


Metapopulations and Movement Ecology

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Learning Objectives

Metapopulations

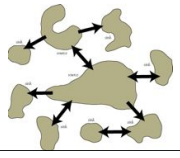
- Define a metapopulation and know some basic characteristics of them.
- Understand why amphibians may or may not have a metapopulation structure.

Movement Ecology

- Name some ways amphibian movement can be measured.
- Know the life stages when amphibians do most of their movement.
- Know the important conservation issues related to amphibian movement ecology.

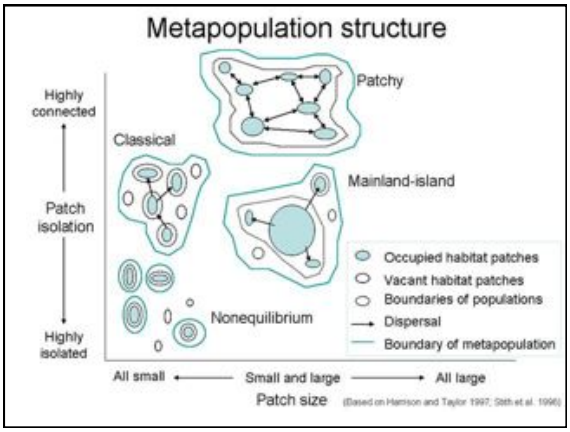
Metapopulation

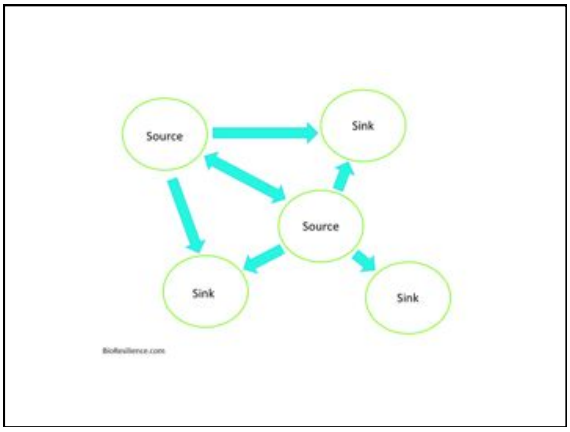
- Key aspect- "a population of populations"
  - habitat is in discrete habitat patches
  - characterized by:
    - extinction: within patch process
    - colonization: movement ecology, rescue of declining populations
- Thought to decrease likelihood of extinction

Hanski's Four Conditions

- Necessary for a true meta-population
  1. Habitat patches contain local breeding sub-populations.
  2. No single sub-population is large enough to ensure long-term survival.
  3. Patches are not too isolated to prevent recolonization.
  4. Local dynamics are sufficiently asynchronous to make simultaneous extinction of all sub-populations unlikely.



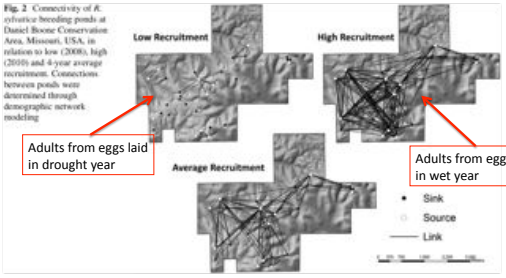


Amphibian Metapopulations

- Ponds as patches
  - Evidence for a few species: *Notopthalmus viridescens*, *Rana lessonae*, *Hyla aborea, Ambystoma opacum*
  - criticism because ignores the terrestrial habitat (Marsh and Trenham 2001, Conservation Biology)
- Many studies don't have evidence that there is actually a meta-population dynamic
  - either too connected or not connected enough (Smith and Green 2005, Ecography- reviews the evidence)
- May also be a good approximation due to habitat fragmentation

Fragmentation

Connectivity can change with climate



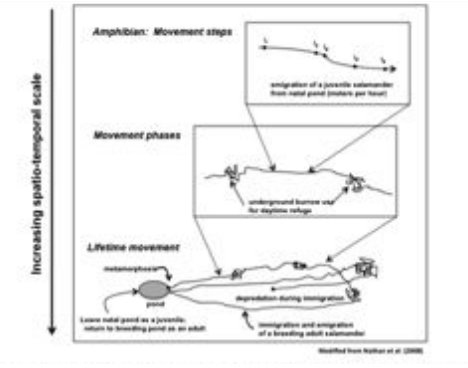
Peterman et al. 2013. Landscape Ecology.

