Effect of water-level fluctuations on resource selection of wading birds

Michelle L. Petersen & Dale E. Gawlik

Florida Atlantic University

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Objective

1. Quantify the long-term habitat selection of wading birds.

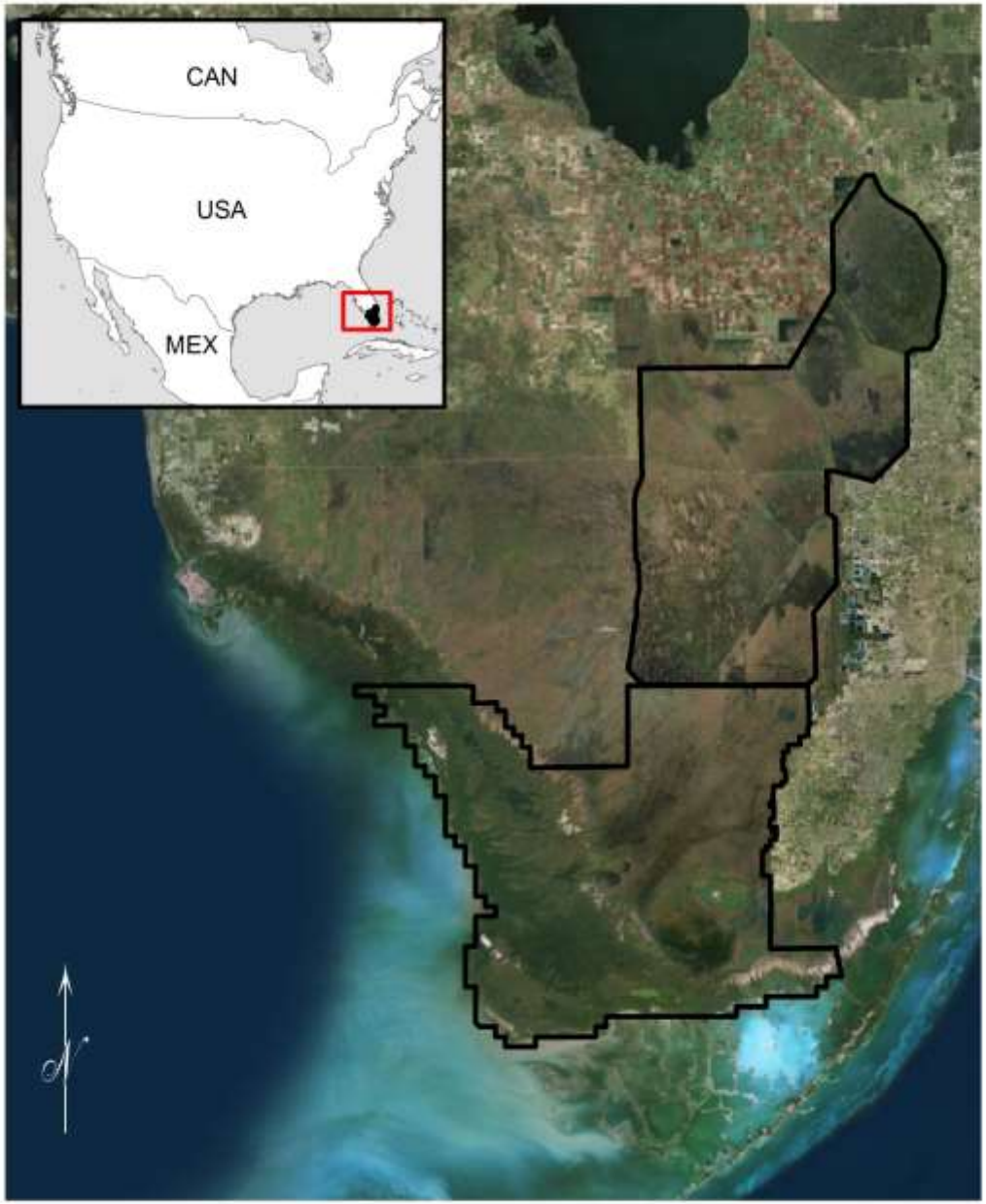
2. Determine the probability of foraging under fluctuating hydrologic patterns.

Great Egret

White Ibis

Wood Stork

Study Area



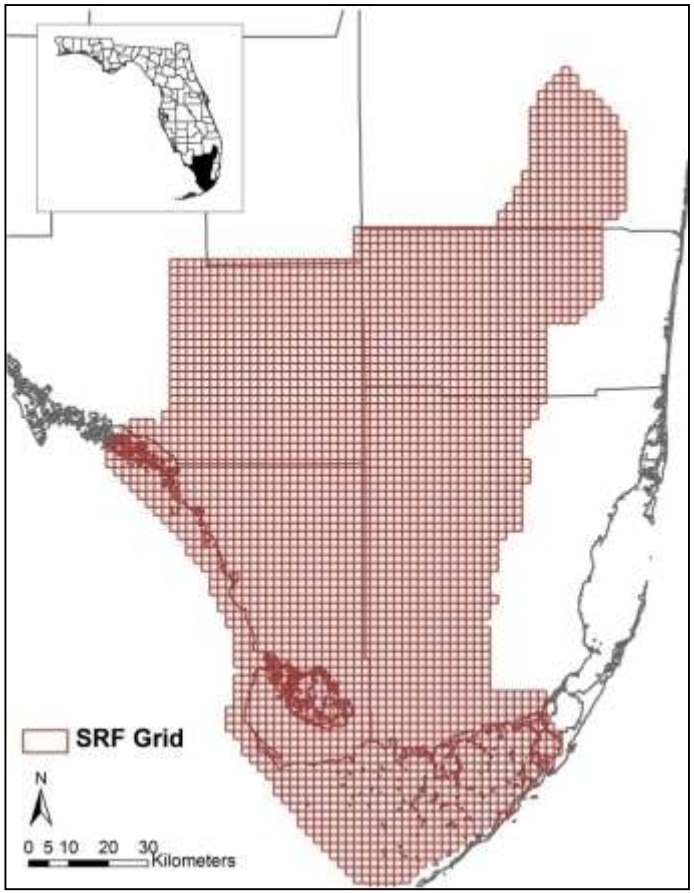
A priori Hypotheses

Hypothesis	Models[1]
Global	Y = WD + DSD + REC + REV
Prey Production	Y = WD
	Y = WD + DSD
	Y = DSD
Prey Concentration	Y = REC
	Y = REV
Production/Concentration	Y = WD + REC
	Y = WD +REV
	Y = WD + REC + REV

