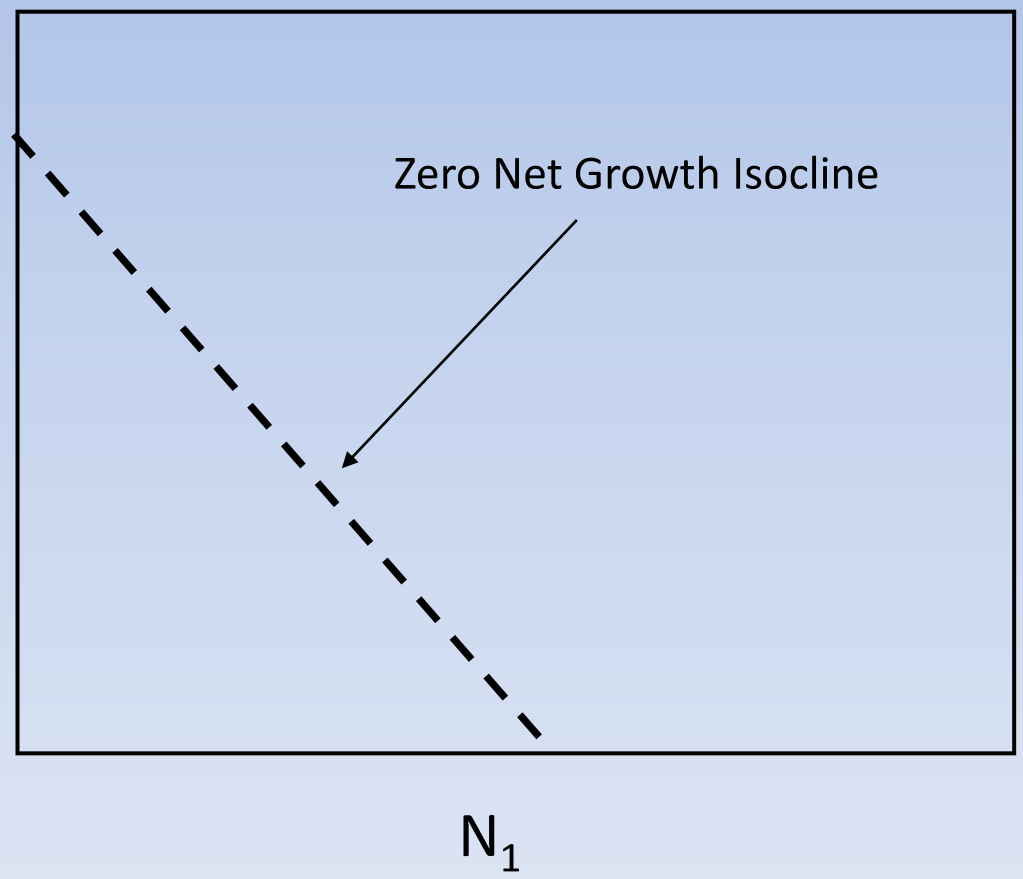
If 2 individuals of sp. 2 = 1 of sp. 1

$\alpha_{12} = 1/2 = 0.5$

If 1 individuals of sp. 2 = 2 of sp. 1

$\alpha_{12} = 2/1 = 2$

Phase Plane Diagram



Zero Net Growth Isoclines (ZNGIs)

At equilibrium, $dN_1/dt = 0$

$$0 = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha_{12} N_2}{K_1} \right)$$

Worked problem: Rearrange this expression to find an equation for the number of species 1 along the zero net growth isocline in terms of the number of species 2.

Zero Net Growth Isoclines (ZNGIs)

