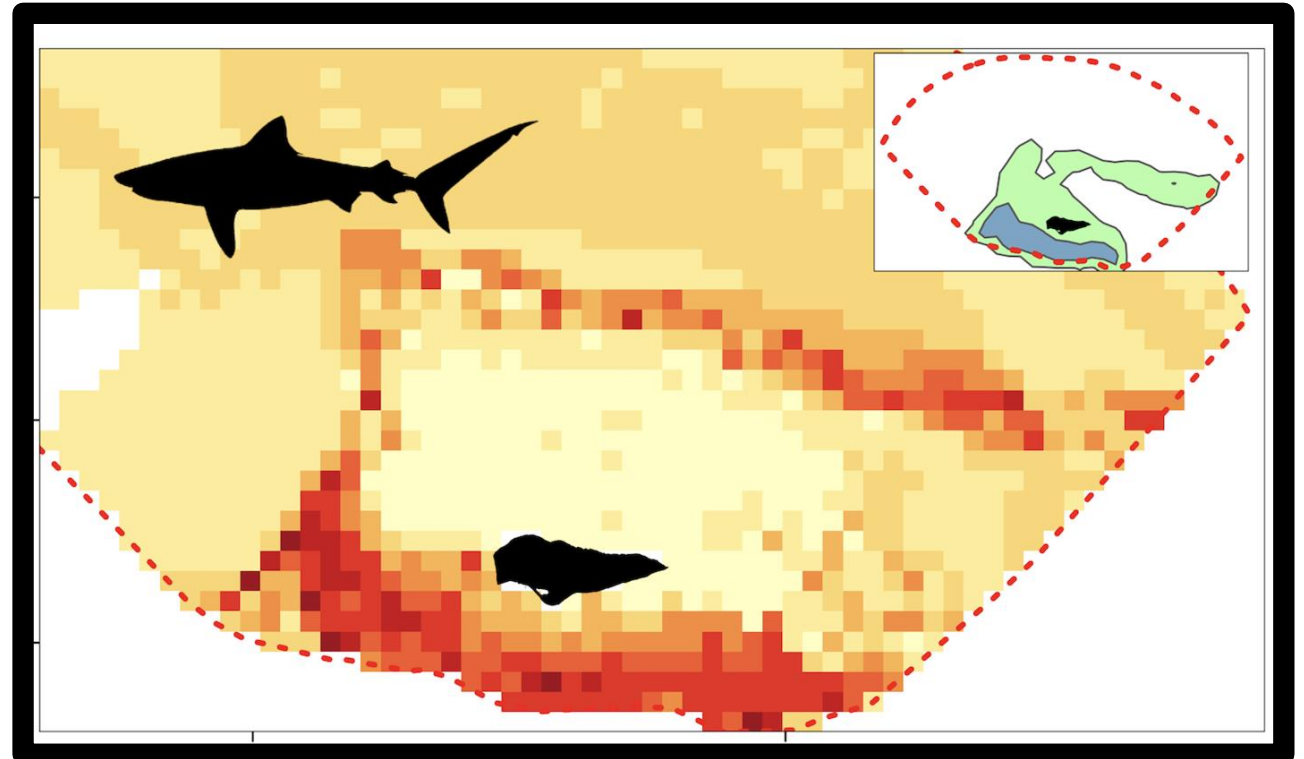


# Relative Habitat Selection and Resource Selection Functions in Aquatic Acoustic Telemetry

## Theory, Application, and Process



**Lucas Griffin**  
**Assistant Professor**  
**University of South Florida**

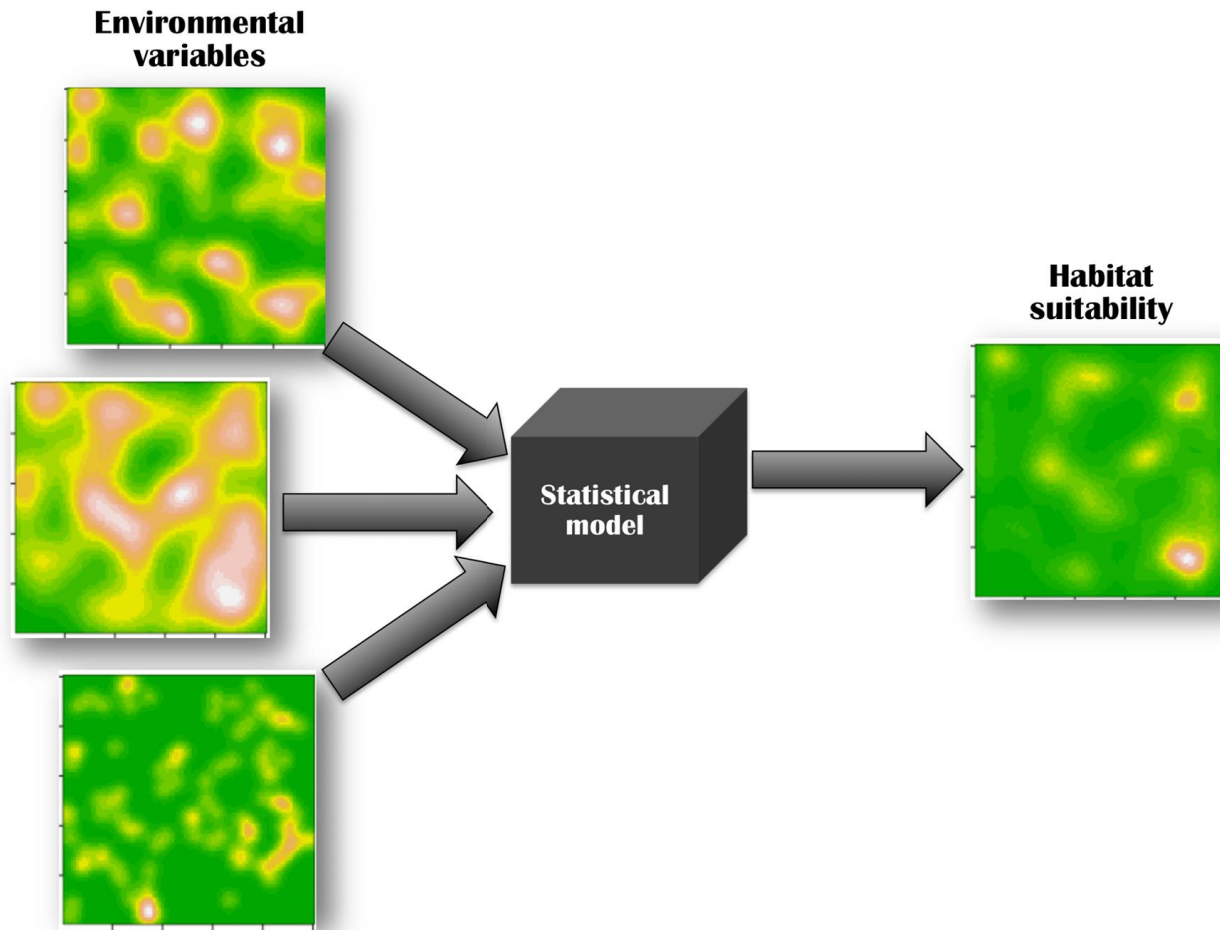


**Jonathan Rodemann**  
**Postdoctoral Associate**  
**Florida International University**

# Roadmap for today

1. Modeling Habitat Selection
  1. Terrestrial vs. Aquatic
  1. Approach with Acoustic Telemetry
  1. Considerations and Next Steps
  1. Hands-on Code with Seatrout Example

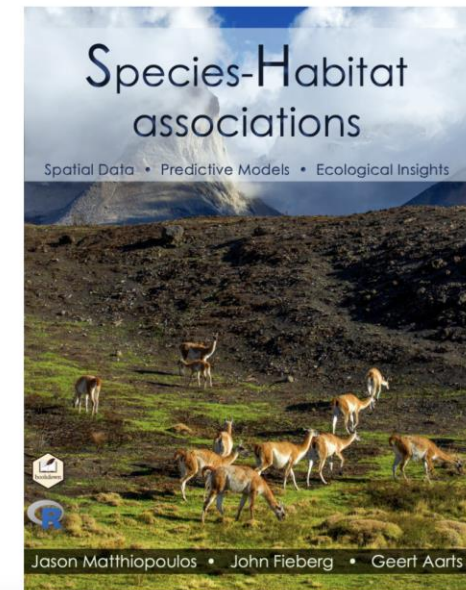
# What habitats do animals like or avoid?



## Species-Habitat Associations: Spatial data, predictive models, and ecological insights

Jason Matthiopoulos, John Fieberg, Geert Aarts

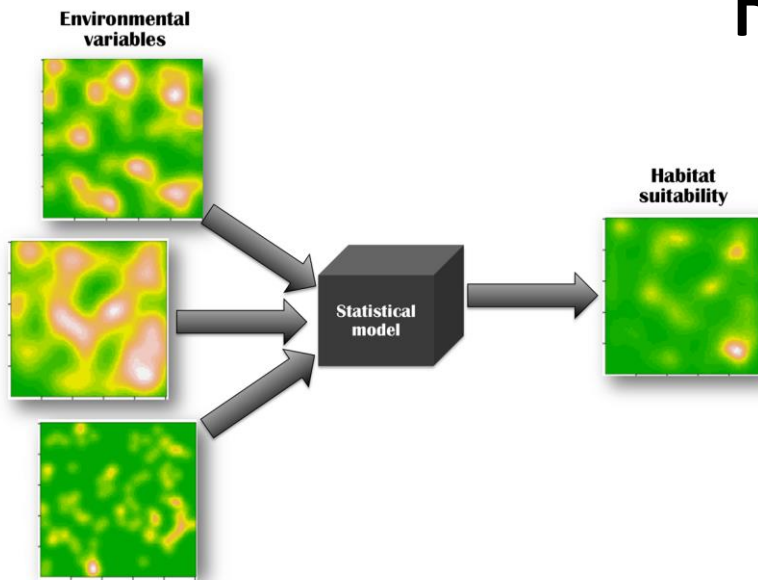
2023-01-03



Matthiopoulos et al. 2023

What habitats do animals like or avoid?

