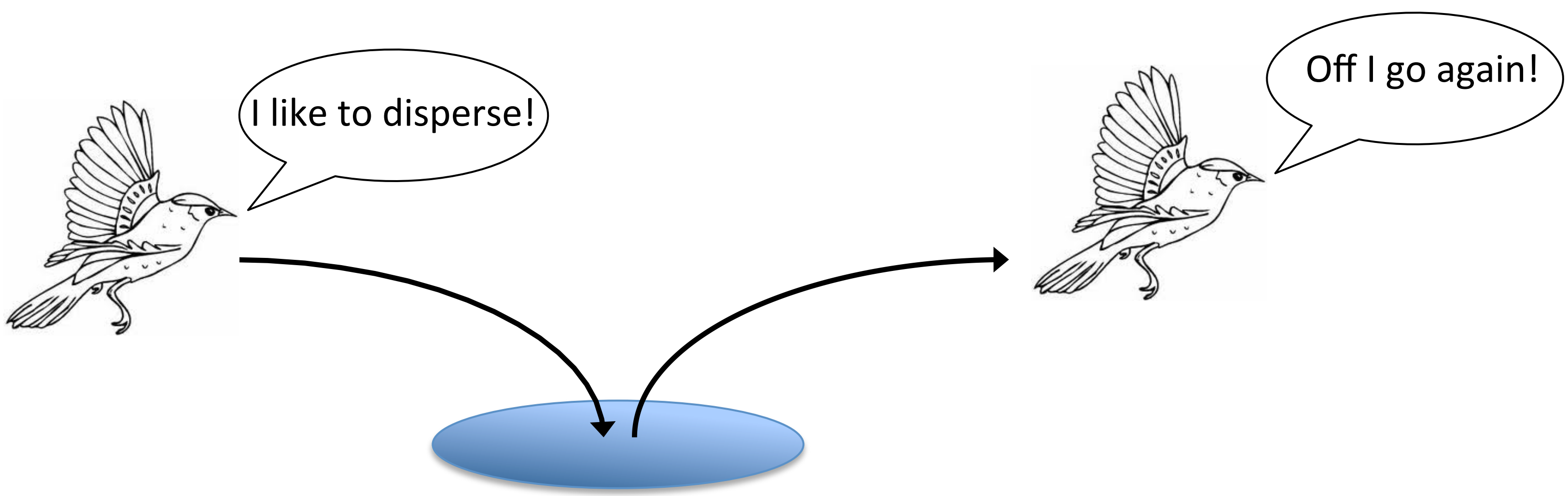
Evolution of Dispersal and Philopatry

Several issues related to the evolution of dispersal:

1. How might dispersal be heritable? What kind of traits might be under selection?

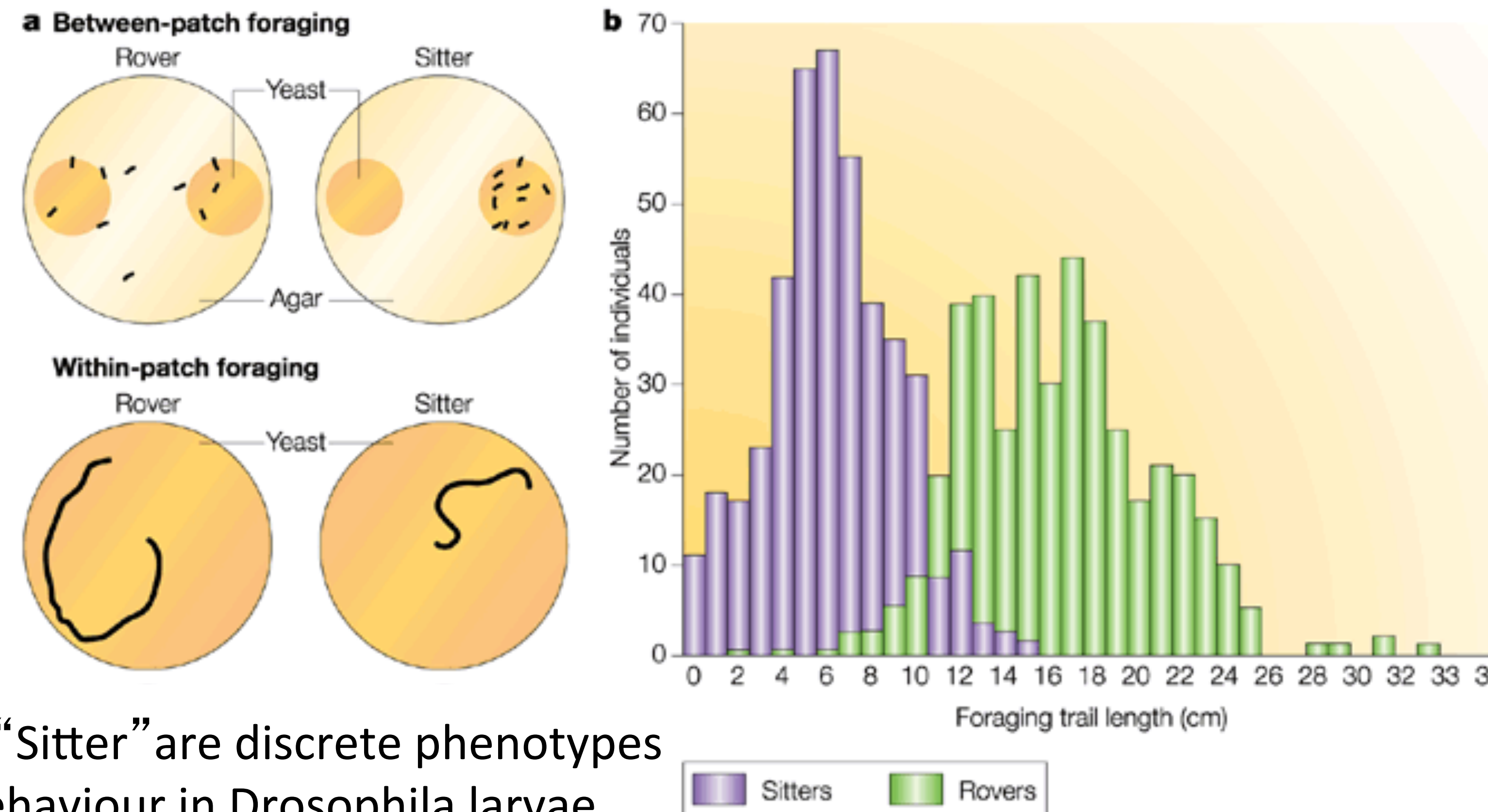
2. How is dispersal maintained in populations if genes for dispersal tend to leave?