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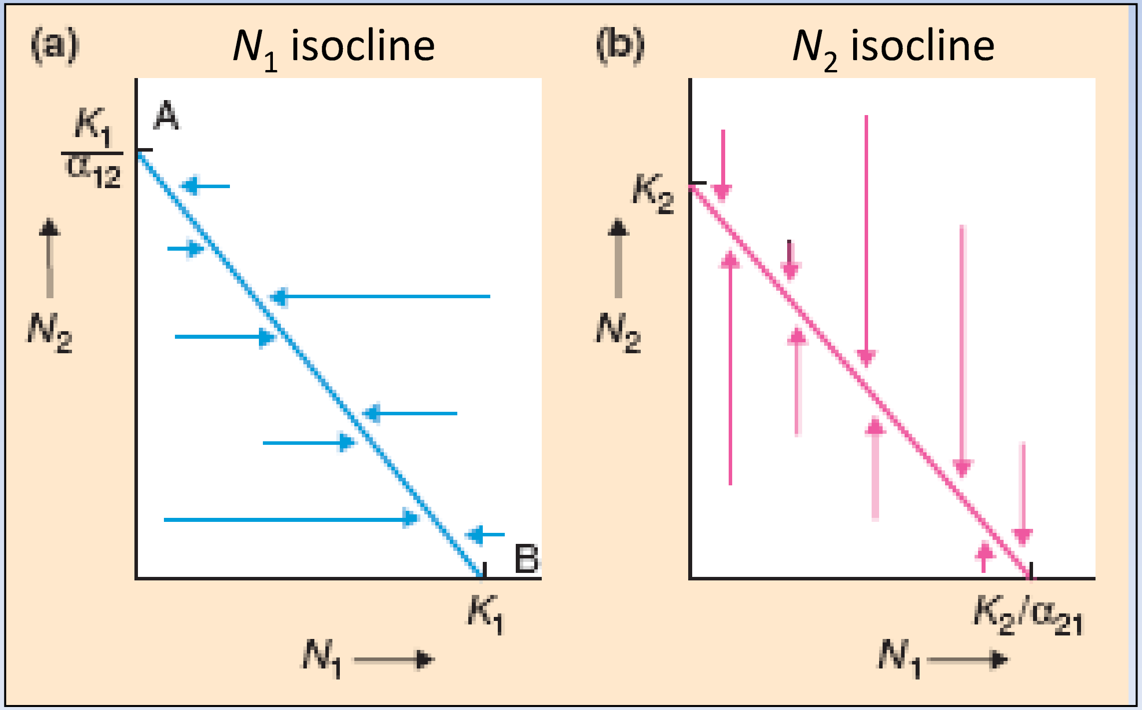
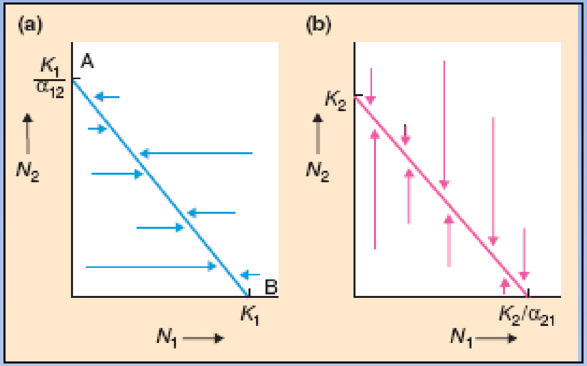
$$0 = r_1 N_1 \left(\frac{K_1 - N_1 - \alpha_{12} N_2}{K_1} \right)$$

Rearranging:

$$N_1 = K_1 - \alpha_{12} N_2$$





Add vectors together to determine direction of system

$K_1/\alpha_{12} > K_2$ & $K_1 > K_2/\alpha_{21}$

N$_1$ excludes *N*$_2$

$K_1/\alpha_{12} < K_2$ & $K_1 < K_2/\alpha_{21}$

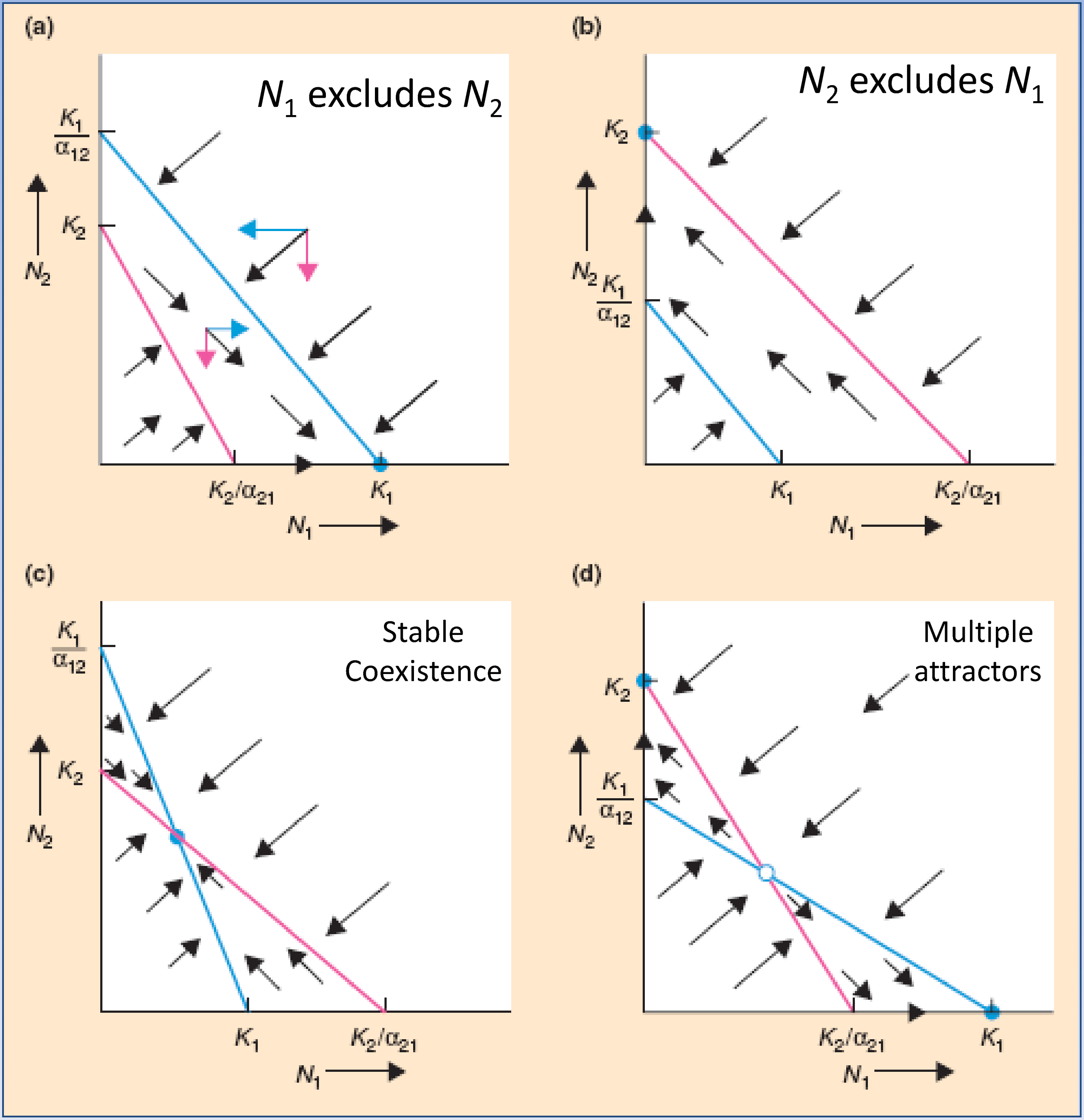
N$_2$ excludes *N*$_1$

$K_1 < K_2/\alpha_{21}$ & $K_2 < K_1/\alpha_{12}$

Stable Coexistence

$K_1 > K_2/\alpha_{21}$ & $K_2 > K_1/\alpha_{12}$

Multiple attractors



A constraint on stable coexistence

$$K_1 < K_2 / \alpha_{21}$$

$$K_2 < K_1 / \alpha_{12}$$

$$K_2 < (K_2 / \alpha_{21}) / \alpha_{12}$$

$$K_2 < K_2 / (\alpha_{21} \times \alpha_{12})$$

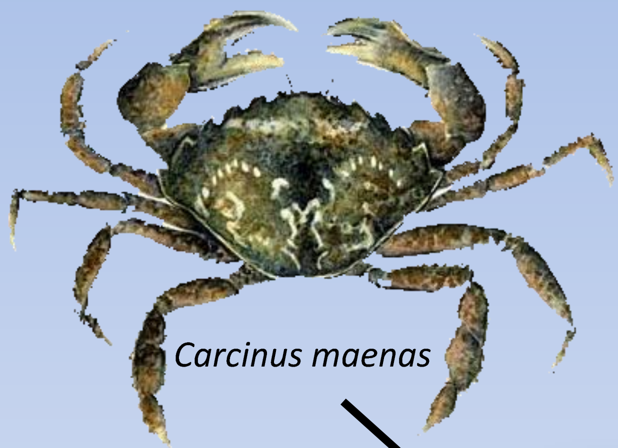
$$1 < 1 / (\alpha_{21} \times \alpha_{12})$$

$$\alpha_{21} \times \alpha_{12} < 1$$

For stable coexistence of both species, the product of the competition coefficients must be less than 1

