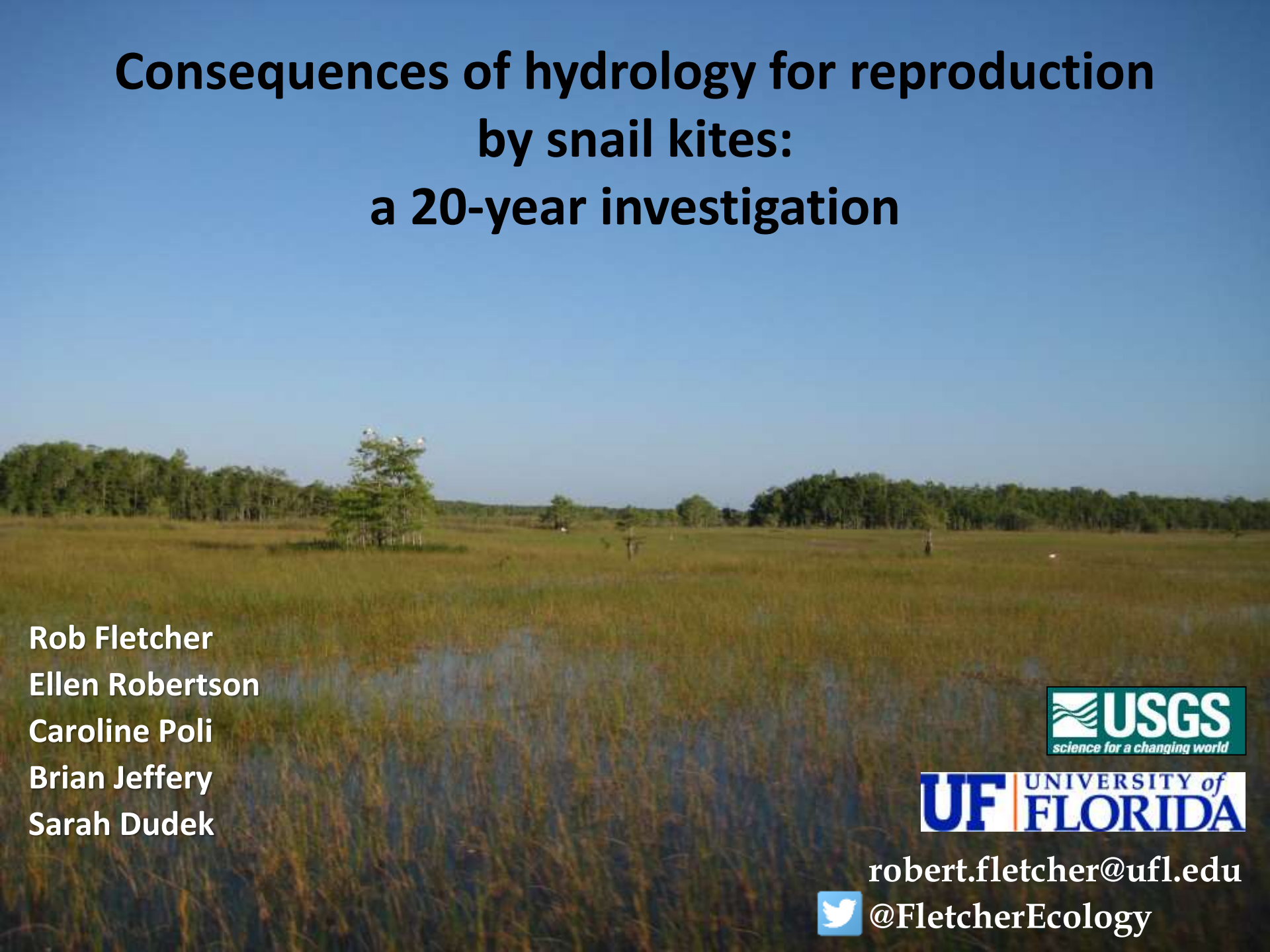
Consequences of hydrology for reproduction by snail kites: a 20-year investigation



Rob Fletcher
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Sarah Dudek

USGS science for a changing world

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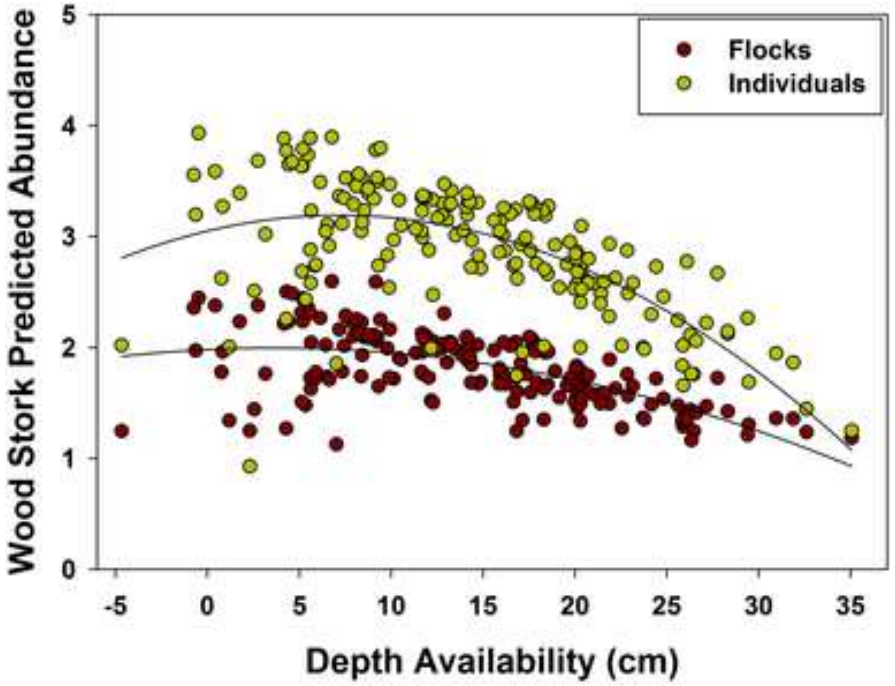
Hydrology and breeding birds

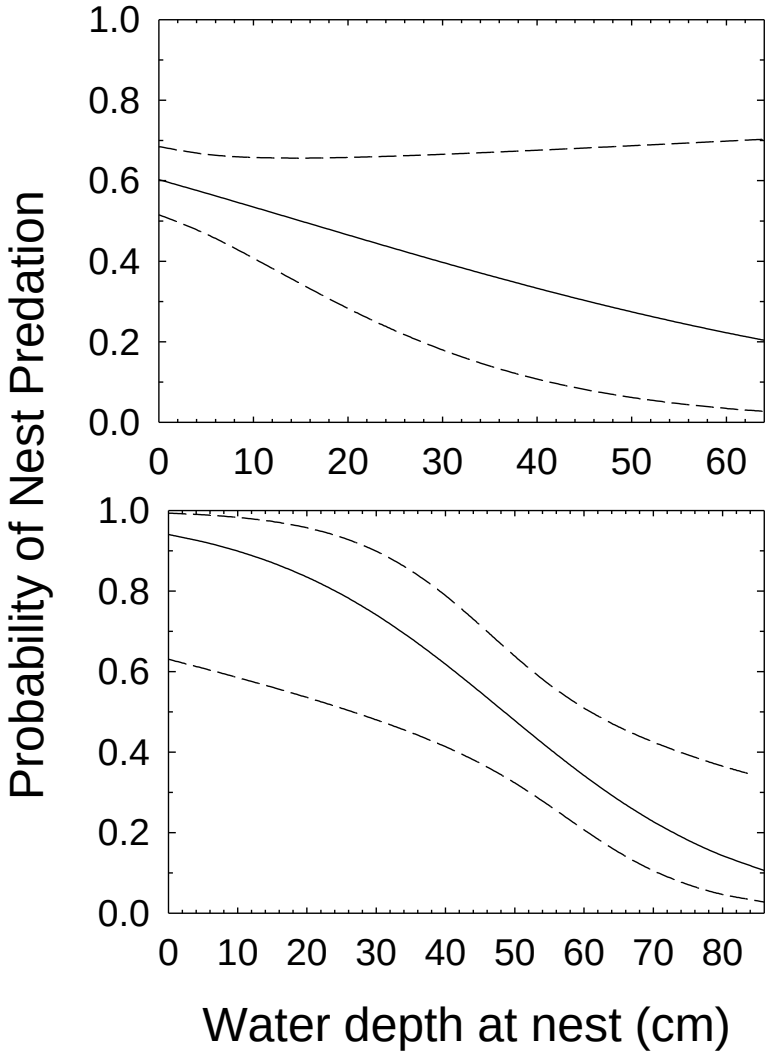
- Number of birds



Beerens et al. (2015)