# Species Distribution Models & Resource Selection Functions



## Input

Locations of individuals

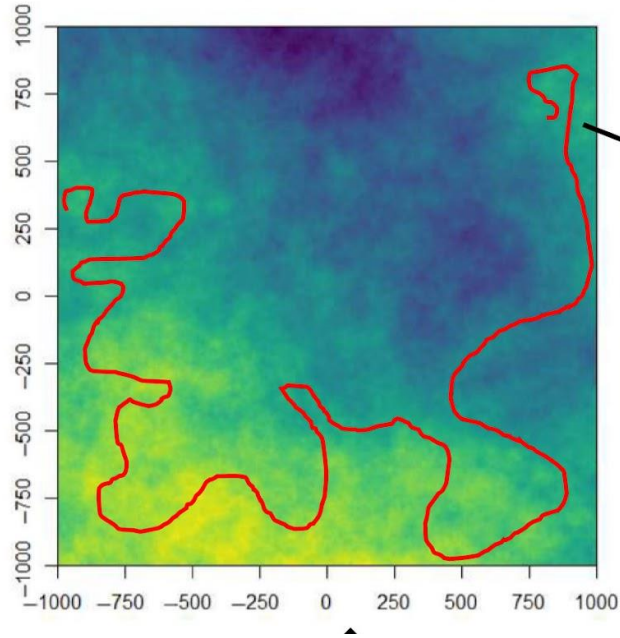
Random assignment of locations, also known as pseudo-absences

## Output

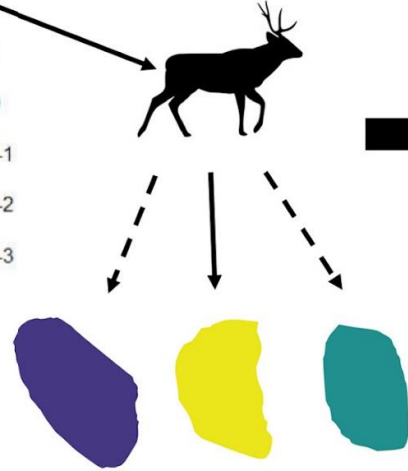
Distribution as a function of resources, risks, conditions



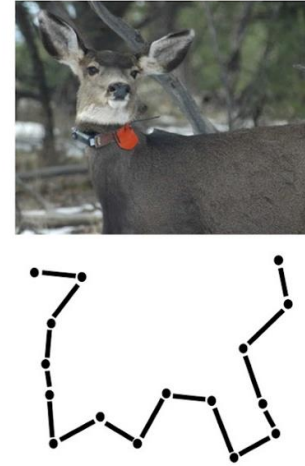
a) Continuous movement path overlaid on map of expected fitness payoff



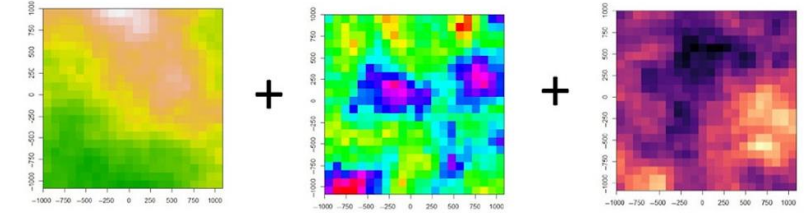
a1) Movement path is result of continuous selection from available habitat based on perceived fitness payoff



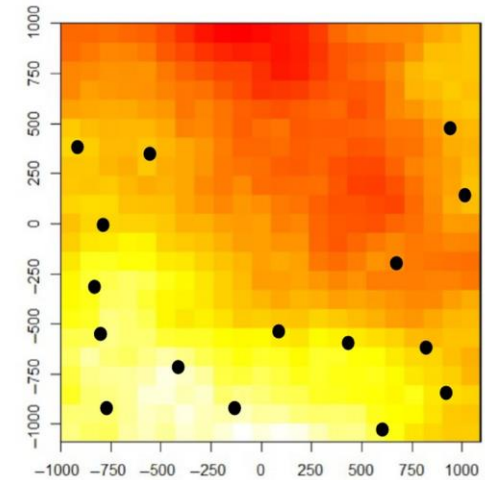
b) Habitat-selection process is sampled using telemetry, providing a sample from the distribution of used locations:  $f^u(x)$



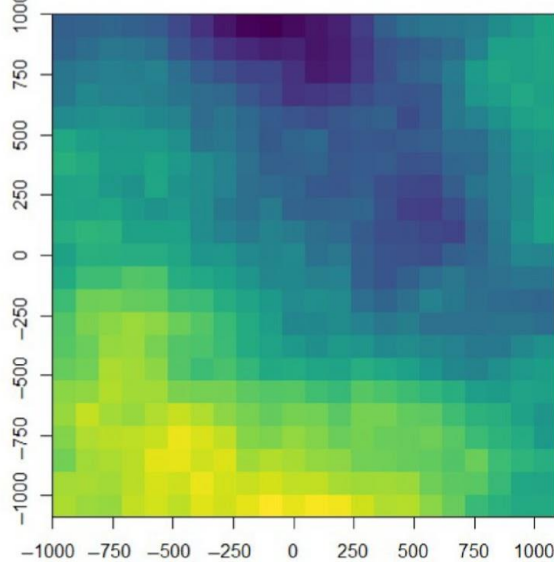
c) Environmental covariates are chosen to represent habitat. Can be in continuous or discrete space



d) Distribution of available habitat ( $f^A(x)$ ) is approximated and sampled. Environmental covariates are extracted for used and available sample



f) Model selection, evaluation, validation, map. Make inference to habitat selection

