



ESTIMATING DIVERSITY OF COASTAL AVIAN AND MAMMALIAN FAUNA

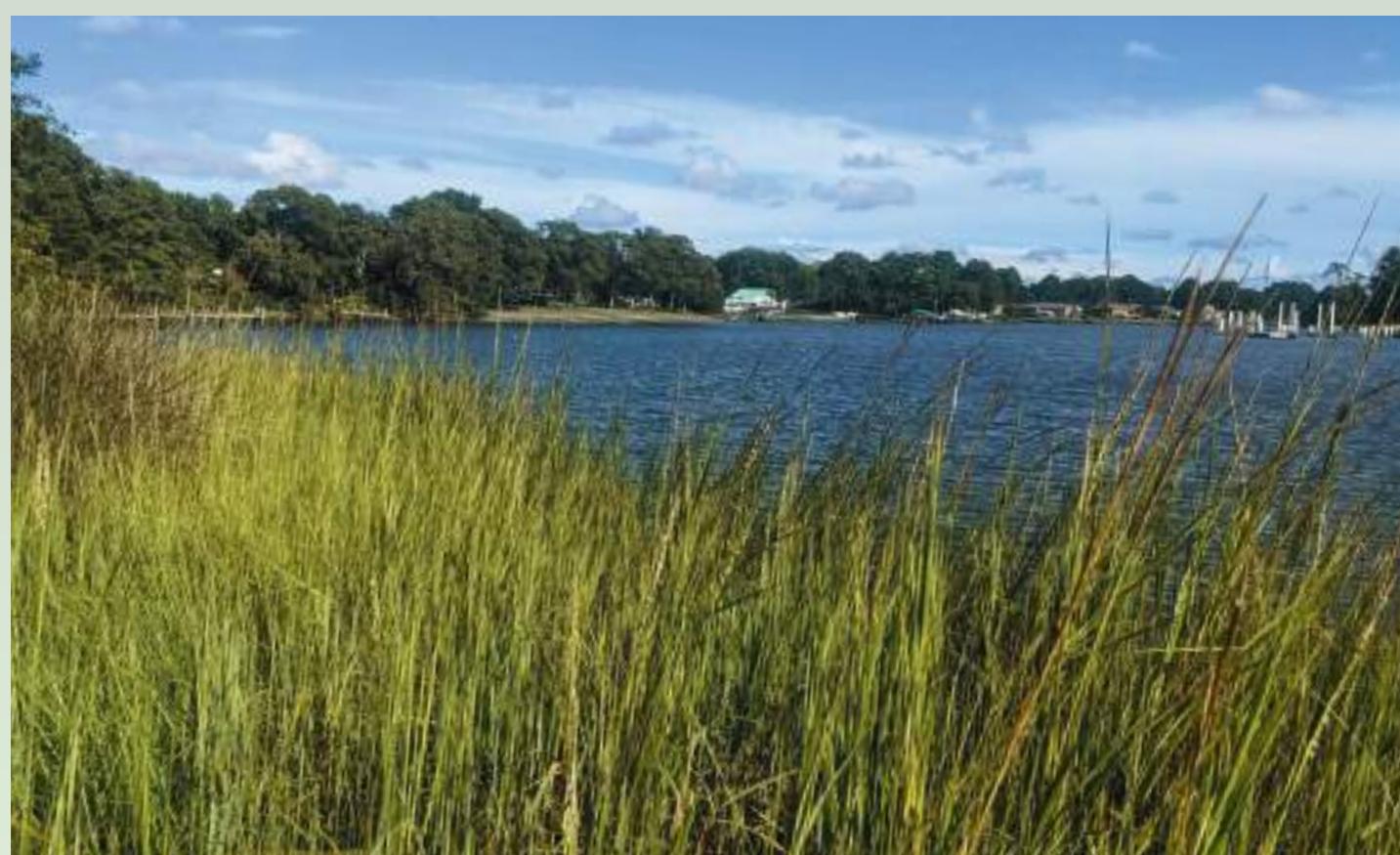
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VAS Annual Meeting, Fredericksburg, VA – May 2024

Intro: Coastal Ecosystems

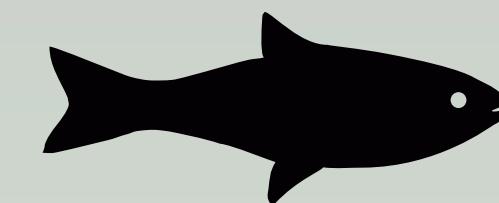
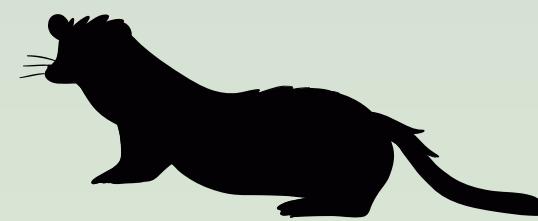
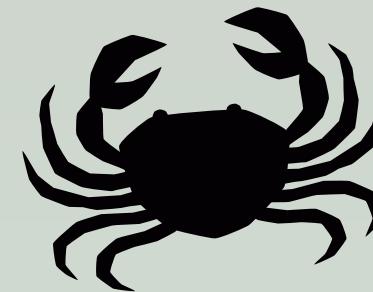
- Highly dynamic
- Low biodiversity but high productivity
- Valuable ecosystem services
- Oyster reef habitats
- VA: 7,000 mi coastline, ~1 mln acres
- >20% of wetlands lost worldwide
 - ~ 60,000 acres per year in the U.S.



Intro: Coastal Ecosystems Functioning



Intro: Animal Diversity of Coastal Shorelines



American Oystercatcher



Red Drum

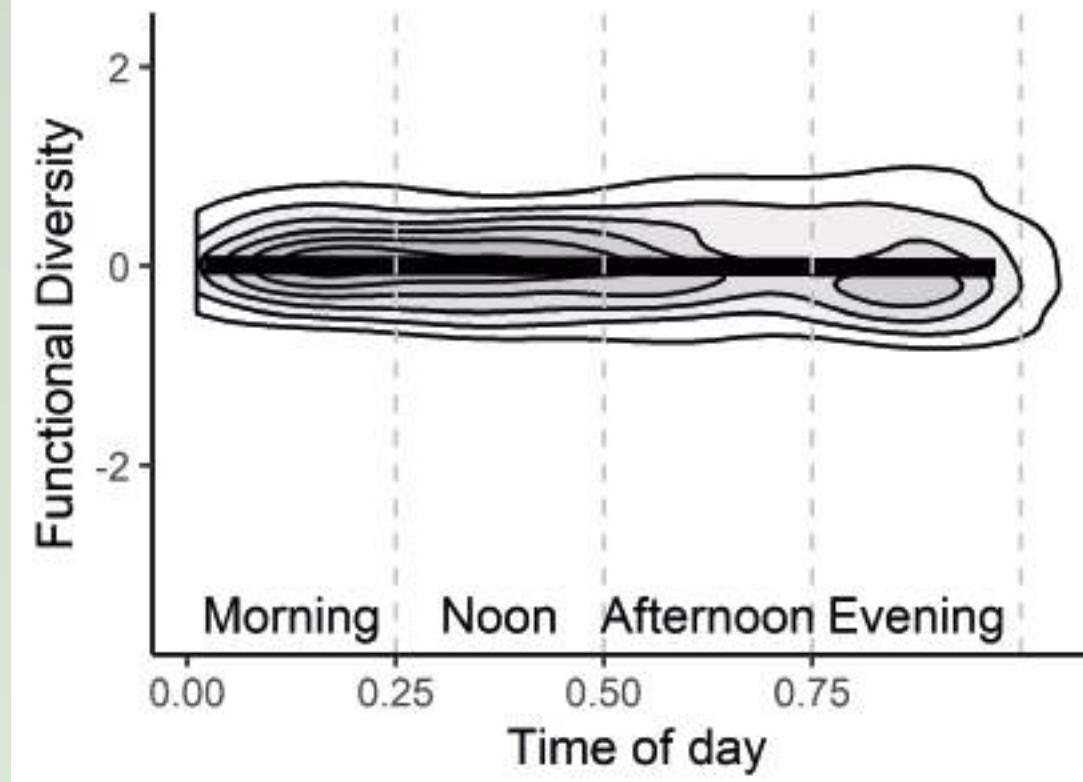
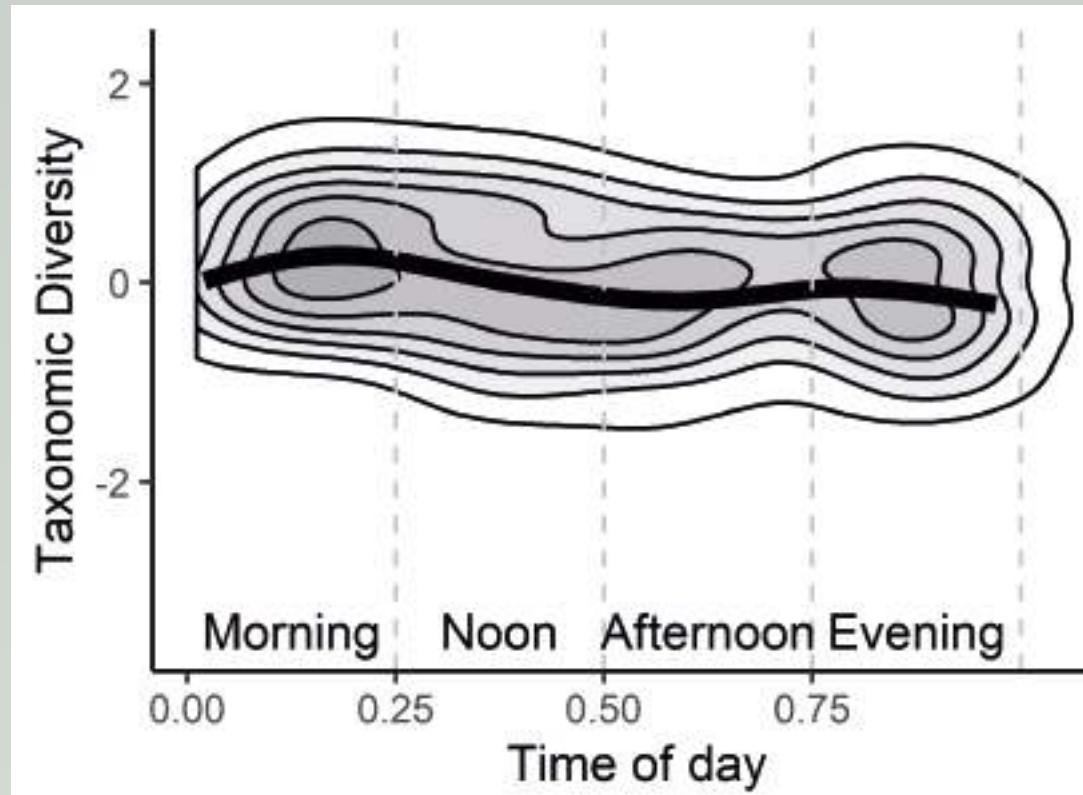