Hydrology and breeding birds

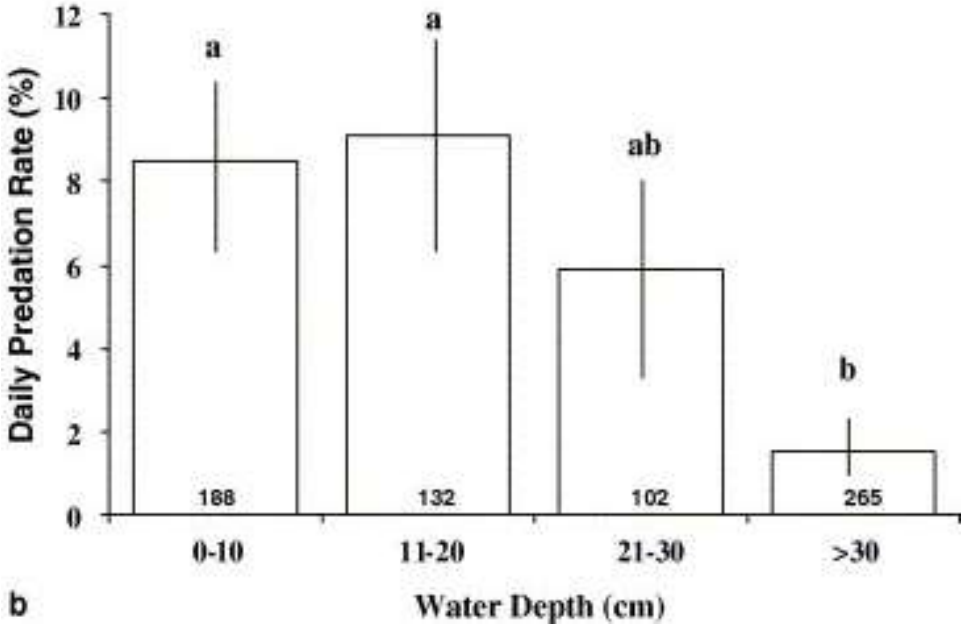
- Number of birds
- Breeding probability
- Fledglings
- Nest survival



Fletcher and Koford (2004)

Hydrology and breeding birds

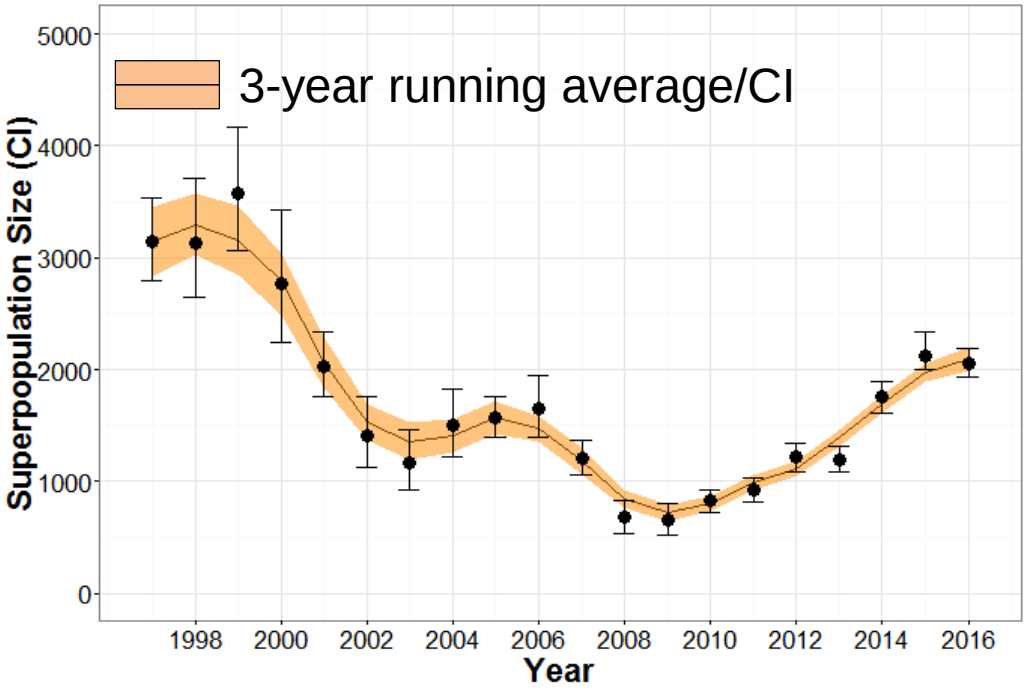
- Number of birds
- Breeding probability
- Fledglings
- Nest survival
- Species interactions



Hoover (2006)

The snail kite

- Critically endangered



The snail kite

- ❑ Critically endangered
- ❑ Wetland dependent
- ❑ Confined to central and south Florida
- ❑ But integrates entire system
- ❑ Closely tied to hydrology and water management

Hydrology and the snail kite

- Low water and rapid recession thought to have negative impacts on reproduction, *but it has long been debated*

SPATIAL AND TEMPORAL VARIABILITY IN NEST SUCCESS OF SNAIL KITES IN FLORIDA: A META-ANALYSIS

Victoria J. Dreitz[1,2,5], Robert E. Bennetts[2,3], Brian Toland[4,6], Wiley M. Kitchens[2] and Michael W. Collopy[3,7]

WATER LEVELS AFFECT NEST SUCCESS OF THE SNAIL KITE IN FLORIDA: AIC AND THE OMISSION OF RELEVANT CANDIDATE MODELS

Steven R. Beissinger[1,3] and Noel F. R. Snyder[2]

SNAIL KITE NEST SUCCESS AND WATER LEVELS: A REPLY TO BEISSINGER AND SNYDER

Victoria J. Dreitz[1,6], Robert E. Bennetts[2], Brian Toland[3], Wiley M. Kitchens[4], and Michael W. Collopy[5]

Extreme weather and experience influence reproduction in an endangered bird

Brian E. Reichert,[1,4] Christopher E. Cattau,[1] Robert J. Fletcher, Jr.,[1] William L. Kendall,[2] and Wiley M. Kitchens[3]

Hydrology and the snail kite

- Low water and rapid recession thought to have negative impacts on reproduction
- High water and rapid ascension less understood but may also impact reproduction and kite habitat

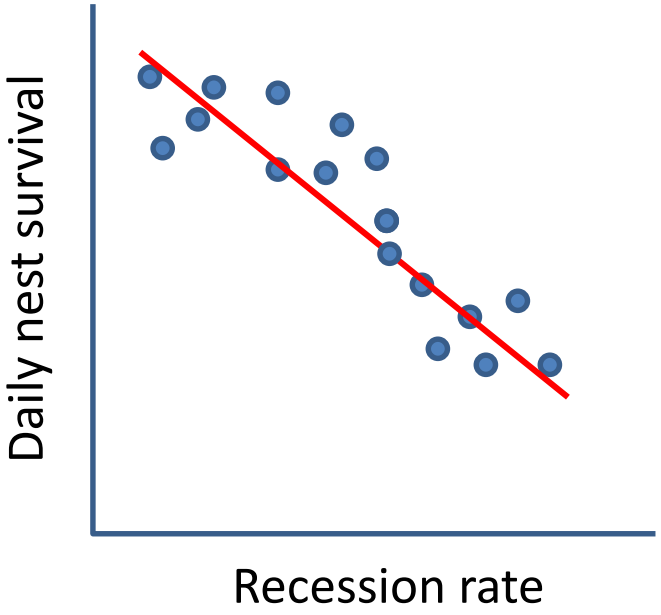
Exploring the effect of drought extent and interval on the Florida snail kite: interplay between spatial and temporal scales

Wolf M. Mooij [a,*], Robert E. Bennetts [b], Wiley M. Kitchens [c], Donald L. DeAngelis [d]

INFLUENCE OF AN EXTREME HIGH WATER EVENT ON SURVIVAL, REPRODUCTION, AND DISTRIBUTION OF SNAIL KITES IN FLORIDA, USA

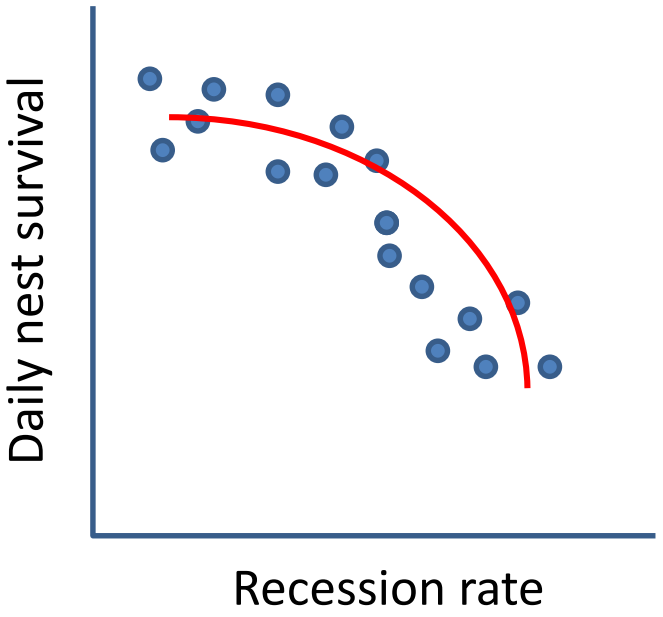
Moving beyond general patterns to specific guidelines:

Most conclusions are based on assuming linear relationships



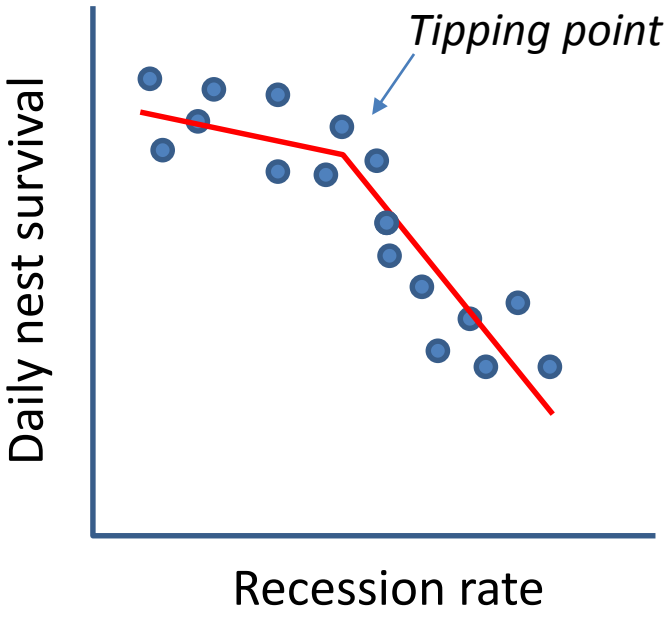
Moving beyond general patterns to specific guidelines:

Simple non-linear models improve on this assumption



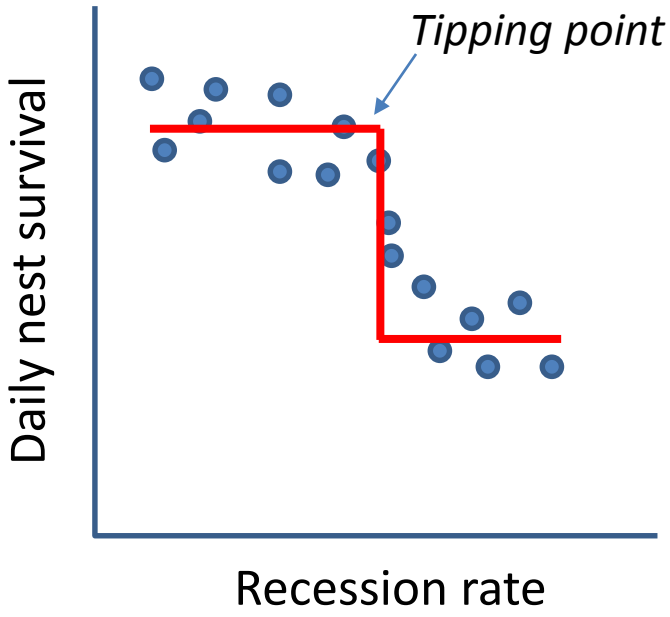
Moving beyond general patterns to specific guidelines:

Change-point models estimate *thresholds* or *tipping points* in effects



Moving beyond general patterns to specific guidelines:

Tipping points can vary in their form



Does hydrology impact reproduction?

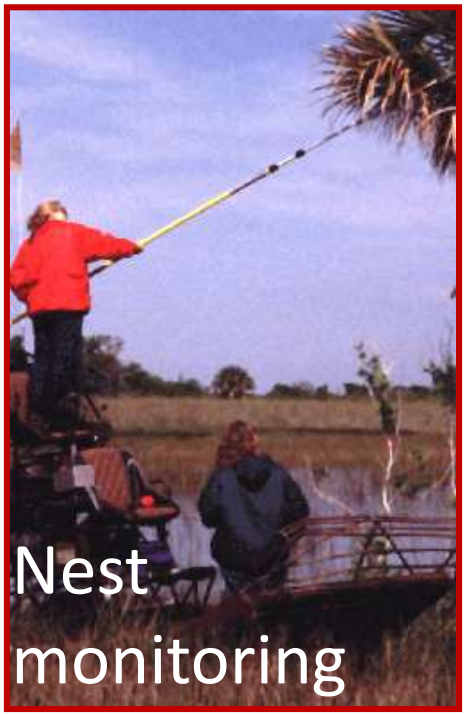
Is there evidence for tipping points, and if so, what is their functional form?

Do tipping points vary across wetlands?

The monitoring program:

- *Designed by Fl Coop Unit, University of Florida, Patuxent Wildlife Research Center, University of Miami*
- 6 intra-annual, airboat surveys (~ 3 weeks apart; 1992 to present) to estimate population trends
- Nest monitoring during breeding season and banding of young