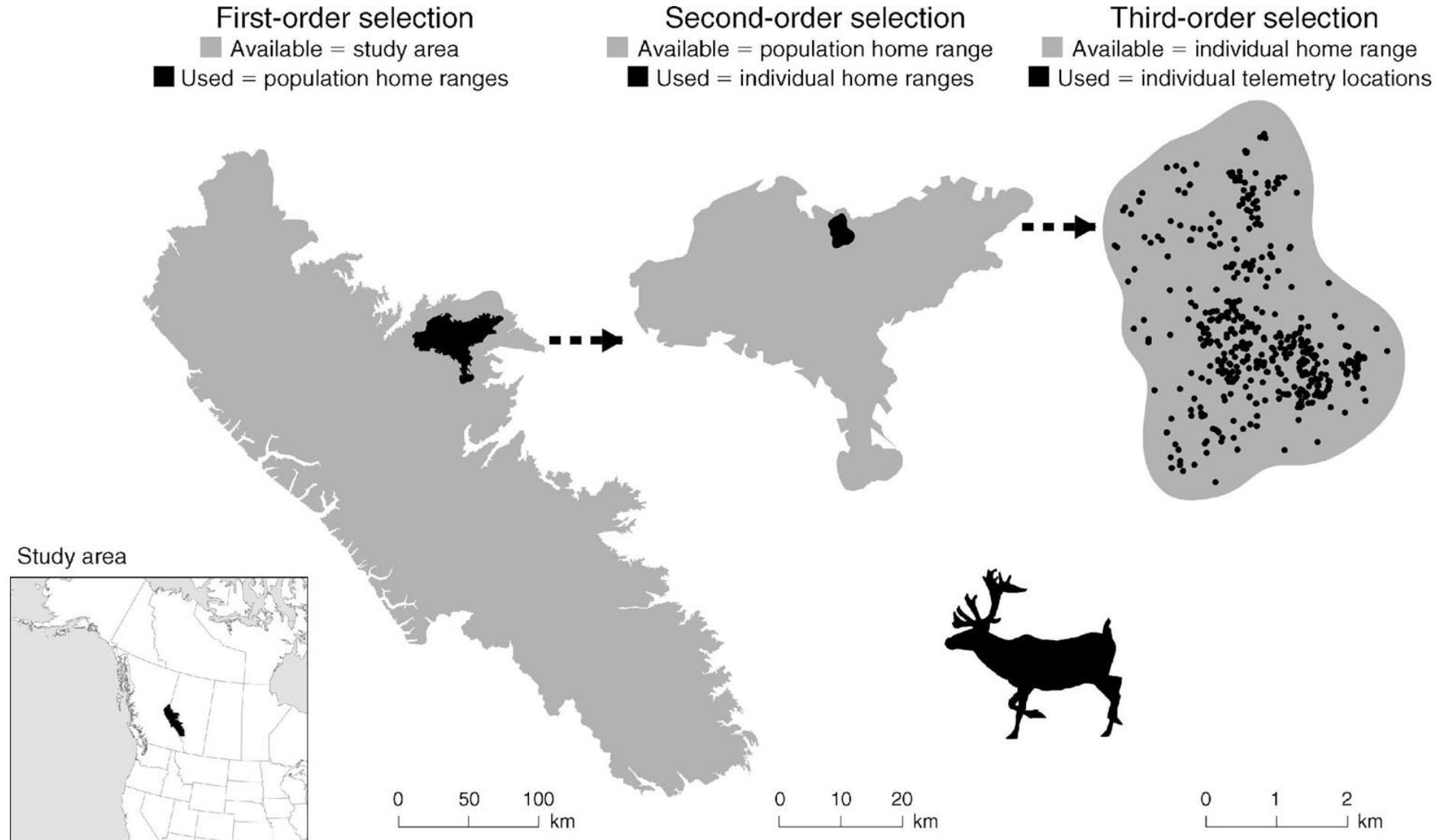


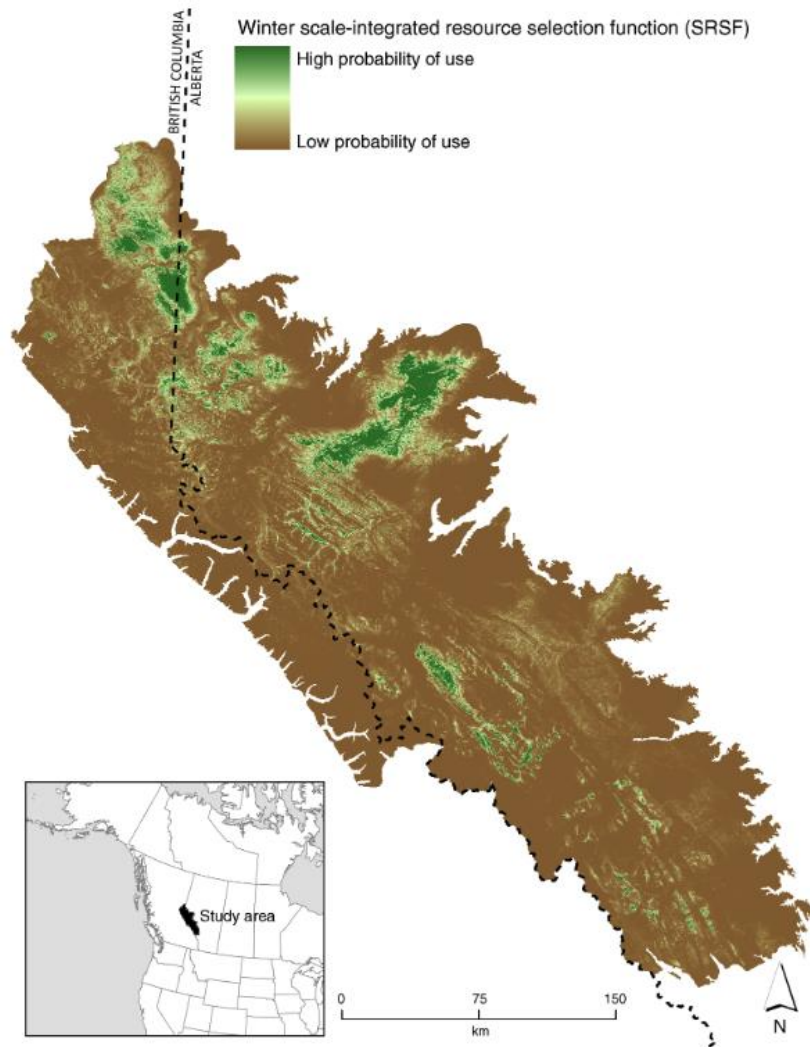
e) Fit selection functions [ $w(x)$ ] to obtain estimates of coefficients from the weighted distribution

$$f^u(x) = \frac{f^A(x)w(x)}{\int f^A(x)w(x)dx}$$

$$w(x) = \exp(x\beta)$$

# What habitats do animals like or avoid?





DeCesare, N. J et al. (2012). *Ecological Applications*.



Ecological Modelling  
Volume 157, Issues 2–3, 30 November 2002, Pages 281–300



## Evaluating resource selection functions

Mark S. Boyce <sup>a, \*</sup>, Pierre R. Vernier <sup>b</sup>, Scott E. Nielsen <sup>a</sup>, Fiona K.A. Schmiegelow <sup>c</sup>

## Journal of Animal Ecology



Standard Paper | [Free Access](#)

## Multi-trophic resource selection function enlightens the behavioural game between wolves and their prey

Nicolas Courbin <sup>a</sup>, Daniel Fortin, Christian Dussault, Viviane Fargeot, Réhaume Courtois

## ECOLOGY

ECOLOGICAL SOCIETY OF AMERICA

Report | [Free Access](#)

## Practical guidance on characterizing availability in resource selection functions under a use–availability design

Joseph M. Northrup, Mevin B. Hooten, Charles R. Anderson Jr., George Wittemyer

## Journal of Applied Ecology



[Free Access](#)

## Use of resource selection functions to identify conservation corridors

Cheryl-Lesley B. Chetkiewicz <sup>a</sup>, Mark S. Boyce



Rangeland Ecology & Management  
Volume 66, Issue 4, July 2013, Pages 419–427



Research Articles

## Winter Resource Selection by Mule Deer on the Wyoming–Colorado Border Prior to Wind Energy Development

Stephen L. Webb <sup>1, \*</sup>, Matthew R. Dzialak <sup>2</sup>, Karl L. Kosciuch <sup>3</sup>, Jeffrey B. Winstead <sup>4</sup>

[Show more](#)

## Trends in Ecology & Evolution

Volume 14, Issue 7, 1 July 1999, Pages 268–272



Review

## Relating populations to habitats using resource selection functions

Mark S. Boyce <sup>a, \*</sup>, Lyman L. McDonald <sup>b</sup>

[Go to Trends in Ecology & Evolution on ScienceDirect](#)

## Diversity and Distributions

Open Access

A Journal of  
Conservation  
Biogeography

BIODIVERSITY RESEARCH | [Open Access](#)

## Humans alter habitat selection of birds on ocean-exposed sandy beaches

Justin J. Meager <sup>a</sup>, Thomas A. Schlacher, Tara Nielsen

## ECOSPHERE

AN ESA OPEN ACCESS JOURNAL

Article | [Open Access](#) | [CC](#) | [i](#)

## Identifying polar bear resource selection patterns to inform offshore development in a dynamic and changing Arctic

Ryan R. Wilson <sup>a</sup>, Jon S. Horne, Karyn D. Rode, Eric V. Regehr, George M. Durner

## Animal Conservation



[Open Access](#)

## Conservation planning using resource selection models: altered selection in the presence of human activity changes spatial prediction of resource use

