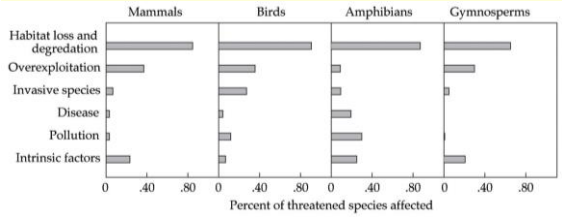
Conserving habitats and landscapes

Why it's ecology and not biology

The biggest *current* problem

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



Data from IUCN Fig. 3.6

In just one biome?

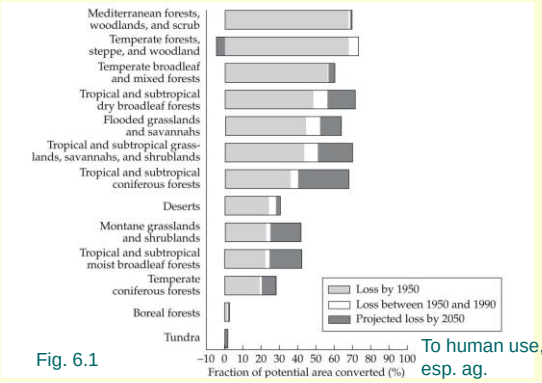


Fig. 6.1

To human use, esp. ag.

Does eating matter?

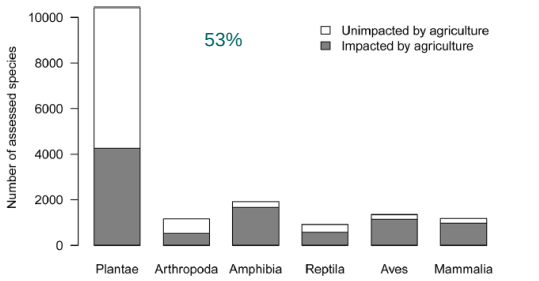


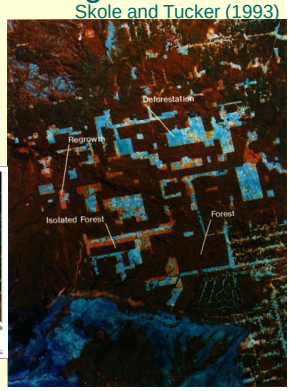
Fig 2. Estimated numbers of threatened species negatively impacted by agriculture.

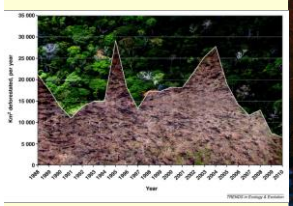
Tanentzap et al. (2015)

Rainforest loss & fragmentation

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

Skole and Tucker (1993)





Sodhi et al. (2011)

L & F in action (1)

- Transamazonian highway—Part 1

L & F in action (2)

- Transamazonian highway—Part 2

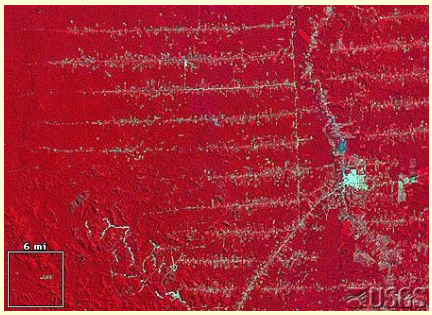
L & F in action (3)

- Brazilian rainforest

Also see Fig. 6.4

L & F in action (4)

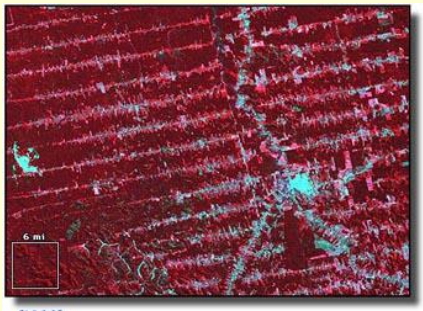
- Brazilian rainforest



1986

L & F in action (5)

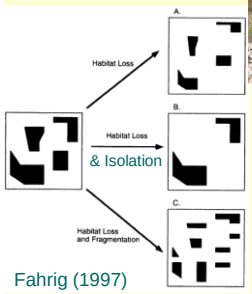
- Brazilian rainforest



More

Habitat problems are multi-dimensional

Degradation



Fahrig (1997)