3. How can new populations be founded by individuals with a behavioural inclination to disperse?



Evolution of Dispersal and Philopatry

1. Genetic basis of dispersal (heritability)



“Rover” and “Sitter”are discrete phenotypes of foraging behaviour in Drosophila larvae which are controlled by the *for* gene

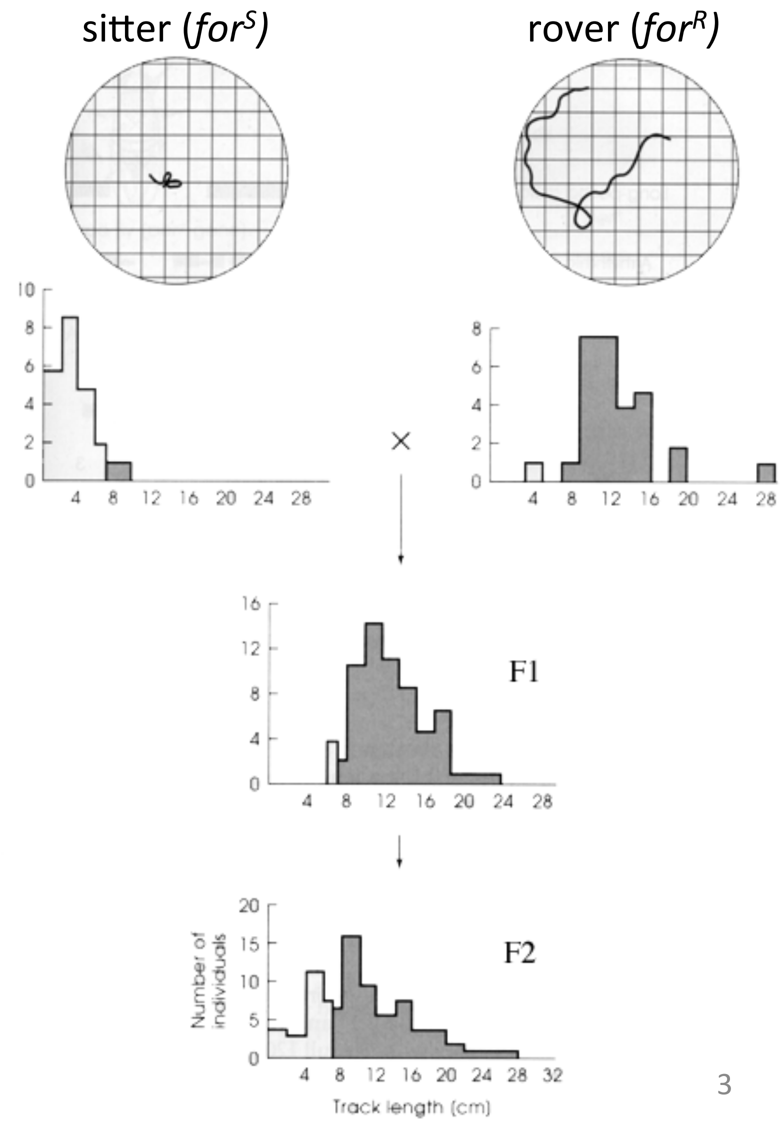
Sokolowski 2001

Evolution of Dispersal and Philopatry

1. Genetic basis of dispersal (heritability)

Dispersal could be related to a specific behaviour or trait, coded by a small number of loci

Dispersal could be related to a quantitative (continuous) trait with some threshold that determines whether or not an individual is a disperser



Evolution of Dispersal and Philopatry

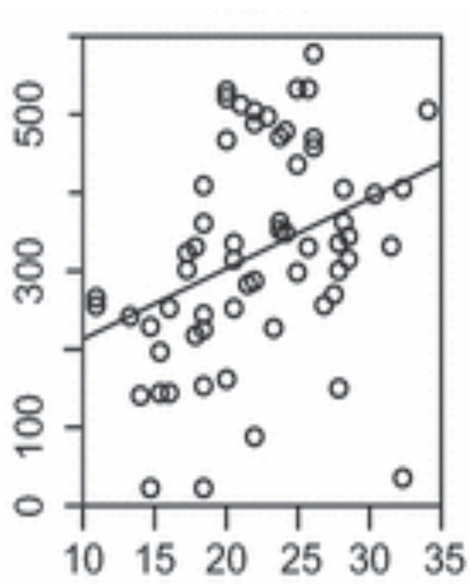
1. Genetic basis of dispersal (nature of the trait)

Dispersal could be based on a trait that determines movement duration or distance

Meta-analysis of 46 species of butterflies

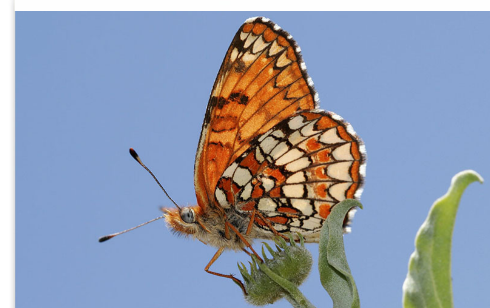
Data compiled from 81 capture-mark-recapture studies

Wingspan is a strong predictor of dispersal ability:



Mean Dispersal Distance (m)

Wingspan (mm)



Sekar 2012

Evolution of Dispersal and Philopatry

1. Genetic basis of dispersal (nature of the trait)

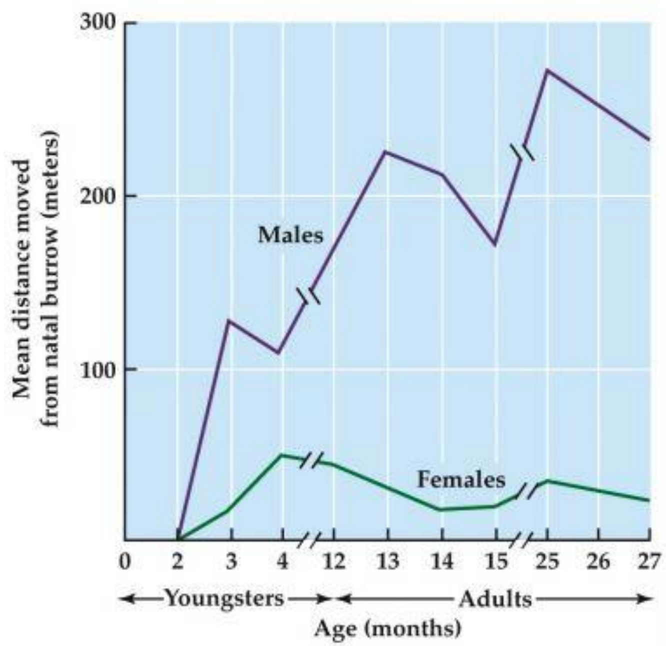
Dispersal could be condition-dependent, where genes link dispersal to the condition of an individual or the environment

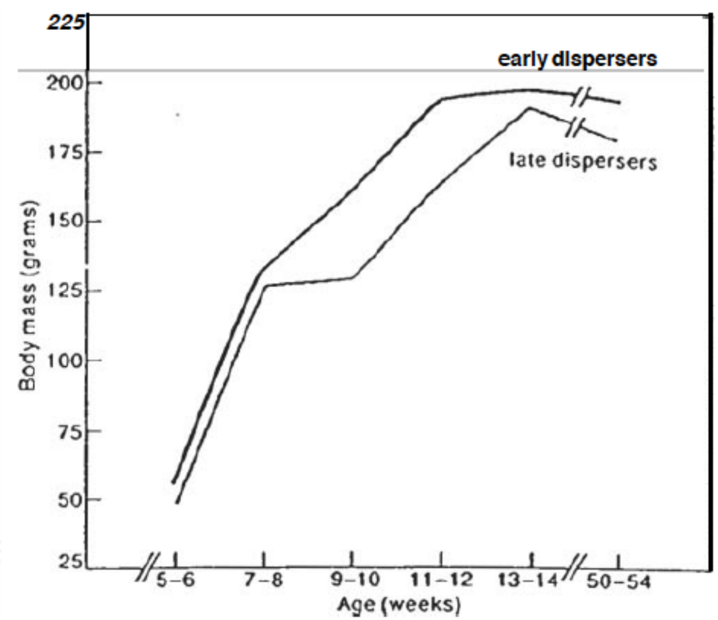
Condition of an individual could be body size, fat reserves or competitive ability

