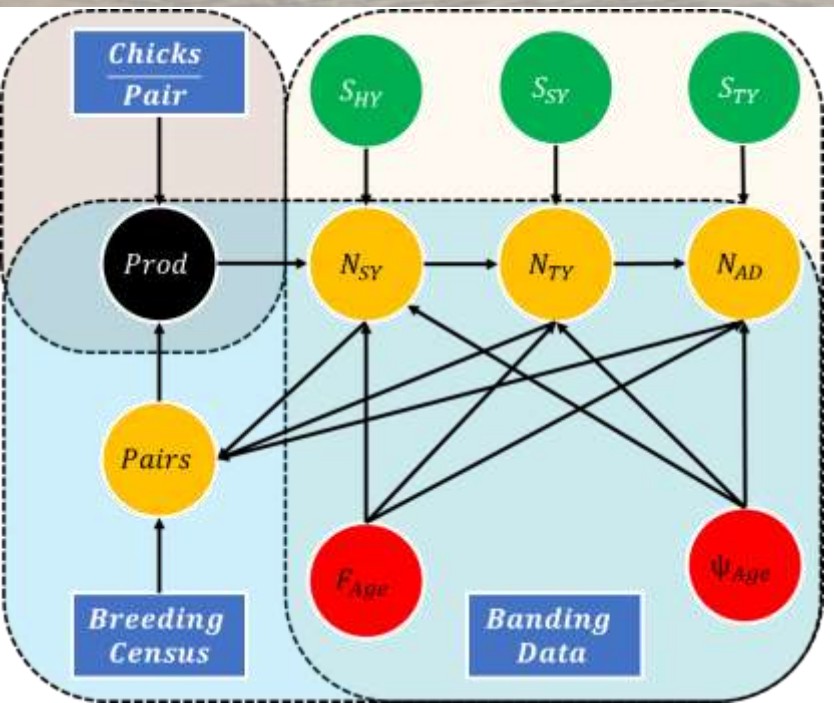
The use of population models to assist in American oystercatcher conservation planning.



Dan Gibson & Thomas Riecke
American Oystercatcher Working Group
12/7/2022

American OYSTERCATCHER WORKING GROUP

Ducks Unlimited Canada

DELTA WATERFOWL

UNIVERSITY OF SASKATCHEWAN

UNIVERSITY OF MONTANA

Outline

1. Primer on integrated population models.
2. How are IPMs being used in conservation decision making.
3. IPMS and AMOY (and you!)
4. Discussion about future goals

While I am talking …

Population Models 101

$$N_{t+1} = N_t \lambda_t$$

Population Models 101

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

Population Models 101

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t + I_t - E_t$$

Population Models 101

$$N_{t+1} = N_t \lambda_t$$

$$\lambda_t = S_t + R_t + I_t - E_t$$

$$R_t = (BP_t \times NS_t) \times CS_t \times HY\ S_t$$

$$S_t = SW_t \times SS_t$$

Integrated Population Models 101

Informed by some type of population census

N_t

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

S_t

Informed by Banding Data

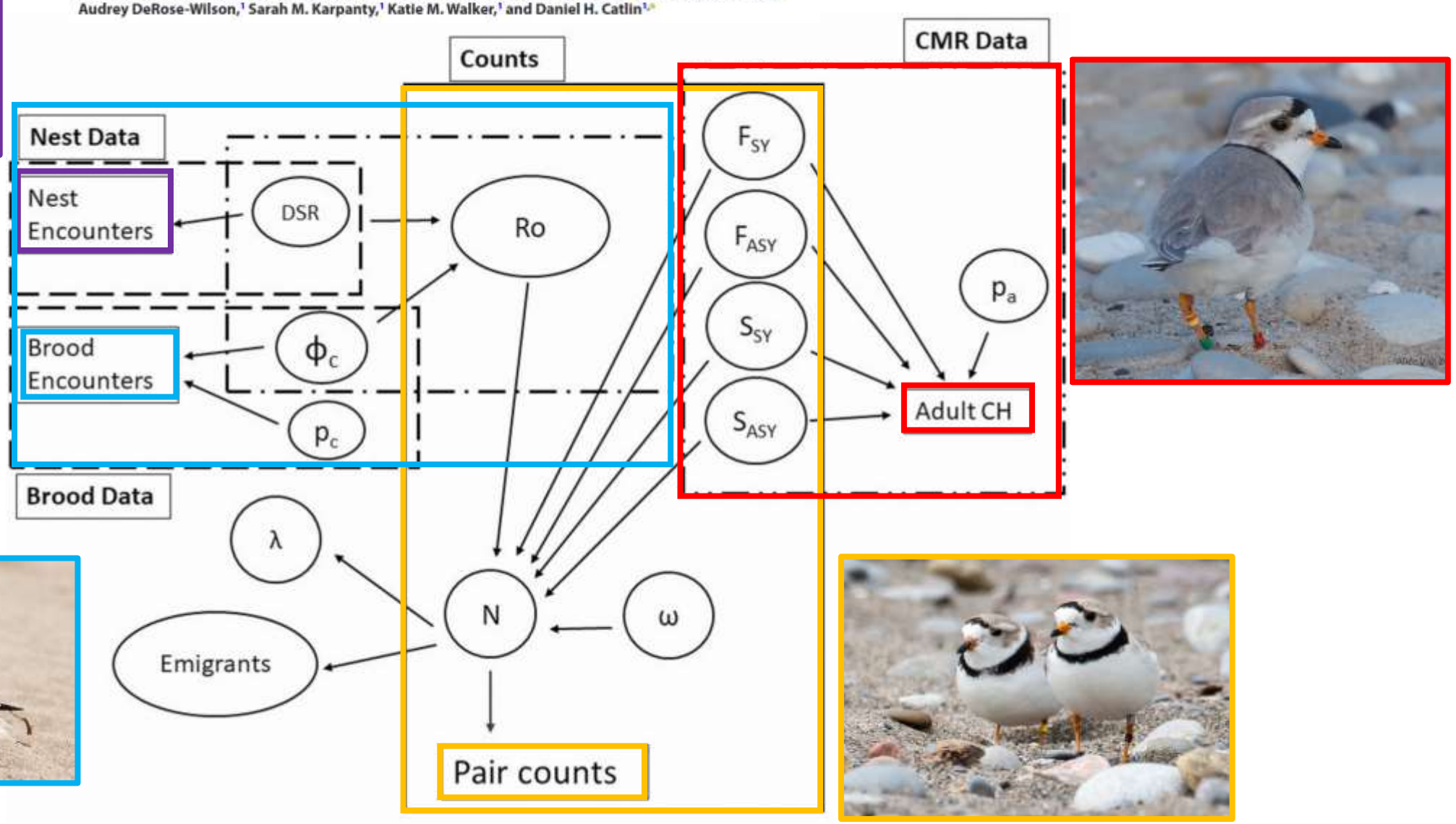
R_t

Informed by some type of post-breeding sample

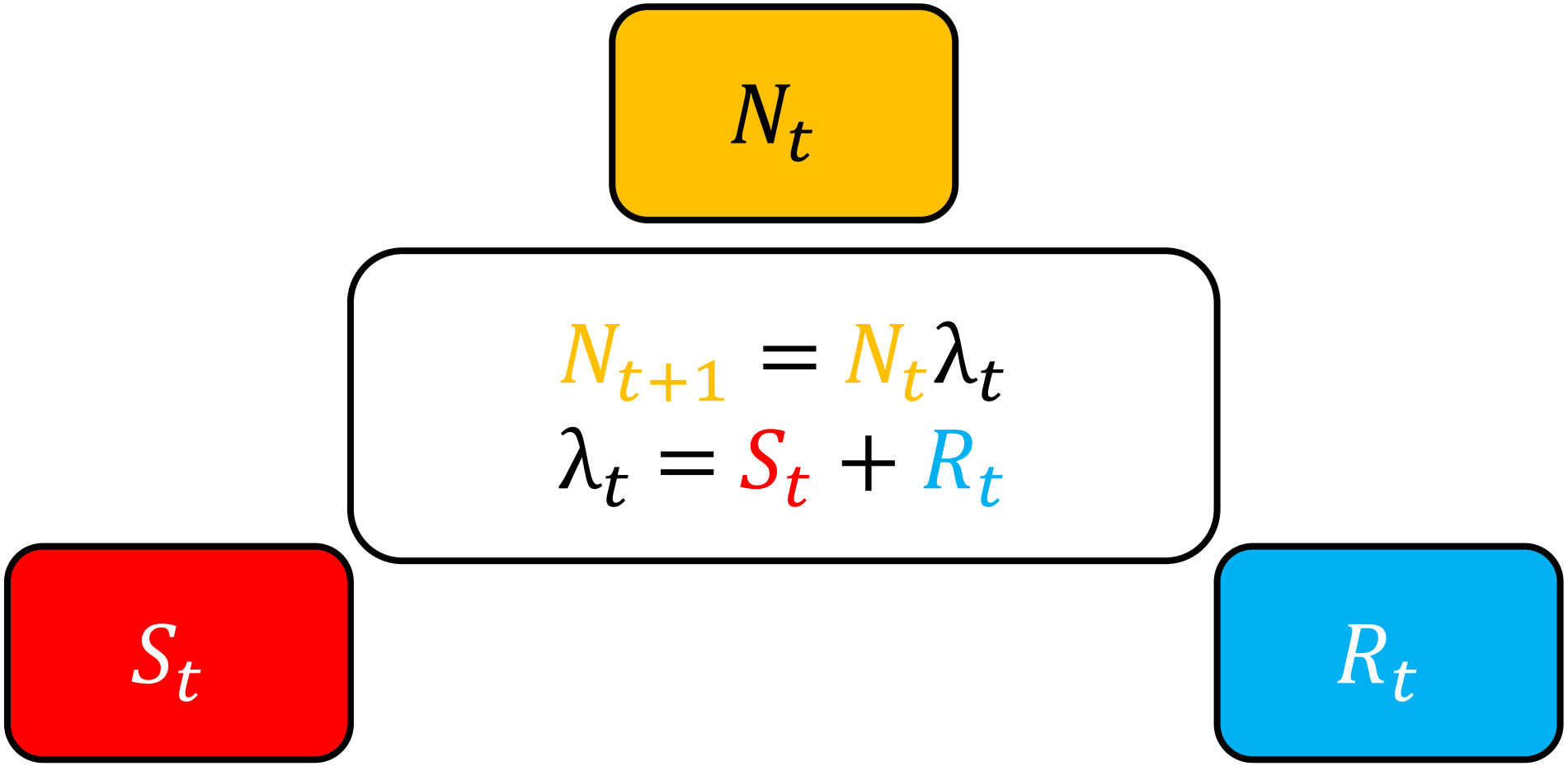
Integrated Population Models 101

Piping Plover population increase after Hurricane Sandy mediated by immigration and reproductive output

Samantha G. Robinson,[1,*] Daniel Gibson,[1,*] Thomas V. Riecke,[2] James D. Fraser,[1] Henrietta A. Bellman,[1] Audrey DeRose-Wilson,[1] Sarah M. Karpanty,[1] Katie M. Walker,[1] and Daniel H. Catlin[1,*]



Integrated Population Models 101: *Benefits?*



Integrated Population Models 101: *Benefits?*

Why are IPM being used?

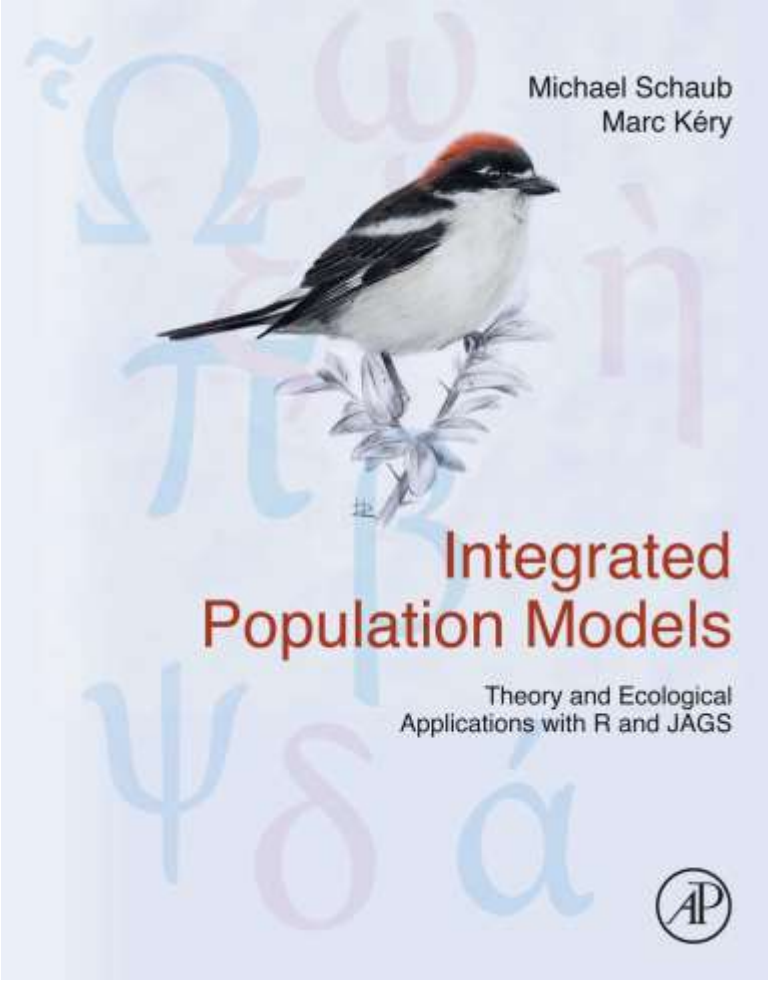
1. Increased precision of parameter estimates.

2. Estimation of parameters in the absence of data.

   CAUTION: USE AT OWN RISK

3. Estimation of process correlation.

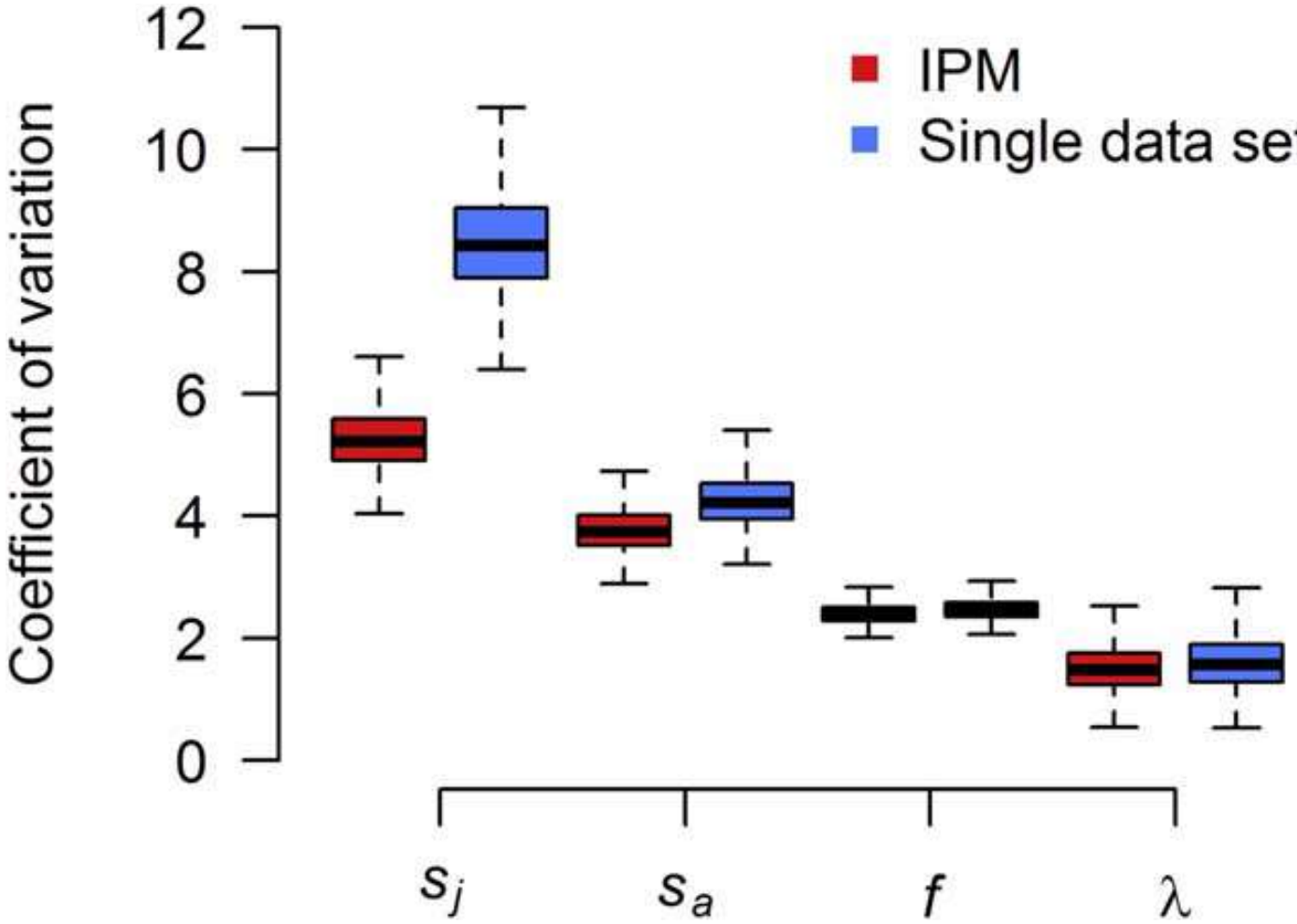
4. Increased capacity to determine how population structure changes over time.

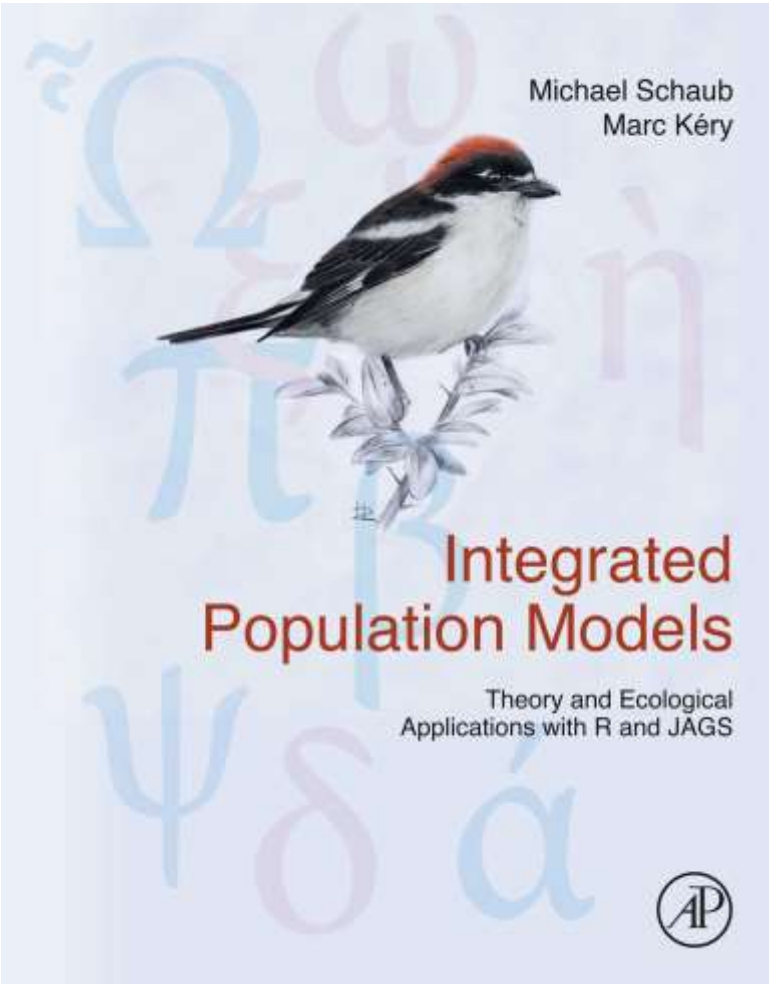


Integrated Population Models 101: *Precision*

1) Increased Precision of Parameter Estimates

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = SA_t + f_t \times SJ_t$$





Integrated Population Models 101: *Missing Data*

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

2) Estimation of parameters in the absence of data

N_t

Breeding Population Census

$\{100, 112, 117, 119, 123, 131, 139, 144, 144, 146, 164\}$

R_t

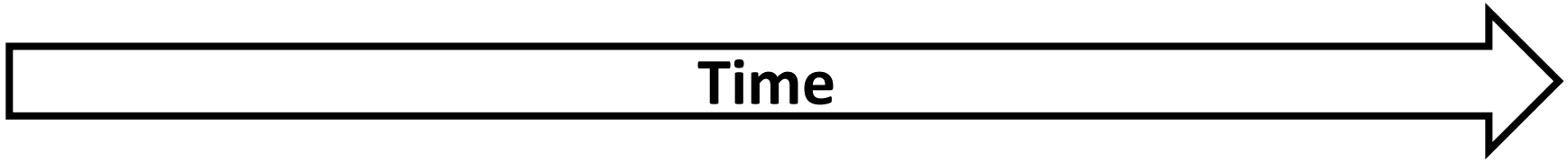
Recruitment Rate

$\{0.26, 0.20, 0.30, 0.27, 0.25, 0.23, 0.23, 0.21, 0.24, 0.31\}$

S_t

Adult Survival Estimates

$\{0.86, 0.85, 0.71, 0.76, 0.81, 0.83, 0.80, 0.79, 0.78, 0.81\}$



2) Estimation of parameters in the absence of data

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

N_t

$\{100, \underline{\mathbf{X}}, \_\_\_\_, \_\_\_\_, 123, \_\_\_\_, 139, 144, \_\_\_\_, 146, 164\}$

R_t

$\{0.26, \_\_\_\_, 0.30, \_\_\_\_, 0.25, \_\_\_\_, 0.23, \_\_\_\_, 0.24, \_\_\_\_\}$

S_t

$\{0.86, 0.85, 0.71, 0.76, 0.81, 0.83, 0.80, 0.79, 0.78, 0.81\}$

Time

Integrated Population Models 101: *Missing Data*

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

$$\mathbf{X} = (\mathbf{0.86} + \mathbf{0.26}) \times \mathbf{100}$$

N_t $\{\mathbf{100}, \underline{\mathbf{X}}, \_\_\_\_, \_\_\_\_, 123, \_\_\_\_, 139, 144, \_\_\_\_, 146, 164\}$

R_t $\{\mathbf{0.26}, \_\_\_\_, 0.30, \_\_\_\_, 0.25, \_\_\_\_, 0.23, \_\_\_\_, 0.24, \_\_\_\_\}$

S_t $\{\mathbf{0.86}, 0.85, 0.71, 0.76, 0.81, 0.83, 0.80, 0.79, 0.78, 0.81\}$

Integrated Population Models 101: *Missing Data*

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Adult Survival Estimates

$\{0.86, 0.85, 0.71, 0.76, 0.81, 0.83, 0.80, 0.79, 0.78, 0.81\}$

Time

Integrated Population Models 101: *Missing Data*

Informed by some type of population census

N_t

$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

S_t

Informed by Banding Data

R_t

Not Collected

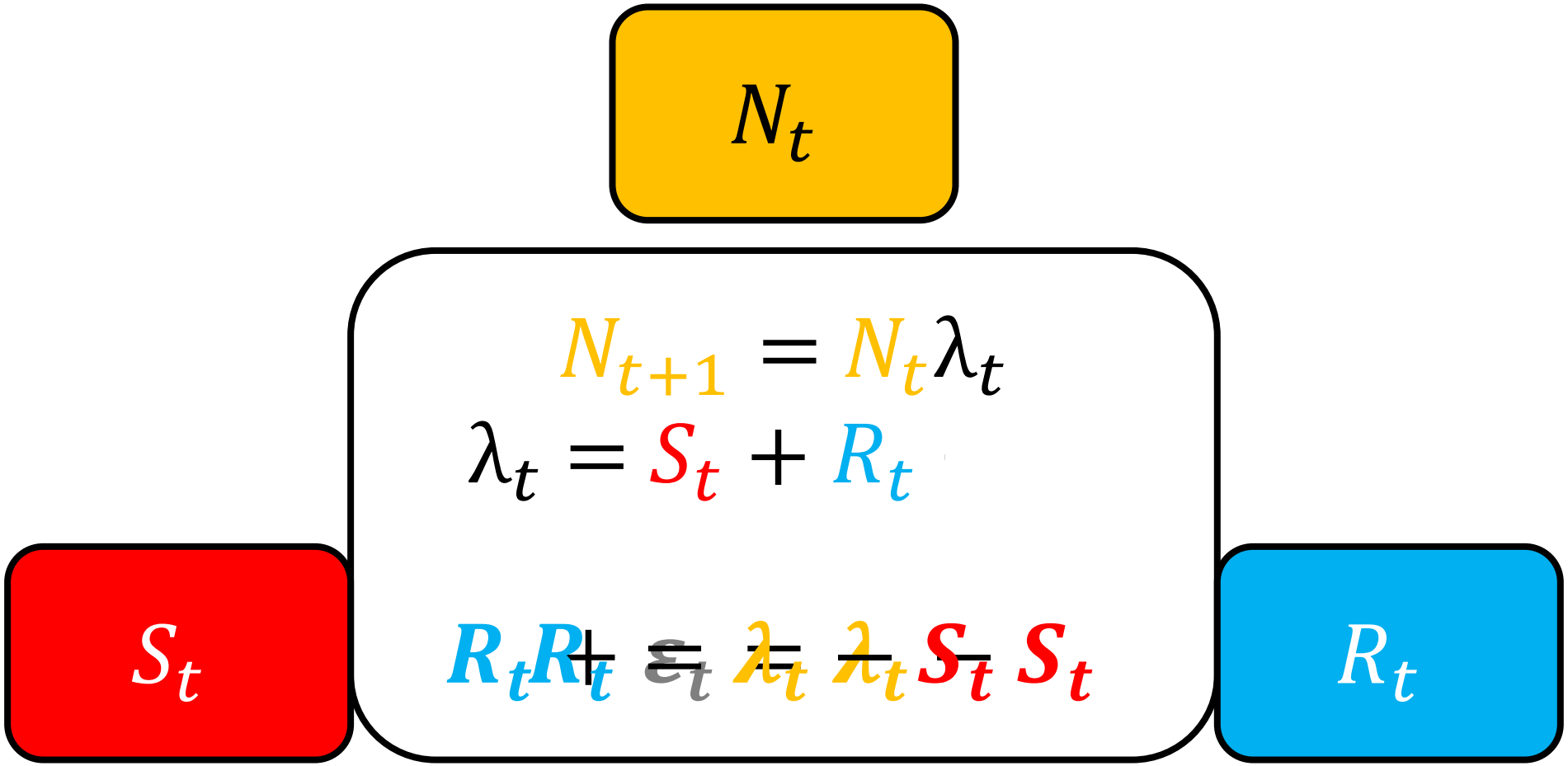
$$N_{t+1} = N_t \lambda_t$$
$$\lambda_t = S_t + R_t$$