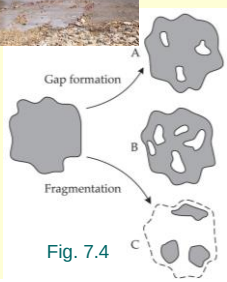
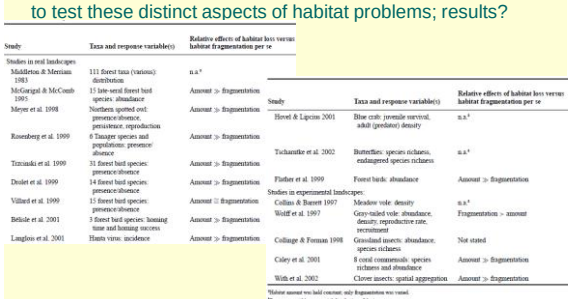


Fig. 7.4

Loss vs. fragmentation (1)

- 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?

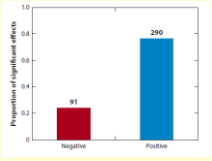


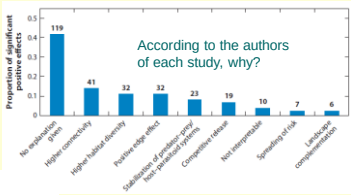
Study	Taxa and response variable(s)	Relative effects of habitat loss versus habitat fragmentation per se
Studies in real landscapes:		
Middleton & Merriam 1983	111 forest taxa (various): distribution	n.a.*
McGarigal & McComb 1995	15 late-seral forest bird species: abundance	Amount ≫ fragmentation
Meyer et al. 1998	Northern spotted owl: presence/absence, persistence, reproduction	Amount ≫ fragmentation
Rosenberg et al. 1999	6 Tanager species and populations: presence/absence	Amount ≫ fragmentation
Trzcinski et al. 1999	31 forest bird species: presence/absence	Amount ≫ fragmentation
Drolet et al. 1999	14 forest bird species: presence/absence	Amount ≫ fragmentation
Villard et al. 1999	15 forest bird species: presence/absence	Amount ≅ fragmentation
Bélisle et al. 2001	3 forest bird species: homing time and homing success	Amount ≫ fragmentation
Langlois et al. 2001	Hanta virus: incidence	Amount ≫ fragmentation
Studies in experimental landscapes:		
Collins & Barrett 1997	Meadow vole: density	n.a.*
Wolff et al. 1997	Grey-tailed vole: abundance, density, reproductive rate, recruitment	Fragmentation > amount
Collinge & Forman 1998	Grassland insects: abundance, species richness	Not stated
Caley et al. 2001	8 coral commensals: species richness and abundance	Amount ≫ fragmentation
With et al. 2002	Clover insects: spatial aggregation	Amount ≫ fragmentation

*Habitat amount was held constant; only fragmentation was varied.
†Response variable was spatial distribution of the insects.

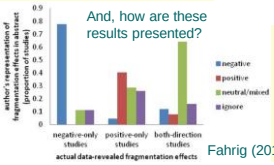
Loss vs. fragmentation (2)

- 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.)

Ecology Letters, (2020) **23**: 674–681 doi: 10.1111/ele.13471

Support for the habitat amount hypothesis from a global synthesis of species density studies Watling et al. (2020)

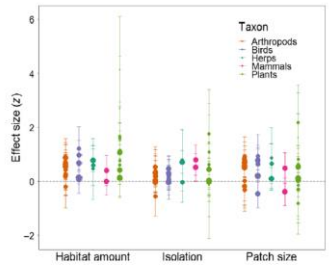


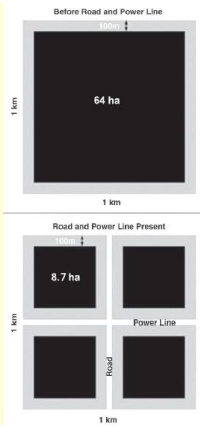
Figure 2 The mean effect size for habitat amount on species density was greater than the mean effect of patch size or isolation in 33 studies of forest species. Here, points indicate effect sizes, and are scaled to be proportional to the number of patches surveyed in each study. Error bars indicate 95% confidence intervals around the effect sizes estimates.