Condition of the environment could be habitat quality or population density

Belding's Ground Squirrel

Males only disperse once they reach body mass of ~125 g

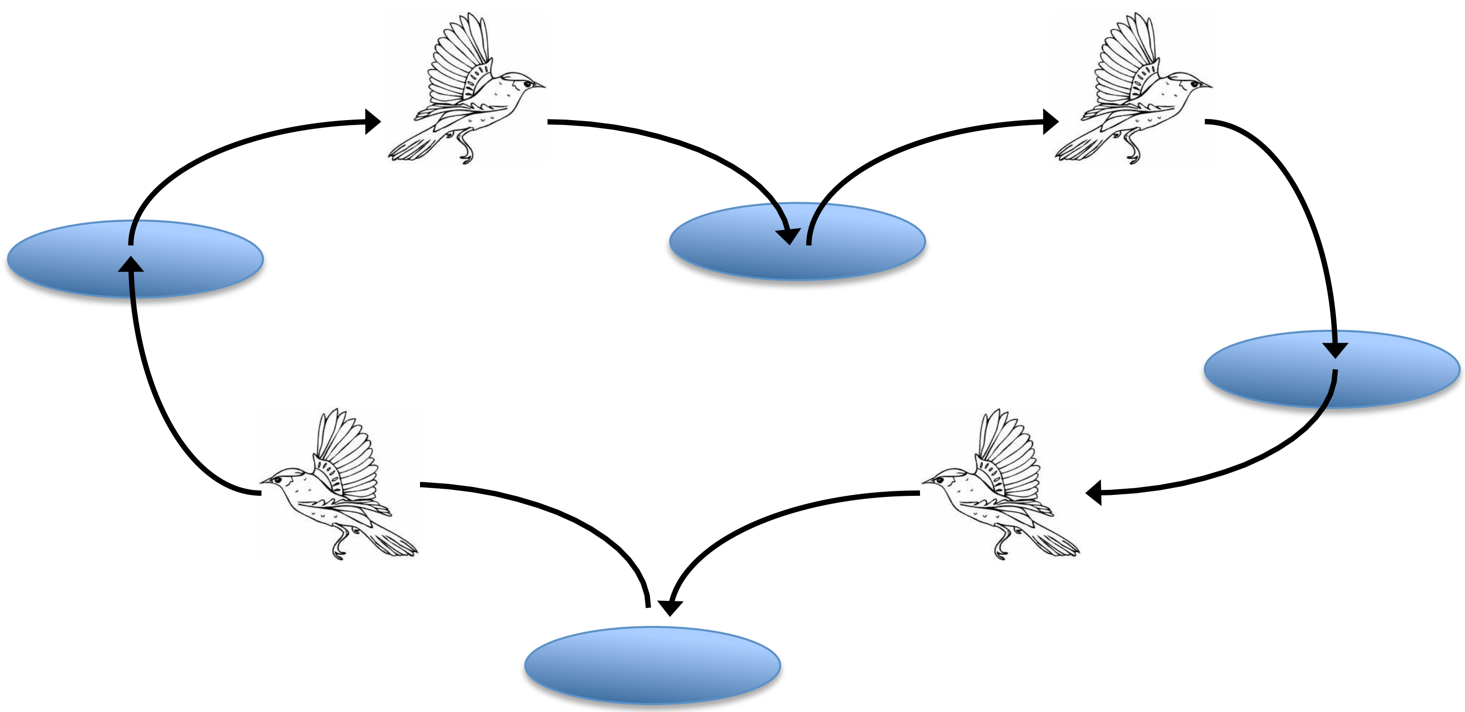




Evolution of Dispersal and Philopatry

2. Maintenance of dispersal potential

Metapopulation dynamics, with multiple populations linked by dispersal, should result in balanced gain and loss of individuals → **density-dependent dispersal**

