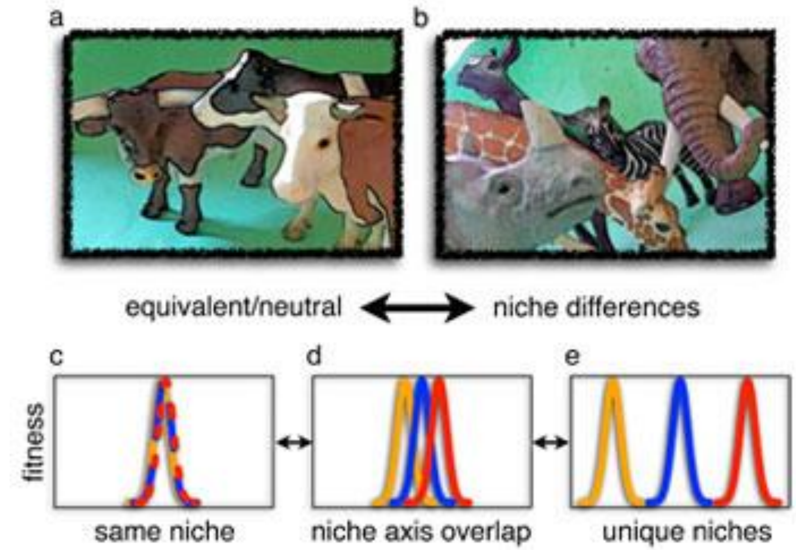
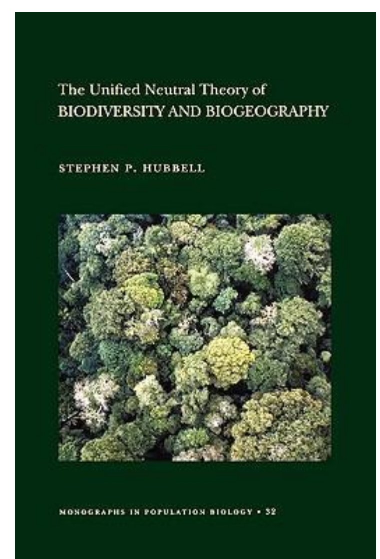
BIOL 410 Population and Community Ecology

Neutral theory and PVA

Niche vs. Neutral

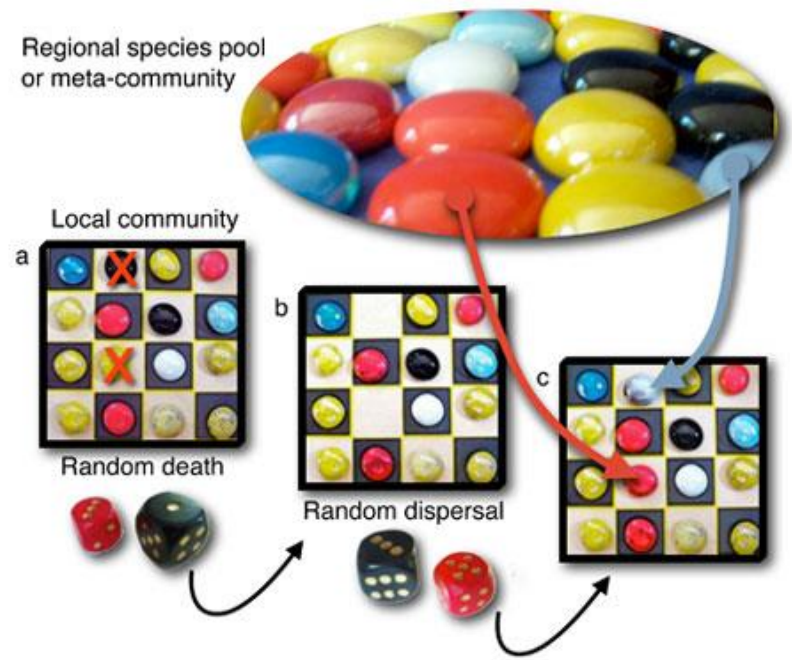
- How ecologically different are species?
- How important are those differences for determining biodiversity?
- Neutral theory
  - Species that are trophically similar are equivalent (i.e. the same fitness)
- Niche perspective
  - A species occupies a unique niche
    - i.e. resource acquisition trade-offs
  - It’s fitness in an community depends on environmental conditions and species interactions matching its niche requirements
  - Composition of ecological communities reflects available niche space
    - i.e. niche differences maintain biodiversity