Overall, interspecific competition must be less than intraspecific competition

Competition in invasive shorecrabs

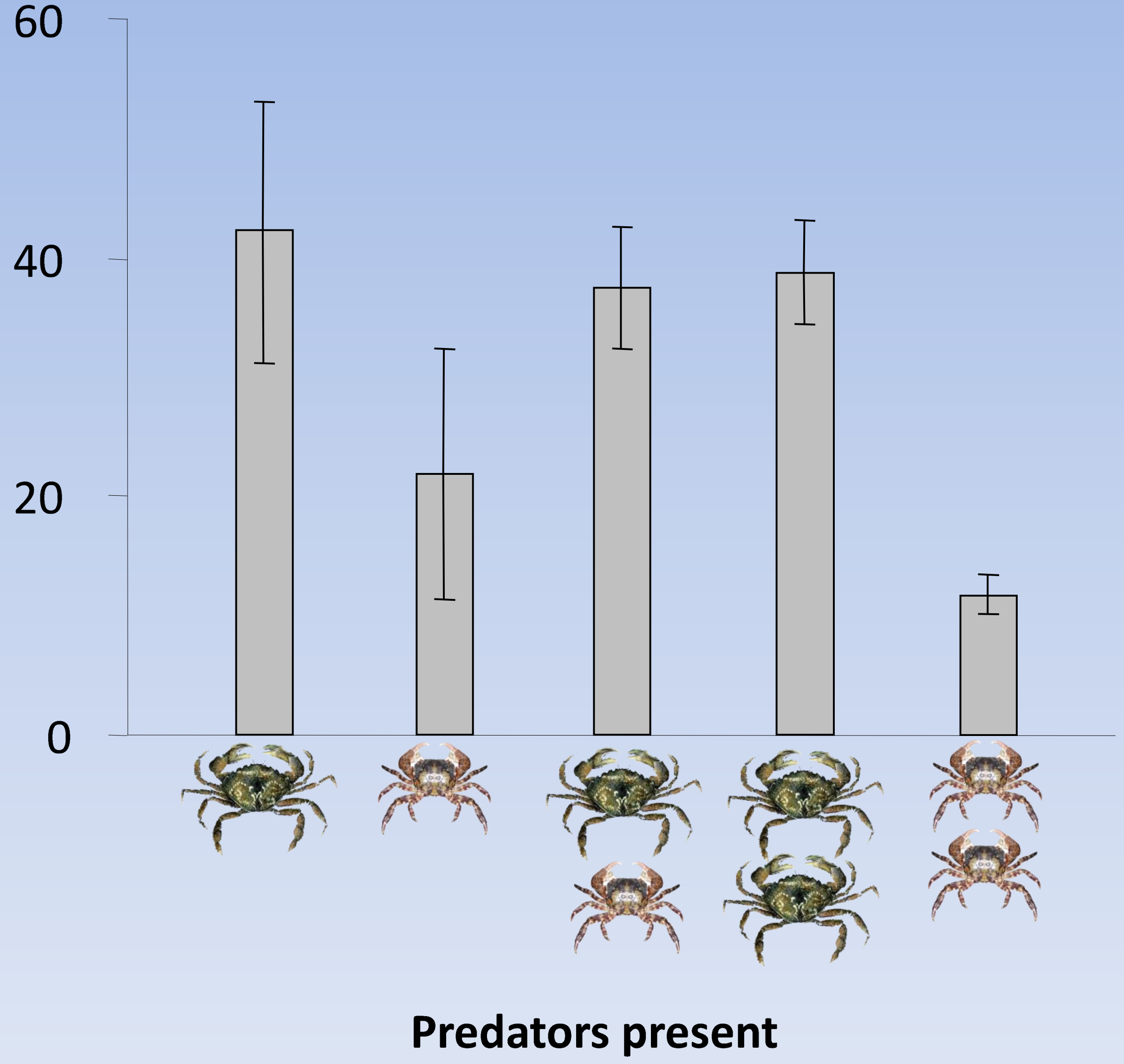


