

Natural Resources Conservation Service U.S. DEPARTMENT OF AGRICULTURE

Informing Turtle Conservation in the Northeast by Thinking Bigger in Space and Time

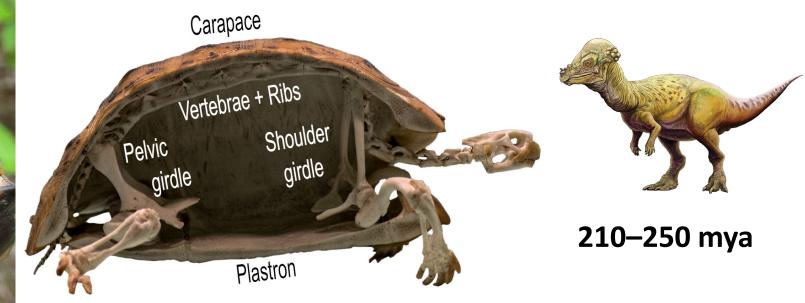


H. Patrick Roberts, PhD Conservation Biologist University of Massachusetts Amherst

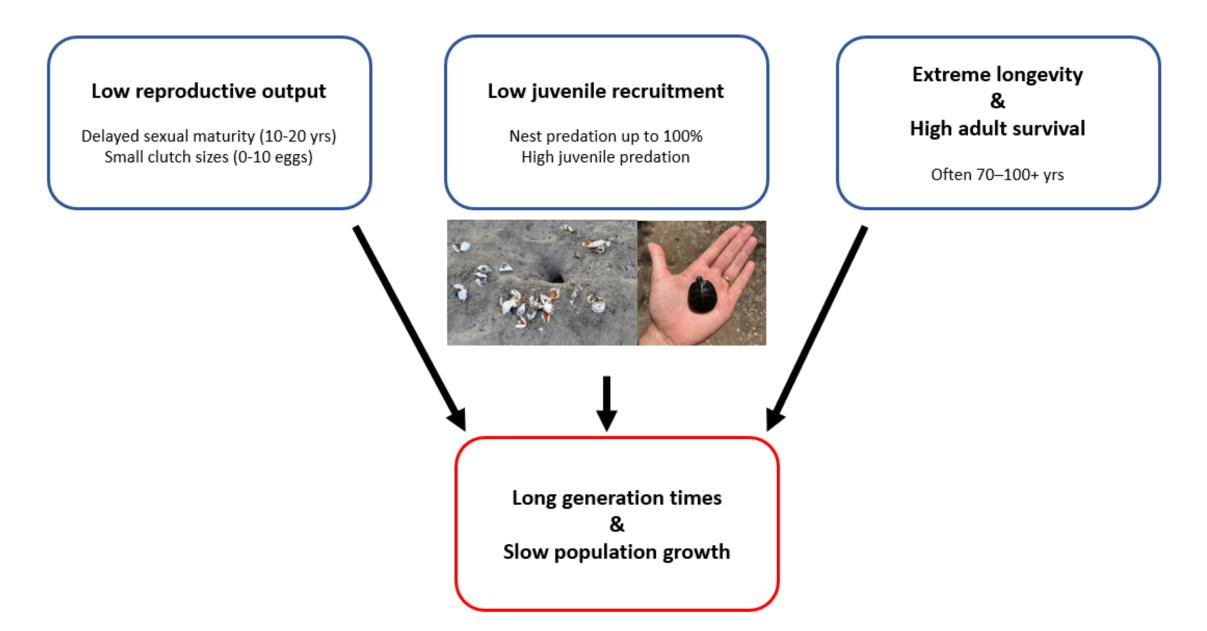
David King, PhD Research Wildlife Biologist U.S. Forest Service Northern Research Station







Life History of Turtles



Threats to Turtles

Habitat loss



Illegal trade



Land use



Human-subsidized predation



Disease Pollution Invasive species Successional changes Climate change

One of the most endangered clades in the world

Articles

\rightarrow 68% of species threatened with extinction



J. WHITFIELD GIBBONS, DAVID E. SCOTT, TRAVIS J. RYAN, KURT A. BUHLMANN, TRACEY D. TUBERVILLE, BRIAN S. METTS, JUDITH L. GREENE, TONY MILLS, YALE LEIDEN, SEAN POPPY, AND CHRISTOPHER T. WINNE



Current Biology

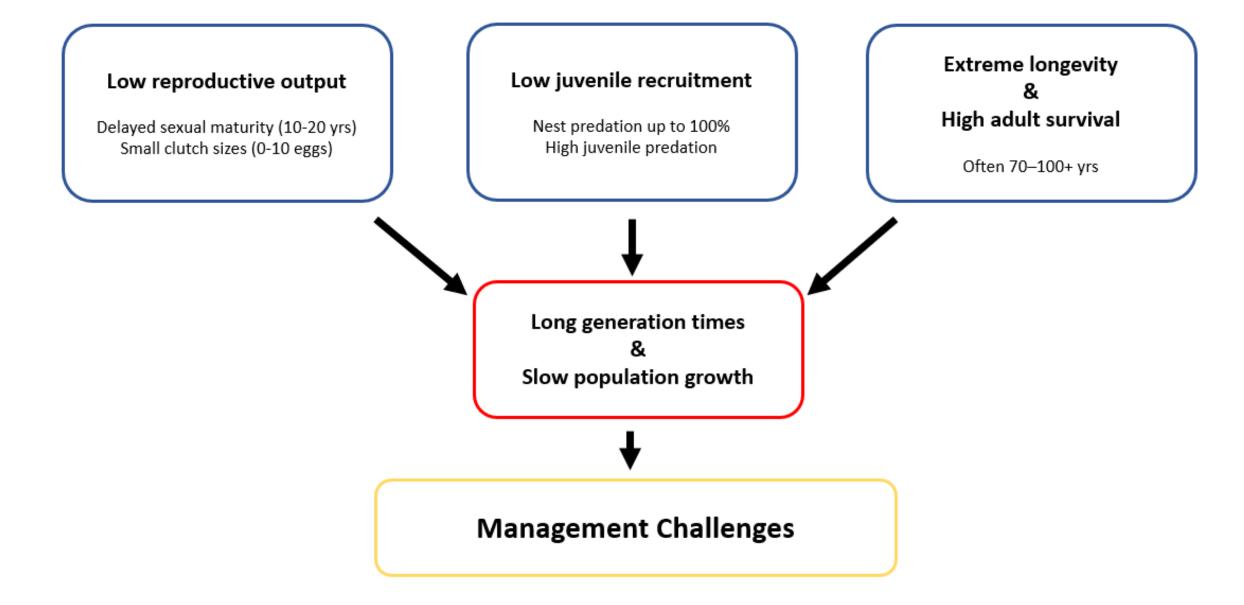
JEFFREY E. LOVICH, JOSHUA R. ENNEN, MICKEY AGHA, AND J. WHITFIELD GIBBONS

Review

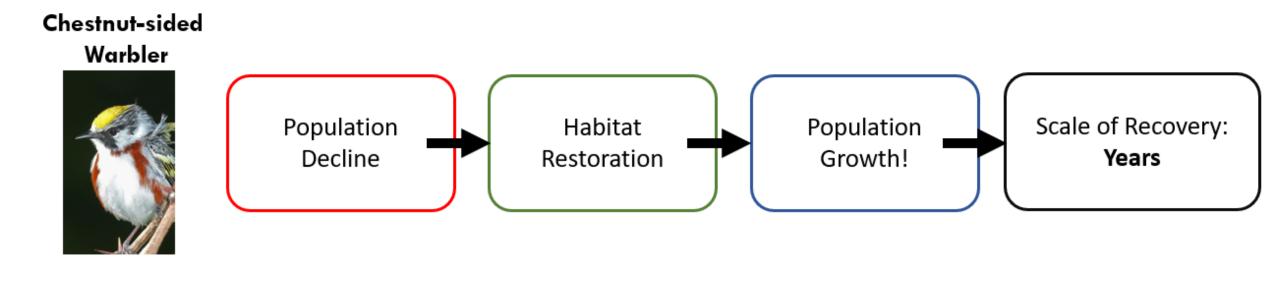
Turtles and Tortoises Are in Trouble

Craig B. Stanford^{1,2,47,*}, John B. Iverson³, Anders G.J. Rhodin^{4,5}, Peter Paul van Dijk^{5,6}, Russell A. Mittermeier⁶, Gerald Kuchling⁷, Kristin H. Berry⁸, Alberto Bertolero⁹, Karen A. Bjorndal¹⁰, Torsten E.G. Blanck¹¹, Kurt A. Buhlmann¹², Russell L. Burke¹³, Justin D. Congdon¹², Tomas Diagne¹⁴, Taylor Edwards¹⁵, Carla C. Eisemberg¹⁶, Josh R. Ennen¹⁷, Germán Forero-Medina¹⁹, Matt Frankel¹⁹, Uwe Fritz²⁰, Natalia Gallego-García^{18,21}, Arthur Georges²², J. Whitfield Gibbons¹², Shiping Gong²³, Eric V. Goode⁵, Haitao T. Shi²⁴, Ha Hoang²⁵, Margaretha D. Hofmeyr²⁶, Brian D. Horne²⁷, Rick Hudson²⁸, James O. Juvik²⁹, Ross A. Kieste⁵, Patricia Koval²⁸, Minh Le^{30,31}, Peter V. Lindeman³², Jeffrey E. Lovich³³, Luca Luiselli^{34,35}, Timothy E.M. McCormack²⁵, George A. Meyer³⁶, Vivian P. Páez³⁷, Kalyar Platt³⁸, Steven G. Platt³⁹, Peter C.H. Pritchard⁴⁰, Hugh R. Quinn⁴¹, Willem M. Roosenburg⁴², Jeffrey A. Seminoff⁴¹3, H. Bradley Shaffer²¹, Ricky Spencer⁴⁴, James U. Van Dyke⁴⁵, Richard C. Vogt⁴⁶ and Andrew D. Walde²⁸

Life History of Turtles and Management Challenges



Challenges for Management: Population Growth



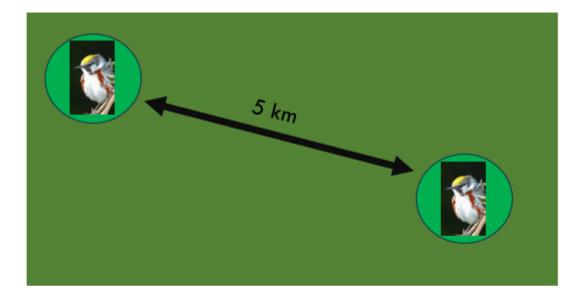
Eastern Box Turtle



Challenges for Management: Dispersal

Chestnut-sided Warbler

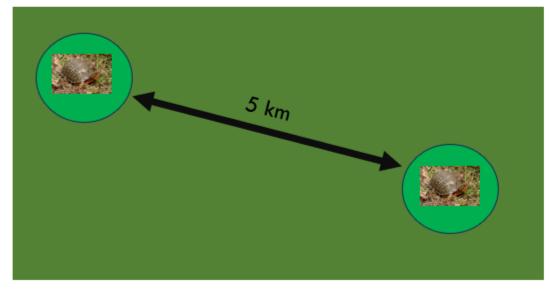




Time to colonization: 1-2 years

Eastern Box Turtle





Time to colonization: Decades?