[1]Survey period and SRF Cell ID added as random effect

Response-variable Data Source

- Systematic Reconnaissance Flight (SRF)
  - Breeding season survey
  - 1991-2009
    - 86 survey periods
  - 2 km x 2 km resolution
    - 1,916 cells
  - Great Egret
    - N = 73,717 obs
  - White Ibis
    - N = 34,505 obs
  - Wood Stork
    - N = 7,184 obs



Explanatory-variable Data Source

EVERGLADES DEPTH ESTIMATION NETWORK
EDEN

- Water Depth + Water Depth^2 = WD
- Days Since Drydown + Days Since Drydown^2 = DSD
- Recession Rate + Recession Rate^2 = REC
- Reversals = REV

Statistical Methods

- Resource Selection Function
- Discrete choice analysis
  - Multinomial logit model – PROC GLIMMIX in SAS
  - Fixed effects – hydrological variables
  - Random effects – survey period, SRF cell ID
- Akaike's Information Criterion
- *K-fold* cross-validation (Johnson et al. 2006)
  - 20% SRF cells withheld
  - Linear regression

Great Egret Top Models

- Resource Selection Model
  - Global Model (w_i = 1.0, R^2 = 0.20)
    - water depth, recession rate, days since drydown, & reversal
  - Model Validation (R^2 = 0.41)

Model	**-2Loglike**	**k**	**AICc**	**ΔAICc**	w_i	R^2
Global	89355.6	10	89379.6	0.00	1.00	0.20
:	:	:	:	:	:	:
Null	102193.5	2	102193.5	12813.9	0.00	0.00

White Ibis Top Models

- Resourse Selection Model
  - Global Model (w_i = 1.0, R^2 = 0.23)
    - water depth, recession rate, days since drydown, & reversal
  - Model Validation (R^2 = 0.29)

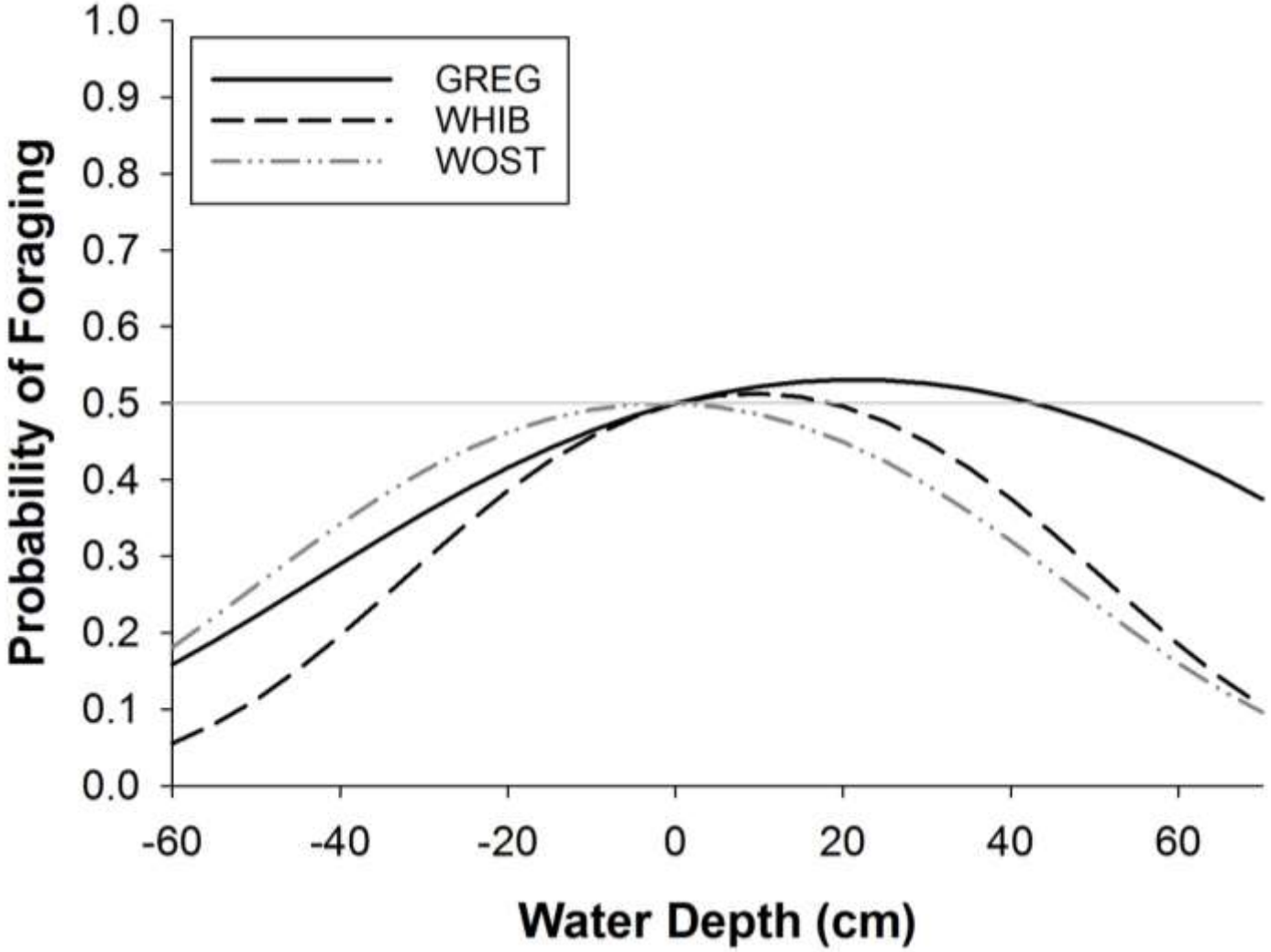
Model	**-2Loglike**	**k**	**AICc**	**ΔAICc**	w_i	R^2
Global	35874.8	10	35898.8	0.00	1.00	0.23
:	:	:	:	:	:	:
Null	42434.2	2	42436.19	6537.4	0.00	0.00