Carcinus maenas

Hemigrapsus sanguineus

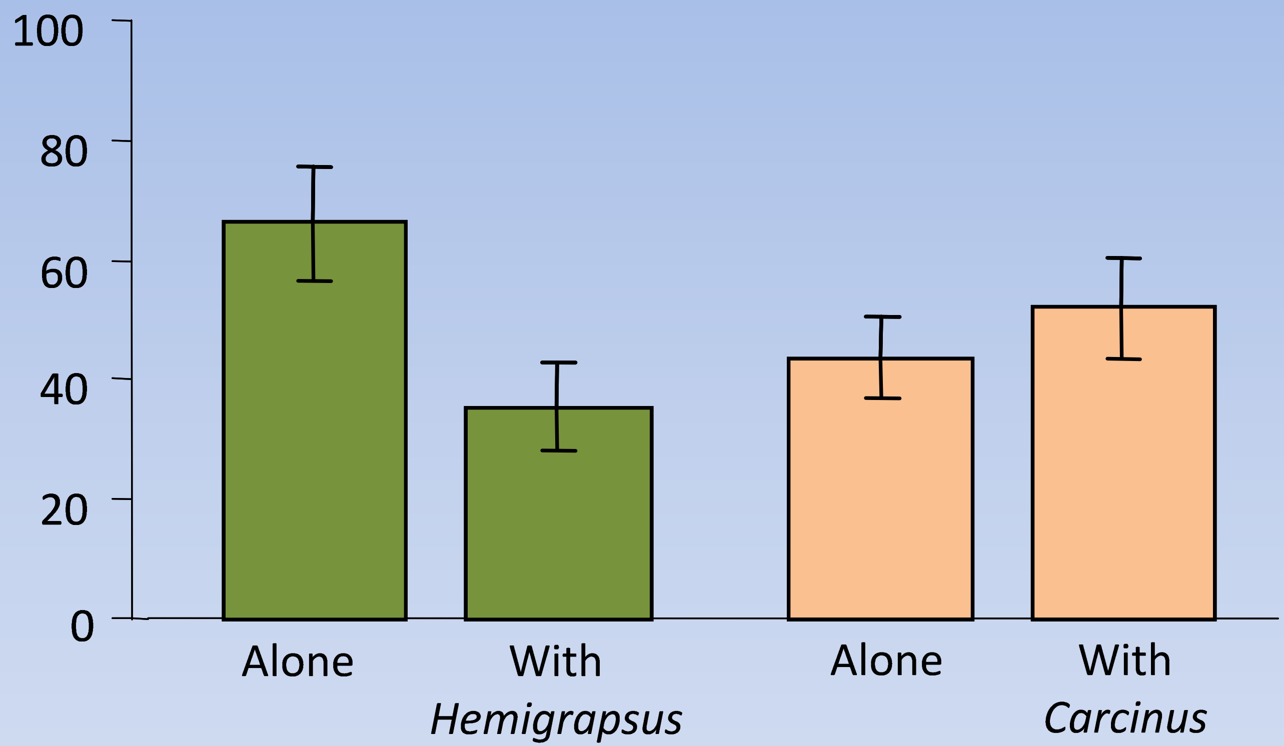
Mytilus edulis

Predation rates on mussels



Griffen (2006)