Time to carrying capacity: Additional decades

Overview

Subproject 1

Individuals: Movement & Space Use

Subproject 2

Populations:

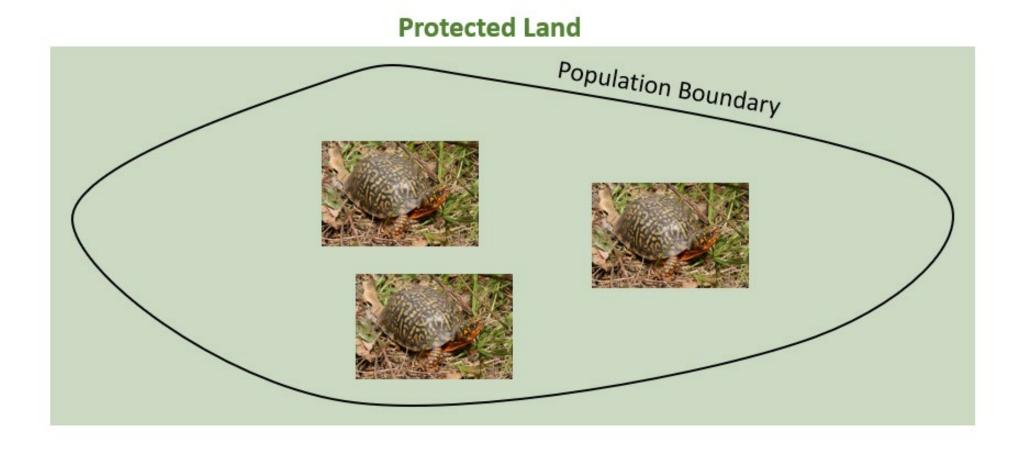
Demographic Parameters

Comparative Long-Term Spatial Ecology of Long-Lived Turtles Subproject 1

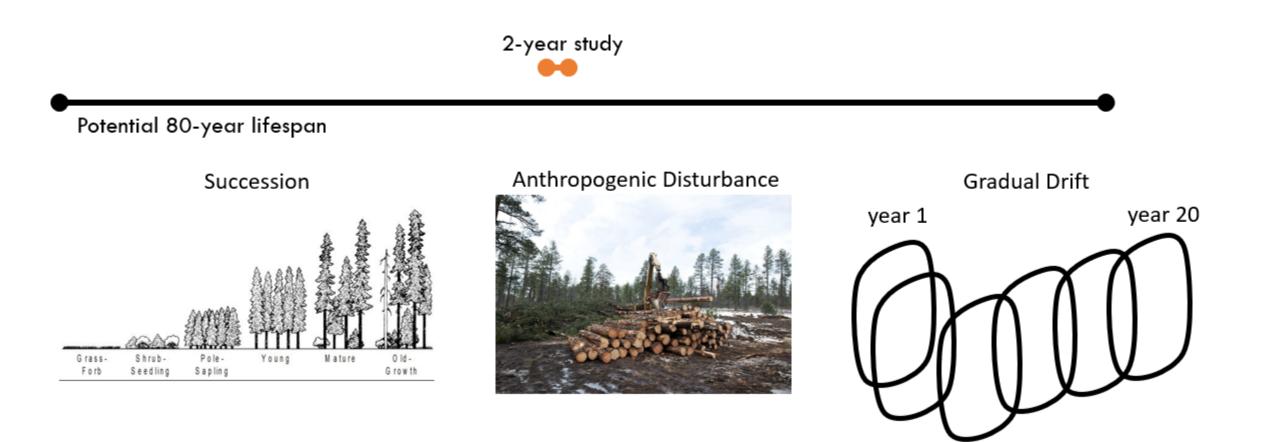
Winderfield

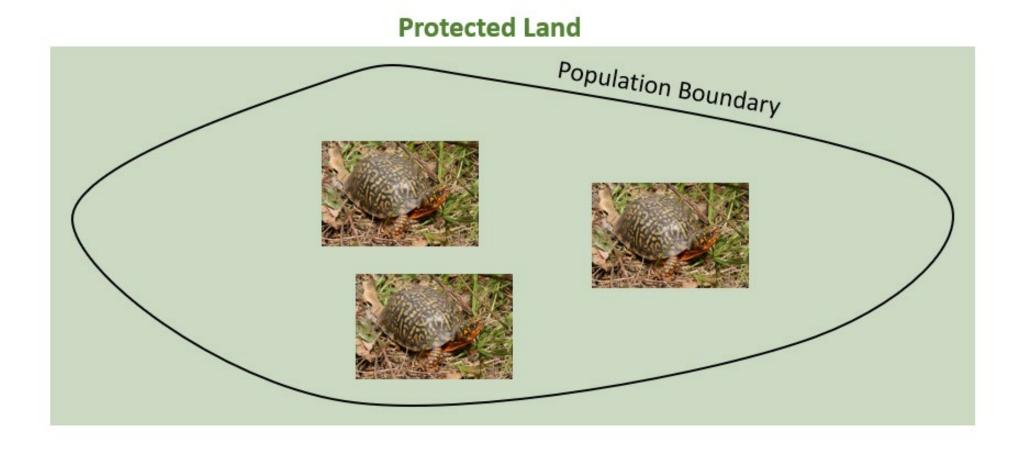
High interannual site fidelity





Typical study duration: 1–4 years





Objective:

Investigate and describe the long-term fidelity of the spotted, wood, and eastern box turtle



Willey 2010 (2005-2008)

University of Massachusetts - Amherst ScholarWorks@UMass Amherst

Doctoral Dissertations 1911-2013

Dissertations and Theses

5-2010

Spatial Ecology Of Eastern Box Turtles (Terrapene C. Carolina) In Central Massachusetts

Lisabeth L Willey University of Massachusetts - Amherst 13 years prior

2 sites



100+ years

Jones 2009 (2004-2007)

University of Massachusetts - Amherst ScholarWorks@UMass Amherst

Dissertations

Dissertations and Theses

5-1-2009

Spatial Ecology, Population Structure, and Conservation of the Wood Turtle, Glyptemys Insculpta, in Central New England

Michael T. Jones University of Massachusetts Amhorst, mtjonesijibio.umass.edu

14 years prior

2 sites



>70 years

Milam and Melvin 2001 (1993-1995)

Journal of Herpetology, Vol. 35, No. 3, pp. 418–427, 2001 Copyright 2001 Society for the Study of Amphibians and Reptiles

> Density, Habitat Use, Movements, and Conservation of Spotted Turtles (*Clemmys guttata*) in Massachusetts

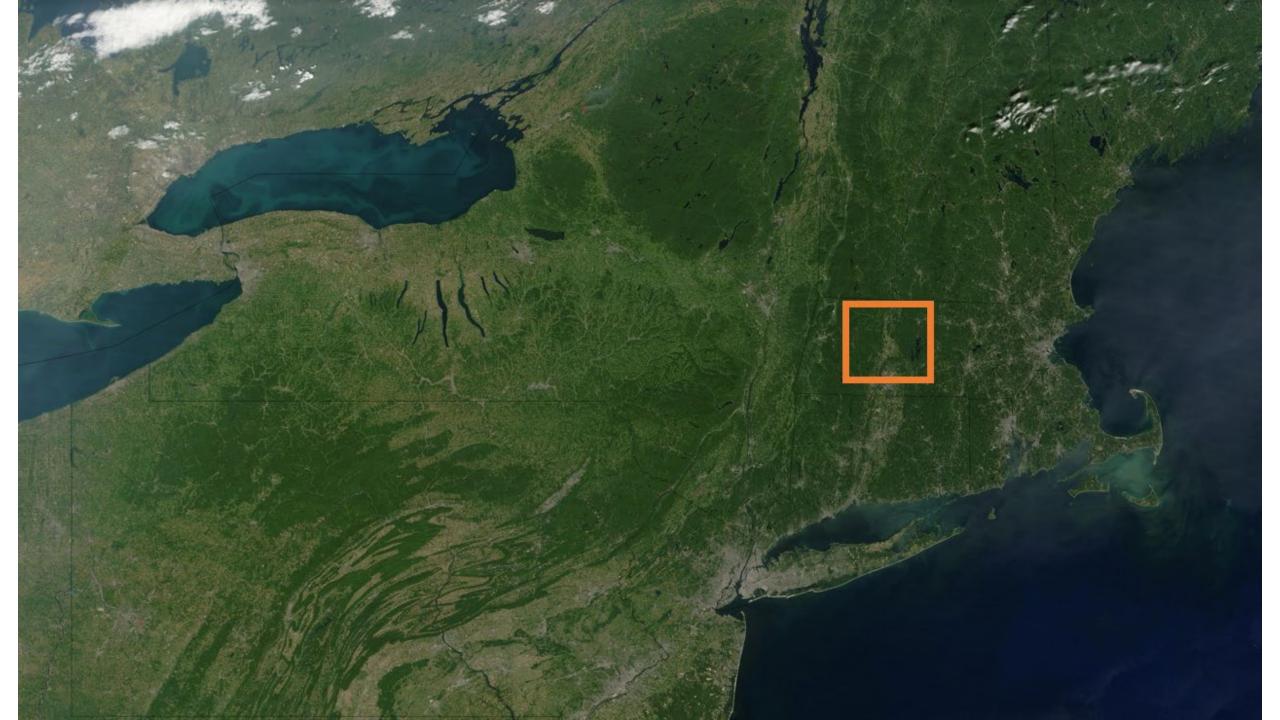
> > JOAN C. MILAM^{1,2} AND SCOTT M. MELVIN³