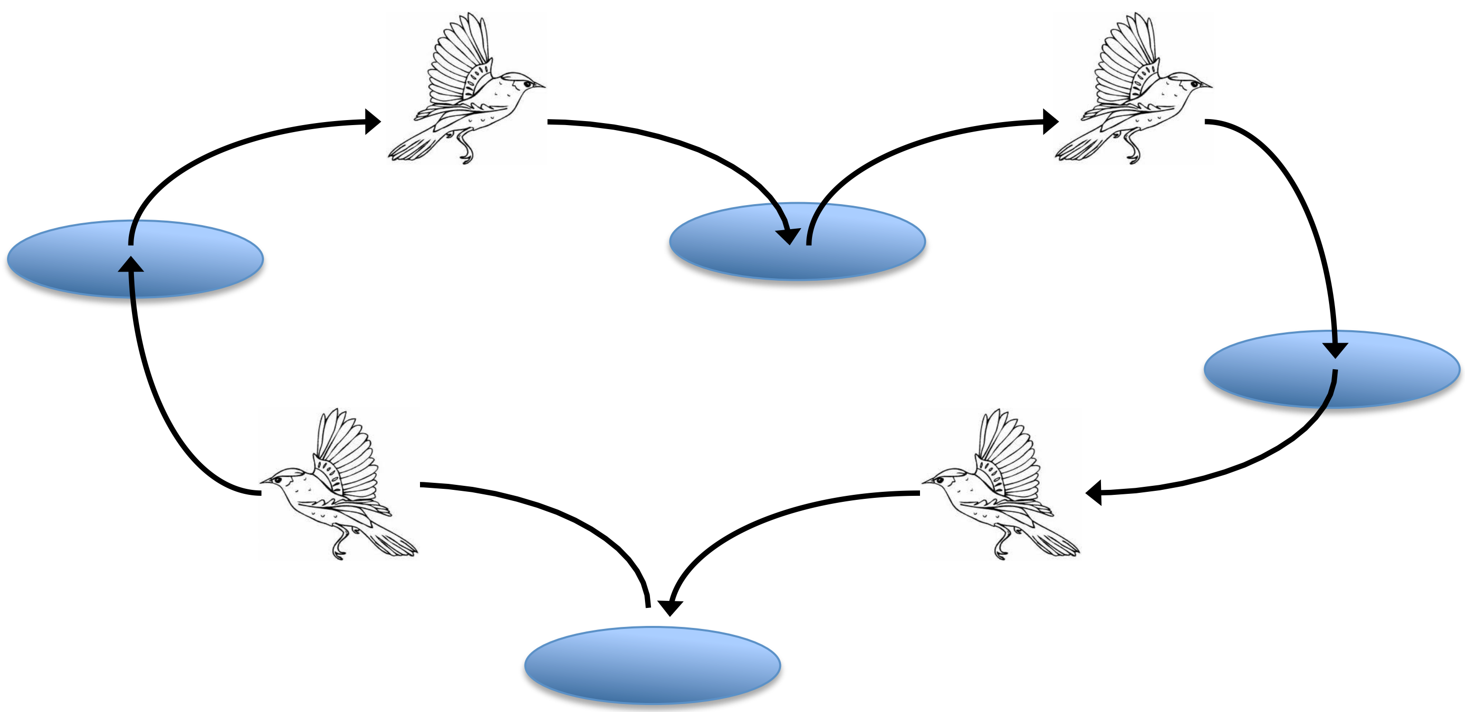


Evolution of Dispersal and Philopatry

2. Maintenance of dispersal potential

Dispersing individuals may colonize low density patches and stay there

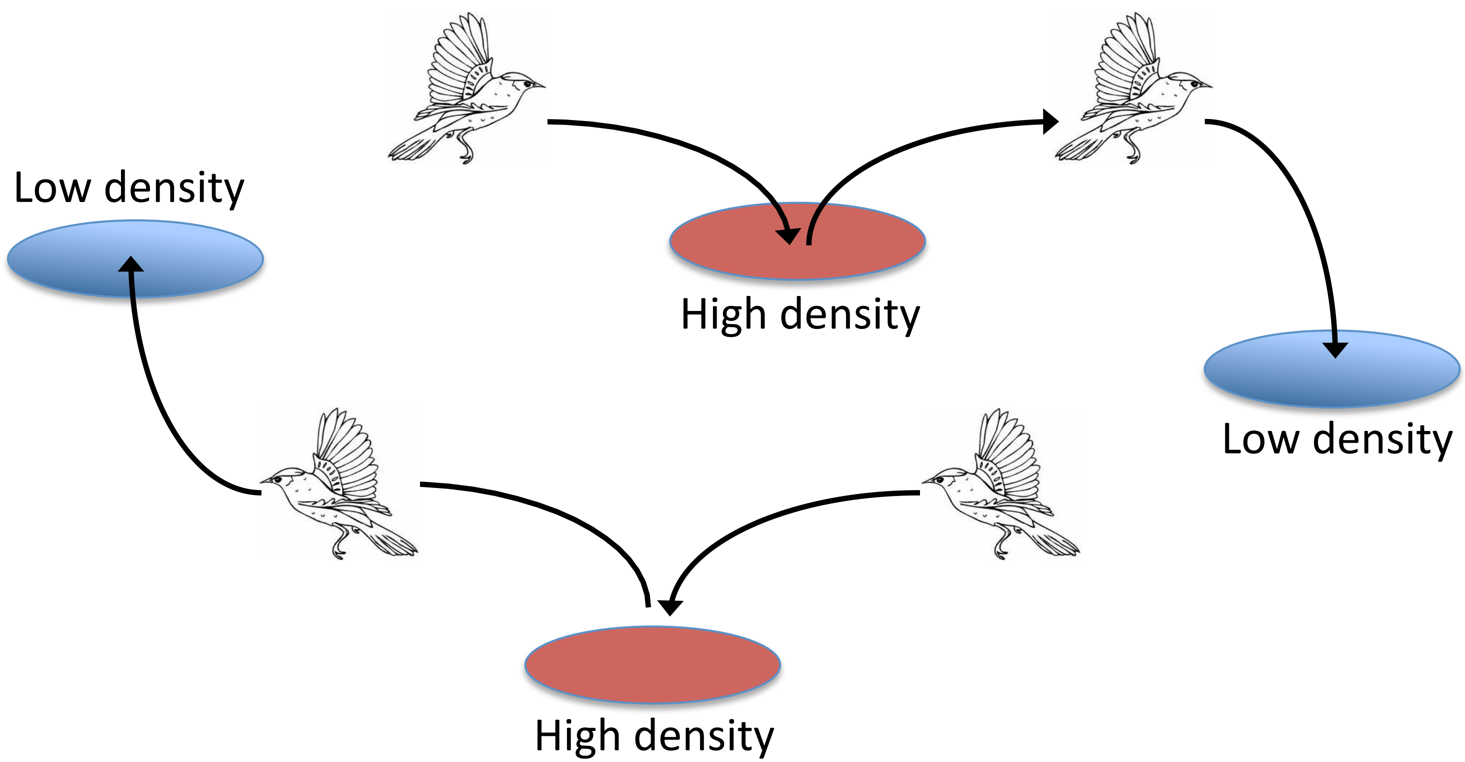
As patches increase in population density, propensity for individuals to disperse should increase



Evolution of Dispersal and Philopatry

3. Establishment of new populations

With condition-dependent dispersal, conditions may have favoured dispersal in the source population (high density and high competition), but not in the new population (low density - low competition)

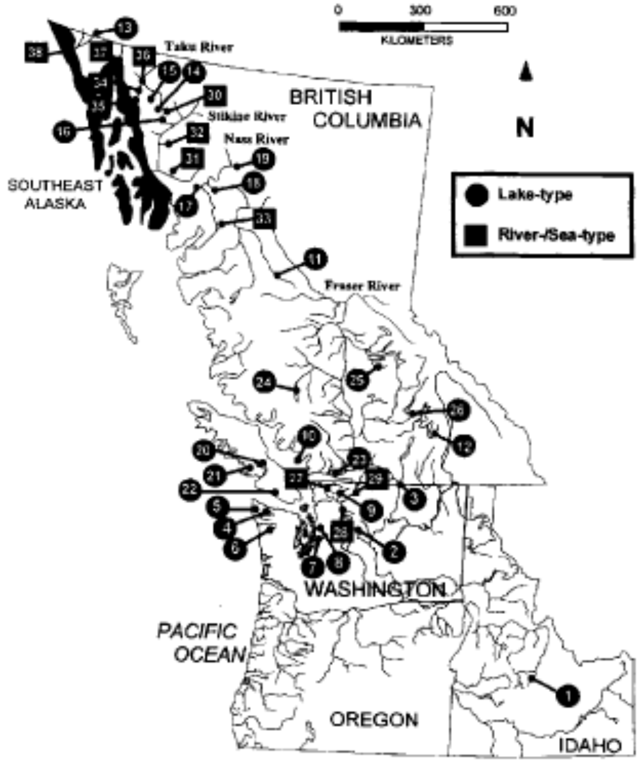


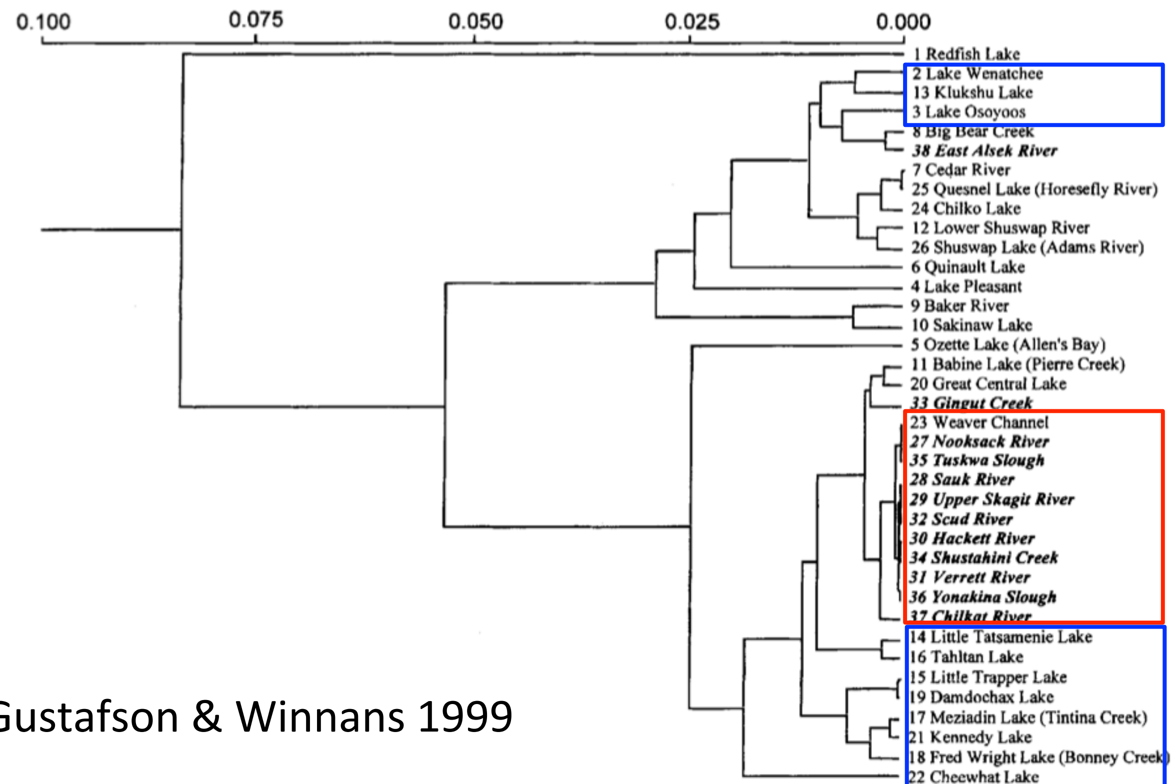
Evolution of Dispersal and Philopatry

Why Disperse?