Saltmarsh Sparrow

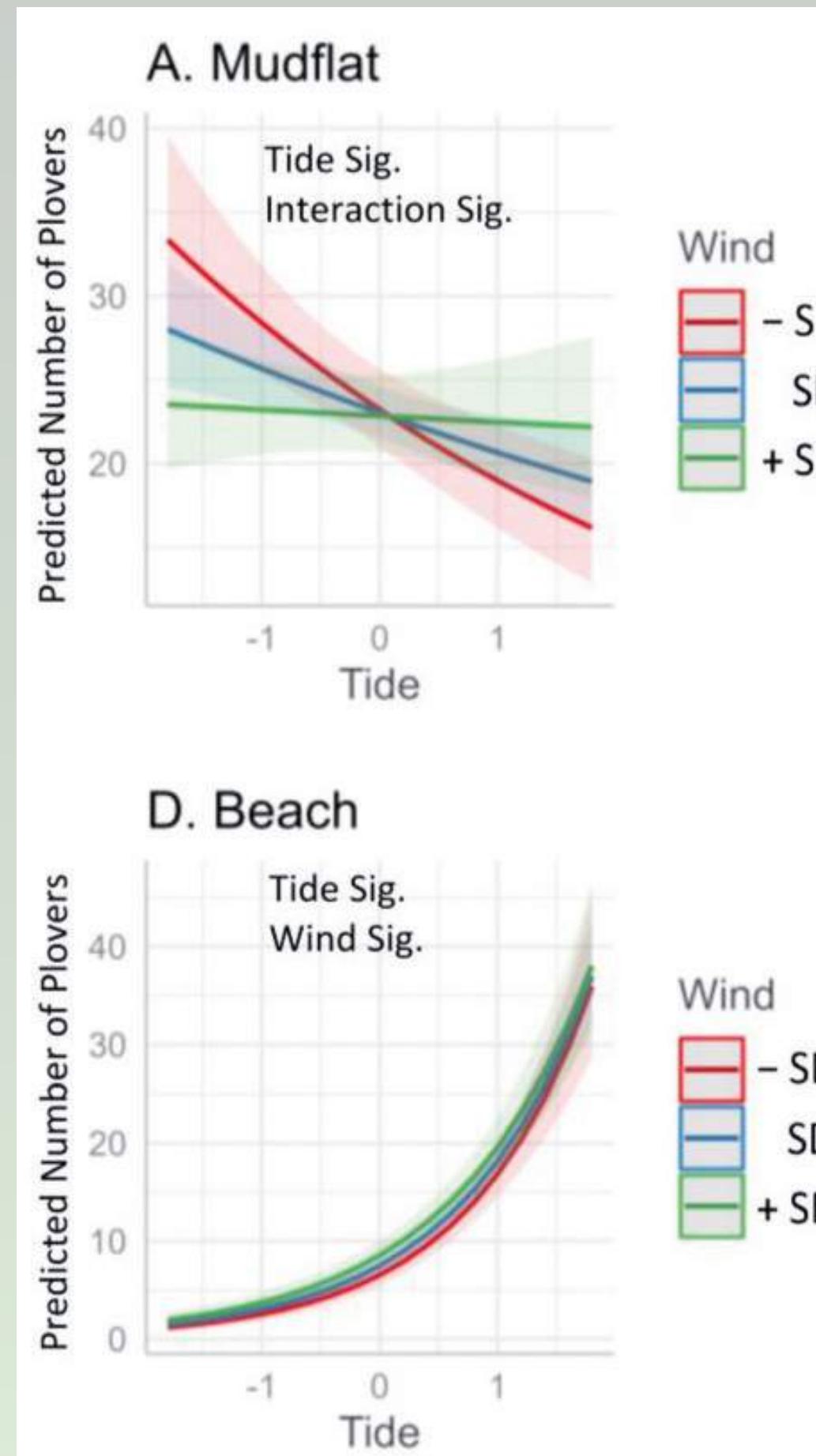


Red-jointed Fiddler Crab

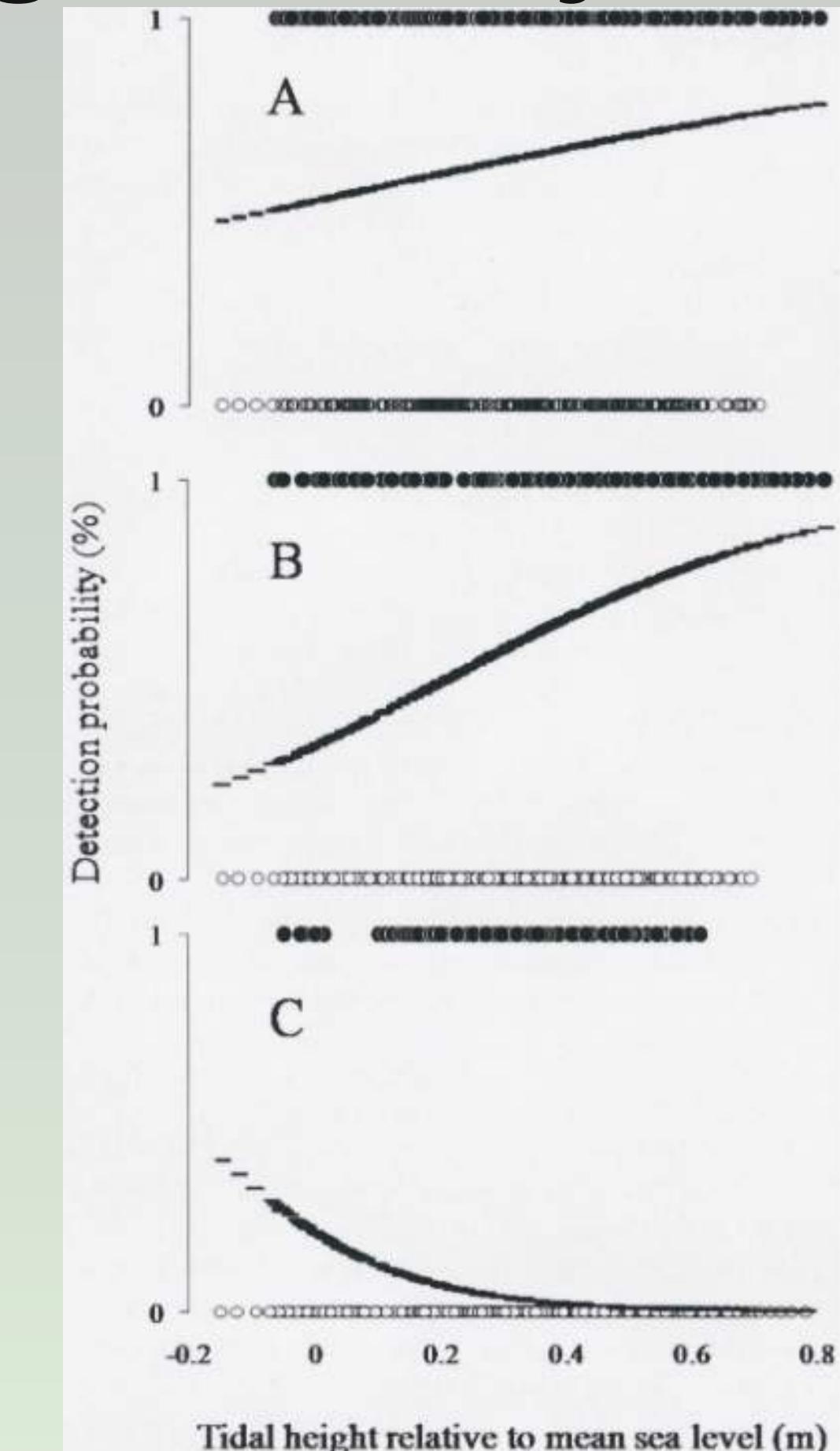
Intro: Challenges with Estimating Diversity



Dubovský & Walters. 2024. *Bird Study*



Jech & Forsy. 2023. *Animals*



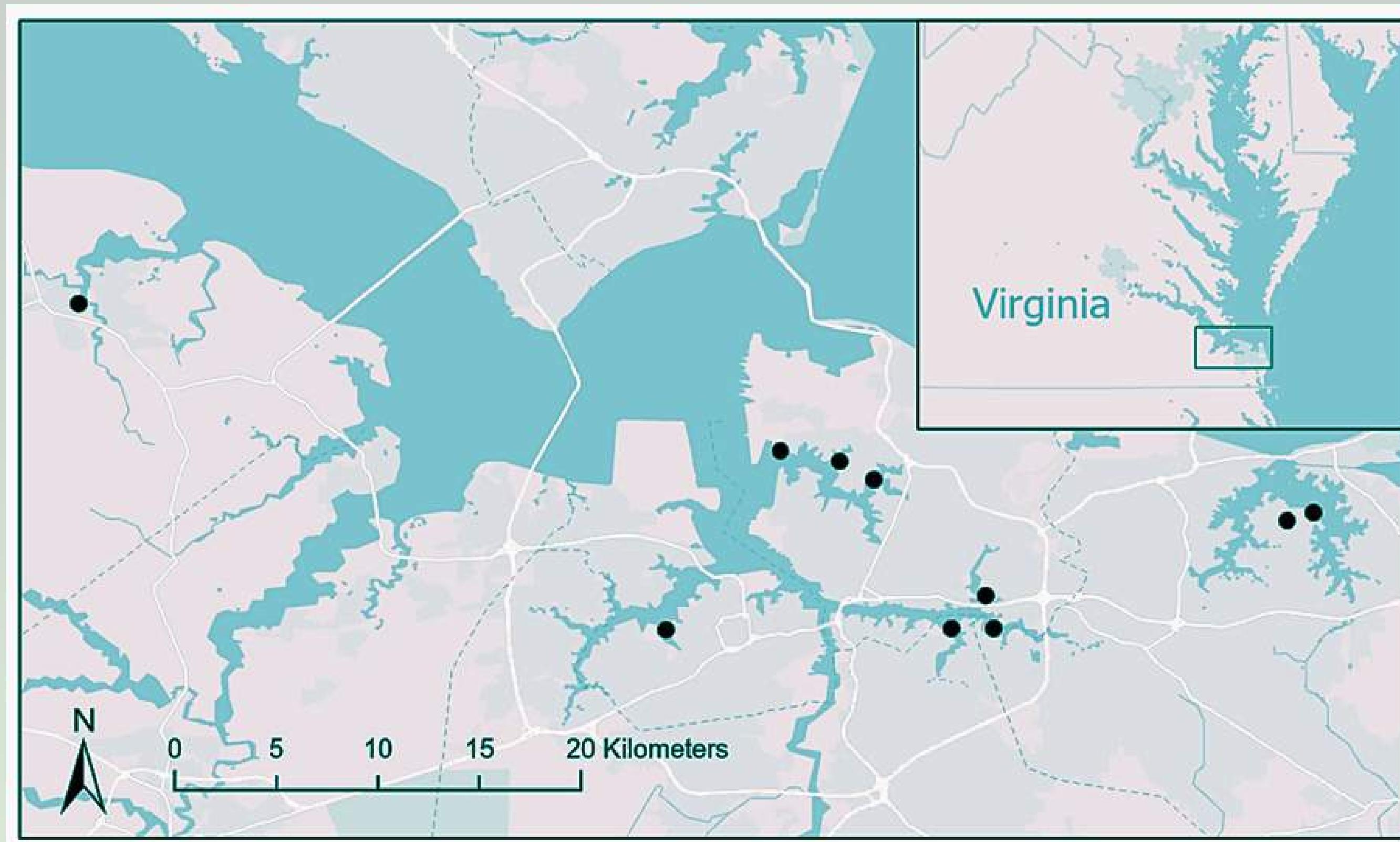
Rush et al. 2009. *Wilson J Ornithol*

Intro: Question and Hypotheses

What is the effect of time-of-day and tide levels on observed diversity of birds and mammals?