³Department of Forestry and Wildlife Management, University of Massachusetts, Amherst, Massachusetts 01003, USA ³Massachusetts Division of Fisheries and Wildlife, Route 135, Westborough, Massachusetts 01581, USA 25 years prior

2 sites



110 years (Females)





Captured 67% of previously tracked turtles (48 of 73) Radio-tracked 60% (43 of 72)

- 68% of eastern box turtles
- 61% wood turtles
- 50% spotted turtles





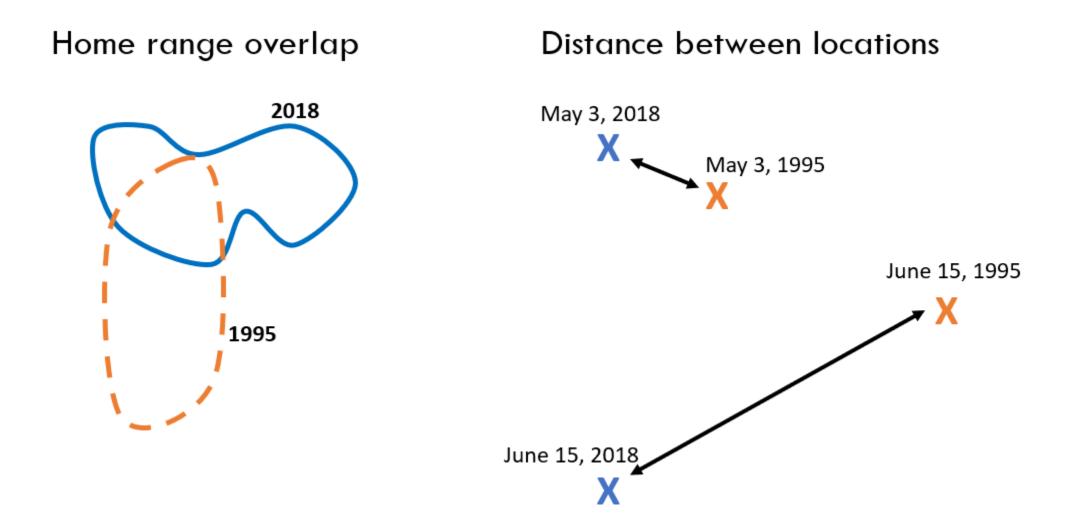






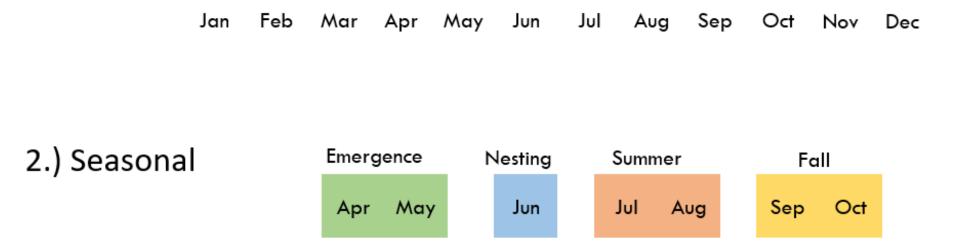


Fidelity Metrics



Fidelity Measured at Multiple Levels

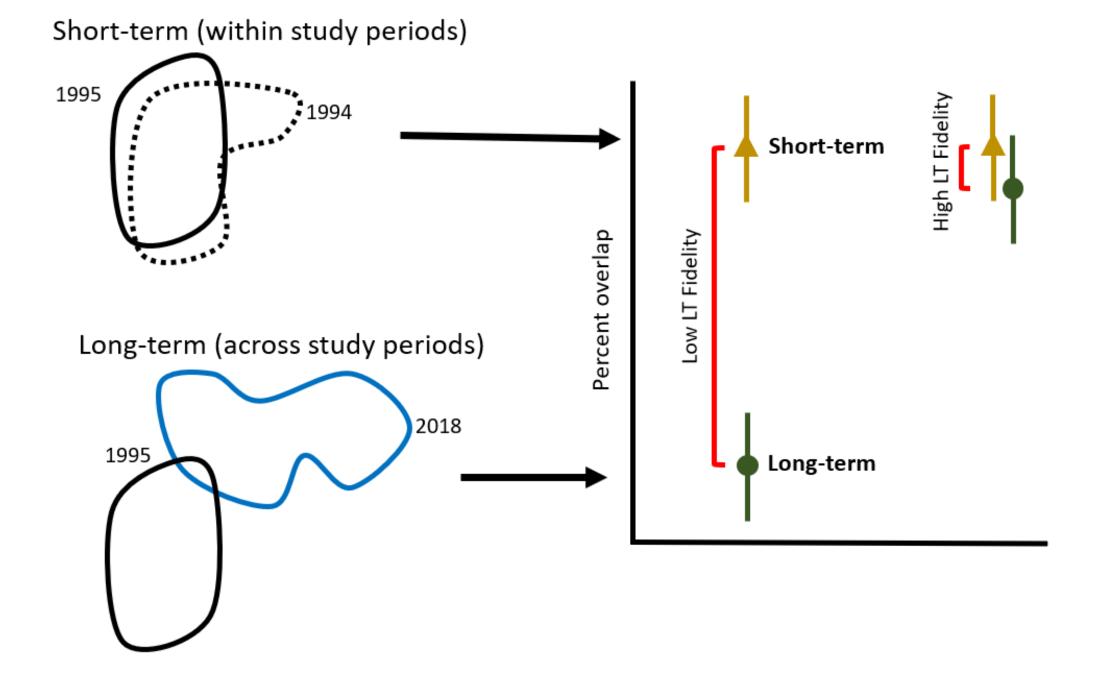
1.) Annual



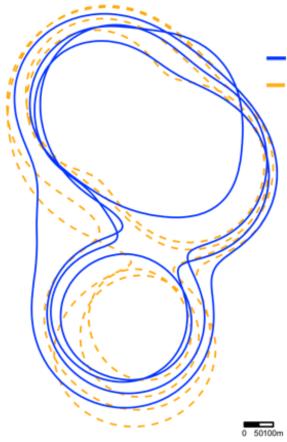
3.) Overwintering location

Nov	Dec	Jan	Feb	Mar

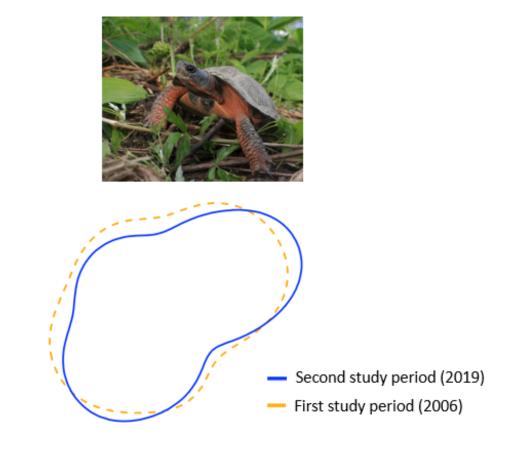








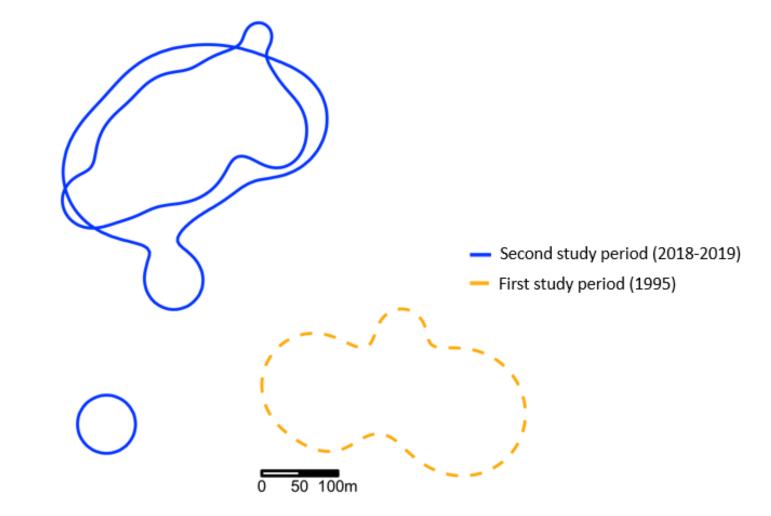
Second study period (2018–2021)
 First study period (2005-2006)