1. Hedging your bets: finding the best situation in a variable environment

Prediction: there should be more dispersal in spatially-variable environments





Gustafson & Winnans 1999

Comparing types of sockeye salmon that are lake-resident (stable environment) and river/sea (unstable environment)

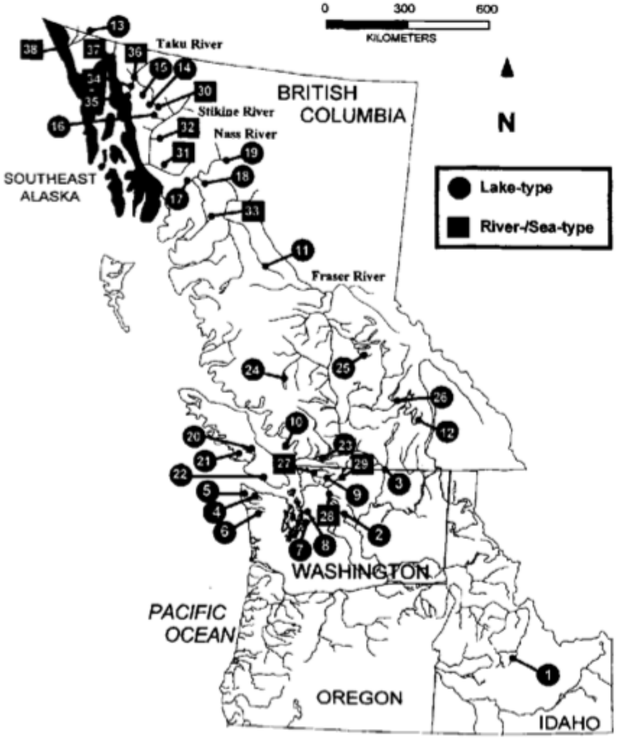
Genetic differentiation was highest among lake types (blue boxes) and lowest among river/sea types (red box)

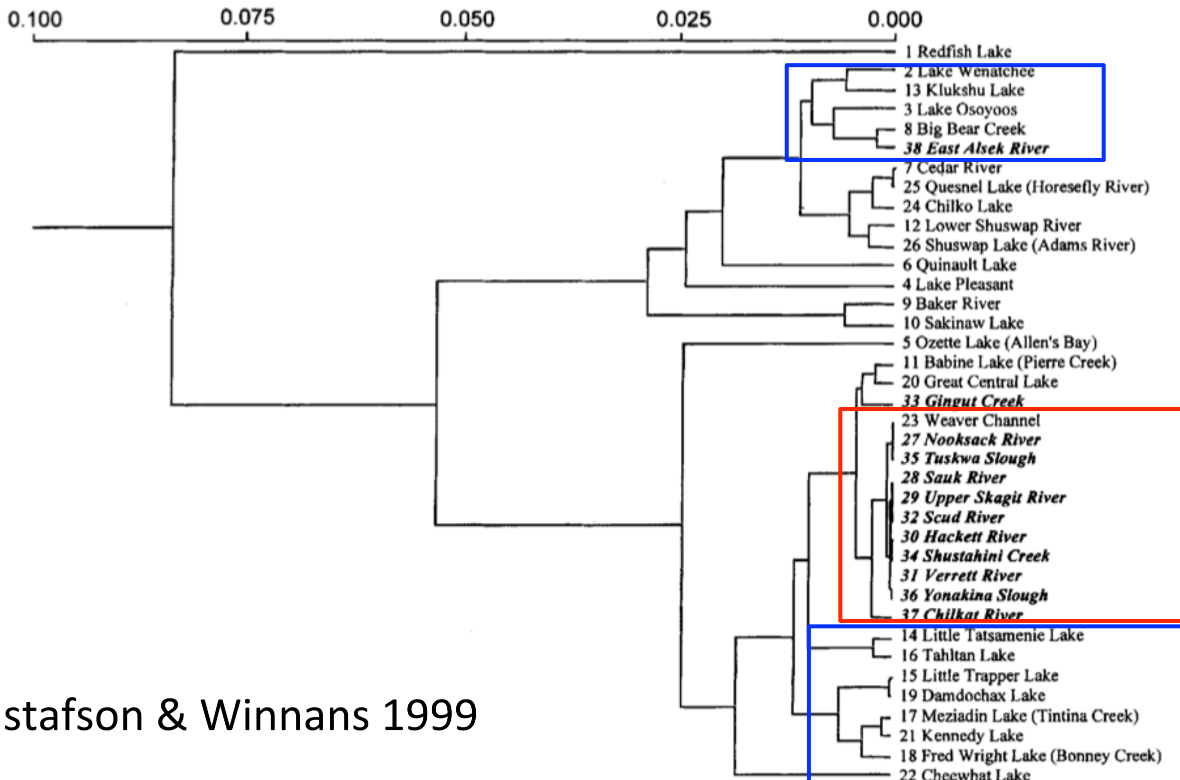
Evolution of Dispersal and Philopatry

Why Disperse?

1. Hedging your bets: finding the best situation in a variable environment

Prediction: there should be more dispersal in spatially-variable environments





Gustafson & Winnans 1999

Genetic differentiation represented by average branch length (e.g., shorter branch lengths in red box populations, longer branch lengths in blue box populations)

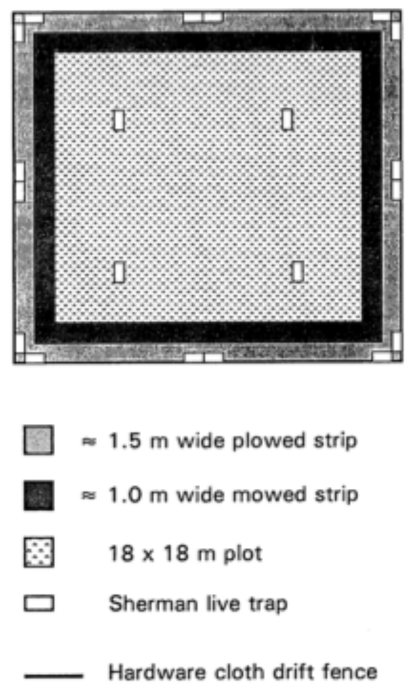
More dispersal and mixing in unstable or variable environments versus less movement of individuals in stable environments

Evolution of Dispersal and Philopatry

Why Disperse?

2. Reduction of inbreeding depression

   Predictions: higher dispersal when chance of inbreeding is higher



Meadow voles released into plots with siblings dispersed at a higher rate than meadow voles released with unrelated individuals