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



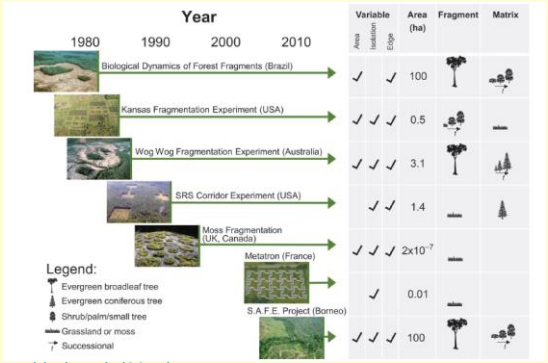
Or: Wildlife management vs. conservation ecology

Wood thrush

Eastern cottontail rabbit
(Sylvilagus floridanus)

Brown-headed cowbird

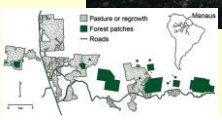
We need experiments



Haddad et al. (2015)

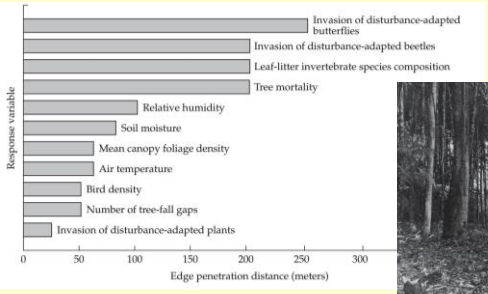
Biological Dynamics of Forest Fragments Project

1979



Fragmentation and edges

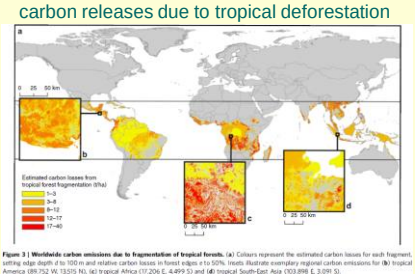
Amazon rain forest, Brazil



William Laurance, Thomas Lovejoy, Rob Bierregaard

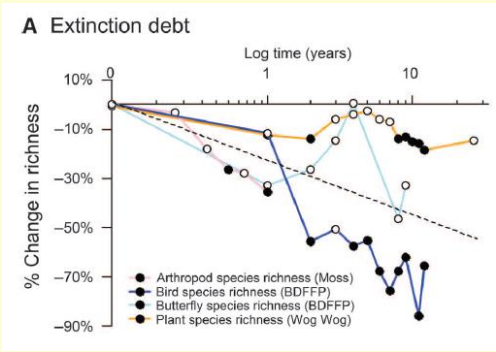
Implications for global climate change

- 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)

One more issue—time



Haddad et al. (2015)

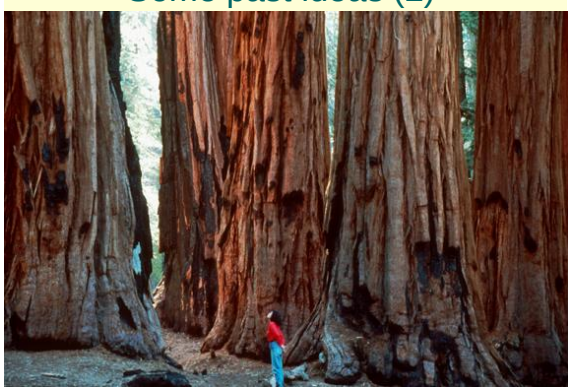
Conserving habitat

- 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

Some past ideas (1)

Some past ideas (2)



Does this agree with biodiversity and rarity?

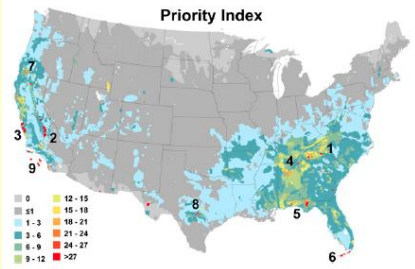
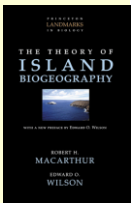


Fig. 4. Summed priority scores across all taxa and recommended priority areas to expand conservation: 1, Middle to southern Blue Ridge Mountains; 2, Sierra Nevada Mountains, particularly the southern section; 3, California Coast Ranges; 4, Tennessee, Alabama, and northern Georgia watersheds; 5, Florida panhandle; 6, Florida Keys; 7, Klamath Mountains, primarily along the border of Oregon and California; 8) South-Central Texas around Austin and San Antonio; 9, Channel Islands of California.