Derive

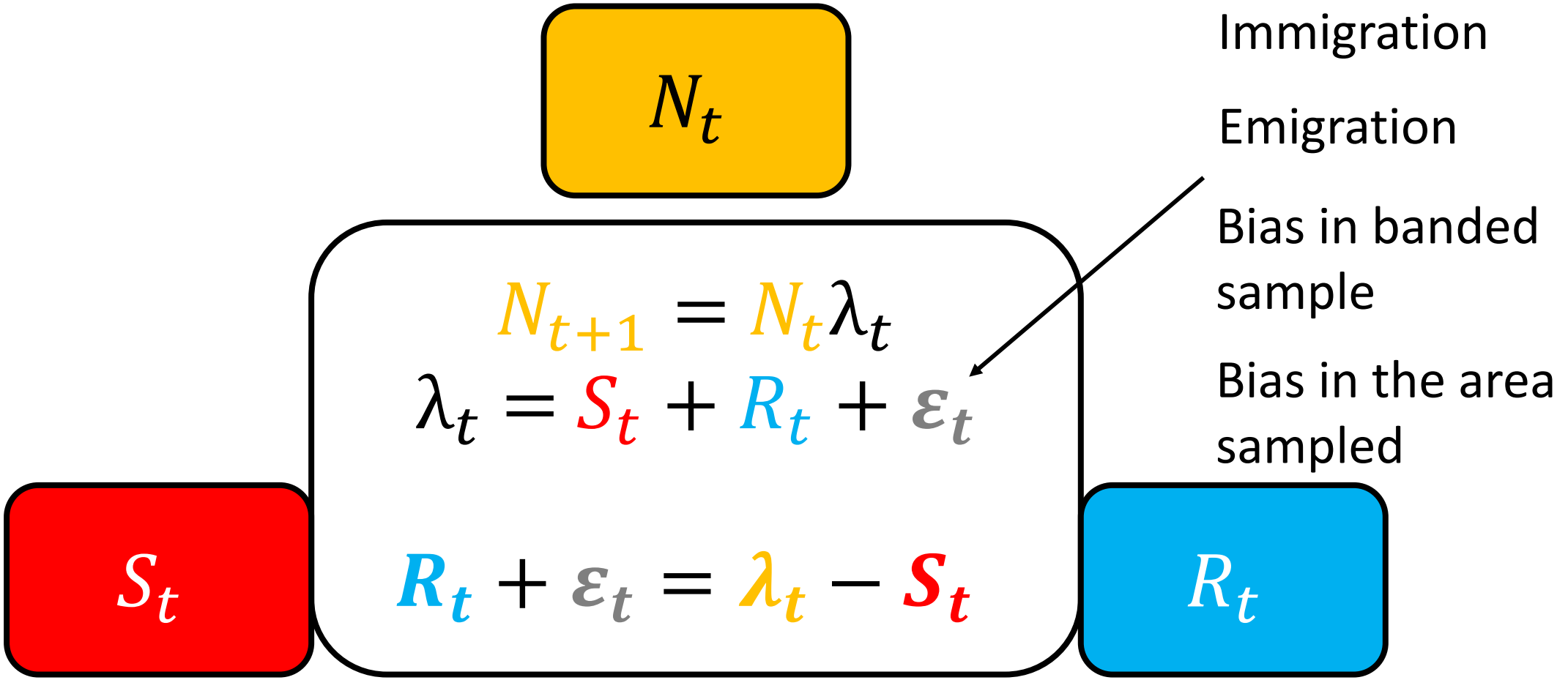
Estimated

$$R_t = \lambda_t - S_t$$

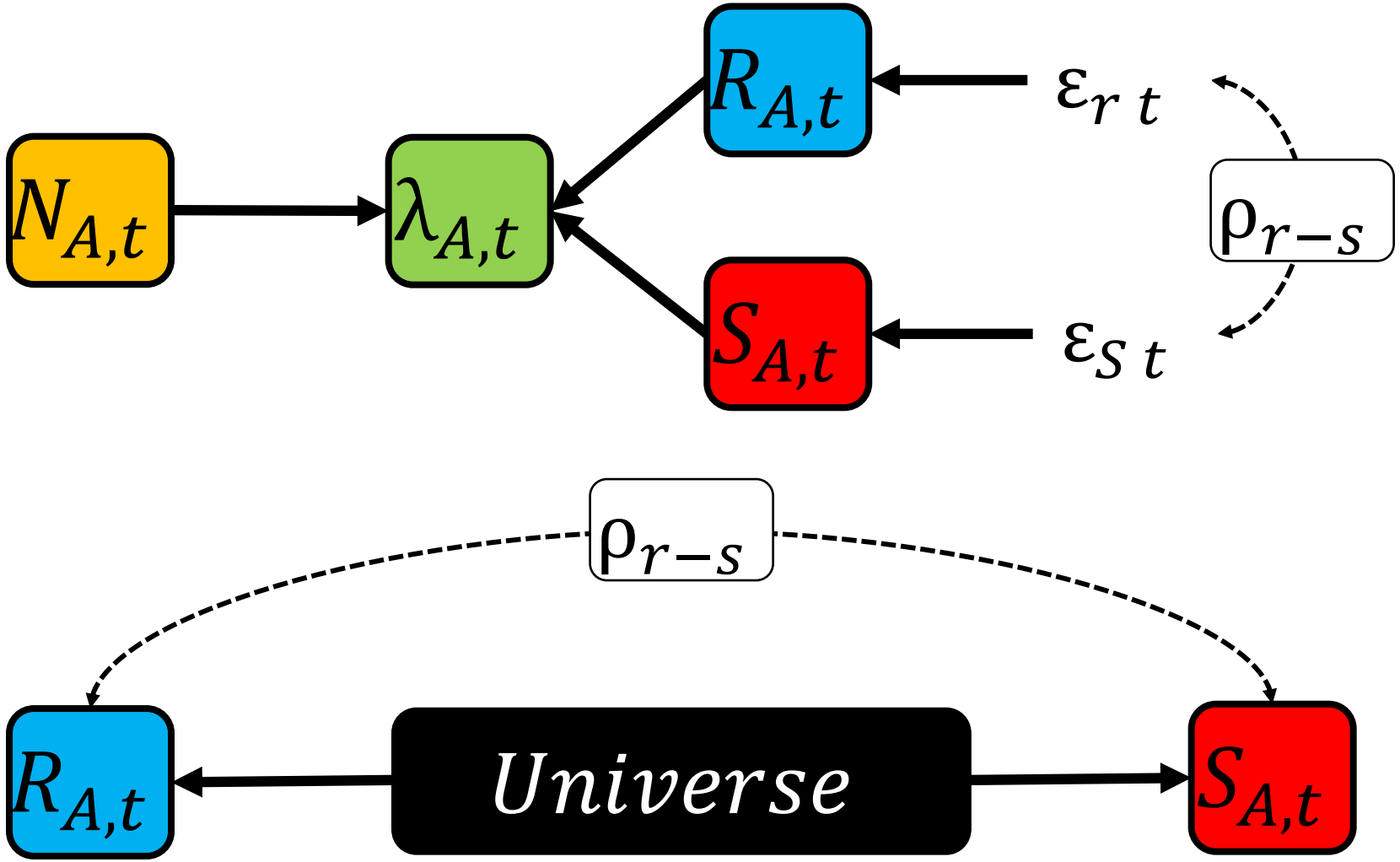
Estimated


N_t
$N_{t+1} = N_t \lambda_t$
$\lambda_t = S_t + R_t$
$R_t R_t + \varepsilon_t \lambda_t \lambda_t S_t S_t$
S_t
R_t

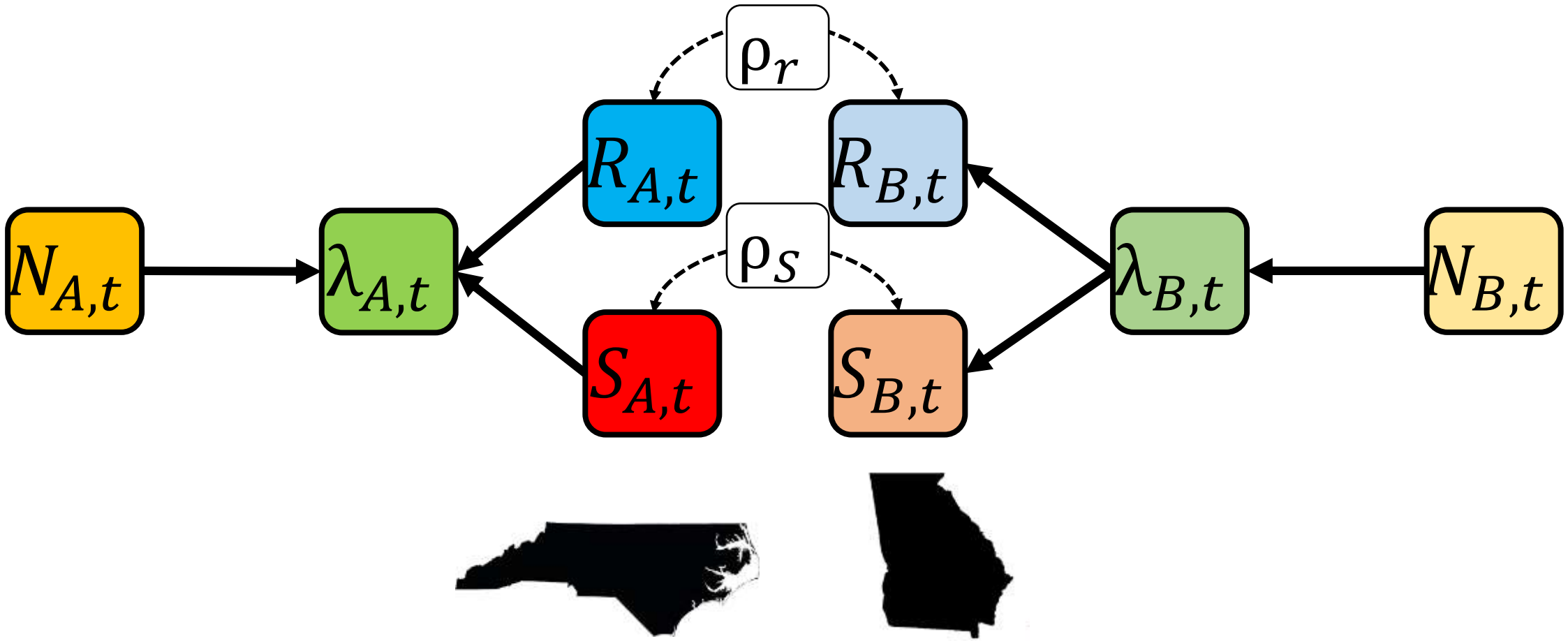
Integrated Population Models 101: *Missing Data*



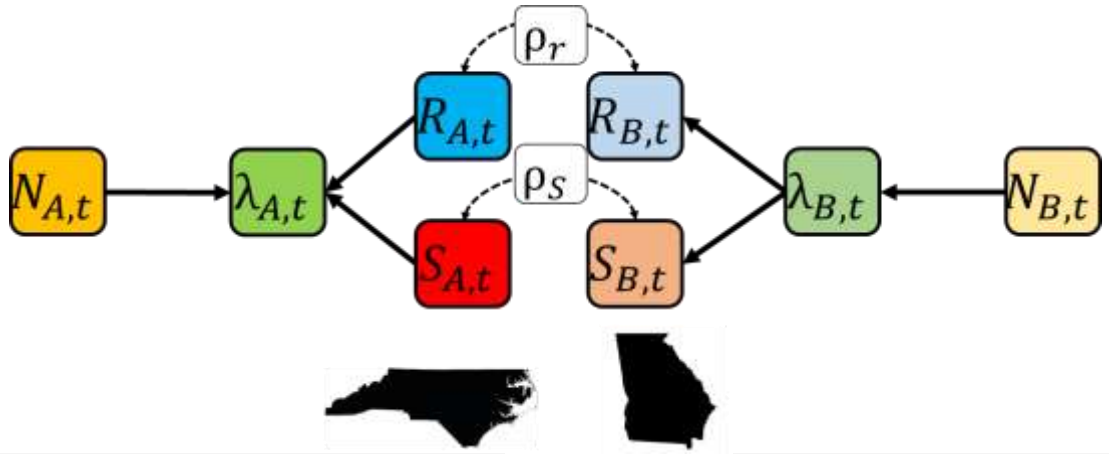
Integrated Population Models 101: *Process Correlation*

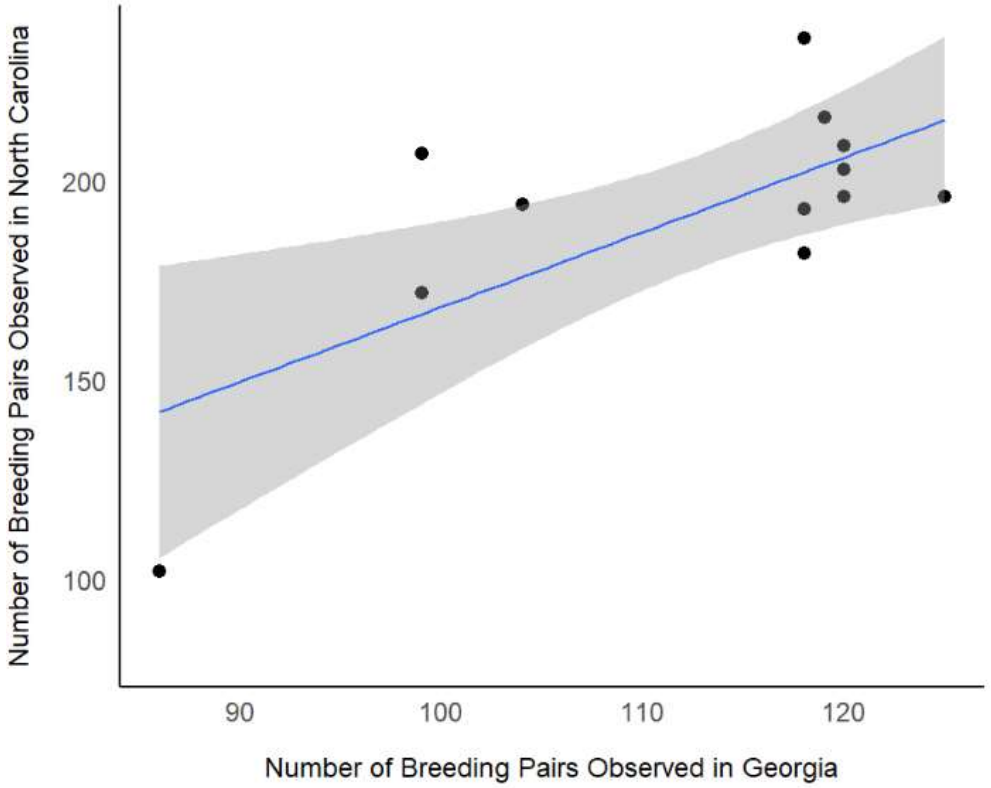


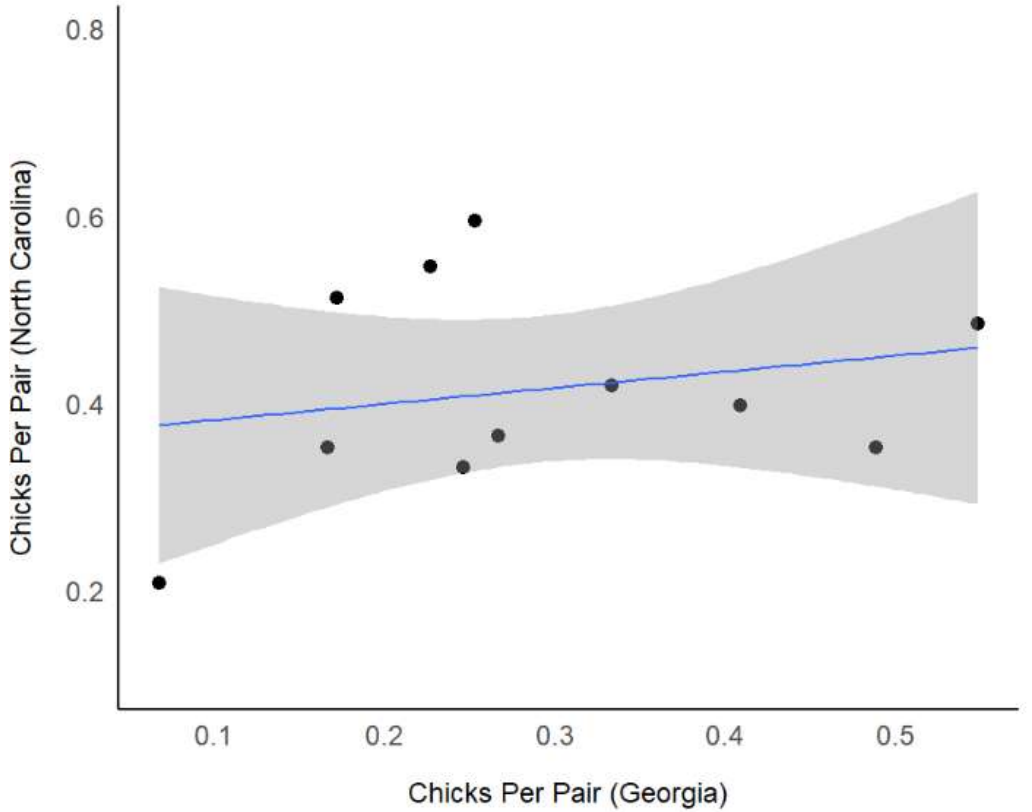
Integrated Population Models 101: *Process Correlation*



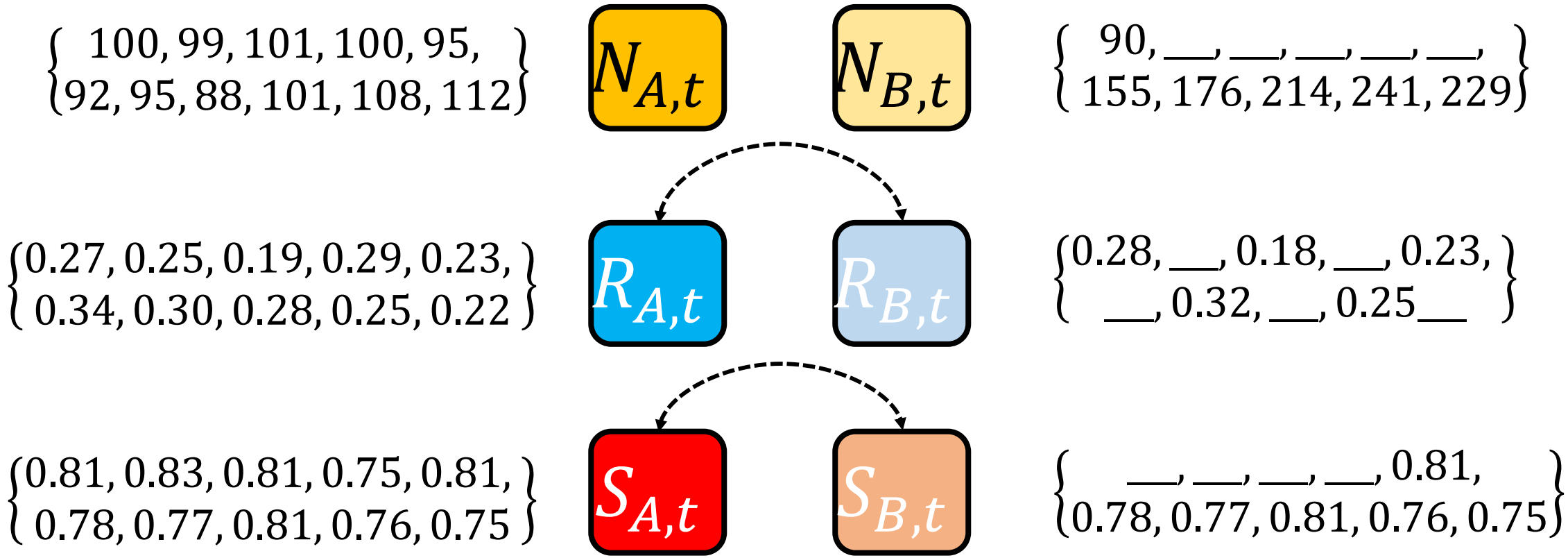
Integrated Population Models 101: *Process Correlation*





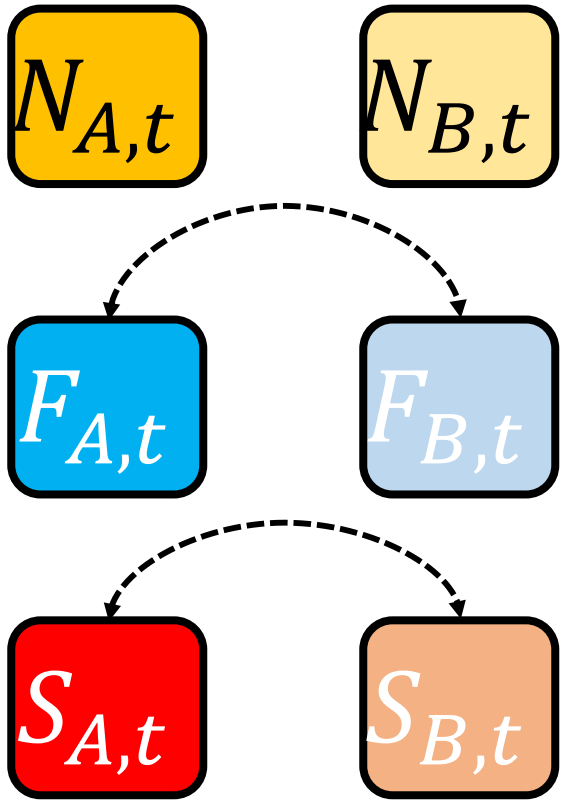


Data Inconsistently Collected Across Populations

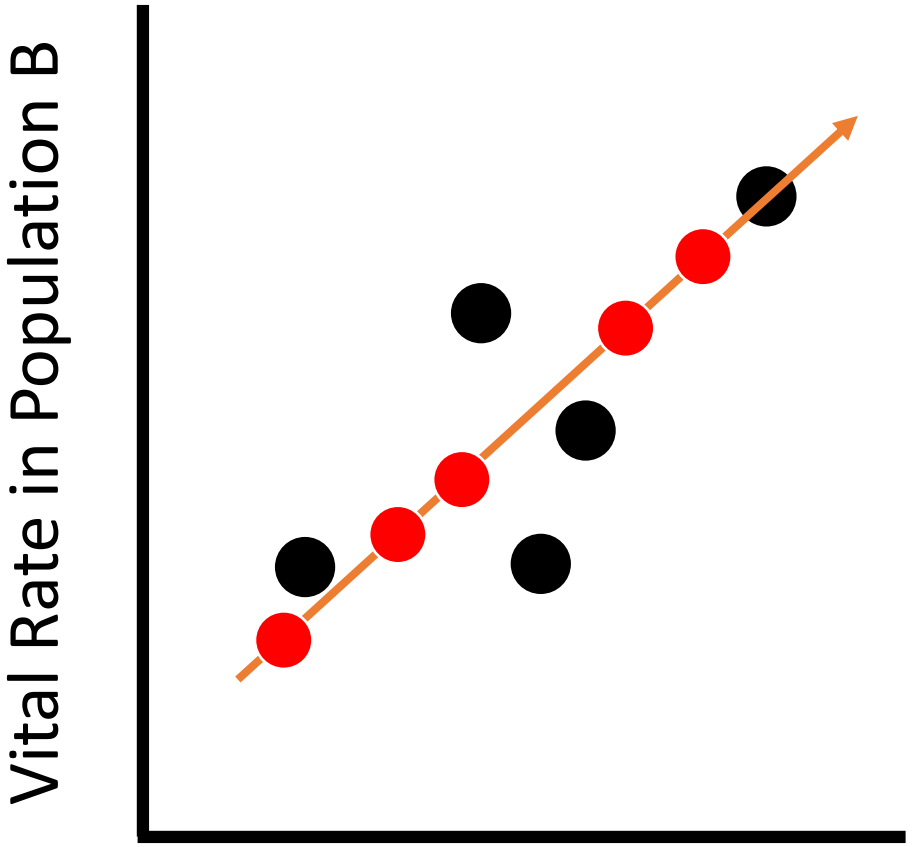


Integrated Population Models 101: *Process Correlation*

Data Inconsistently Collected Across Populations



$$\{0.28, \mathbf{0.27}, 0.18, \mathbf{0.26}, 0.23,\}$$
$$\{\mathbf{0.31}, 0.32, \mathbf{0.25}, 0.25, \mathbf{0.24}\}$$



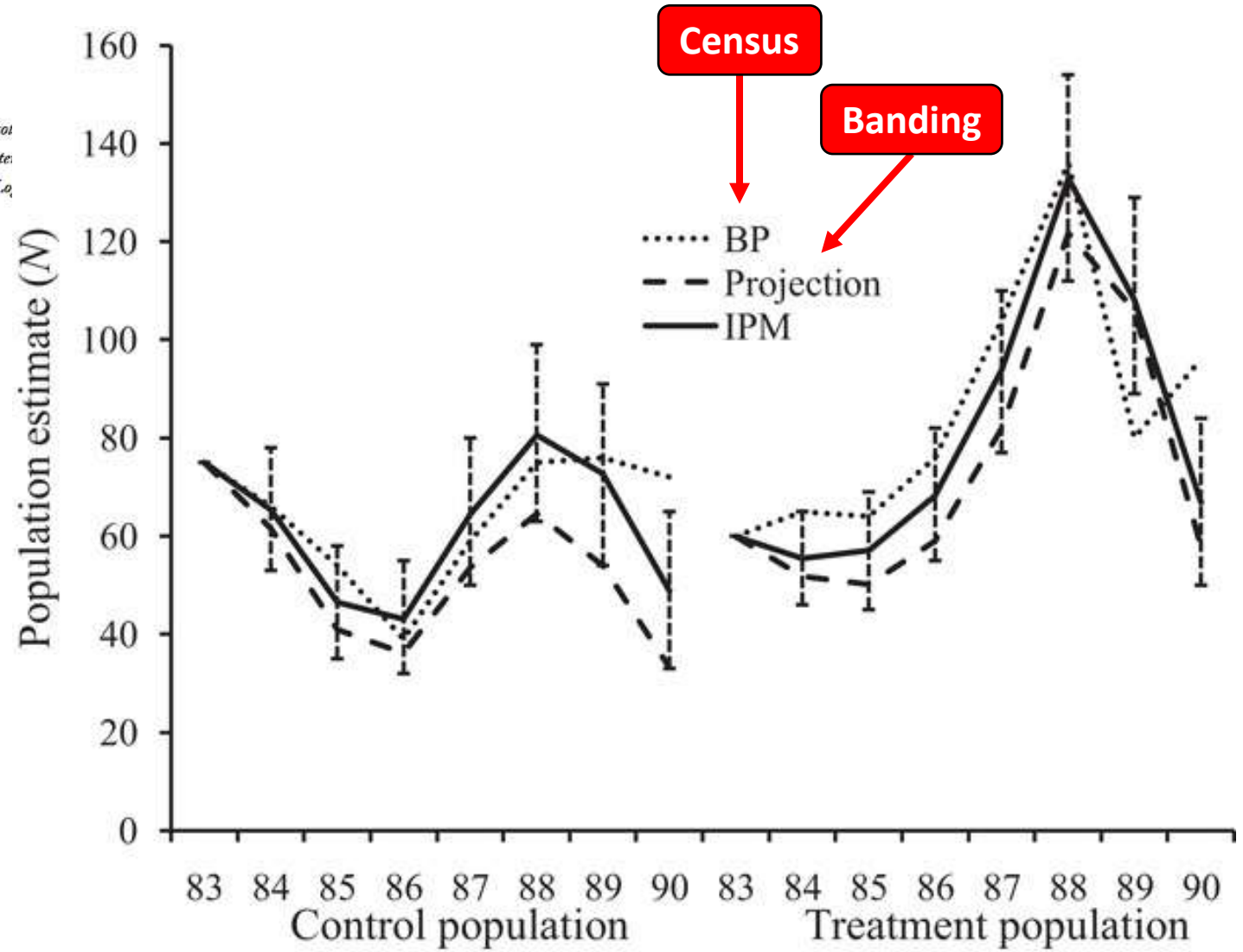
$$\{0.27, 0.25, 0.19, 0.29, 0.23,$$
$$0.34, 0.30, 0.28, 0.25, 0.22\}$$

What are IPMs being used for?