S. M. Harju, M. R. Dzialak, R. G. Osborn, L. D. Hayden-Wing, J. B. Winstead

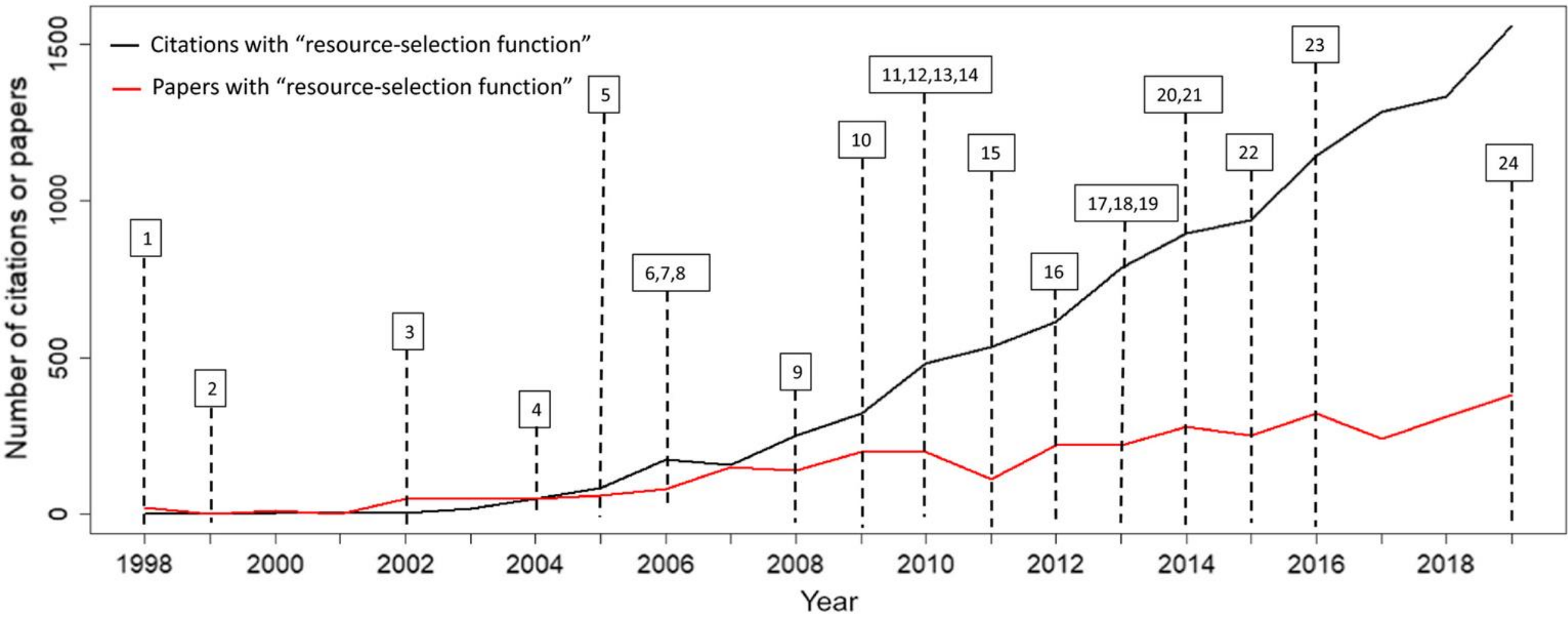


Ecological Modelling  
Volume 359, 10 September 2017, Pages 449–459



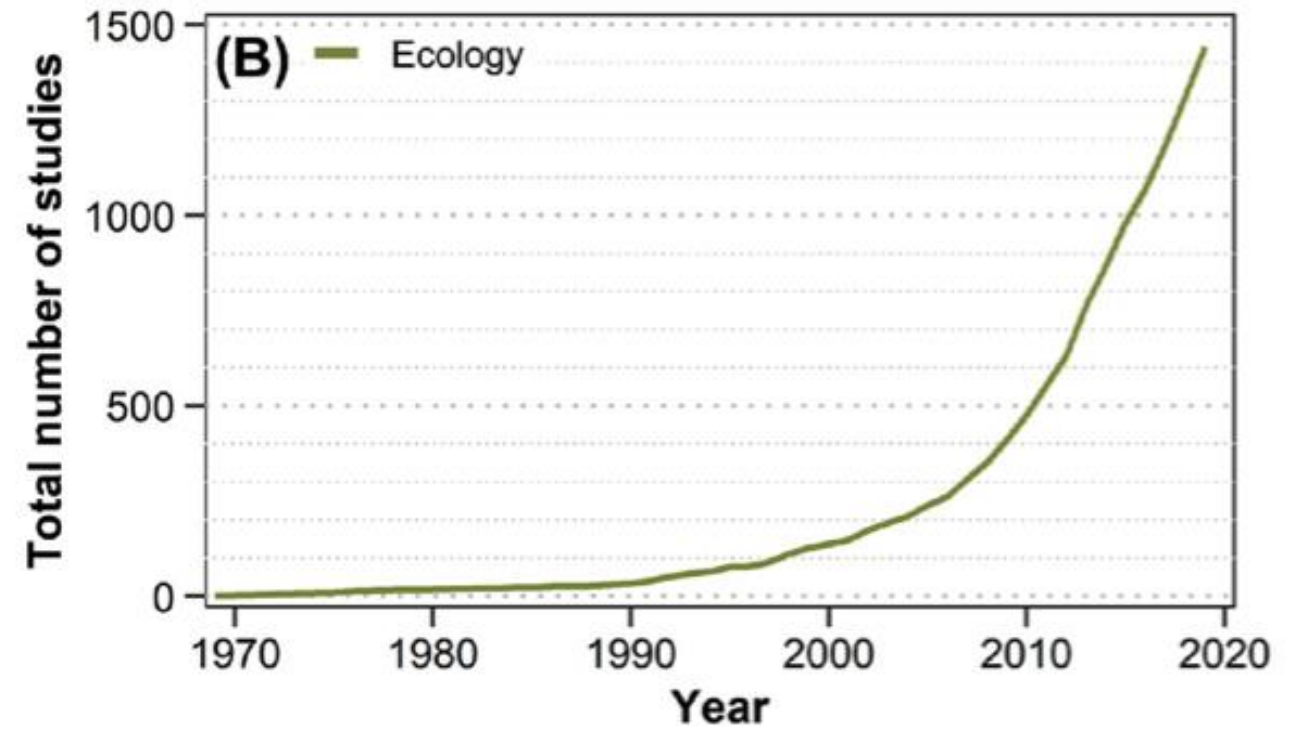
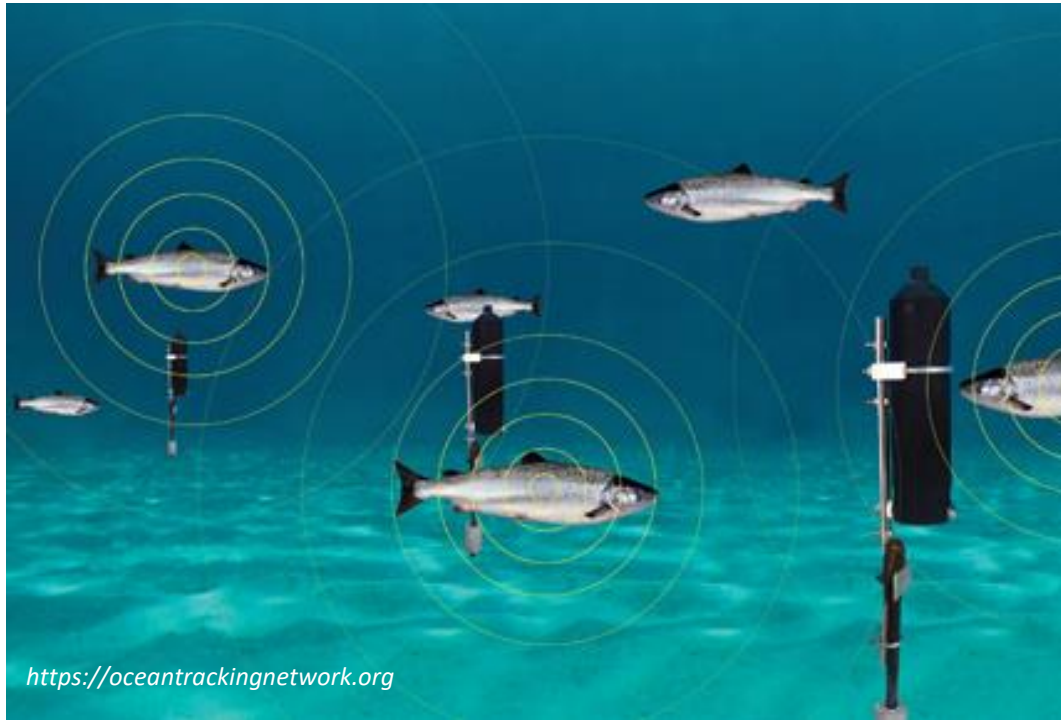
## Using dynamic population simulations to extend resource selection analyses and prioritize habitats for conservation

Julie A. Heinrichs <sup>a, \*</sup>, Cameron L. Aldridge <sup>a</sup>, Michael S. O'Donnell <sup>c</sup>, Nathan H. Schumaker <sup>d</sup>



Northrup, J.N., et al. (2012). *Ecological Applications*.





Matley, J. K., et al. (2021). Global trends in aquatic animal tracking with acoustic telemetry. *Trends in Ecology & Evolution*.



# Juvenile hawksbill residency and habitat use within a Caribbean marine protected area

Thomas H. Selby<sup>1,\*</sup>, Kristen M. Hart<sup>2</sup>, Brian J. Smith<sup>1</sup>, Clayton G. Pollock<sup>3</sup>, Zandy Hillis-Starr<sup>3</sup>, Madan K. Oli<sup>4</sup>

RESEARCH

Open Access

## Space use and relative habitat selection for immature green turtles within a Caribbean marine protected area

Lucas P. Griffin<sup>1\*</sup>, Brian J. Smith<sup>2</sup>, Michael S. Cherkiss<sup>3</sup>, Andrew G. Crowder<sup>3</sup>, Clayton G. Pollock<sup>4</sup>, Zandy Hillis-Starr<sup>4</sup>, Andy J. Danylchuk<sup>1</sup> and Kristen M. Hart<sup>3</sup>



ORIGINAL RESEARCH  
published: 29 April 2021  
doi: 10.3389/fmars.2021.631262



## A Novel Framework to Predict Relative Habitat Selection in Aquatic Systems: Applying Machine Learning and Resource Selection Functions to Acoustic Telemetry Data From Multiple Shark Species

OPEN ACCESS

Edited by:  
Mark J. Henderson,

Lucas P. Griffin<sup>1\*</sup>, Grace A. Casselberry<sup>1</sup>, Kristen M. Hart<sup>2</sup>, Adrian Jordaan<sup>1</sup>, Sarah L. Becker<sup>1</sup>, Ashleigh J. Novak<sup>1</sup>, Bryan M. DeAngelis<sup>3</sup>, Clayton G. Pollock<sup>4</sup>, Ian Lundgren<sup>5</sup>, Zandy Hillis-Starr<sup>6</sup>, Andy J. Danylchuk<sup>1†</sup> and Gregory B. Skomal<sup>7†</sup>

Movement Ecology

RESEARCH

Open Access

## Habitat and movement selection processes of American lobster/jakej within a restricted bay in the Bras d'Or Lake/Pitu'paq, Nova Scotia, Canada

Shannon Landovskis<sup>2†</sup>, Megan Bailey<sup>1</sup>, Sara Iverson<sup>1,2</sup>, Skyler Jeddore<sup>3</sup>, Robert J. Lennox<sup>1,2,4</sup>, Caelin Murray<sup>1</sup> and Fred Whoriskey<sup>2</sup>



PERSPECTIVE

## Applications of telemetry to fish habitat science and management

Jacob W. Brownscombe, Lucas P. Griffin, Jill L. Brooks, Andy J. Danylchuk, Steven J. Cooke, and Jonathan D. Midwood

ORIGINAL RESEARCH article

Front. Mar. Sci., 25 July 2022  
Sec. Marine Conservation and Sustainability  
Volume 9 - 2022 | https://doi.org/10.3389/fmars.2022.851757

This article is part of the Research Topic  
Novel Technologies for Assessing the Environmental and  
Ecological Impacts of Marine Renewable Energy Systems

[View all 8 articles >](#)

## Modeling the Probability of Overlap Between Marine Fish Distributions and Marine Renewable Energy Infrastructure Using Acoustic Telemetry Data

Charles W. Bangley<sup>1\*</sup>, Daniel J. Hasselman<sup>2</sup>, Joanna Mills Flemming<sup>1</sup>,  
Fredrick G. Whoriskey<sup>3</sup>, Joel Culina<sup>2</sup>, Lilli Enders<sup>4</sup>, Rod G. Bradford<sup>5</sup>



Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: [www.elsevier.com/locate/ecolind](http://www.elsevier.com/locate/ecolind)



Original Articles

## Habitat selection and spatial behaviour of vulnerable juvenile lemon sharks: Implications for conservation

Molly M Kressler<sup>a,b,\*</sup>, Evan E Byrnes<sup>c,d</sup>, Alice M Trevaill<sup>a</sup>, Clemency E White<sup>e</sup>, Vital Heim<sup>f</sup>, Matthew Smukall<sup>b</sup>, Adrian C Gleiss<sup>c,g</sup>, Richard B Sherley<sup>a,h</sup>