- time and tide explains variation in detected diversity
- there is uneven distribution of observations across time and tide levels

Methods: Study Sites



Methods: Camera Monitoring



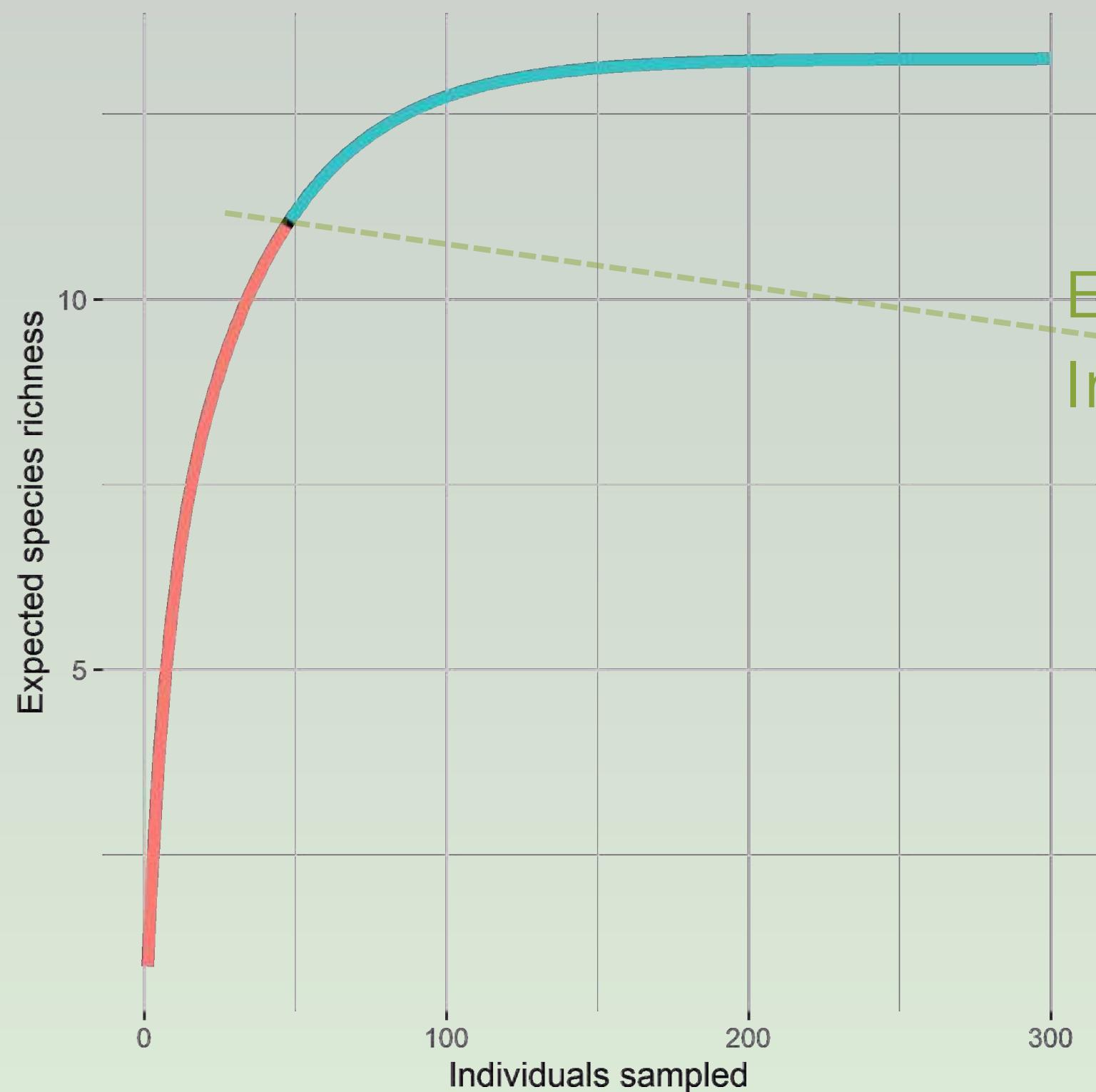
May – December 2022
> 2.6 million photographs
double review
~18,400 photos of birds and mammals

Methods: Camera Monitoring



Methods: Rarefaction Analysis

{10, 9, 8, 5, 5, 3, 2, 2, 1, 1, 1}, n = 47, S = 11



$$S(N + m) = S(N) + \hat{f}_0 \left[1 - \left(1 - \frac{f_1}{N\hat{f}_0 + f_1} \right)^m \right]$$

species observed at N individuals
m additional individuals sampled

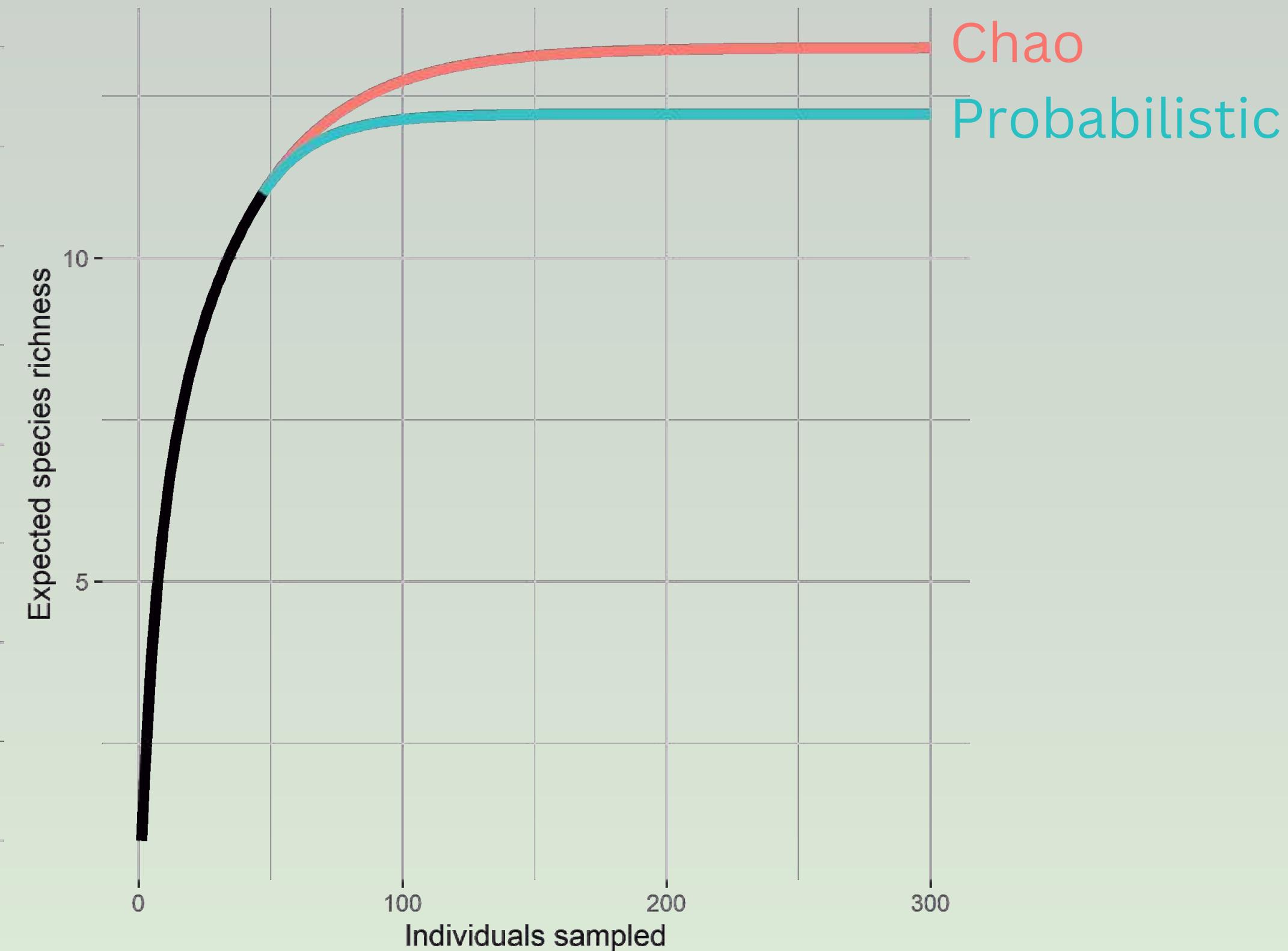
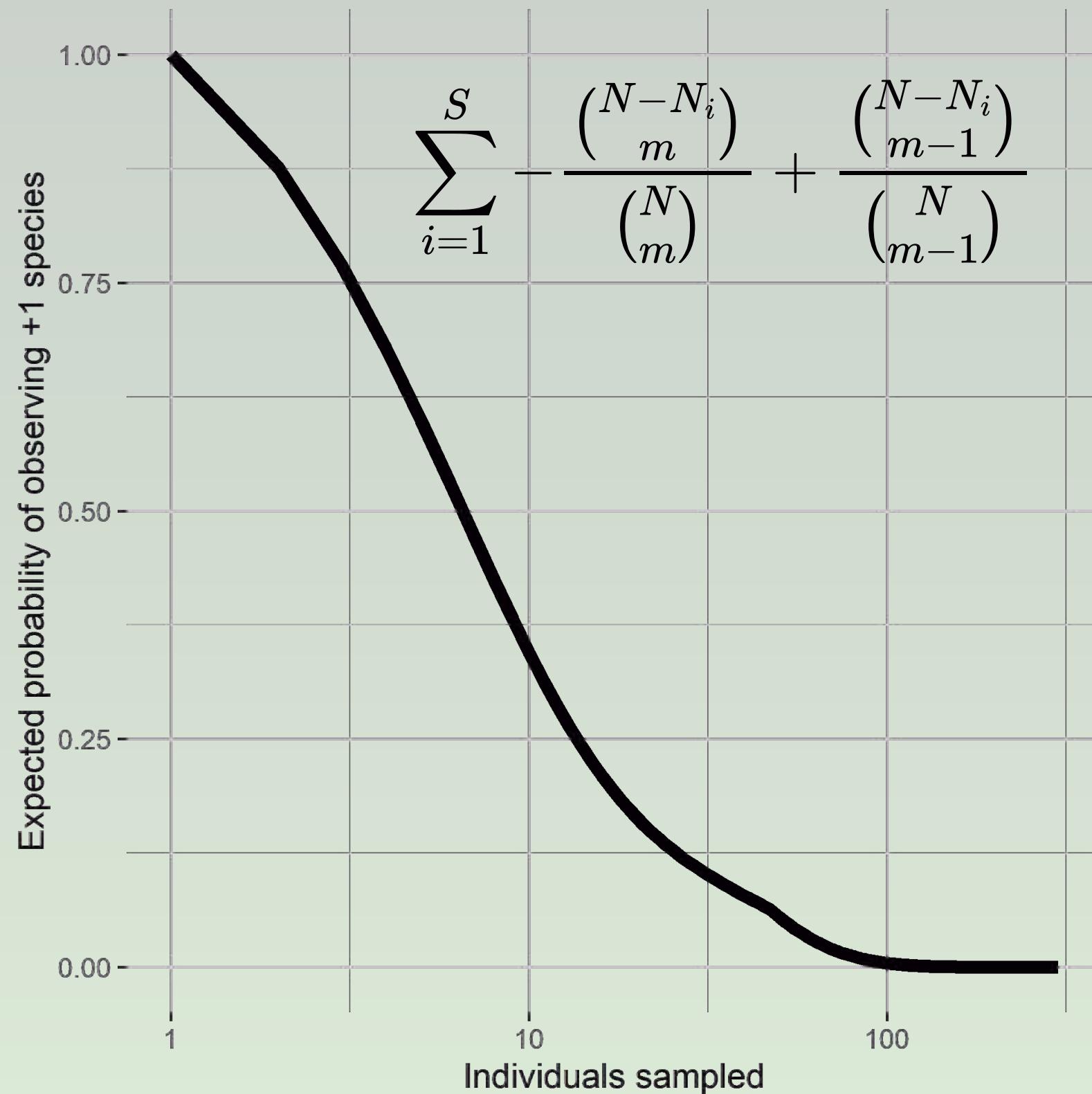
where $\hat{f}_0 = f_1^2 / 2f_2$ is Chao1 estimator