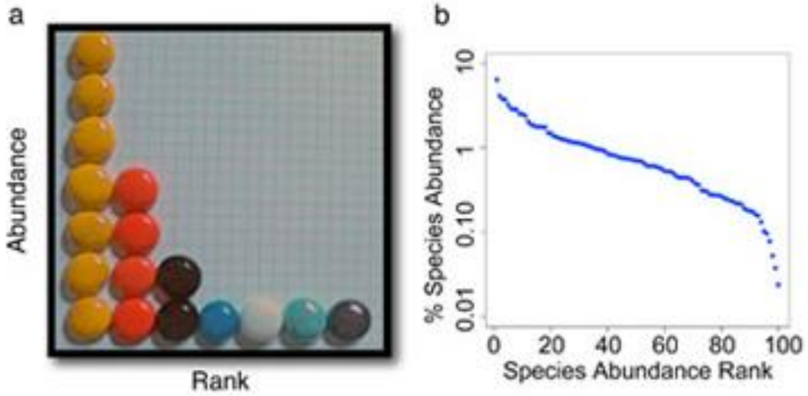


Neutral theory

- Regional species pool
  - Species are equivalent
    - within groups of similarly functioning species (trophically similar)
    - i.e. tree not equivalent to a mosquito
  - Random death leads to "opening" in community
  - Random dispersal of individuals from species pool into opening
  - Long term: ecological drift, species abundance changes randomly over time



Niche vs. Neutral



- Reinvigoration of niche theory

- Current thought
  - Species are different, and niche space influences community composition
  - “Random” processes can be important in determining community composition and structure
    - mortality, dispersal

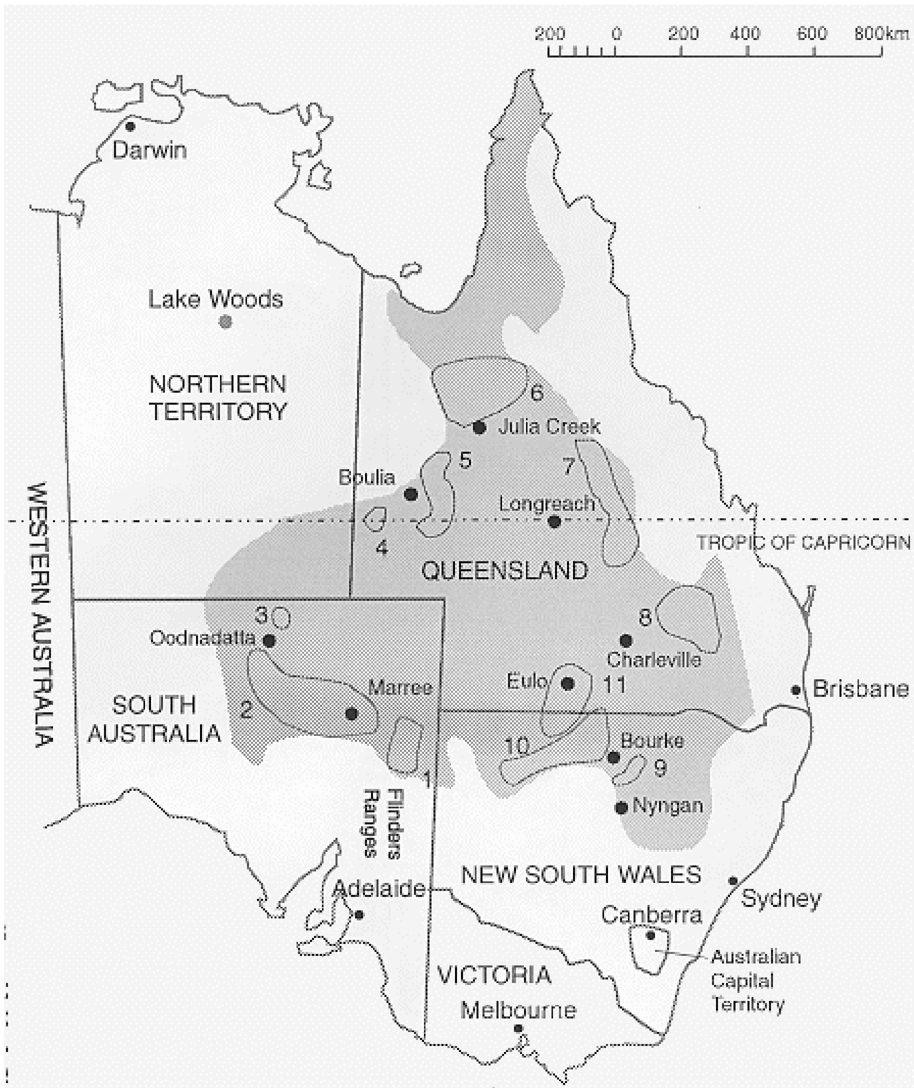
  - What is the relative importance of niche dynamics vs. stochastic processes?