Received: 21 July 2023 | Accepted: 14 April 2024

DOI: 10.1111/1365-2656.14108

RESEARCH ARTICLE

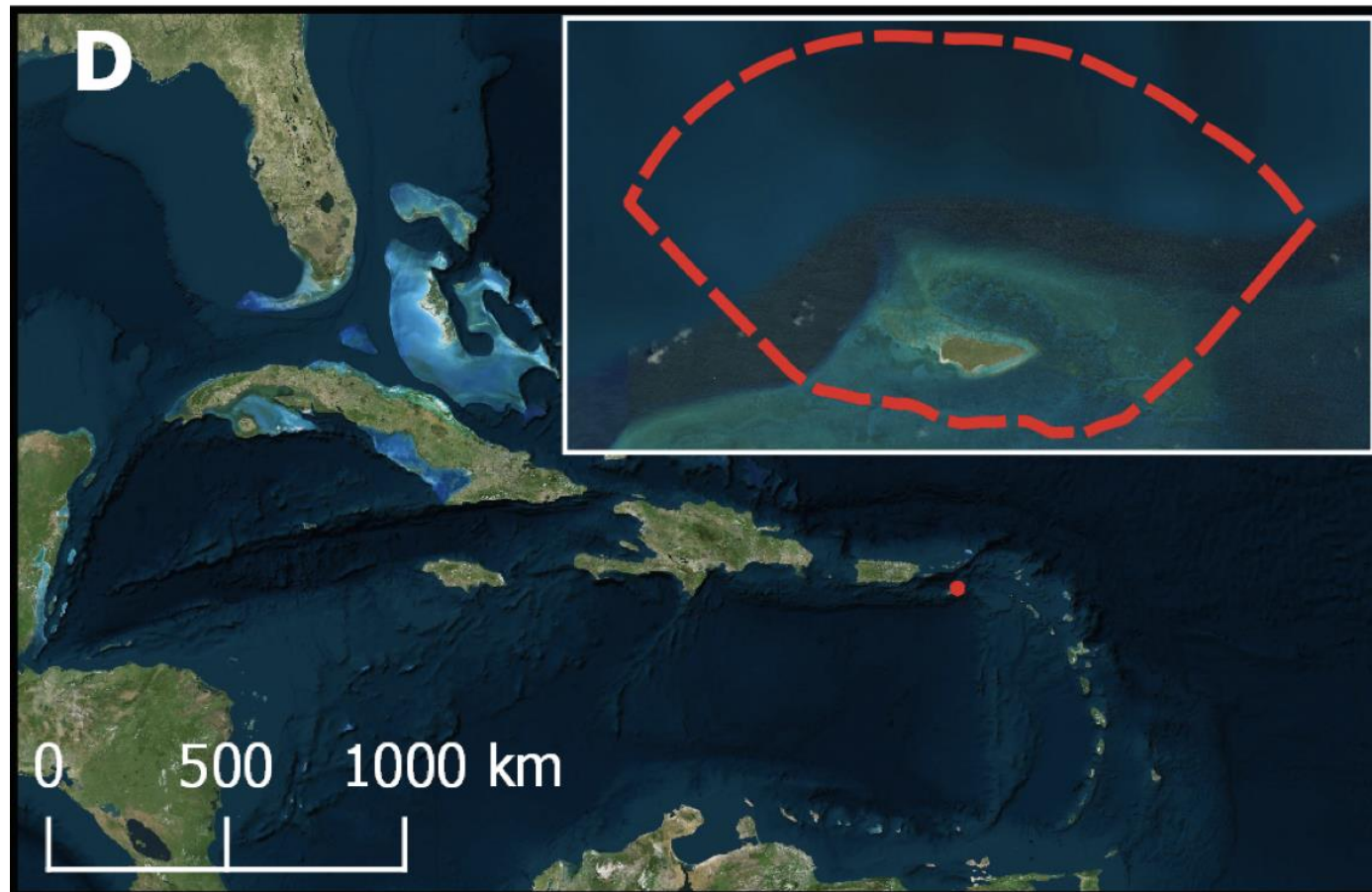
## Intraguild processes drive space-use patterns in a large-bodied marine predator community

Maurits P. M. van Zinnicq Bergmann<sup>1,2</sup>, Lucas P. Griffin<sup>3</sup>, Thomas W. Bodey<sup>4</sup>,  
Tristan L. Guttridge<sup>2,5</sup>, Geert Aarts<sup>6,7</sup>, Michael R. Heithaus<sup>1</sup>,  
Matthew J. Smukall<sup>2,8</sup>, Yannis P. Papastamatiou<sup>1</sup>

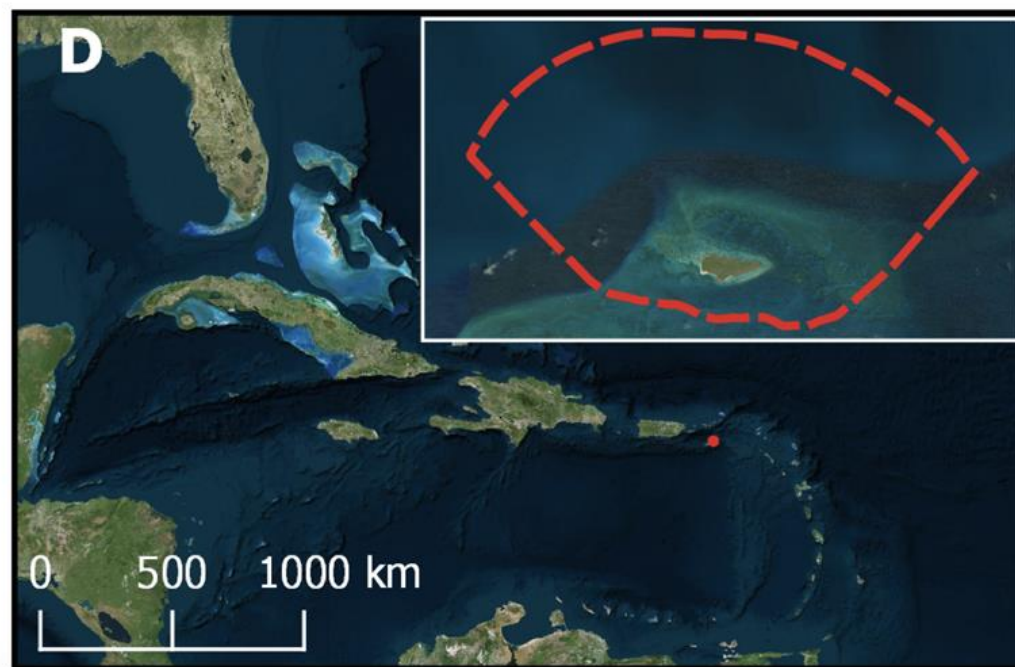
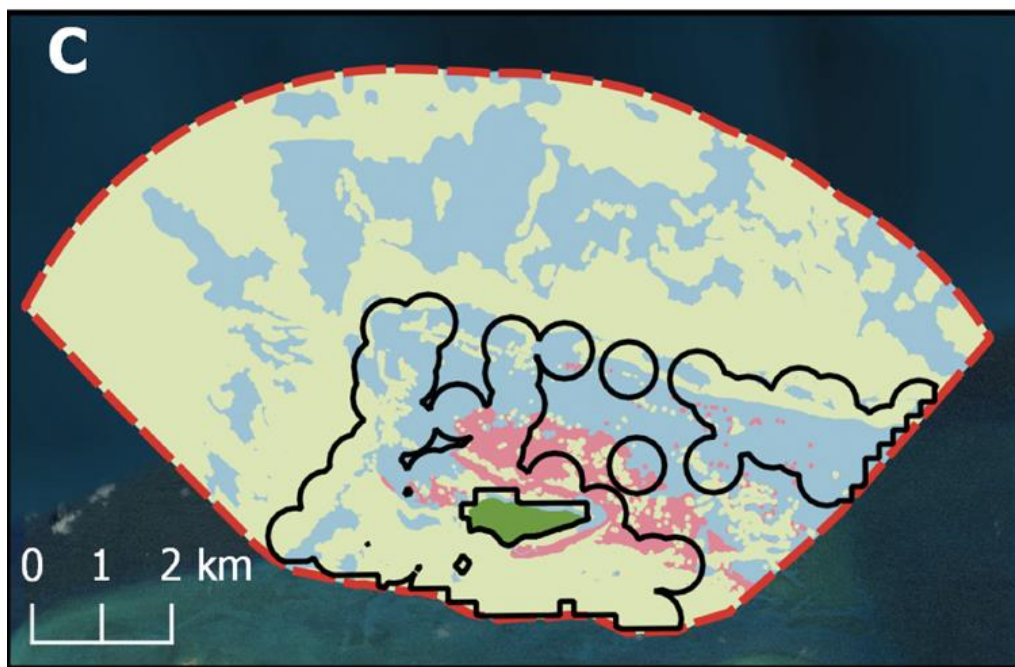
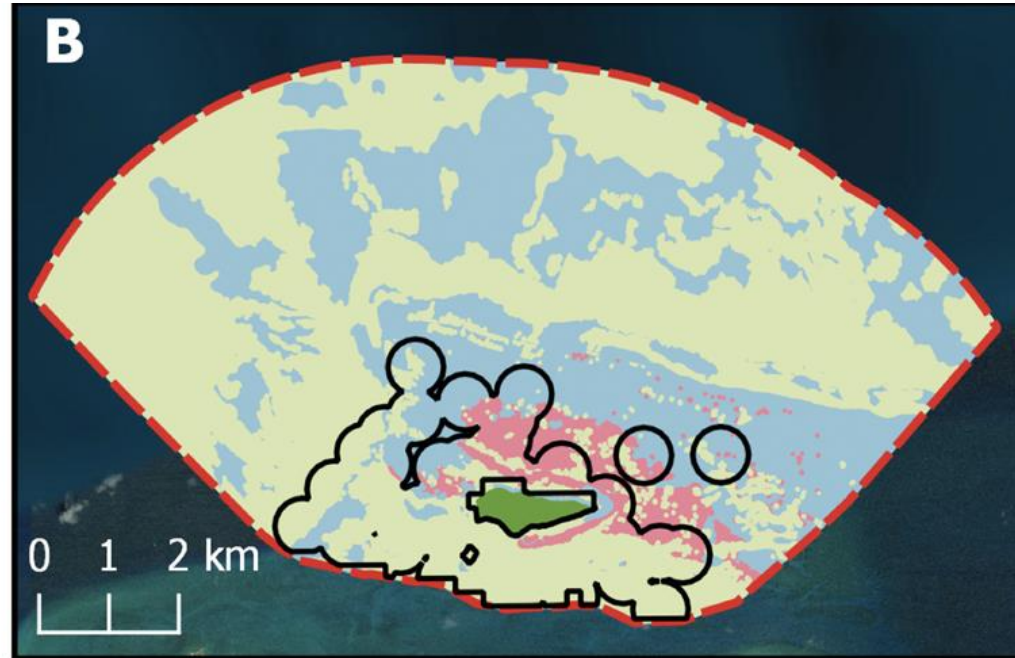
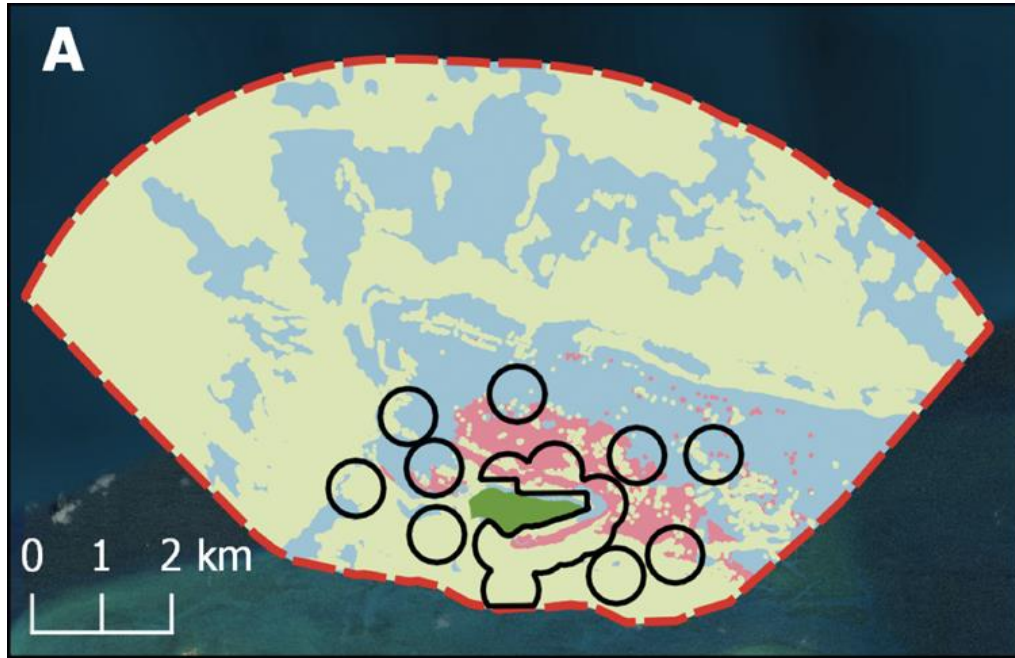