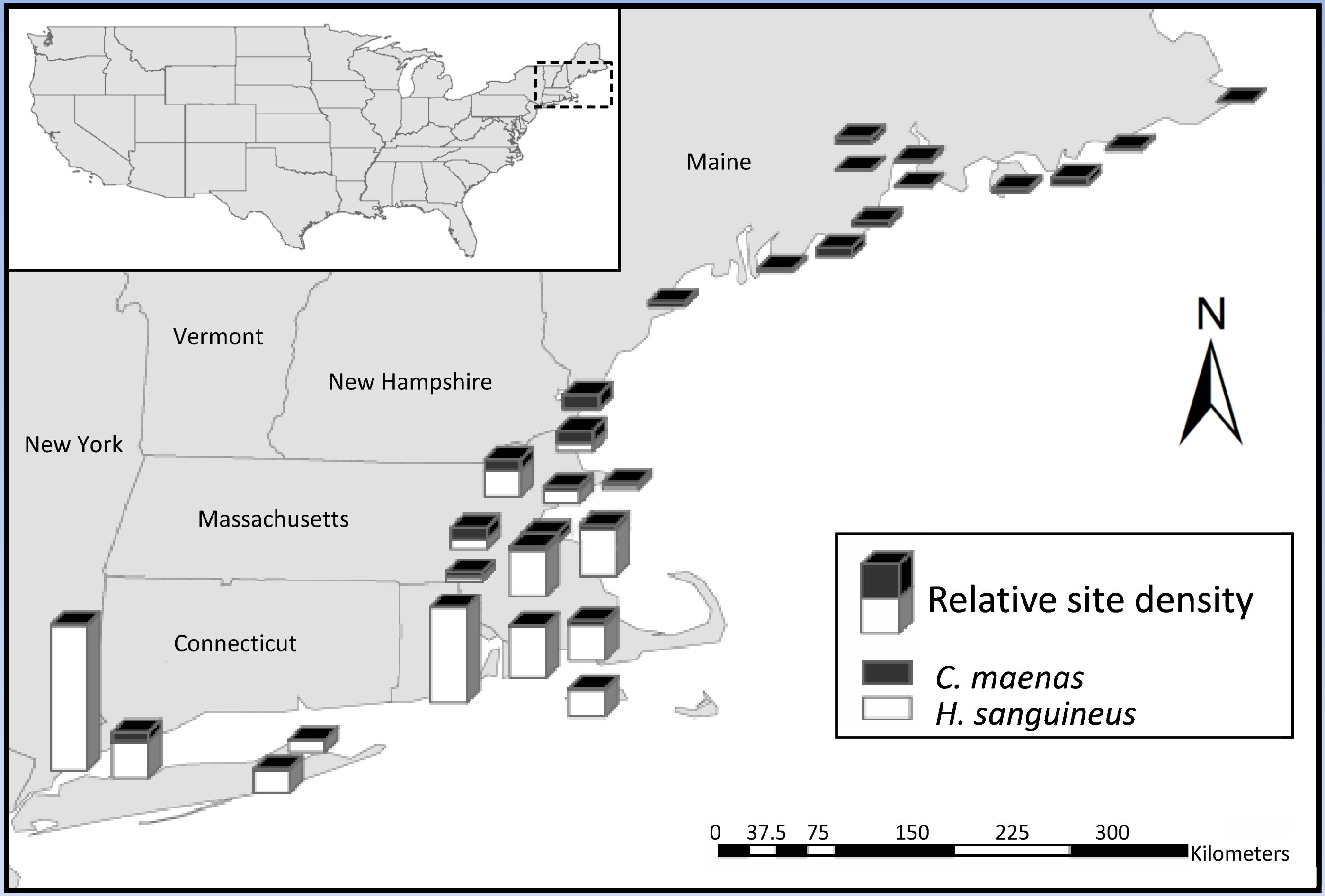
Foraging success



α_{12} is large

α_{21} is small

Griffen et al. (2007)



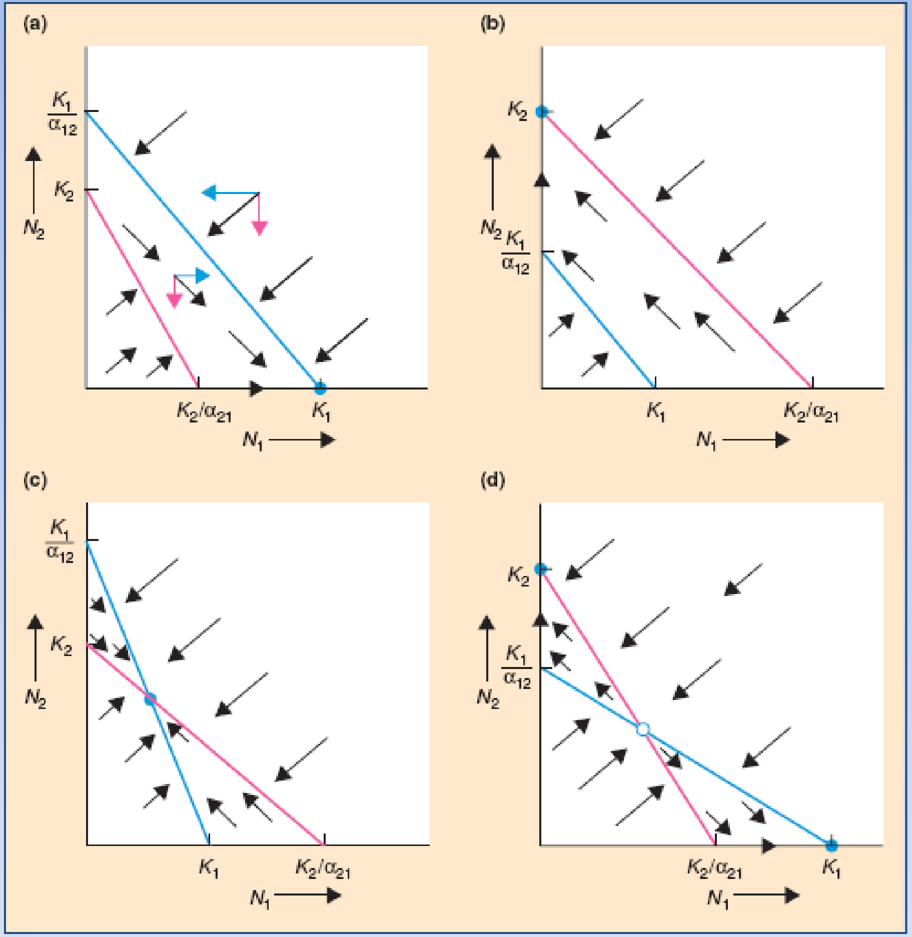
K_1 is small

K_2 is large

Griffen &Delaney (2007)

Challenge Problem

Which scenario does the Lotka-Volterra theory of competition predict will occur when *Hemigrapsus* is introduced to a location occupied by *Carcinus*?