$$S(n) = S(N) - \binom{N}{n}^{-1} \times \sum_{i=1}^{S(N)} \binom{N - N_i}{n}$$

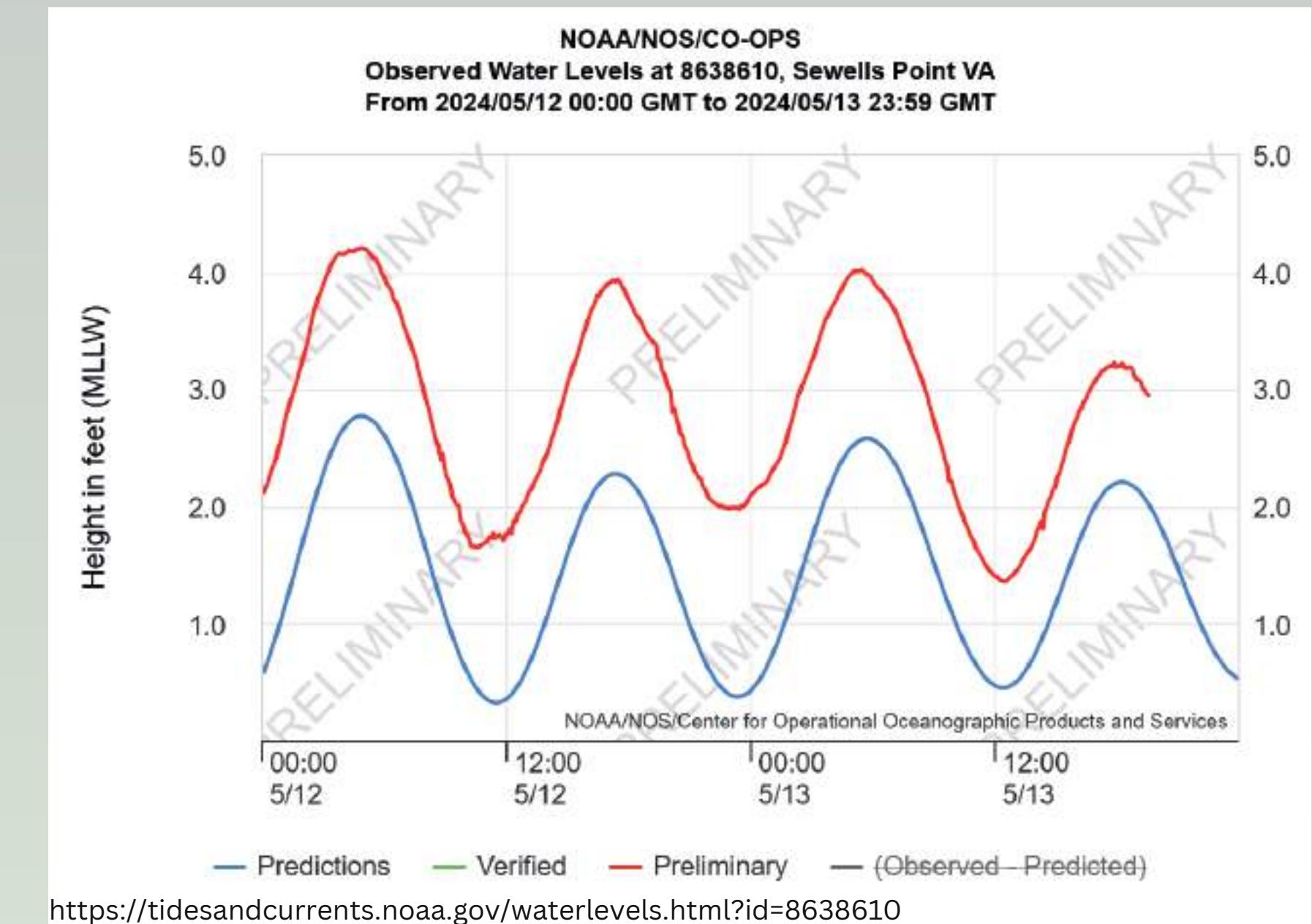
Extrapolation
Interpolation

Methods: Rarefaction Analysis

$\{10, 9, 8, 5, 5, 3, 2, 2, 1, 1, 1\}$, $n = 47$, $S = 11$

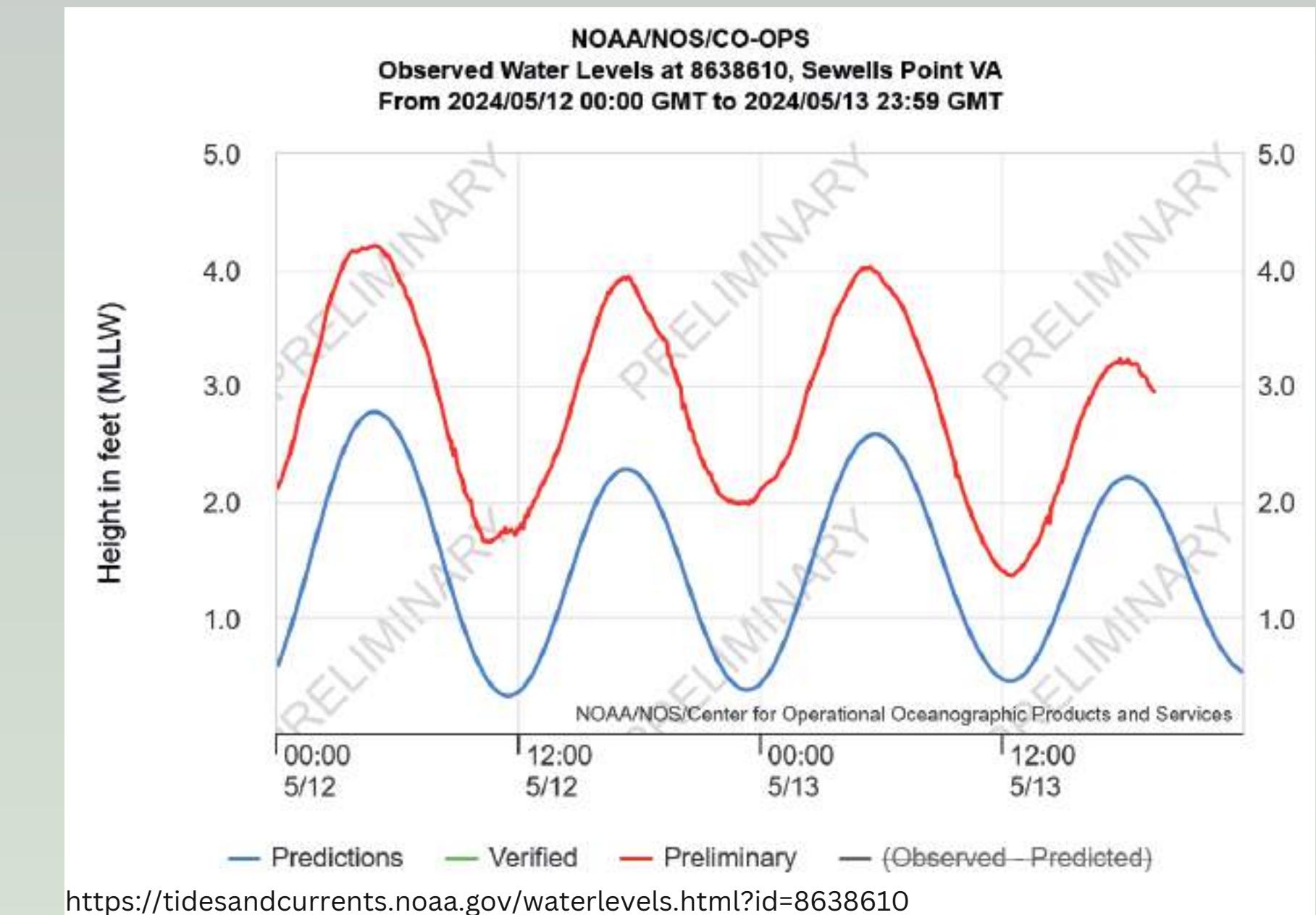
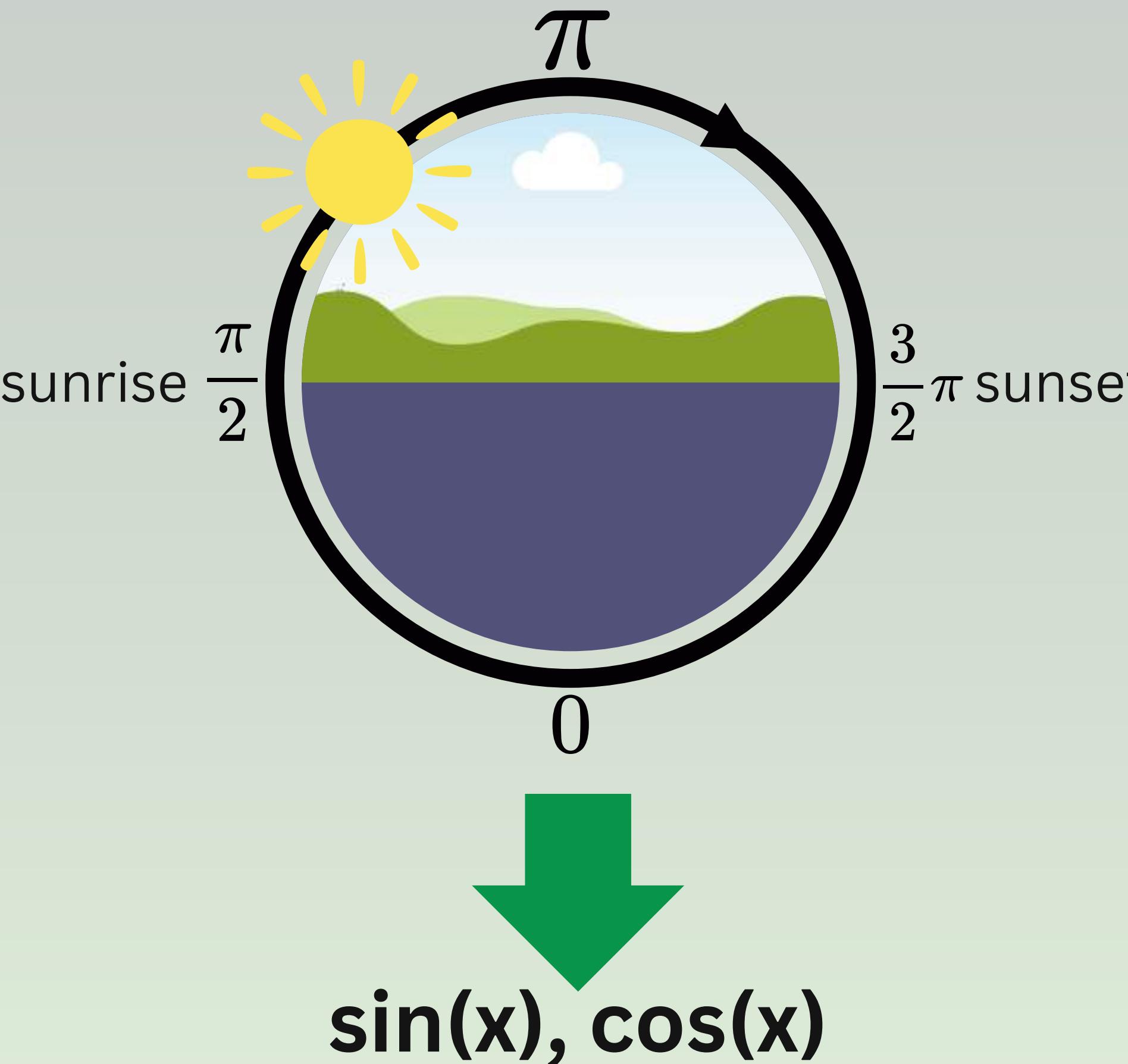