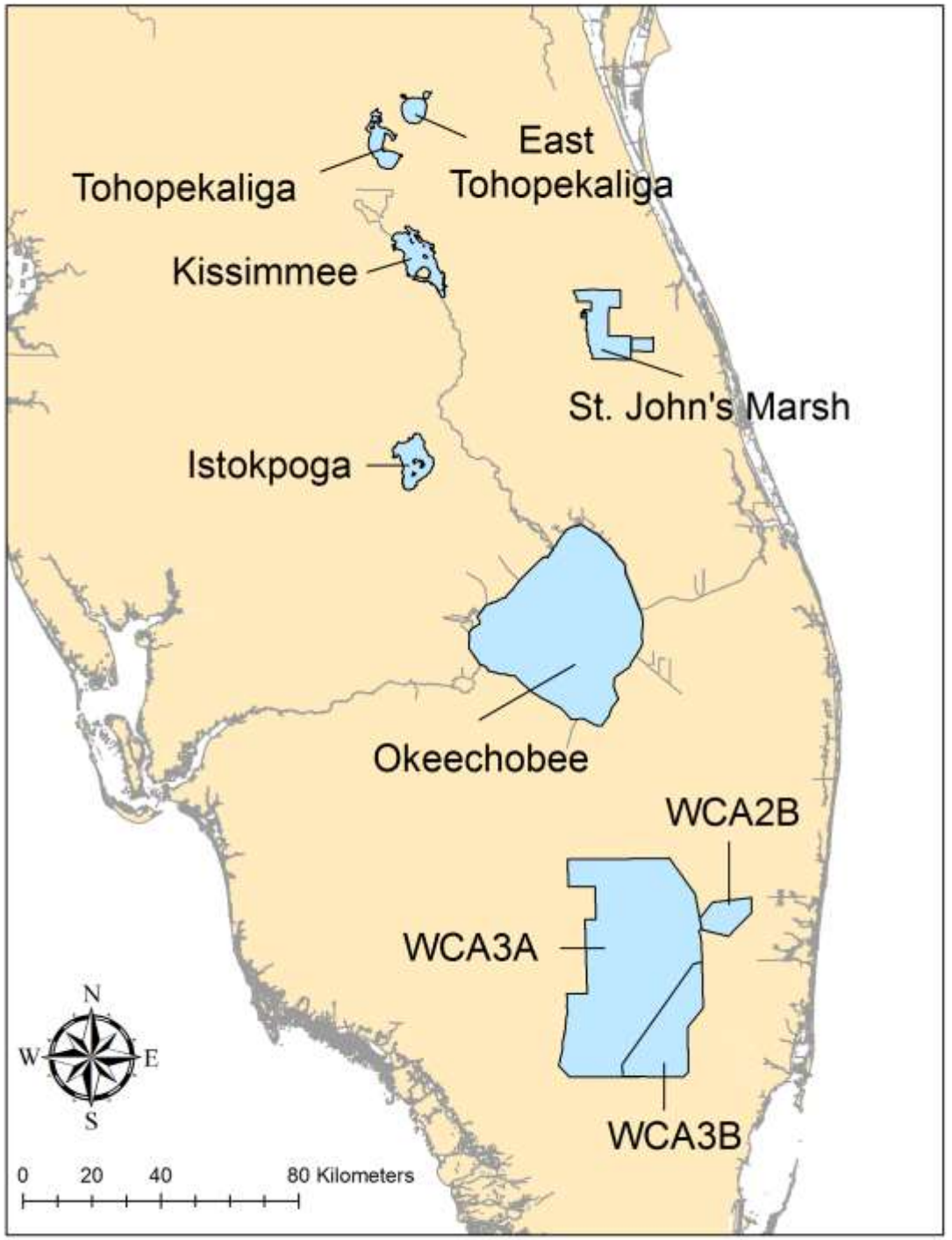

Surveys


Nest monitoring

Marking

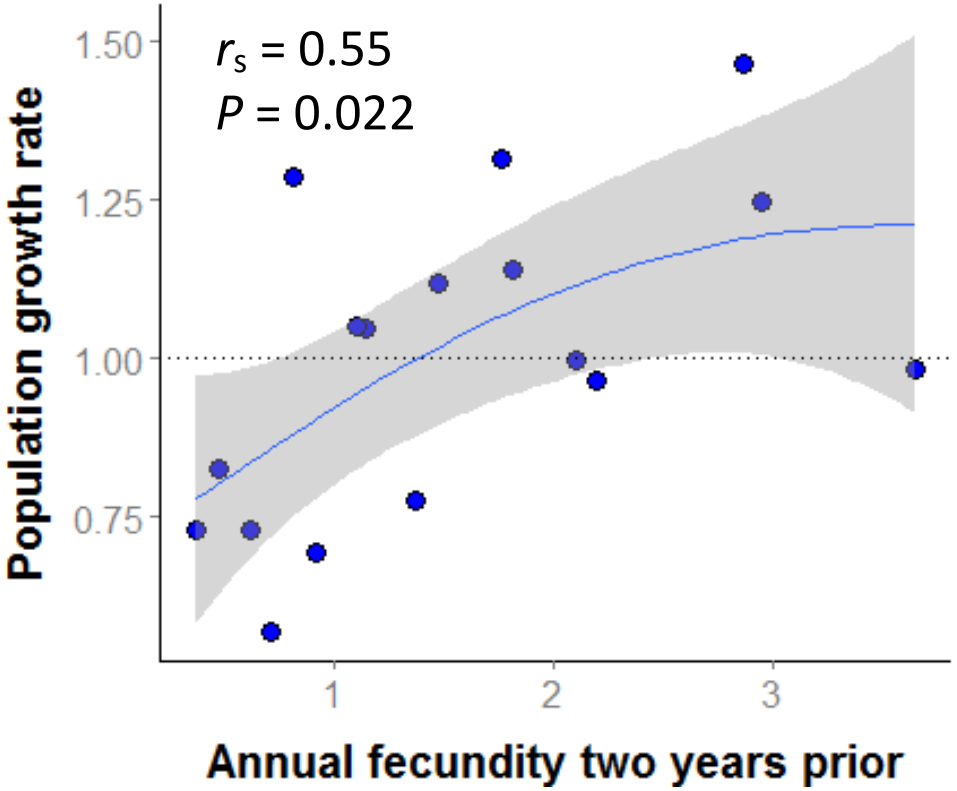
Nesting data

- 1996-2016
- 9 sites
- 2790 nests



Why nest survival?

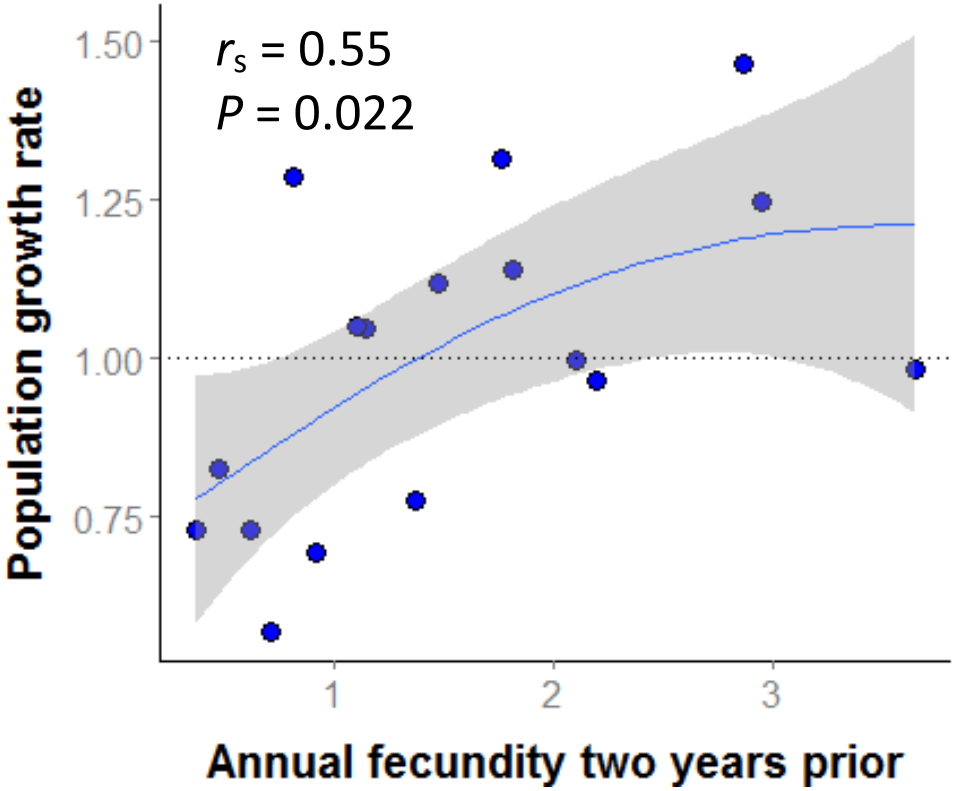
Fecundity explains observed population growth



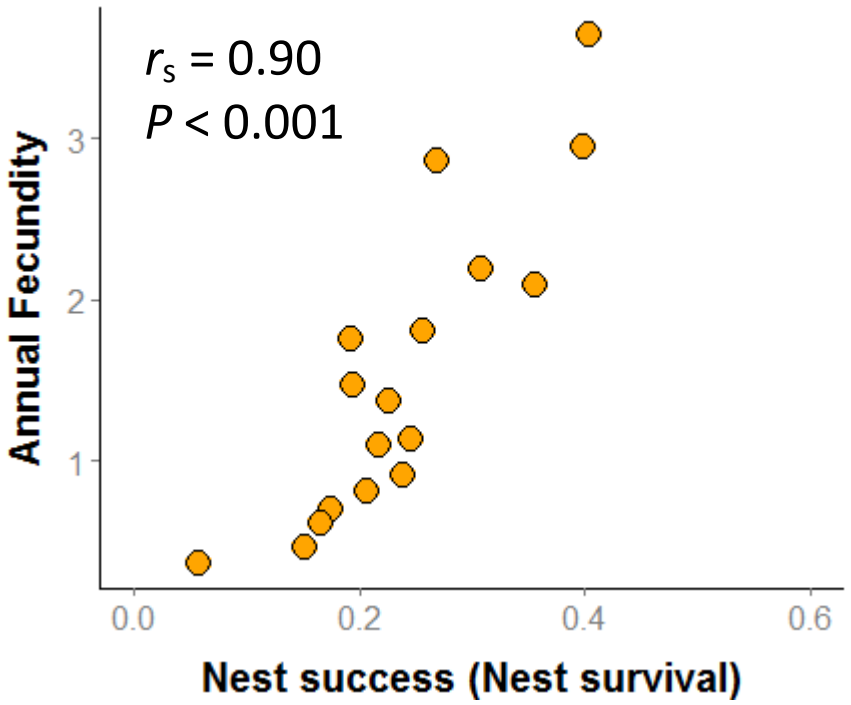
Data from 1996-2014

Why nest survival?

Fecundity explains observed population growth



*Fecundity most correlated with **nest survival***

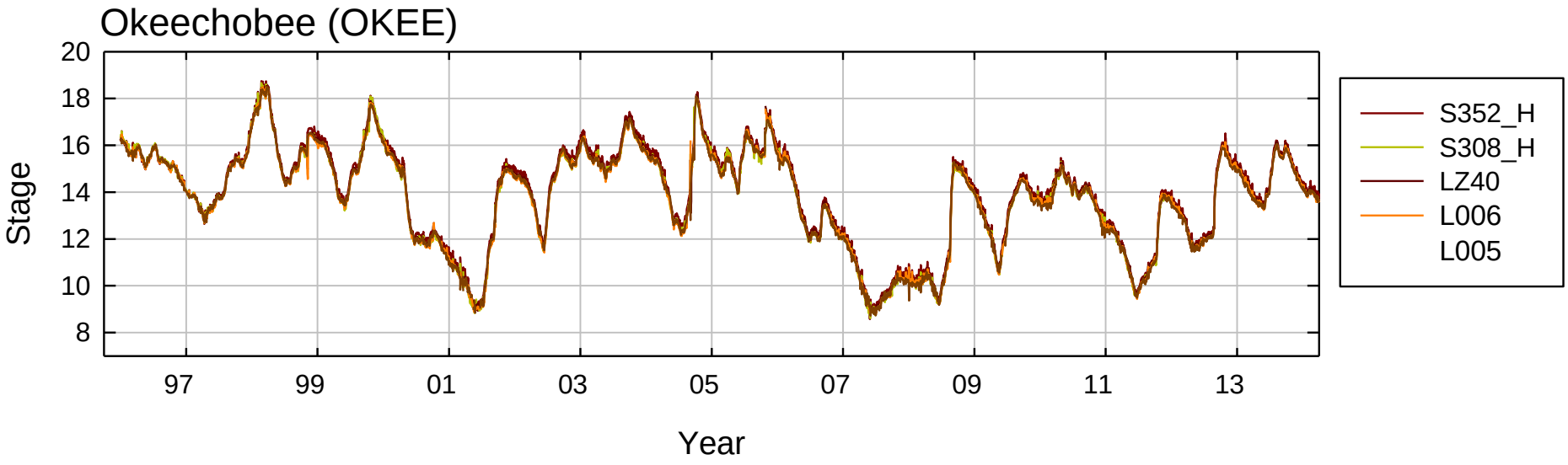


Data from 1996-2014

Hydrology

Two scales:

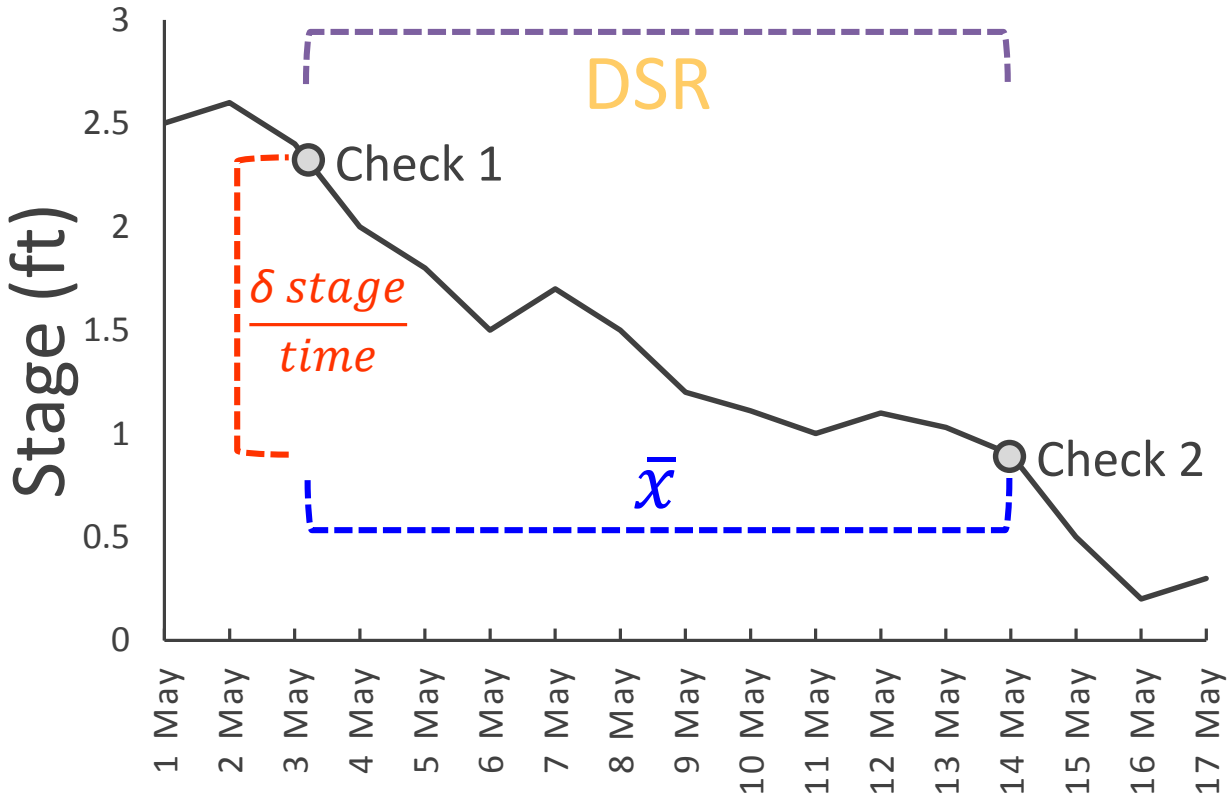
- Site-scale:
  Gauge data
  (DBHYDRO)



Hydrology

Two scales:

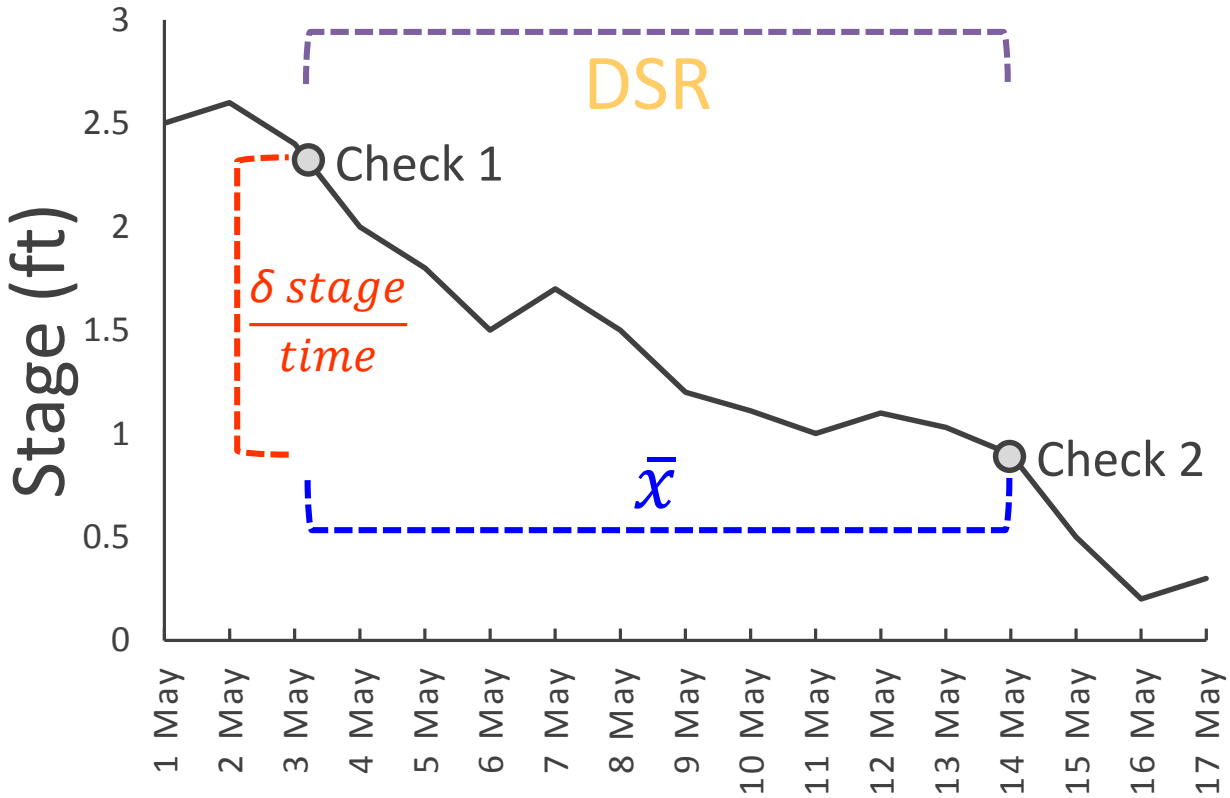
- Site-scale: Gauge data (DBHYDRO)
  - Mean stage
  - Δstage



Hydrology

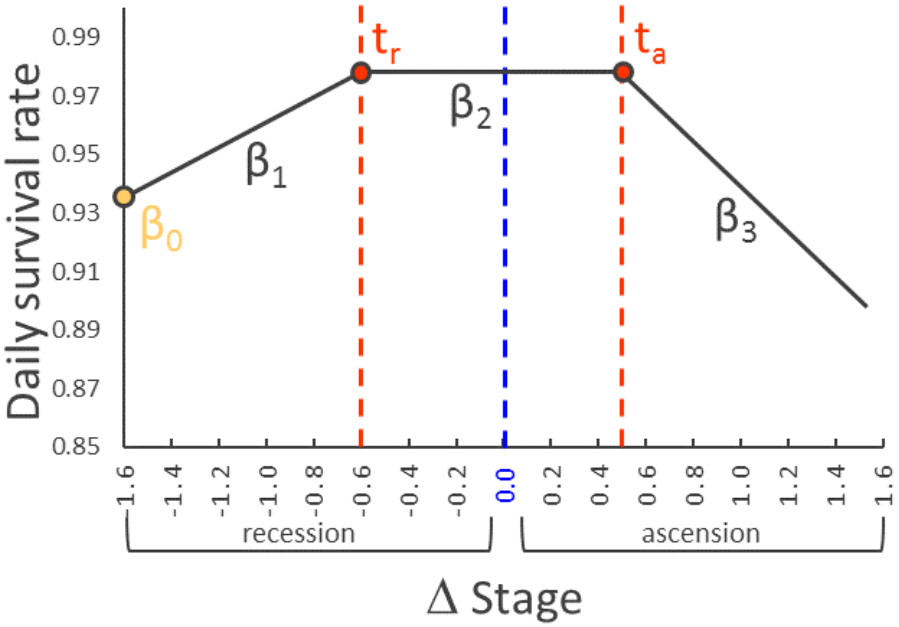
Two scales:

- Site-scale: Gauge data (DBHYDRO)
  - Mean stage
  - Δstage
- Nest-scale: Water depth at nest
  - Mean depth
  - Δdepth

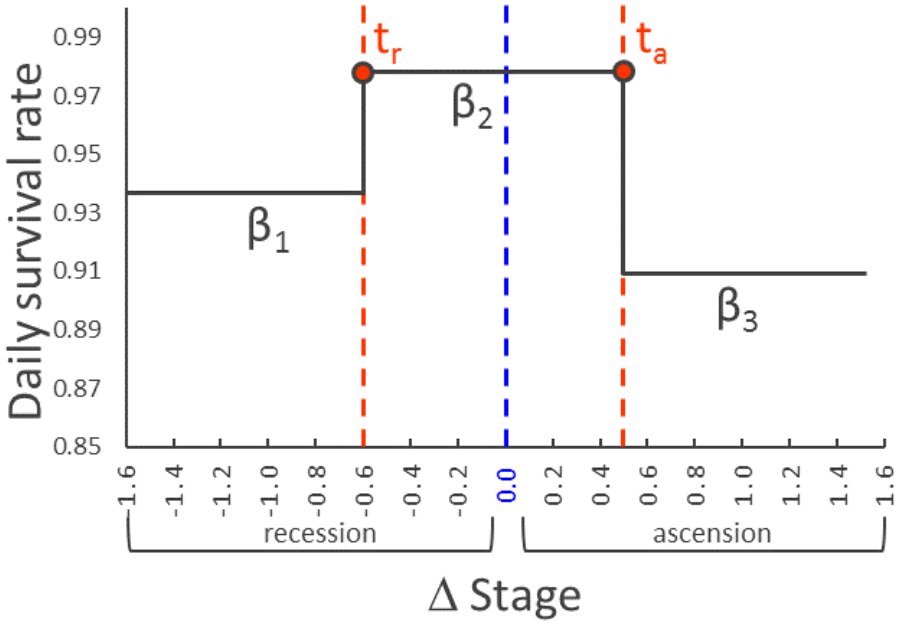


Change-point models for hydrology tipping points on nest survival

"hockey stick"

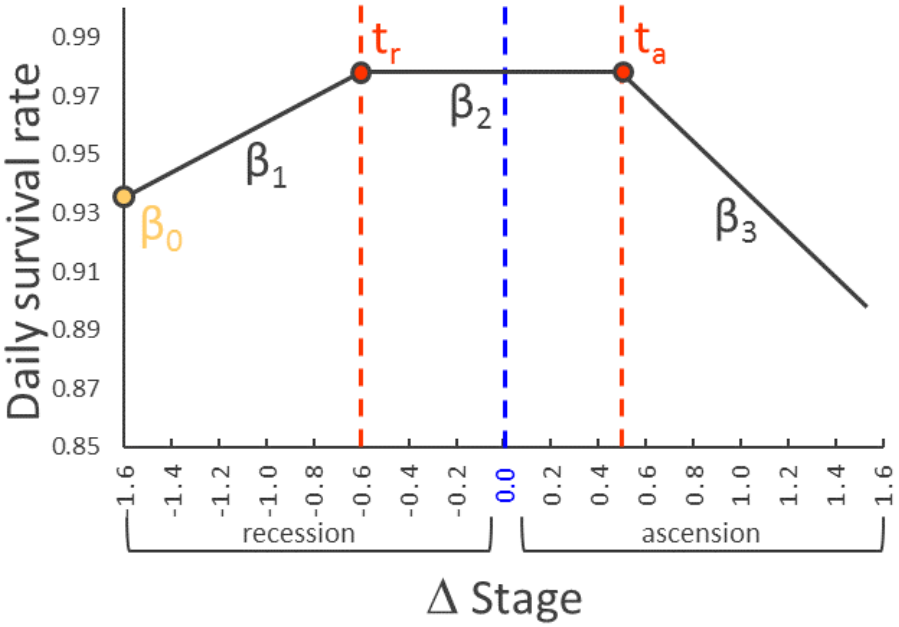


"step"

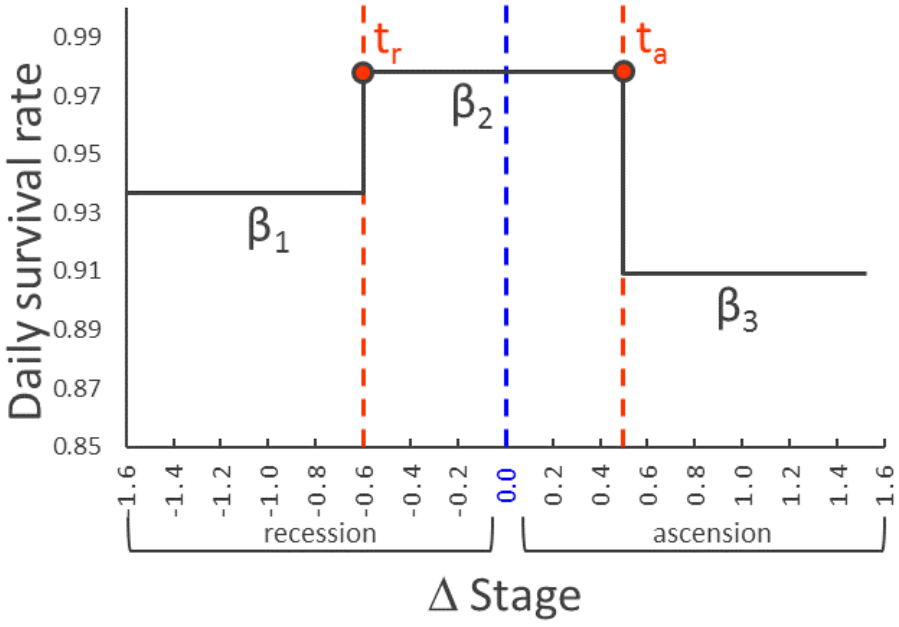


Change-point models for hydrology tipping points on nest survival

"hockey stick"



"step"

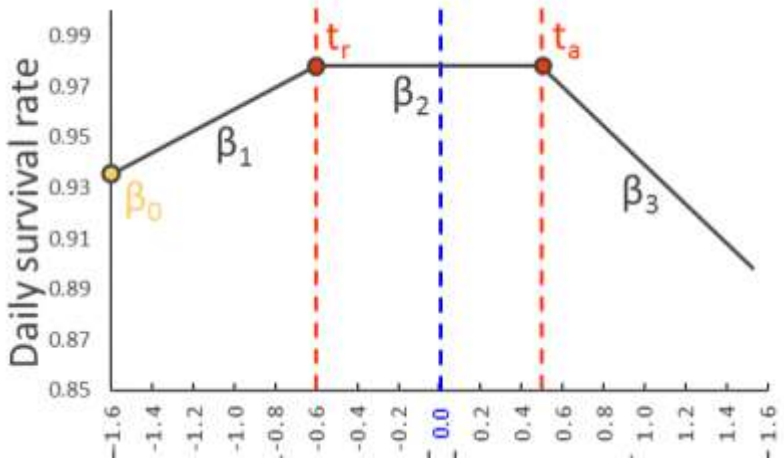


- Allowed effects to vary by site
- Four variables: stage, Δstage, water depth, Δwater depth
- Compared to linear models
- Fit via MCMC: estimates tipping points and their uncertainty

For nest scale, consistent support for site-specific tipping points

Model selection suggested:

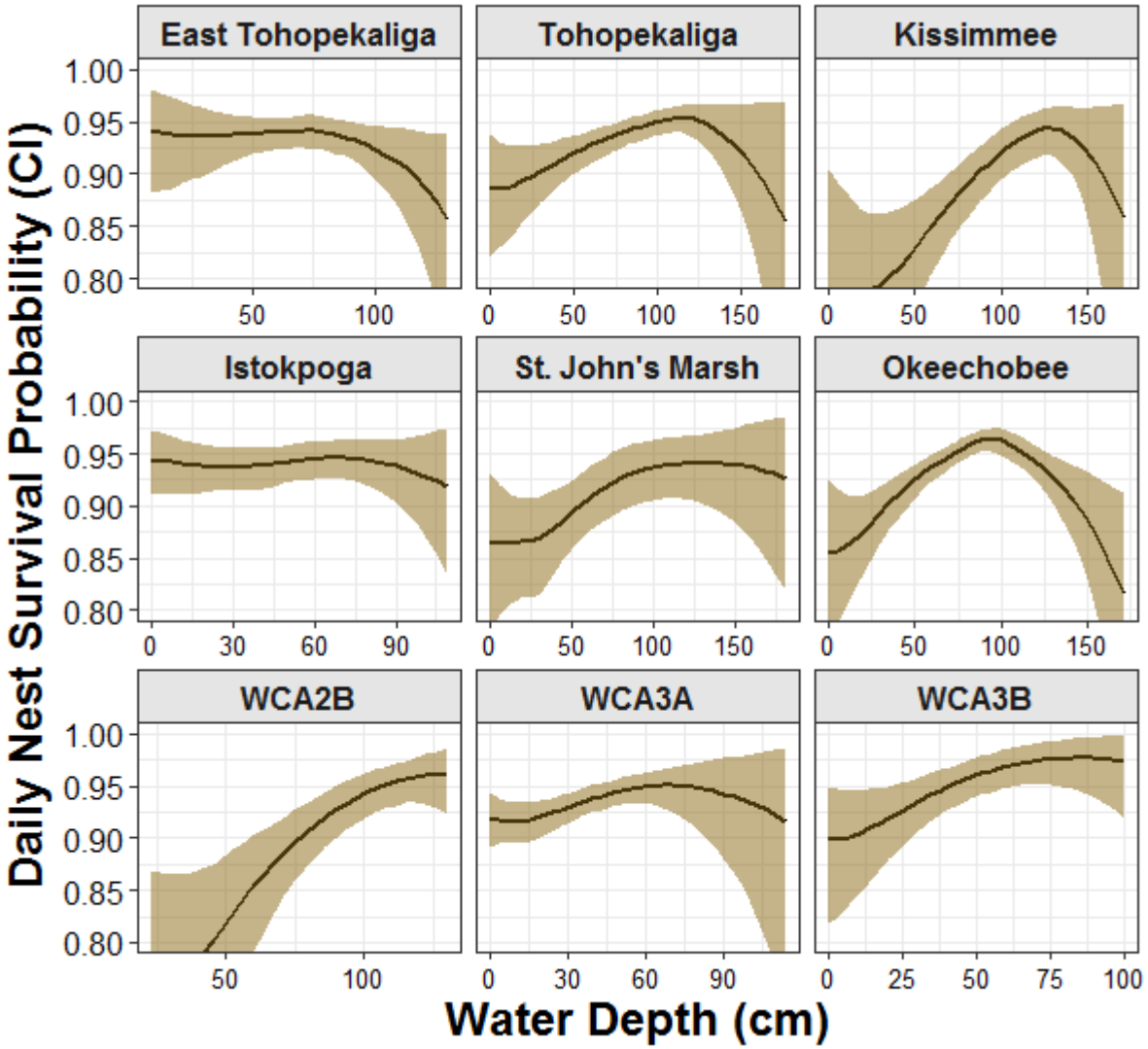
- Water depth >> Δwater depth
- Site-specific tipping points (hockey stick function)



Effects of water depth at nests vary by wetland

predictions from best model:

tipping points for water depth

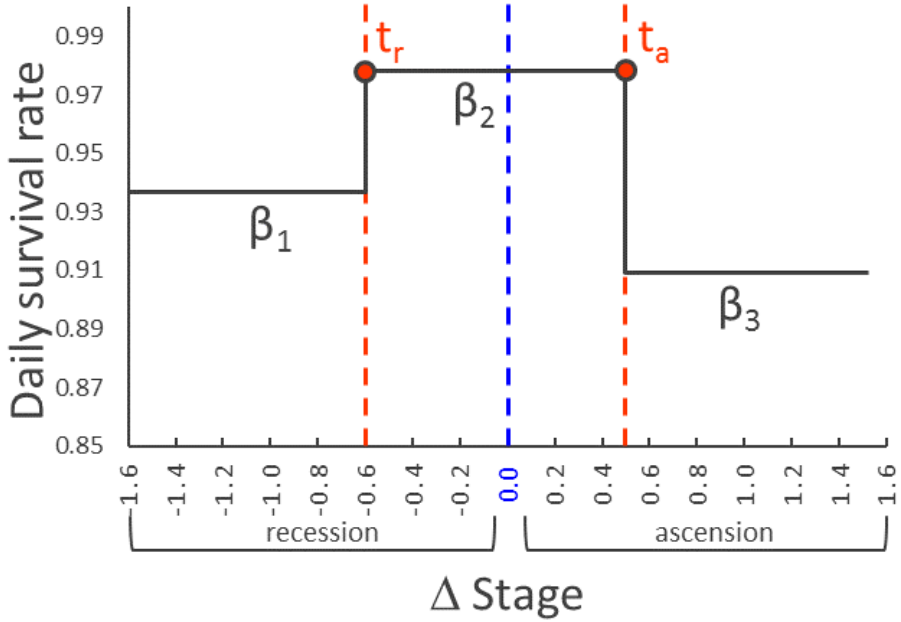


Low water tipping points ~ 13-43 cm

For site scale, consistent support for site-specific tipping points

Model selection suggested:

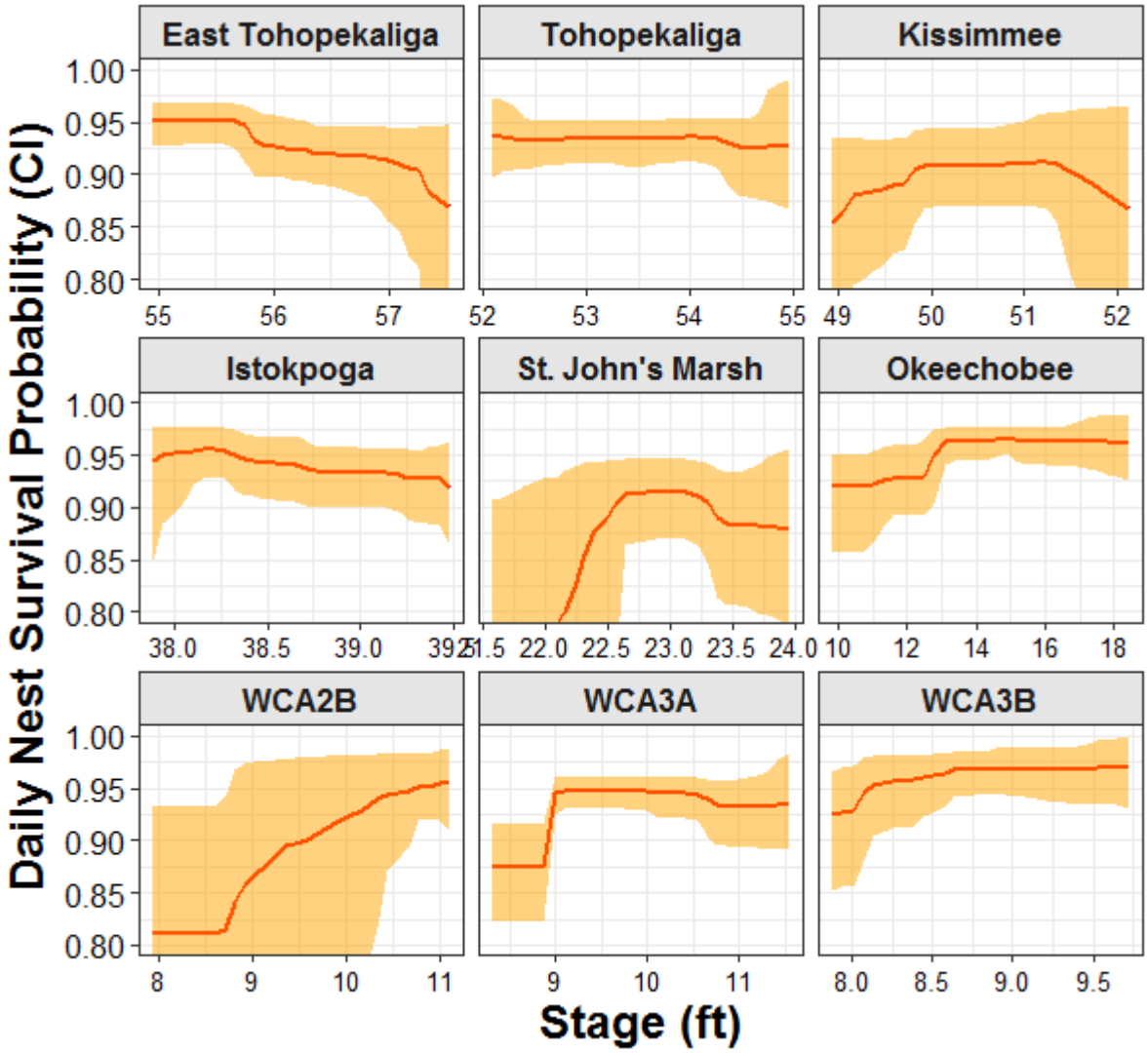
- Stage > Δstage
- Site-specific tipping points (step function)