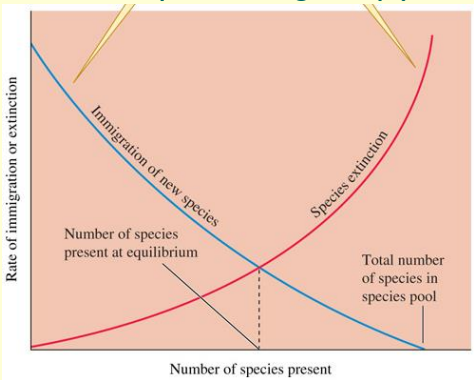
Jenkins et al. (2015)

What does ecology have to say about reserve design?

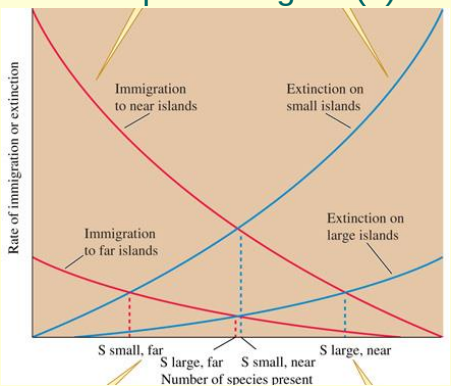
- Many consider MacArthur and Wilson's Island Biogeography theory (1967) to be a major stimulus for conservation biology
- Although started with oceanic islands, there have been many applications in other systems
- Strengths:
  - Provided testable hypotheses
  - Brought the landscape into the picture—more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



An important figure (1)



An important figure (2)



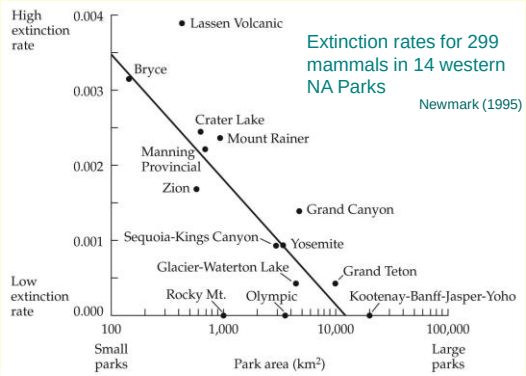
Some issues

- 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_____ L_____**
  - **O_____**
- **S_____ S_____**?
- One 10,000 ha reserve vs. four 2,500 ha reserves—which is better?
- Usually depends on degree of *nestedness*

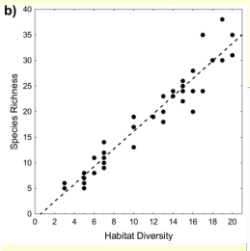
Total area matters



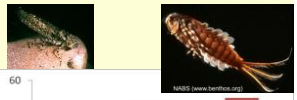
Extinction rates for 299 mammals in 14 western NA Parks

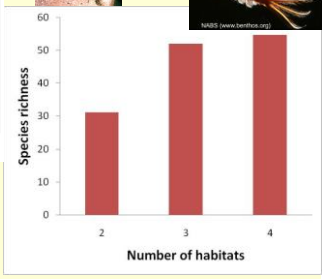
Newmark (1995)

Heterogeneity also matters (1)



MN stream invertebrates



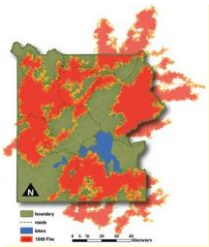


Terrestrial isopods on Greek islands (Hortal et al., 2009)

Heterogeneity also matters (2)