Improve Estimation

Integrated Population Models Facilitate Ecological Understanding and Improved Management Decisions

TODD W. ARNOLD,[1] *Department of Fisheries, Wildlife and Conservation Biology, University of Minneso*
ROBERT G. CLARK, *Wildlife Research Division, Environment and Climate Change Canada, 115 Perimete*
DAVID N. KOONS,[2] *Department of Wildland Resources and the Ecology Center, Utah State University, Lo*
MICHAEL SCHAUB, *Swiss Ornithological Institute, 6204 Sempach, Switzerland*



What are IPMs being used for?

Improve Estimation

Winter Census

Mark Recapture

Breeding Surveys

Nest Surveys

Brood Surveys

Chick/Pair

Migration Surveys

Winter Surveys

What are IPMs being used for?

Missing Data

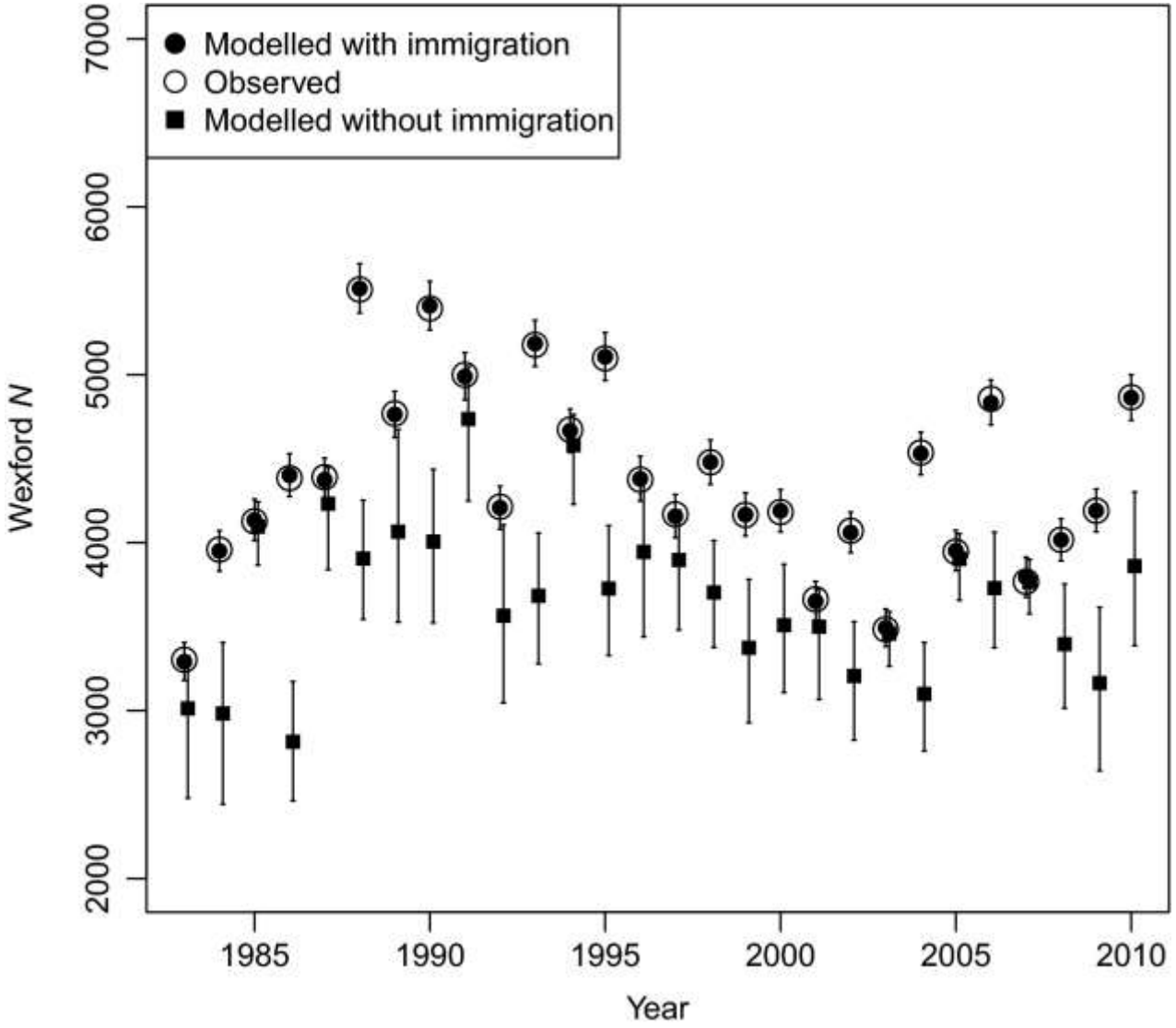
Journal of Animal Ecology
BRITISH ECOLOGICAL SOCIETY

Standard Paper | Open Access

Integrated population modelling reveals a perceived source to be a cryptic sink

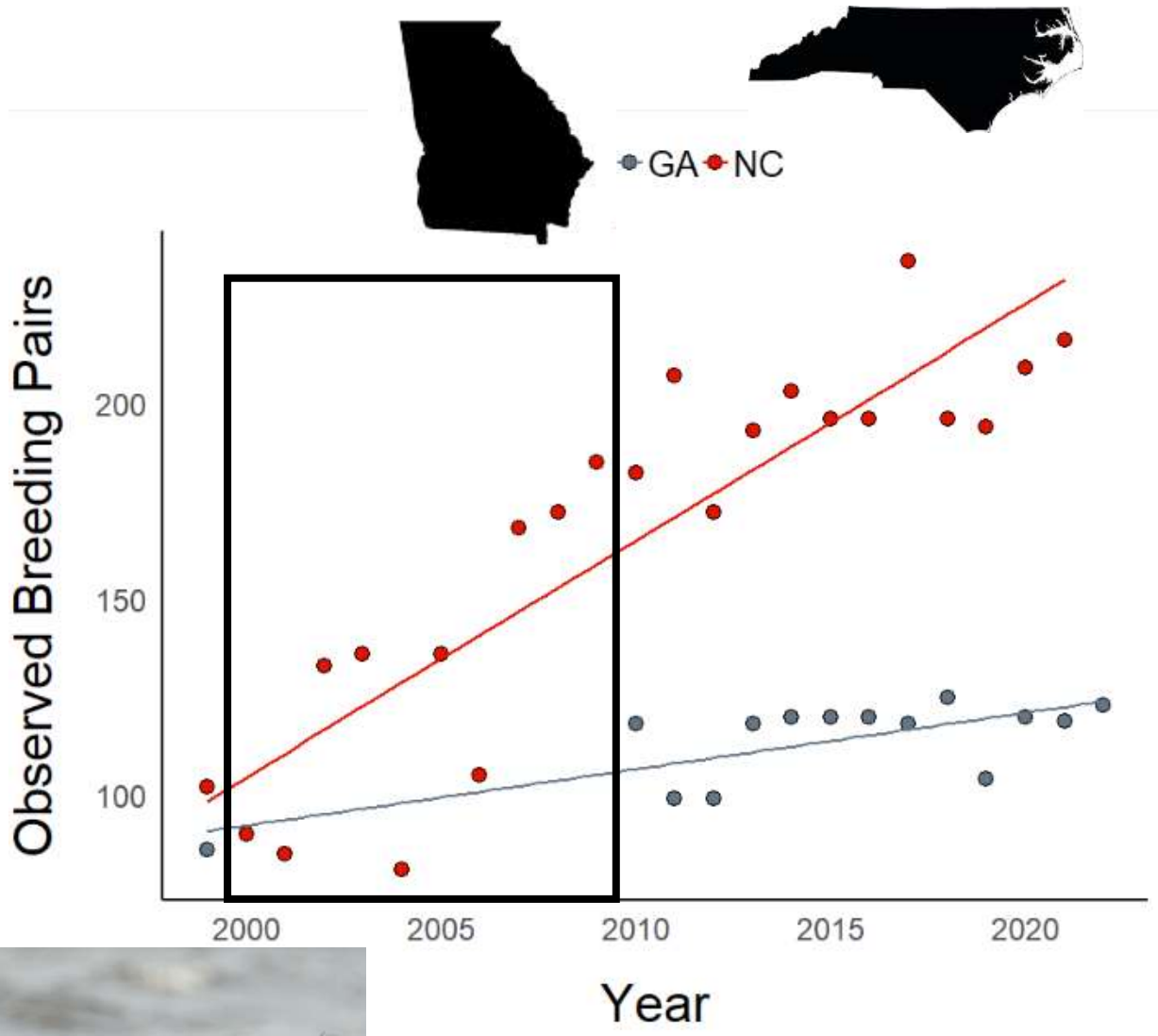
Mitch D. Weegman, Stuart Bearhop, Anthony D. Fox, Geoff M. Hilton, Alyn J. Walsh, Jennifer L. McDonald, David J. Hodgson

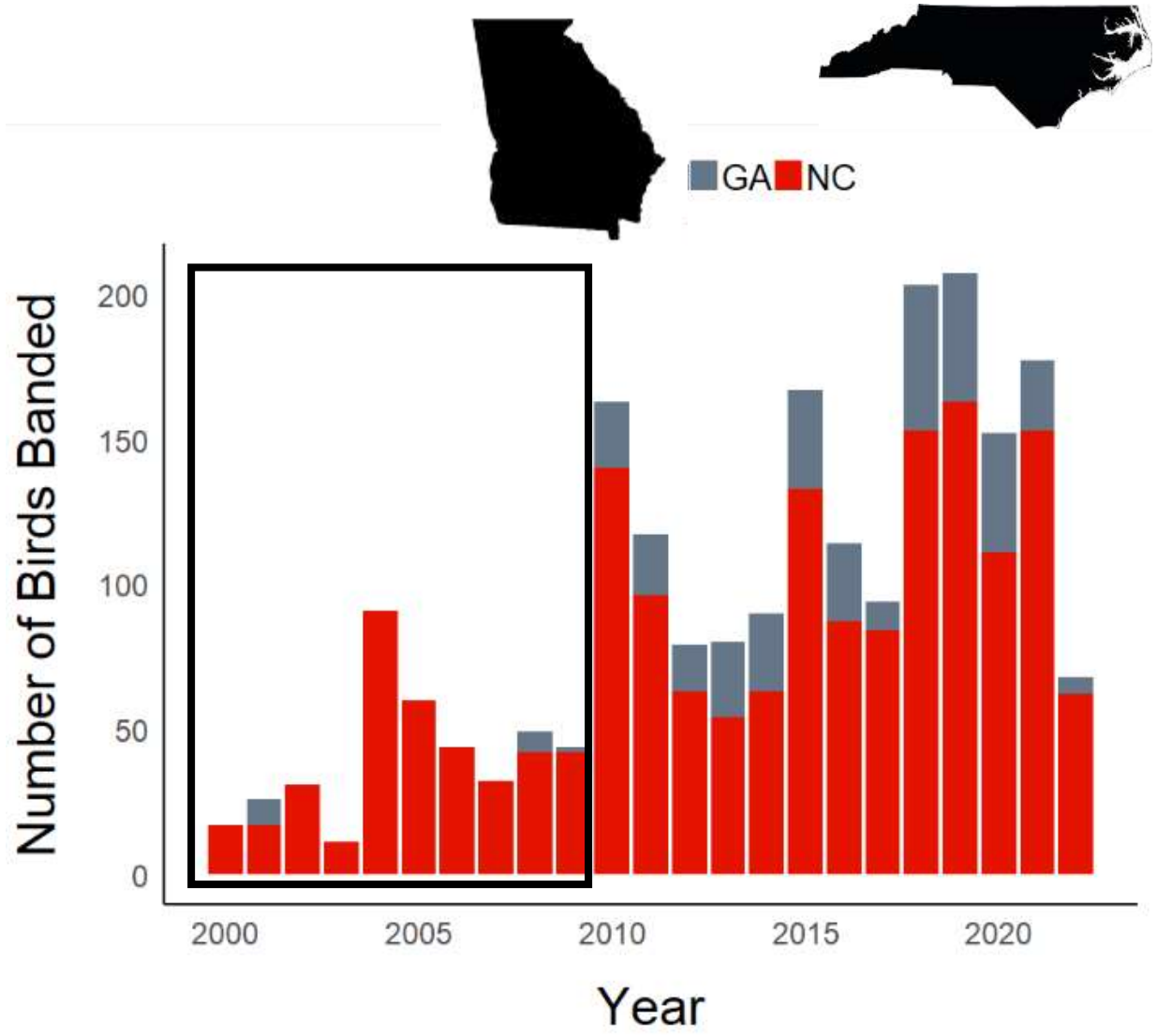
Greenland white-fronted goose



What are IPMs being used for?

Missing Data





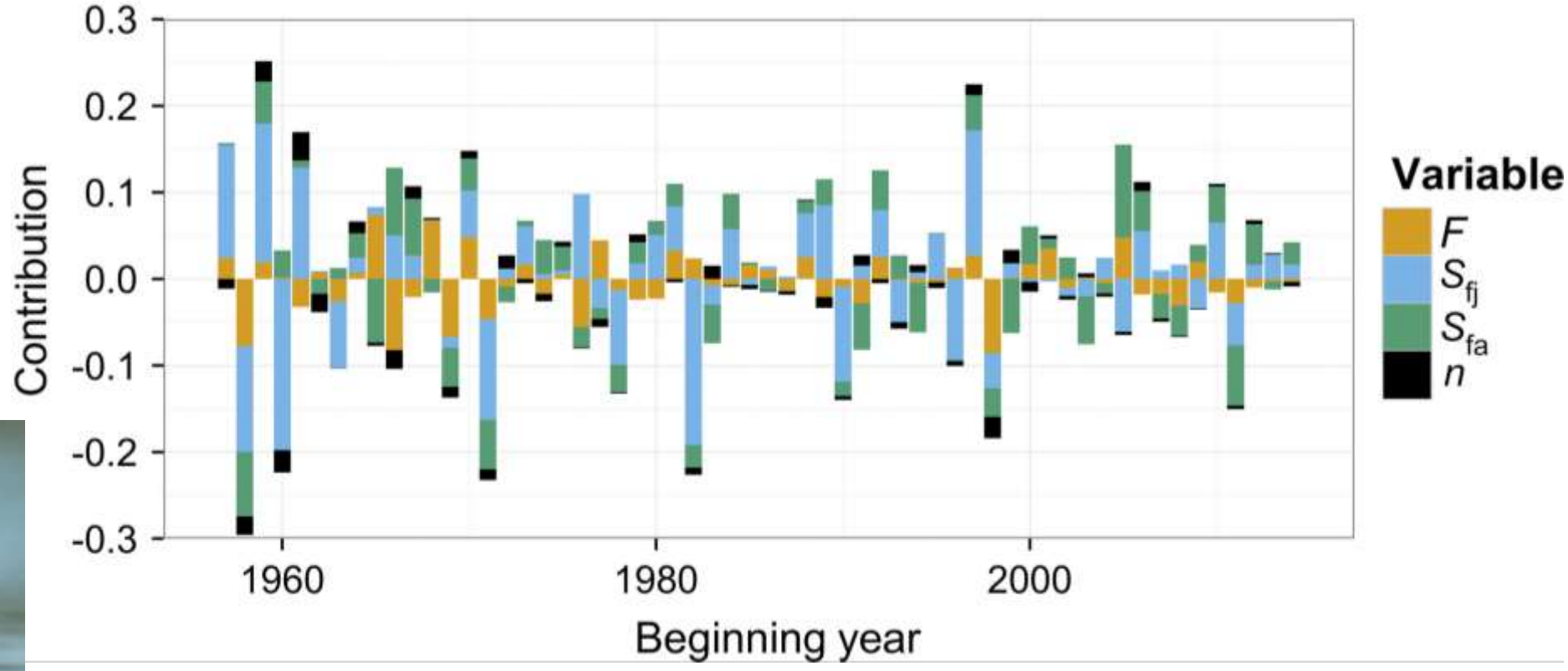
What are IPMs being used for? *Understanding the past*

ECOLOGICAL APPLICATIONS
ECOLOGICAL SOCIETY OF AMERICA

Article

Understanding the demographic drivers of realized population growth rates

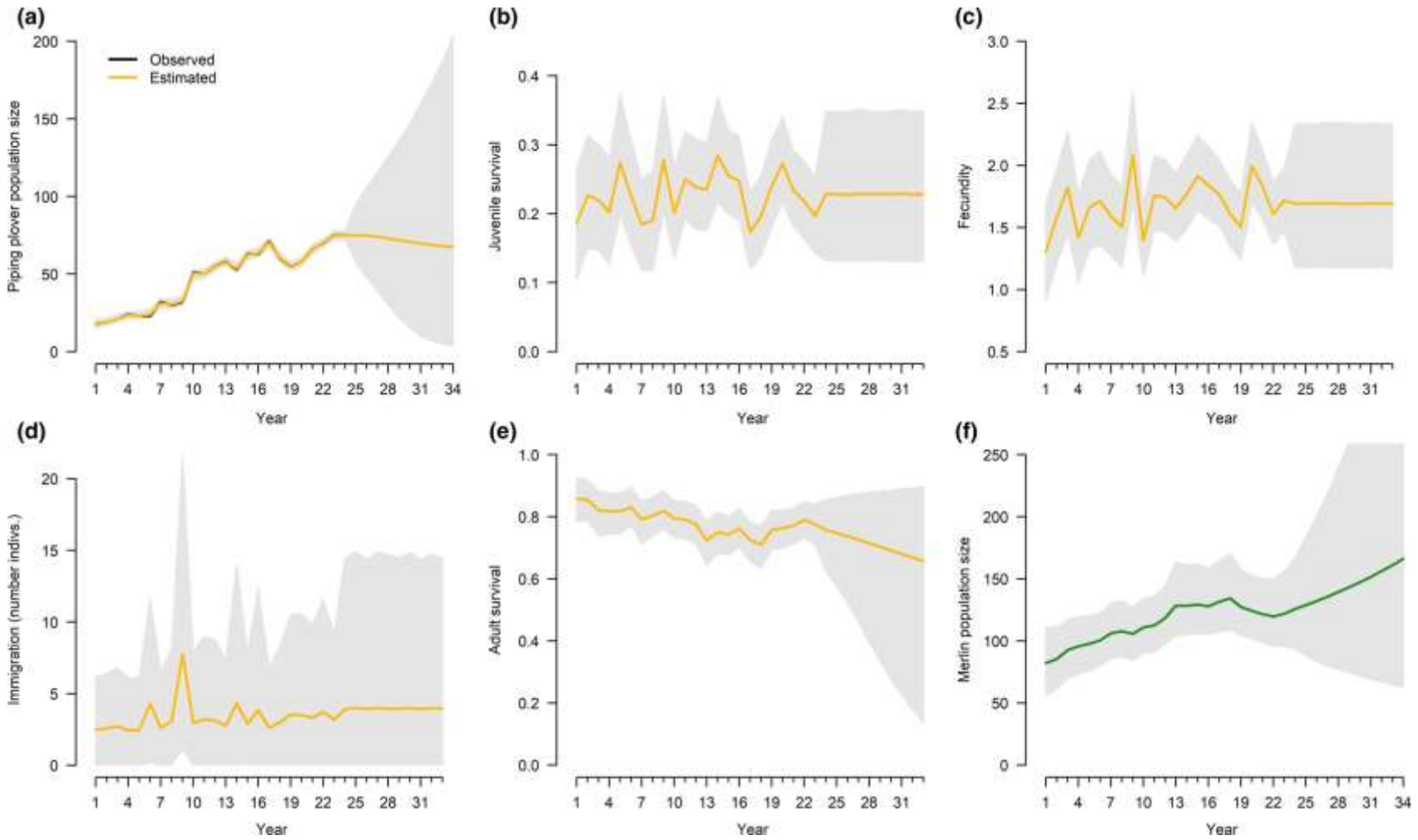
David N. Koons ✉, Todd W. Arnold, Michael Schaub



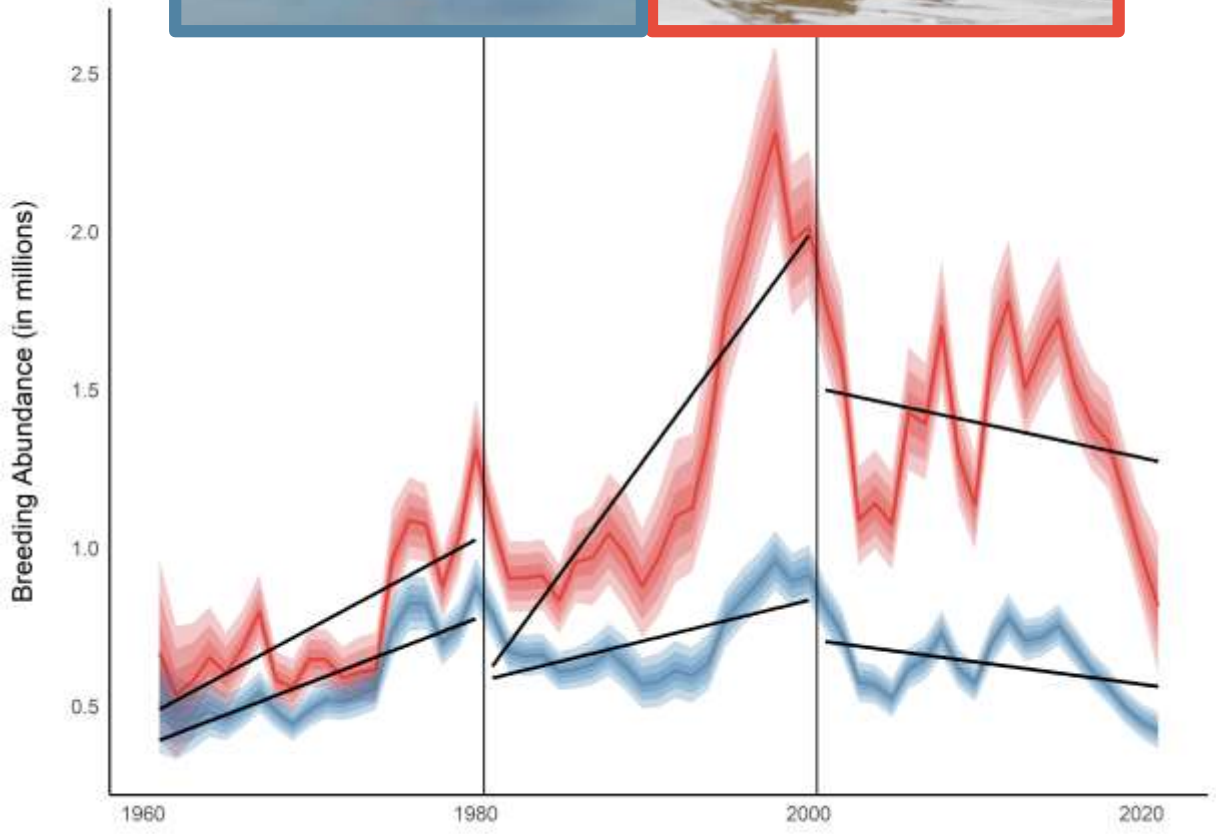
What are IPMs being used for? *Predictions into the future*

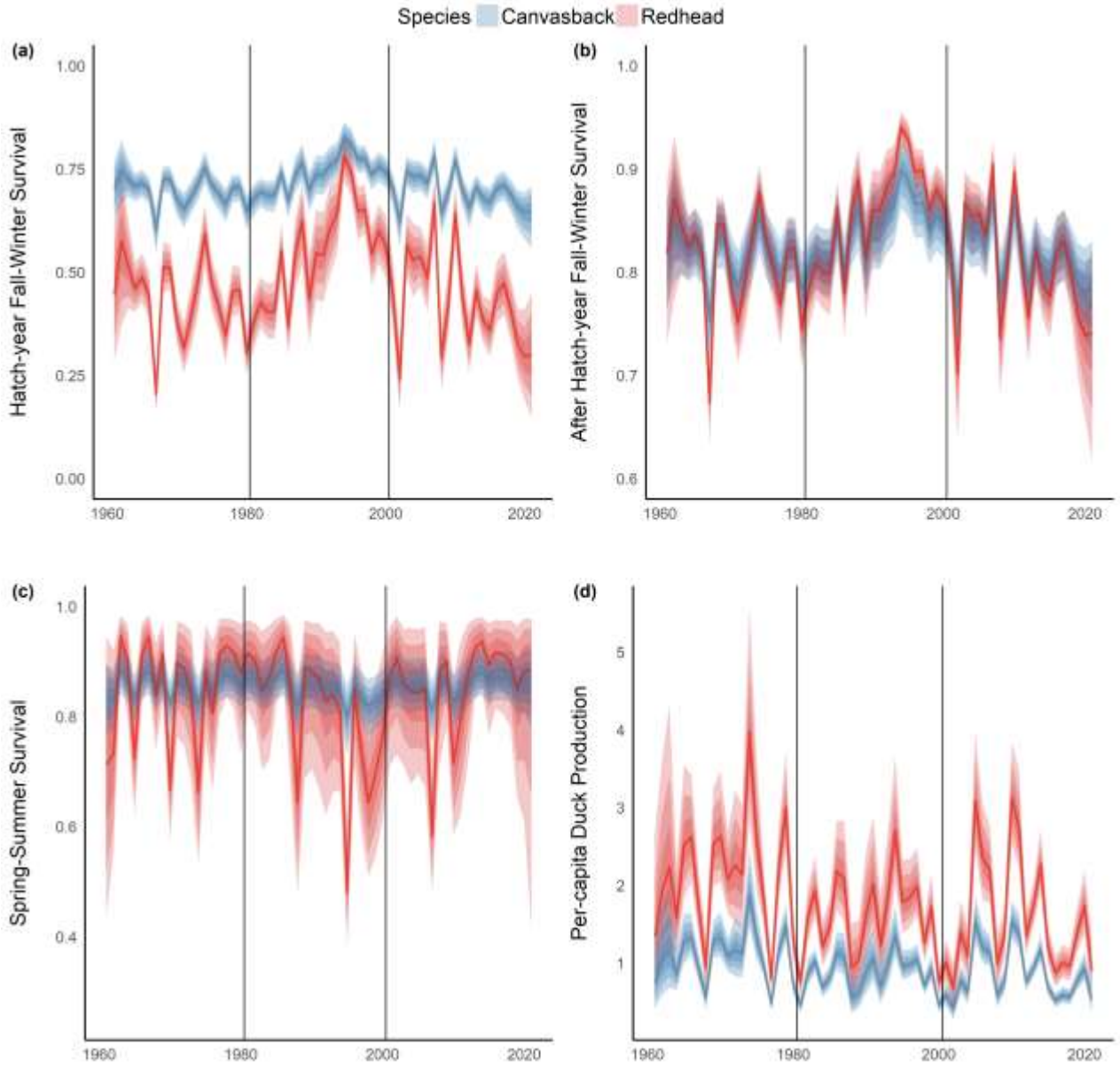
Evaluating population viability and efficacy of conservation management using integrated population models

Sarah P. Saunders[1] | Francesca J. Cuthbert[2] | Elise F. Zipkin[1,3]



What are IPMs being used for? *Community Dynamics*





What are IPMs being used for?