Effects of stage vary by wetland

predictions from best model:

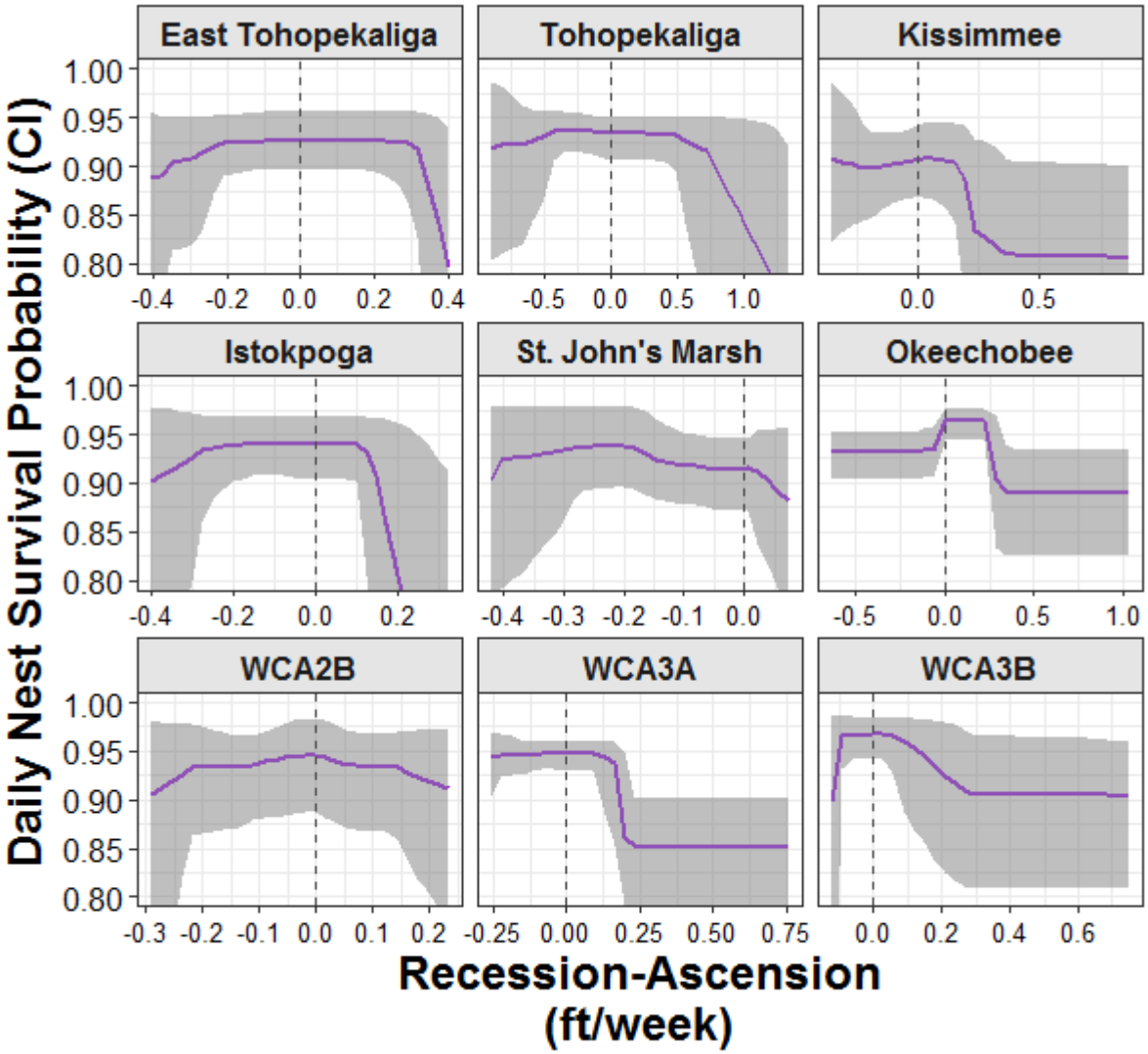
tipping points for stage



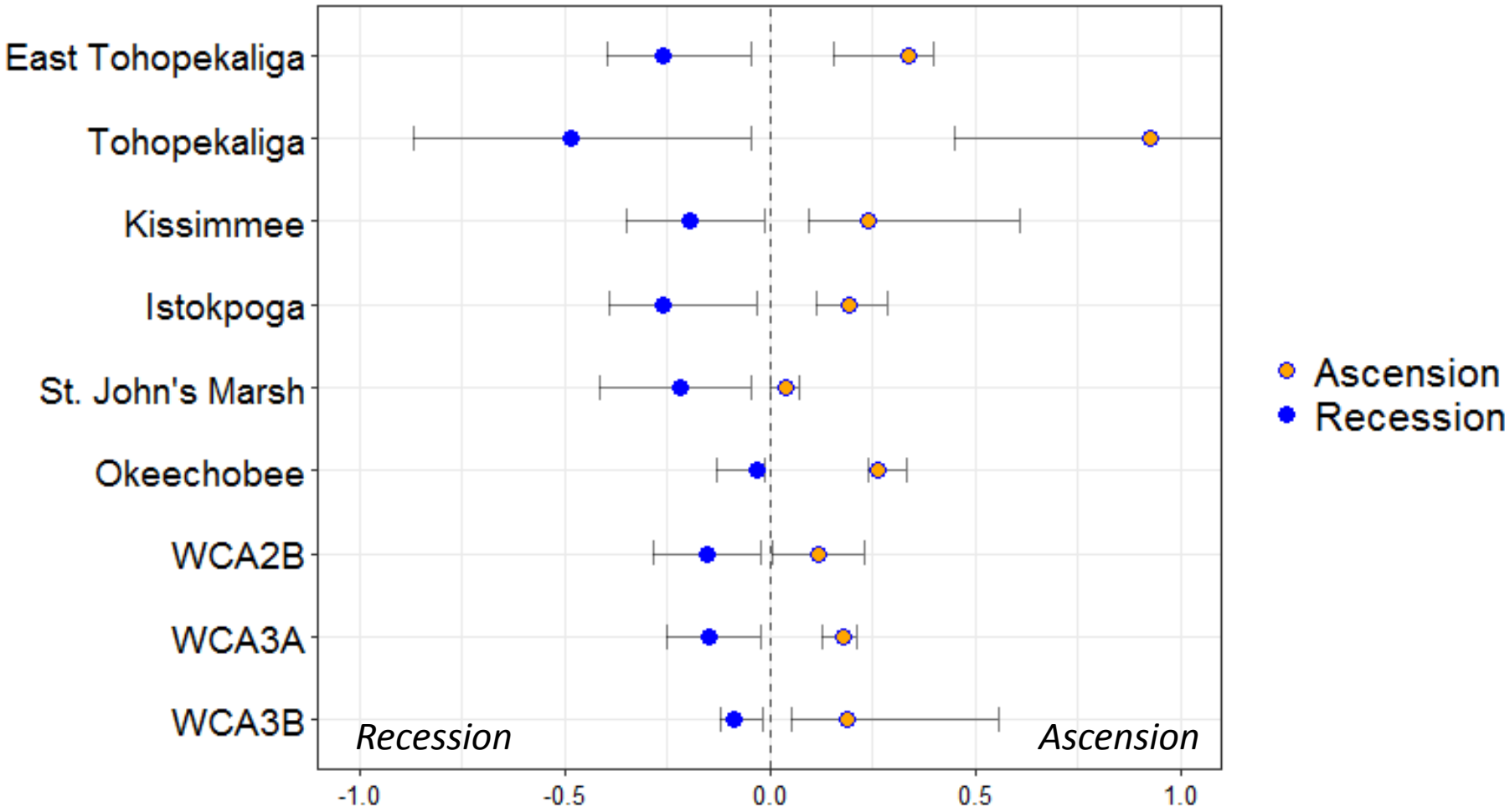
Effects of recession and ascension vary by wetland

predictions from best model:

tipping points for stage and Δstage



Tipping points from Δstage



Implications

- Hydrology has major effects on the nest survival of snail kites
- Consistent support for tipping points of hydrology on snail kite nest survival
- Tipping points provide formal criteria for identifying key hydrologic conditions

Acknowledgments

Monitoring design and implementation:
Wiley Kitchens, Rob Bennetts, Vicky Dreitz, Don DeAngelis, James Nichols, Bill Kendall, Jim Hines, FL Coop Unit

Funding:
U.S. Army Corps, U.S.G.S., USFWS, St. John's River Water Management District, South Florida Water Management District, Florida Fish & Wildlife Conservation Commission