Quiz

The two key processes in metapopulation dynamics are:

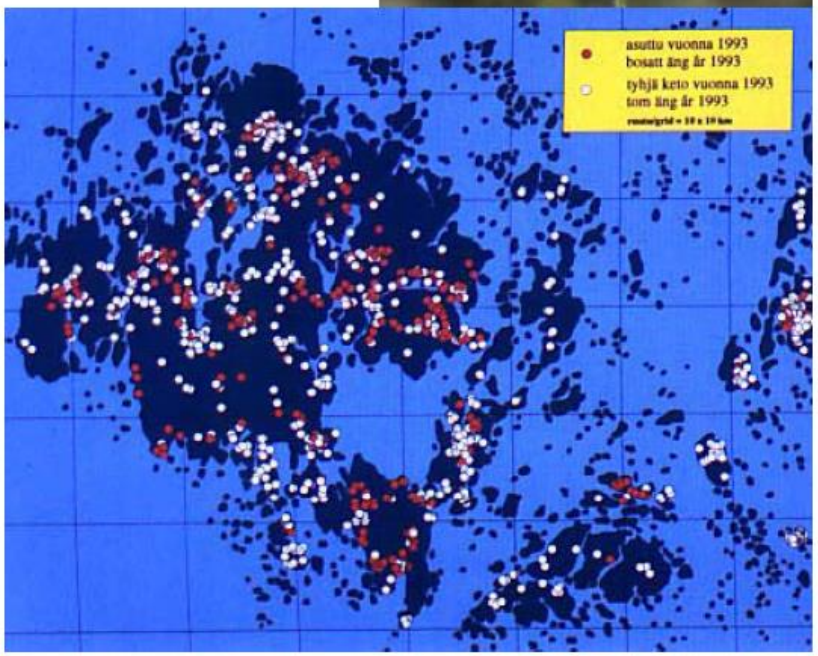
a) Competition & Extinction
b) Colonization & Predation
c) Predation & Competition
d) Colonization & Extinction
e) Parasitism & Predation
f) Competition & Parasitism

Metapopulation Dynamics

Discrete Space – Patchy Habitat

- Glanville Fritillary in Finland
  - Åland islands

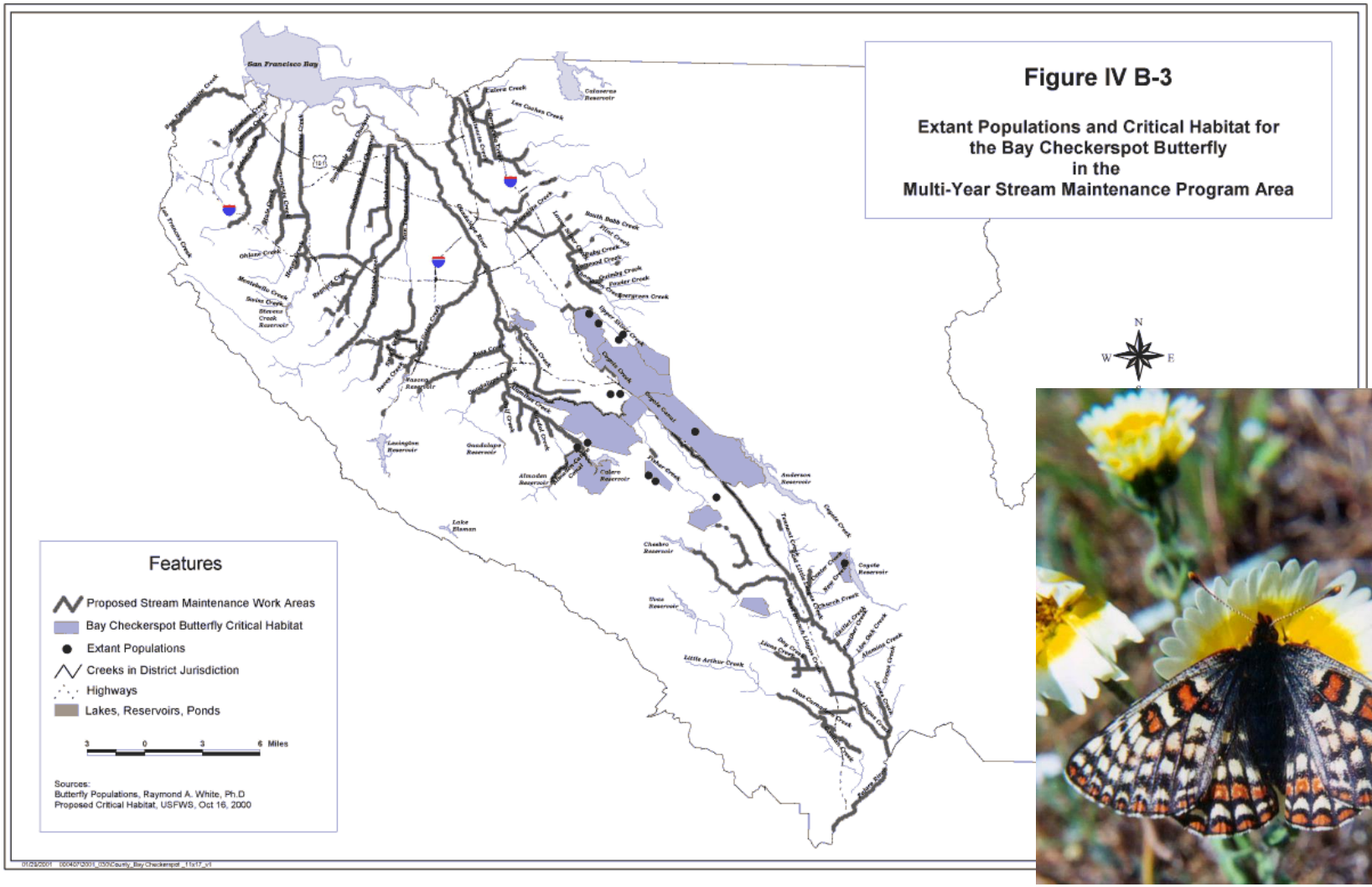
Feeds on *Plantago lanceolata*
~1/3 habitat patches occupied any given yr
High population turnover



