assignment tests using isotopes

- problem of assignment
- assignments with data
- assumptions & sources of error
- applying the data on connectivity

the problem of assignment

- goal: **estimate** the **origin** of an individual
- requirement: calibrated isoscape

the problem of assignment

- goal: **estimate** the **origin** of an individual
- requirement: calibrated isoscape
  1. species-specific tissues

the problem of assignment

- goal: **estimate** the **origin** of an individual

- requirement: calibrated isoscape

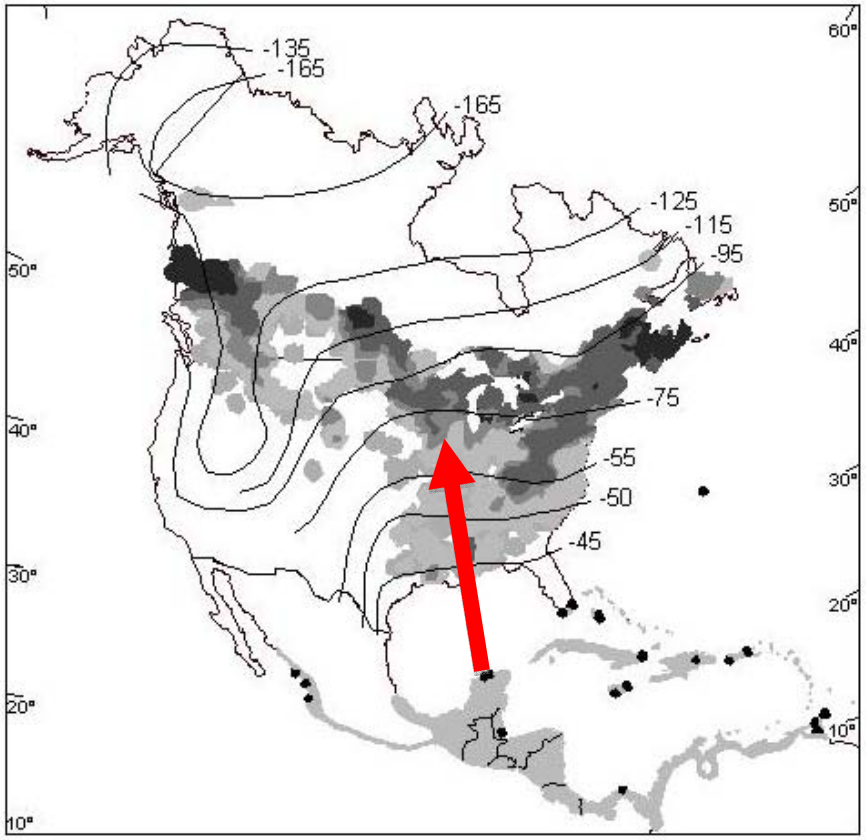
  1. species-specific tissues
  2. environmental basemap (discrimination, slope)

y = mx + b

y = isotope in animal tissue
x = isotope value in environment
m = slope (ideally should be linear and 1)
b = intercept: discrimination value between animal tissue and environment

the problem of assignment

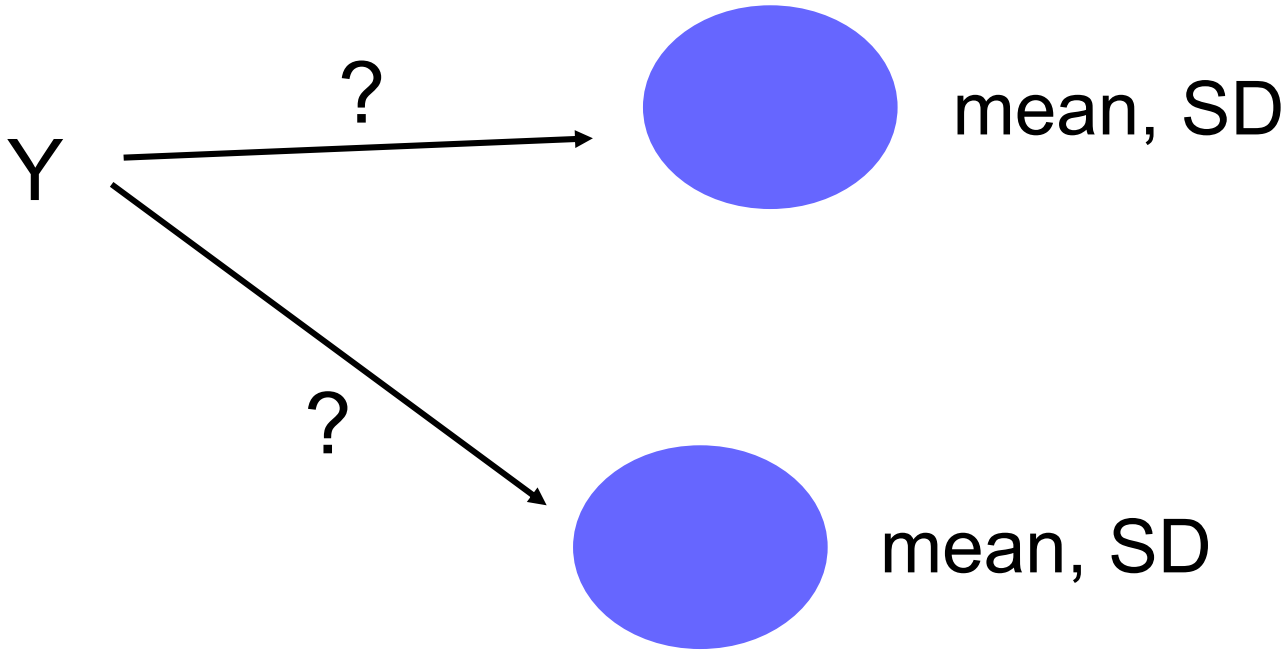
- first types of assignments used a “map look up” approach



- individual A came from between x and y latitude

likelihood assignments

- likelihood of the value occurring given the data



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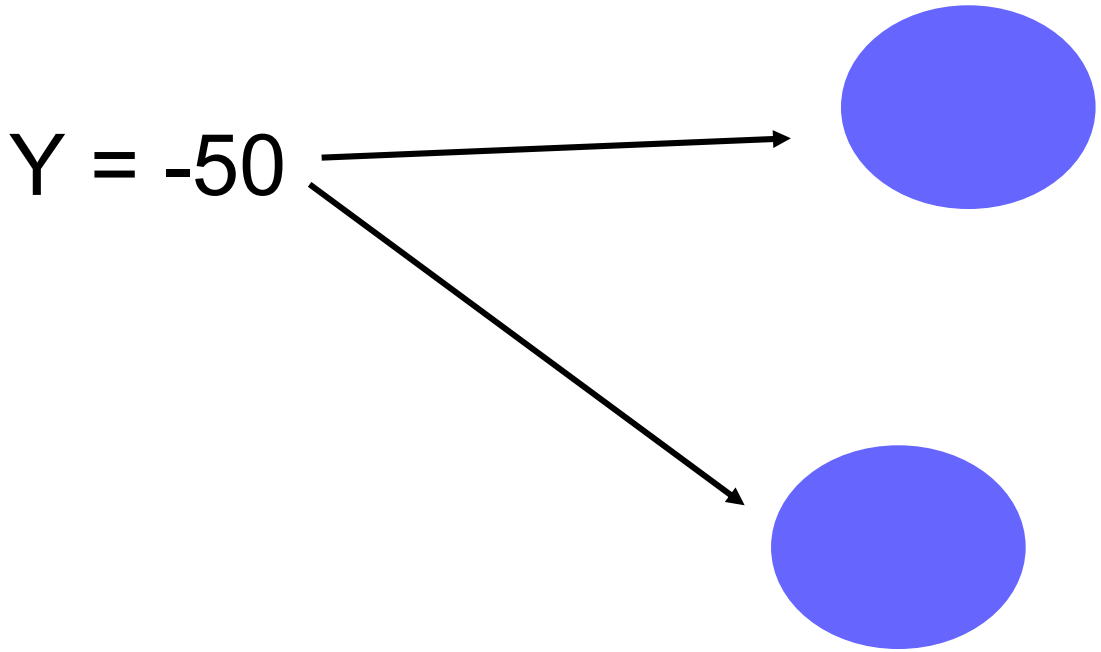

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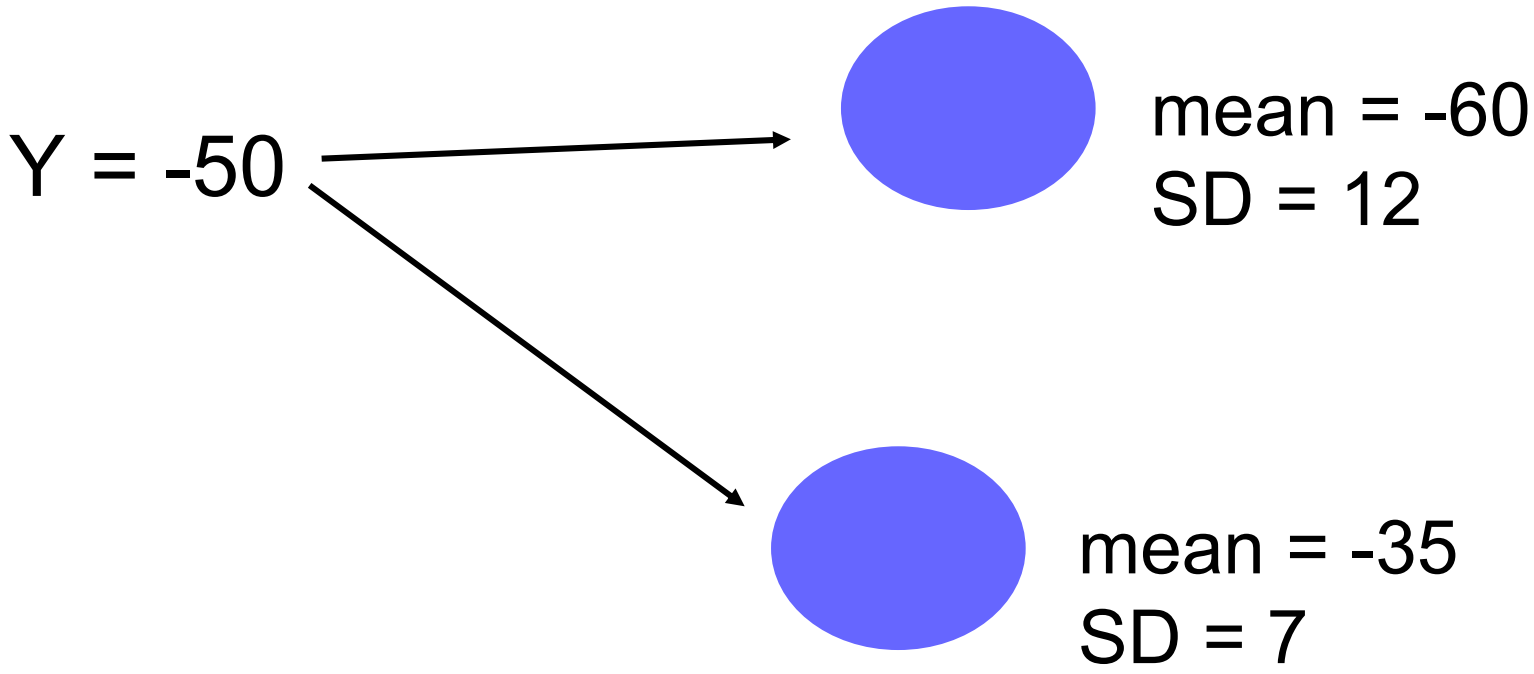

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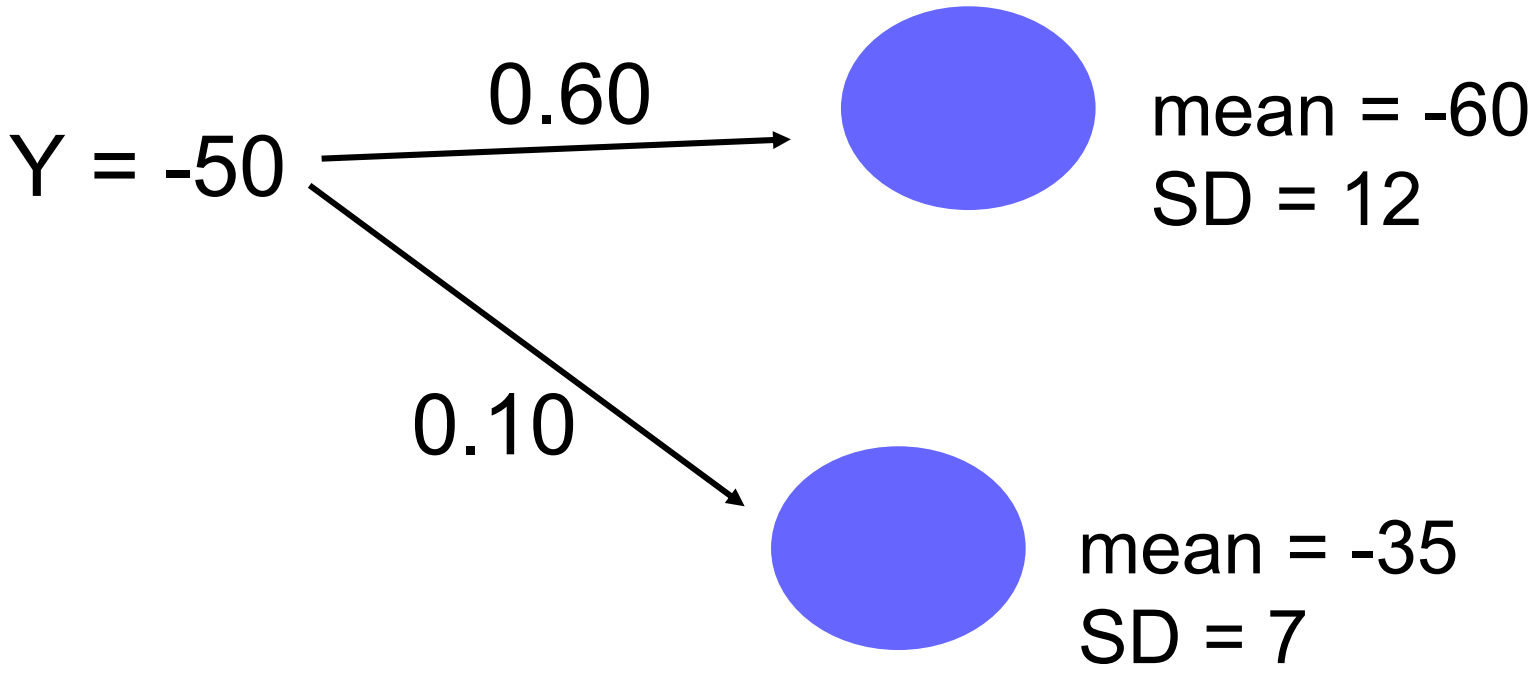
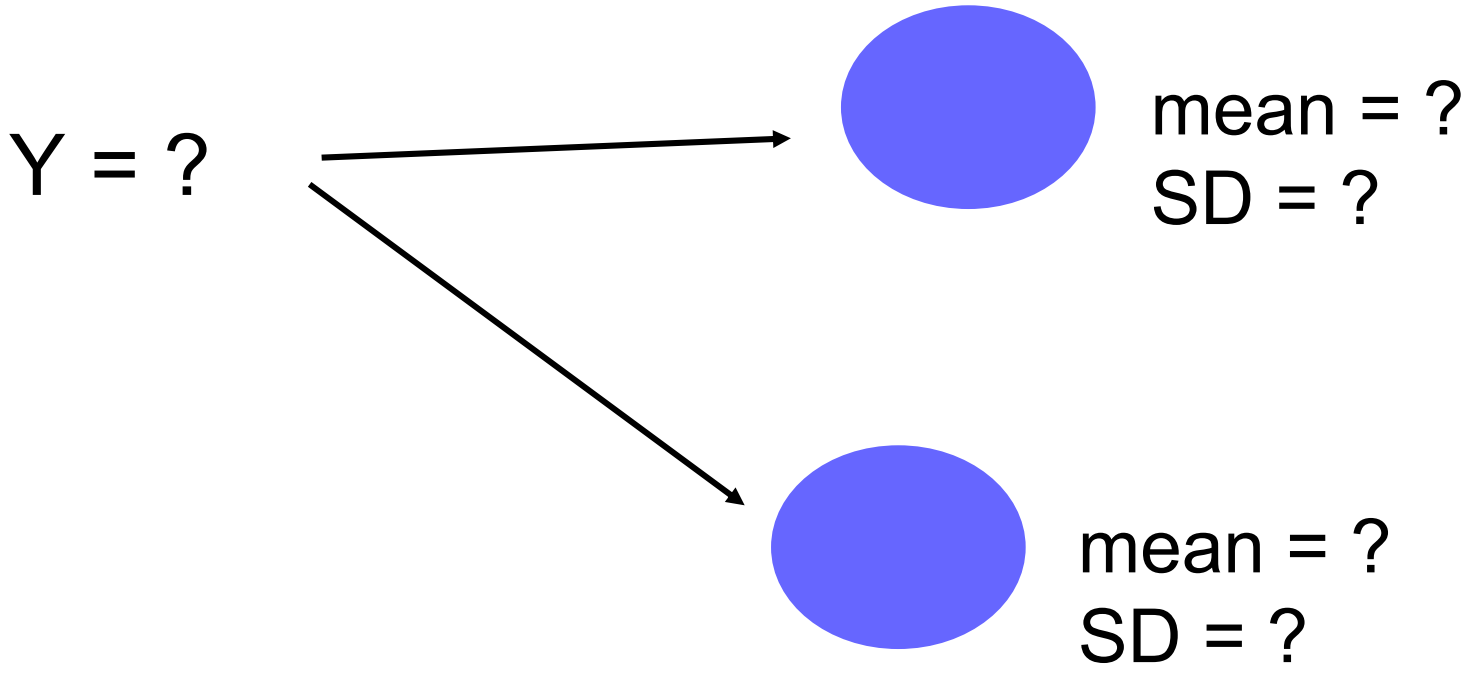