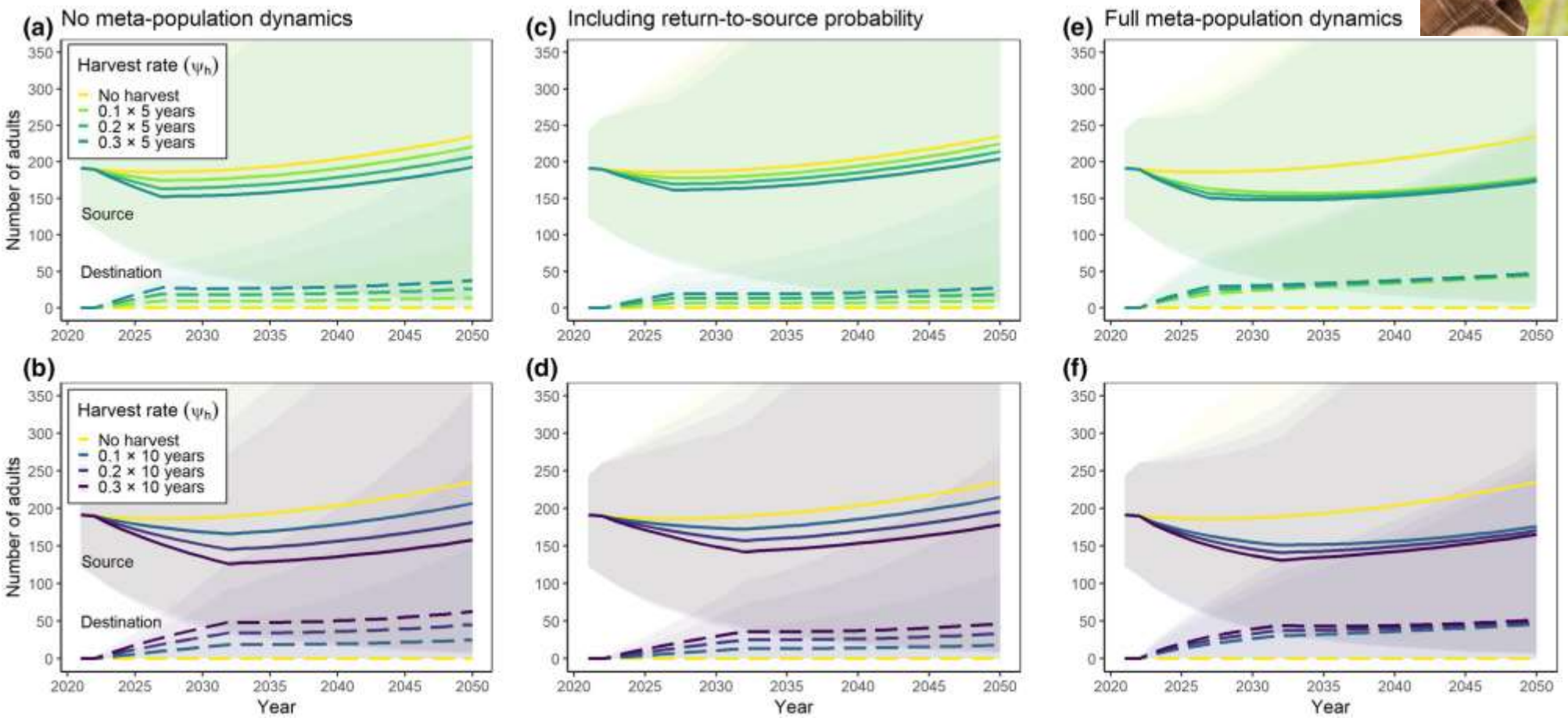
Metapopulation Dynamics

Journal of Applied Ecology
BRITISH ECOLOGICAL SOCIETY

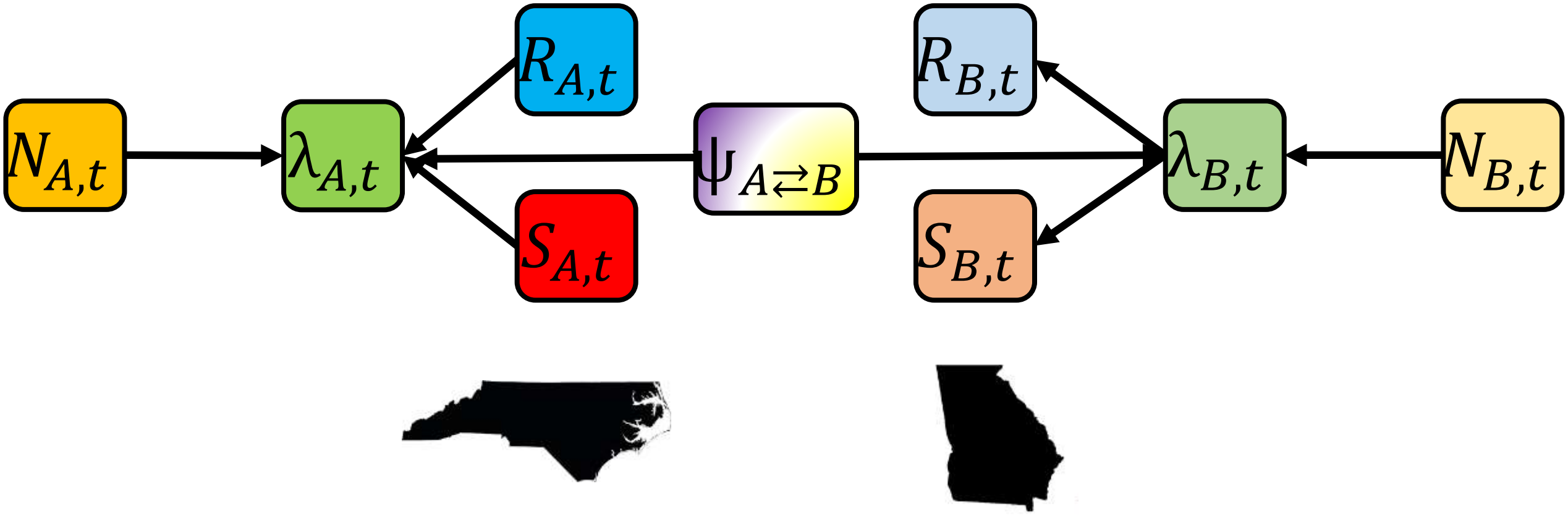
RESEARCH ARTICLE | Open Access

Predicting harvest impact and establishment success when translocating highly mobile and endangered species

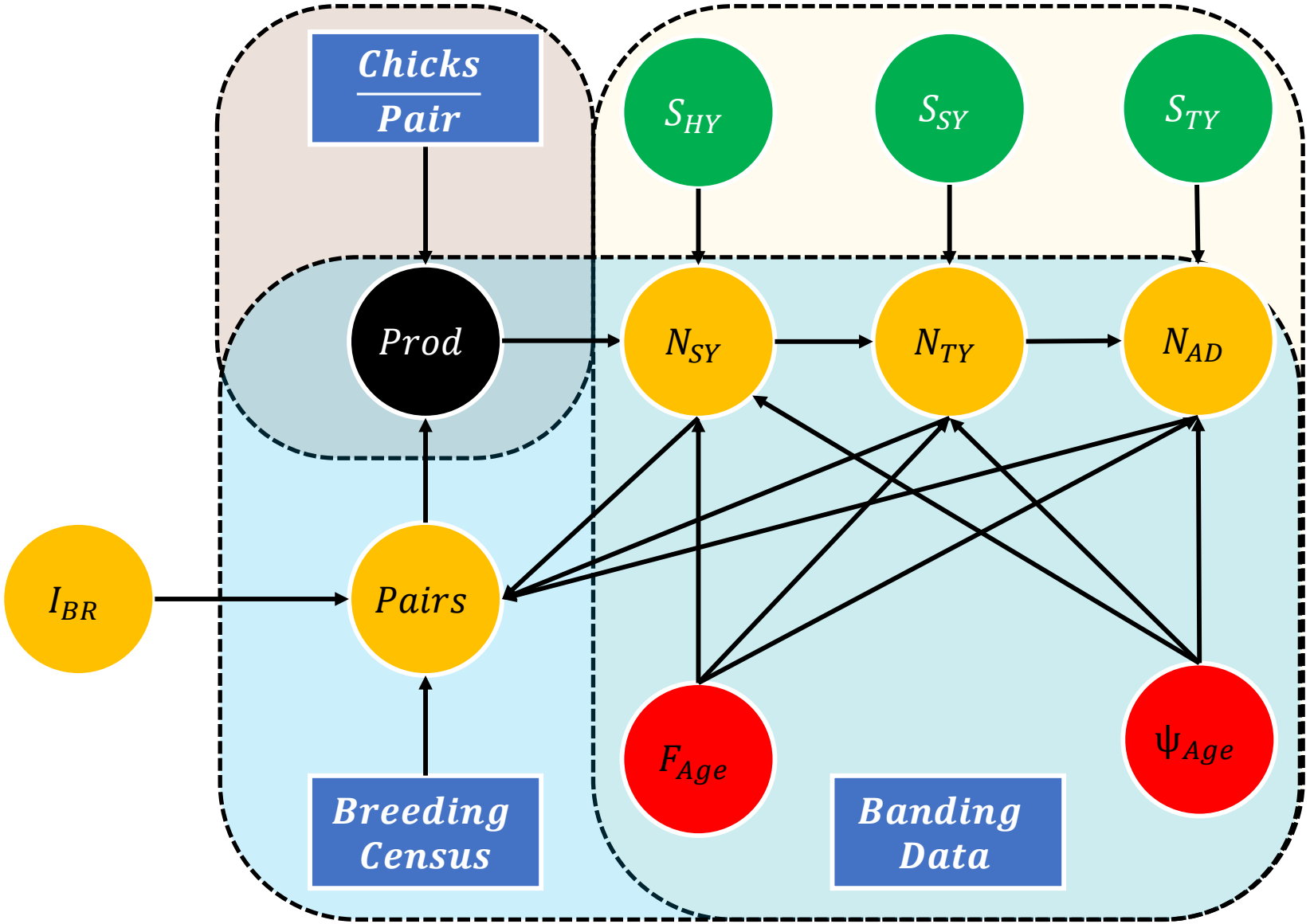
Johannes H. Fischer, Heiko U. Wittmer, Caio F. Kenup, Kevin A. Parker, Rosalind Cole, Igor Debski, Graeme A. Taylor, John G. Ewen, Doug P. Armstrong



What are IPMs being used for? *Metapopulation Dynamics*



What could an AMOY IPM look like?



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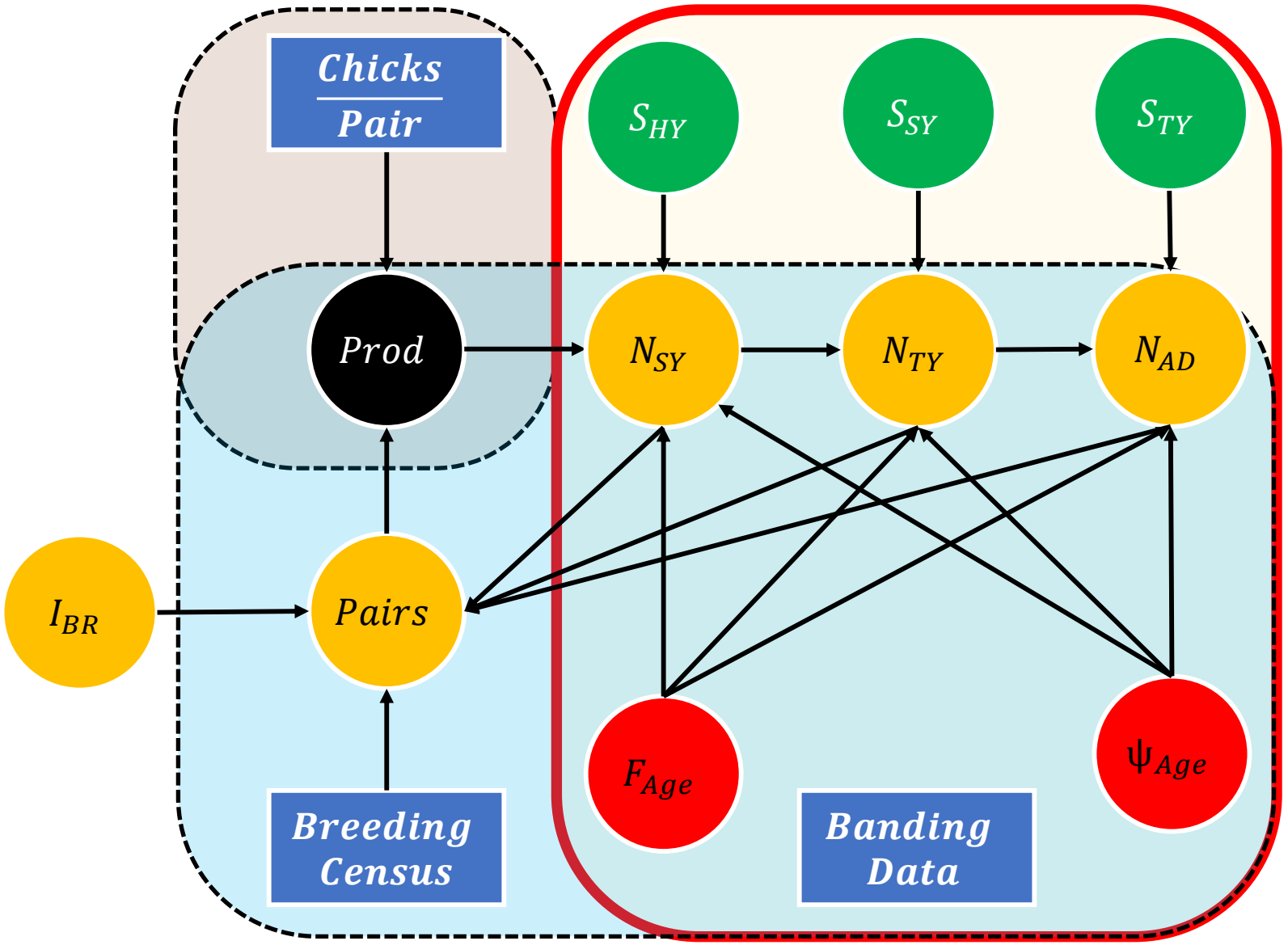


Prototype:

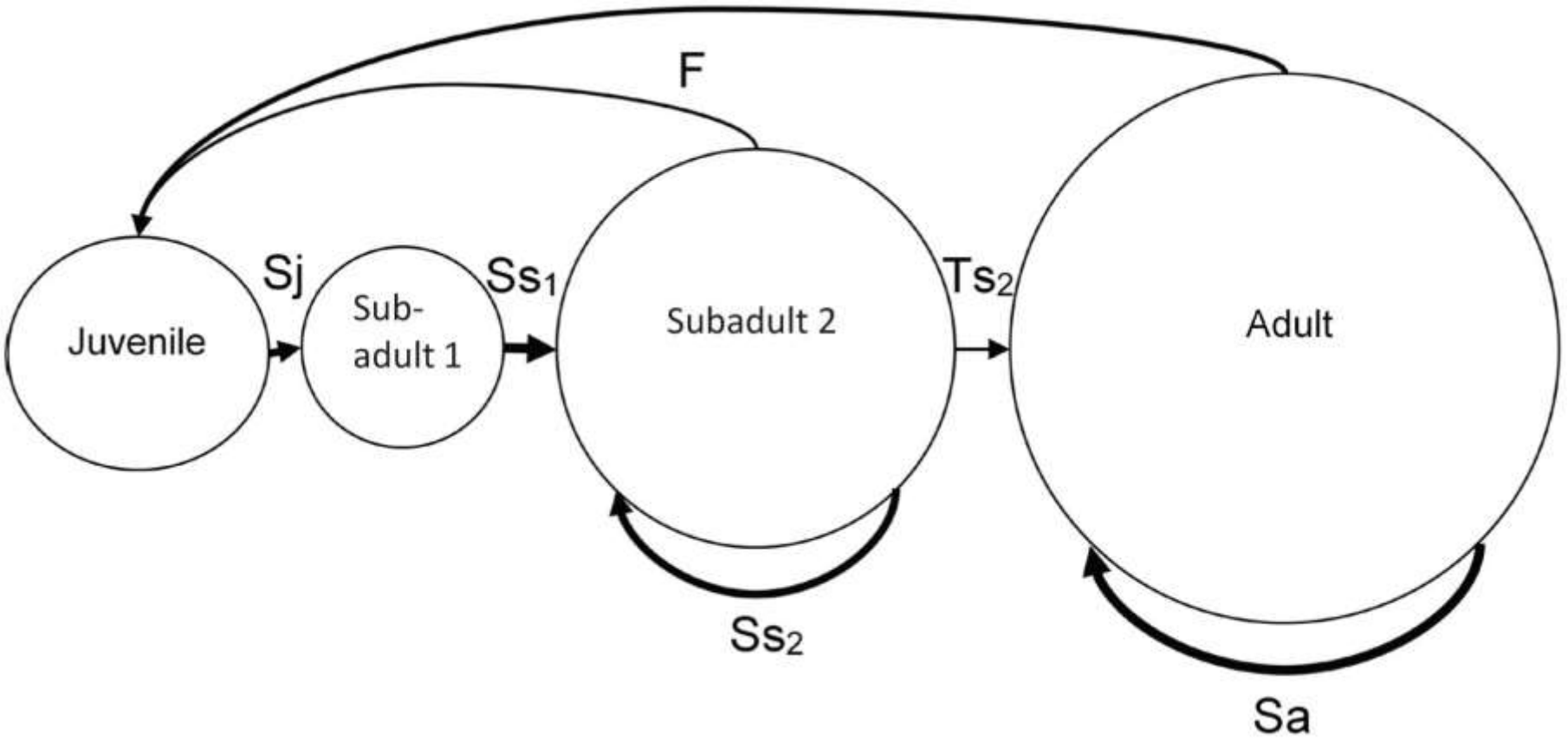
- Resights of:
  1. Confirmed breeding individuals in their natal state.
  2. Non-breeding individuals in their natal state (between April-July).
  3. Confirmed breeding individuals outside of their natal state.
- Only included individuals born in, or bred in, North Carolina, Georgia, Florida, Virginia, and New Jersey.

Components to Integrated Population Models: Survival

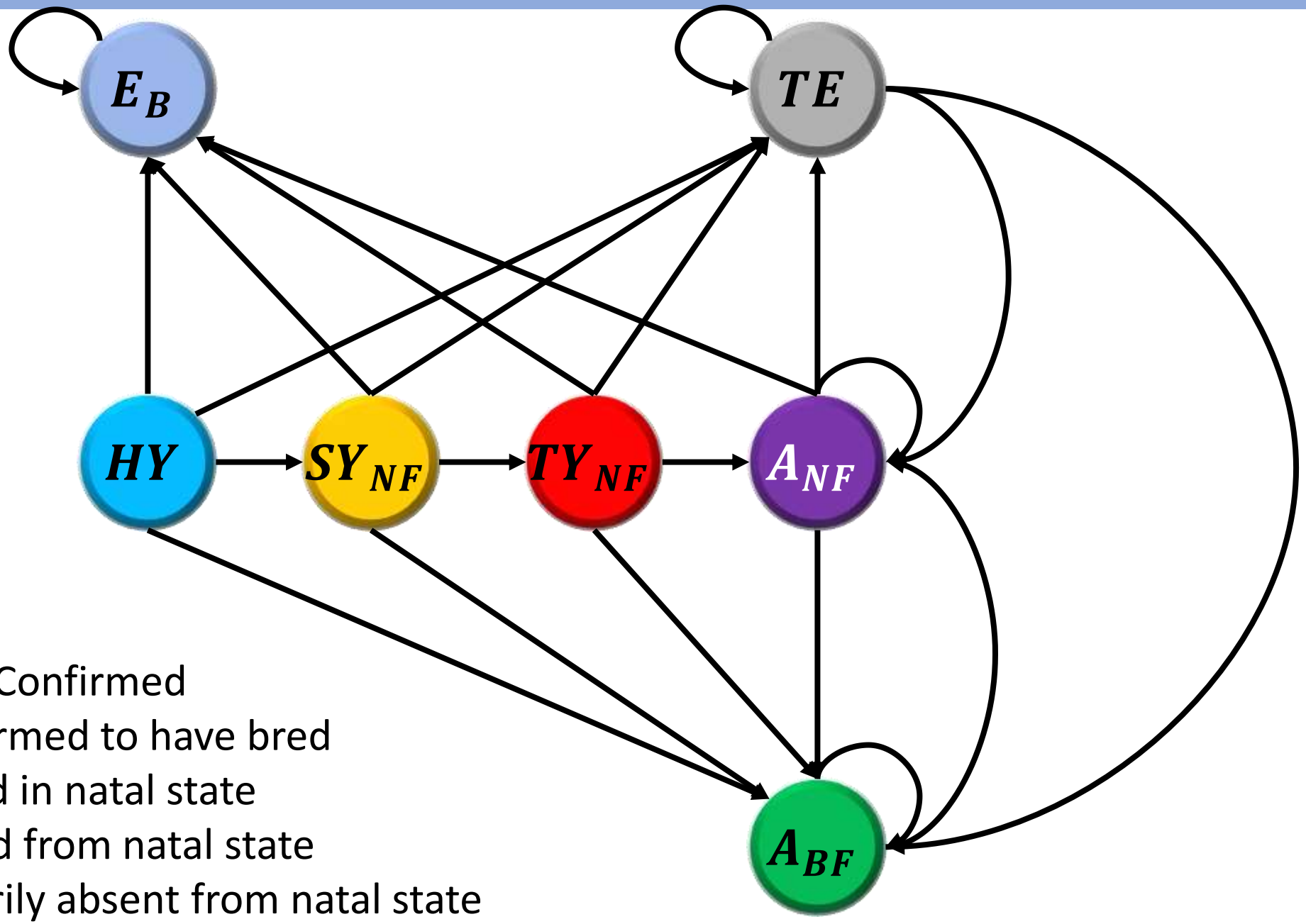
WATERBIRDS
JOURNAL OF THE WATERBIRD SOCIETY
VOL. 40 SPECIAL PUBLICATION 1 PAGES 1-126

The American Oystercatcher (*Haematopus palliatus*) Working Group: 15 Years of Collaborative Focal Species Research and Management

THEODORE R. SIMONS

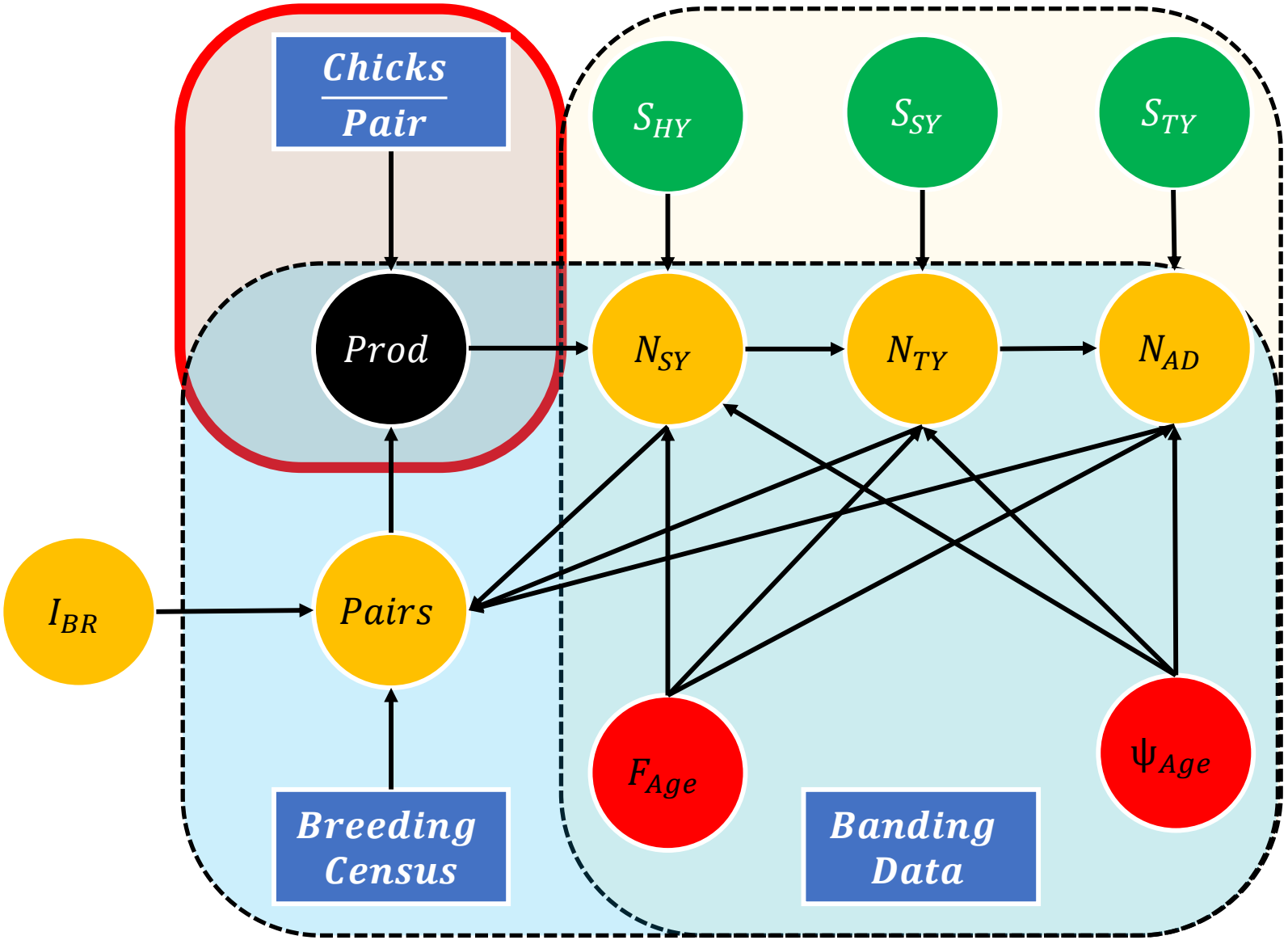


Components to Integrated Population Models: Survival



B = Breeding Confirmed
N = Not confirmed to have bred
F = Remained in natal state
E = Emigrated from natal state
TE = Temporarily absent from natal state

What could an AMOY IPM look like?