Wood Stork Top Models

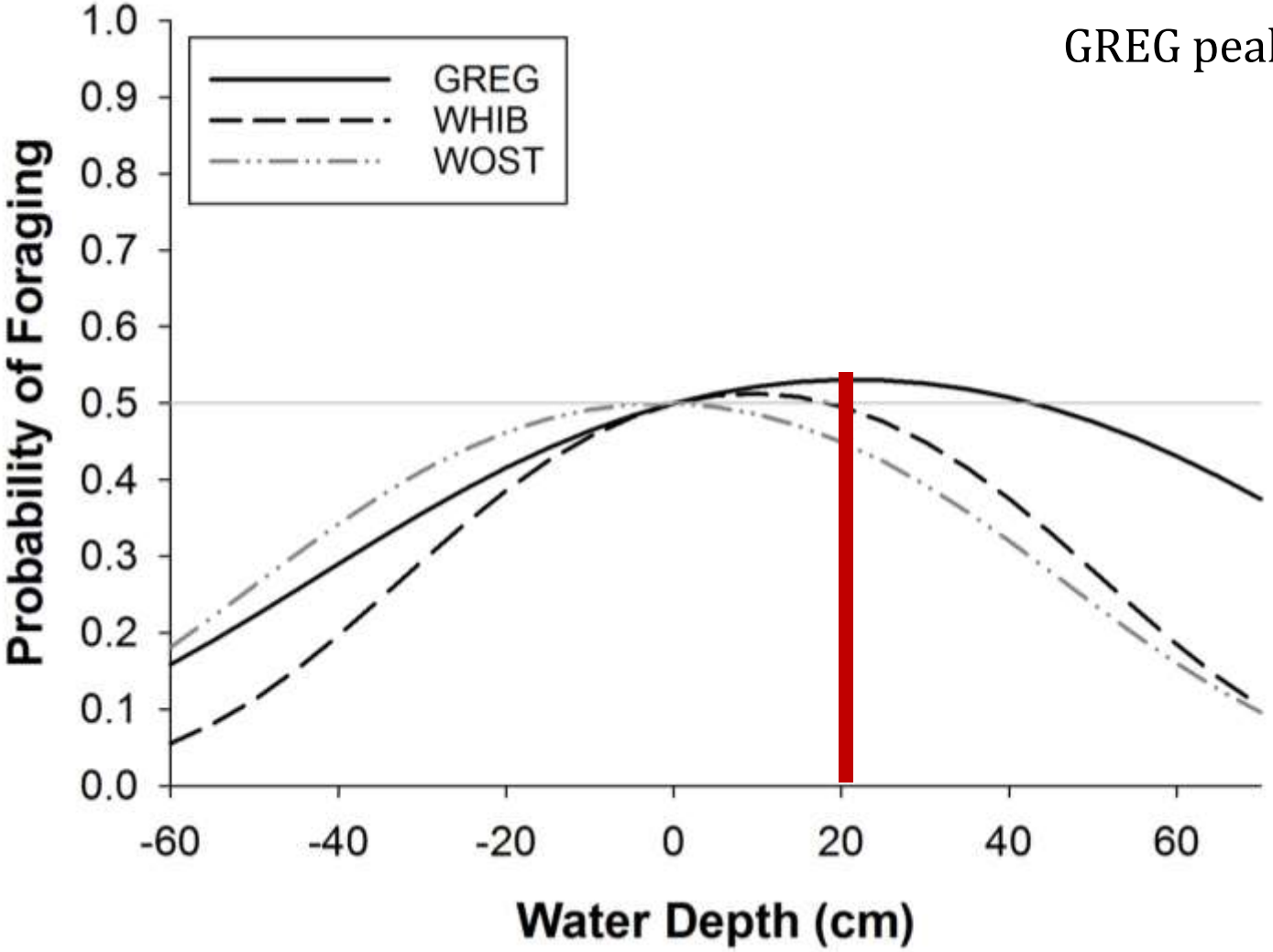
- Resource Selection Model
  - Global Model (w_i = 1.0, R^2 = 0.25)
    - water depth, recession rate, days since drydown, & reversal
  - Model Validation (R^2 = 0.19)

Model	**-2Loglike**	**k**	**AICc**	**ΔAICc**	w_i	R^2
Global	8440.4	10	8460.4	0.00	1.00	0.20
:	:	:	:	:	:	:
Null	9902.0	2	9904.0	3608.2	0.00	0.00