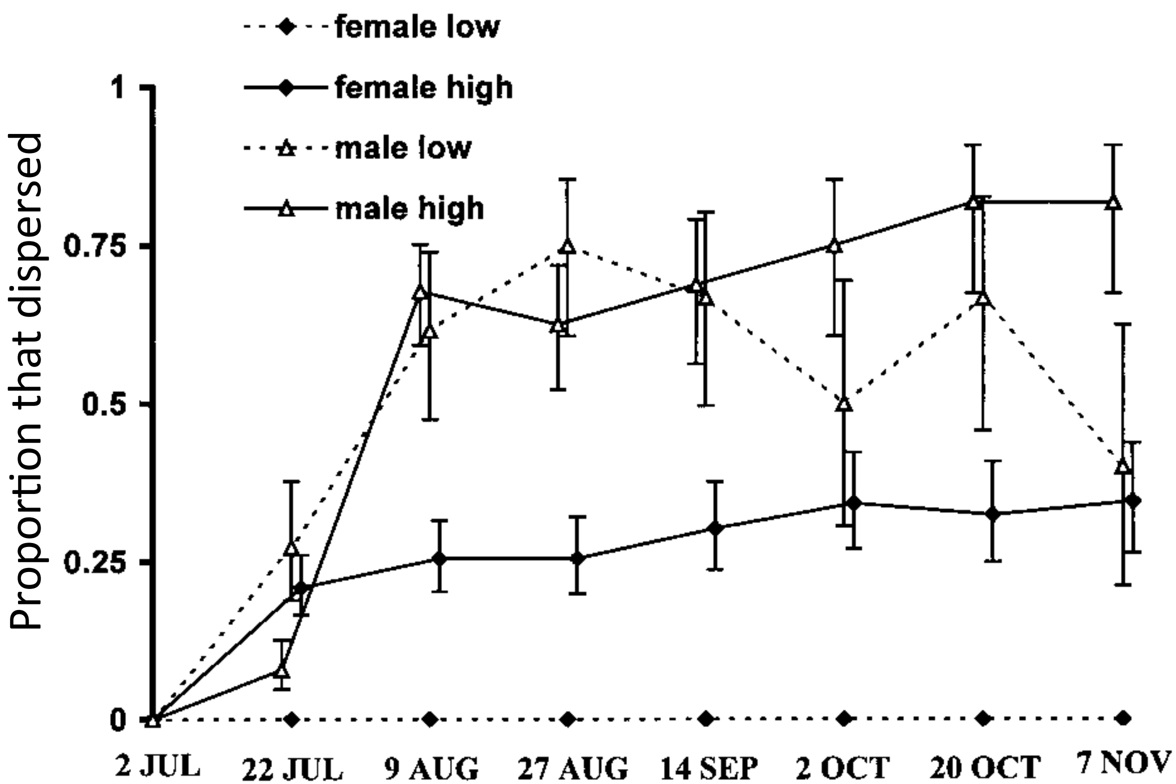
Bollinger *et al.* 1993

Evolution of Dispersal and Philopatry

Why Disperse?

3. Dispersal reduces competition

Prediction: higher dispersal when population density is higher



High female density in natal plot

Low female density in natal plot

Female root voles (*Microtus oeconomus*) moved from high to low density plots (sex-biased dispersal – all males disperse)

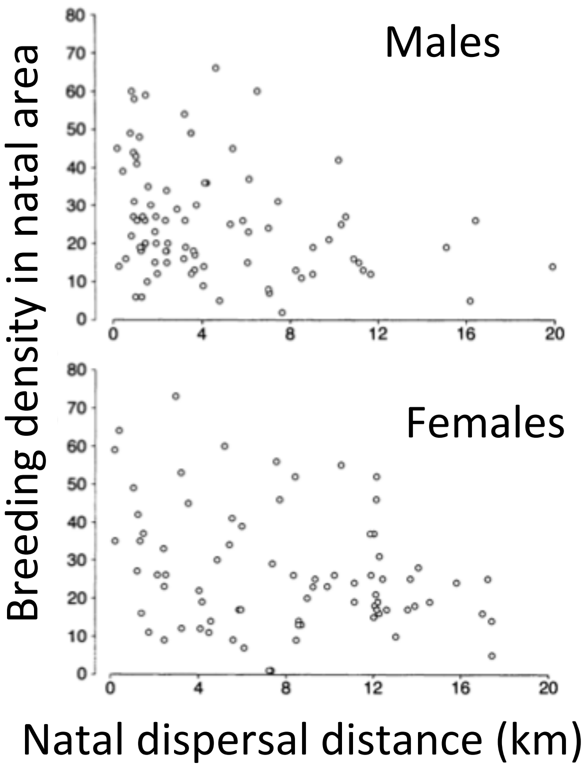
Aars & Ims 2000

Evolution of Dispersal and Philopatry

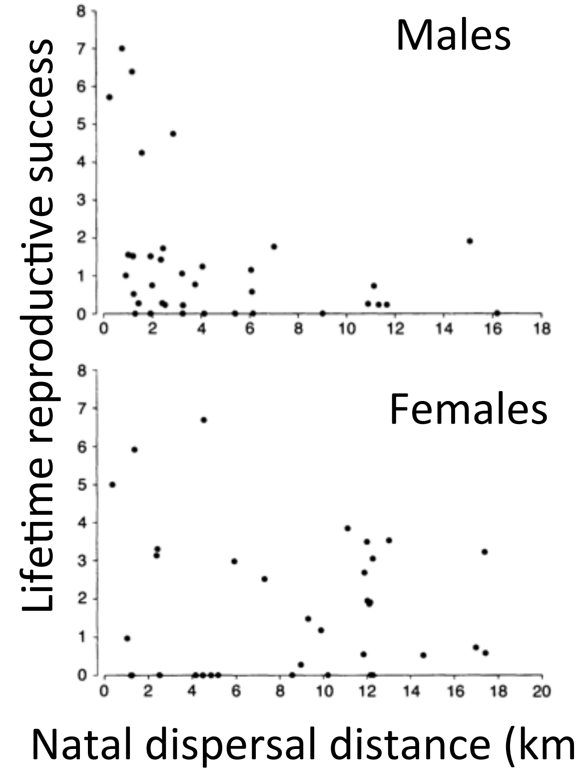
Why be philopatric?

1. With variation in habitat quality, philopatry increases chance of finding suitable breeding site and mate, increases familiarity with local conditions.

Prediction: the best breeding sites have highest density, lowest dispersal distance



European black kites (*Milvus migrans*) disperse shorter distances when natal population density is high, and have highest fitness when dispersal distance is shortest



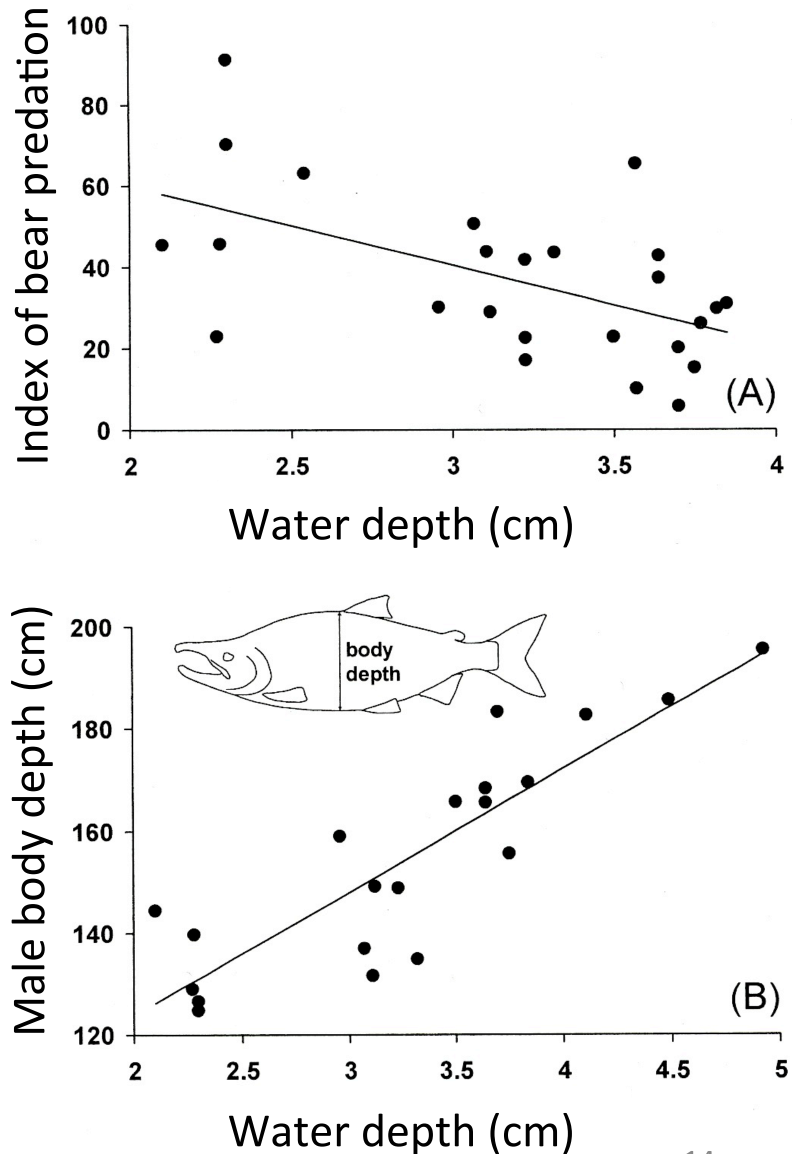
Forero *et al.* 2002

Evolution of Dispersal and Philopatry

Why be philopatric?