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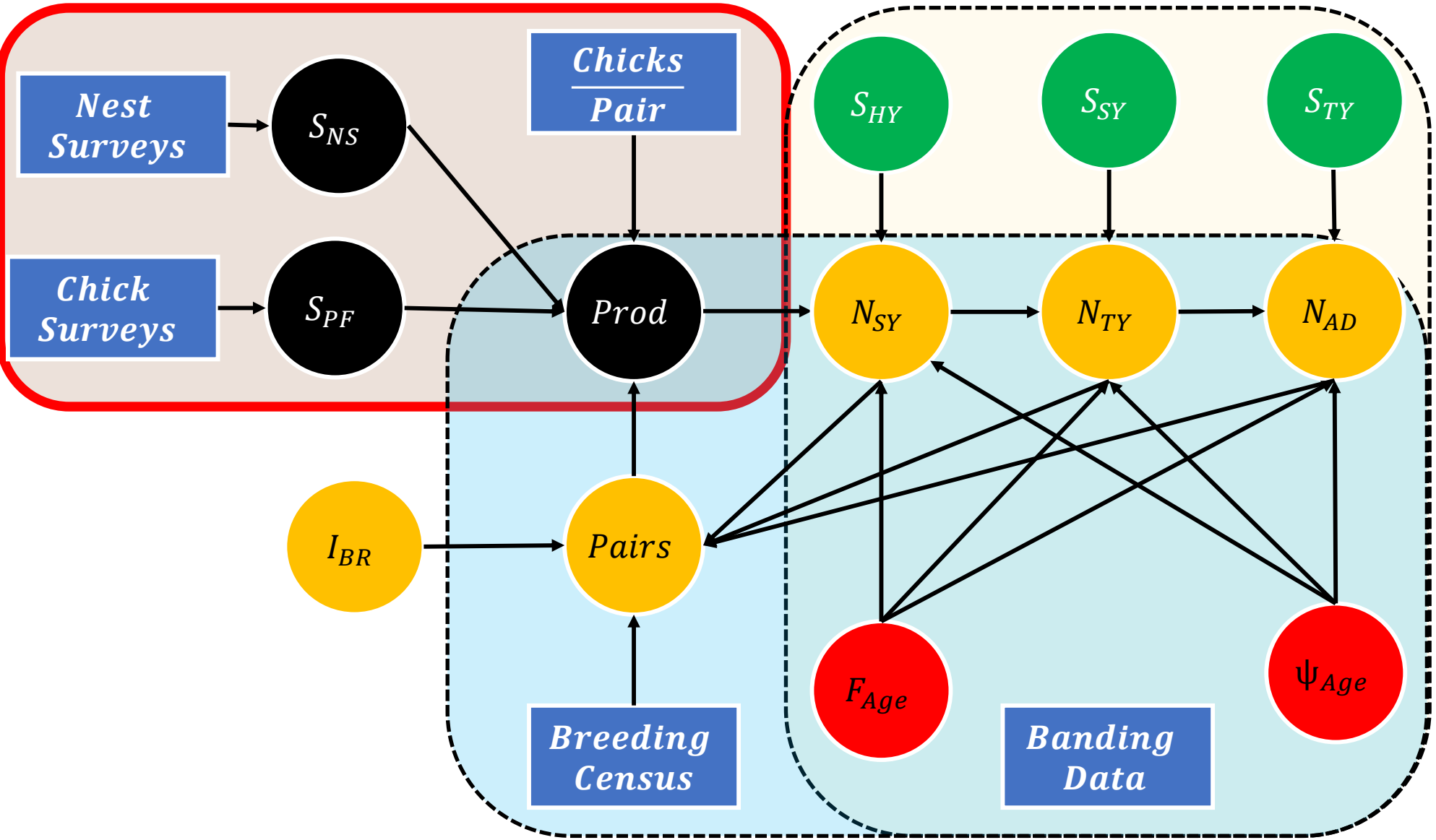

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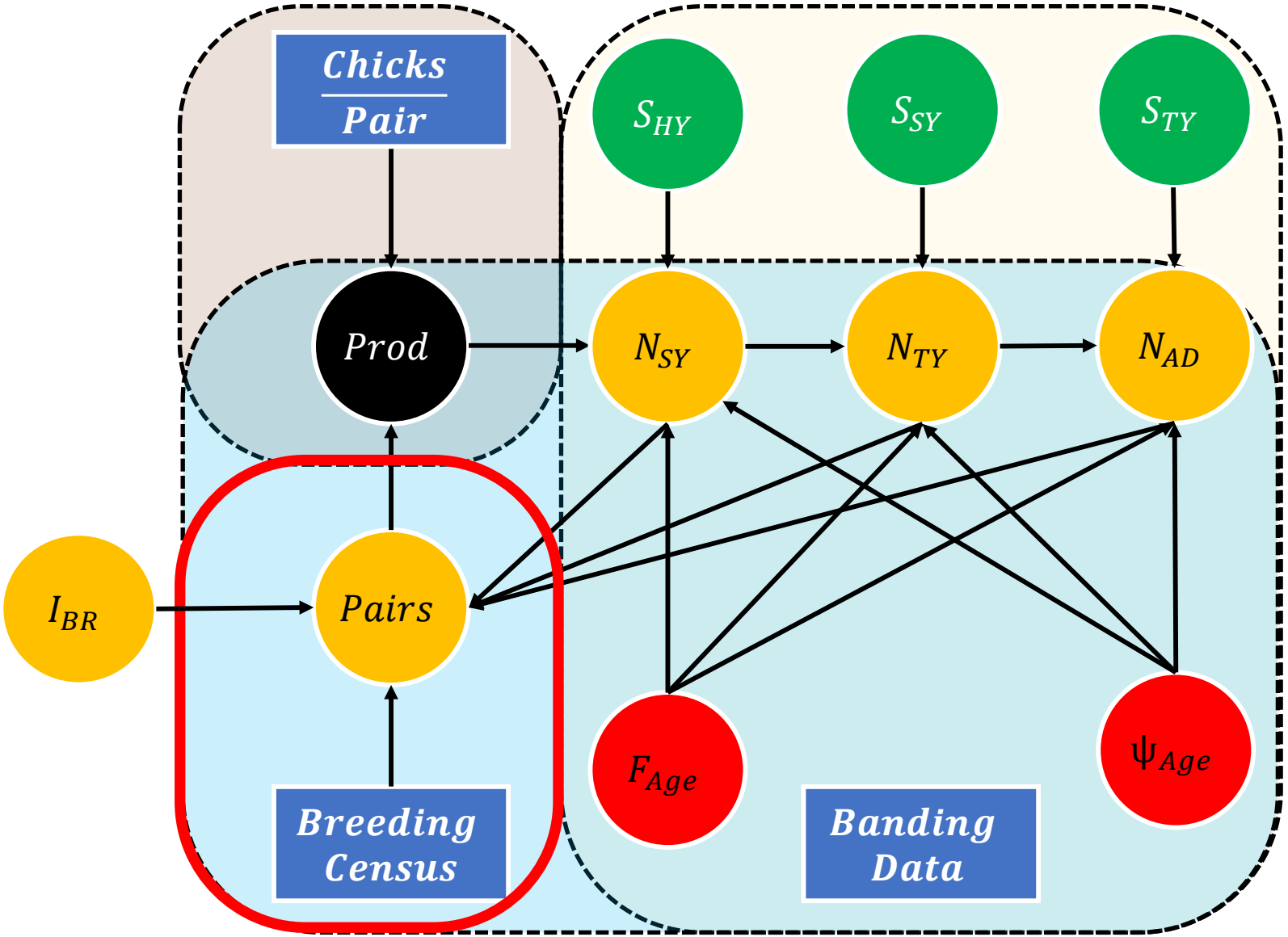
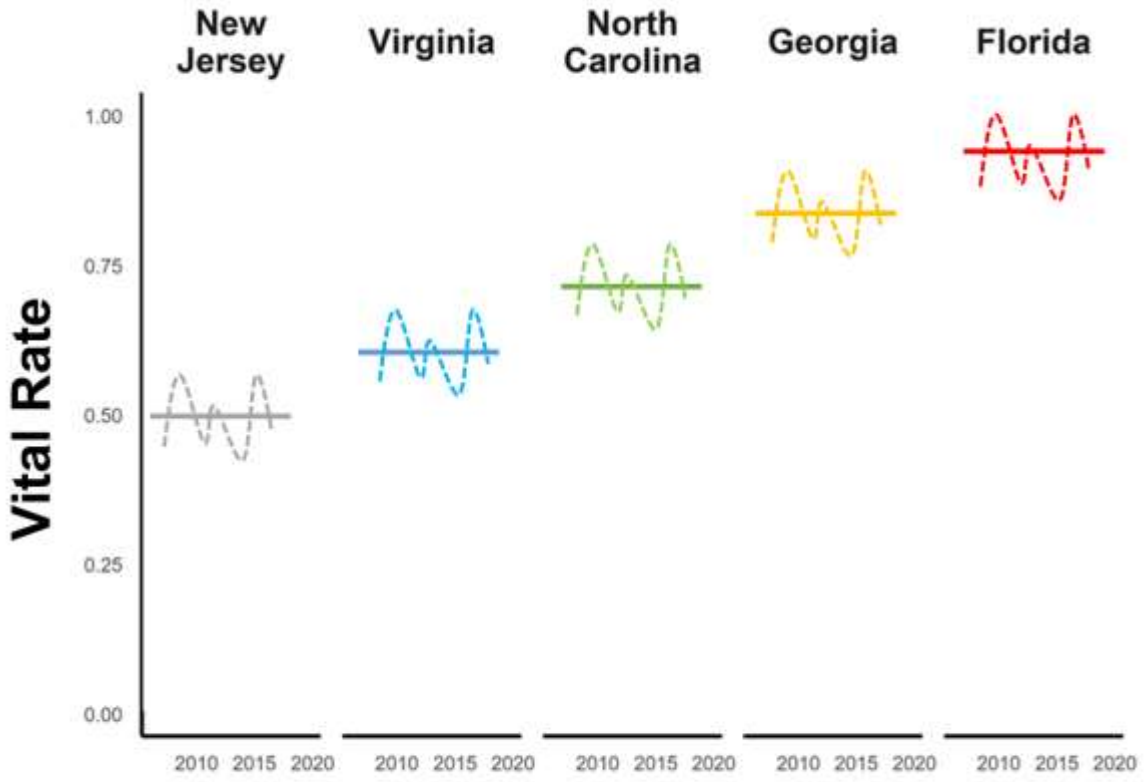


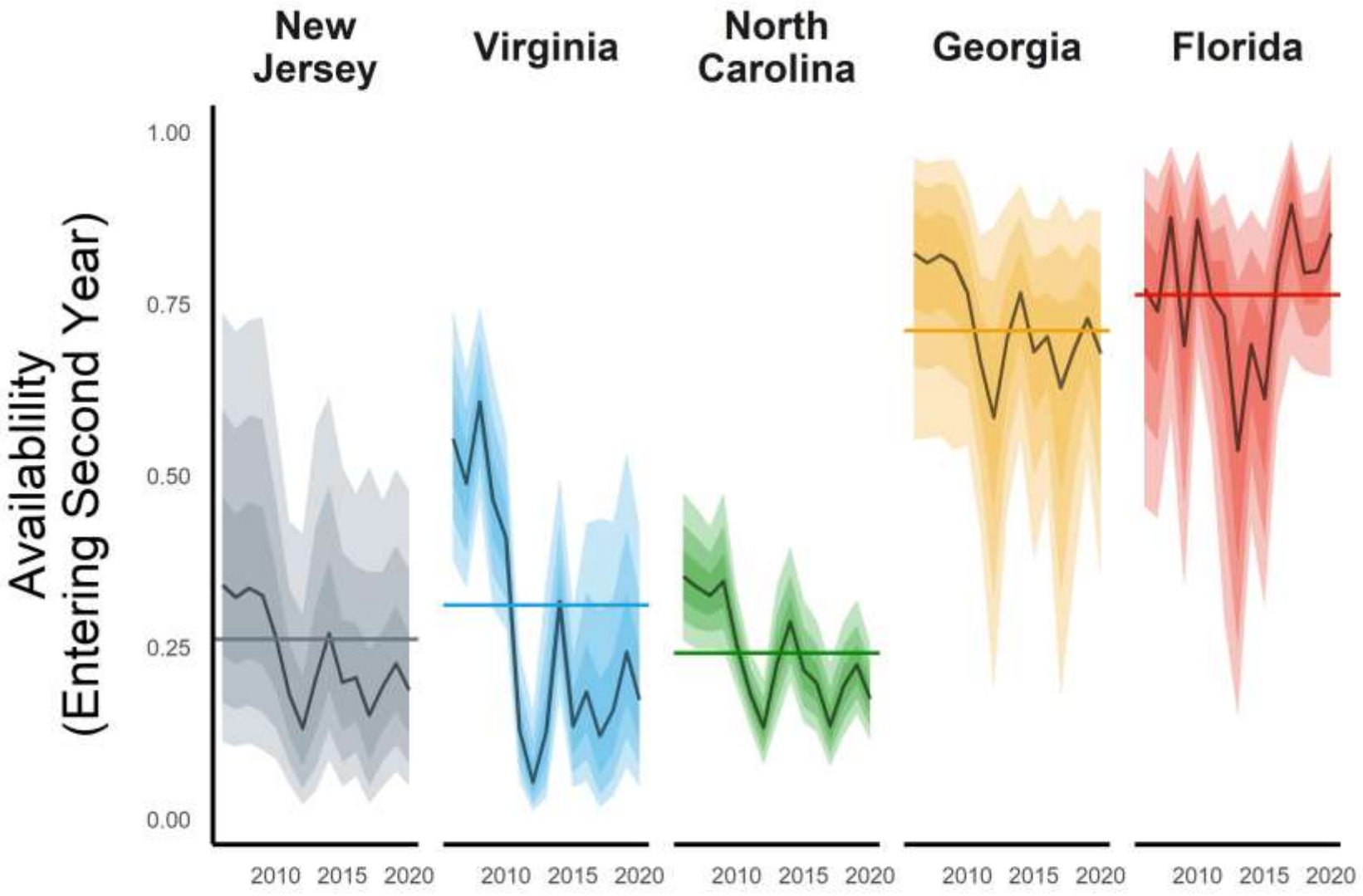
What can we derive from this model?

- For each age-class and state:
  1. Survival
  2. Maturation rates
  3. Availability (i.e., returned to natal state)
  4. Permanent emigration (i.e., breeding in a different state)
  5. Post-maturation breeding propensities
- For NC and GA:
  - Per-capita chick production rates
  - Population growth rates
  - Breeding population size
  - Spring breeding and non-breeding population sizes
  - The number of individuals temporarily associated with a different state
  - Immigration + slop

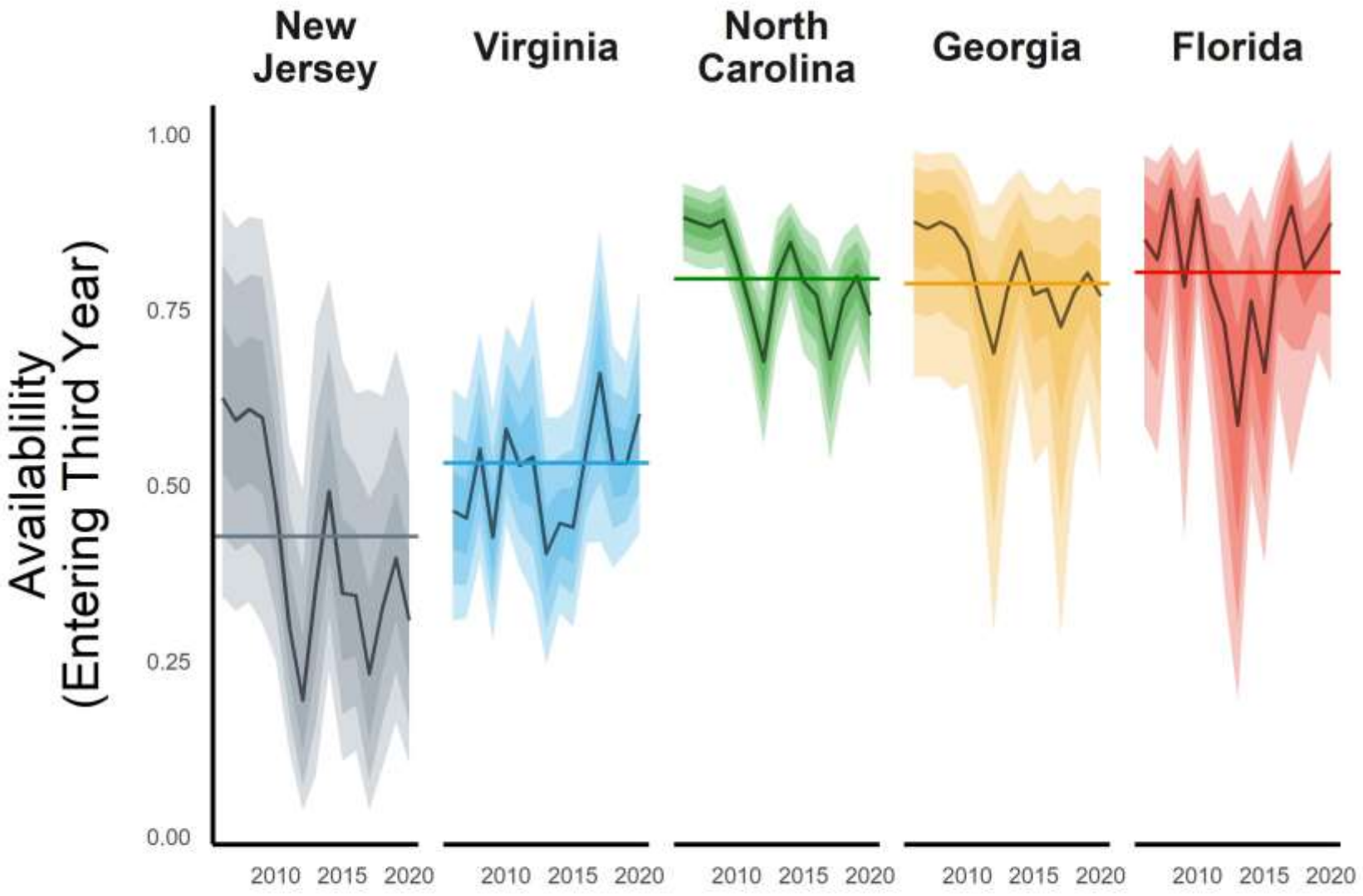


- Spatial variation in demographic rates is the focus for today

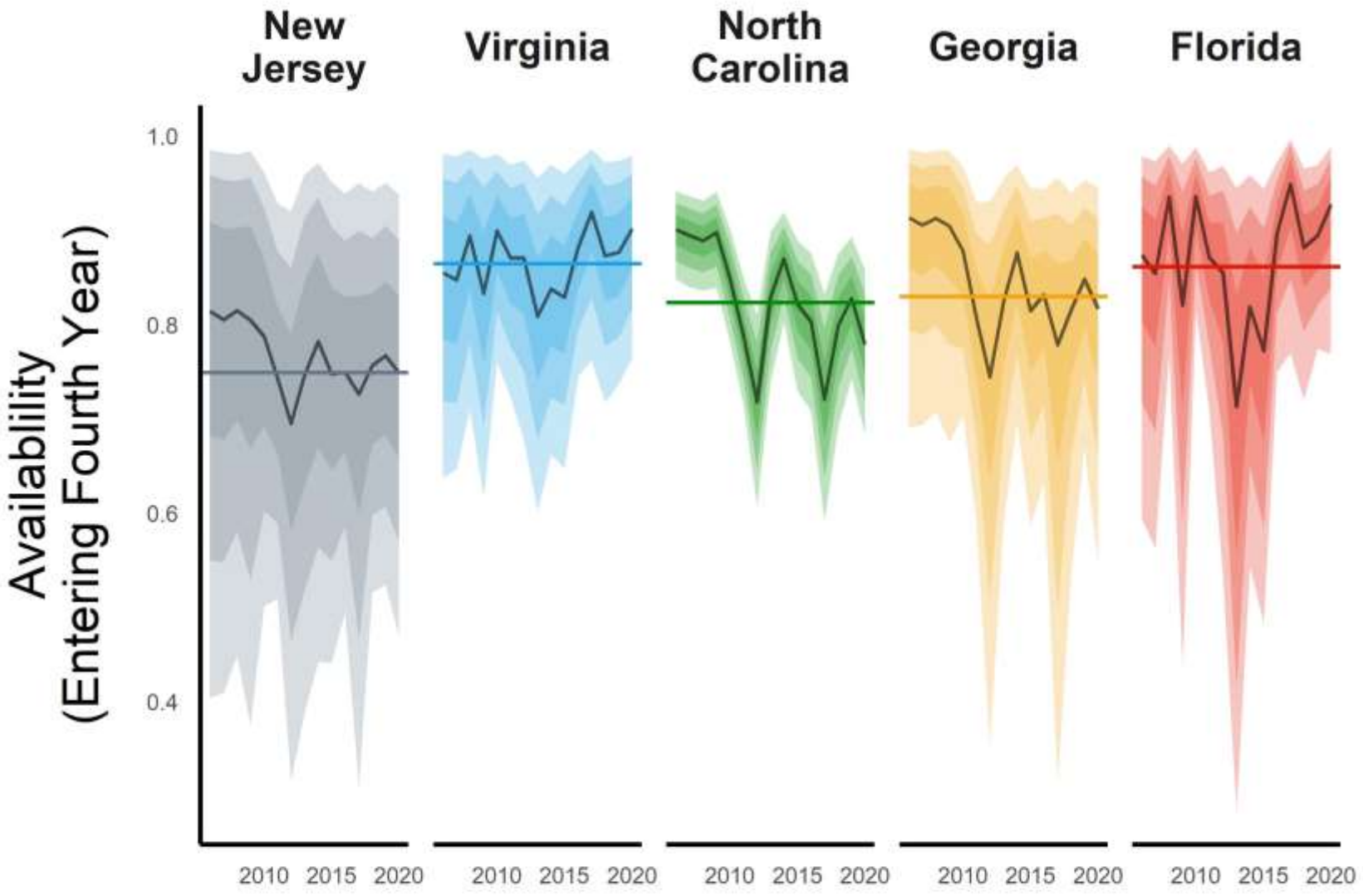
Probability of being available for detection in natal state: SY



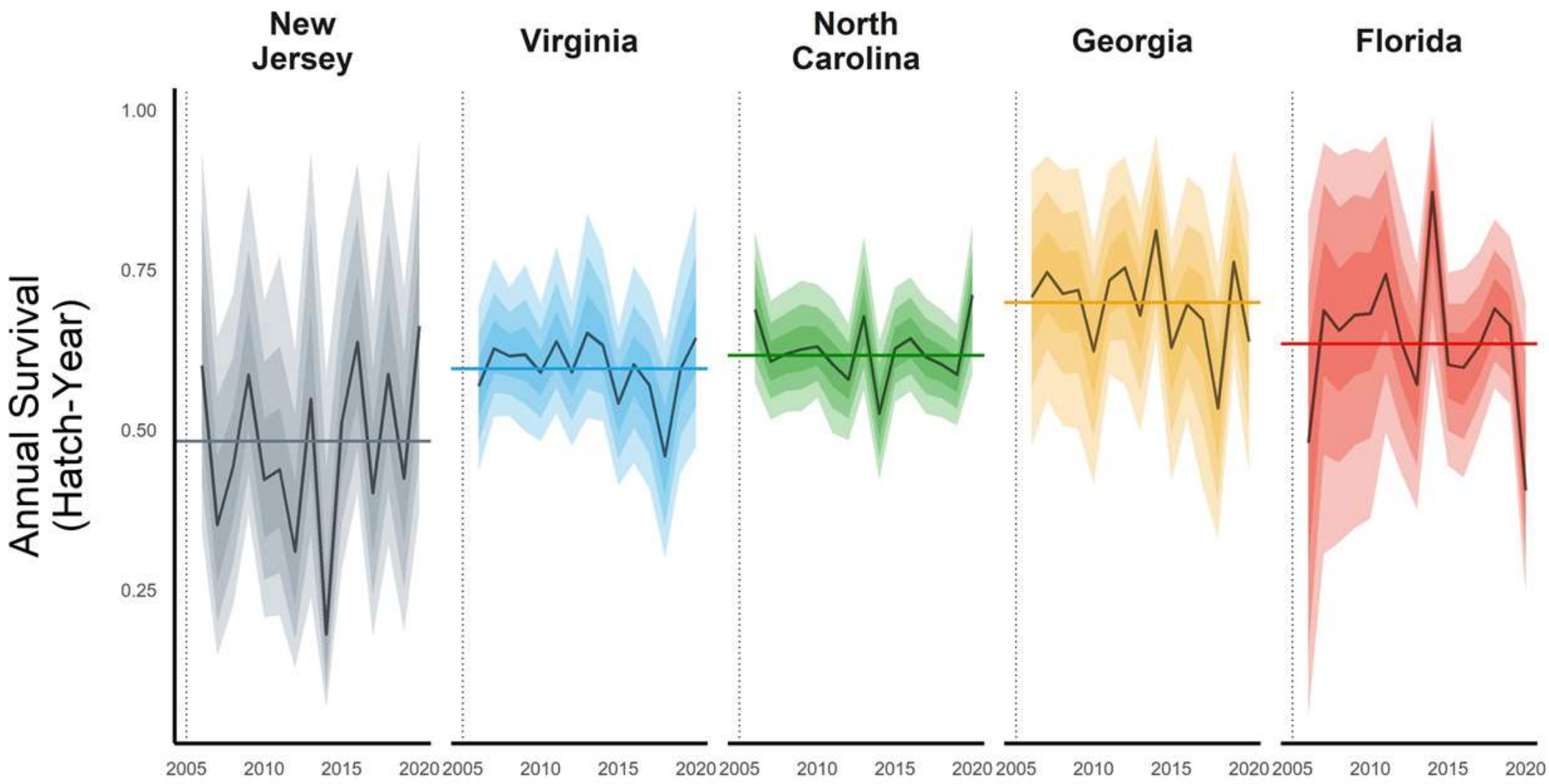
Probability of being available for detection in natal state: TY



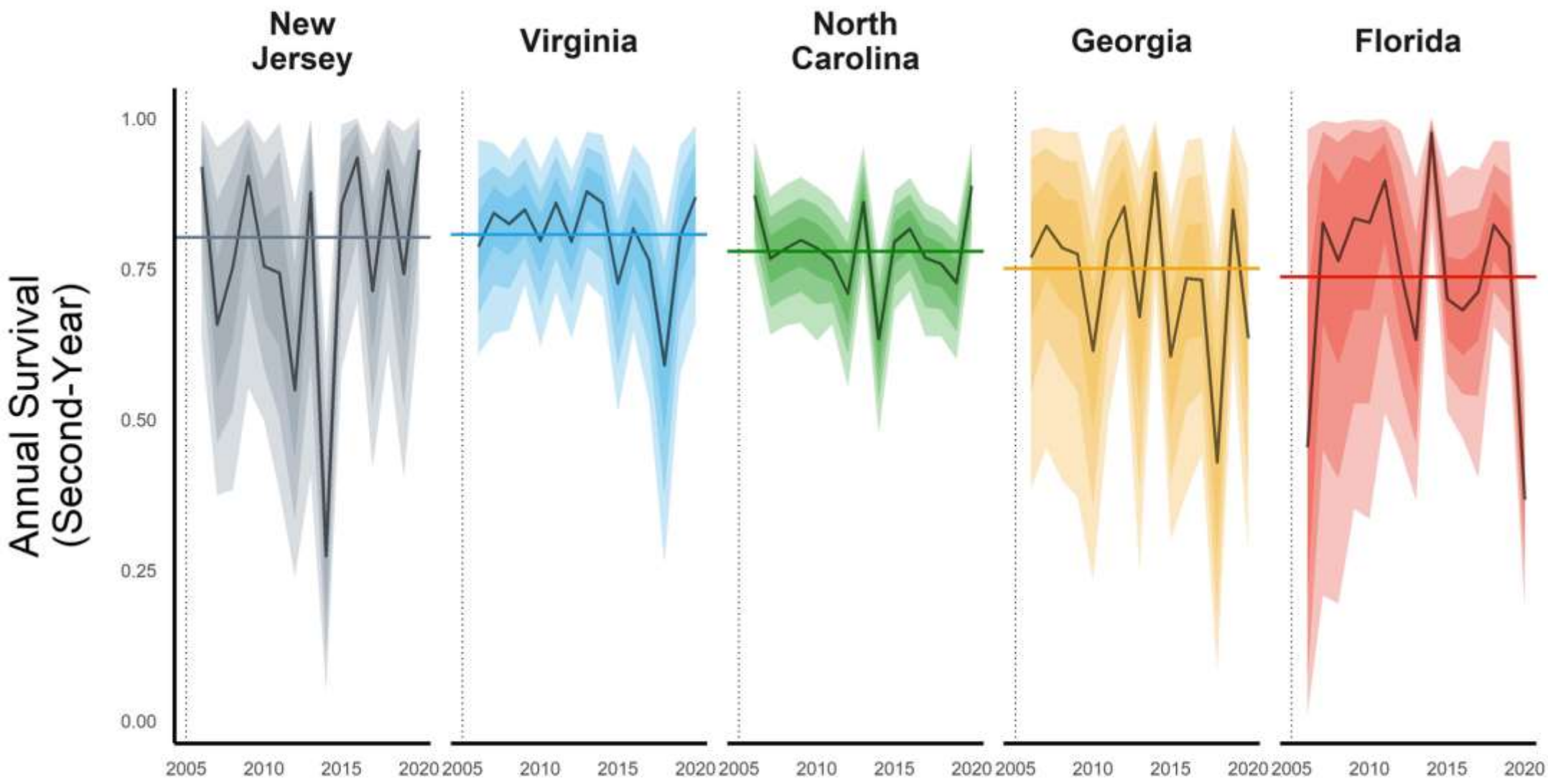
Probability of being available for detection in natal state: FY