Water Depth

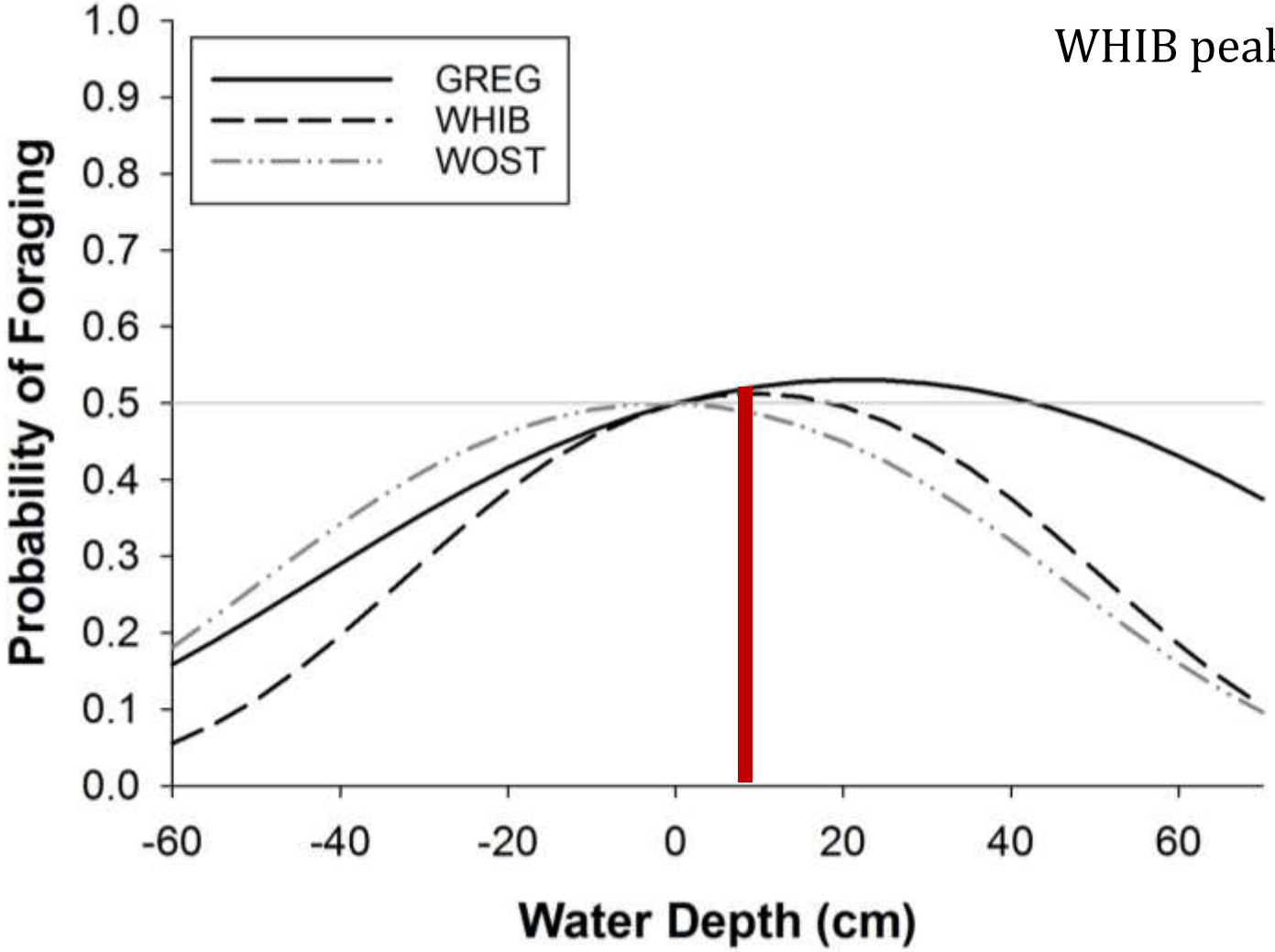

GREG
WHIB
WOST
Probability of Foraging
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-60
-40
-20
0
20
40
60
Water Depth (cm)