Methods: Solar Time and Tide Level



Low / Mid / High

Methods: Solar Time and Tide Level



Low / Mid / High

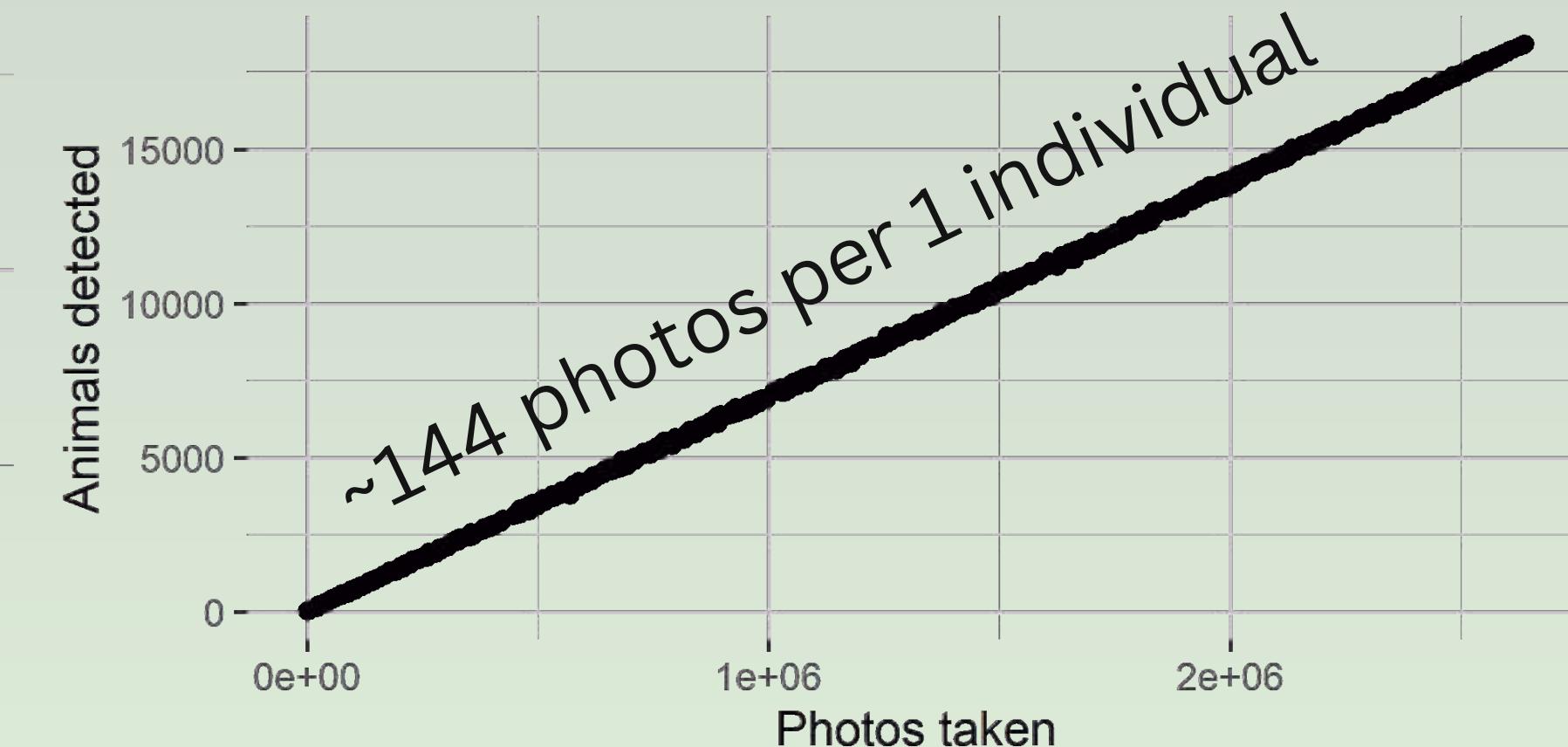
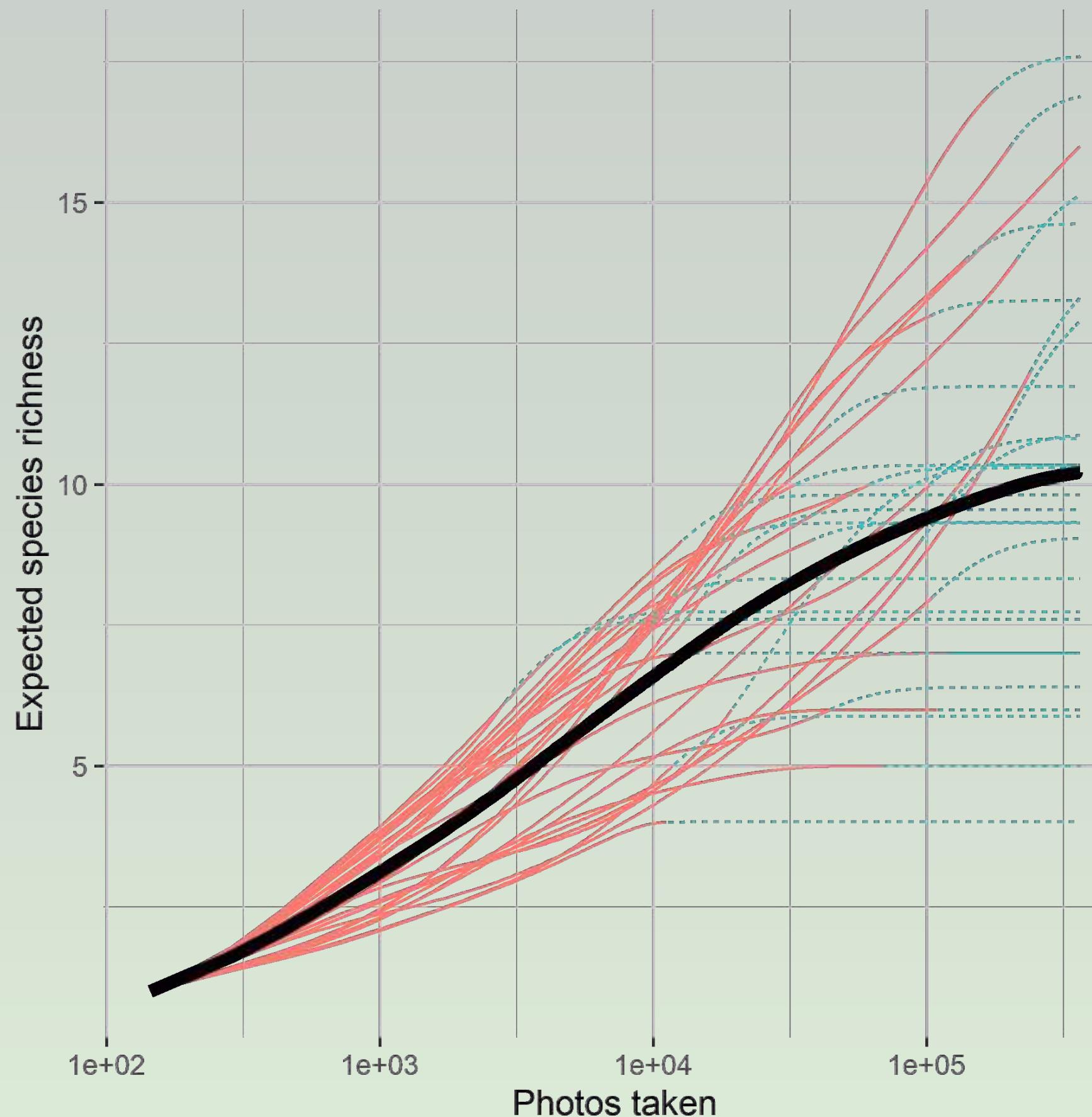
Results: Observed Diversity