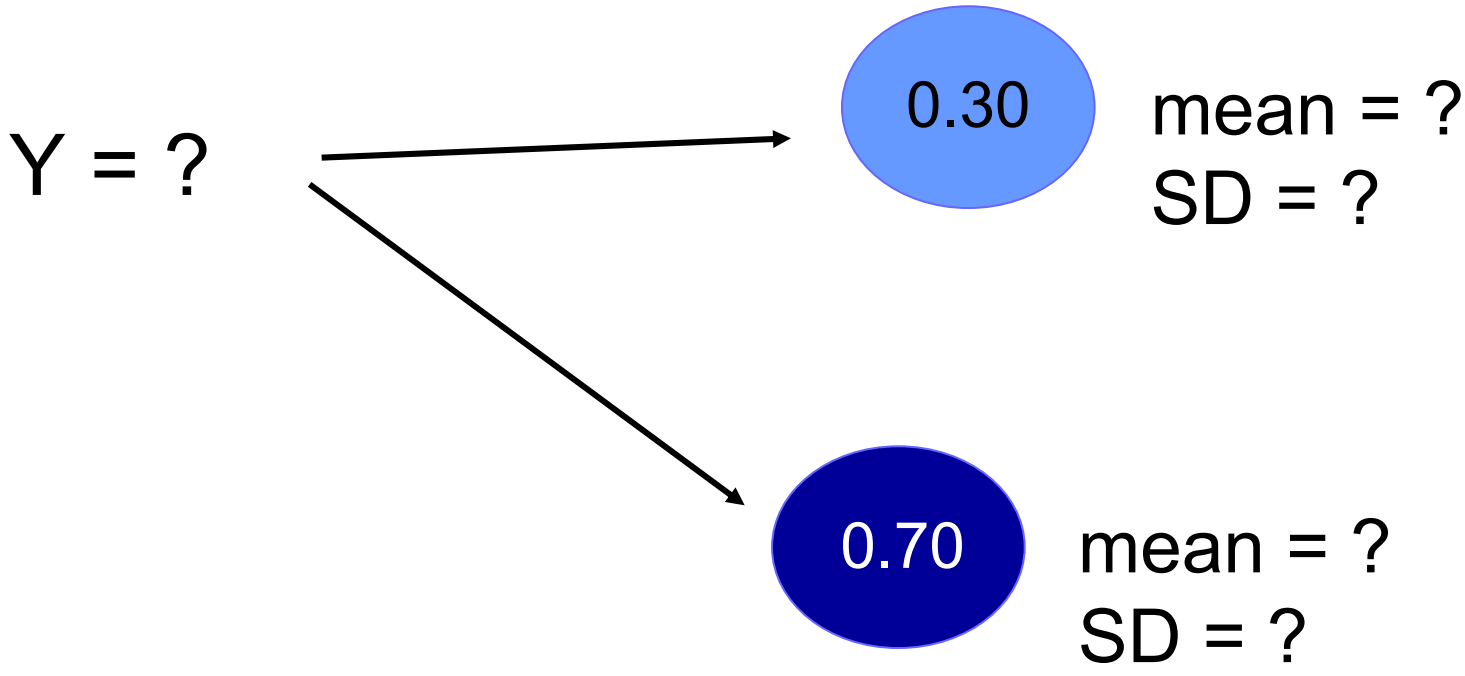
likelihood assignments with prior probability

- is there any ‘hidden’ information?



likelihood assignments with prior probability

- additional information (e.g. relative breeding abundance)



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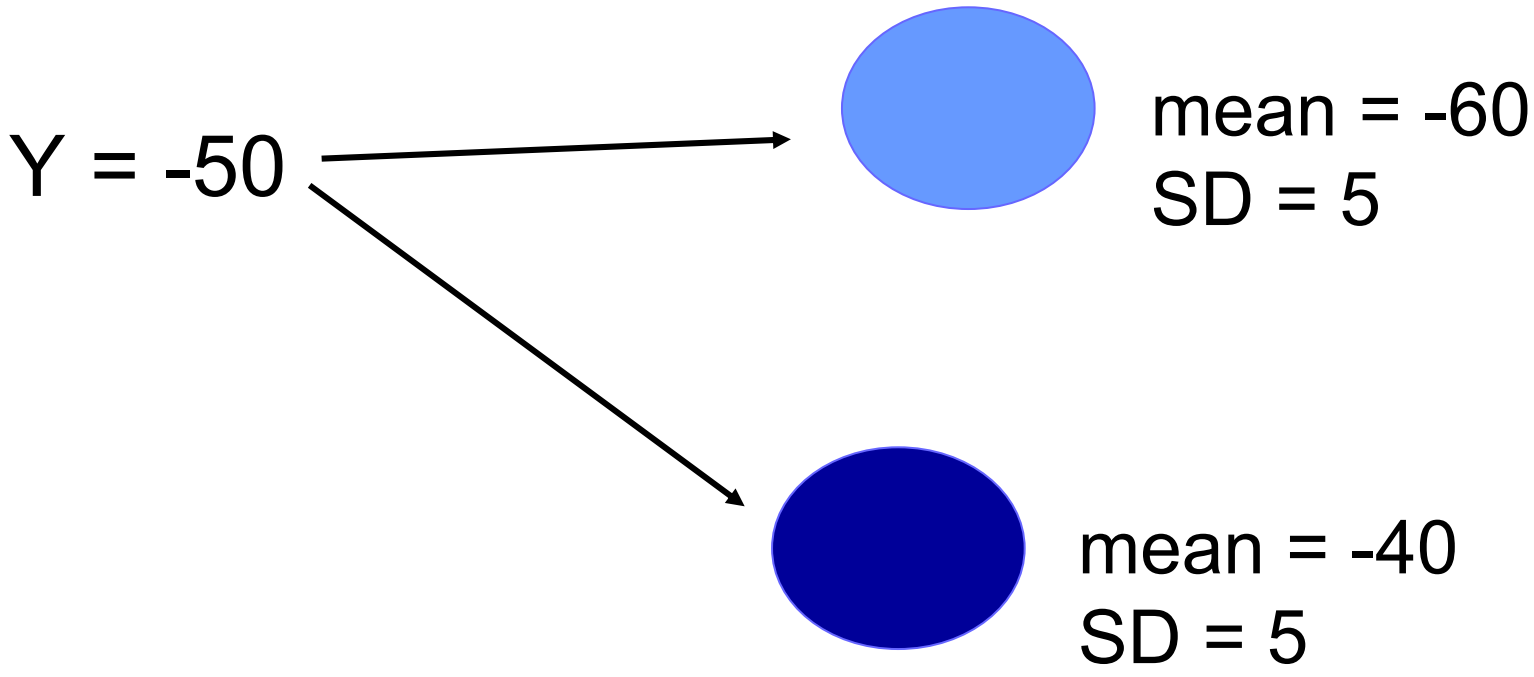

likelihood assignments with prior probability

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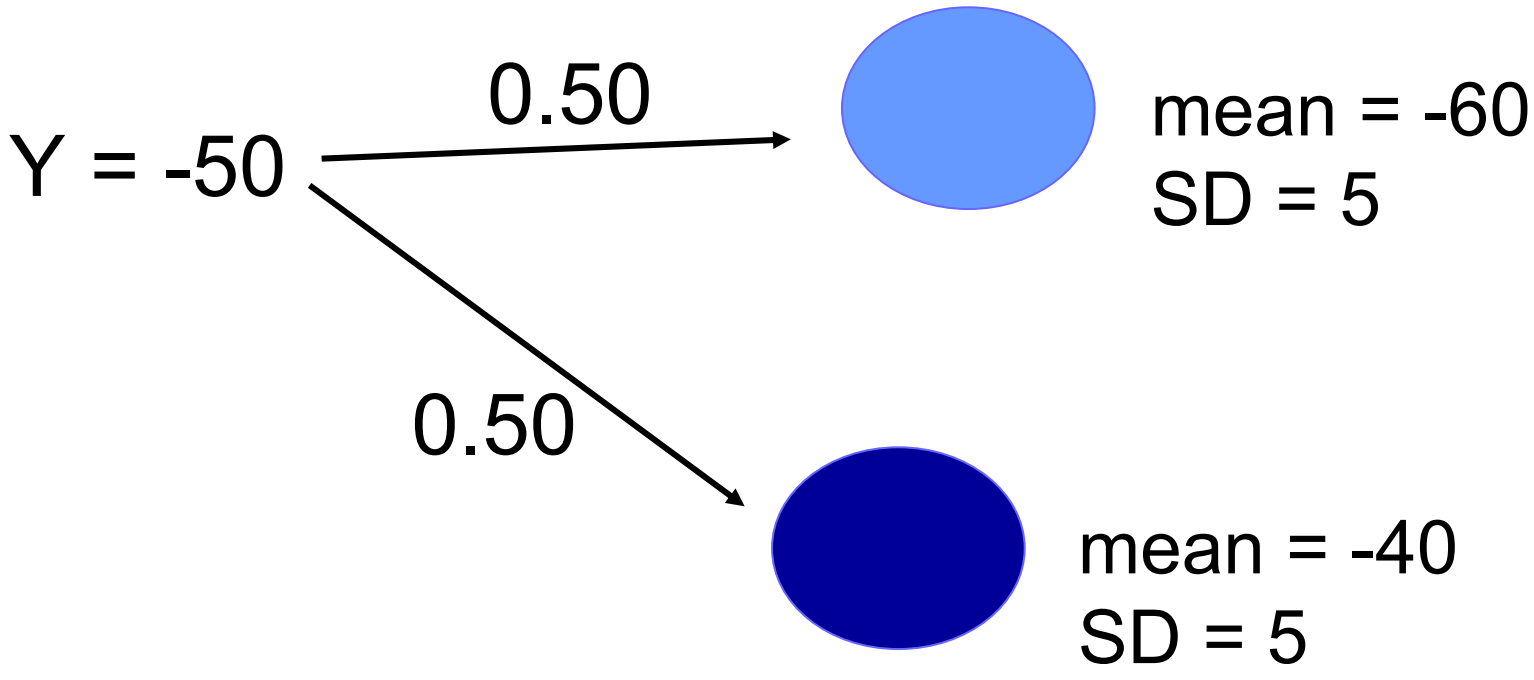
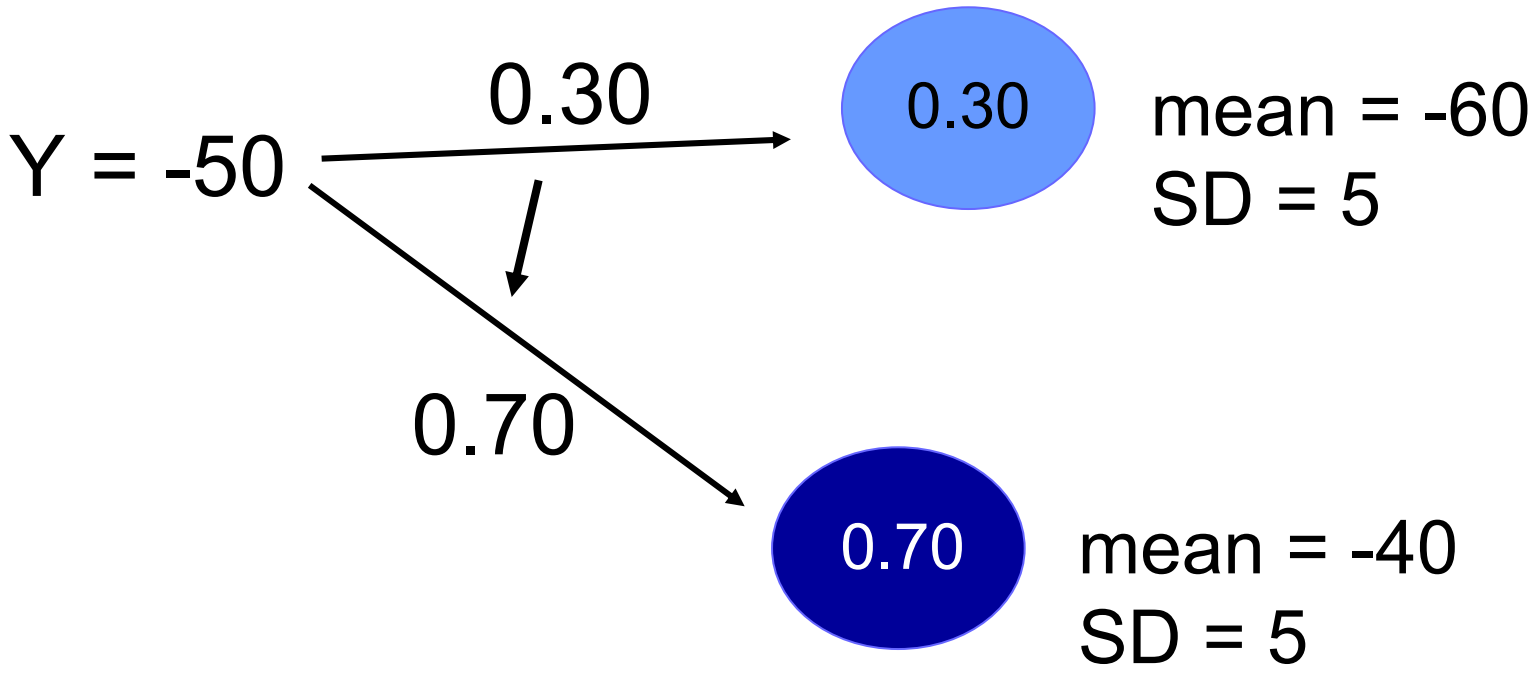


likelihood assignments with prior probability

- moves the “fence sitters”



doing assignments

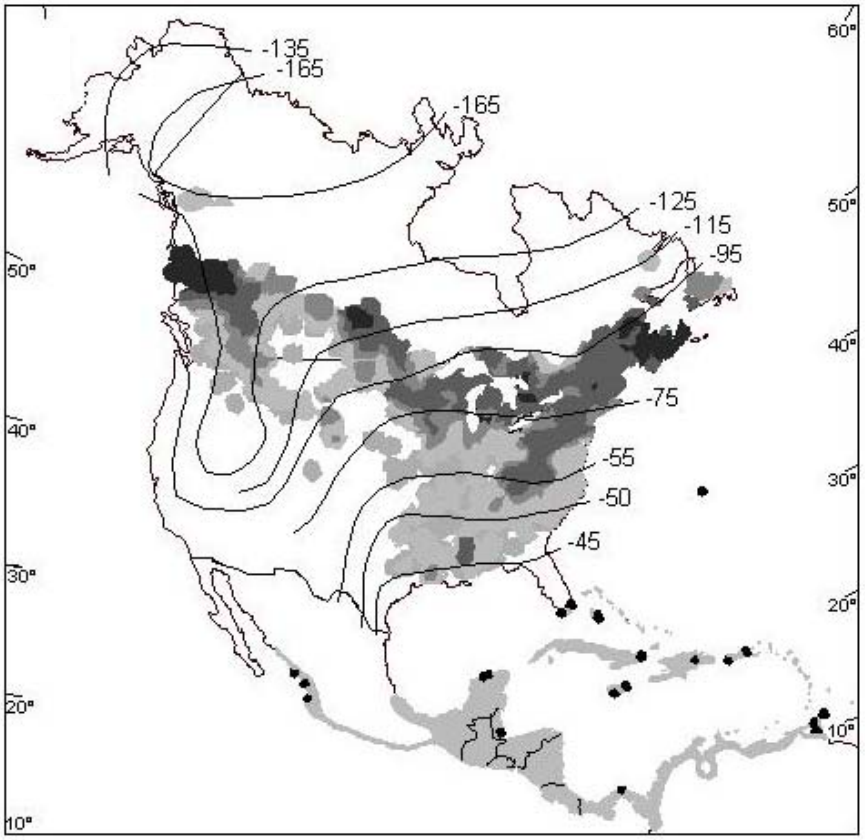
δD: latitudinal gradient

feathers are:

(a) molted on breeding grounds

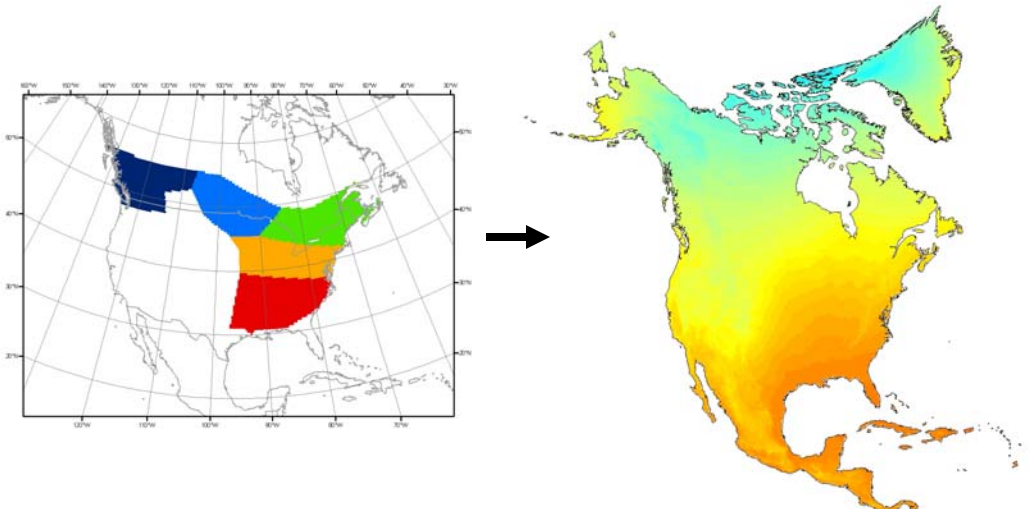
(b) metabolically inert after growth

N=188 feathers from 25 sites, 11 countries



likelihood assignments

- likelihood assignment based on mean and SD of δD in each breeding region



likelihood assignments

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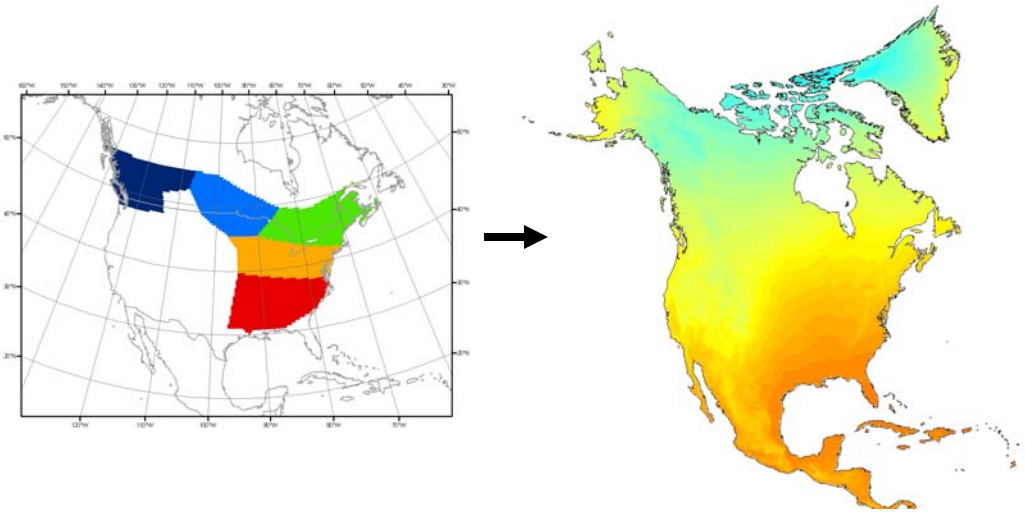
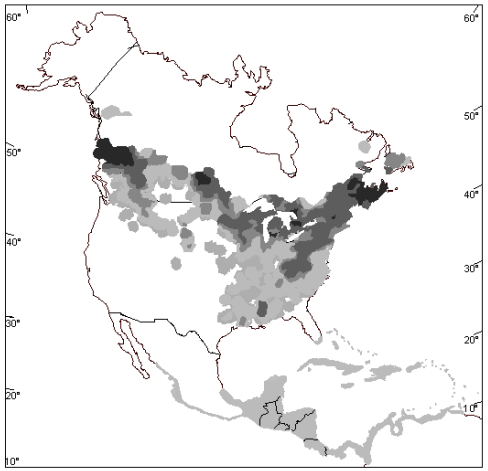
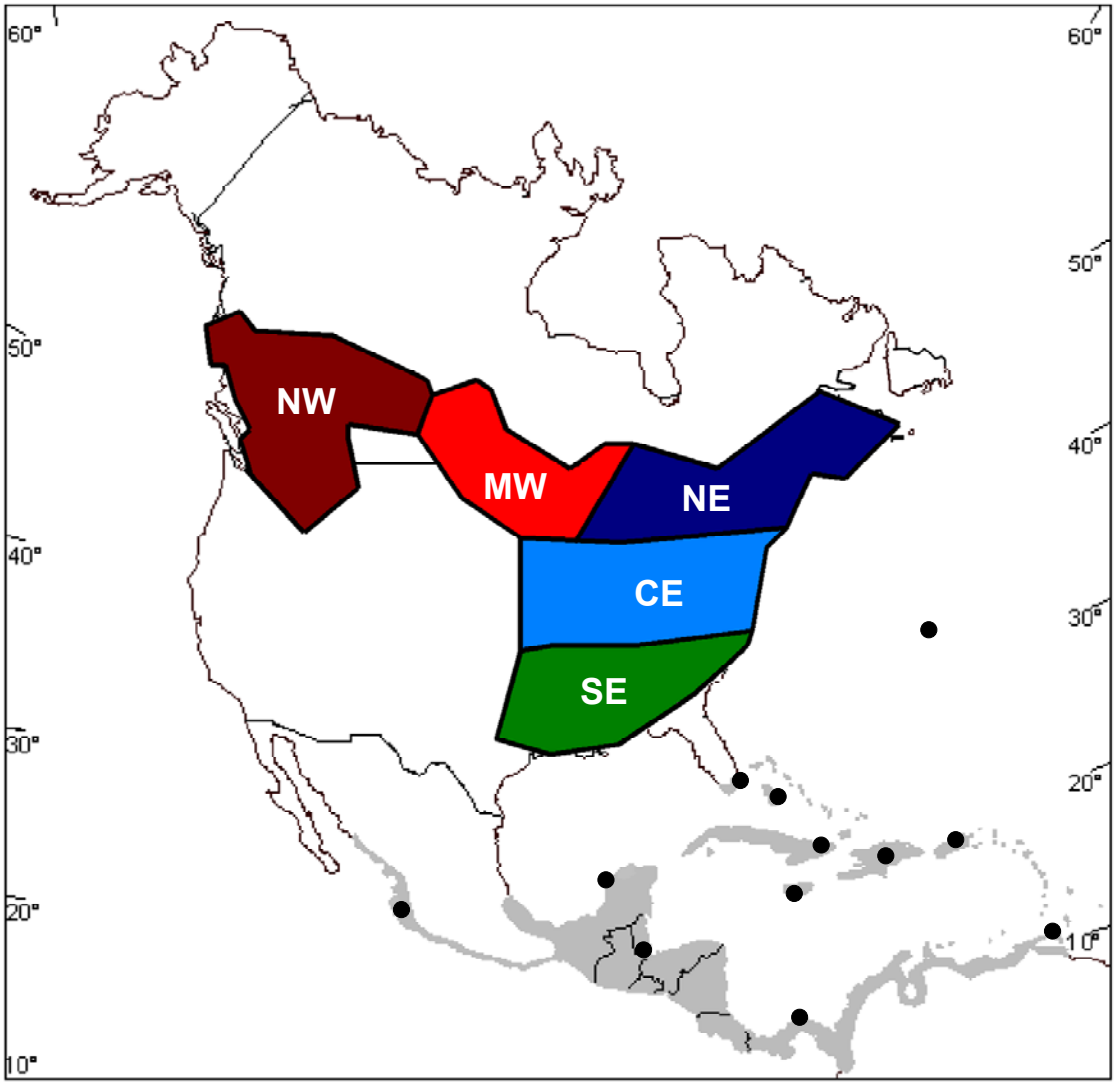


- incorporate a prior probability of relative breeding abundance using Bayes' Rule

breeding bird survey →



likelihood assignments



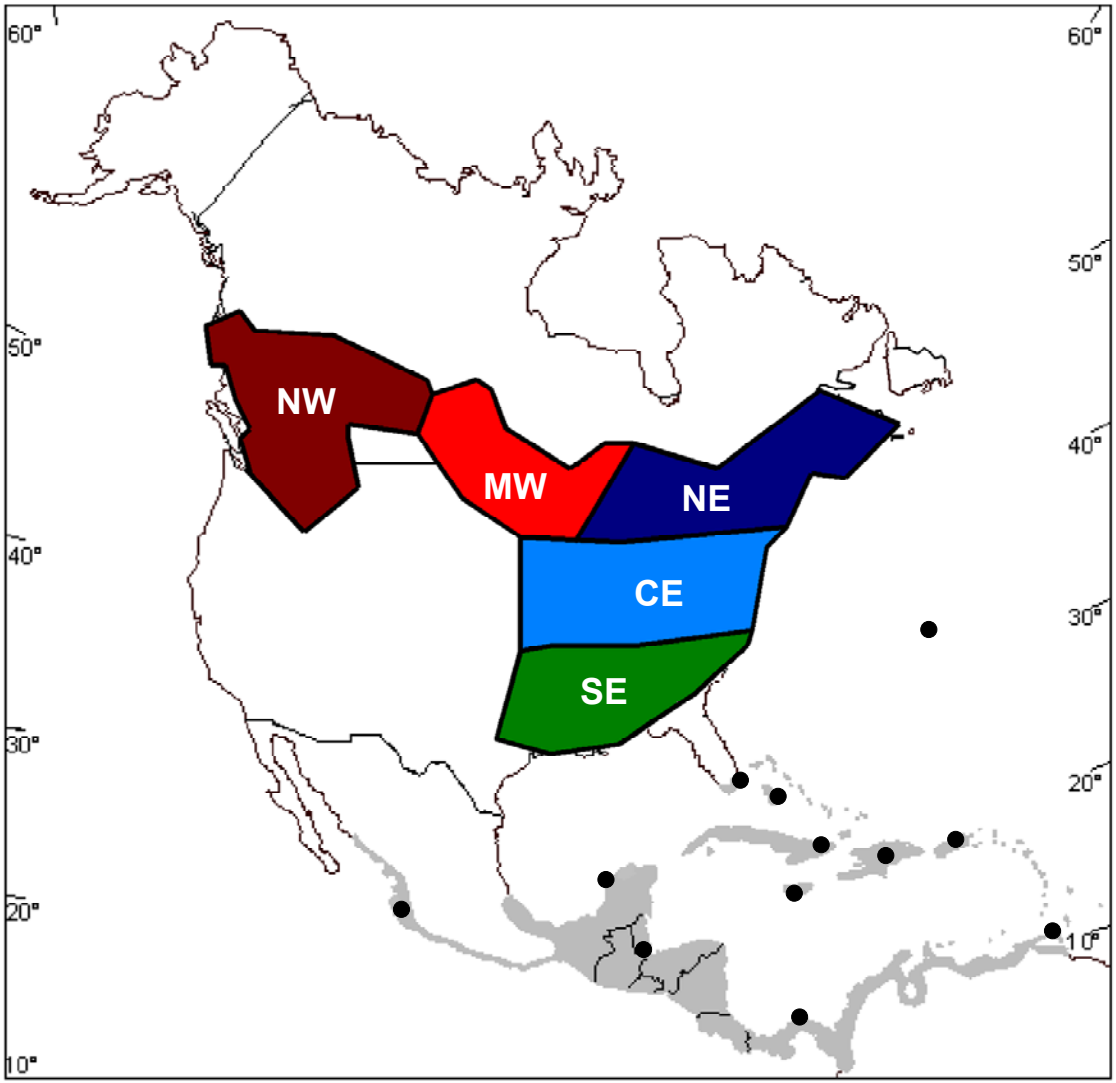
estimating patterns of connectivity

Region	dD precip mean	dD precip std	Relative abundance (BBS)
A (NW)	-118.5	13.6	0.251
B (MW)	-104.3	14.2	0.224
C (NE)	-79.5	5	0.381
D (ME)	-65.4	5.9	0.113
E (SE)	-52.8	7.8	0.031