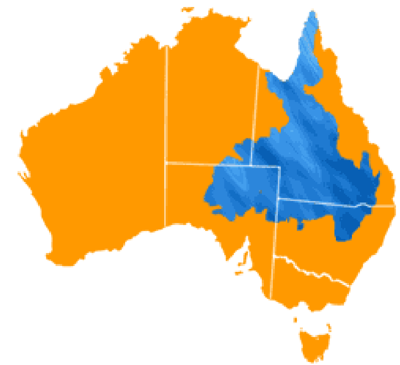
Population and community ecology

- Conservation?
- Management? (resource, ecosystem)
  - Population management
  - Disease control
  - Impact assessment
- Exploitation?

- Population viability analysis (PVA)

Mound springs in Arid Australia

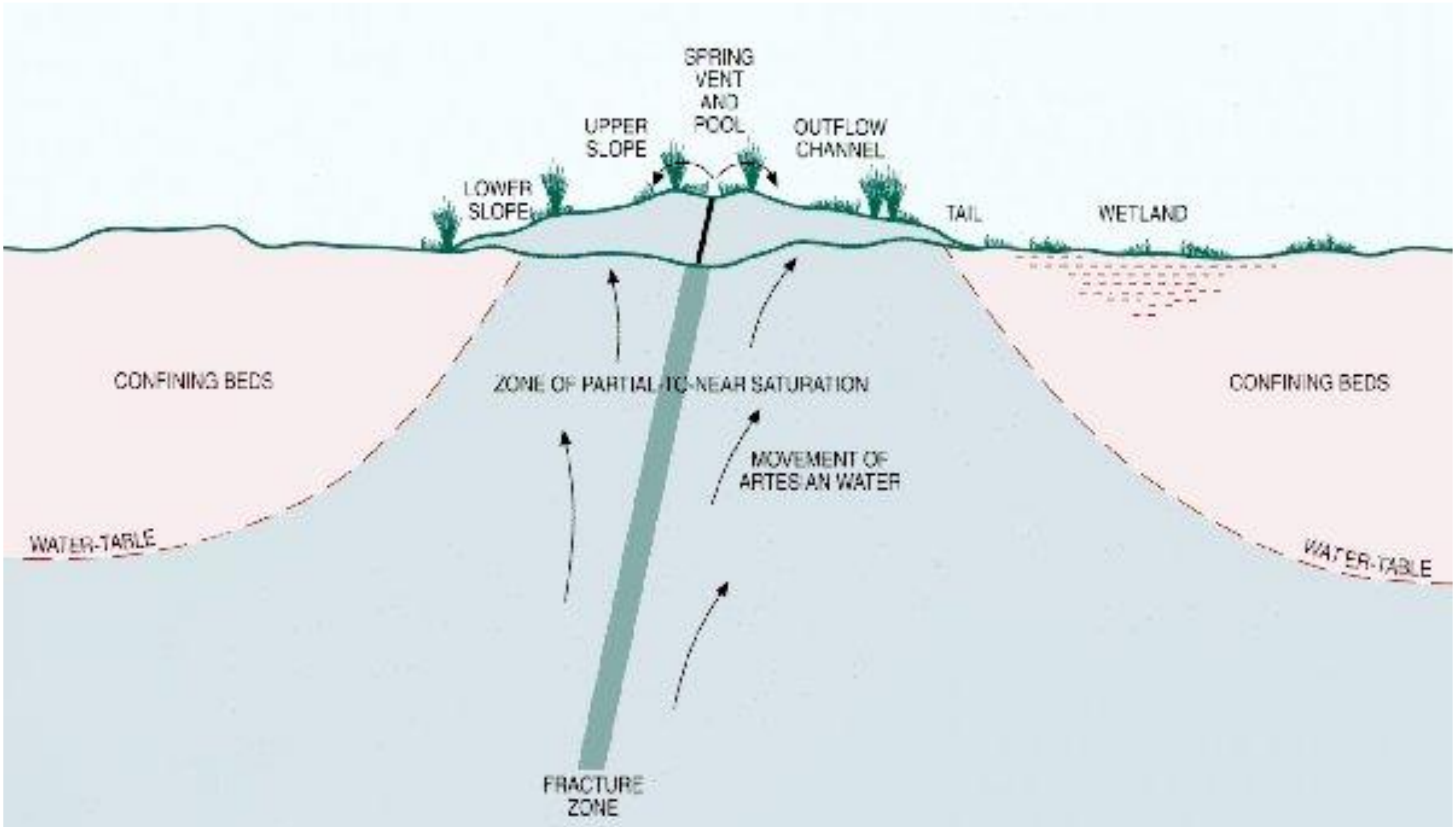




Great Artesian Basin

- Covers ~ 22% Australia (1.76 million square km)
- Recharged from rainfall and stream flow
- Artesian springs on fringes of basin

Mound springs in Arid Australia



What is the appropriate scale of ecological evaluation?

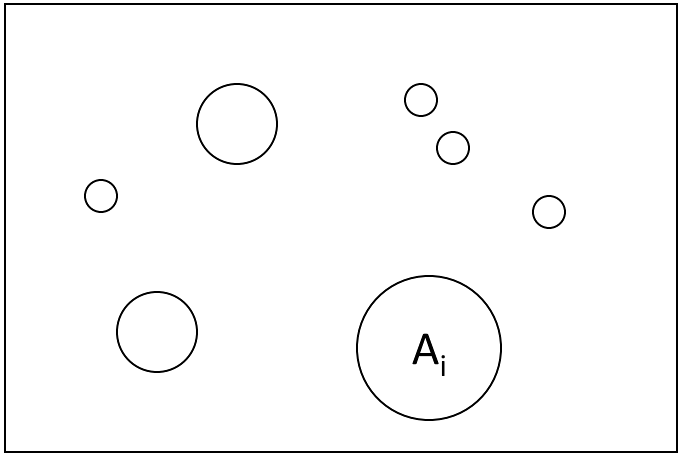
Mound springs in Arid Australia

- Metapopulations