37 vertebrate species detected:

- **26** species of birds:
 - Yellow-crowned Night Heron
 - Mallard
 - Great Blue Heron
 - Crow sp.
 - Canada Goose
 - Great Egret
 - Green Heron
 - Spotted Sandpiper
 - Song Sparrow
 - American Wigeon
 - Hooded Merganser
 - Common Grackle
 - Double-crested Cormorant
 - Clapper Rail
 - Red-winged Blackbird
 - Northern Cardinal
 - Mourning Dove
 - American Robin
 - Common Loon
 - Bald Eagle
 - Wood Duck
 - Pied-billed Grebe
 - Eastern Bluebird
 - American Goldfinch
 - Yellow-rumped Warbler
 - Greater Yellowlegs
- **11** species of mammals:
 - North American Raccoon
 - Muskrat
 - Eastern Gray Squirrel
 - River Otter
 - American Mink
 - White-tailed Deer
 - Feral Cat
 - Red Fox
 - Gray Fox
 - Eastern Cottontail
 - Nutria

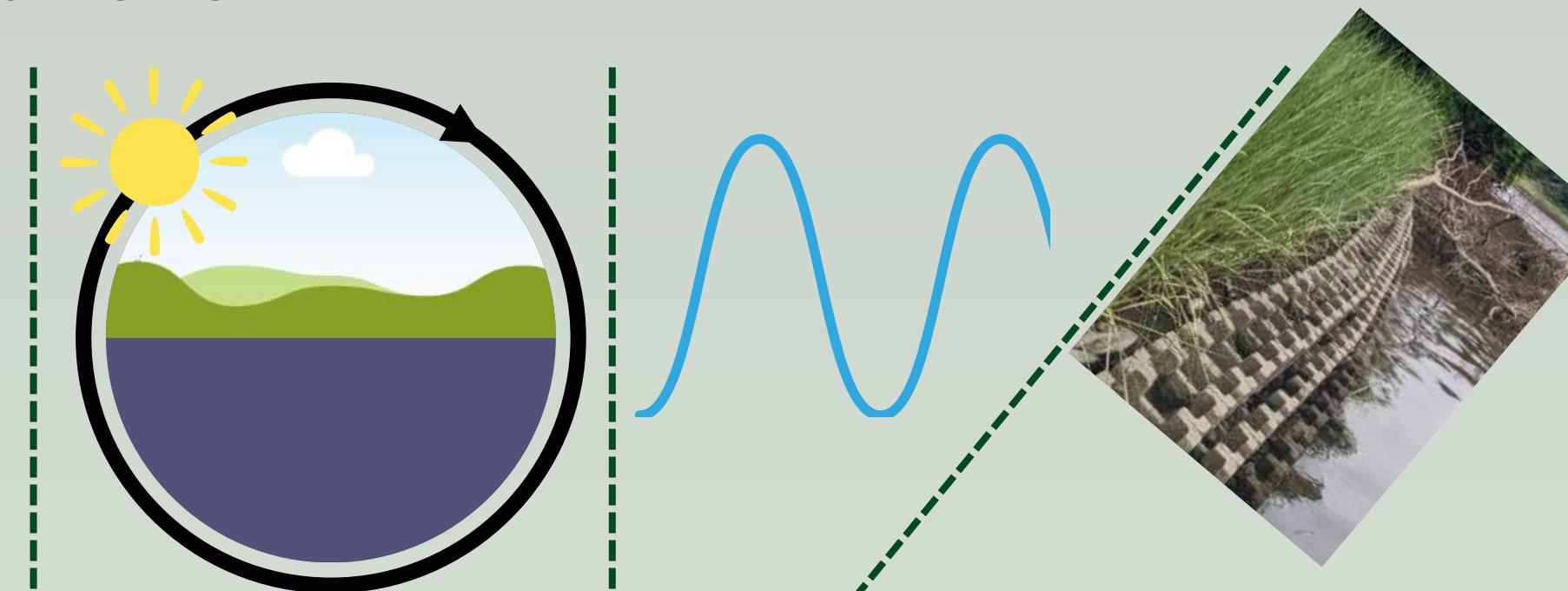
Results: Diversity Detection

- combinations of tide vs. site
- $S(\max(ind)) = 13.97$
- 85,465 [6,023; 267,250] 95%CI photos to cover 95% of expected maximum richness
- avg completeness: 95.2% [73.2; 100]%



Results: Diversity Detection vs. Time & Tide

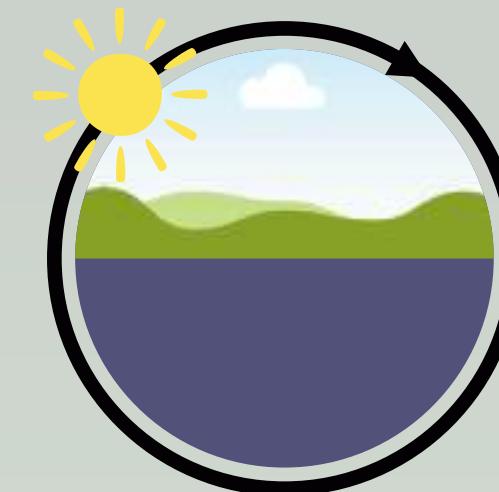
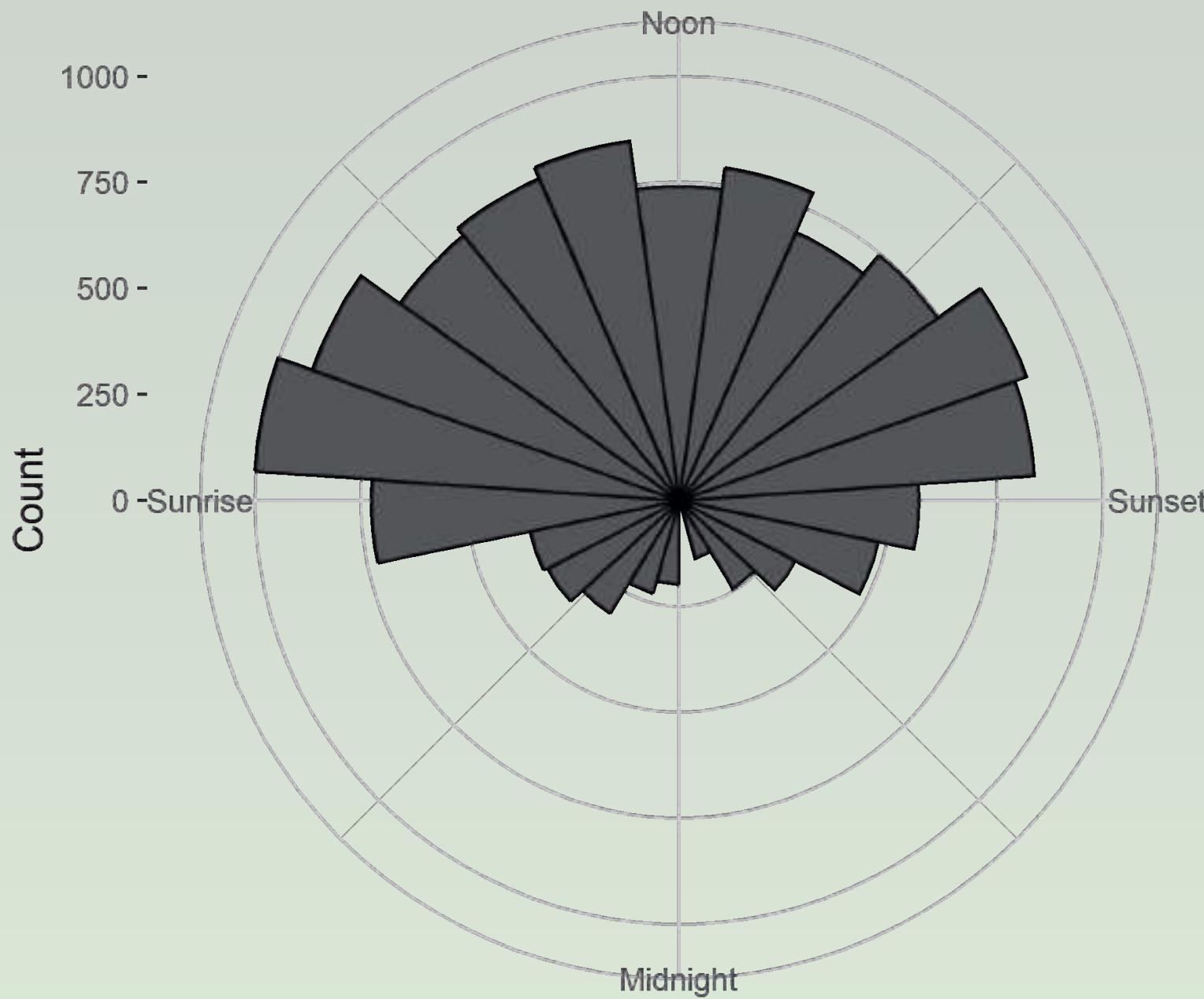
- Zero-inflated Poisson regression GAMs
- AIC framework