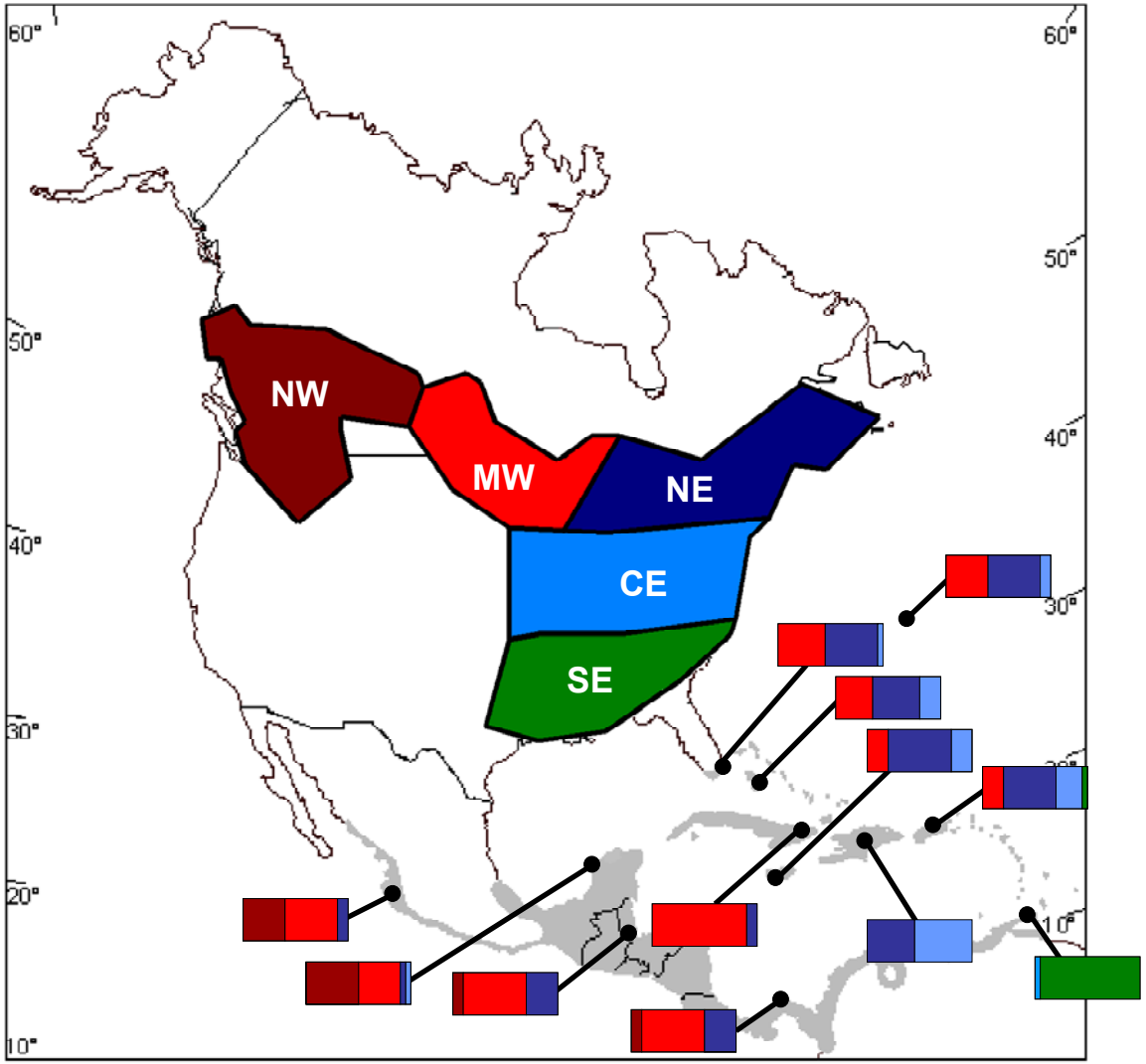
estimating patterns of connectivity

parameter	definition
dD retrix	The stable-hydrogen isotope value from tail feather of individual sampled on wintering grounds
bi	Breeding region i, where i = A…E
y*	The dD value from the tail feather
u_{bi}	The mean stable hydrogen isotope value of precipitation (corrected for discrimination) from bi
std_{bi}	The standard deviation of stable hydrogen isotopes of precipitation (corrected for discrimination) from bi
Pr(y/bi)	Probability of originating from region i based on likelihood
pi(y/bi)	Standardized probability of originating from region i based on likelihood
pi(y/bi)*	Region of most likely origin based on likelihood (highest probability)
P(bi)	Relative abundance of region i
P(bi/y)	Standarddized probability of originating from region i based on likelihood + prior
P(bi/y)*	Region of most likely origin based on likelihood + prior (highest probability)
P(bi/y)* = pi*	Is assignment without prior (likelihood only) the same as the asssignment with prior (Y or N)

estimating patterns of connectivity



estimating patterns of connectivity

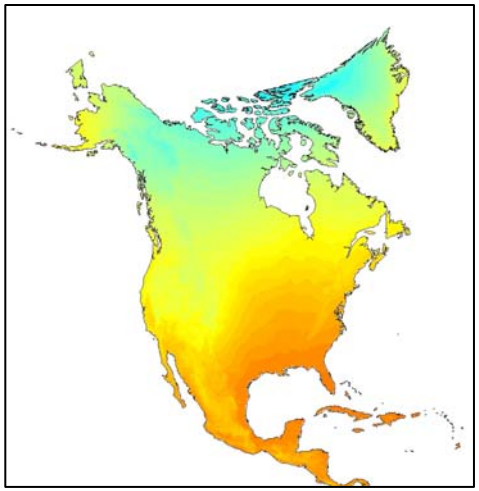


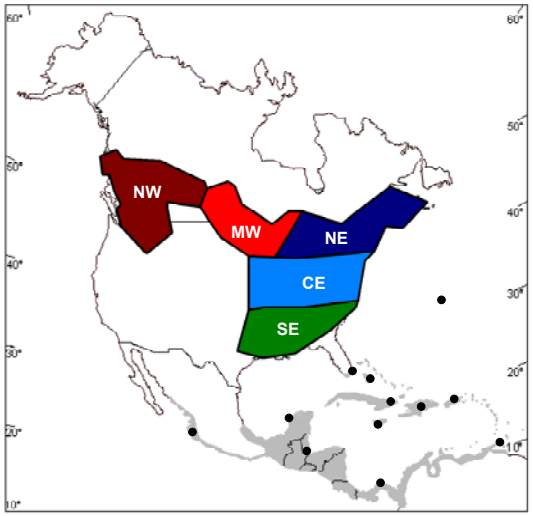
assumptions – sources of error

- what are potential sources of error?