2. Philopatry returns locally-adapted individuals to appropriate habitats.

Prediction: local adaptation



Higher bear predation and a higher probability of stranding probably select for smaller sockeye salmon in some Alaskan streams (Hendry *et al.* 2004)

Evolution of Dispersal and Philopatry

Why be philopatric?

2. Philopatry returns locally-adapted individuals to appropriate habitats.

Prediction: rate of dispersal is higher than the rate of gene flow

In populations of chum salmon in adjacent streams, tagging data suggested that the rate of straying was 37.9%, but genetic data suggested that there was only 5% gene flow

Straying salmonids had lower reproductive success

Individuals may show "exploration" behaviour by straying, but are more selective of streams where they actually breed

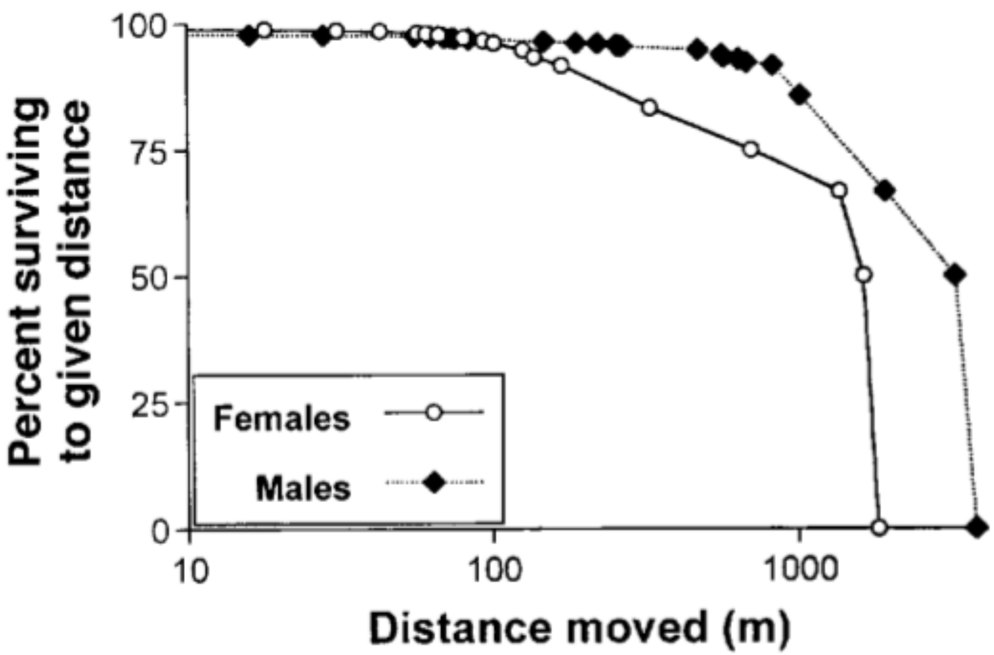
Tallman & Healey 1994

Evolution of Dispersal and Philopatry

Why be philopatric?

3. Philopatry avoids costs of movement.

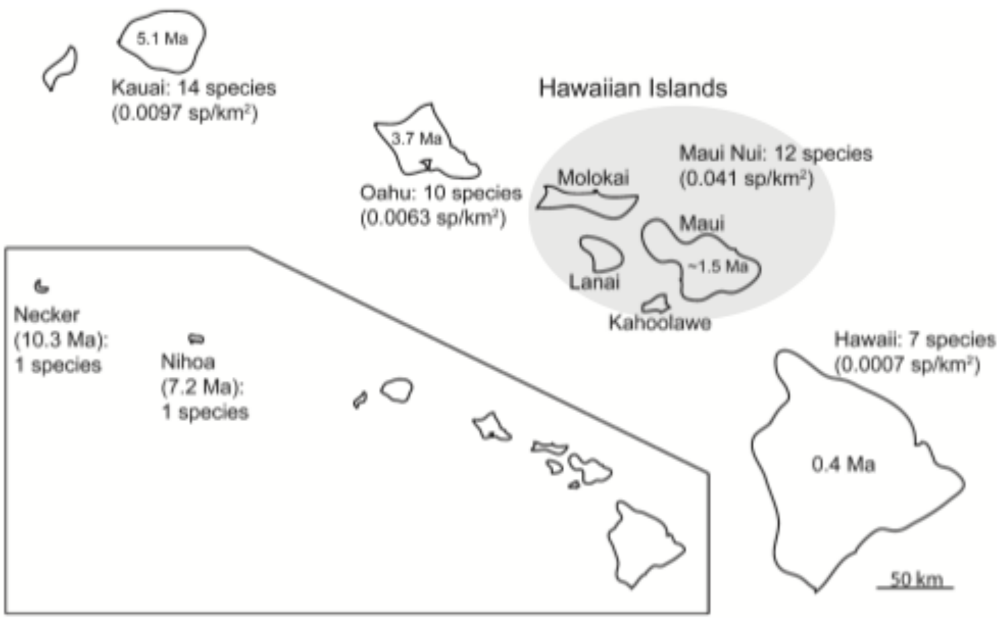
Prediction: more philopatry where costs of movement are higher