  - Patches of habitat embedded in a landscape that is unsuitable
- Defined by two processes
  - Patch colonization (λ)
  - Patch extinction (μ)

Mound springs in Arid Australia

Patch extinction (μ_i)

- dependent on patch area



$$\mu_i = m/A_i^x$$

m = minimum patch area that will support a population (set at 1m)

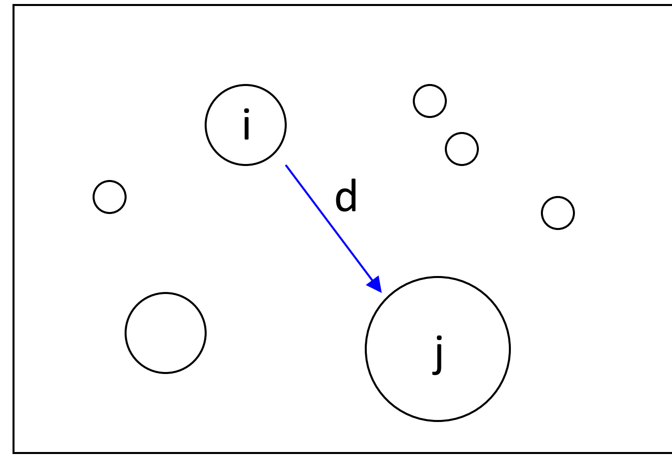
A_i = wetland area of spring

x set to < 1

- extinction rate decreases less than linearly with increased area
- (x > 0.1, x < 0.5)

Mound springs in Arid Australia

Patch colonization (λ_i)
- dependent on state of system



Colonization between patches

$$p_{i,j} = e^{-\alpha d}$$

d = distance between patches
α = rate at which colonization declines with distance