assumptions – sources of error

δD precip ➔ δD feathers

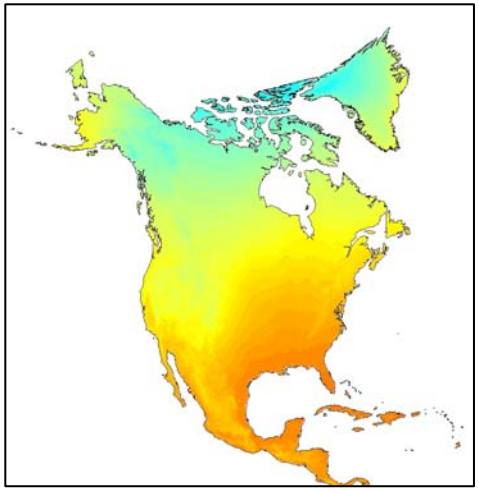


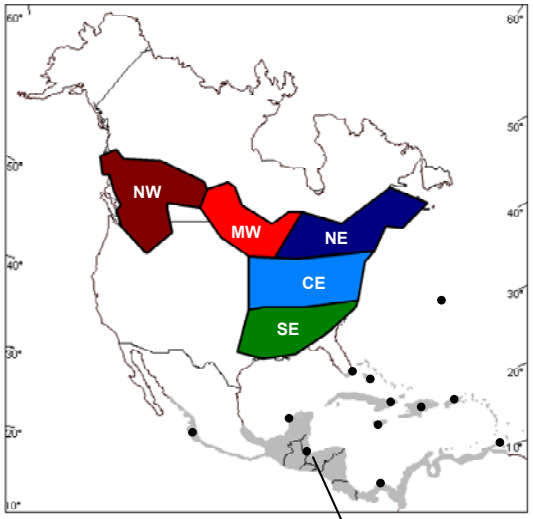


- discrimination factor

assumptions – sources of error

δD precip ➔ δD feathers

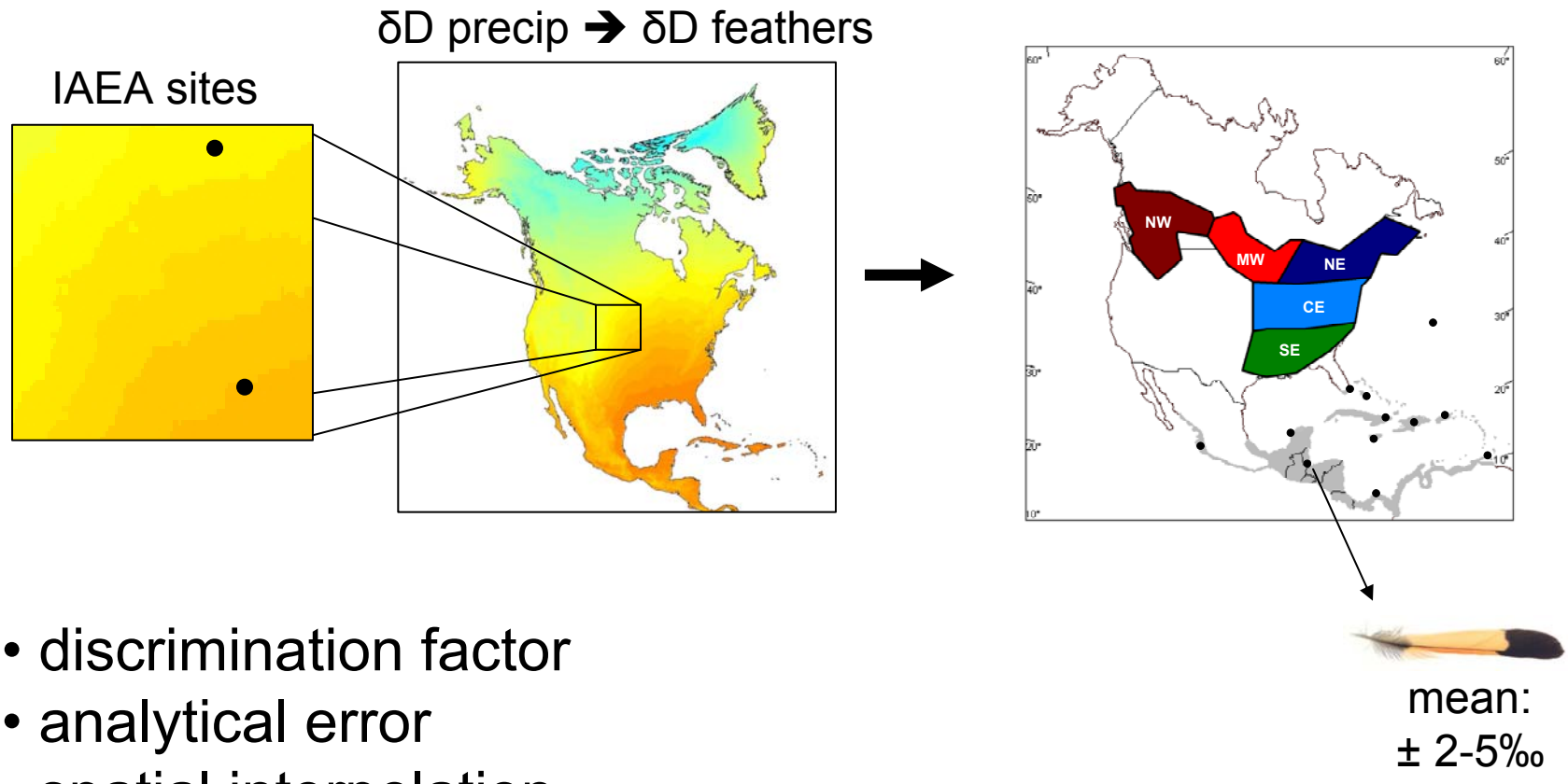




mean:
± 2-5‰

- discrimination factor
- analytical error

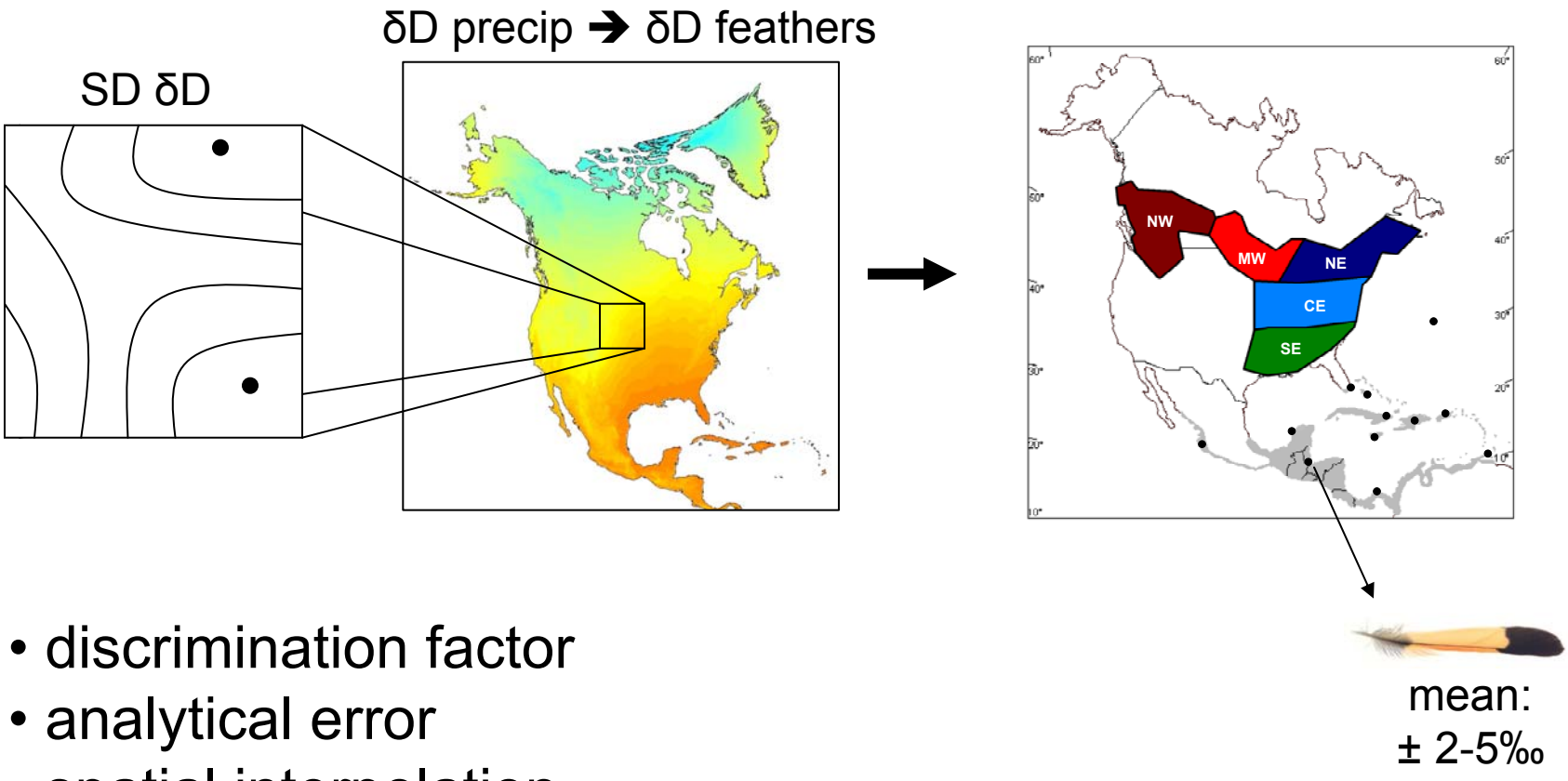
assumptions – sources of error



- discrimination factor
- analytical error
- spatial interpolation

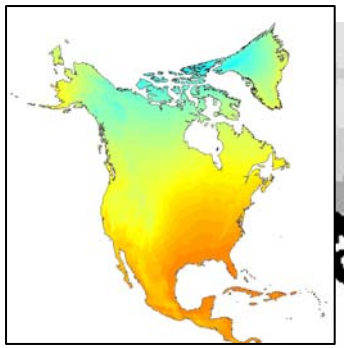
mean:
± 2-5‰

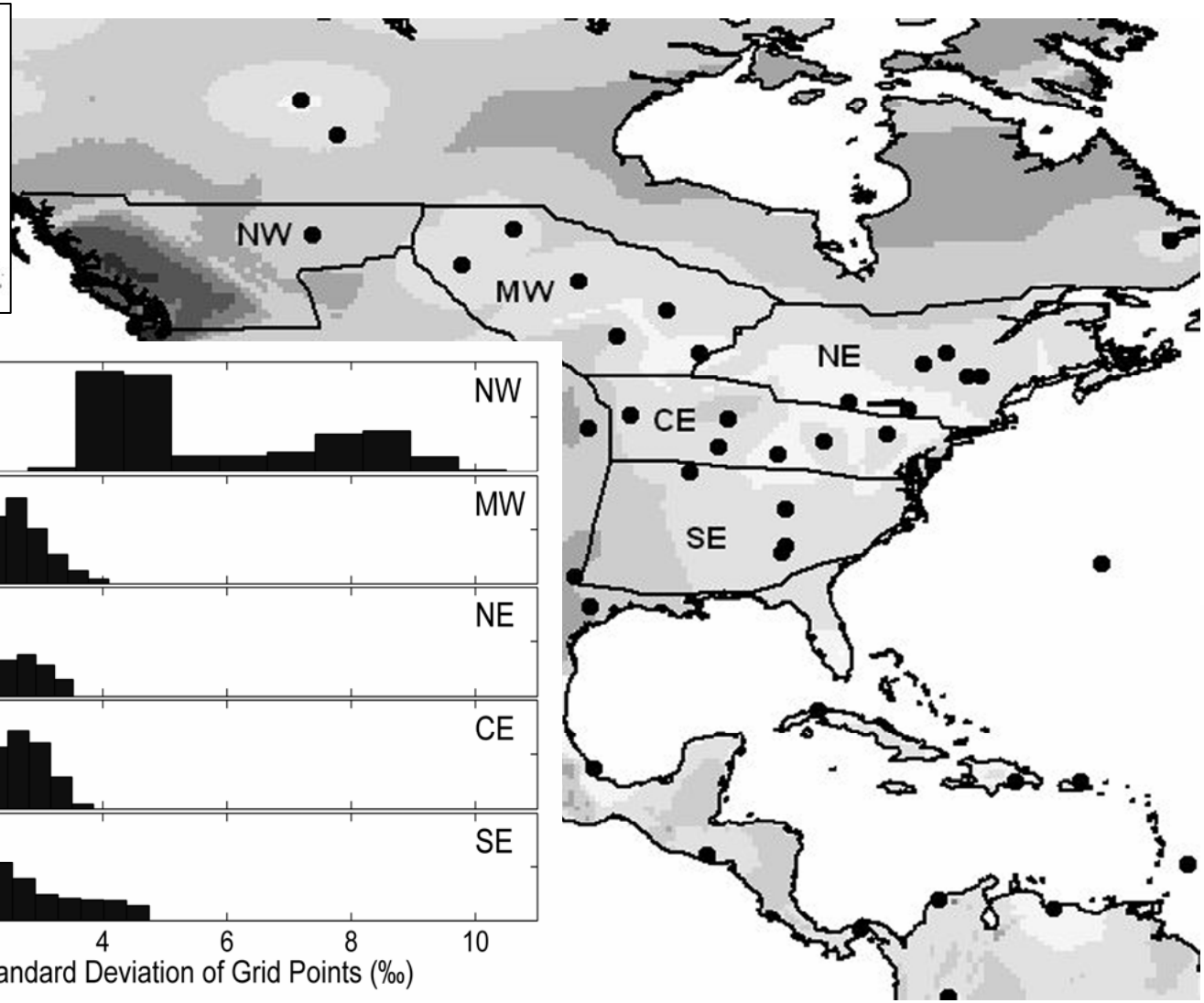
assumptions – sources of error



- discrimination factor
- analytical error
- spatial interpolation

assumptions – sources of error

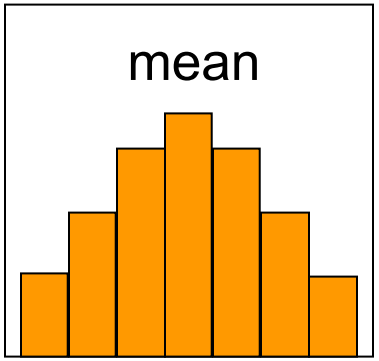




assumptions – sources of error

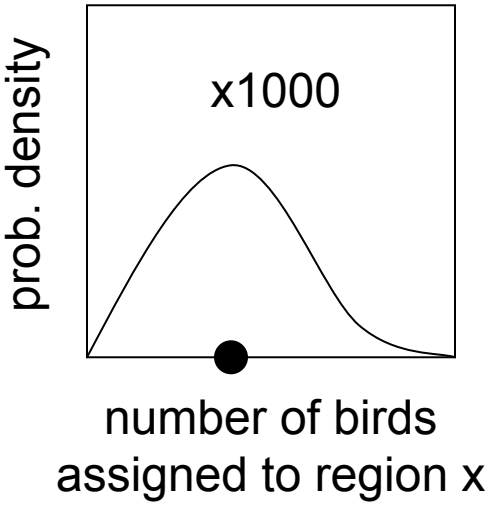
incorporating spatial interpolation error…

individual grid point



mean ± SD for each breeding region

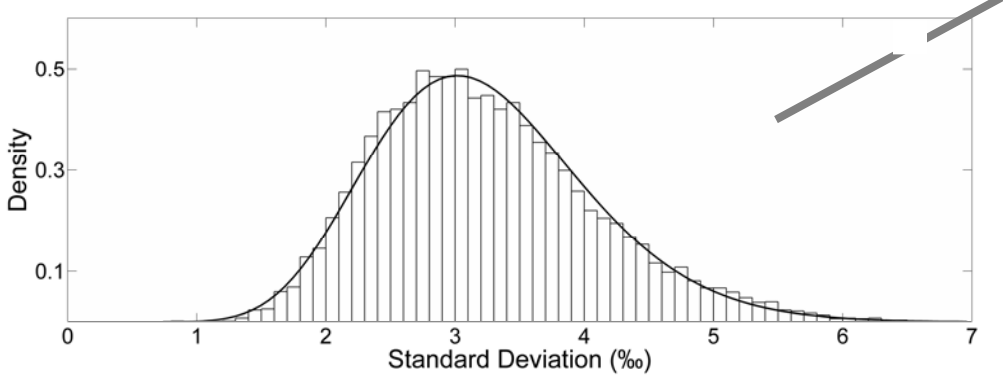
$\delta D_{feather}$

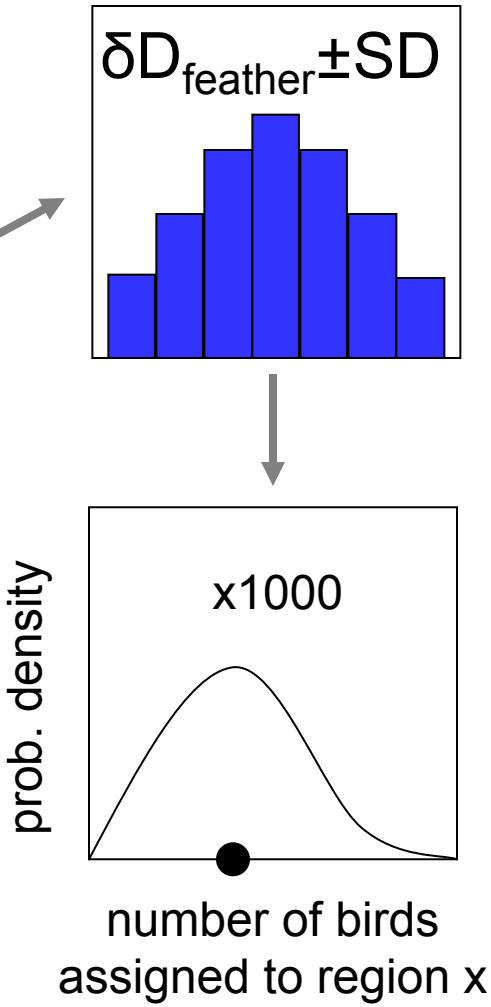


assumptions – sources of error

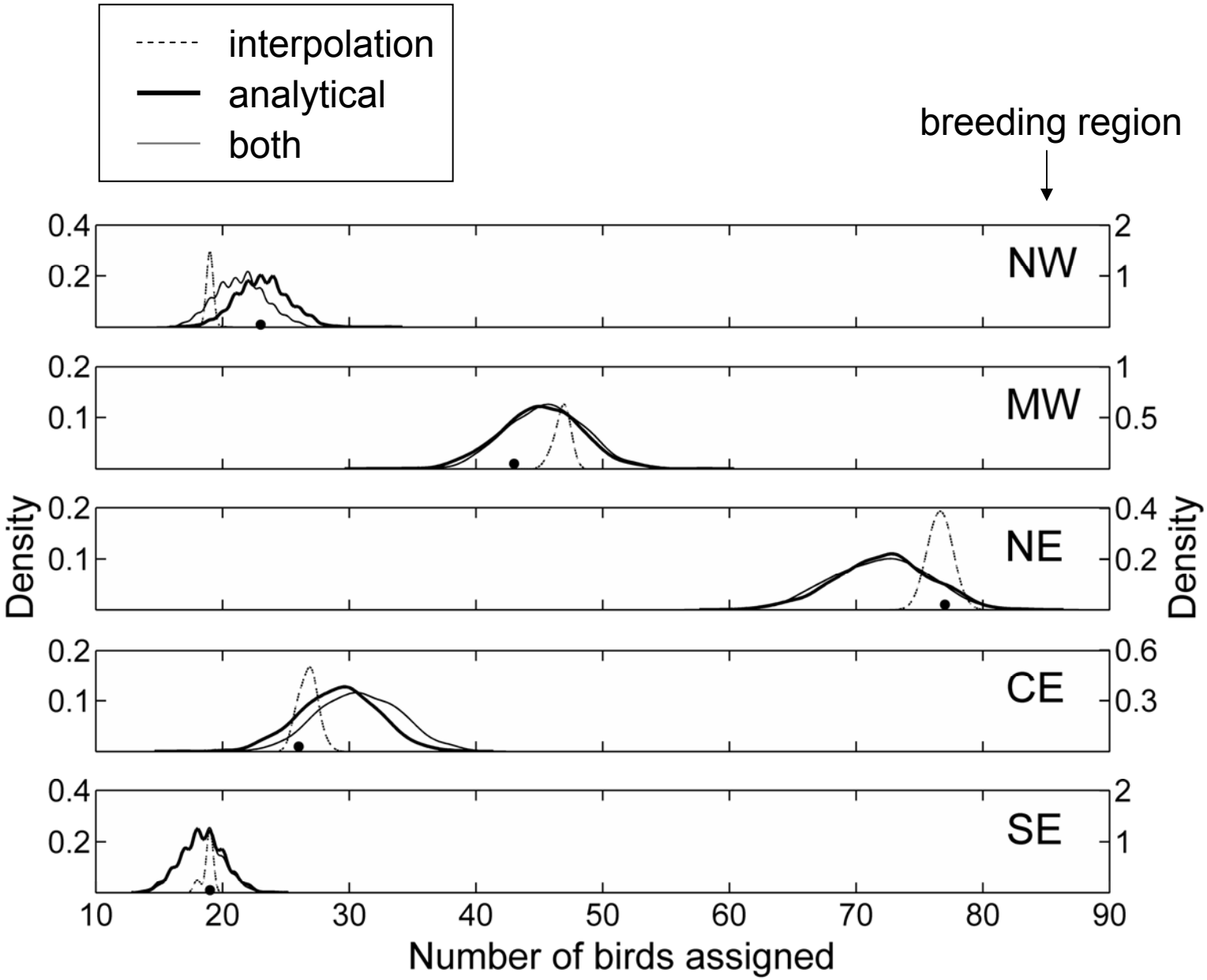
incorporating analytical error…

distribution standard deviations from analytical error

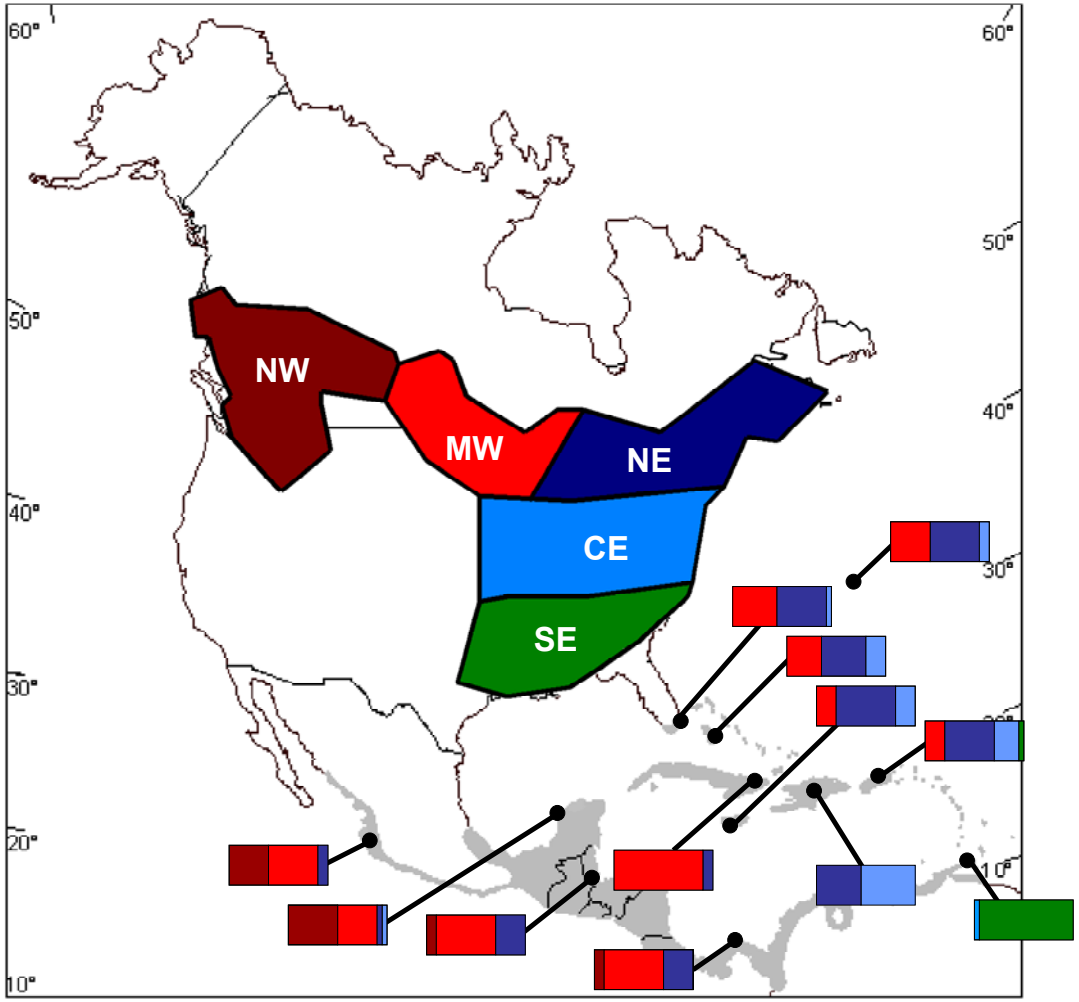




estimating patterns of connectivity



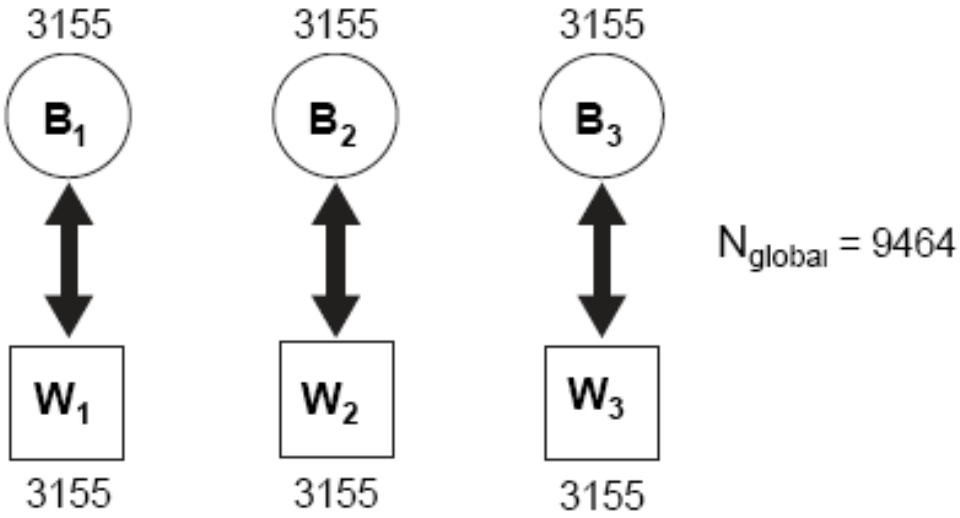
what do you do with the data?