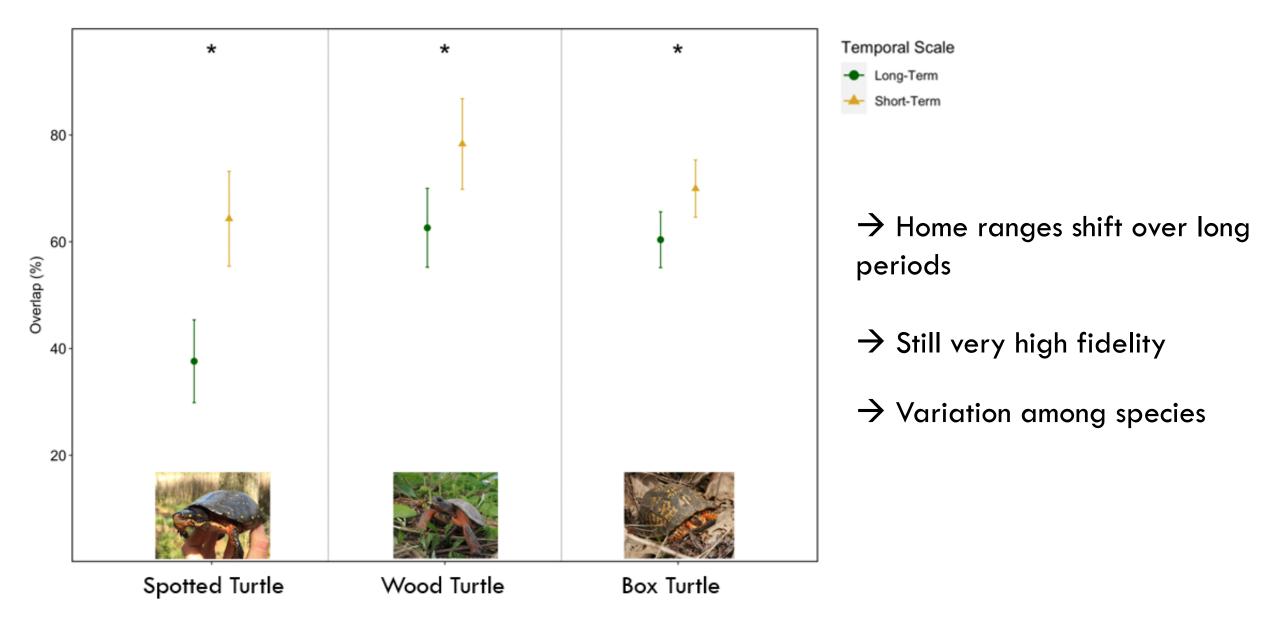


0 100 200m





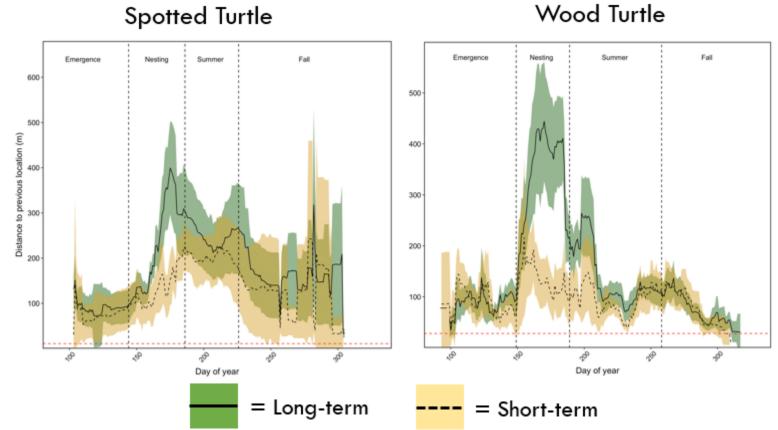
Annual Home Range Overlap



Female Fidelity Among Seasons



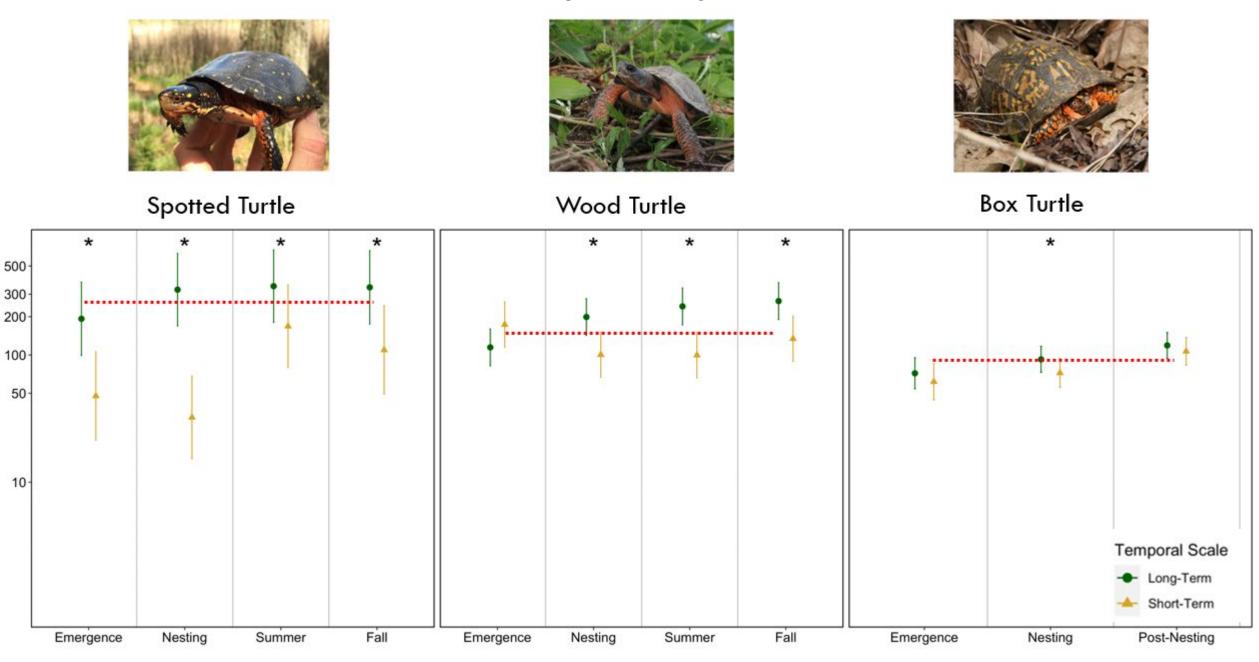
Continuous Fidelity Estimates



 \rightarrow Females are exploring the landscapes to find new nesting habitat

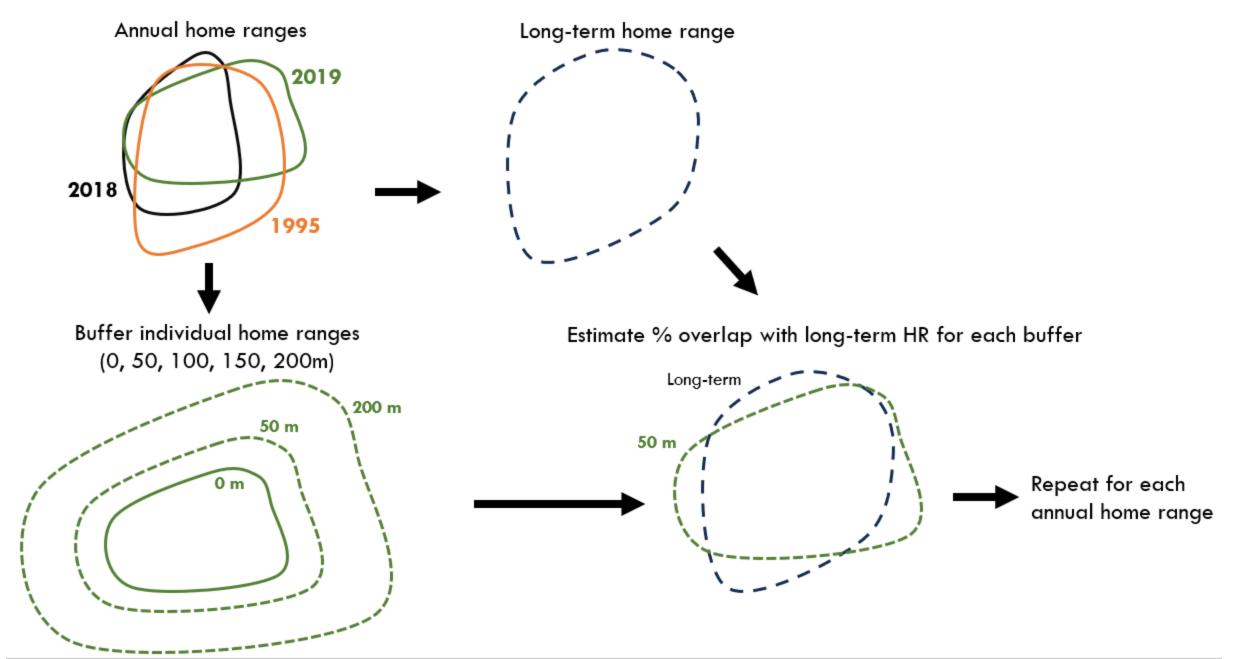


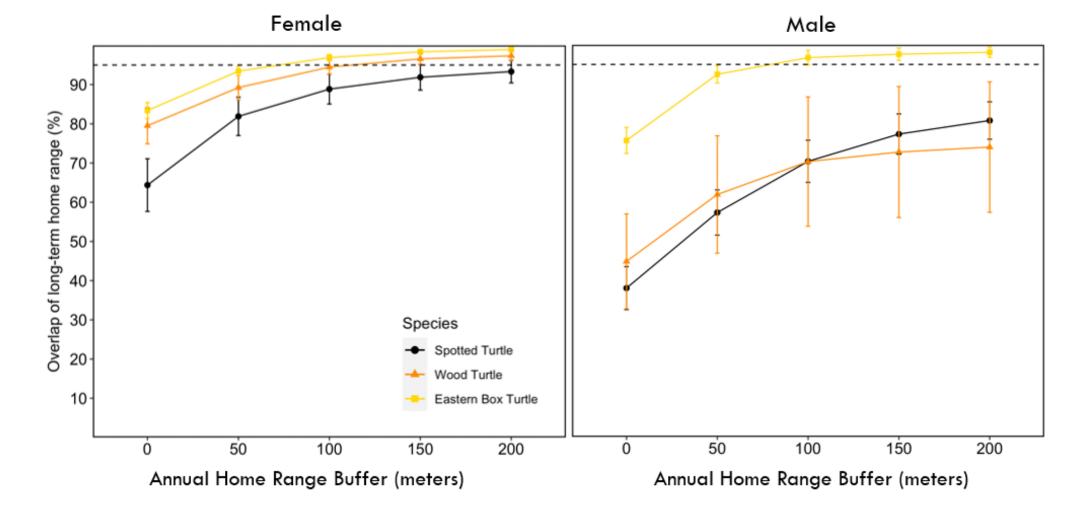
Male Fidelity Among Seasons



Distance (m)

How well do annual home range buffers reflect long-term space use?





