Some causes and consequences of dispersal in real and model systems

EVERYTHING DISPERSES TO MIAMI
THE ROLE OF MOVEMENT AND DISPERSAL IN SPATIAL ECOLOGY, EPIDEMIOLOGY AND ENVIRONMENTAL SCIENCE

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Dispersal is a solution to the struggle for existence in heterogeneous environments

Dispersal depends on density

Dispersal is contingent on habitat
Dispersal is a solution to the struggle for existence in heterogeneous environments

- Can we use habitat selection to predict evolutionary futures? (Arctic lemmings)
- Do different habitat-selection strategies coexist in the same population? (Simulated habitat selection)
- What are the necessary and sufficient conditions for adaptive movement? (Model organisms)
Habitat A

Habitat B
Fitness vs. Density

Habitat B

Habitat A
Divergent Population Regulation
(qualitatively different habitats)

Single strategy of density-dependent habitat selection
(no directional selection)

Weak stabilizing selection at low density

Strong stabilizing selection at high density
Fitness vs. Density

Habitat B

Habitat A
Convergent Population Regulation
(quantitatively different habitats)

Weak stabilizing selection
at low density (fixed)

Strong directional selection
at intermediate density

Strong stabilizing selection
at high density

Mean Fitness

Total N

Proportion in B

Strong stabilizing selection
at high density
The Habitat Isodar

Fitness vs. Density

Habitat B

Habitat A

Density in B

Density in A
Two Habitat Classes at Walker Bay

![Graph showing two habitat classes: meadow and upland. The x-axis represents the habitat gradient, and the y-axis represents the number of stations. The graph shows a higher number of stations for meadow than for upland.]
In 2011, *Dicrostonyx* preference for upland depended only on *intra-specific* competition.

\[ Du = 0.19 + 0.94 \, Dm \]

\[ p < 0.001, \, R^2 = 0.54 \]
**Dicrostonyx fitness landscape**

- Fitness
- Population size
- Proportion in upland

- Image of Collared Lemming: [Link](http://users.iab.uaf.edu)
**Dicrostonyx** fitness invasion landscape

![Image of a Collared Lemming](http://users.iab.uaf.edu/Morris, Dupuch & Halliday, EER In Press)
In 2011, *Lemmus* preference for meadows depended only on intra-specific competition:

\[ L_m = 0.02 + 0.52 \, L_u \]

\[ p < 0.001, R^2 = 0.42 \]
Lemmus fitness landscape

Fitness

Population size

Proportion in upland

Brown Lemming, http://users.iab.uaf.edu
Lemmus fitness invasion landscape
Habitat B

Density

Declining Site Quality
An Ideal Pre-emptive Isodar
Question: Under what conditions will ideal pre-emptive (site dependent) habitat selection outperform despotic habitat choice?

Answer: Clearly not when territoriality is cost free.

Surprise?

1. The two strategies coexist across a broad range of parameter values.

2. Priority effects determine the frequency of the pre-emptive strategy.
An example of priority effects when costs of territoriality are low

When despotism is the resident strategy, high-quality territories are occupied and unavailable to pre-emptive individuals.

When pre-emption is the resident strategy, the population maintains itself in territories of low (replacement) quality.
Motility and sensory capability are necessary traits for adaptive movement.

But are they sufficient?
*Chlamydomonas reinhardtii*

Single-celled haploid algae

Possess two flagellae

Are both chemotactic and phototactic (eyespot)

Physiology and genetics are well known

Easily cultured in the lab
Experimental Design
Many Thanks

Robert Bromley
Robert Buchkowski
Todd Burnside
Ian Clarke
Victoria Danco
Douglas Davidson
Benjamin Dippo
Mathieu Dumond
Gilles Gauthier
William Halliday
Robert Harmer

Charles Krebs
Jody MacEachern
Debra Moore
Kelly Morris
Michael Oatway
Wensheng Qin
Donald Reid
Shane Sather
Douglas Stern
Vijayan Sundararaj
Debra Wilson