Conserving habitats and landscapes

Why it’s ecology and not biology

The biggest current problem

- 88% of the species listed by the ESA are there because of …

![Graph showing percentage of threatened species affected by various factors](image)

Data from IUCN
Fig. 3.6

In just one biome?

![Diagram showing the fraction of potential area converted in different biomes](image)

To human use, esp. ag.

Does eating matter?

![Bar chart showing the number of threatened species negatively impacted by agriculture](image)

Tanentzap et al. (2015)

Rainforest loss & fragmentation

- Amazonian deforestation
  - From 1978 to 1988:
    - Deforestation increased 3 fold
    - Adjacent forest degradation increased 3 fold

![Image of deforestation](image)

Sodhi et al. (2011)

L & F in action (1)

- Transamazionian highway—Part 1

![Image of Transamazionian highway](image)
Habitat problems are multi-dimensional

- Fragmentation is confounded with habitat loss—you need to test for effects of breaking habitat apart after controlling for loss
- One early review (Fahrig 2003) only found 17 studies available to test these distinct aspects of habitat problems; results?
Loss vs. fragmentation (2)

- A recent review (Fahrig 2017) found 118 studies available to test for effects of fragmentation after controlling for habitat loss.

According to the authors of each study, why?

And, how are these results presented?

Fahrig (2017; book chapter, not Annual Rev. Ecol. Syst.)

Fragmentation vs. species behavior

- Hypothetically, removing 2% of habitat can have a big differential impact:
  - **Interior species** lose 46% of habitat
  - **Edge species** gain 76% of habitat

Grey = edge
Black = interior

Also see Fig. 7.12

Hypothetical scenario: removing 2% of habitat can have a big differential impact:

- Interior species lose 46% of habitat
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We need experiments

**Or: Wildlife management vs. conservation ecology**

- Wood thrush
- Brown-headed cowbird

Biological Dynamics of Forest Fragments Project

- Wood thrush
- Brown-headed cowbird

1979

- Haddad et al. (2015)

**We need experiments**

**Year**

<table>
<thead>
<tr>
<th>Variable</th>
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<td>Matrix</td>
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Amazon rain forest, Brazil

- Invasion of disturbance-adapted butterflies
- Invasion of disturbance-adapted beetles
- Lead-fitter invasibility of species composition
- Tree mortality
- Relative humidity
- Soil resistance
- Mean canopy foliage density
- Air temperature
- Herb density
- Number of tree-fall gaps
- Invasion of disturbance-adapted plants

- William Laurance, Thomas Lovejoy, Rob Bierregaard

- Biological Dynamics of Forest Fragments Project

1979
Implications for global climate change

- 19% of the remaining area of tropical forests lies within 100 m of a forest edge
- 50 million km of tropical forest edges today
- Edge effects represent 31% of the currently estimated annual carbon releases due to tropical deforestation

Brinck et al. (2017)

Conserving habitat

- Because habitat is so important, conservation reserves are a major focus
- This leads to some key questions:
  - What and where should we be conserving?

Semenggoh National Park, Malaysia

One more issue—time

Haddad et al. (2015)

Some past ideas (1)

Jenkins et al. (2015)

Does this agree with biodiversity and rarity?
What does ecology have to say about reserve design?

- Many consider MacArthur and Wilson’s Island Biogeography theory (1967) to be a major stimulus for conservation biology
- Although started with oceanic islands, there have been many applications in other systems
- Strengths:
  - Provided testable hypotheses
  - Brought the landscape into the picture—more ‘real-world’

Some issues

- Considered all species the same—colonization ability not considered, for example
- Considered all habitats the same as long as they were the same ??
- Equilibrium-based theory
- Actual tests have been pro and con

The SLOSS debate

- \( S \square L \square \)
- \( O \square \)
- \( S \square S \square ? \)
- One 10,000 ha reserve vs. four 2,500 ha reserves—which is better?
- Usually depends on degree of nestedness

Total area matters

Extinction rates for 299 mammals in 14 western NA Parks
Newmark (1995)

Heterogeneity also matters (1)

MN stream invertebrates
Terrestrial isopods on Greek islands (Hortal et al., 2009)
Heterogeneity also matters (2)

- How do you incorporate it?
  - Bigger areas
  - Multiple, unique areas
  - Preserve heterogeneity-forming processes
  - Minimum Dynamic Area (MDA)

The 3 C’s

- Some pros and cons of corridors
  - Purchase of a small connecting area can:
    - Result in an overall much larger area
    - Enhance gene flow
    - Enhance movement of predators and disease

Overpasses as corridors

- Review by Corlatti et al. (2009) found:
  - Most studies were observational and quantify use/no use vs. numbers of crossings
  - Genetic effectiveness not well studied (i.e., is gene flow enhanced with overpasses?)
- Remains a current research topic

Some examples (1)

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- Remains a current research topic
More Banff data
- Sawaya et al. (2014) found 47% of black bears and 27% of grizzly bears that used crossings successfully bred; included both genders.

Three examples (2)
Sanctuary along Belize River plus aerial bridges help black howler monkeys.

Three examples (3)
- Tewksbury et al. (2002)
- Brudvig et al. (2009)