- → Long-term fidelity similar to short-term fidelity reported by other studies
 200 m buffer around an annual home range will encompass:
 - \sim 95% of long-term movements for females and male box turtles
 - >70% for male spotted and wood turtles

Caveats

Potentially biased toward sedentary individuals

 \rightarrow Thus, fidelity estimates might be overestimates

Not all populations are the same

 \rightarrow Landscape context, individual behavior may vary

Conclusion

Novel information within freshwater turtle ecology

High long-term fidelity across species

Nevertheless, long-term effectiveness of land protection may vary by species → More effective for box turtle, less effective for spotted turtle

 \rightarrow Less effective for male spotted turtle, wood turtle

Lower long-term fidelity for females in nesting season suggests benefits of periodic nest site maintenance

Effects of Landscape Structure and Land Use on Turtle Demographics Across the Eastern United States

Subproject 2



Effects of landscape structure and land use on turtle communities across the eastern United States

H. Patrick Roberts^{a,*}, Lisabeth L. Willey^{b,c}, Michael T. Jones^d, David I. King^e, Thomas S.B. Akre^f, John Kleopfer[§], Donald J. Brown^{h,i}, Scott W. Buchanan^J, Houston C. Chandler^{k,i}, Phillip deMaynadier^m, Melissa Wintersⁿ, Lori Erb^o, Katharine D. Gipe^p, Glenn Johnson^q, Kathryn Lauer^{b,c}, Eric B. Liebgold^T, Jonathan D. Mays[§], Jessica R. Meck^{d,e}, Joshua Megyesyⁿ, Joel L. Mota^h, Nathan H. Nazdrowicz^t, Kevin J. Oxenrider^u, Molly Parren^c, Tami S. Ransom^v, Lindsay Rohrbaugh^w, Scott Smith^x, Derek Yorks^m, Brian Zarate^y



 Received: 28 June 2022
 Accepted: 15 December 2022

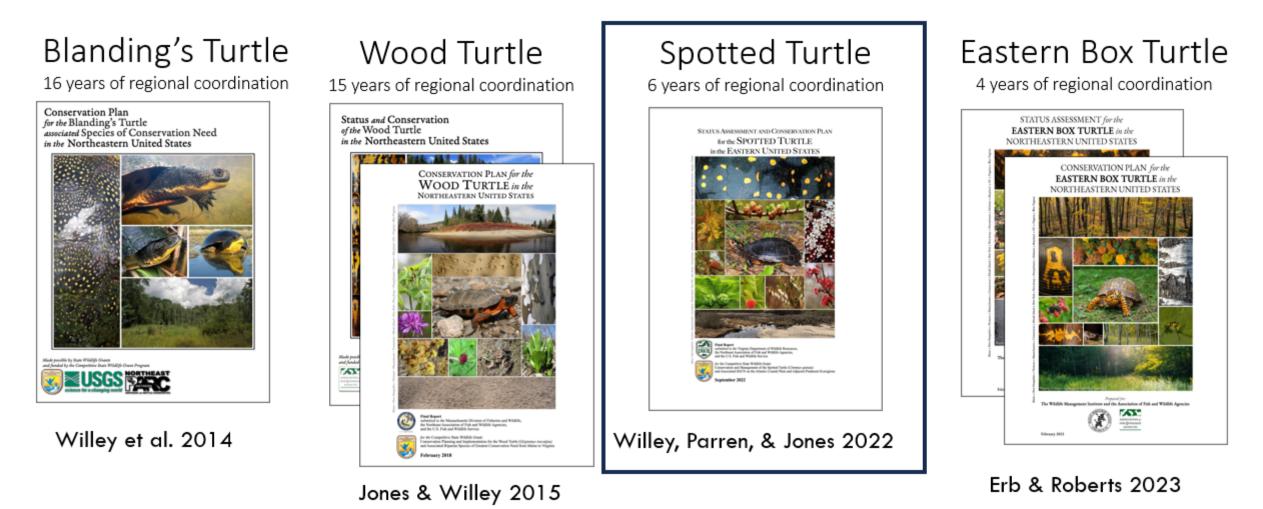
 DOI: 10.1111/gcb.16625



RESEARCH ARTICLE

Is the future female for turtles? Climate change and wetland configuration predict sex ratios of a freshwater species

Collaborative Turtle Conservation in the Northeast



Roberts & Erb 2023

Jones, Roberts, & Willey 2018

Northeastturtles.org



northeastturtles.org

J.D. Kleopfer (VADGIF) / Jonathan Regosin, (MassWildlife) / Lisabeth L. Willey (ATO/Antioch), Mike Jones (MassWildlife) / Lori Erb (MACHAC) / Thomas Akre & Jess Meck (SCBI) / Derek Yorks & Phillip DeMaynadier (ME IF&W) / Mike Ravesi (CTDEEP) / Kathy Gipe & Chris Urban, (PFBC) / Michael Marchand & Josh Megyesy & Melissa Doperalski (NHFG) / Houston Chandler (Orianne Society) / Scott Buchanan (RI DEM) / Lindsay Rohrbaugh (DDOE) / Glenn Johnson (SUNY Potsdam) / Angelena Ross (NYDEC) / Kevin Oxenrider (WVDNR) / Steve Parren (VT F&W) / Ed Thompson & Scott Smith (MD DNR) / Brian Zarate (NJDFW)

CSWG Partners: Virginia Department of Game and Inland Fisheries (VDGIF); Smithsonian Conservation Biology Institute (SCBI); American Turtle Observatory (ATO); Connecticut Department of Energy and Environmental Protection (DEEP); District of Columbia Department of Energy & the Environment (DOEE), Fisheries and Wildlife Division; Georgia Department of Natural Resources (GADNR); The Orianne Society (TOS); Maine Department of Inland Fisheries and Wildlife (MEIF&W); Massachusetts Division of Fisheries and Wildlife (MassWildlife); New Hampshire Fish and Game Department (NHFG); Pennsylvania Fish and Boat Commission (PFBC); The Mid-Atlantic Center for Herpetology and Conservation (MACHAC)

Additional, unfunded Partners: Florida Fish and Wildlife Conservation Commission (FFWCC); North Carolina Wildlife Resources Commission; South Carolina Department of Natural Resources; Vermont Fish and Wildlife Department (VTFWD); Virginia Department of Conservation and Recreation, Natural Area Preserve System; The Natural Conservancy Virginia Chapter (TNC VA); Department of Defense (DoD) PARC; USDA Natural Resources Conservation Service; USDA USFS George Washington and Jefferson National Forests

<u>Threats</u>

- Habitat loss
- Human land use
- Climate change
- Subsidized predation
- Illegal trade
- Disease
- Invasive species
- Successional changes

Environment

- Climate
- Landscape pattern
- Elevation
- Habitat
- Etc.

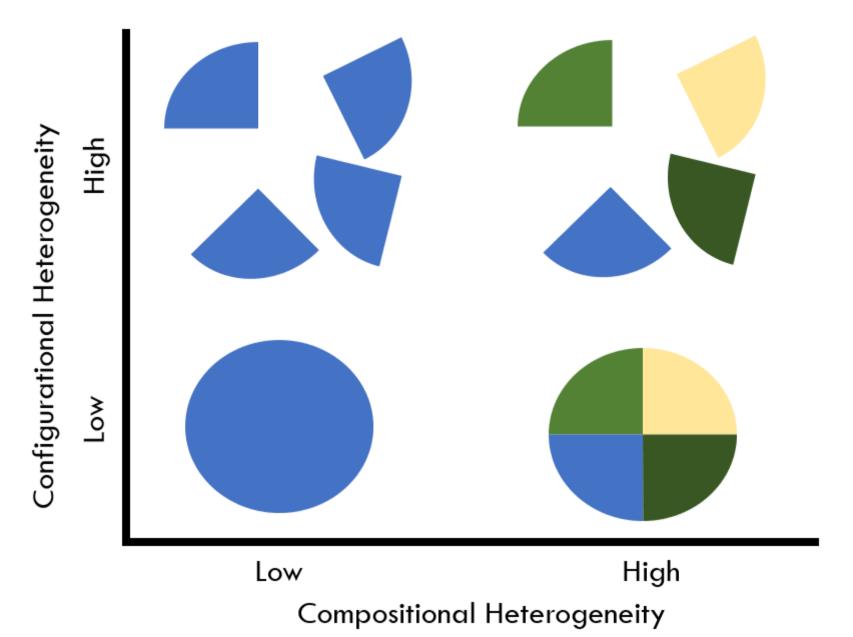
Populations

- Abundance
- Juvenile recruitment
- Sex ratio

Landscape Pattern



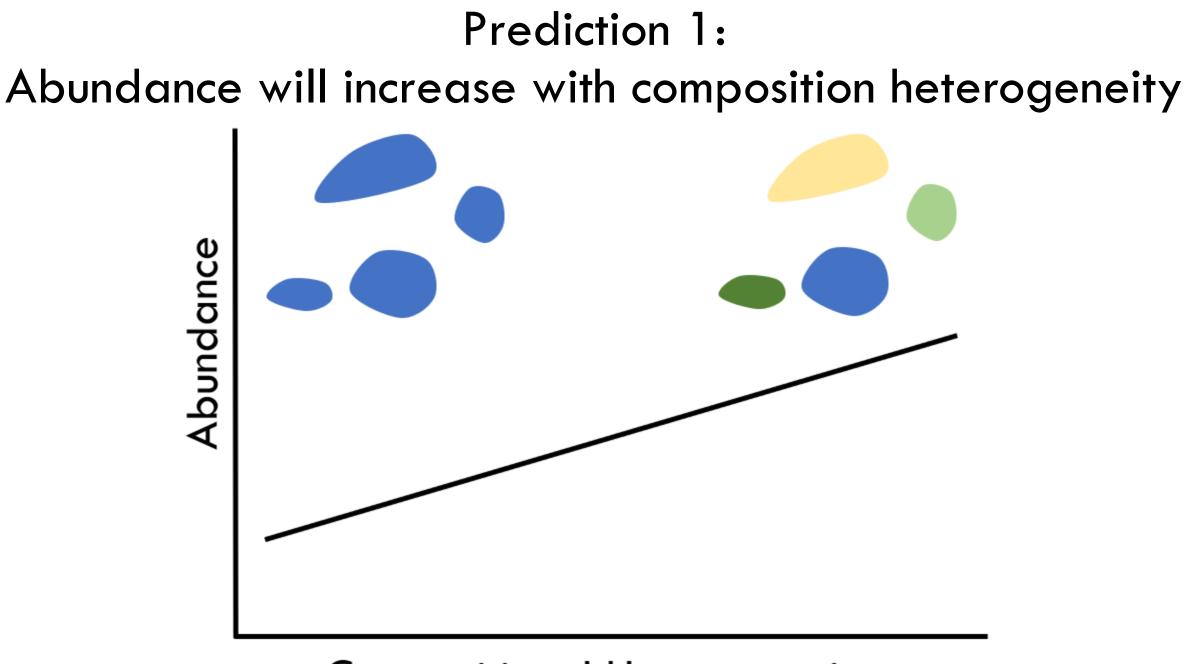
Landscape Heterogeneity



Goal

Understand the influence of landscape heterogeneity and human land use on turtle populations across the eastern United States