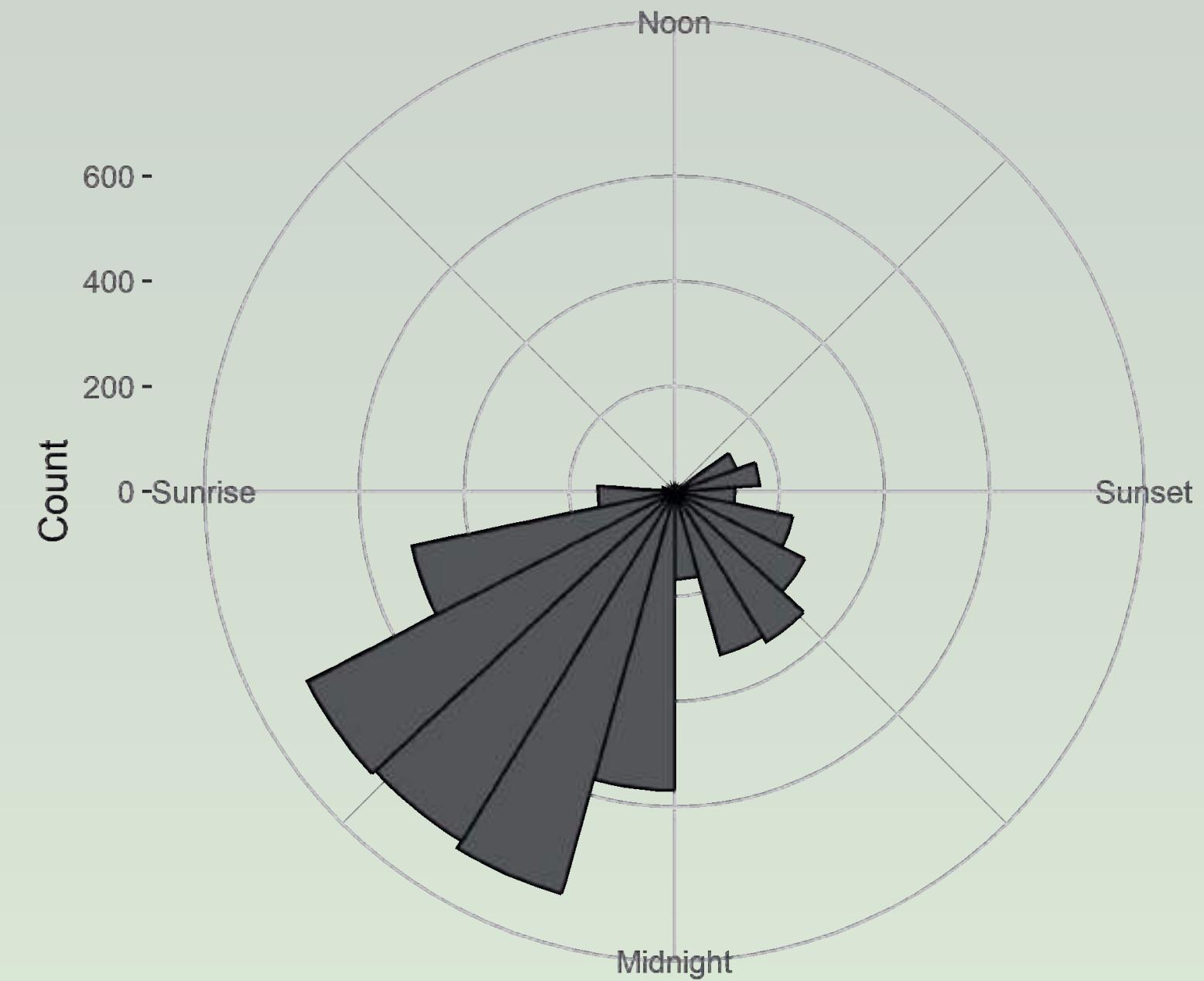
	Model	AIC	ΔAIC	Weight	logLik	df
	~ site + s(dsincos)	44506.5	0	0.79	-22235	18.35
	+ tide					
	~ site + s(dsincos) + tide	44509.2	2.68	0.21	-22235	19.35
	+ type					
	~ site + tide	44867.2	360.68	0	-22422	12
	~ site + s(dsincos)	45727.7	1221.2	0	-22847	16.42
	+ tide					
	~ site	46135	1628.42	0	-23057	10

Results: Solar Time

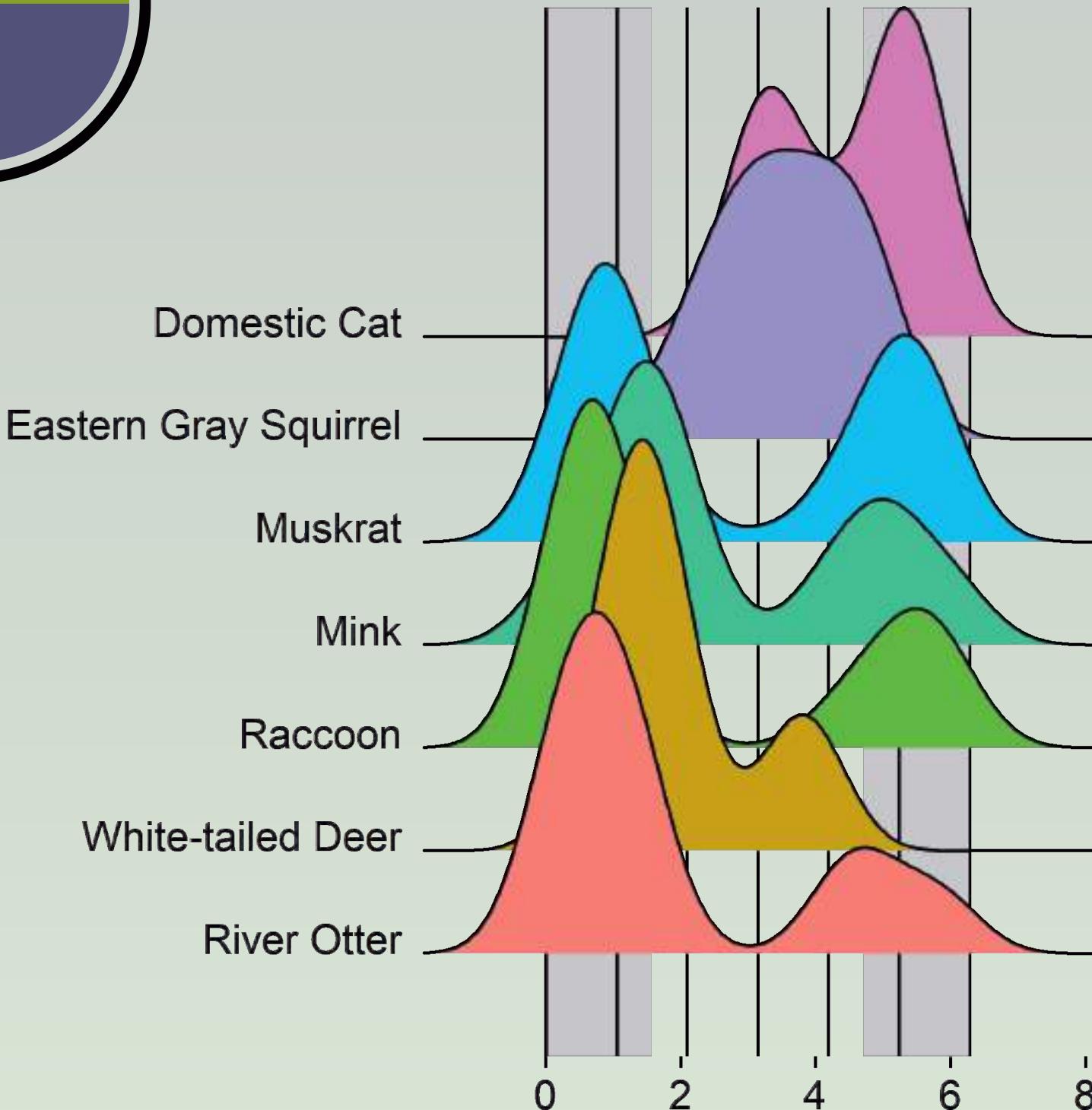
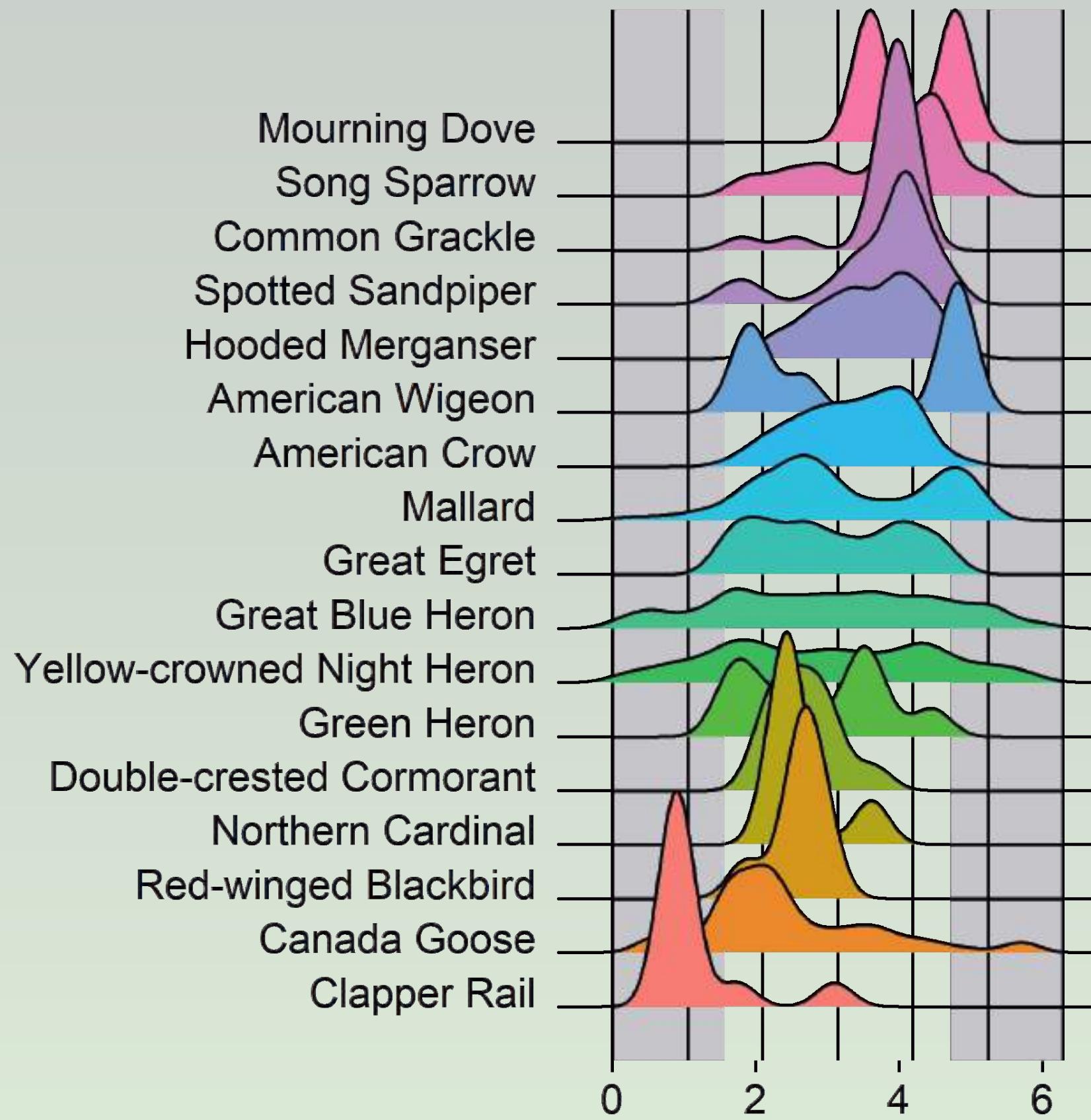
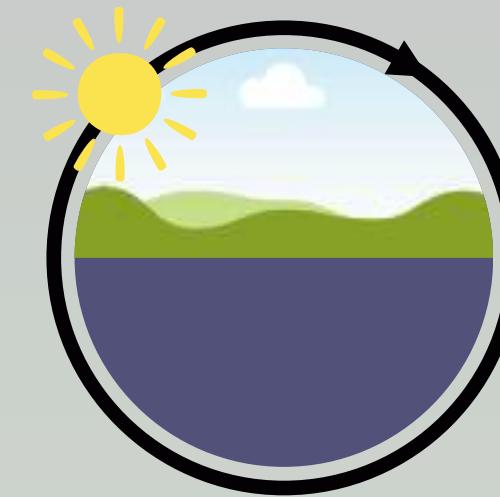
Birds