Movement Ecology

Salamandra robotica II
Credit: Kostas Karakasiliotis, Biorobotics Laboratory, EPFL

Why is Movement Ecology Important?

- Maintains metapopulations
- Maintains genetic diversity
- Decision where to establish a home range
- Maintains ability to have different habitats for breeding and non-breeding



Pittman et al. 2014. Biological Conservation 169: 44-53.

How do we measure amphibian movements?

A radio-tagged *Scaphiophryne gottlebei*
Photo by Gonçalo Rosa

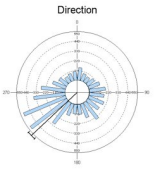
powder tracking for fine-scale movements

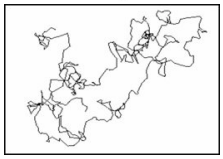
Trapping or other survey types- marked individuals

PIT tag tracking

Analyzing movement

- Directionality- are individuals orienting towards a particular habitat?
- Movement paths- do movements match particular patterns?





Amphibians: Great Diversity in Movement Ecology

- Slimy salamanders- rarely move a few meters
- 7% of frogs- maximum movement recorded is over 10 km
- Some newts can move km
- On average frogs move farther than salamanders (Smith and Green 2005, Ecography 28:110-128)

Home ranges

- Typically small
- Often centered around a cover object- burrow or log
- Unlike mammals and birds, likely to sit in the same spot for long periods of time
- Typical methods for calculating home ranges not very accurate
  - Too much weight towards very rare long distance movements
- Can also be linear transects around streams
- No clear relationship between home range size and body size
- Females of some species set up home ranges farther from the pond than males

Adult Migration

- Rainy nights
- Some species move toward the pond in the fall for hibernation- easy access to breeding pond
- Many hibernate within their home range, while others make additional migratory movements to a hibernation site- e.g. springs
- Strong site fidelity, some even use the same movement paths

Juvenile Movements

- Very little known
- Thought to be the dispersal stage
- Very high mortality- must mark 100s to 1000s of individuals to get data
- Most dispersal events are to the nearest pond

Marbled Salamanders

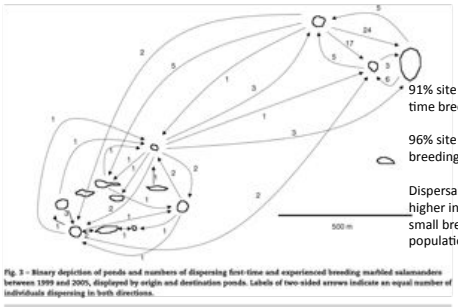


Fig. 3 – Binary depiction of ponds and numbers of dispersing first-time and experienced breeding marbled salamanders between 1999 and 2005, displayed by origin and destination ponds. Labels of two-sided arrows indicate an equal number of individuals dispersing in both directions.

91% site fidelity by 1st time breeders

96% site fidelity for breeding across years

Dispersal probabilities higher in ponds with small breeding populations

Gamble et al. 2007 Biological Conservation 139: 247-257

Genetics

- Can estimate dispersal via genetics as well
- Genetic differentiation among populations
- Many exhibit isolation by distance
- Barriers to gene flow may not always be obvious
  - Sometimes represented by historical range shifts

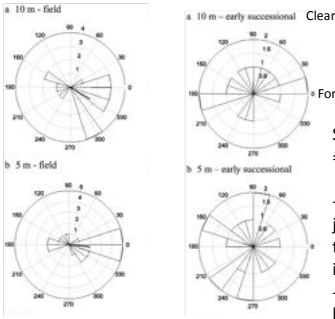
How do they get there?

- Homing- have the ability to make it back to their home range when displaced
- Olfactory cues, moisture gradients
- Internal compass- magnetic orientation
  - Newts

Movement and Conservation

- Maintaining genetic diversity
- Concern about barriers to movement and the separation of terrestrial and aquatic habitats
- Crossing unsuitable habitat
  - Will individuals enter unsuitable habitat to reach suitable habitat?
    - often the answer is no or to a limited extent
  - At what distance can individuals perceive suitable habitat?
    - orientation study is only one investigating this so far
    - appears to depend on habitat type

Example: Directionality



Clearcut

Forest

Spotted Salamanders = forest specialists

-Determining if juveniles will orient towards forest when in unsuitable habitat
-If not, habitat could be an ecological trap

Pittman and Semlitsch 2013 Journal of Zoology 291: 154-162

Corridors/ Underpasses

- No information about use of corridors
- Camera traps confirm use of underpasses
- Landscape planning and road construction planning