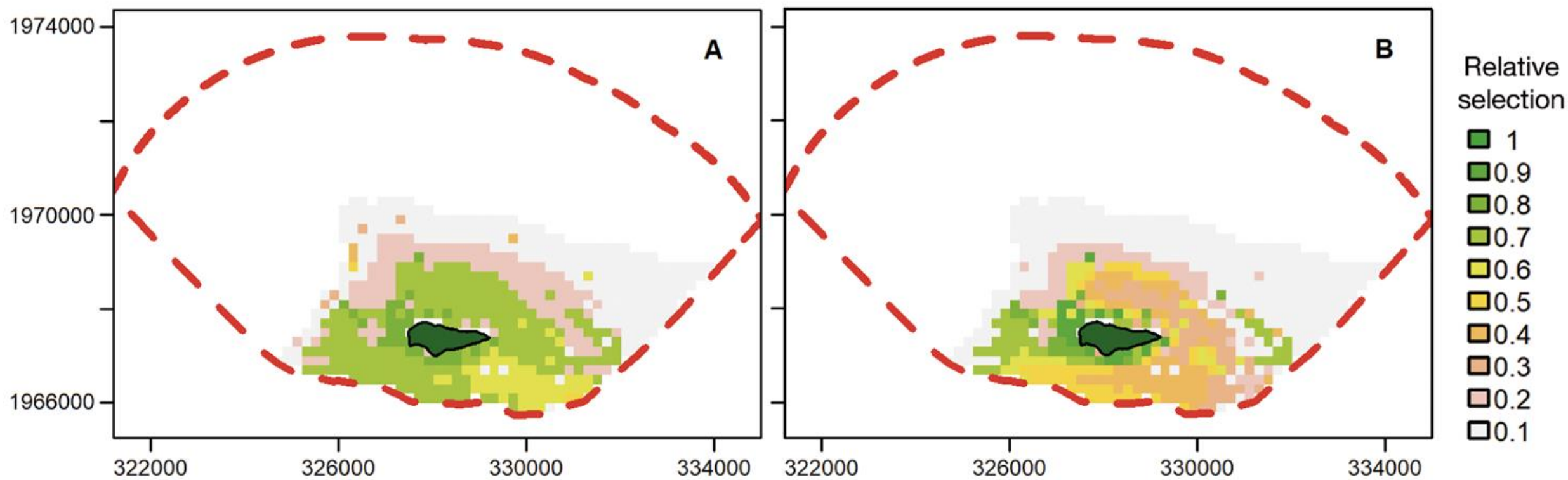
## Juvenile hawksbill residency and habitat use within a Caribbean marine protected area

Thomas H. Selby<sup>1,\*</sup>, Kristen M. Hart<sup>2</sup>, Brian J. Smith<sup>1</sup>, Clayton G. Pollock<sup>3</sup>,  
Zandy Hillis-Starr<sup>3</sup>, Madan K. Oli<sup>4</sup>







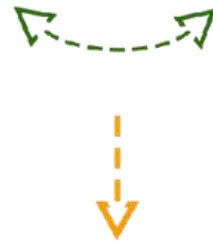
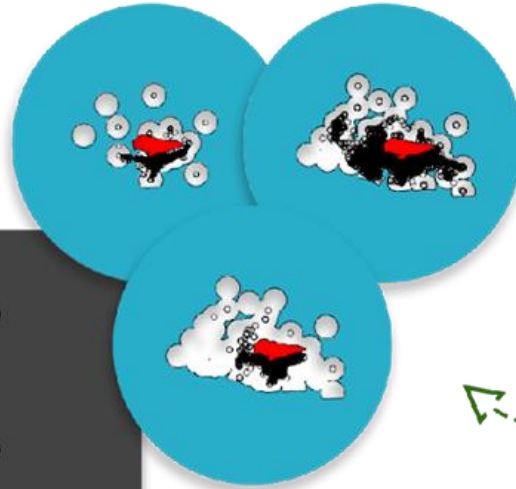




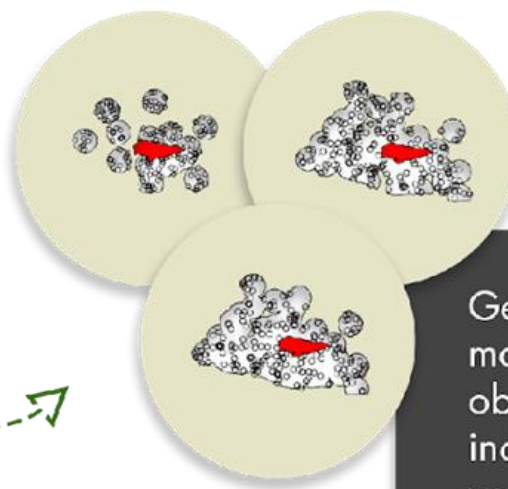
## ACOUSTIC TELEMETRY PRESENCE DATA

## BACKGROUND POINTS

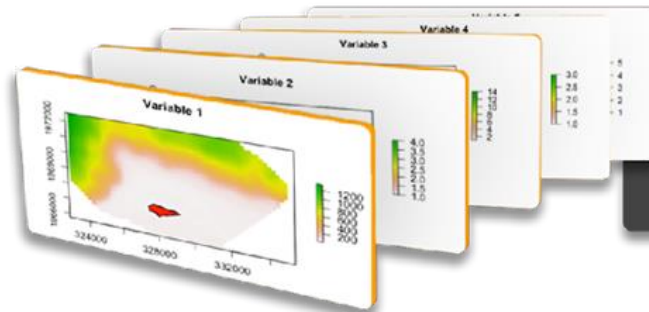
Calculated centers of activity (COAs) constrained to the available resource units.



Generate random points matching the number of observed COAs at the individual, diel, and year level, constrained to the available resource units.