$$\lambda_j = 1 - \prod_{i=1, i \neq j}^{n} (1 - p_{i,j}) 0_i$$

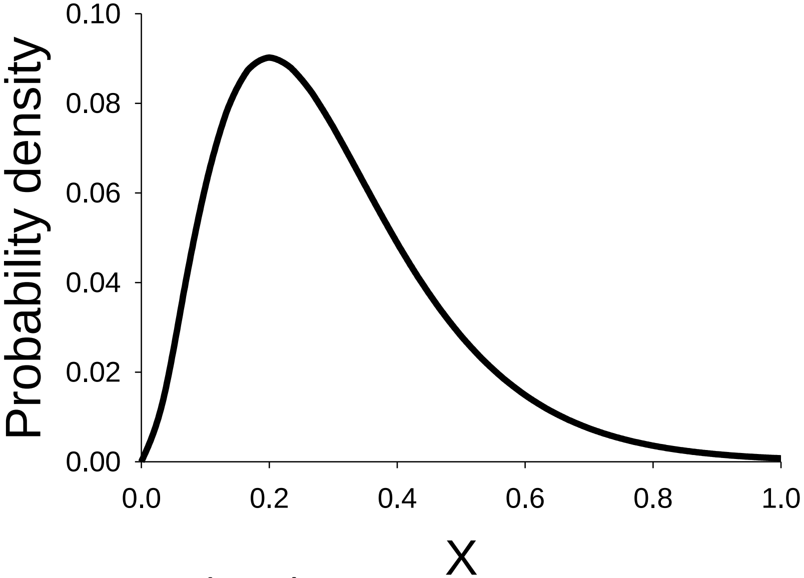
O_i = patch occupancy (0,1)

Mound springs in Arid Australia

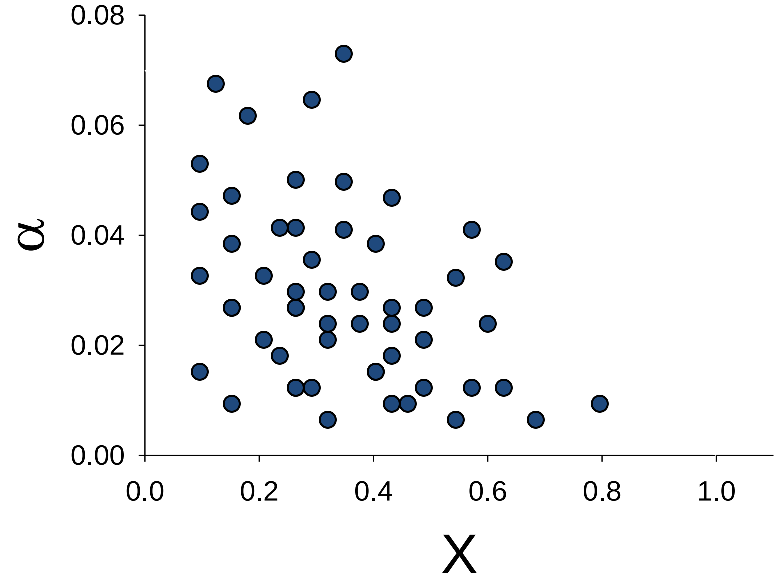
Patch extinction (μ_i) $\mu_i = m/A_i^x$

Patch colonization (λ_i) $p_{i,j} = e^{-\alpha d}$

Parameter uncertainty (x = ?, α = ?)



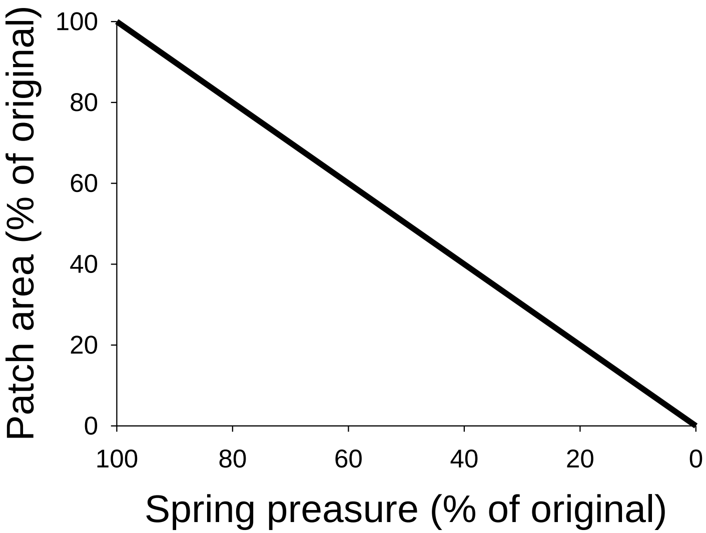
Gamma distribution
2.5 & 97.5% quantiles
match predicted range (i.e. 0.1<x<0.5)