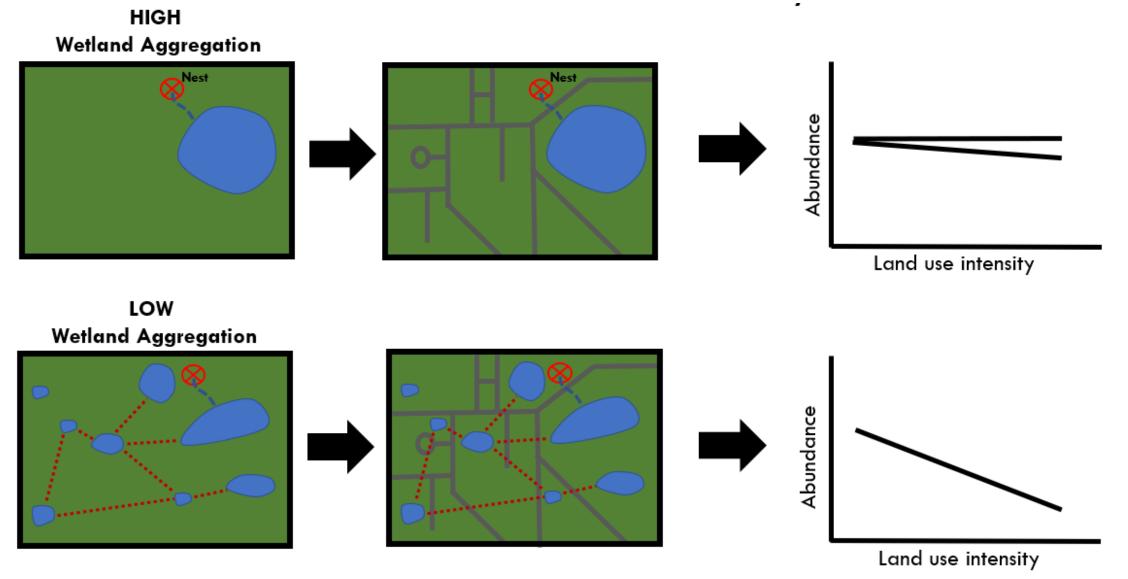




Compositional Heterogeneity

Prediction 2:

Configurational heterogeneity will interact with land use to affect abundance differently



Standardized Sampling Protocol



Habitats

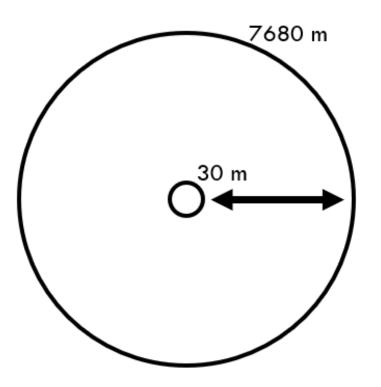
- Vernal Pools
- Shrub swamps
- Emergent marshes
- Forested wetlands
- Wet meadows
- Ditches





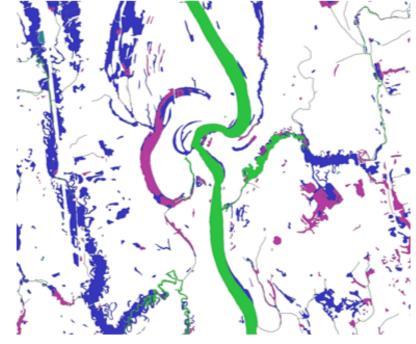
Landscape Characterization

Multiple spatial scales: 30 – 7680m



Compositional Heterogeneity

→ Wetland diversity

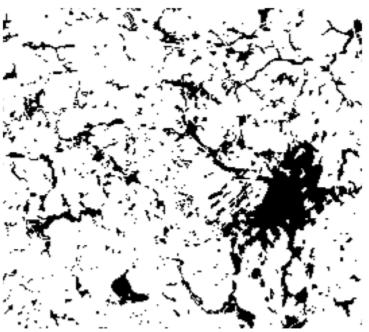


Shannon Diversity Index

Landscape Characterization: Wetland Aggregation and Land Use

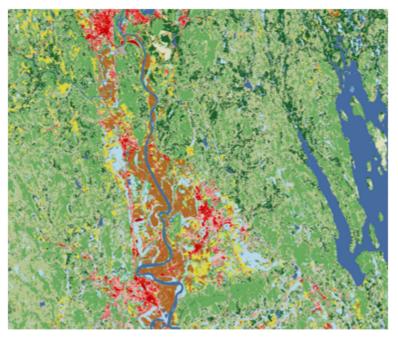
Configurational Heterogeneity

 \rightarrow Wetland aggregation



Aggregation index (FRAGSTATS)

Land use



- National Land Cover Database
- Road density, imperviousness, proportion crops, proportion hay/pasture

Results

- 531 reference plots
- 4930 turtle detections from 2018–2020
- 12 turtle species

Focal Species

Eastern Mud Turtle





Snapping Turtle

Spotted Turtle



Yellow-bellied Slider



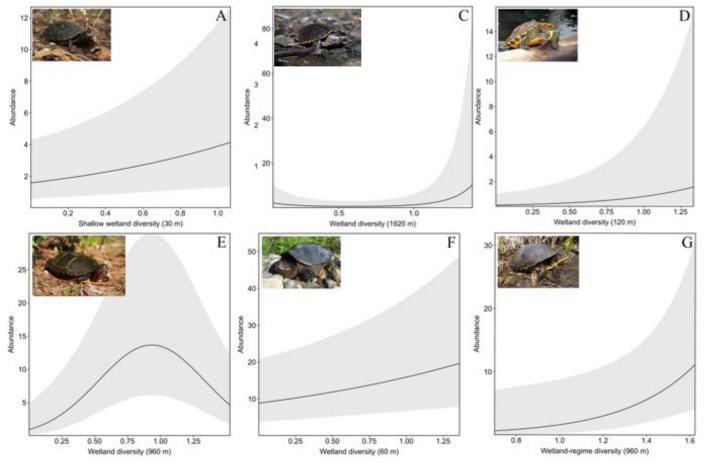
Painted Turtle



Striped Mud Turtle



Compositional Heterogeneity



All but one species were positively associated with wetland diversity

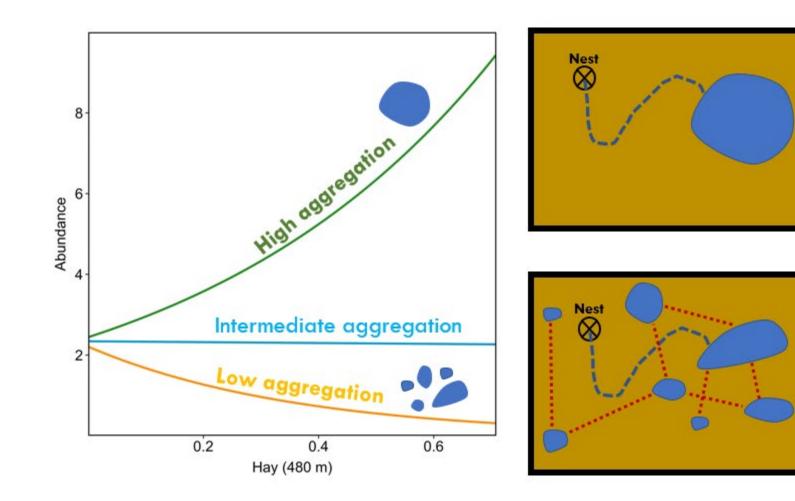
 \rightarrow Support for prediction





Configurational Heterogeneity

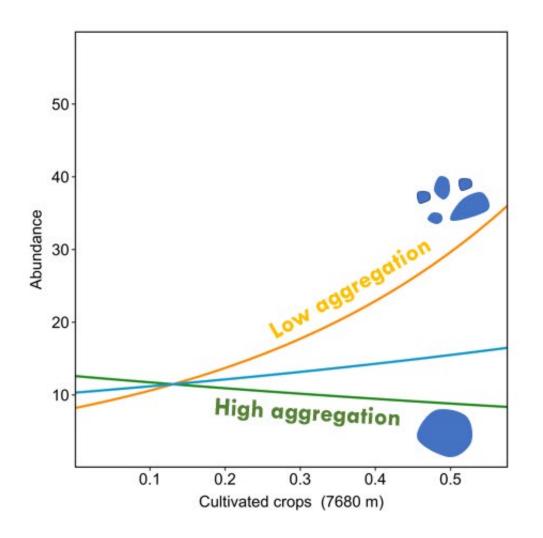
 \rightarrow Mixed support for prediction