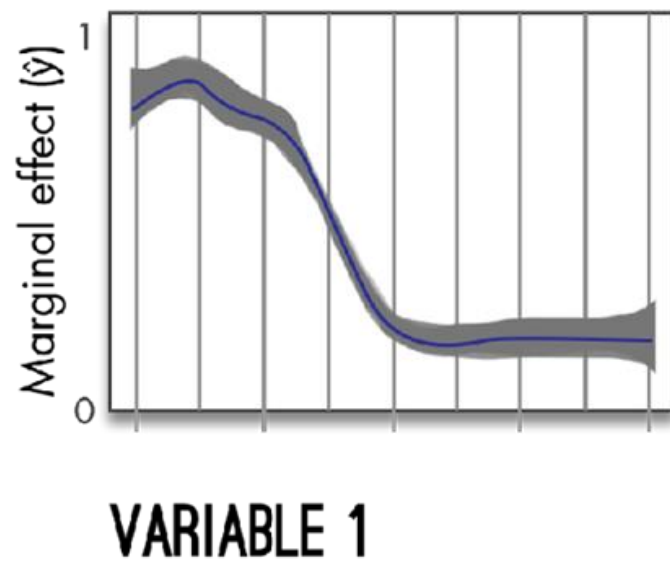
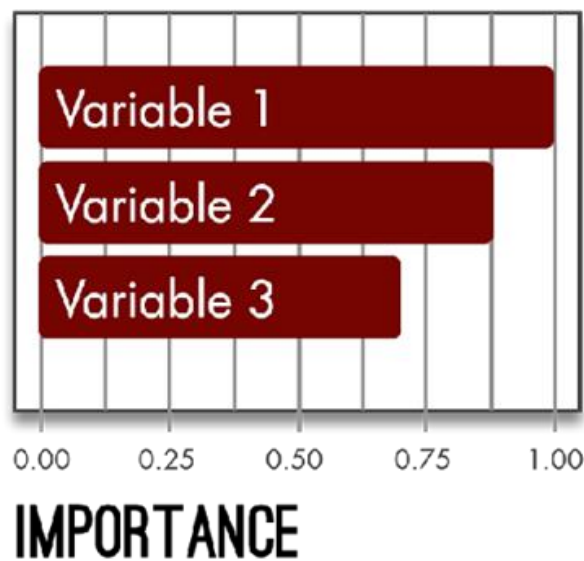


## ENVIRONMENTAL VARIABLES

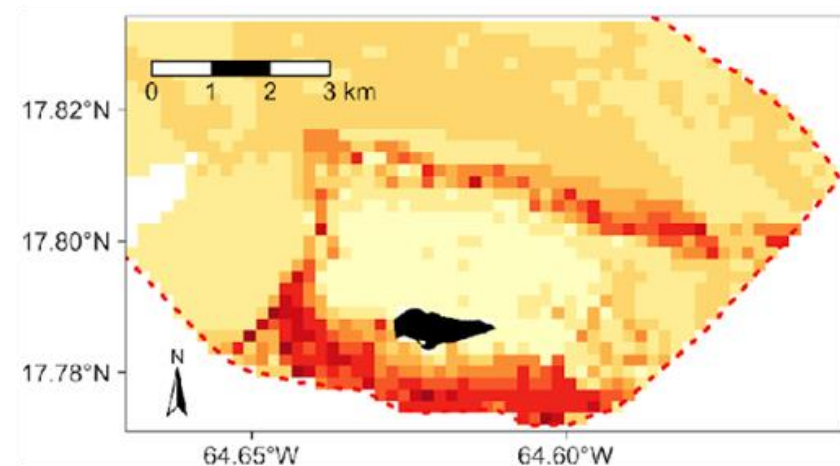


Environmental raster aggregation, assignment to COAs, and background points.

Resource selection  
functions



Trained model to predict and  
extrapolate across study area.



# Considerations with RSFs and Acoustic Telemetry

- Array Design
  - Does it cover all representative habitats? Home range of animal?
  - How does detection efficiency get incorporated?
  - What's your available habitat delineation?
- Deriving location data
  - Centers of activity, correlated random walks, etc. (see *patter* package)
- Spatial and temporal autocorrelation
  - Modeling approach
  - Thinning the data
- Habitat variables
  - Static vs dynamic
  - Scales
- Location to pseudo-absence points ratio
- Extrapolations:
  - How robust are predictions into new systems (see *dsmextra* package)

# Considerations with RSFs and Acoustic Telemetry

## Array Design

- Does it cover all representative habitats? Home range of animal?

- How does detection efficiency get incorporated?

- What's your available habitat delineation?

## Deriving location data

- Centers of activity, correlated random walks, etc. (see *patter* package)

## Location to pseudo-absence points ratio

## Spatial and temporal autocorrelation

- Modeling approach

- Thinning the data

## Habitat variables

- Static vs dynamic

- Scales

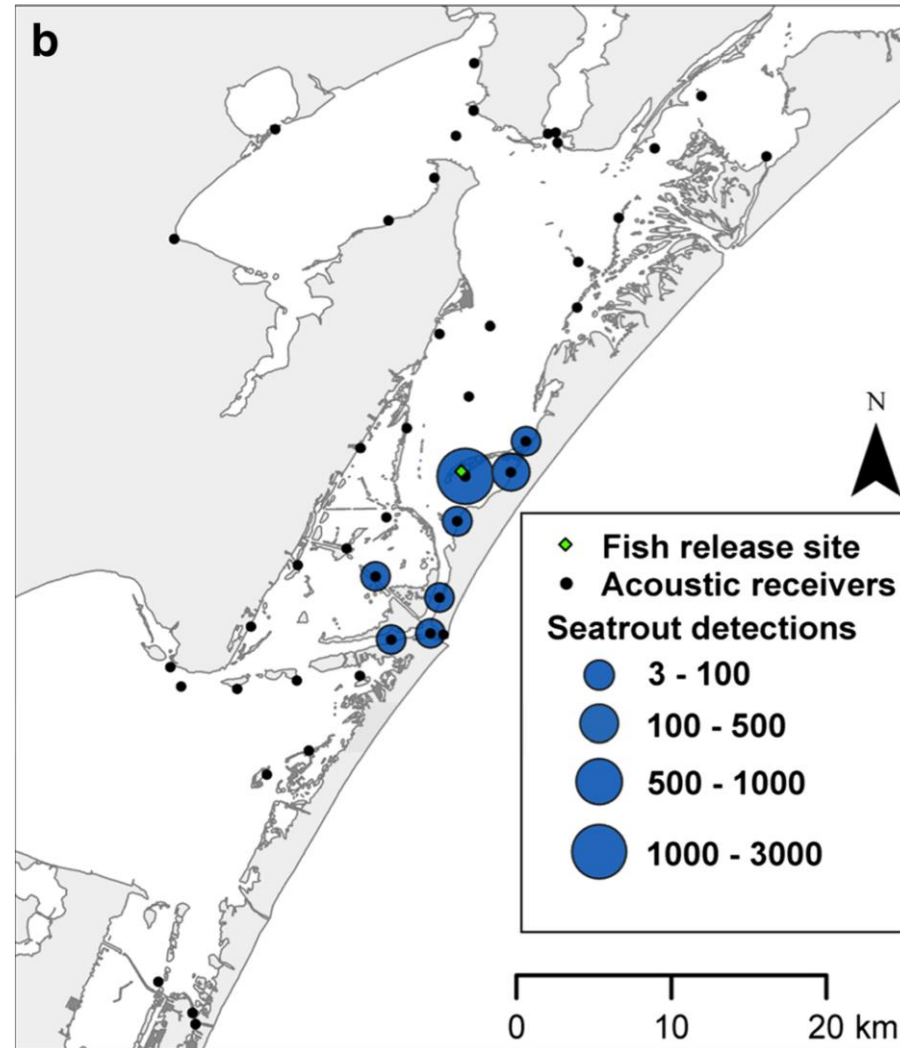
## Extrapolations:

- How robust are predictions into new systems (see *dsmextra* package)