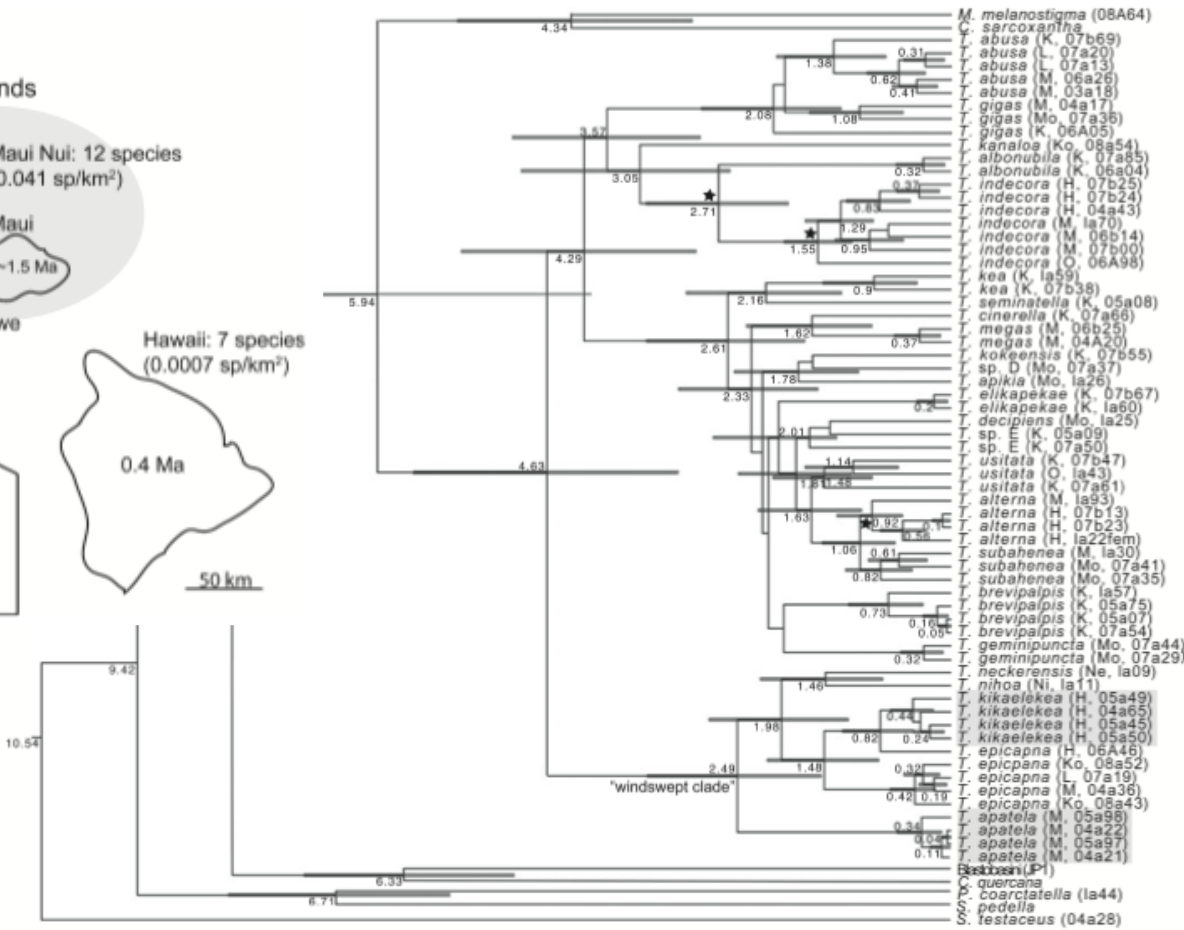


No direct evidence for higher philopatry where costs of movement are higher, but clearly dispersal can be costly
(data on arctic ground squirrels, from Byrom & Krebs 1999)

Evolution of Dispersal and Philopatry

Example of dispersal evolution

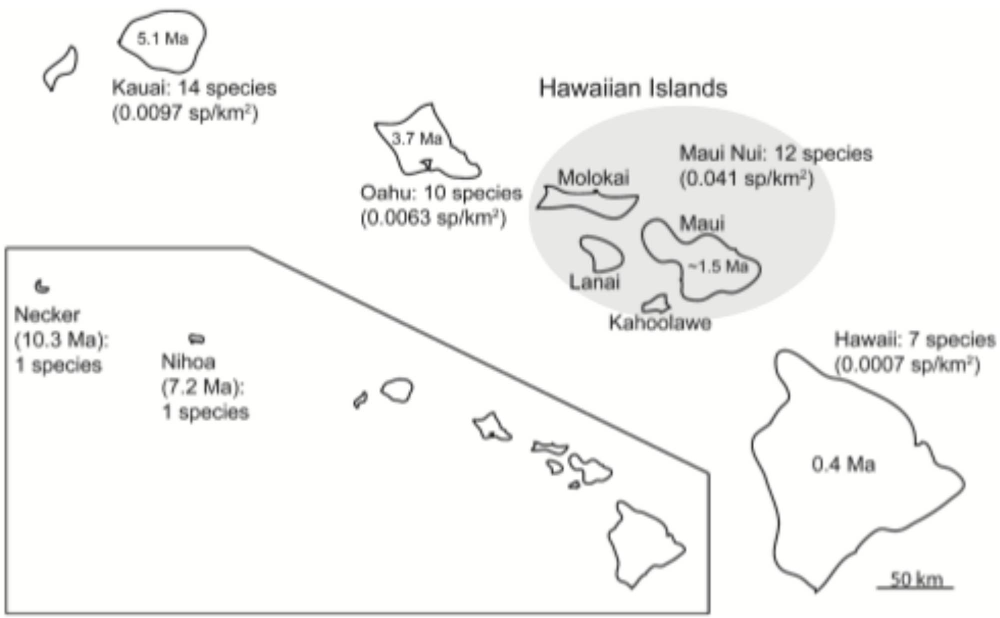


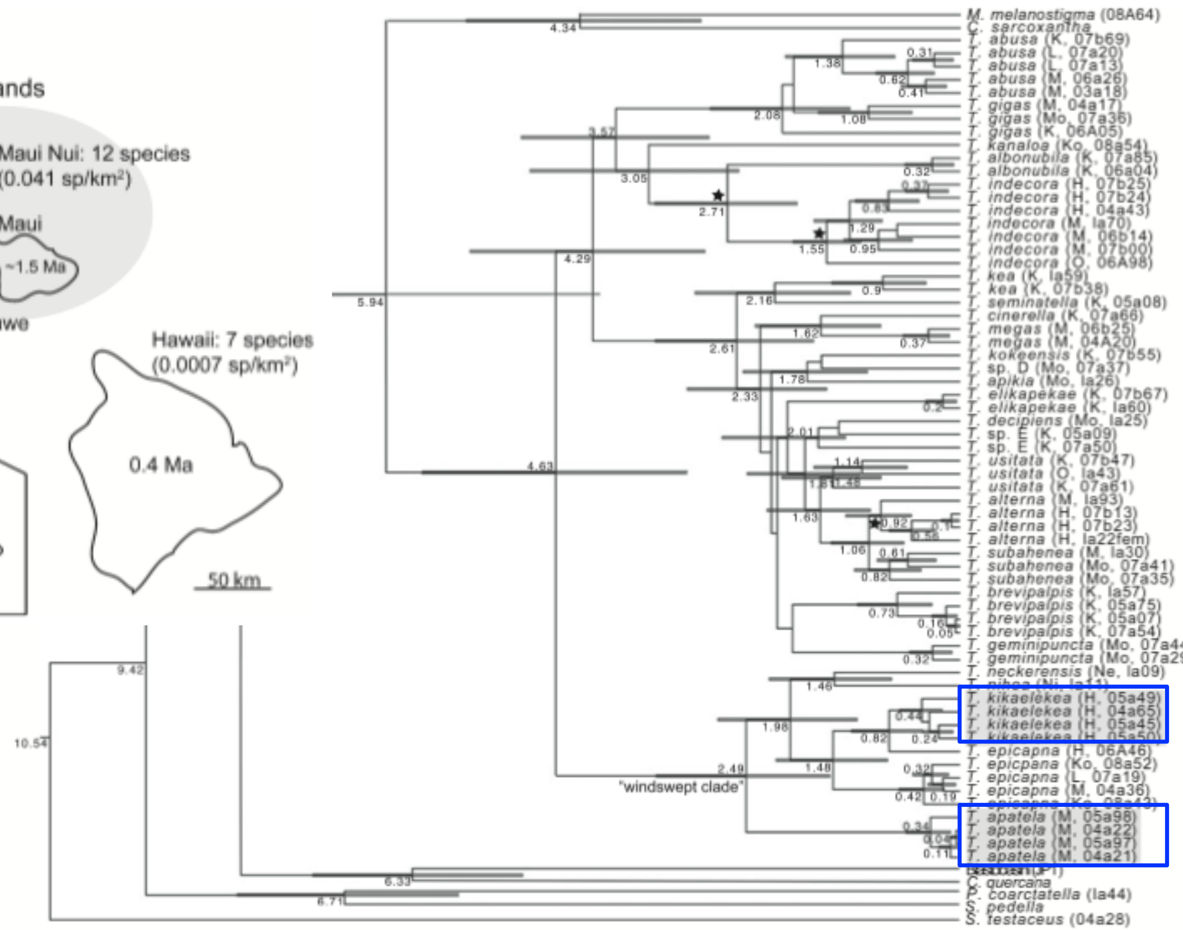


Loss of flight (i.e., increase in philopatry) in Hawaiian moths (Medeiros & Gillespie 1999)

Evolution of Dispersal and Philopatry

Example of dispersal evolution





Loss of flight has evolved twice, perhaps due to low temp, high winds and low predation pressure

Dispersal

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Dispersal

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