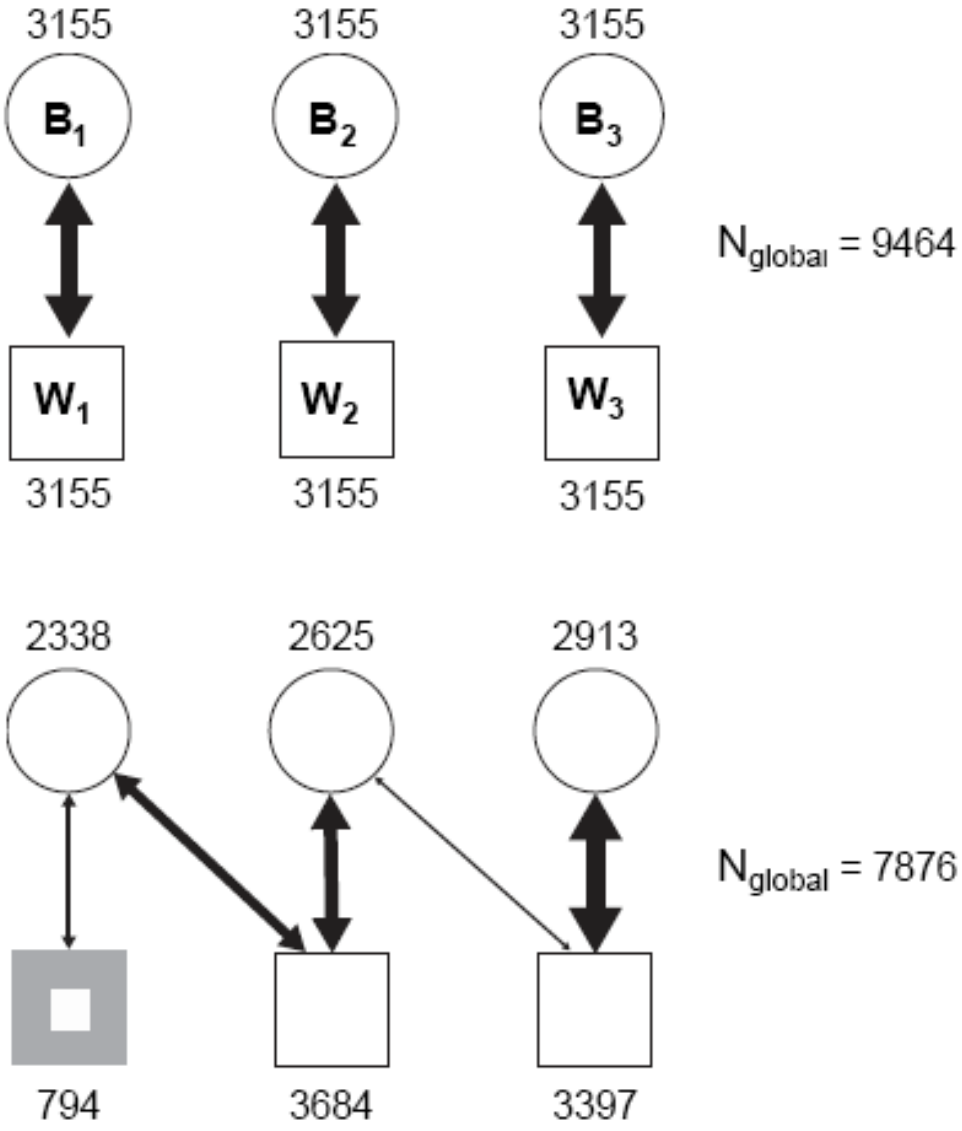
what do you do with the data?

- incorporating patterns of connectivity to predict changes in population size

migratory connectivity: applications



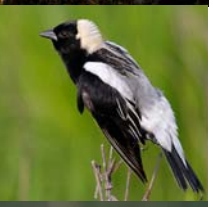
migratory connectivity: applications



what do you do with the data?

- incorporating patterns of connectivity to predict changes in population size
- develop conservation plans




conservation planning in migratory animals

- billion(s) spent annually on migratory animals
- current allocation of funds largely based on ad-hoc or ranking methods
- rarely incorporate cost, relative density, rate of habitat loss in a systematic approach

optimal allocation model for a migratory bird

- **problem**:
  how much, where, and when to acquire land?

Martin et al. (2007) *PLoS ONE*

optimal allocation model for a migratory bird

- **problem**:
  how much, where, and when to acquire land?

- **goal**:
  maximize the number of birds across the wintering range

Martin et al. (2007) *PLoS ONE*

optimal allocation model for a migratory bird

- **problem**:
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  maximize the number of birds across the wintering range

- **assumption**:
  wintering habitat limits population growth

Martin et al. (2007) *PLoS ONE*

optimal allocation model for a migratory bird

- **problem**:
  how much, where, and when to acquire land?

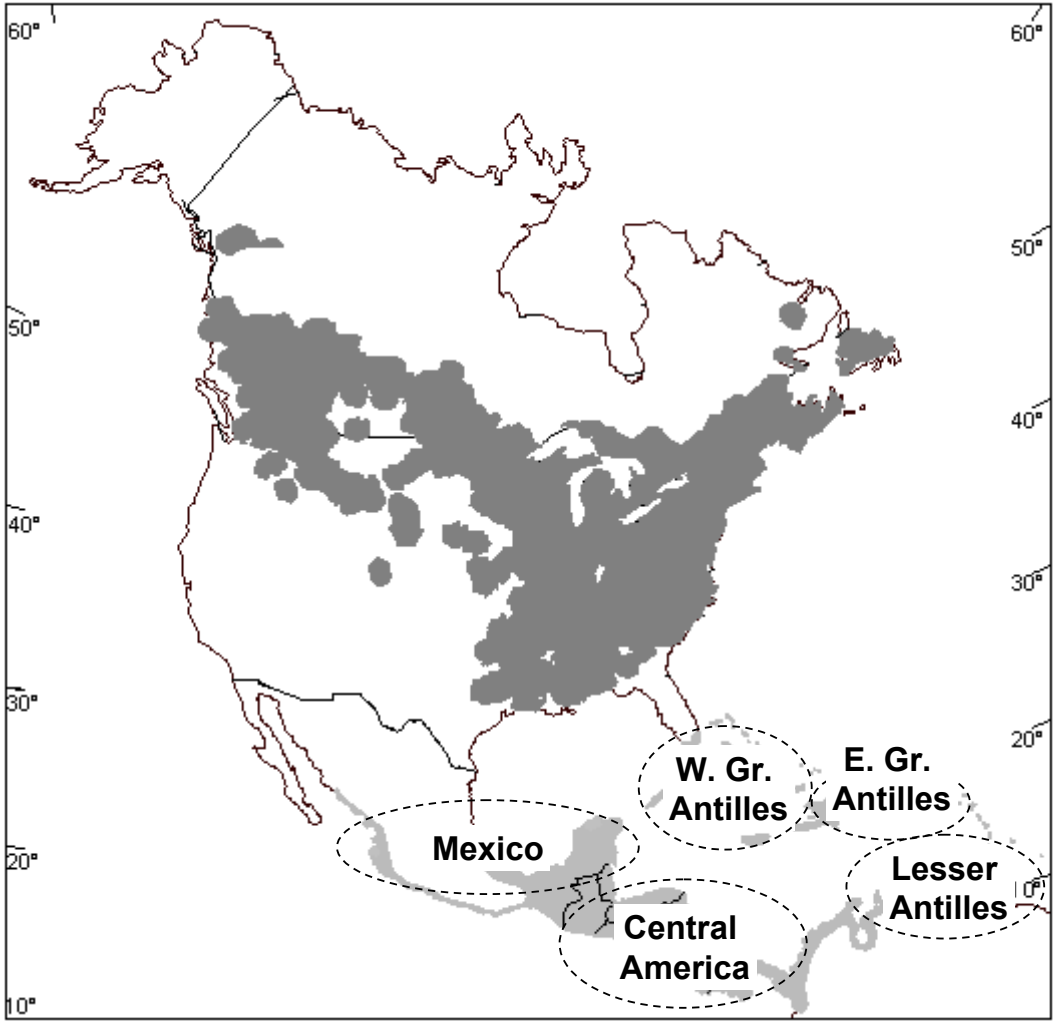
- **goal**:
  maximize the number of birds across the wintering range

- **assumption**:
  wintering habitat limits population growth

- **action**:
  with a fixed budget, purchase habitat over a 45-year period

Martin et al. (2007) *PLoS ONE*

migratory connectivity: conservation applications



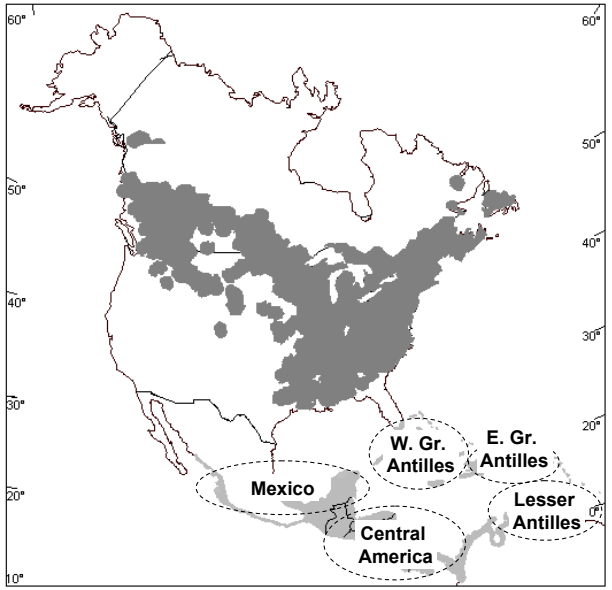
- for acquisition of winter habitat, divided wintering range into 5 regions
- compare 2 strategies (models)

Martin et al. (2007) *PLoS ONE*

migratory connectivity: conservation applications

strategy 1: optimize number of redstarts on the wintering grounds based on

- land cost
- rate of habitat loss
- redstart density



Martin et al. (2007) *PLoS ONE*

migratory connectivity: conservation applications

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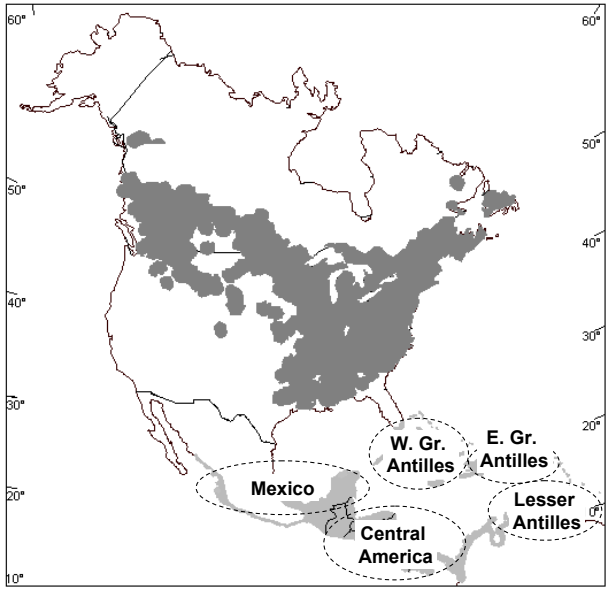


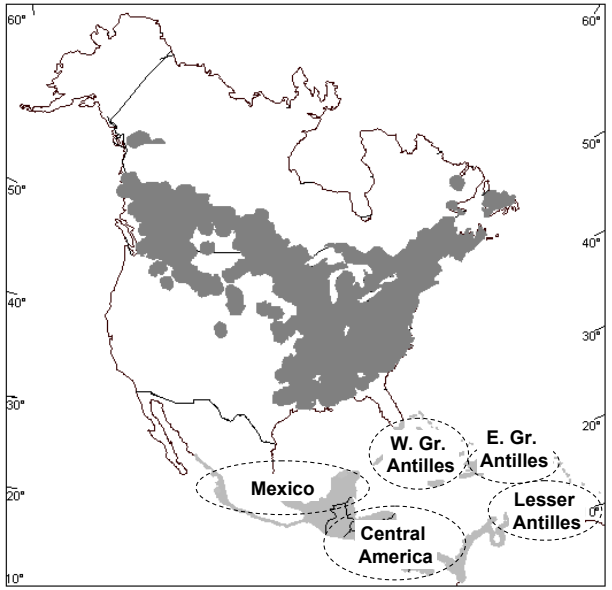
Region	Cost of habitat ($US/km^2)	Bird density (km^2)^1	Cost per bird (km^2) $US	Rate of habitat loss	Available habitat (km^2)
Western Greater Antilles	2.88 (4)	360 (2)	8,012 (4)	2.5% (1)	351
Eastern Greater Antilles	3.88 (5)	537 (1)	7,238 (3)	1.4% (3)	3523
Lesser Antilles/South America	1.85 (2)	320 (3)	5,768 (1)	0.7% (4)	2366
Mexico	2.29 (3)	215 (4)	10,645 (5)	2.1% (2)	4400
Central America	0.63 (1)	90 (5)	7,055 (2)	0.7% (4)	2207