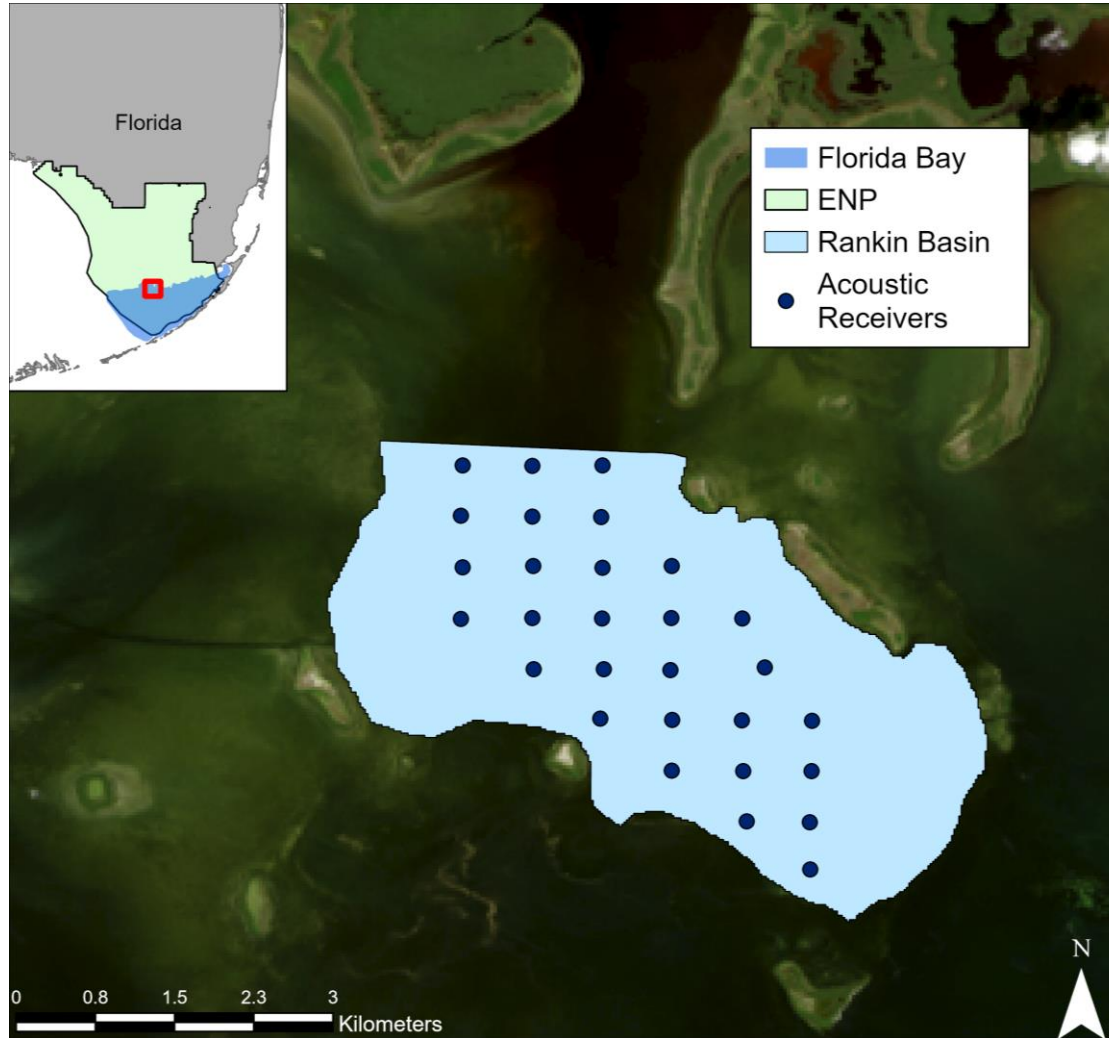
# Seatrout Example



# Spotted Seatrout (*Cynoscion nebulosus*)



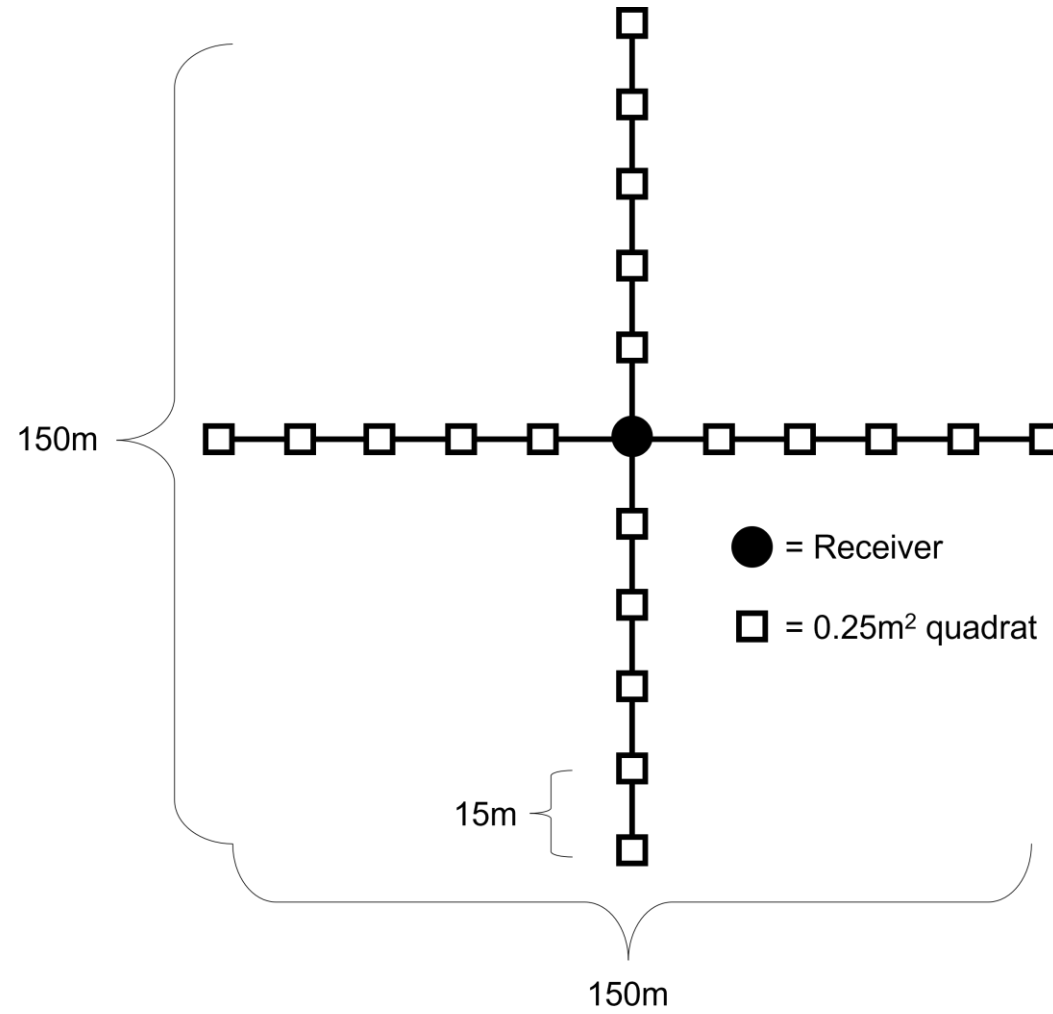
# Methods



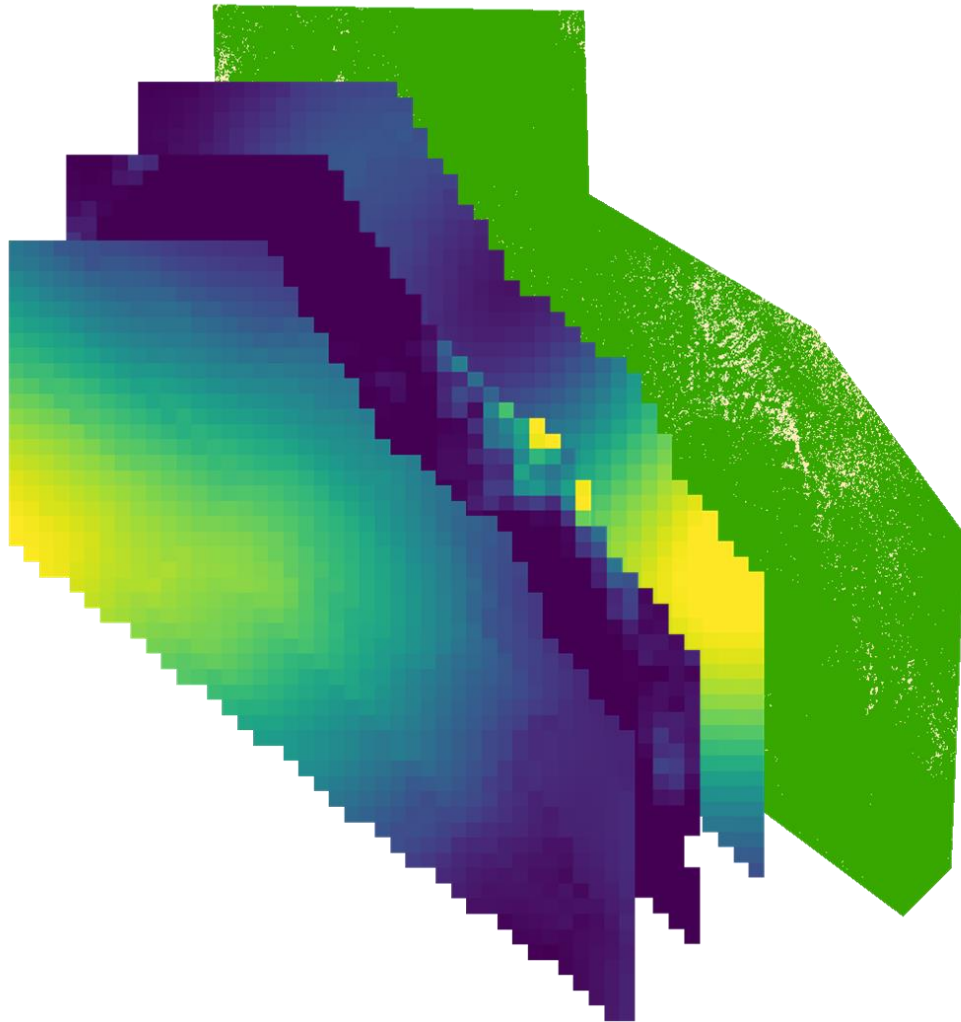
❖ 29 receivers

❖ 151 tagged seatrout  
❖ Using a subset of 8 individuals

# Methods



# Methods

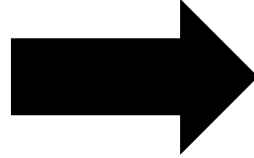


Receiver SAV surveys  
FHAP SAV surveys  
Aerial imagery

# Methods

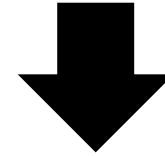
## Acoustic data

Take out false detections,  
include only trout,  
calculate center-of-  
activity in 1 hour time  
bins



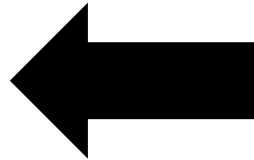
## Random pseudo-absence points

1 across array for every  
presence



## Extract habitat data

Extracted at each point



## Random Forest Models

Training and testing  
datasets, model validation