Water Depth



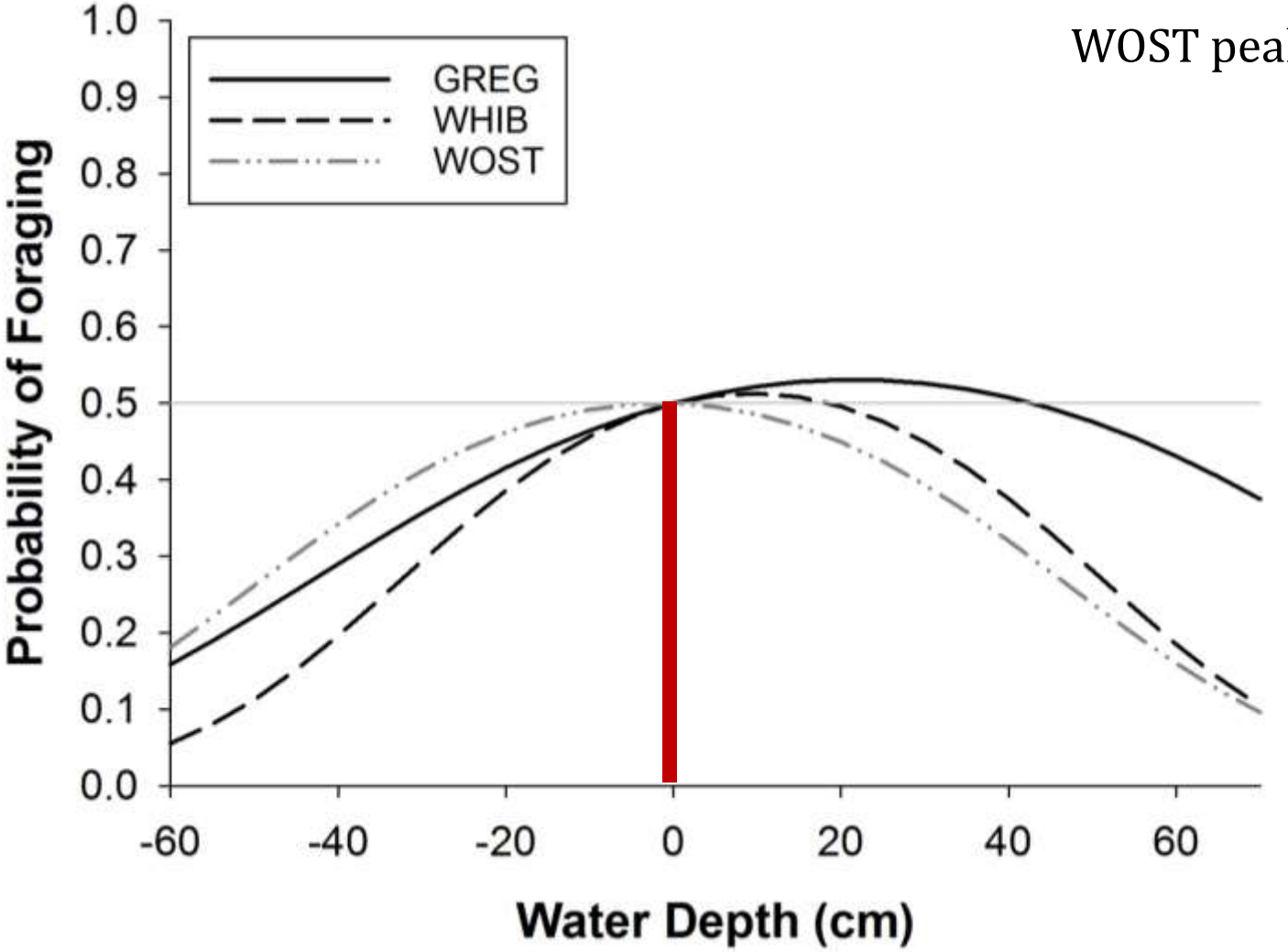
GREG peak use at 20 cm

Water Depth



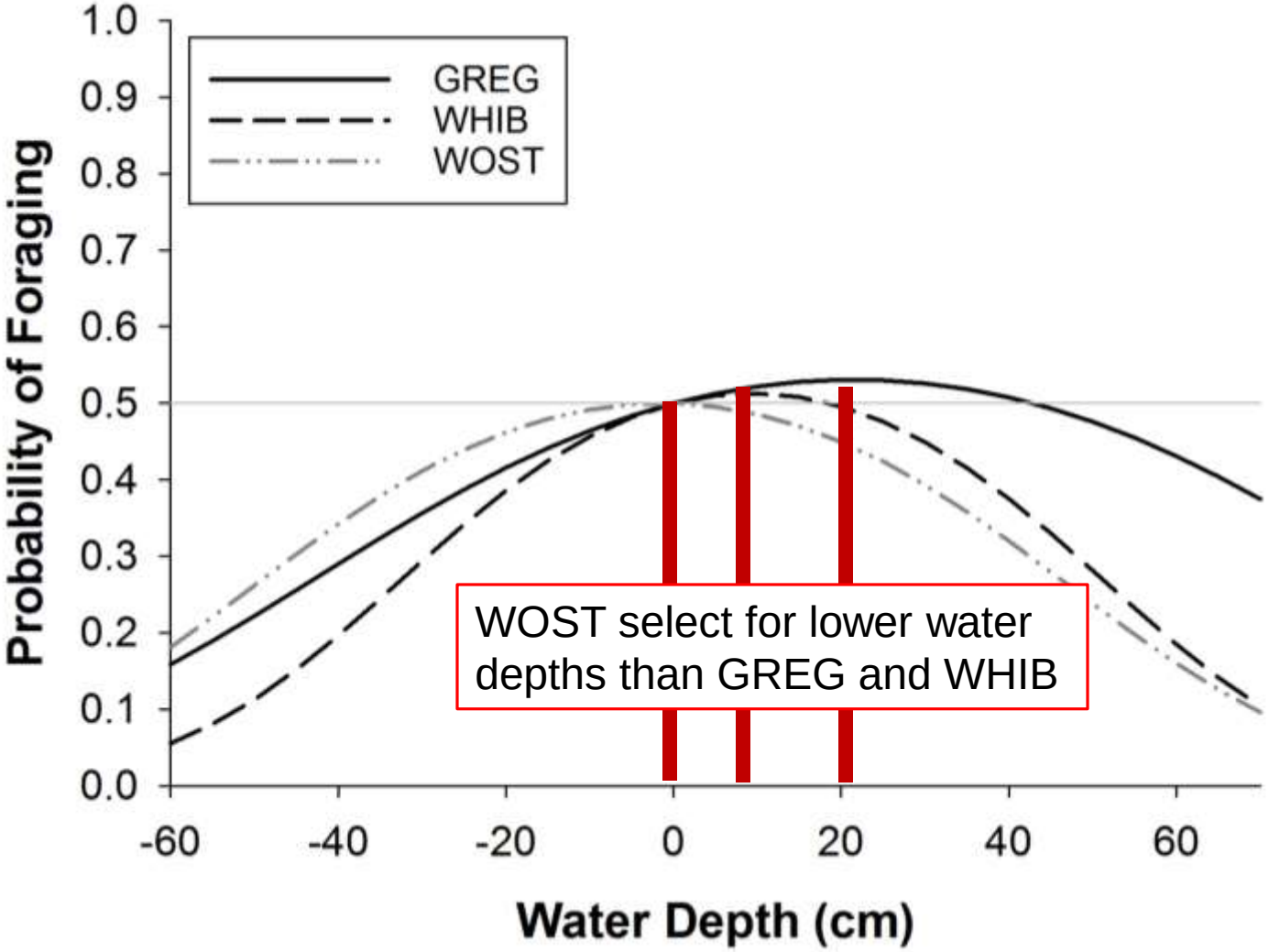
WHIB peak use at 10 cm

Water Depth



WOST peak use at 0 cm

Water Depth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WOST