Parameter sensitivity
(100 parameter combinations)

Mound springs in Arid Australia

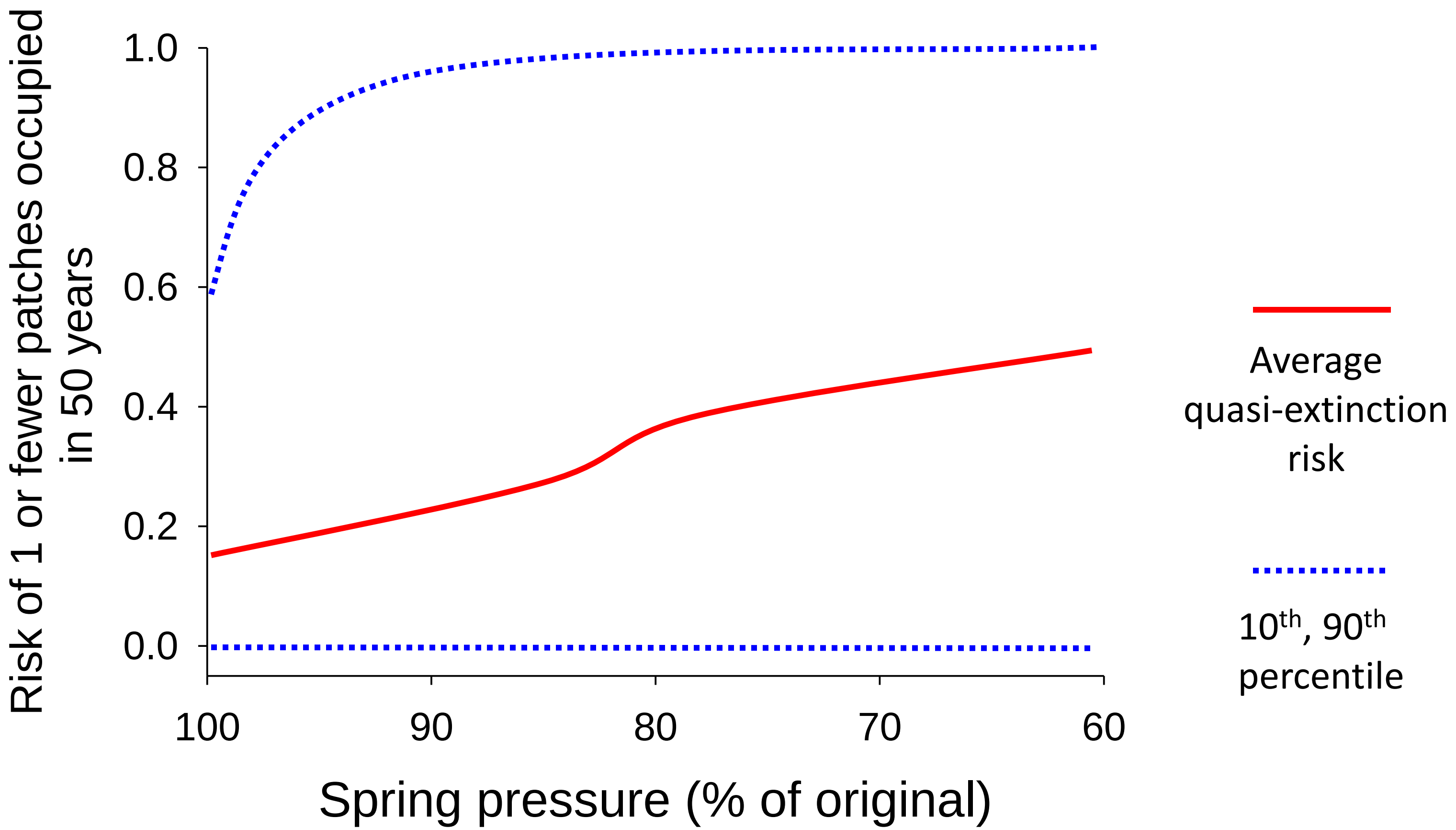
How will metapopulations respond to decreased pressure?



- Simulate metapopulation over 50 years
- Test different levels of decreased pressure (% decrease)
- Run model 10,000 time with each of 100 parameter combinations

- Estimate probability that # occupied springs decreases to 1 or less over a 50 year period (quasi-extinction risk)

Mound springs in Arid Australia



Current level of parameter uncertainty precludes clear statement of risk for metapopulations