The Question of Scale in Ecology

Individuals

10^0–10^1 cm

Populations

10^2–10^4 cm

Regions

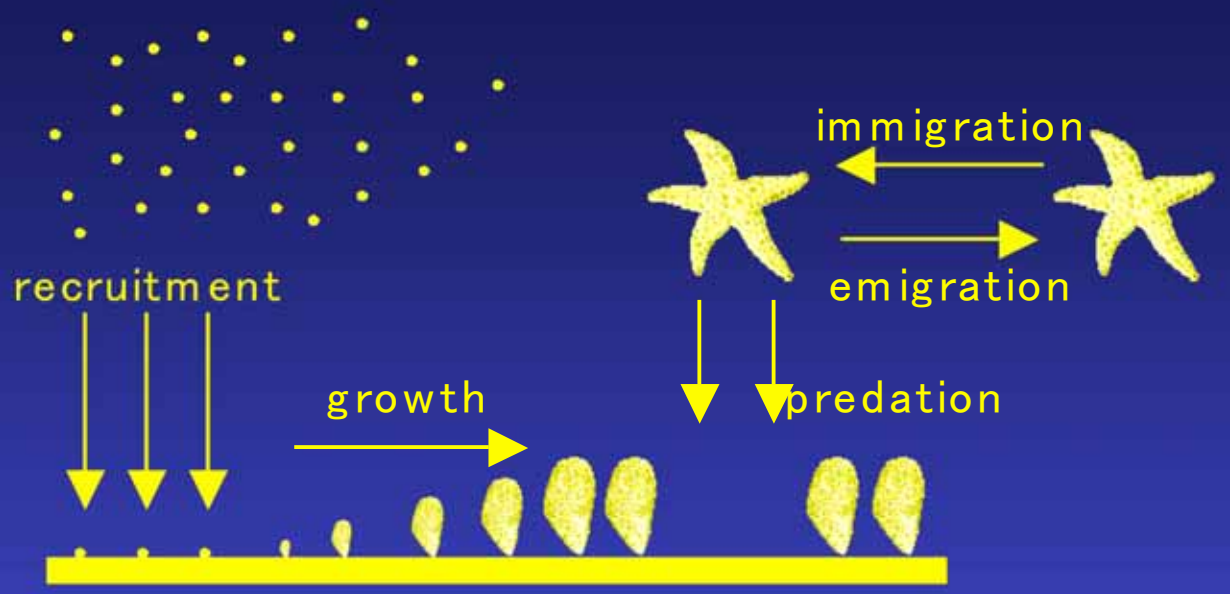
10^5–10^6 cm

Continents

10^7–10^8 cm

How do we make the transition from modeling the dynamics on one spatial scale to another?

Open System Model of Mussel Population



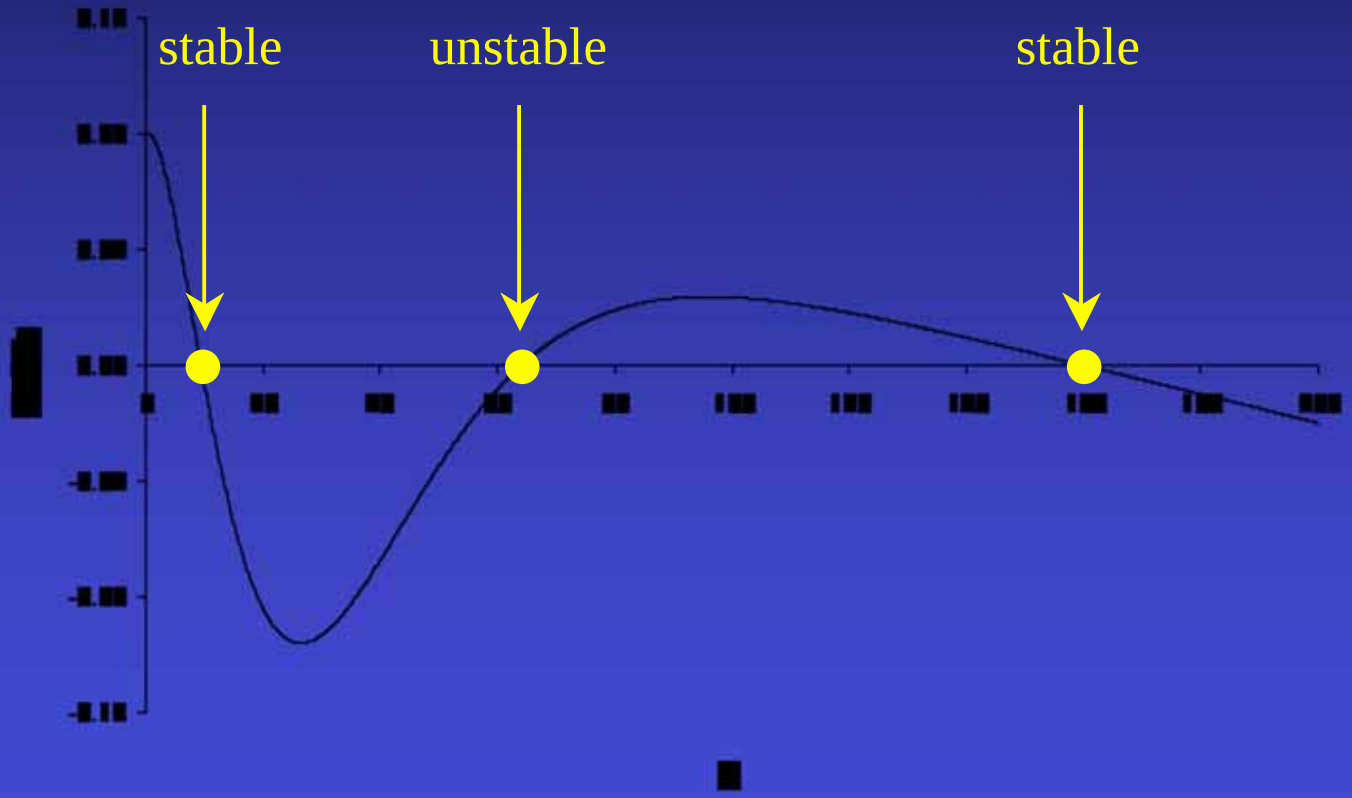
$$\frac{dS(t)}{dt} = s_0\sigma\left(1-\frac{N(t)}{K}\right) + \beta\left(s_\infty N(t) - S(t)\right) - \left(\mu_0 + \theta P(t)e^{-cS(t)}\right)S(t)$$

$$\frac{dN(t)}{dt} = \sigma\left(1-\frac{N(t)}{K}\right) - \left(\mu_0 + \theta P(t)e^{-cS(t)}\right)N(t)$$

$$\frac{dP(t)}{dt} = I - \frac{e_0 P(t)}{\theta S(t)e^{-cS(t)}}$$

Mean Field Model Dynamics

The model can have two stable equilibria.



$\sigma = 1,\ s_0 = 1,\ s_\infty = 200,\ \beta = 0.0004,\ \mu_0 = 0.0001,\ K = 1,\ \theta = 1,\ c = 0.04,\ I = 0.01,\ e_0 = 5$

Metapopulation Models of Mussel Beds