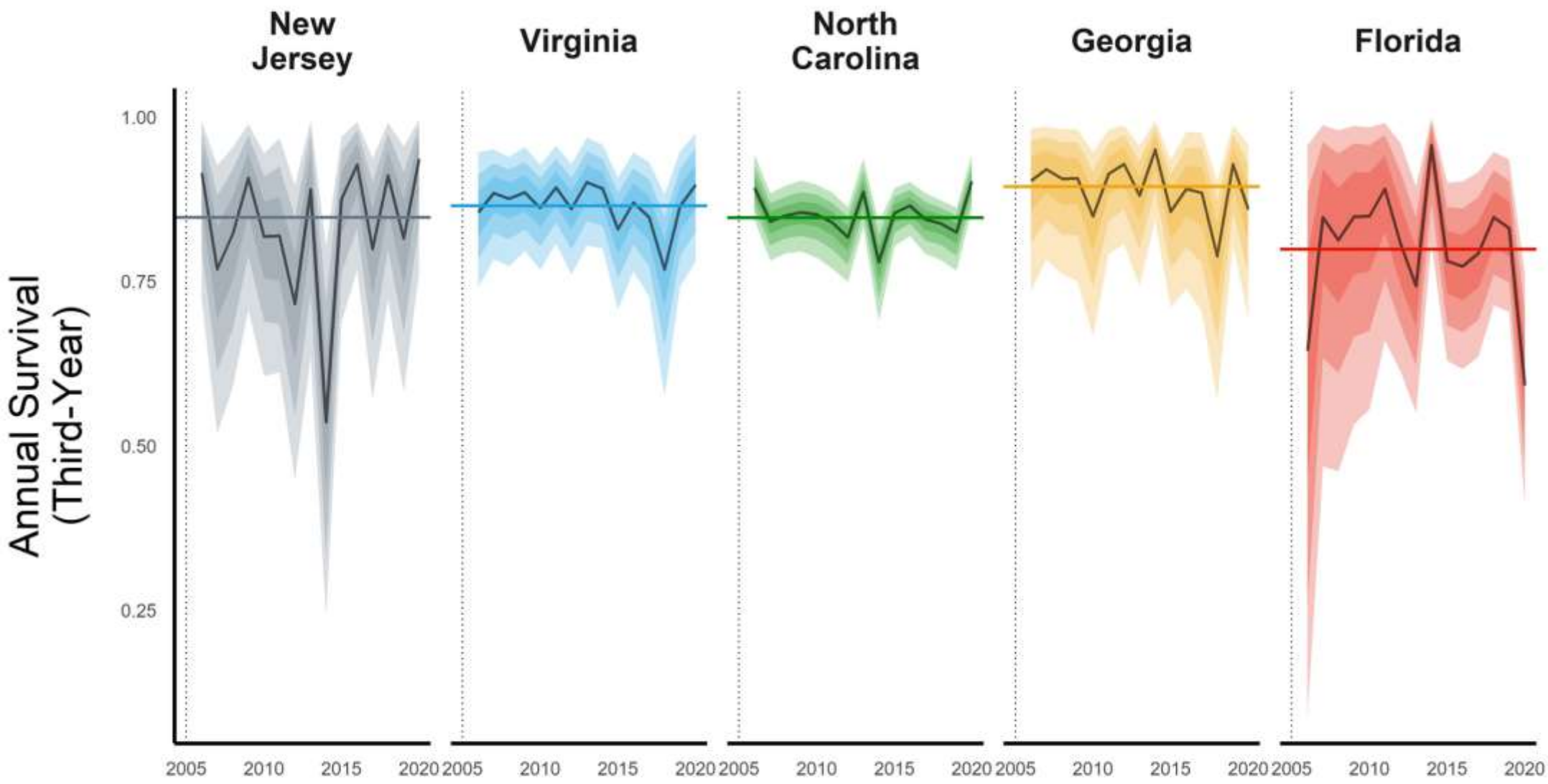
Survival: Hatch-year



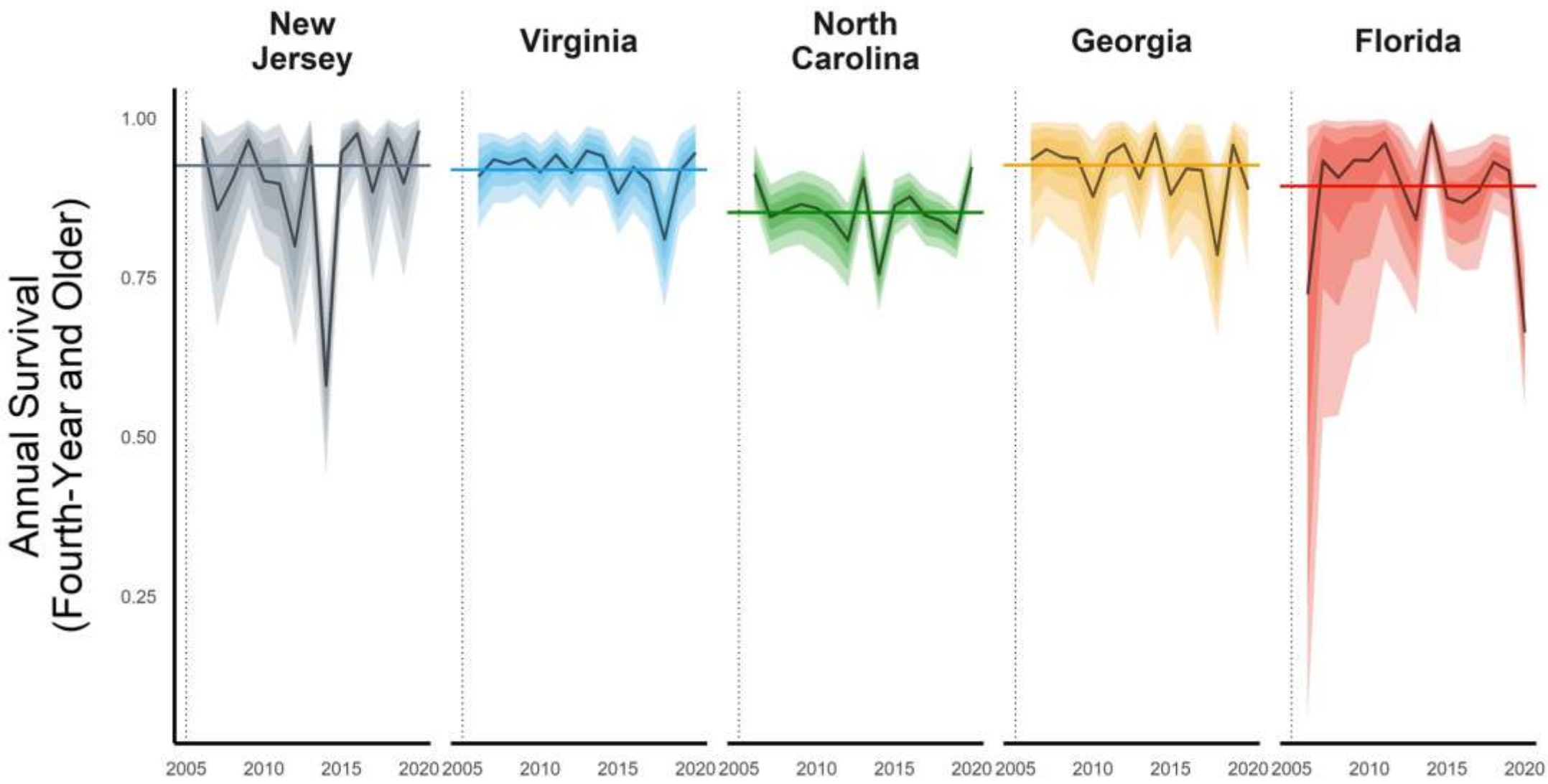
Survival: Second-Year



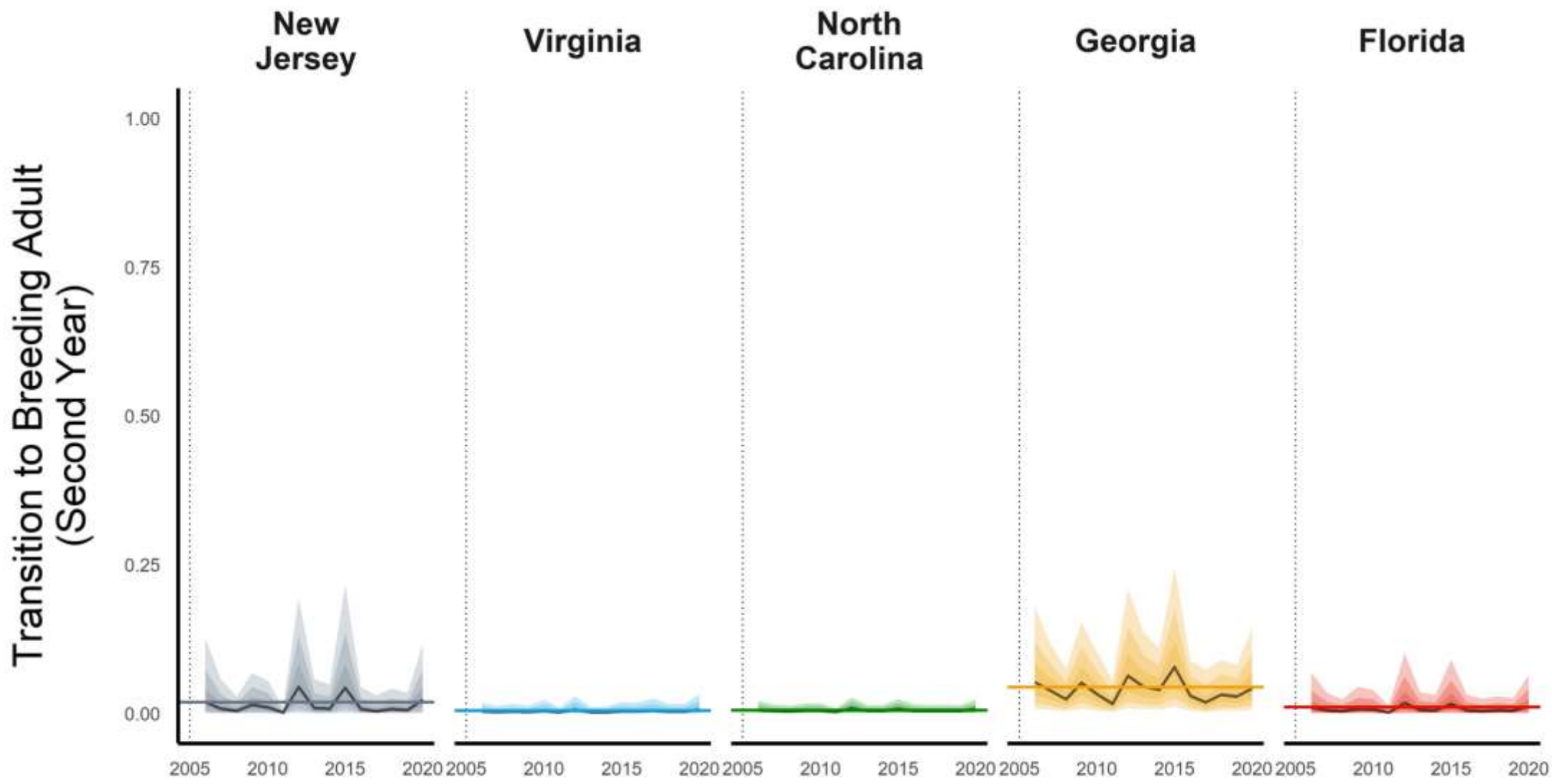
Survival: Third-Year



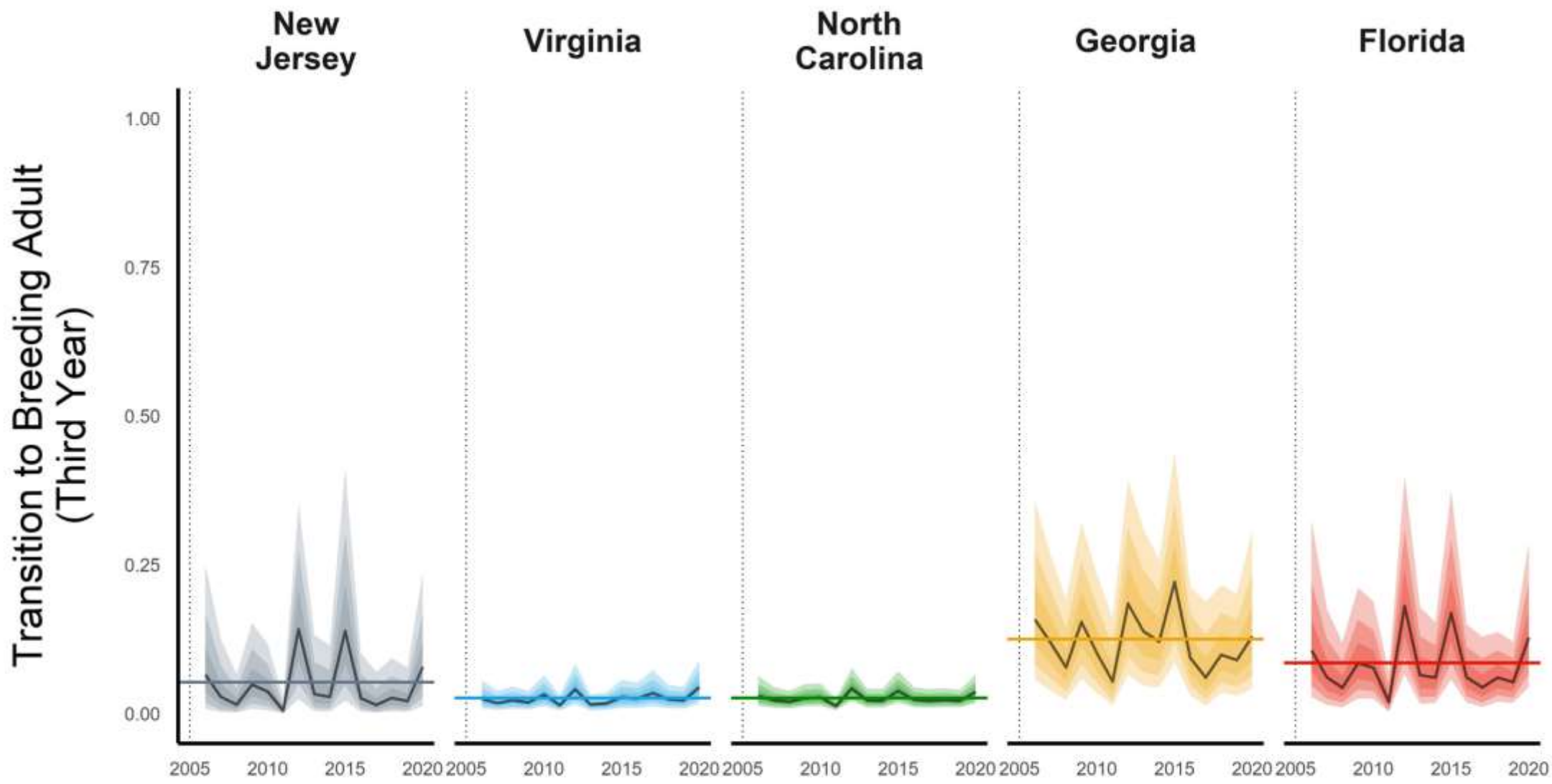
Survival: Fourth Year and Older



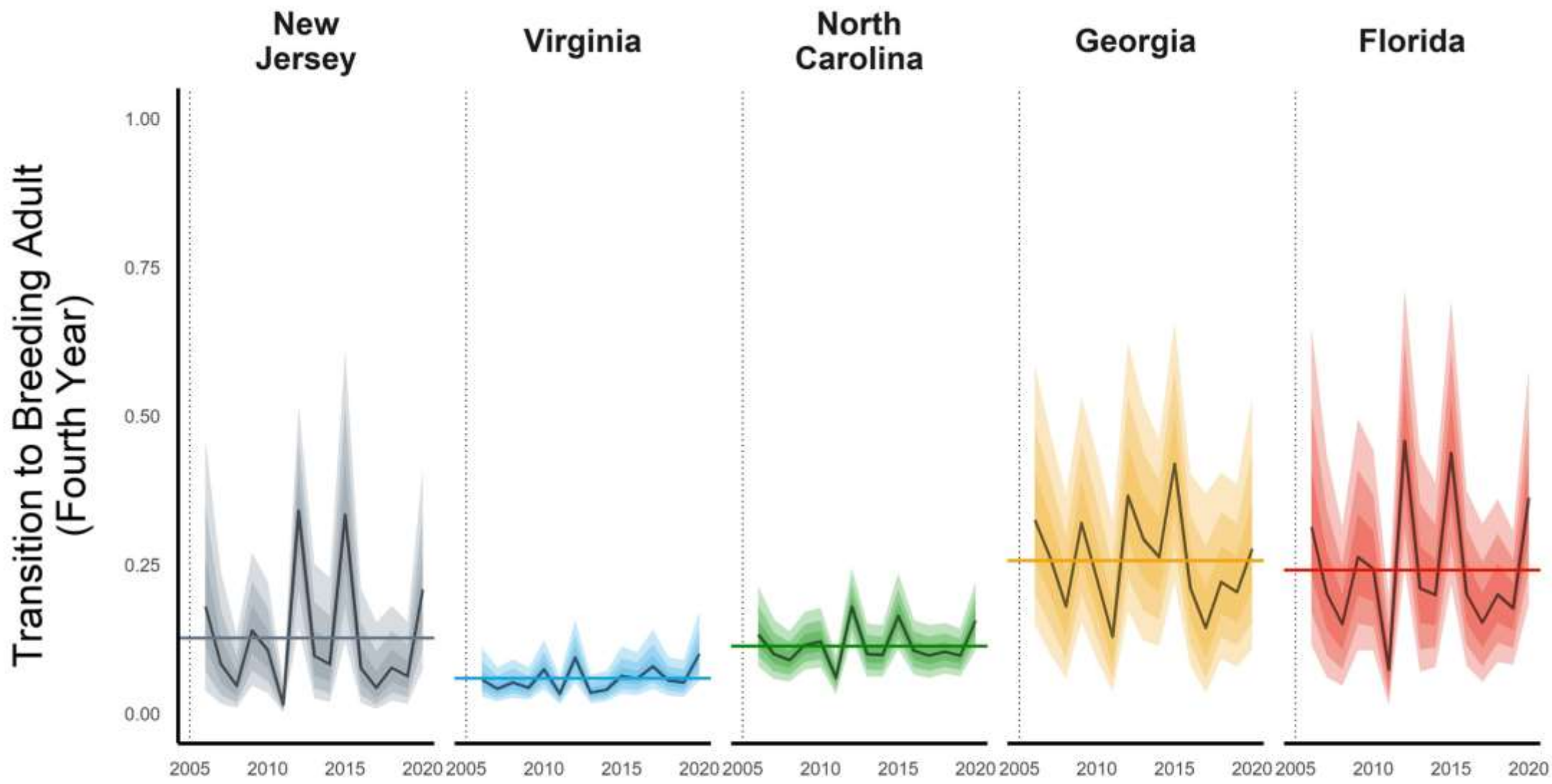
Probability of Maturation: Second-Year



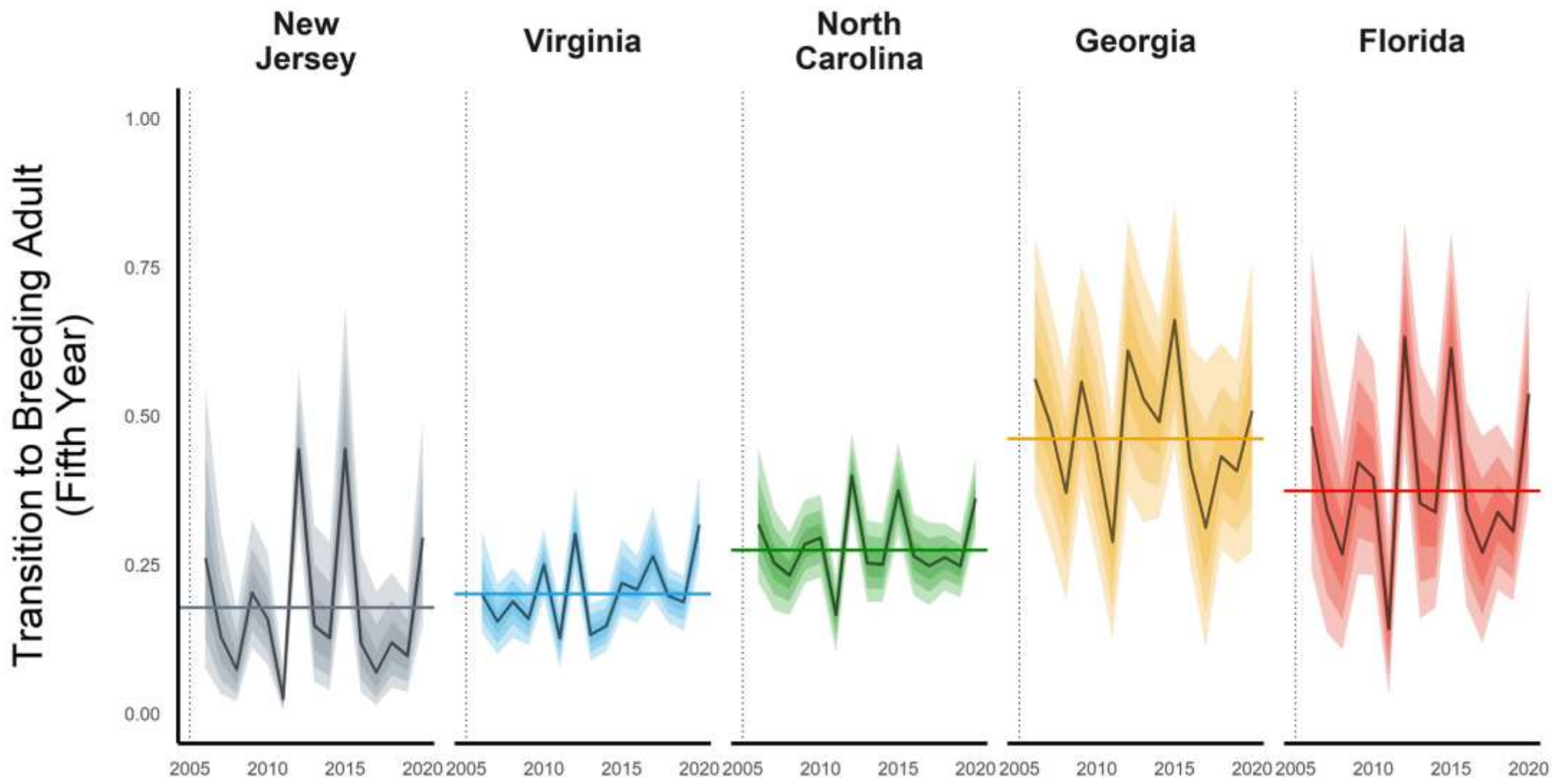
Probability of Maturation: Third-Year



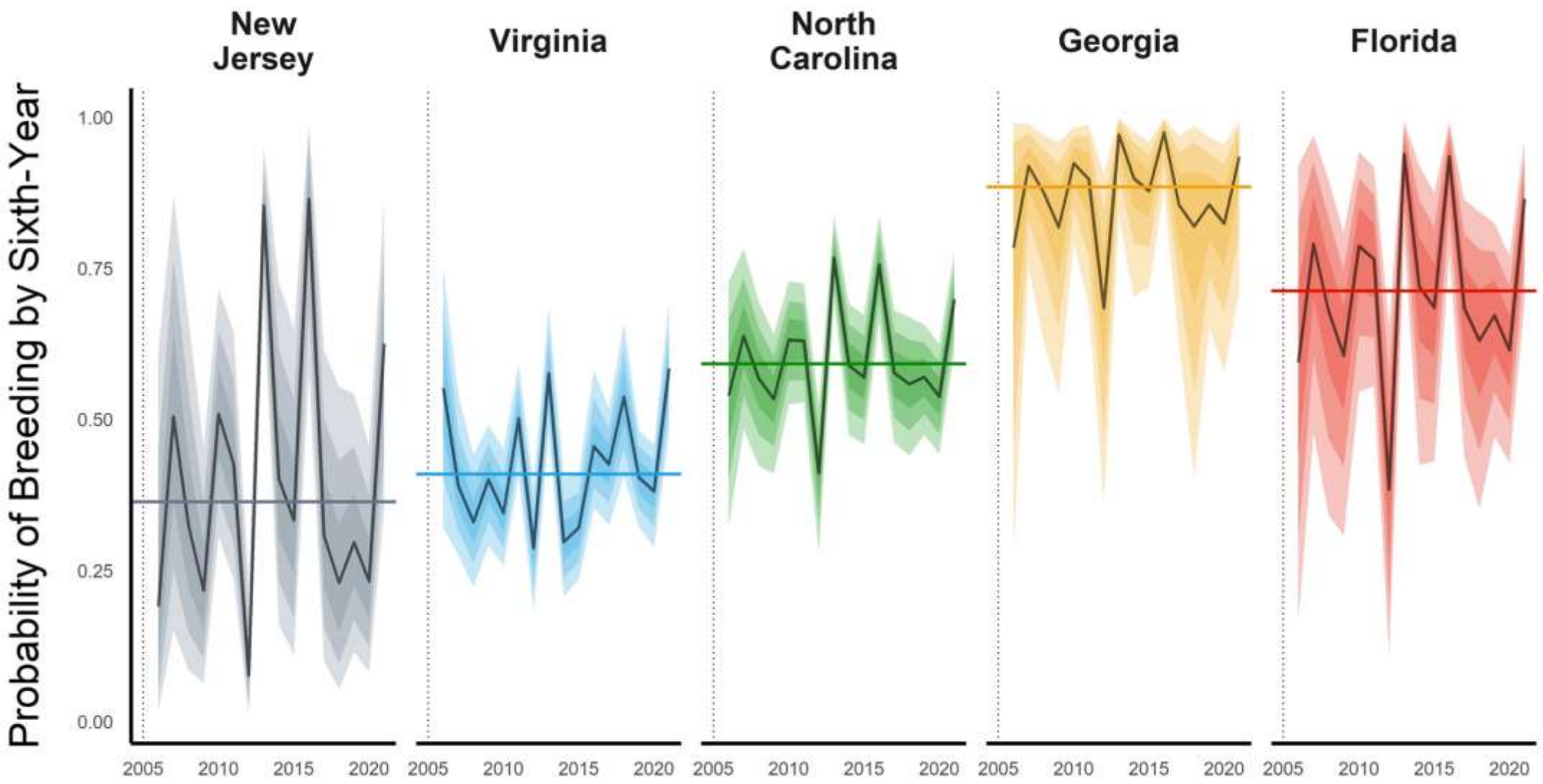
Probability of Maturation: Fourth-Year



Probability of Maturation: Fifth-Year

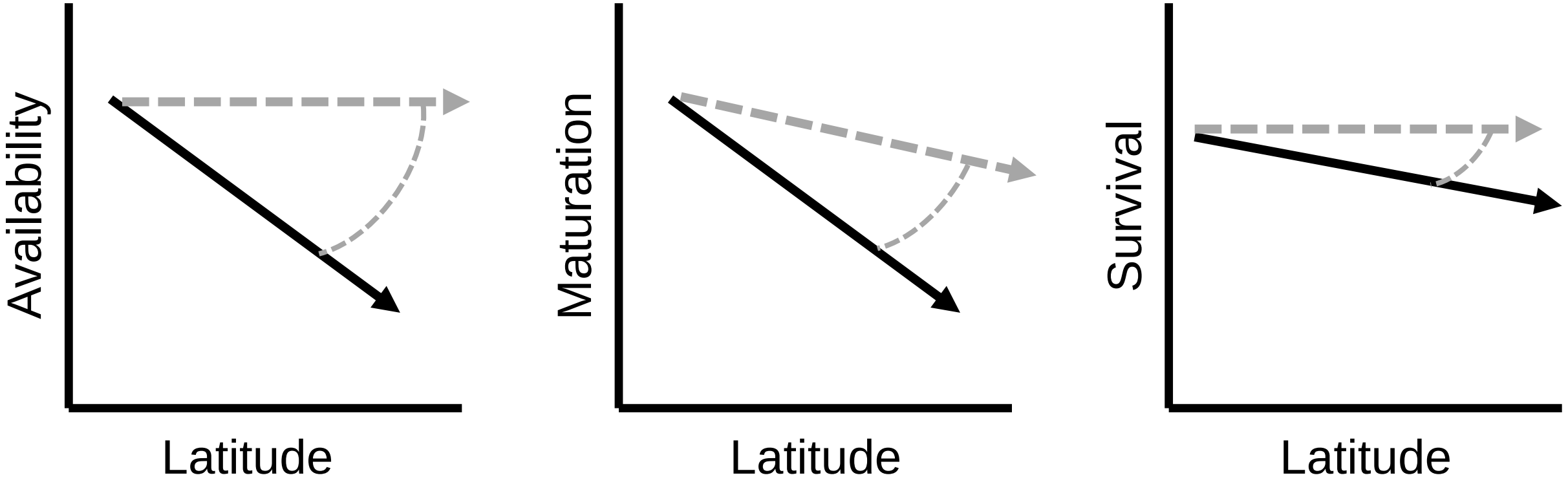