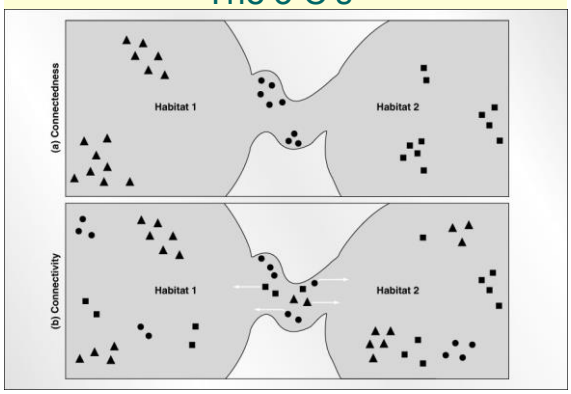
- How do you incorporate it?
  - SLOSS?
    - Bigger areas
    - Multiple, unique areas
  - Preserve heterogeneity-forming processes
    - Minimum Dynamic Area (MDA)

1988 Yellowstone NP



Yellowstone's park photographer chose specific locations to photograph in 1988 and subsequent years. This set was taken 3 miles east of the West Entrance in 1988 (left) and 1998 (right).

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

How Corridors Reduce Indigo Bunting Nest Success

AIMEE J. WELDON*
Department of Zoology, Box 7617, North Carolina State University, Raleigh, NC 27695-7617, U.S.A.

2006

Edge effects, not connectivity, determine the incidence and development of a foliar fungal plant disease

2011

BRENDA L. JOHNSON[1] AND NICK M. HADDAD

North Carolina State University, Department of Biology, Box 7617, Raleigh, North Carolina 27695-7617 USA

Human corridors beget the need for wildlife corridors

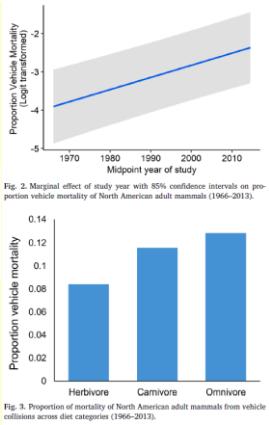


Fig. 2. Marginal effect of study year with 85% confidence intervals on proportion vehicle mortality of North American adult mammals (1966–2013).

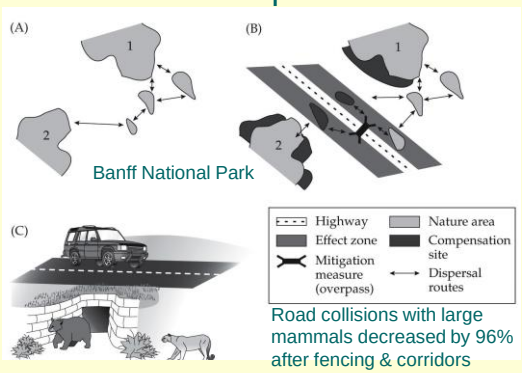
Fig. 3. Proportion of mortality of North American adult mammals from vehicle collisions across diet categories (1966–2013).

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
- Remains a current research topic

& WY

Some examples: Banff



Road collisions with large mammals decreased by 96% after fencing & corridors

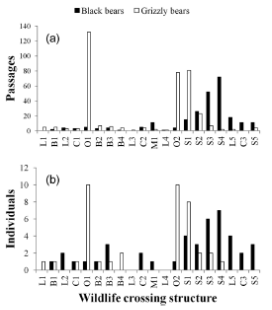


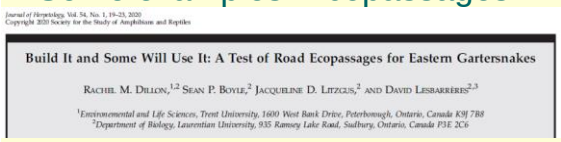
Figure 1. Total number of grizzly and black bear (a) passages through crossing structures and (b) individuals detected at each wildlife crossing structure between 2006 and 2008. Number of passages is the sum of unique crossing events recorded at track pads over 3 years. Number of individuals is the sum of unique individuals detected at a given crossing structure on the basis of DNA analysis of hair samples

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

Sawaya et al. (2013)

Some examples: Ecopassages



Build It and Some Will Use It: A Test of Road Ecopassages for Eastern Gartersnakes

Rachel M. Dillon, Sean P. Boyle, Jacqueline D. Litzgus, and David Lesbarrères

Pix from Ontario Parks

Animex Wildlife Mitigation Solutions

Some examples: SREL

- Tewksbury et al. (2002)
- Brudvig et al. (2009)