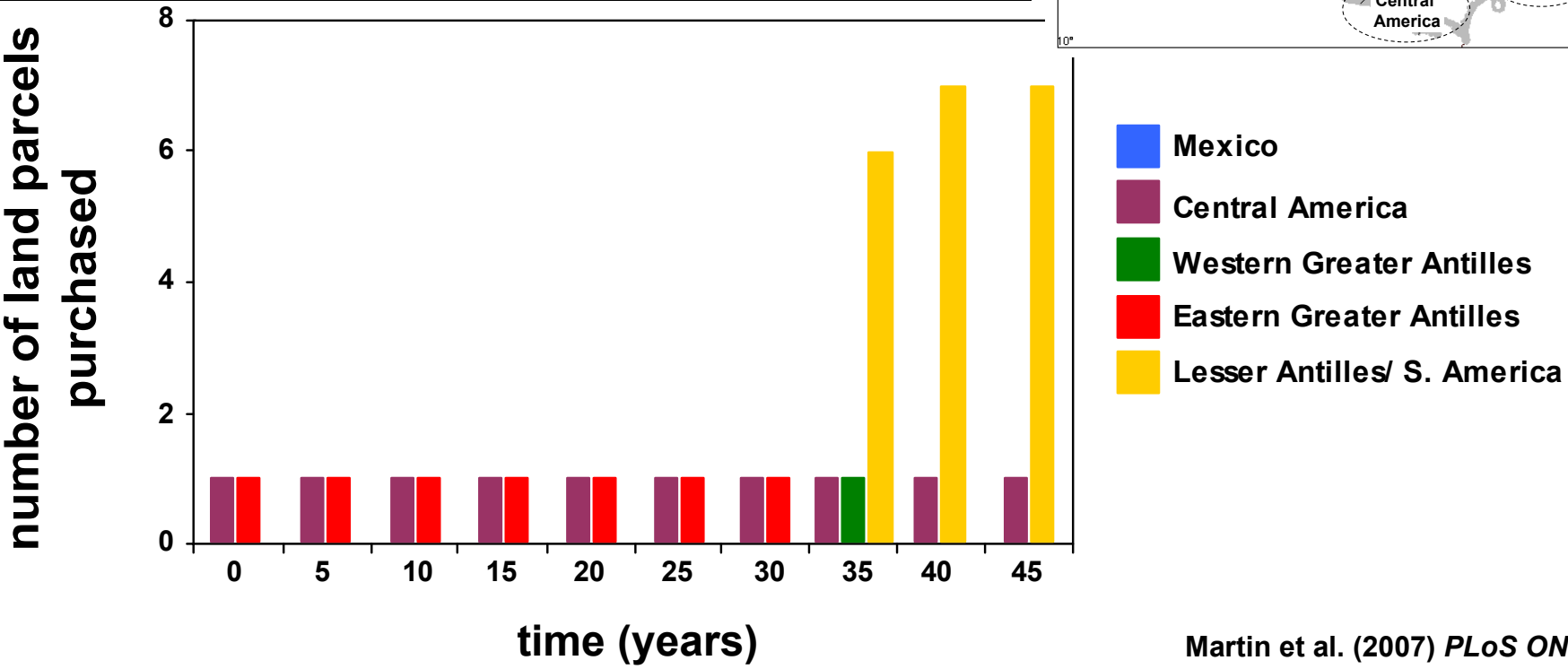
Martin et al. (2007) *PLoS ONE*

migratory connectivity: conservation applications

strategy 1: optimize number of redstarts on the wintering grounds based on

- land cost
- rate of habitat loss
- redstart density





Martin et al. (2007) *PLoS ONE*

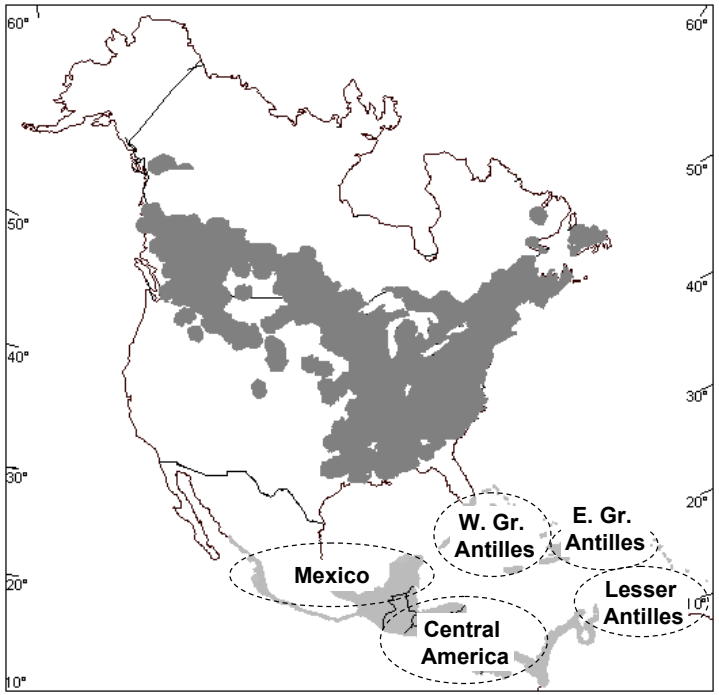
consequences for breeding populations

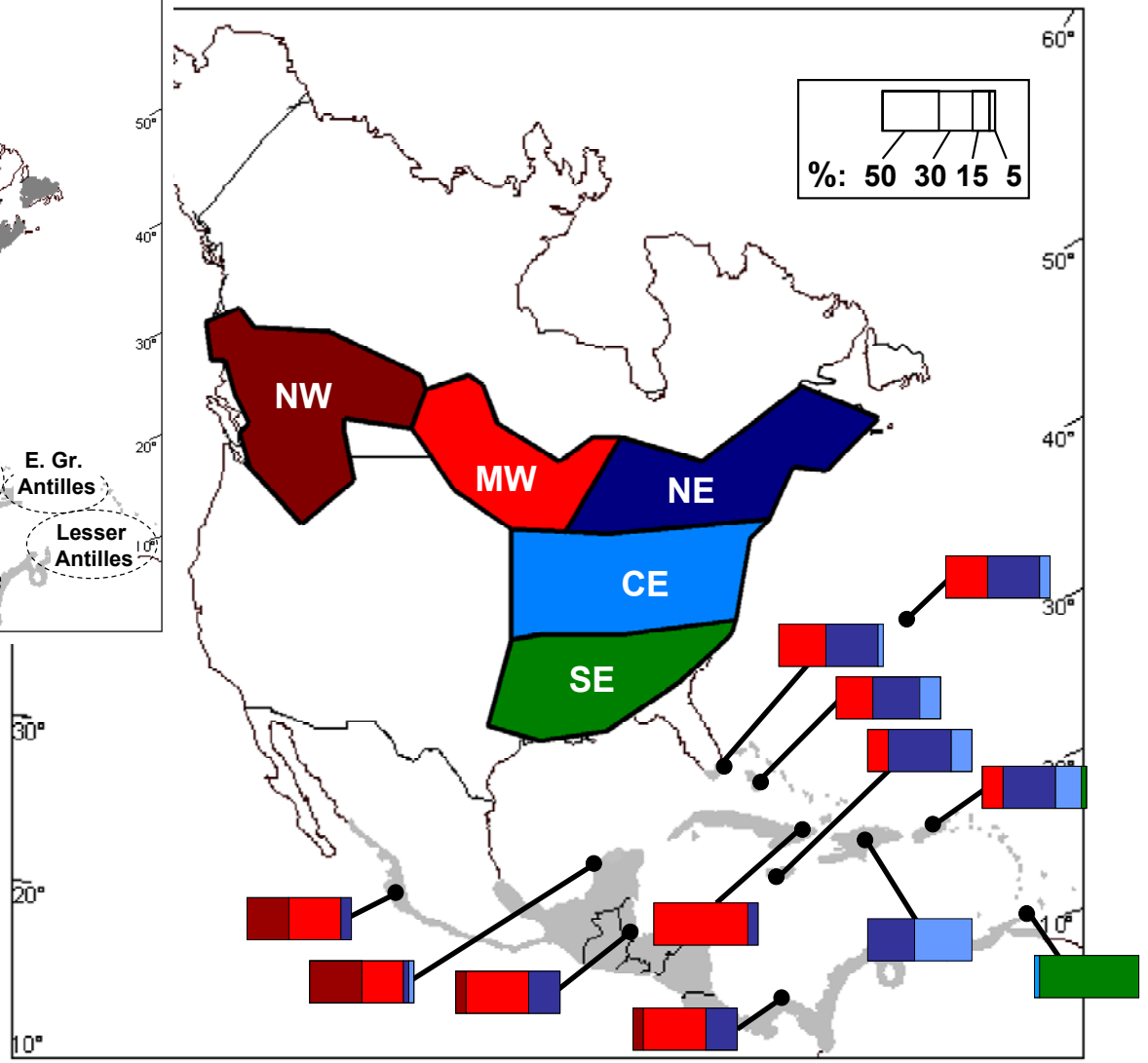
- goal:
  maximize the number of birds across the wintering range

- how does “optimizing” habitat acquisition on the wintering grounds influence breeding populations?

Martin et al. (2007) ***PLoS ONE***

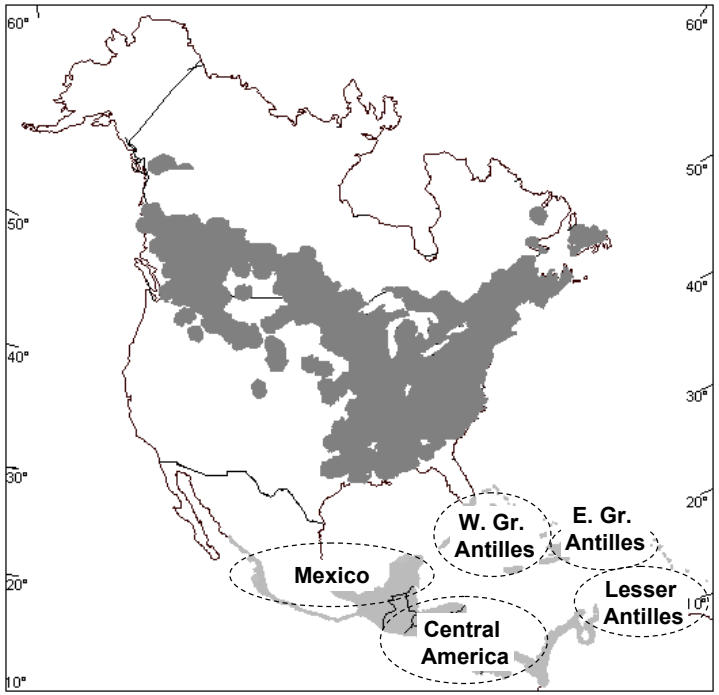
breeding consequences of strategy 1

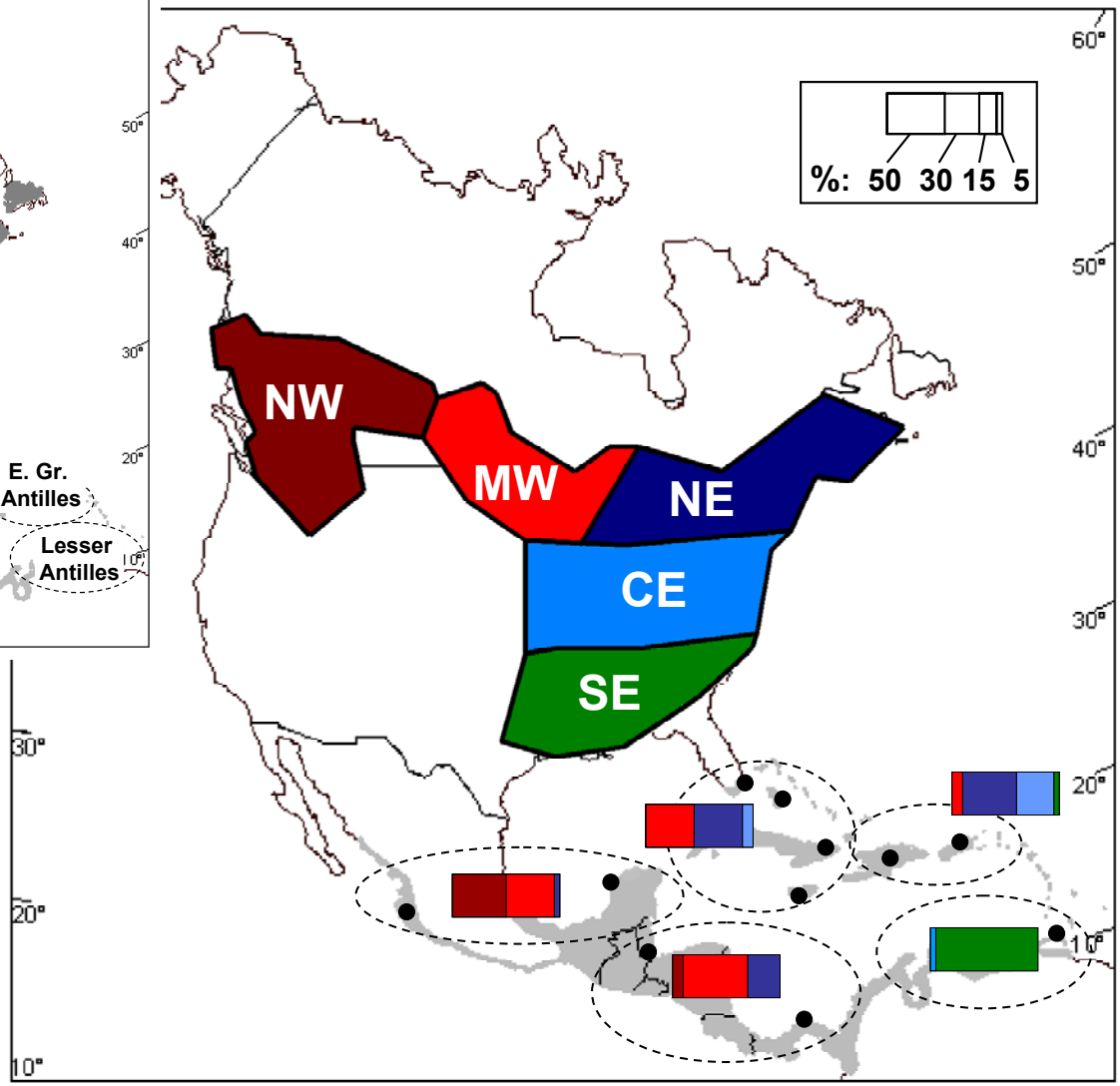




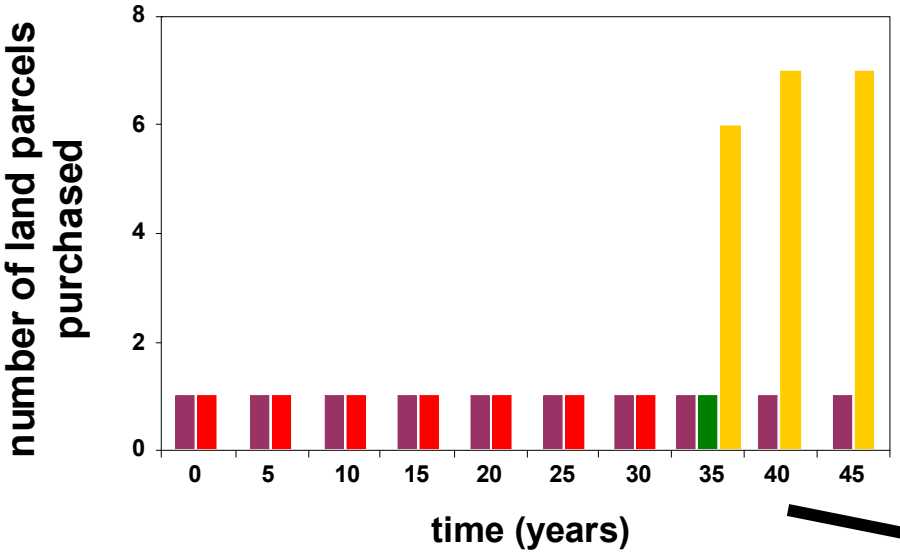
from Norris et al. 2006 *Orn Monographs*

