Overview

- Introduction to landscape ecology
  - Metapopulation dynamics
- Natural habitat fragmentation
- Anthropogenic habitat fragmentation
- Opportunities for landscape ecology

Introduction

- Landscape ecology (LE) "considers [the] influences of spatial heterogeneity on biotic and abiotic processes..." (Karr, 1985)
- LE themes:
  - the spatial pattern or structure of landscapes, ranging from wilderness to cities
  - the relationship between pattern and process in landscapes
  - the relationship of human activity to landscape pattern, process and change
  - the effect of scale and disturbance on the landscape (IALE 2009)
Metapopulation Dynamics

- Matrix, patches, corridors, landscapes
  - Patches of populations
  - Landscapes of metapopulations
  - Dispersal & migration take place through matrix

Amphibians are adapted to fragmented habitats
- Evolution of dispersal
- Natural habitat fragmentation

Natural Habitat Fragmentation

- Mountains, water bodies, deserts, changes in elevation
- Variety of scale
- Absolute barriers = usually geologic (large scale)
Natural Habitat Fragmentation
- Quality of matrix affects likelihood of successful dispersal
- Hostile matrix:
  - less likely to attempt dispersal, more likely to experience mortality (Joly 2003)
  - Sensitivity to isolation and area of patches increased (Prugh 2008)

Anthropogenic Habitat Fragmentation
- Human land use alters landscape greatly
  - Increases habitat loss and fragmentation
  - Affects quality of matrix
  - Creates many small-scale absolute barriers

Landscape Alteration: Deforestation
- Effects:
  - Increases temperature, reduces moisture and vegetative cover
- Variables:
  - frequency and intensity of timbering
  - second-growth vegetation
Landscape Alteration: Agriculture

Effects:
- Disturbs substrate
- Decreases plant diversity

Examples:
- Row crops, vineyards
- Livestock pasture
- Forage production

Landscape Alteration: Hydrology

Effects:
- Affects habitat access
- Affects water permanency and quality

Examples:
- Dams
- Canals
- Drained wetlands
Landscape Alteration: Urban Development

- Effects:
  - Decreases overall habitat quality (water into sewage system, paved land, loss of vegetation, traffic, etc.)
  - Habitat is lost
  - Creation of many absolute barriers

Landscape Alteration: Roads

- Variables:
  - Traffic density
  - Width and direction of road
  - Proximity of road to habitat (Langen 2008)

- Effects:
  - Increase edge effects (predation)
  - Traffic: demographic sink
  - "Key factor limiting dispersal" (Ficetola 2008)
  - May be factor in decline (Elzanowski 2009)

Anthropogenic Habitat Fragmentation

- Interaction of different types of landscape alteration produces highly hostile matrices
- Greatly altered landscapes result in habitat loss and fragmentation
Temporal Aspects

- Landscapes naturally change over a long period of time
  - Geology’s effect on populations (Gulve 1994)

Temporal Aspects

- Anthropogenic landscape change happens quickly
  - Seral continuum (Welsh 2005)
  - "Lag" in response to habitat degradation (Piha 2007)

Consequences of Fragmentation

- Altered landscapes may not be uninhabitable
  - However, they favor different species than before
  - Terrestrial elf stage’s pros and cons (Gibbs 1998)
Consequences of Fragmentation

- Dispersal stage most sensitive to fragmentation (Gibbs 1998)
  - Red-spotted newts' threshold: 50%
  - Redbacked salamanders' threshold: 5-30%

However, landscapes greatly impacted by anthropogenic alteration often cannot serve as amphibian habitat.

Amphibians may be especially prone to local extinction from landscape alteration due to "the spatially and temporally dynamic nature of their populations." (Gibbs 1998)

Urbanization is probably a major cause of global amphibian decline (Pillsbury 2008)

Opportunities for Landscape Ecology

- Landscape ecologists have devised tools for better conservation efforts
  - Genetic studies across landscapes
  - Landscape anisotropy
  - Resistance indexes
  - Connectivity maps
  - Wildlife bridges, ecoducts, and wildlife fences
  - Corridors and buffers
Opportunities for Landscape Ecology

- Common practices
  - Forested corridors
  - Multiple scales

Opportunities for Landscape Ecology

- Common practices
  - Riparian buffer zones
  - Ought to be 50-300m (Semlitsch 2003)
  - Usually only 5-25m
  - Does not provide for activities that take place away from the stream

Opportunities for Landscape Ecology

- Common practices
  - Keep livestock out of streams
  - Partial timbering
  - Using permeable materials
Opportunities for Landscape Ecology

- Landscape anisotropy
  - Landscape has different qualities when measured along different axes (Ficetola 2008)
- Disproportionate use of landscape
  - Some spaces or directions more useful than others (Olson 2007)

Opportunities for Landscape Ecology

- Assessing connectivity (Joly 2003)
  1. Each type of landscape given a "resistance coefficient", based on the friction provided by the landscape with regards to a given individual
  2. Interaction with roads

Opportunities for Landscape Ecology

- Assessing connectivity (Joly 2003)
  3. Habitat map
  4. Connectivity map (could be used in land use planning?)
Opportunities for Landscape Ecology

- Predicting “hot spots” of road mortality (Langen 2008)
  - Causeway scenario
  - Allowing continued flow of amphibian movement

Opportunities for Landscape Ecology

- Genetic analysis as a method for generating routes (Koscinski 2009)
  - Gather DNA
  - Assess lineages
  - Generate routes
The end... on to "defragmentation" in Europe