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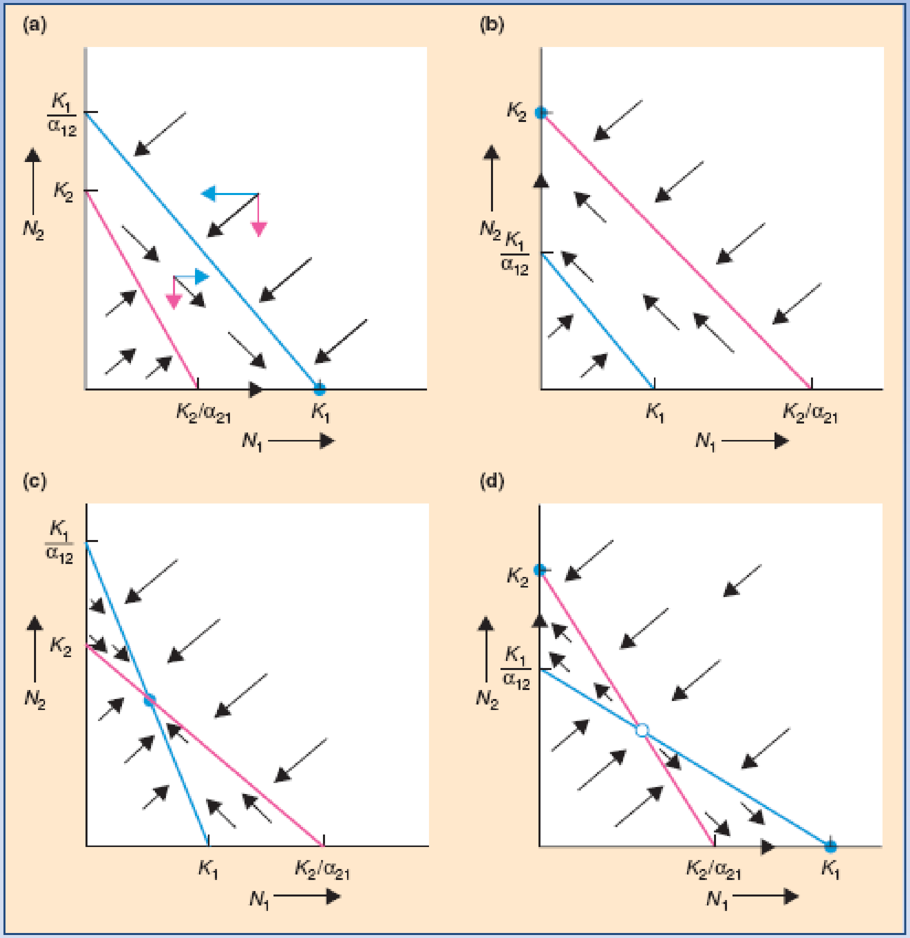
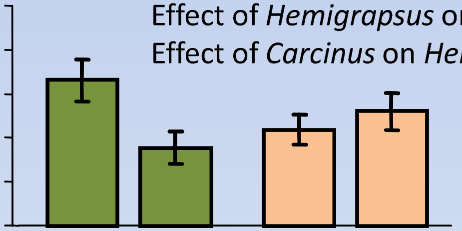
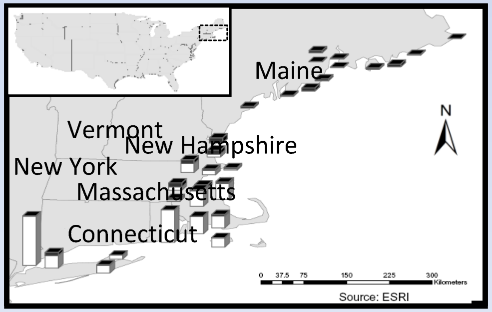


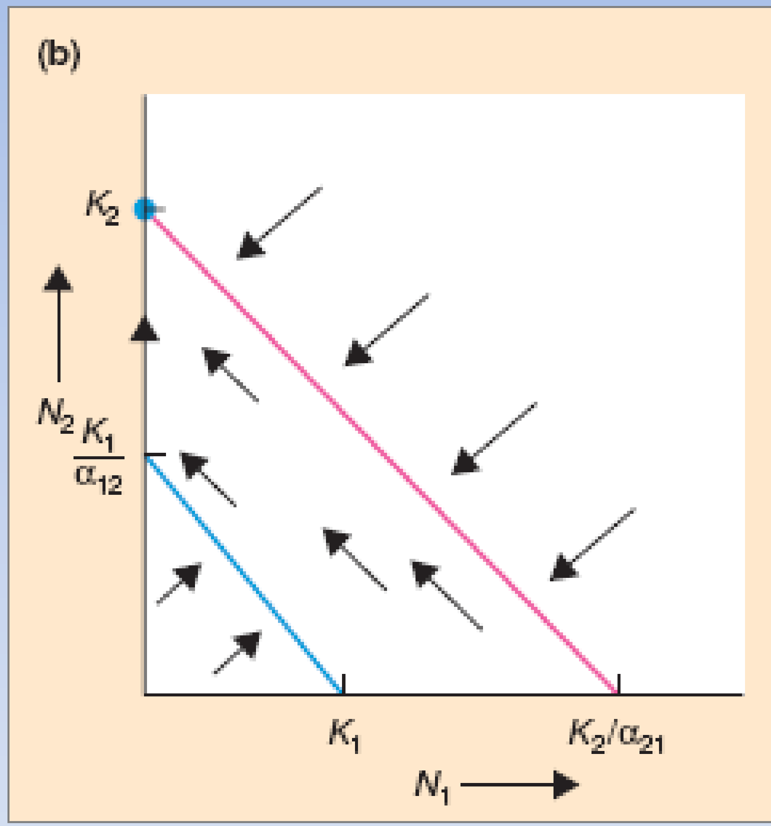
Effect of *Hemigrapsus* on *Carcinus* large
Effect of *Carcinus* on *Hemigrapsus* small