Spotted Turtle

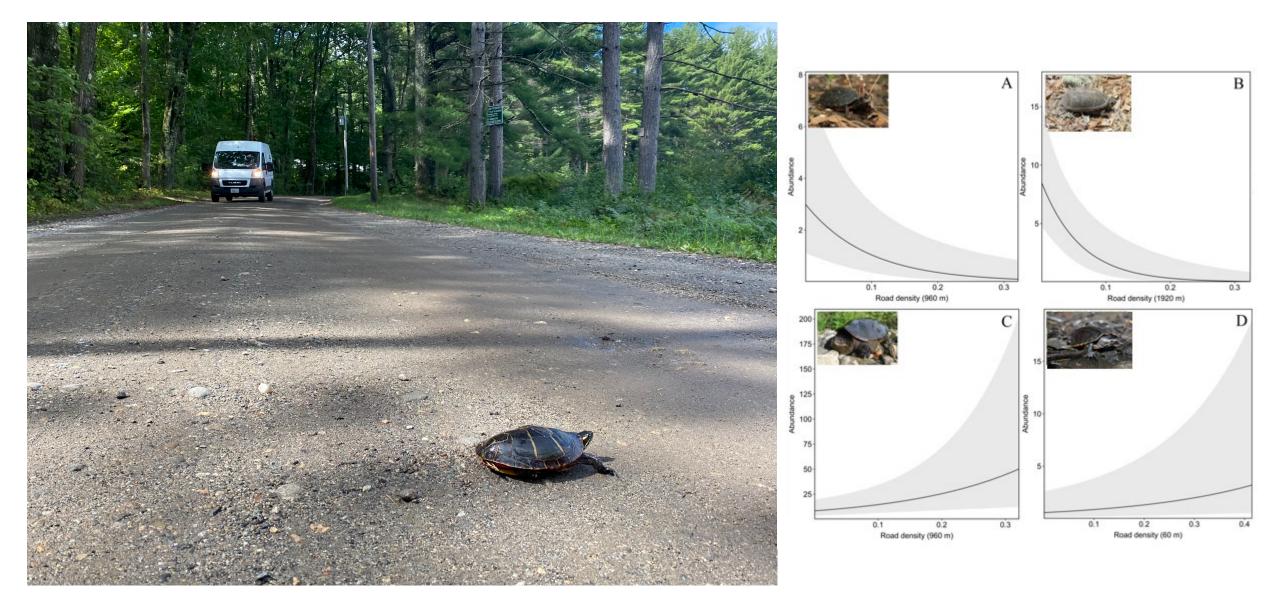
 \rightarrow Opposite pattern in snapping turtles





Snapping Turtle

Roads



Predation release

Higher recruitment



Received: 22 January 2021 Revised: 14 June 2021 Accepted: 1 July 2021
DOI: 10.1002/ecs2.3946

ARTICLE



Reduced predation on roadside nests can compensate for road mortality in road-adjacent turtle populations

Rowan E. Murphy¹ | Amanda E. Martin^{2,3} | Lenore Fahrig¹

Anthropogenic Threats

- Habitat loss
- Human land use
- Climate change
- Subsidized predation
- Illegal trade
- Disease
- Invasive species
- Successional changes

Environment

- Climate
- Landscape pattern
- Elevation
- Habitat
- Etc

Populations

- Abundance
- Juvenile recruitment
- Sex ratio

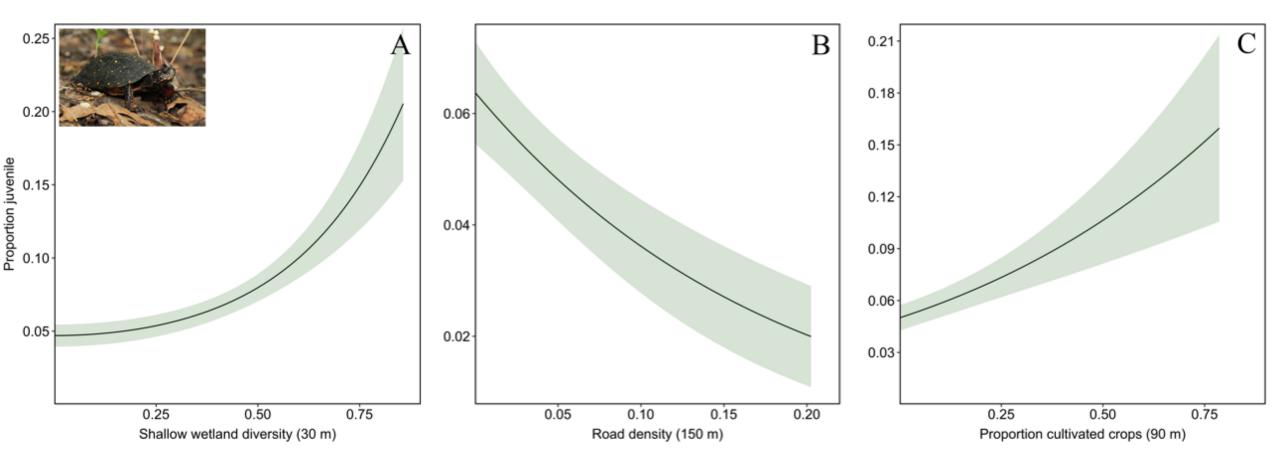
Juvenile Recruitment





Analyses only include spotted turtles

Juvenile Recruitment and Shallow Wetland Diversity, Road Density, and Proportion Cultivated Crops



<u>Threats</u>

- Habitat loss
- Human land use
- Climate change
- Subsidized predation
- Illegal trade
- Disease
- Invasive species
- Successional changes

Environment

- Climate
- Landscape pattern
- Elevation
- Habitat
- Etc

Populations

- Abundance
- Juvenile recruitment
- Sex ratio

Effects of Roads on the Structure of Freshwater Turtle Populations

DAVID A. STEEN AND JAMES P. GIBBS*

350 Illick Hall, 1 Forestry Drive, State University of New York College of Environmental Science and Forestry, Syracuse, NY 13210, U.S.A.

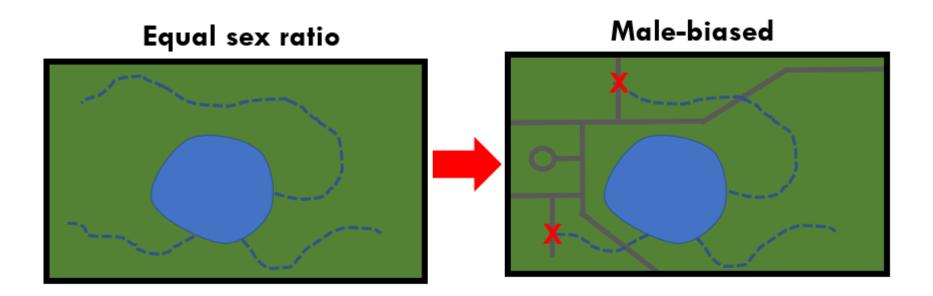
Trends in Sex Ratios of Turtles in the United States: Implications of Road Mortality

JAMES P. GIBBS* AND DAVID A. STEEN†

State University of New York College of Environmental Science and Forestry, 350 Illick Hall, 1 Forestry Drive, Syracuse, NY 13210, U.S.A.

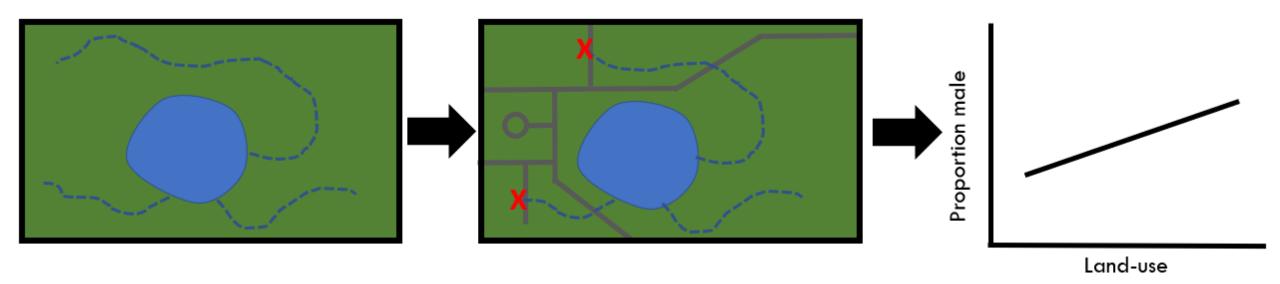
Relative vulnerability of female turtles to road mortality

D. A. Steen¹, M. J. Aresco², S. G. Beilke³, B. W. Compton⁴, E. P. Condon¹, C. Kenneth Dodd Jr.⁵, H. Forrester⁶, J. W. Gibbons⁷, J. L. Greene⁷, G. Johnson⁸, T. A. Langen⁹, M. J. Oldham¹⁰, D. N. Oxier¹¹, R. A. Saumure^{12,†}, F. W. Schueler¹³, J. M. Sleeman¹⁴, L. L. Smith¹, J. K. Tucker¹⁵ & J. P. Gibbs¹⁶