Overall Probability of Maturation by Sixth-Year

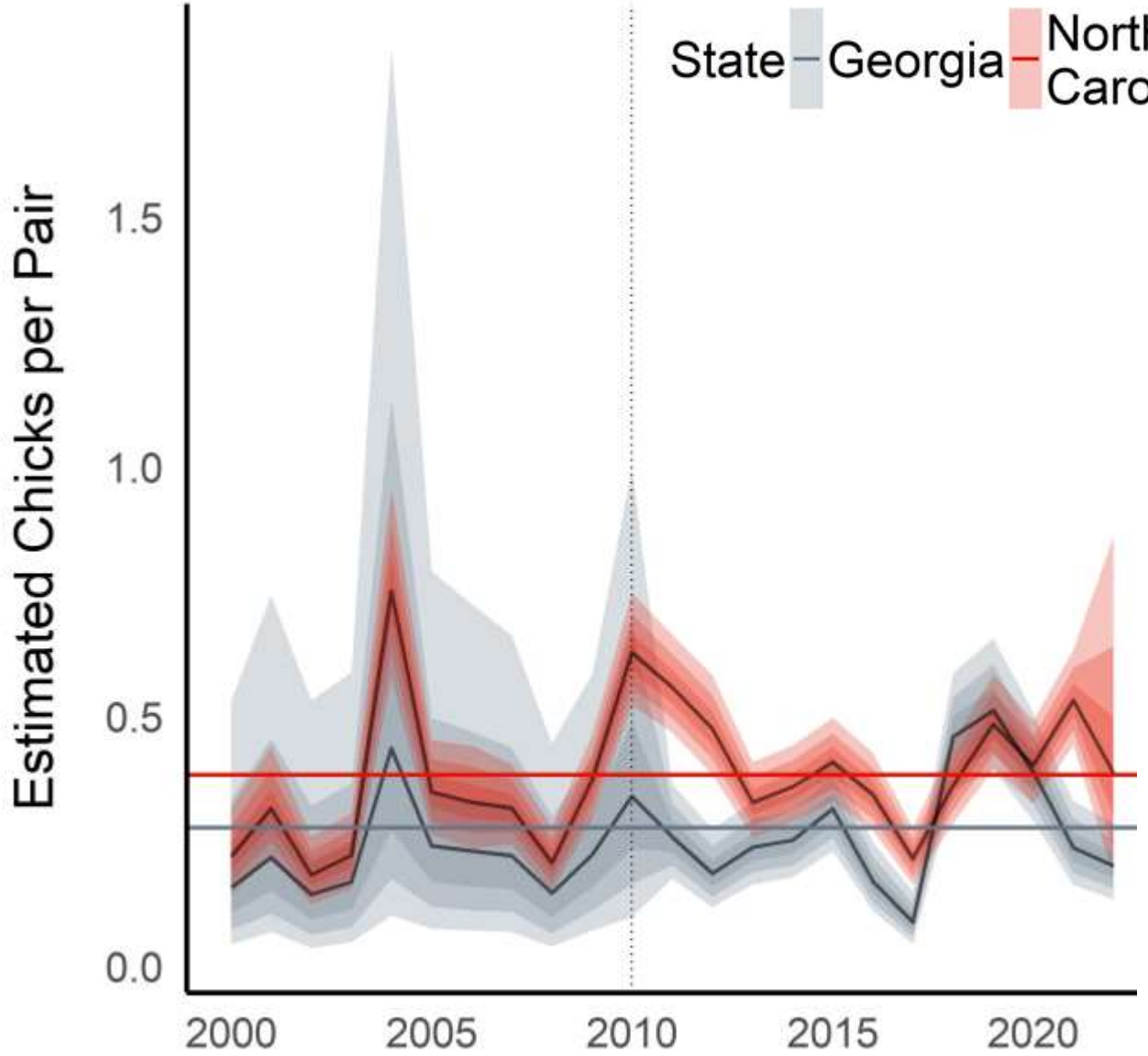


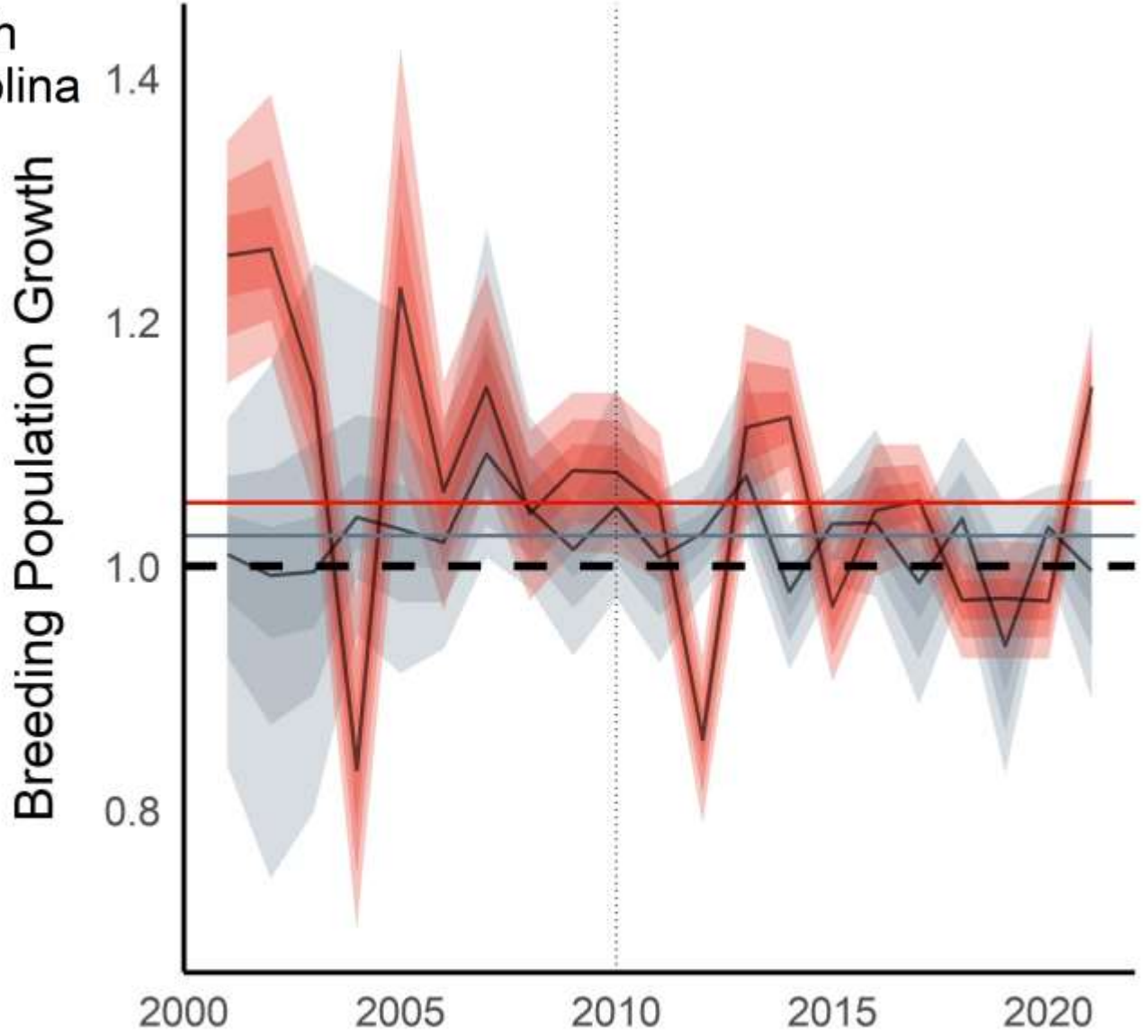
Model indicated spatial variation across parameters

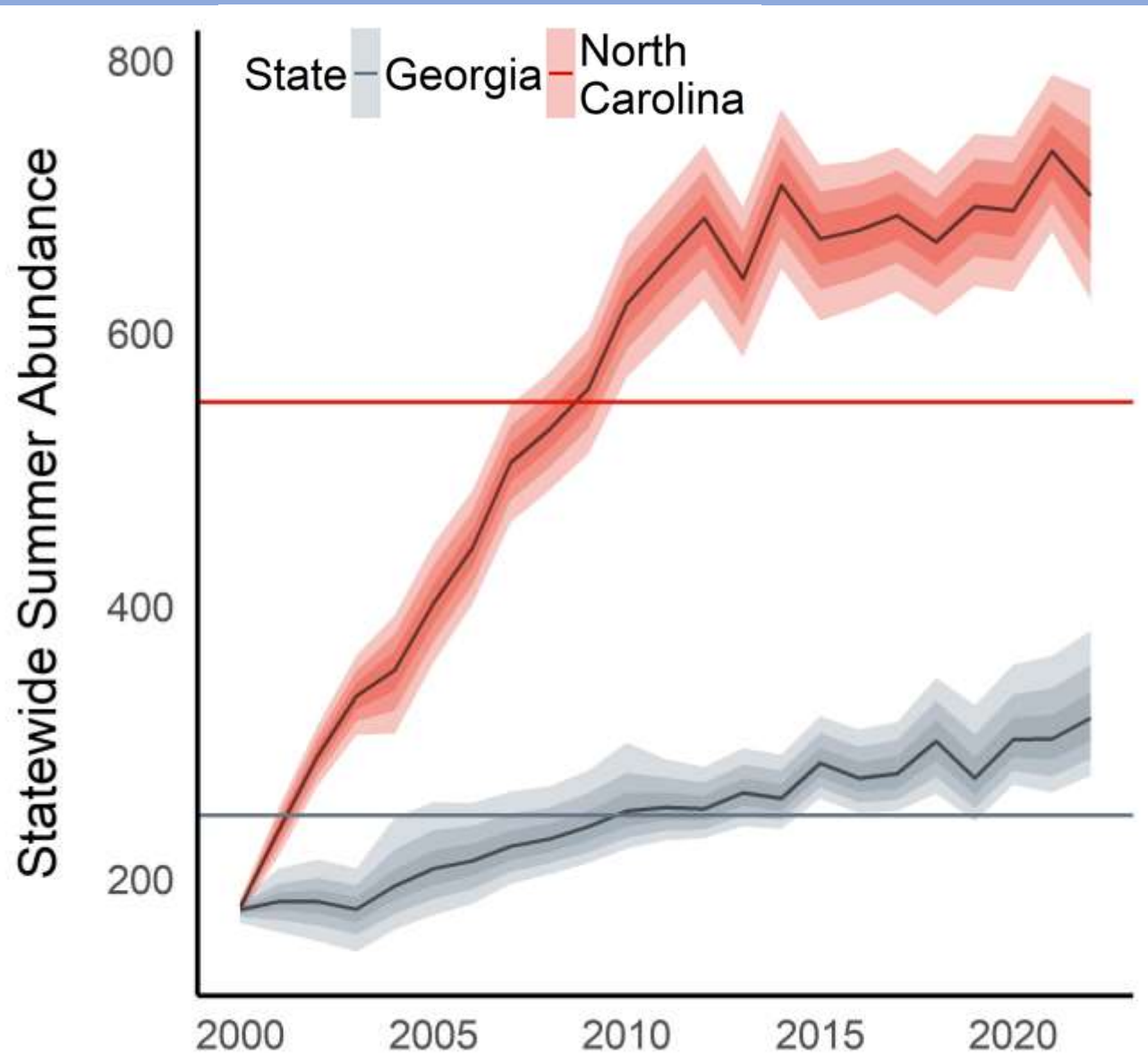
The transition of hatched chicks into the breeding population appears to favor southern populations.

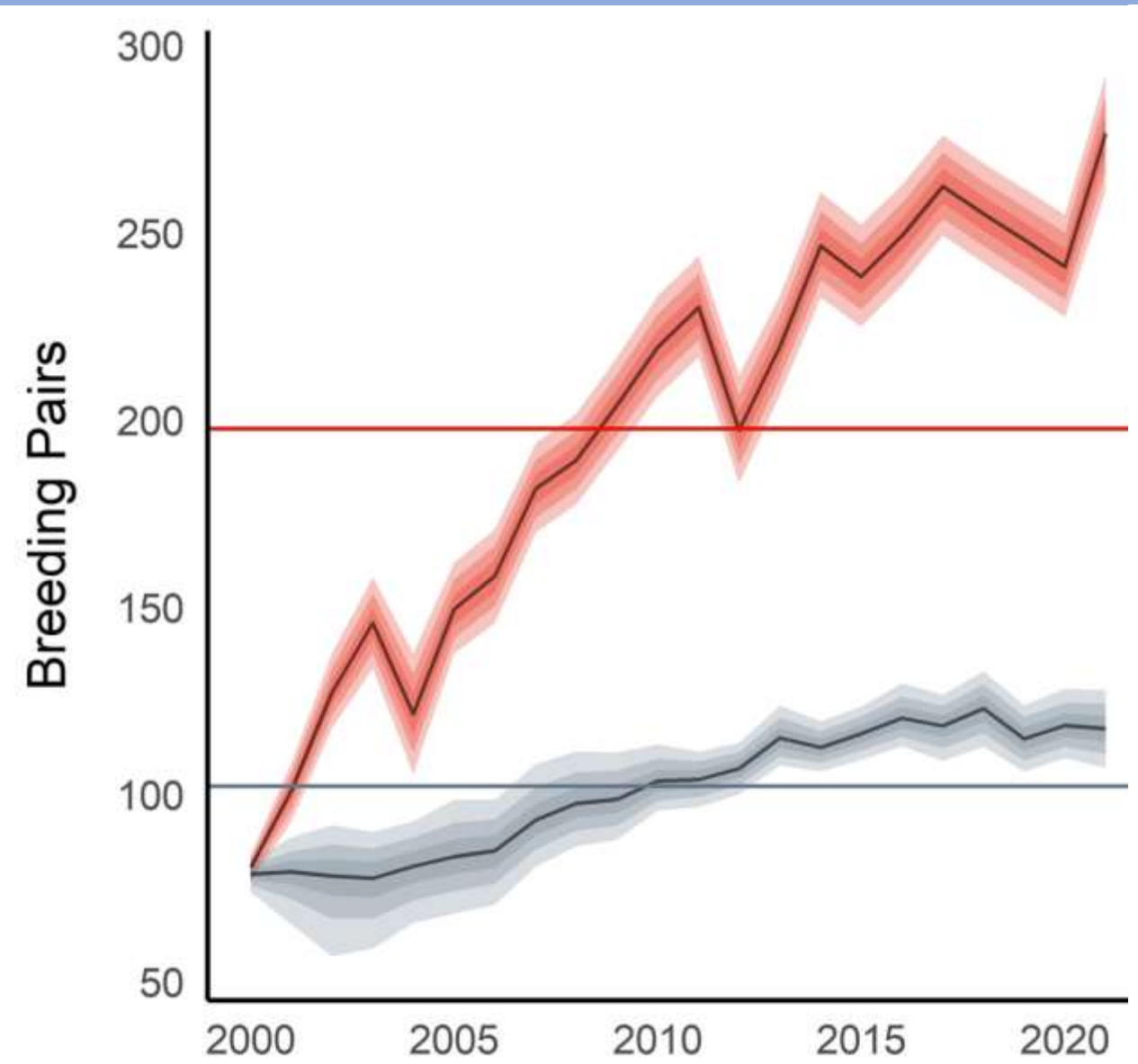


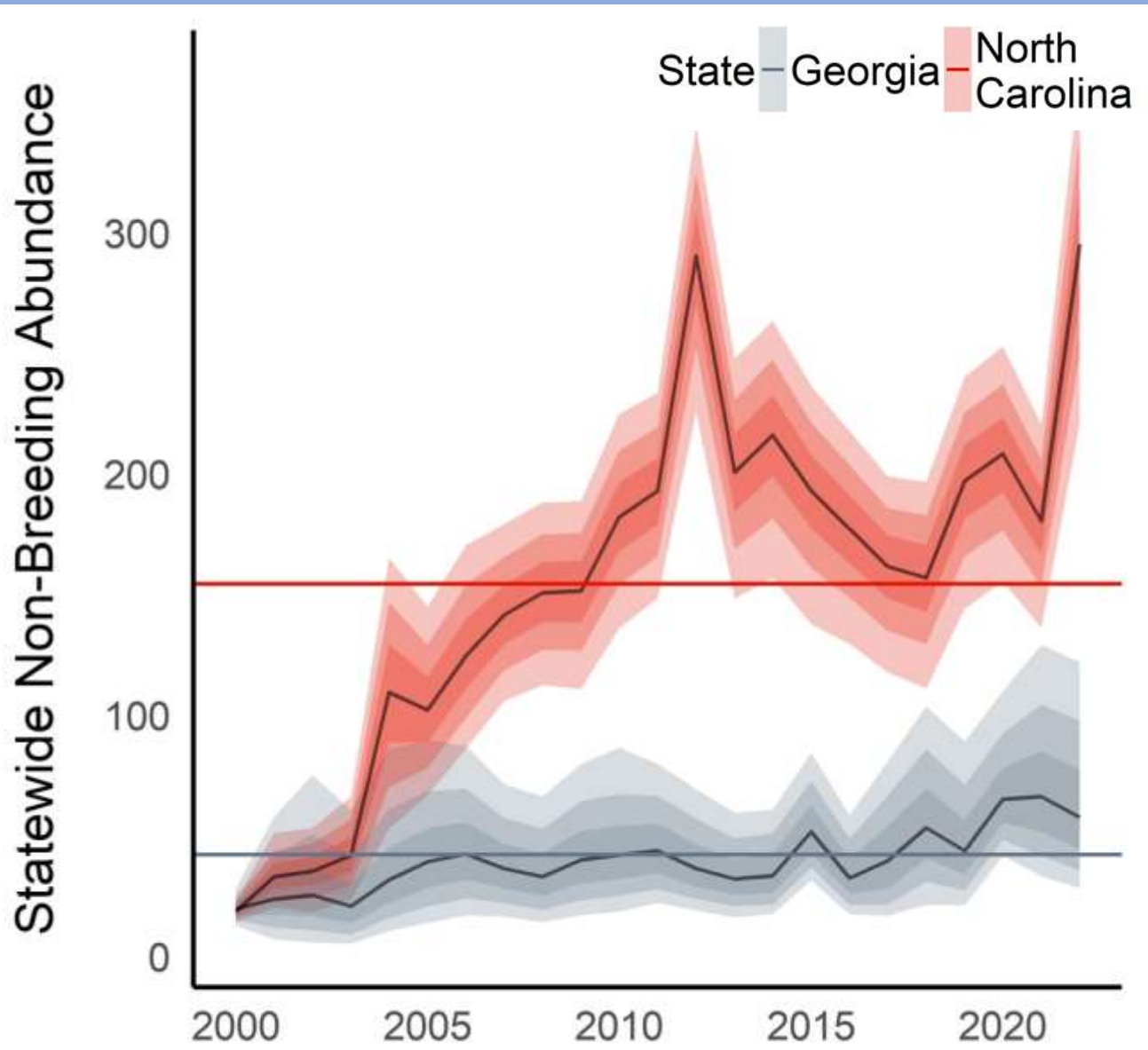
Chick production.



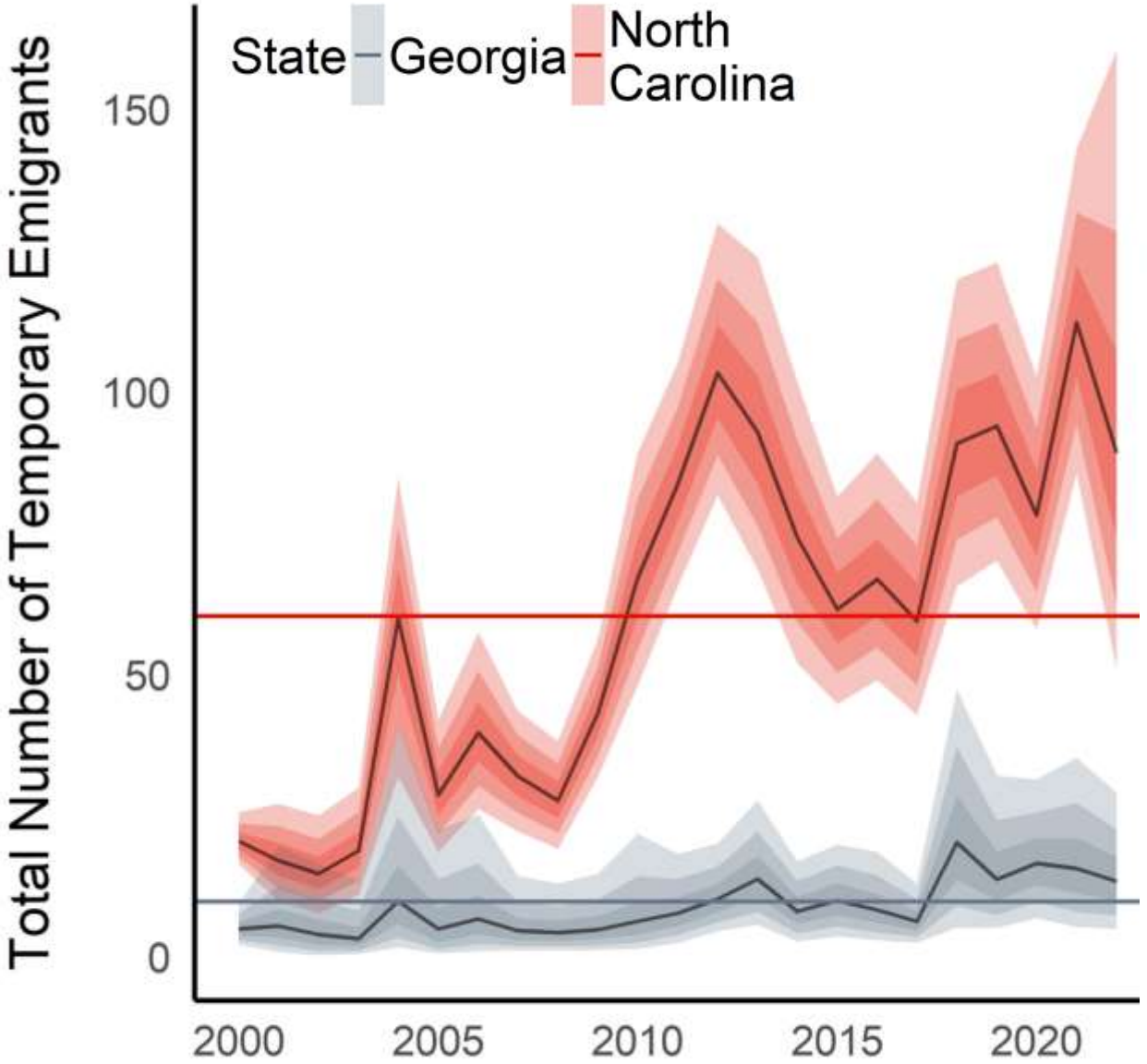


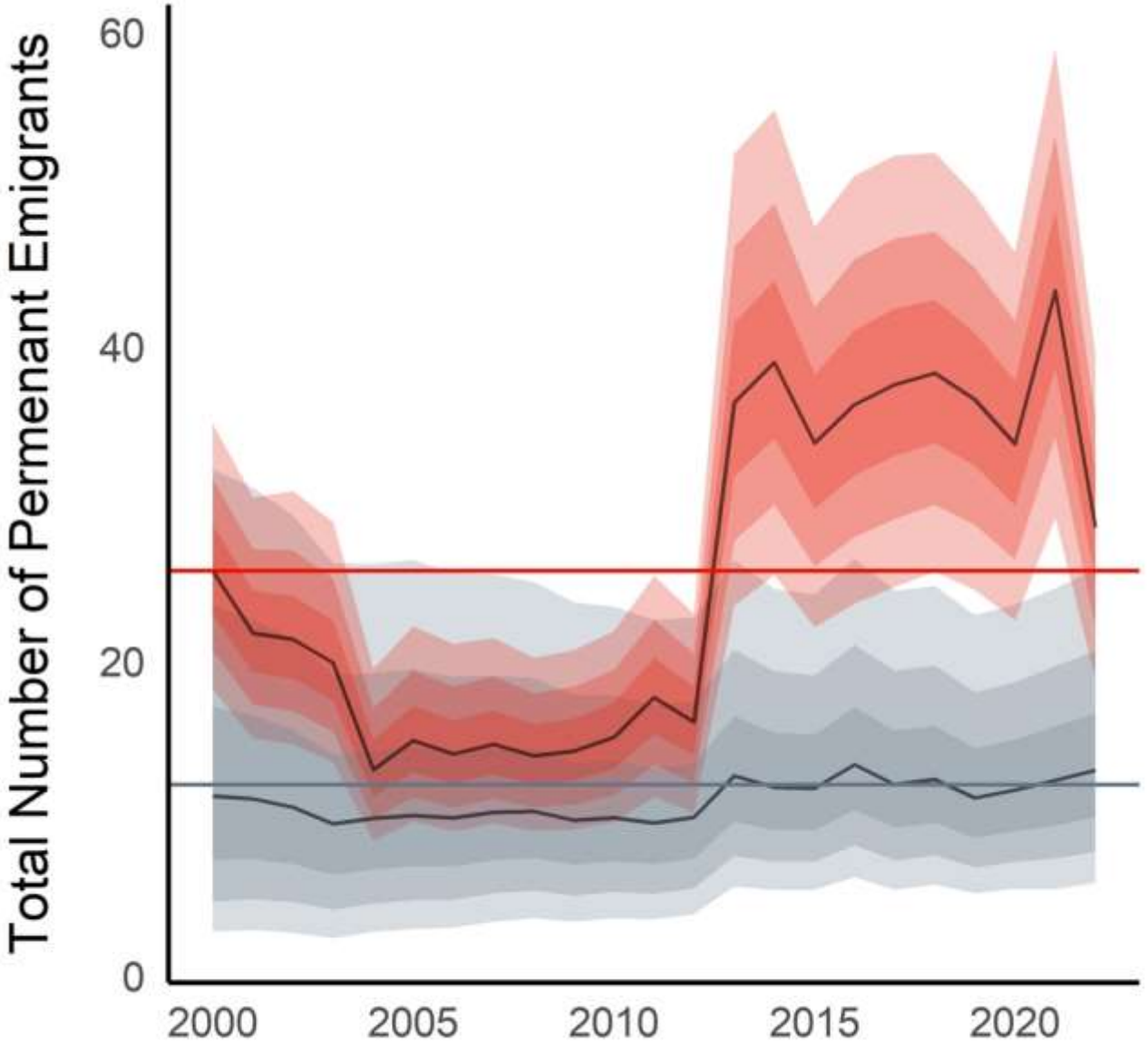

State
Georgia
North Carolina
Statewide Summer Abundance
800
600
400
200
2000
2005
2010
2015
2020