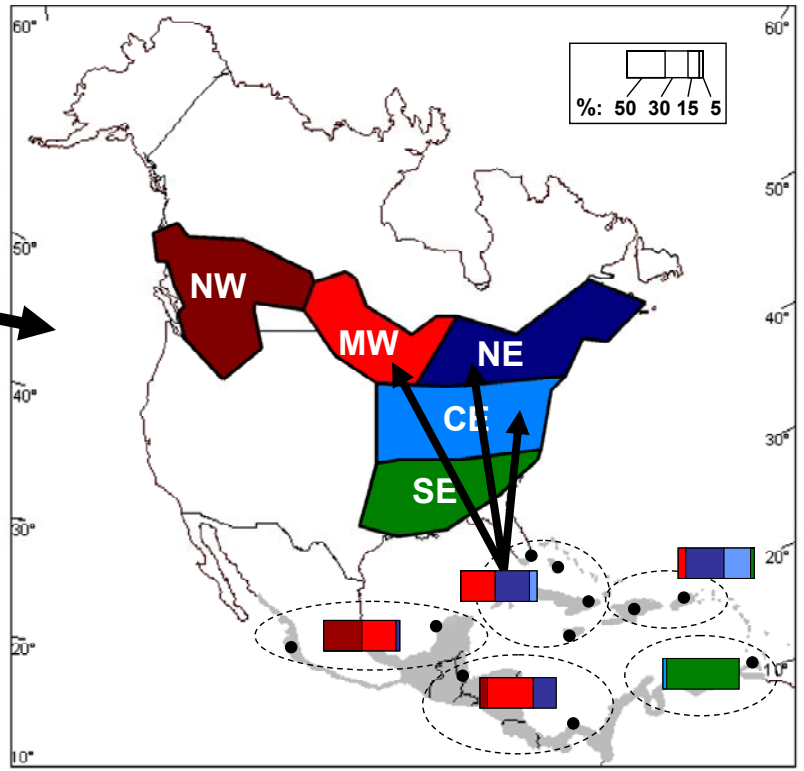
breeding consequences of strategy 1





breeding consequences of strategy 1

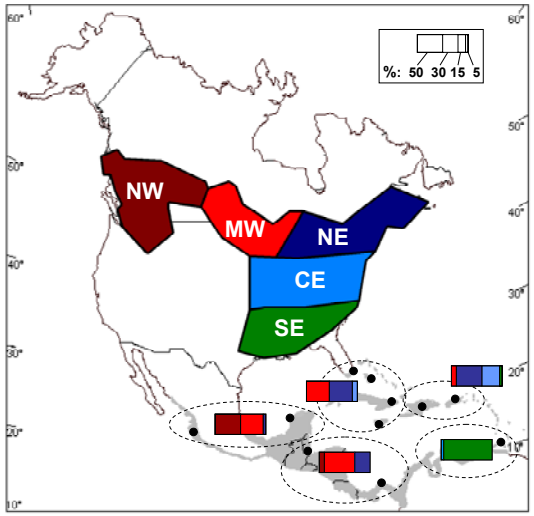


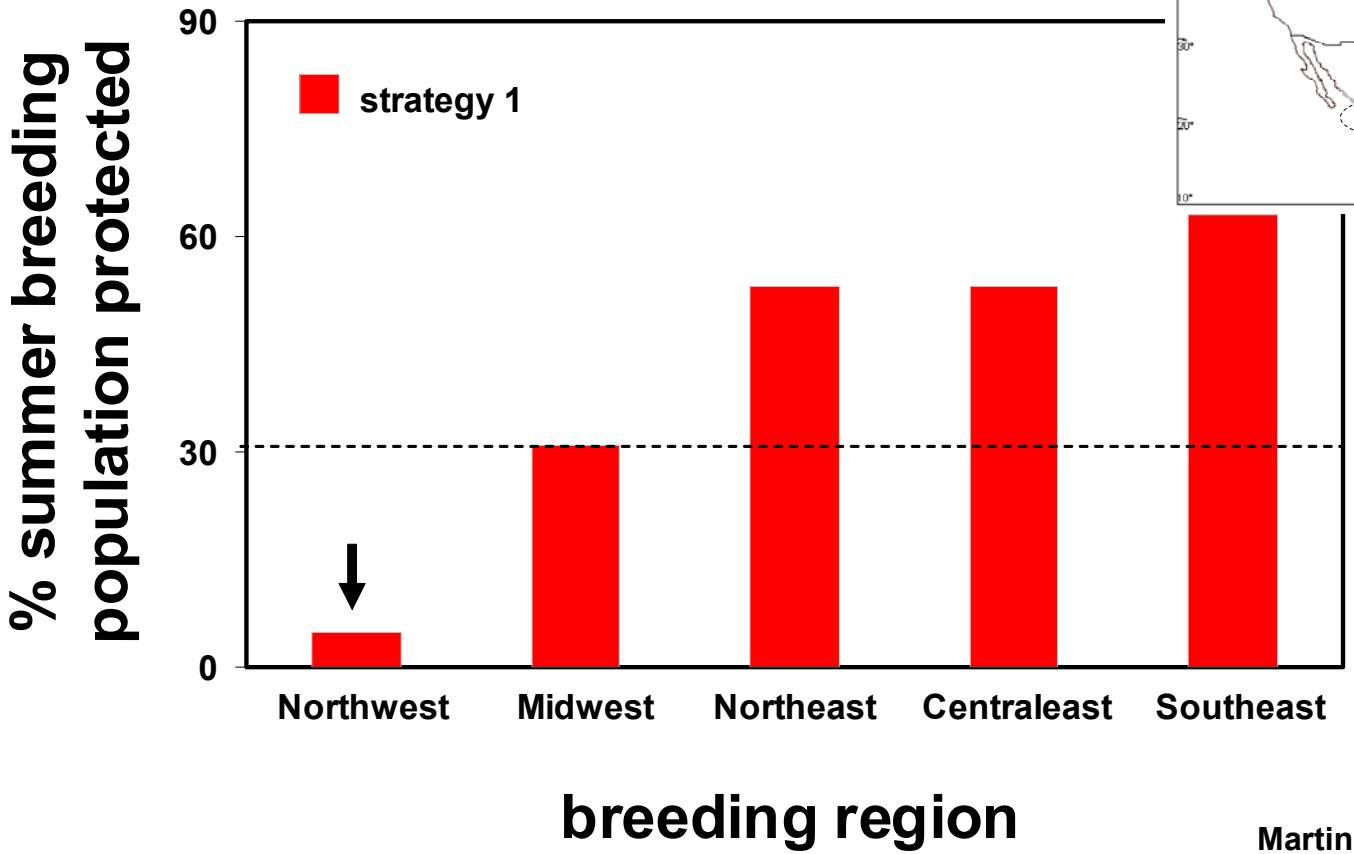


- translate % winter habitat protected to % breeding population protected based on connectivity patterns

Martin et al. (2007) *PLoS ONE*

breeding consequences of strategy 1





Martin et al. (2007) *PLoS ONE*

migratory connectivity: conservation applications

strategy 2: optimize number of redstarts on the wintering grounds based on:

- land cost
- rate of habitat loss
- redstart density

Martin et al. (2007) *PLoS ONE*

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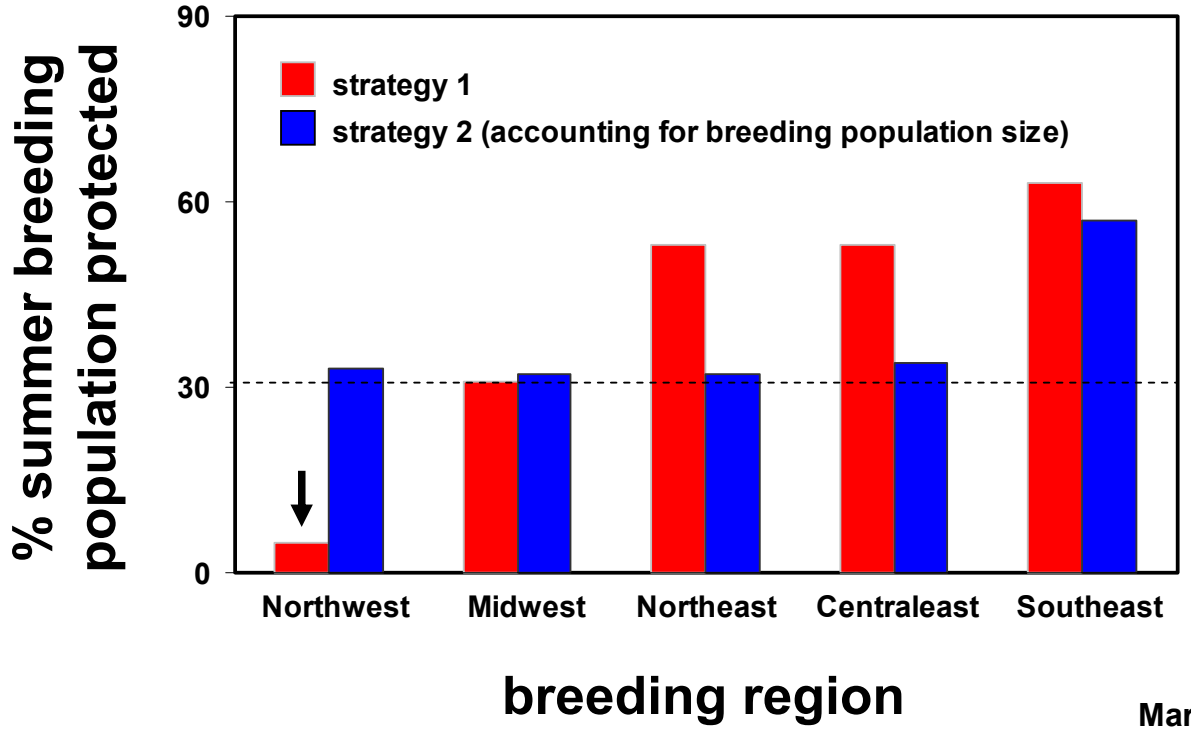

Martin et al. (2007) *PLoS ONE*

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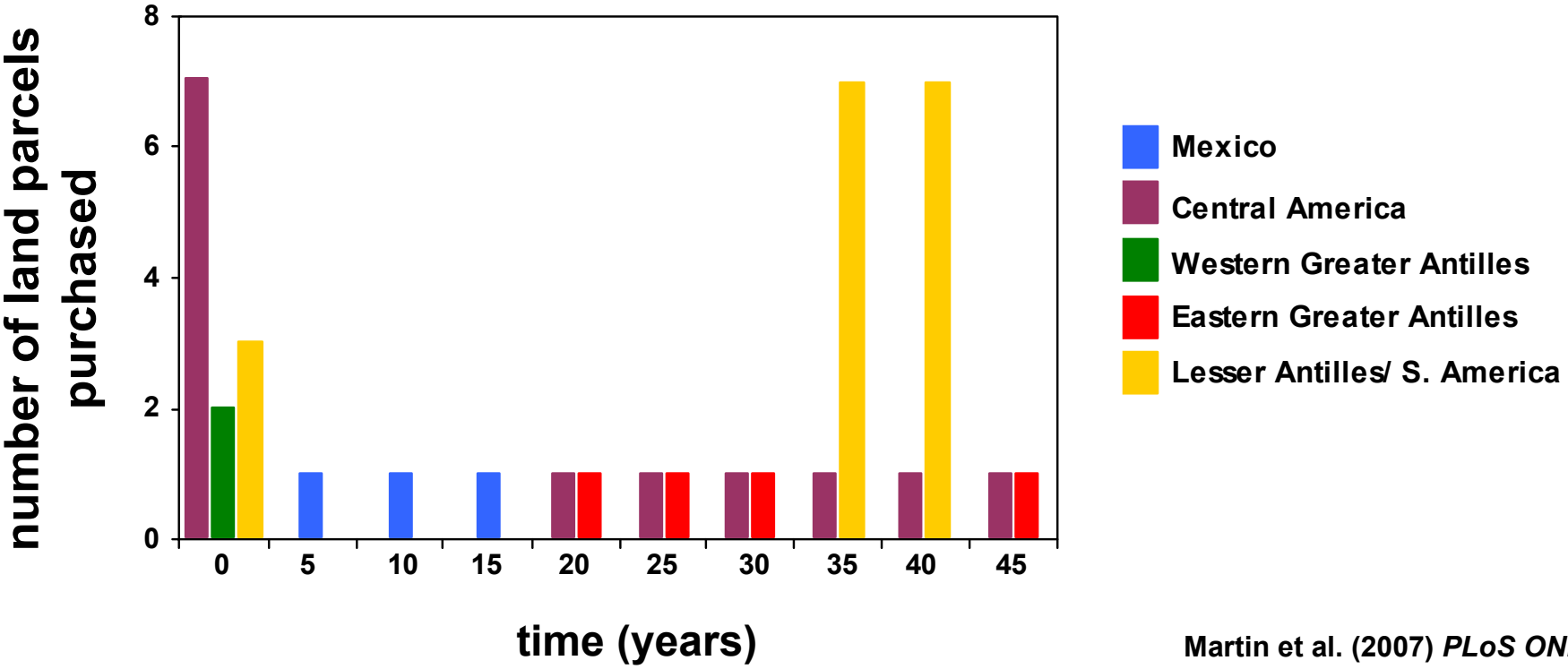

Martin et al. (2007) *PLoS ONE*

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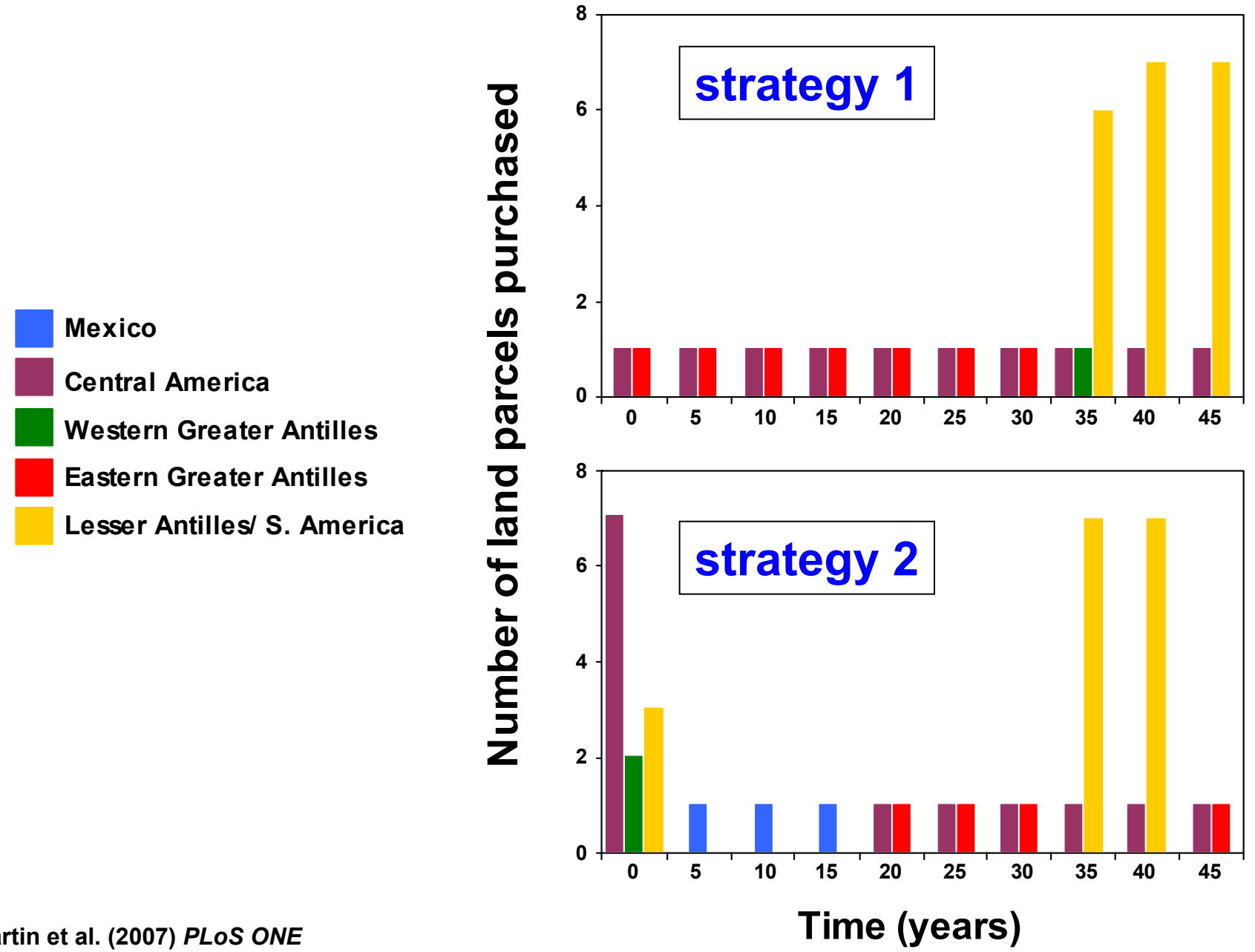
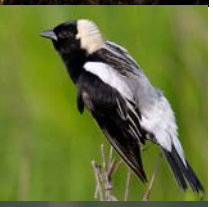


Martin et al. (2007) *PLoS ONE*




conclusions

- information on migratory connectivity is essential for developing effective conservation plans and predicting changes in population sizes
- conservation solutions would not be possible based on ranking method
- general approach can be modified to include stopover sites, multiple species, & species-at-risk

estimating patterns of connectivity

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