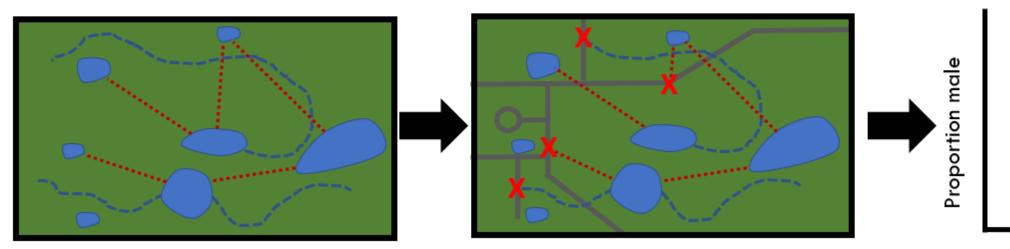


→ Many studies find <u>no effect</u>

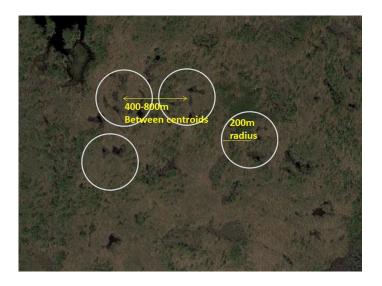
HIGH Wetland Aggregation



LOW Wetland Aggregation



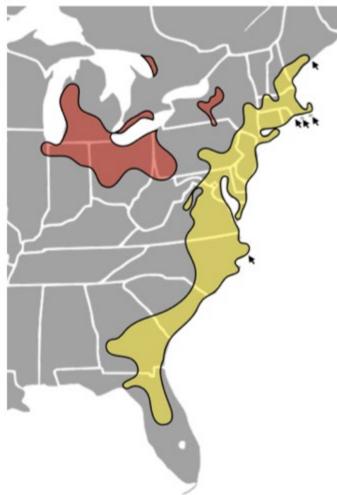
Standardized Sampling Protocol



Habitats

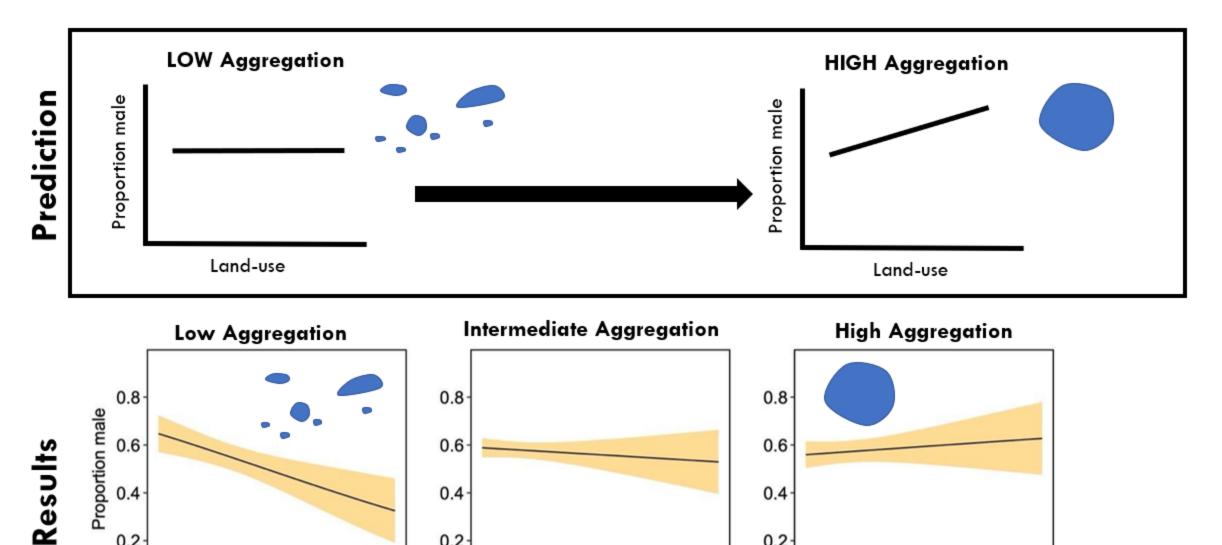
- Vernal Pools
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- Ditches





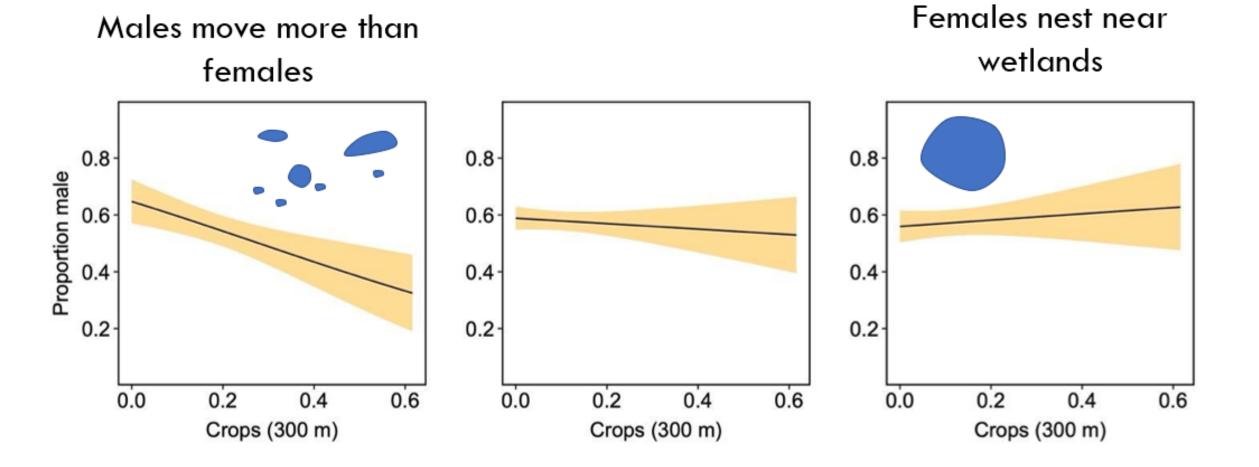
No support for prediction

0.2



0.2 0.2 0.0 0.2 0.6 0.0 0.2 0.4 0.6 0.0 0.2 0.4 0.4 Crops (300 m) Crops (300 m) Crops (300 m)

0.6



Findings and Implications

Turtle communities are shaped by the composition and configuration of habitat

Abundance positively influenced by wetland diversity

- Protection efforts should prioritize landscapes with varied wetland types and hydrological regimes
- \rightarrow Restoration efforts should focus on wetland diversity
- Destruction or degradation of "non-critical" wetlands may still trigger population decline



 \rightarrow Landscapes with high wetland diversity may also serve as climate refugia

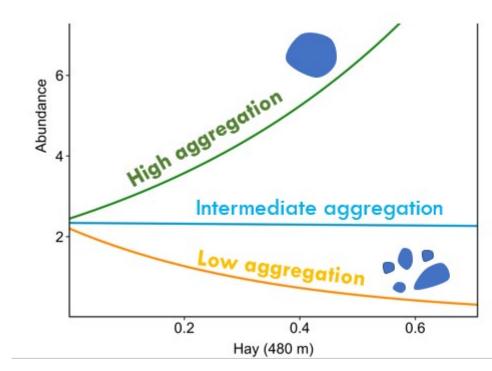


Findings and Implications: Wetland Configuration and Land Use

Wetland configuration may determine the effect of land use on populations

→ Land cover types may not be strictly "good" or "bad," but strongly dependent upon landscape context

 \rightarrow Management plans should explicitly consider landscape context





Findings and Implications: Roads and Agriculture

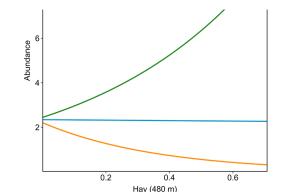
Roads negatively affect spotted turtle abundance and juvenile recruitment

 \rightarrow Restoration projects may consider prioritizing sites with lower road density



Agriculture negatively affects spotted turtle abundance and sex ratio BUT the effect is dependent upon wetland configuration

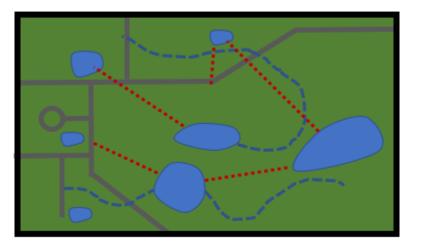




Implications

Supports the shift away from individual-wetland and buffered-based conservation to multi-scale landscape-level conservation







northeastturtles.org

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Thank you!!

USDA Natural Resources Conservation Service

Liz Willey **Mike Jones** The King Lab Joan Milam **Emily Bartone** Allyson Maloney **Connor Hughes** Kat Lauer Megan Ormsby Lea Kablik Cullen MacKenzie **Rachel Yurchisin**









Photo Credits by Slide

- Slide 1: Patrick Roberts
- Slide 2, turtle: Patrick Roberts
- slide 2, dinosaur: https://commons.wikimedia.org/wiki/File:202004_Pachycephalosaurus_wyomingensis.png
- slide 2, skeleton diagram: https://en.wikipedia.org/wiki/Turtle_shell#/media/File:Turtle_skeleton_cross-section, labelled as infographic.svg
- slide 3, egg shell: Mike Jones
- Slide 3, juvenile: Patrick Roberts
- Slide 4, development: USDA
- Slide 4, turtle on road: USFWS
- Slide 4, turtles in container: USFWS
- Slide 5, raccoon: USFWS
- Slide 7, bird: USFWS
- Slide 7, turtle: Patrick Roberts
- Slide 10, left and right turtle: Patrick Roberts
- Slide 10, middle turtle (wood): Mike Jones
- Slide 11: Patrick Roberts
- Slide 13, succession: U.S. Forest Service, USDA
- Slide 13, logging: USDA
- Slide 16, all photos: Mike Jones
- Slide 18, turtle: Mike Jones
- Slide 18, people: Patrick Roberts
- Slide 19: Patrick Roberts
- Slides 20, 21, 22, 24: Patrick Roberts
- Slide 26, box turtle: Patrick Roberts
- Slide 26, wood turtle: Mike Jones
- Slide 27: Patrick Roberts
- Slide 28: see 26 and 27
- Slide 29: see 26 and 27

Photo Credits by Slide (Continued)

- Slide 30: Patrick Roberts
- Slide 31: see 26 and 27
- Slide 36: Patrick Roberts
- Slide 42, wetland and development: Sam Stafford
- Slide 42, wetland: Evan Barrientos/Audubon Rockies
- Slide 42, all turtles: Mike Jones
- Slide 45, wetland: Patrick Roberts
- Slide 45, distribution map: American Turtle Observatory
- Slide 48, yellow-bellied slider: USFWS, Roy W. Lowe
- Slide 48, eastern mud: Houston Chandler
- Slide 48, all other turtles: Mike Jones
- Slide 49: see slide 48 credits
- Slide 50: Mike Jones
- Slide 51: Mike Jones
- Slide 52: see slide 48 credits
- Slide 53, development: USDA
- Slide 53, raccoon: USFWS
- Slide 55, both photos: Mike Jones
- Slide 65: USFWS, Larry Palmer
- Slide 66: Mike Jones
- Slide 67, corn field: USDA, Preston Keres
- Slide 67, turtle on road: USFWS