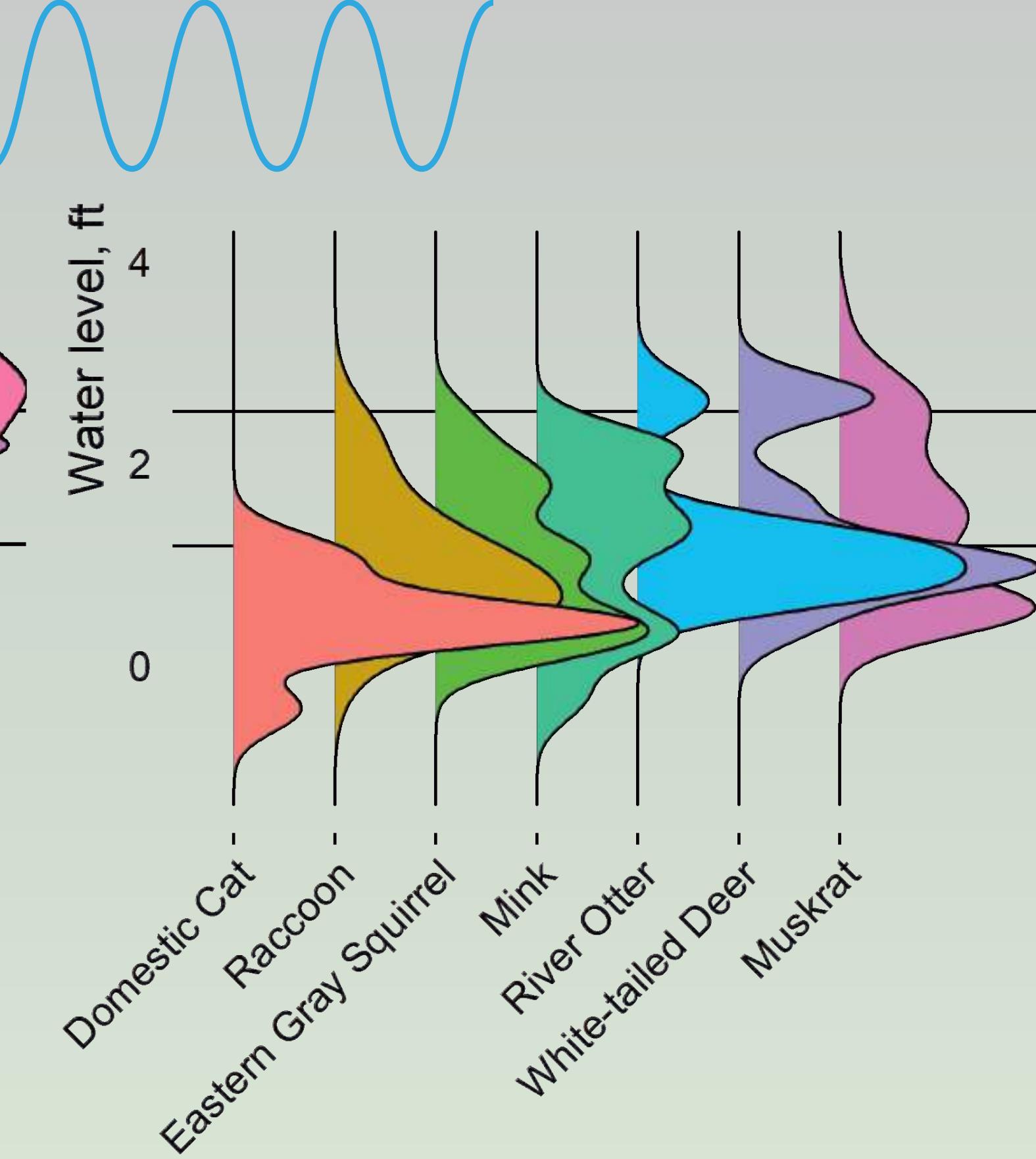
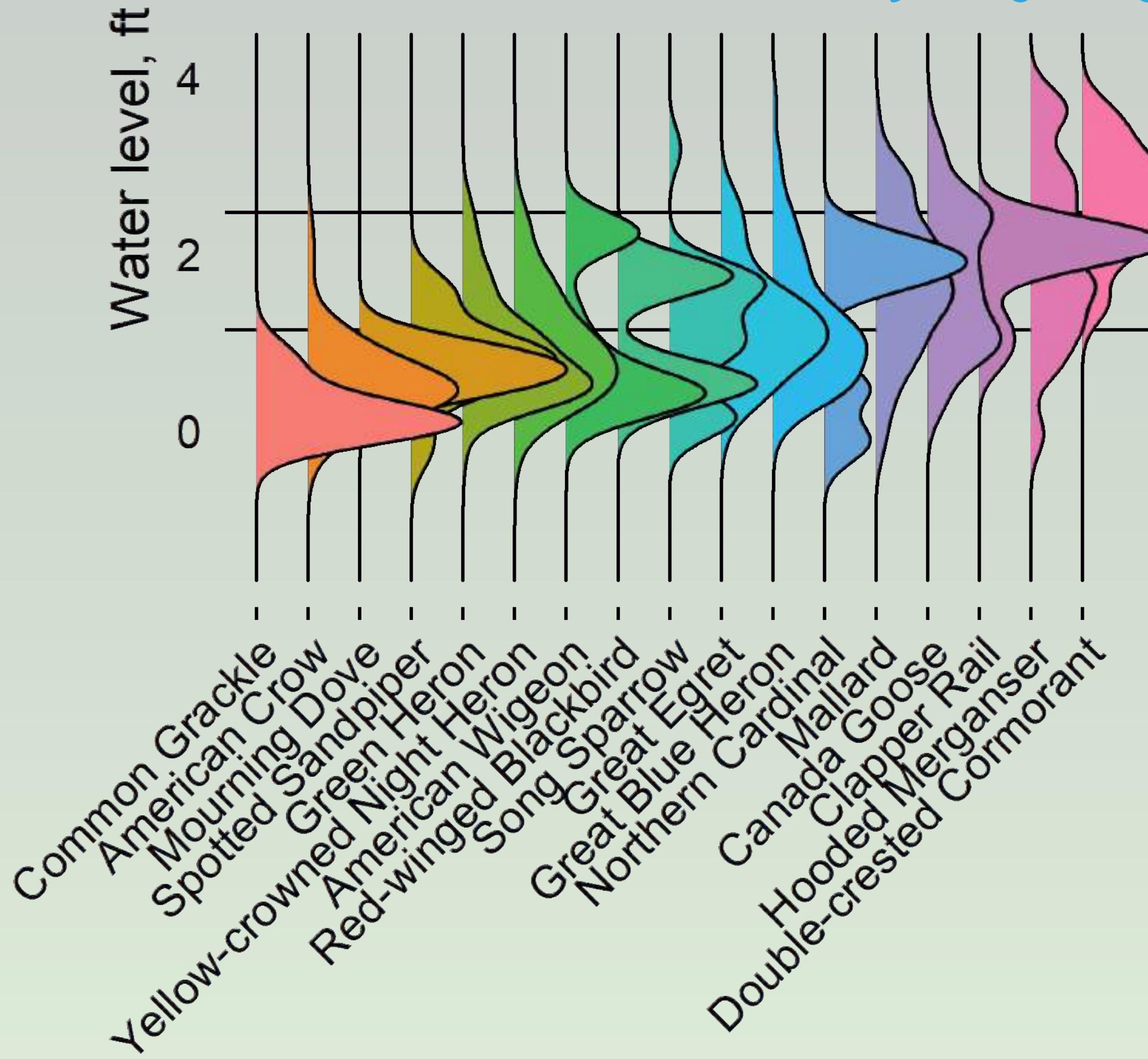
Mammals



Results: Solar Time



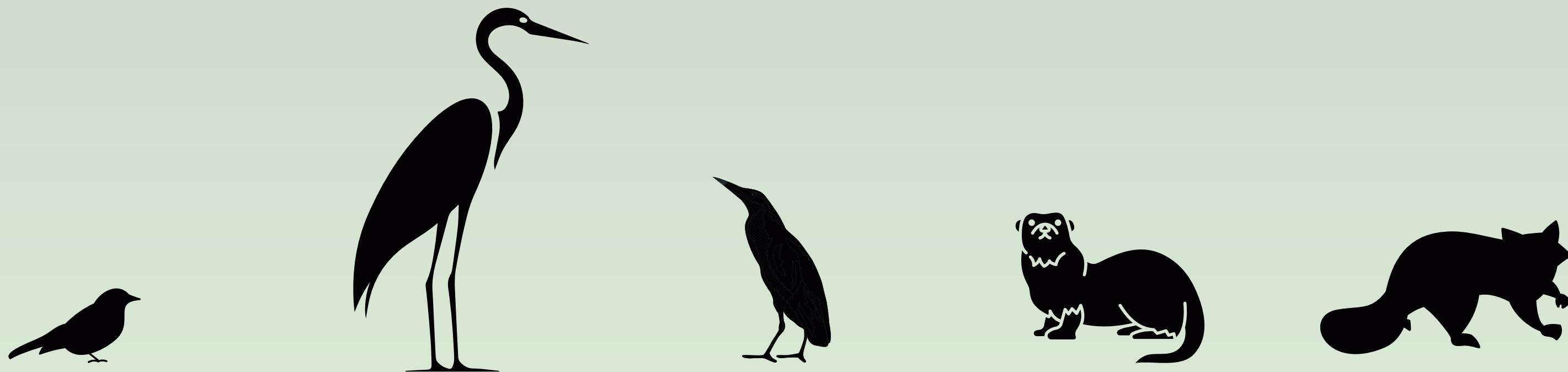
Results: Tide Levels



Discussion

- Different conditions = different species sets
- Bird sampling often when tide is low → bias
- At least ~100 hrs of sampling for representative diversity levels

- Time / tide preference ~ functional traits?
- Detection of functional diversity?



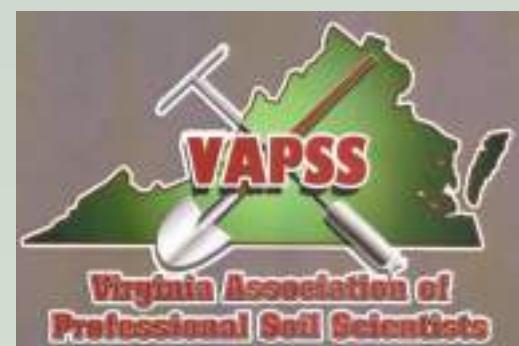
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Sara Jones



OLD DOMINION
UNIVERSITY



Northern Neck Of
Virginia Chapter of
the National
Audubon Society



Thank you!

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[https://github.com/
OleksiiDubovyk/CoastalDiversity](https://github.com/OleksiiDubovyk/CoastalDiversity)