$K_1 < K_2$

Theoretical Prediction



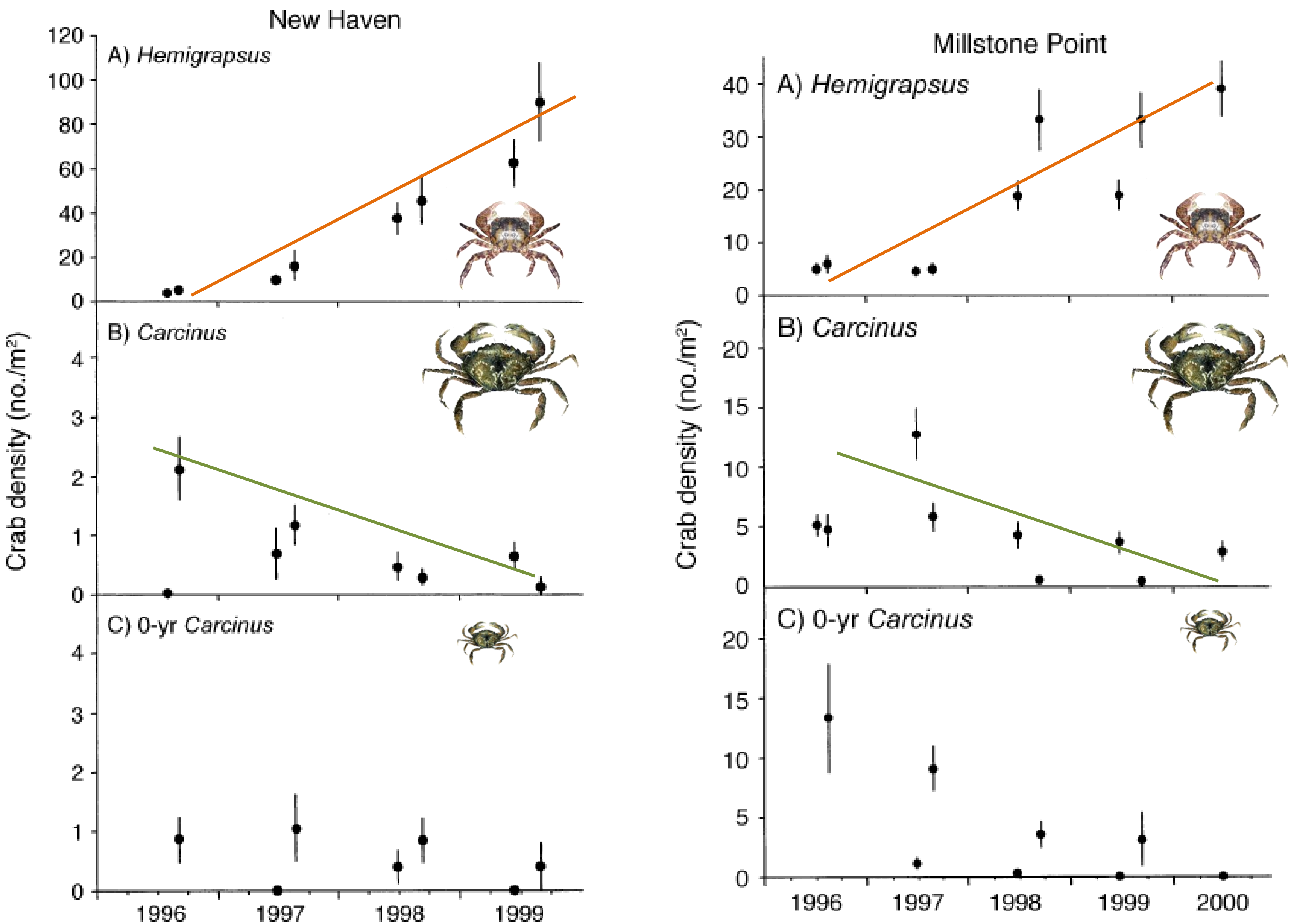
$K_1/\alpha_{12}<K_2$ & $K_1<K_2/\alpha_{21}$

N_2 excludes N_1

Effect of *Hemigrapsus* on *Carcinus* **large**
Effect of *Carcinus* on *Hemigrapsus* **small**

$K_1<K_2$

Competitive displacement of *Carcinus* by *Hemigrapsus*



Lohrer & Whitlatch (2002)