Hanski et al.

Bay Checkerspot Butterfly

(*Euphydryas editha bayensis*)



Levin's Model

- Shift gears: No longer model dynamics of populations on patches, but dynamics of occupied patches on a landscape
- Assumptions
  - Patches are roughly equivalent
  - Population colonization/extinction is not related to properties of the patch, including current population size
  - A large number of patches justified modeling p=n/x the proportion of patches occupied
  - Colonization rate is proportional to fraction of patches occupied

Levin's Model

patch colonization rate

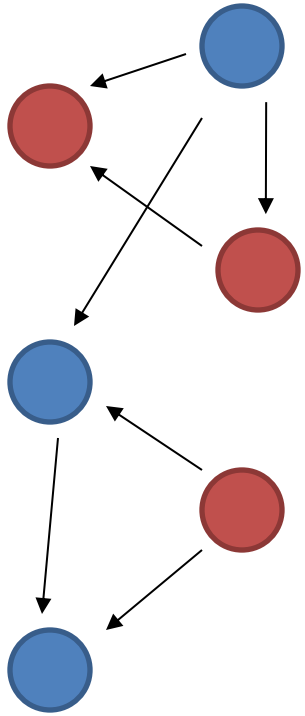
patch extinction rate

$$\frac{dp}{dt} = cp(1-p) - ep$$

proportion of patches empty

proportion of patches occupied

overall rate at which proportion of patches occupied changes



Levin's Model

Set equal to zero and solve for equilibrium occupancy

$$\frac{dp}{dt} = cp\left(1\text{-}p\right) - e\,p$$

$$cp\left(1\text{-}p\right) - e\,p = 0$$

$$c\left(1-p\right) = e$$

$$1-p = e/c$$

$$p^* = 1 - e/c$$

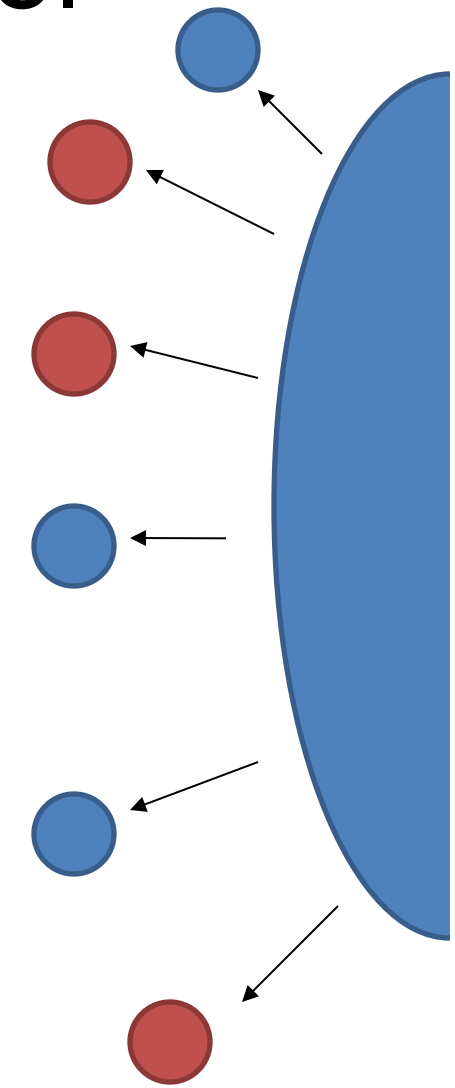
Conclusions:

- At equilibrium, not all sites are occupied unless e=0
- For persistence ($p^* > 0$), c must be greater than e

Mainland-Island Model

- Assumptions
  - Patches are roughly equivalent
  - Population colonization/extinction is not related to properties of the patch, including current population size
  - A large number of patches justified modeling p=n/x the proportion of patches occupied
  - Colonization is proportional to a constant rate *c* ("propagule rain")

$$\frac{dp}{dt} = c\left(1\text{-}p\right) - e\,p$$



Mainland-Island Model

Set equal to zero and solve for equilibrium occupancy

$$\frac{dp}{dt} = c(1-p) - e\,p = 0$$

$$c(1-p) - e\,p = 0$$

$$c - cp - ep = 0$$

$$c = cp + ep$$

$$c = p(c+e)$$

$$p^* = c/(c+e)$$

Conclusions:

- At equilibrium, not all sites are occupied unless e=0
- Population persists for all c>0