Breeding Pairs
300
250
200
150
100
50
2000
2005
2010
2015
2020

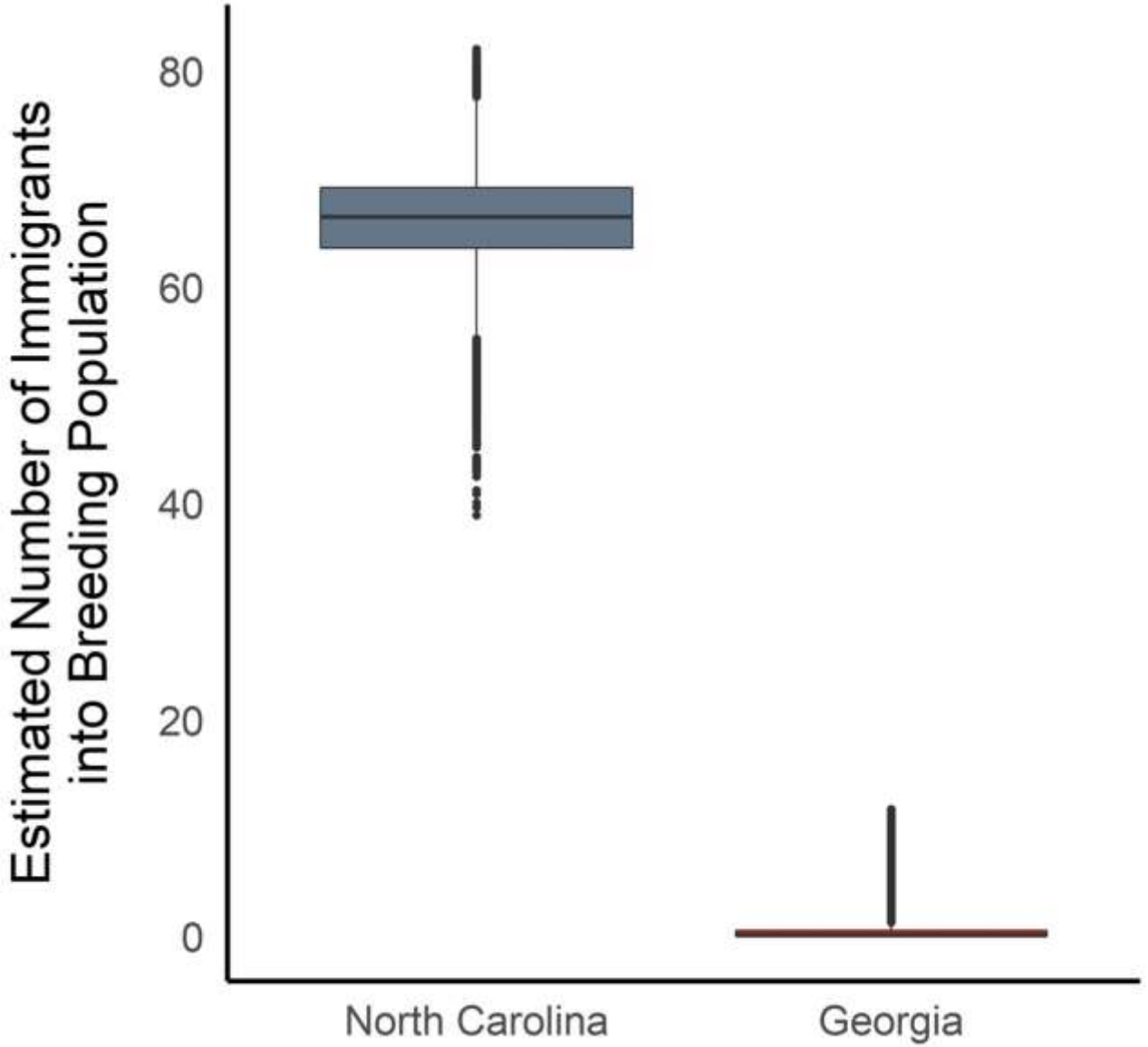

Statewide Non-Breeding Abundance
State
Georgia
North Carolina
300
200
100
0
2000
2005
2010
2015
2020

Evidence for meta-population dynamics





Survival and Production does not fully explain λ in NC

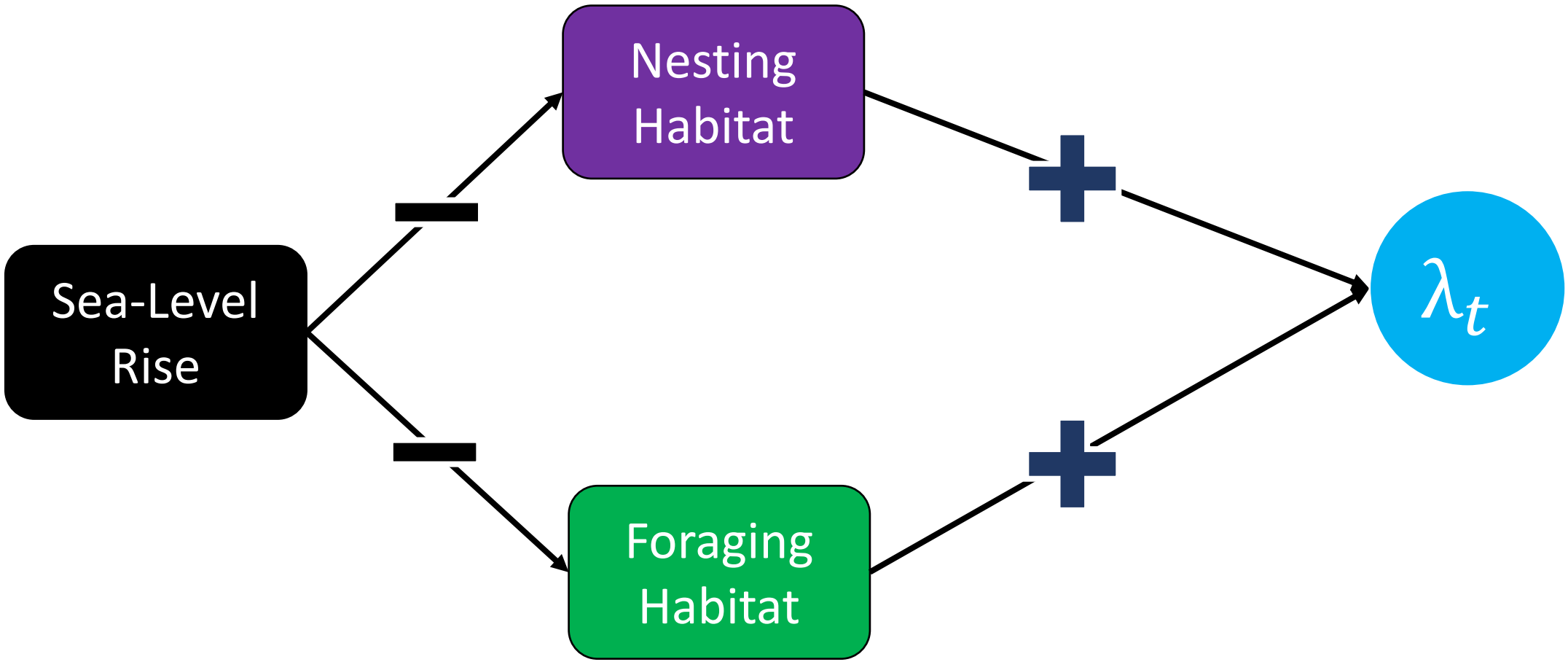


Future Directions

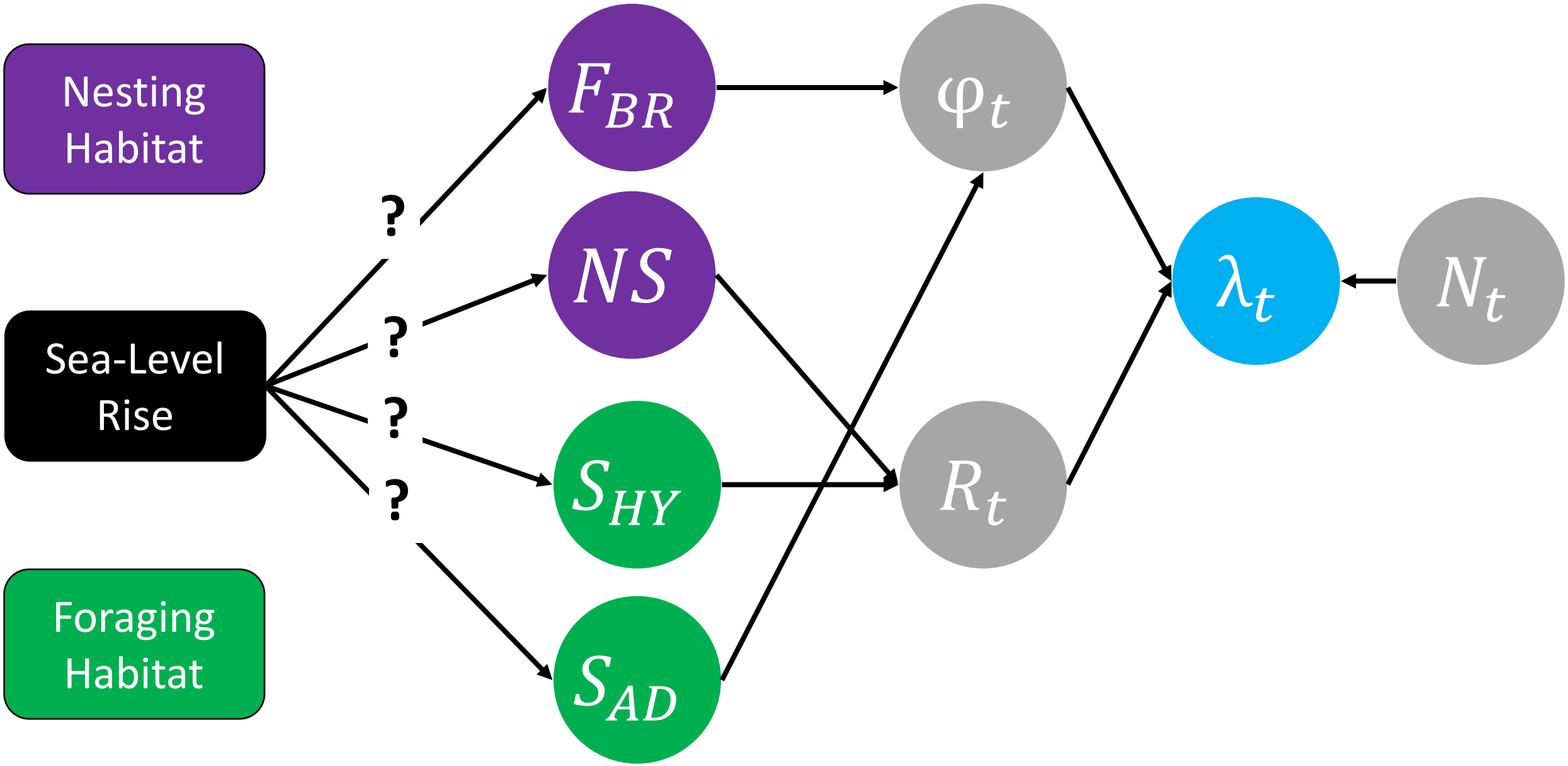
- The model is incomplete …
  - Increase the number of states/regions
  - Productivity model would benefit from increased spatial and demographic resolution.
  - Explicitly model region-region movements of individuals.

- The model is not currently designed to ‘explain’ anything

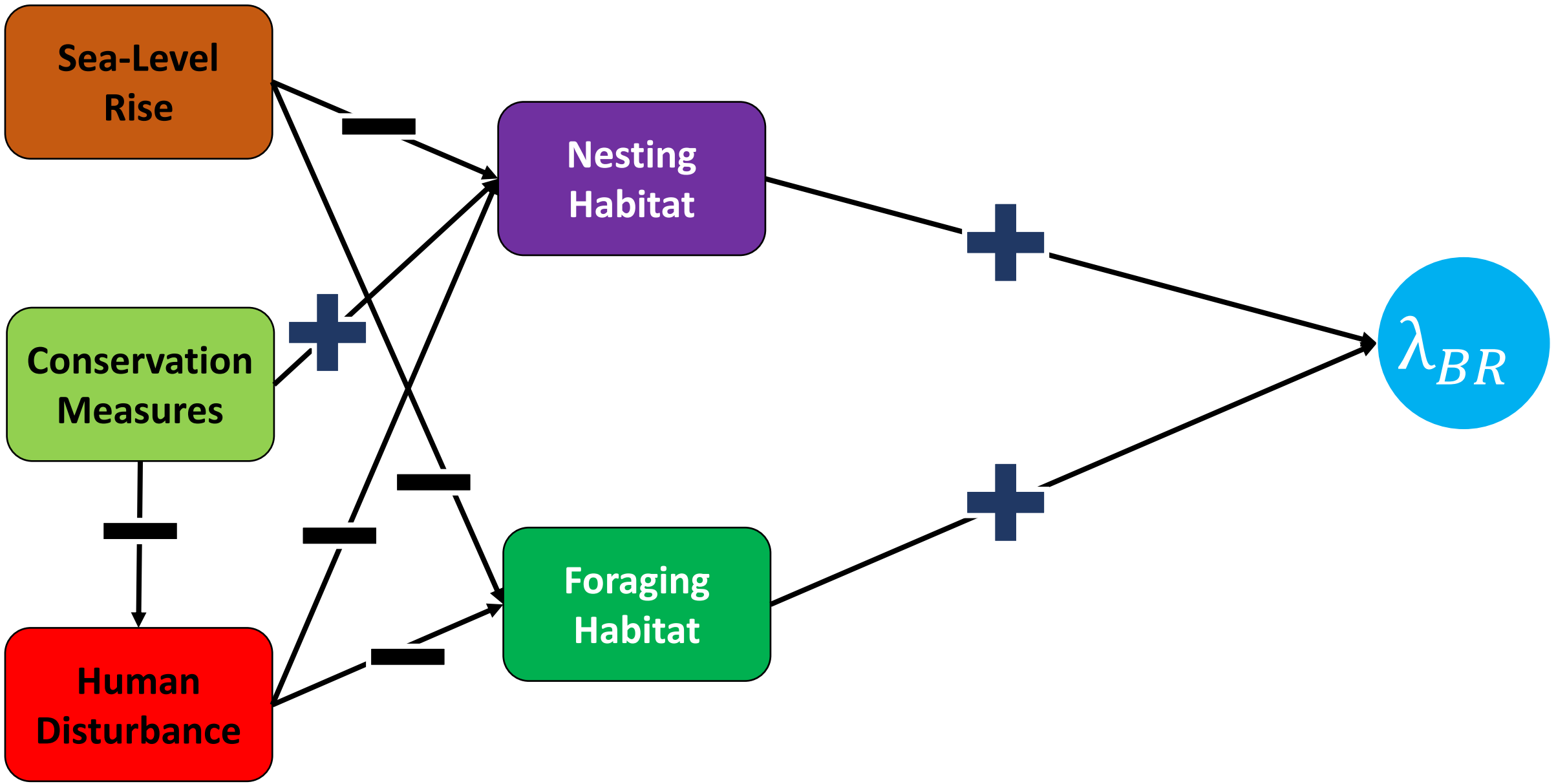
Use of IPMS in AMOY conservation planning?



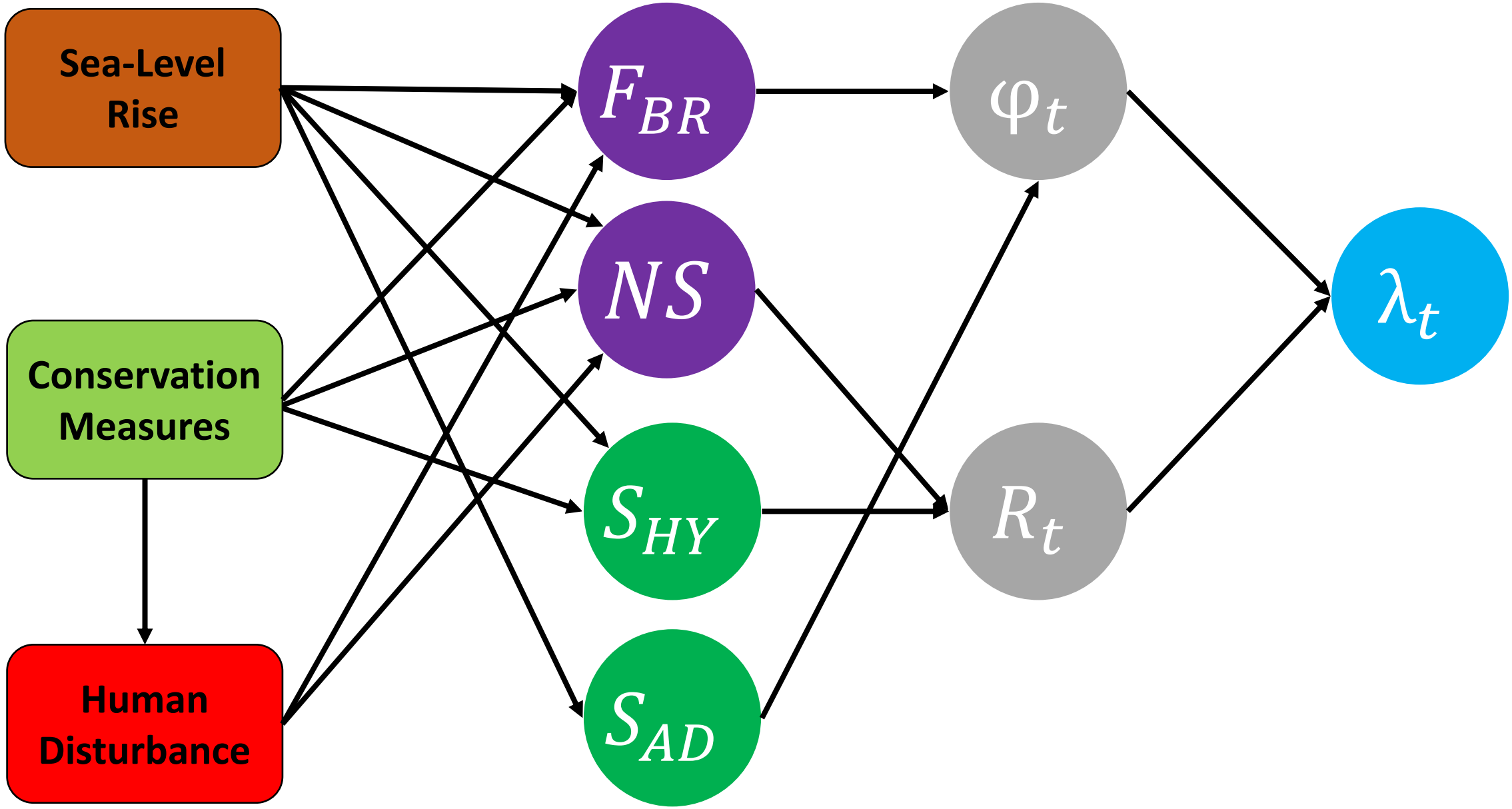
Use of IPMS in AMOY conservation planning?



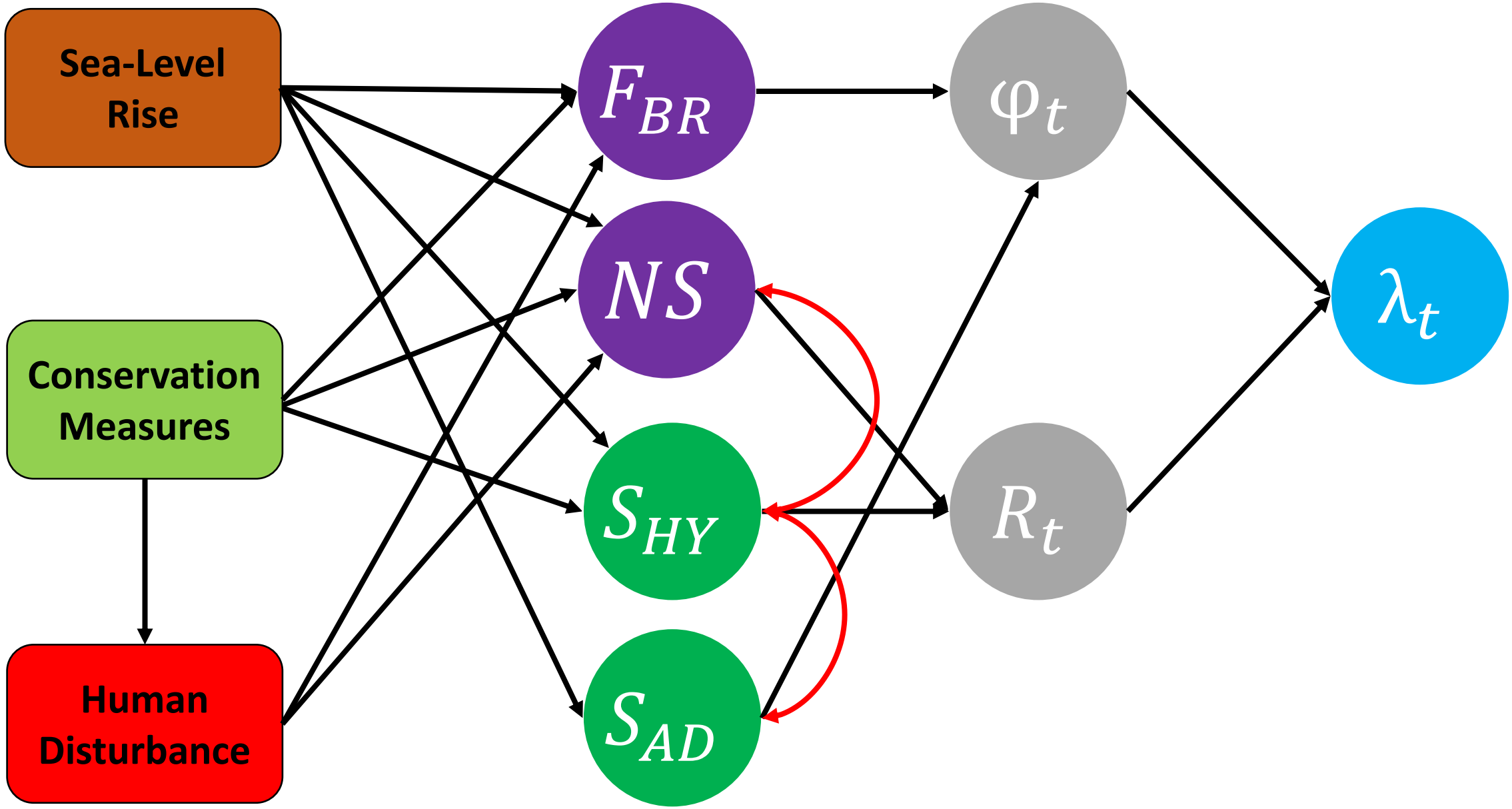
Use of IPMS in AMOY conservation planning?



Use of IPMS in AMOY conservation planning?



Use of IPMS in AMOY conservation planning?



Discussion

- What's needed?
  - Interest
    - Institutional 'buy-in' in the conceptual design of the scenario building framework.
    - Capacity to, at least, maintain current levels of data collection efforts into the foreseeable future.
  - Support
    - Maintenance and potential expansion of the flyway demographic databases.
    - Demographic modeling.

End Slide

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Zero-inflated count distributions for capture–mark–reencounter data

Thomas V. Riecke, Daniel Gibson, James S. Sedinger, Michael Schaub

Brothers Michael

Robert Emond

Chris Billman

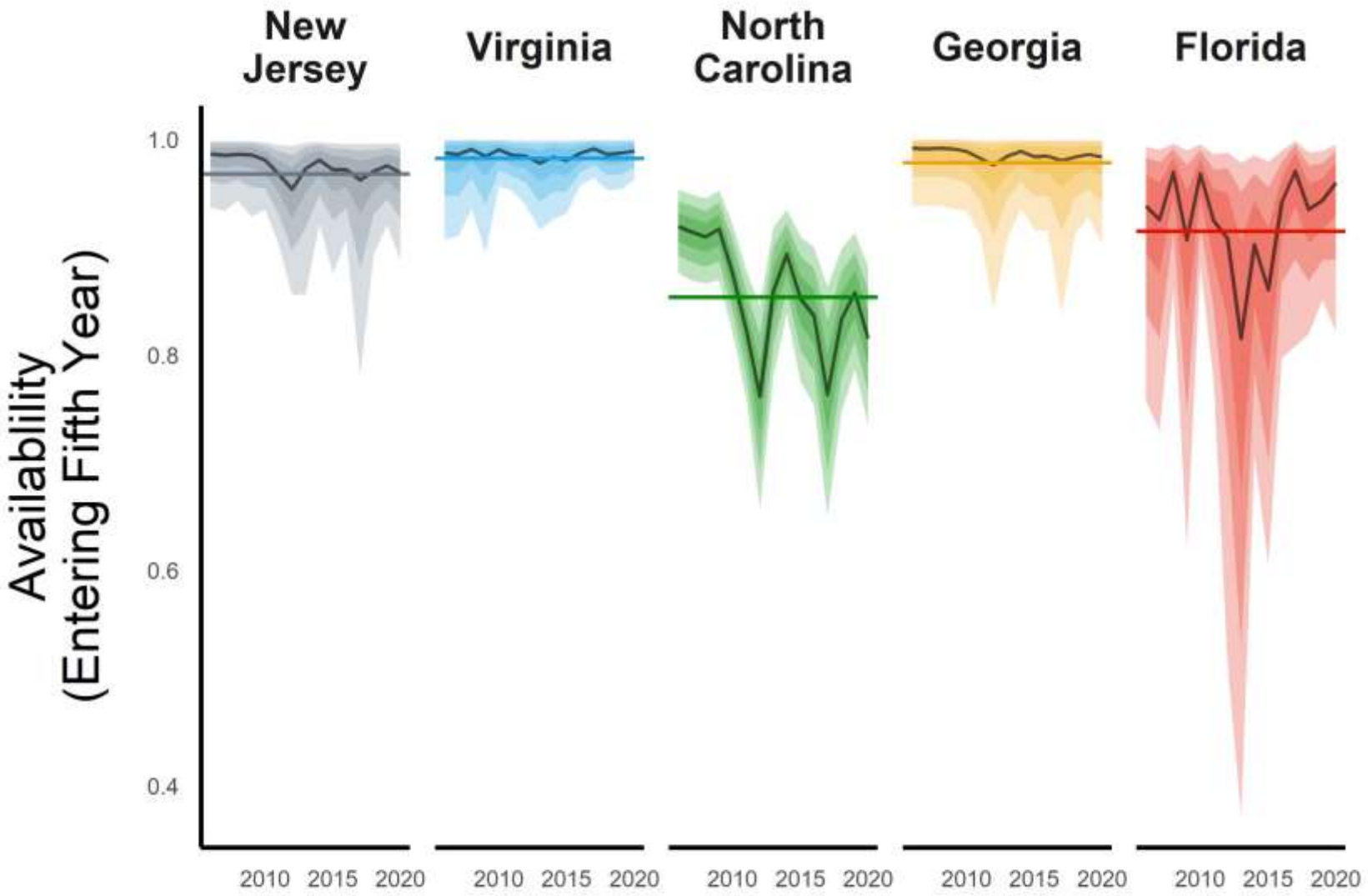
Pam Denmon

Collette Lauzau

Harold Davis

Heterogeniety Index

Individual


New Jersey
Virginia
North Carolina
Georgia
Florida
Availablility (Entering Fifth Year)
1.0
0.8
0.6
0.4
2010 2015 2020
2010 2015 2020
2010 2015 2020
2010 2015 2020
2010 2015 2020