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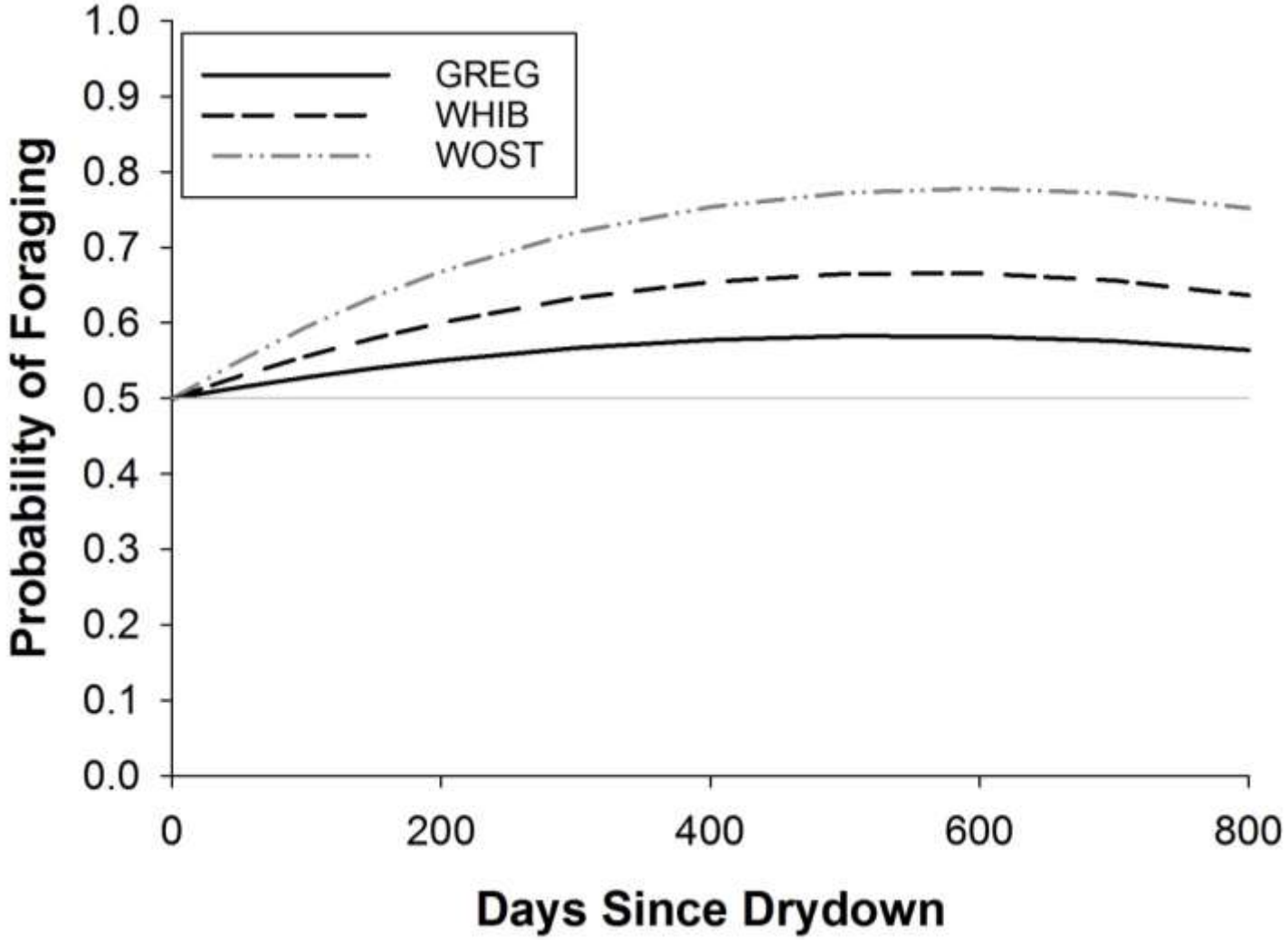
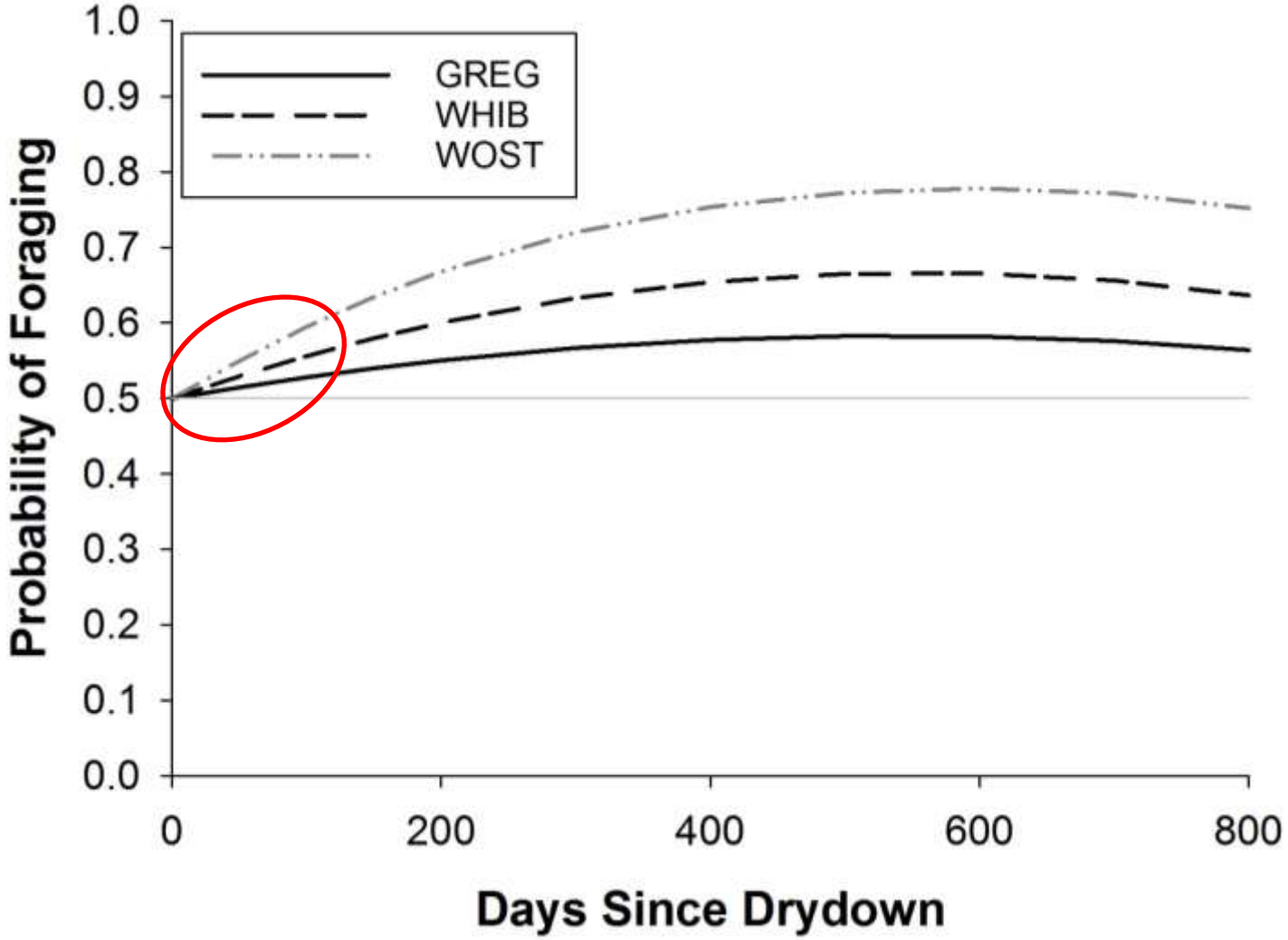
0.4
0.3
0.2
0.1
0.0
-60
-40
-20
0
20
40
60
Water Depth (cm)
WOST select for lower water depths than GREG and WHIB

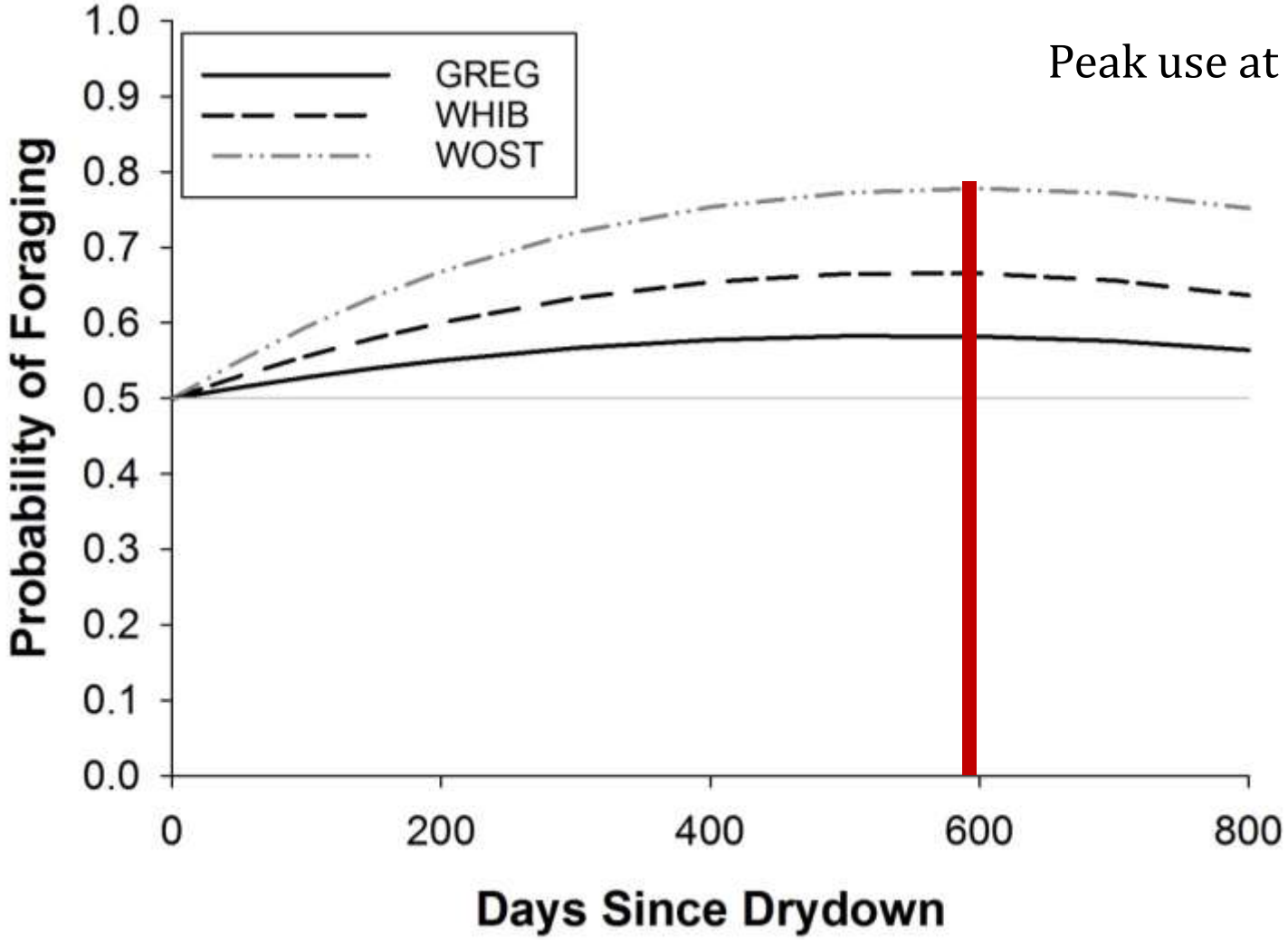
Days Since Drydown



Days Since Drydown

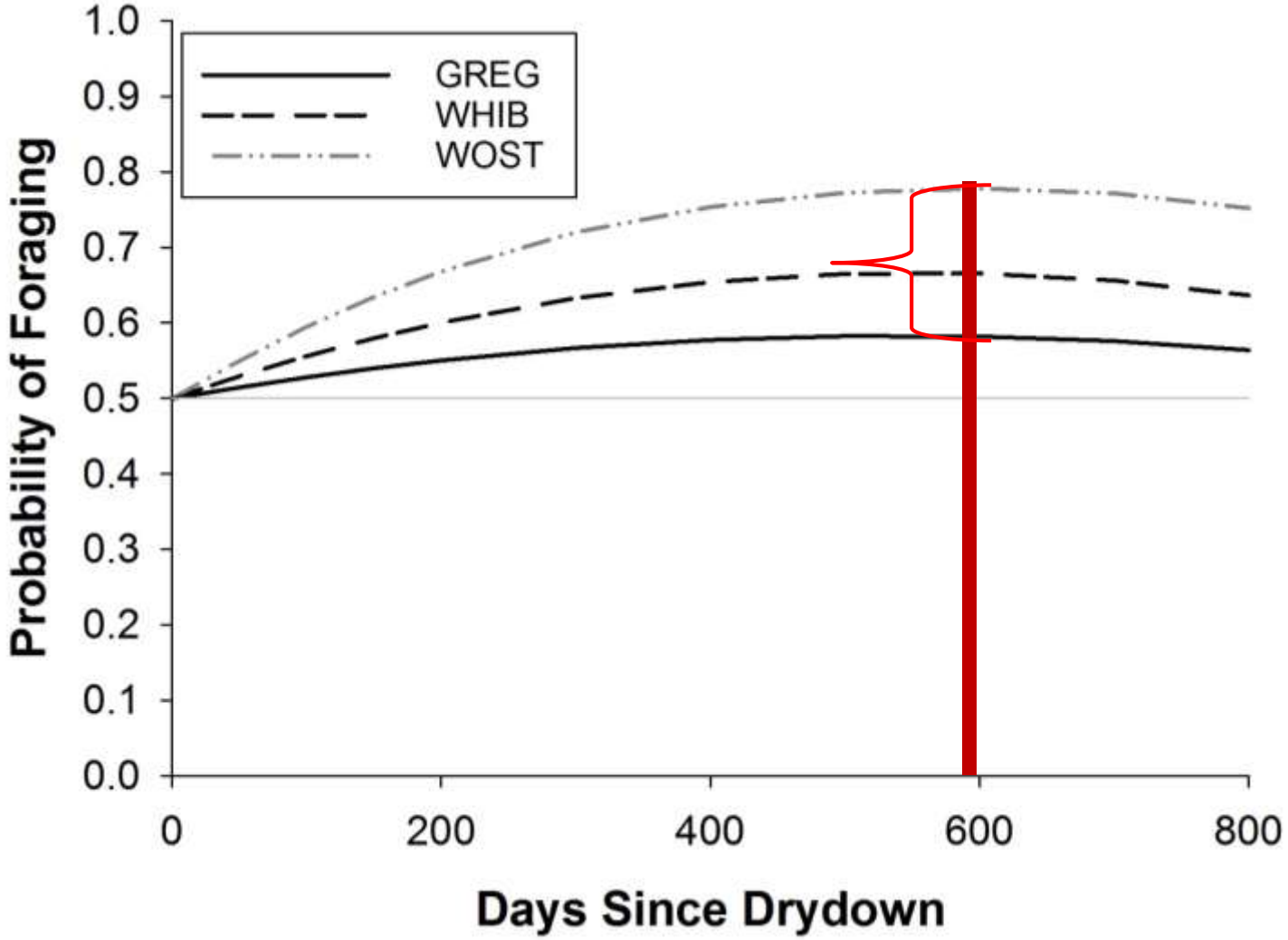


Days Since Drydown

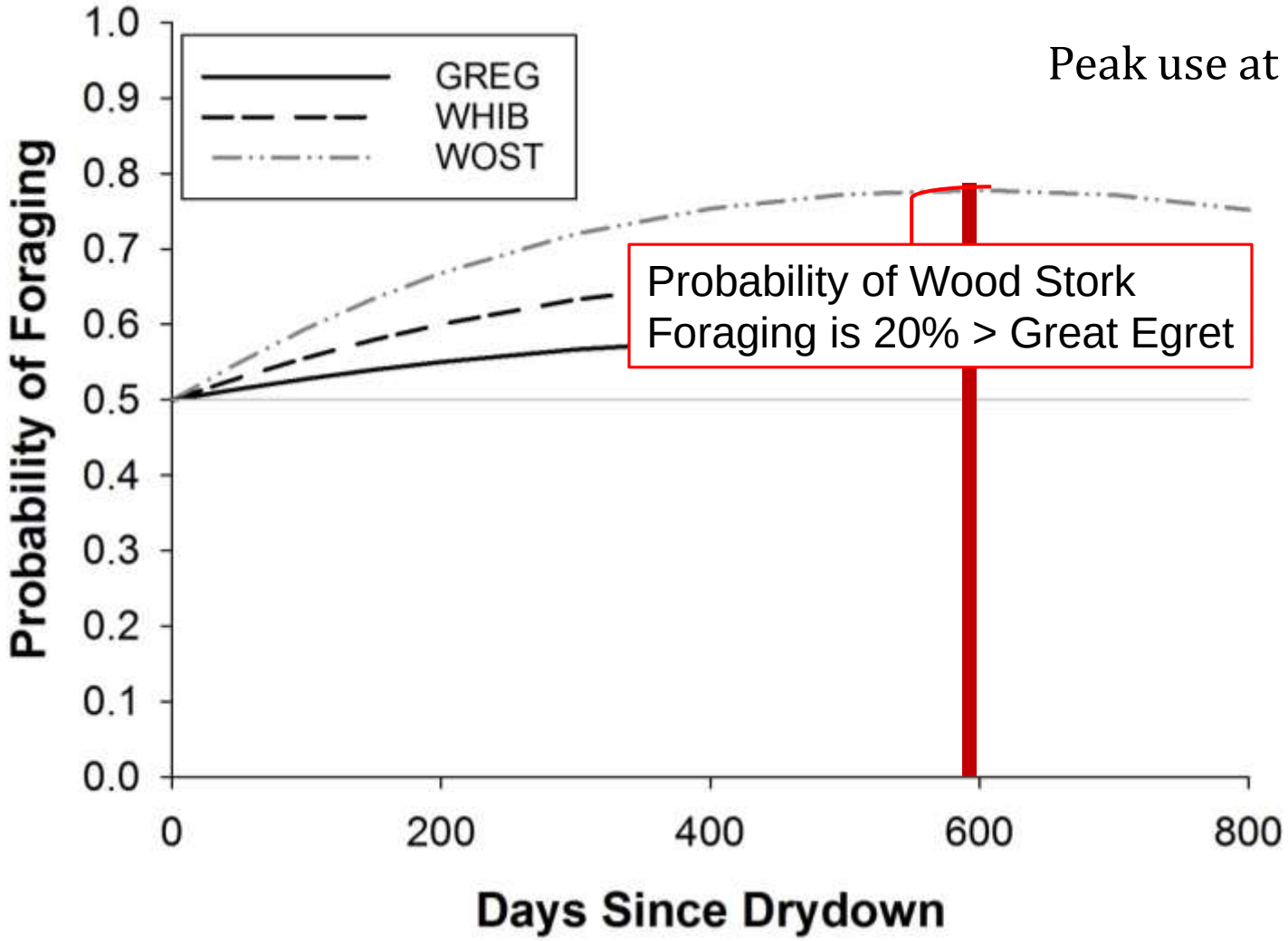


Peak use at 600 DSD

Days Since Drydown



Days Since Drydown



Peak use at 600 DSD

Recession Rate

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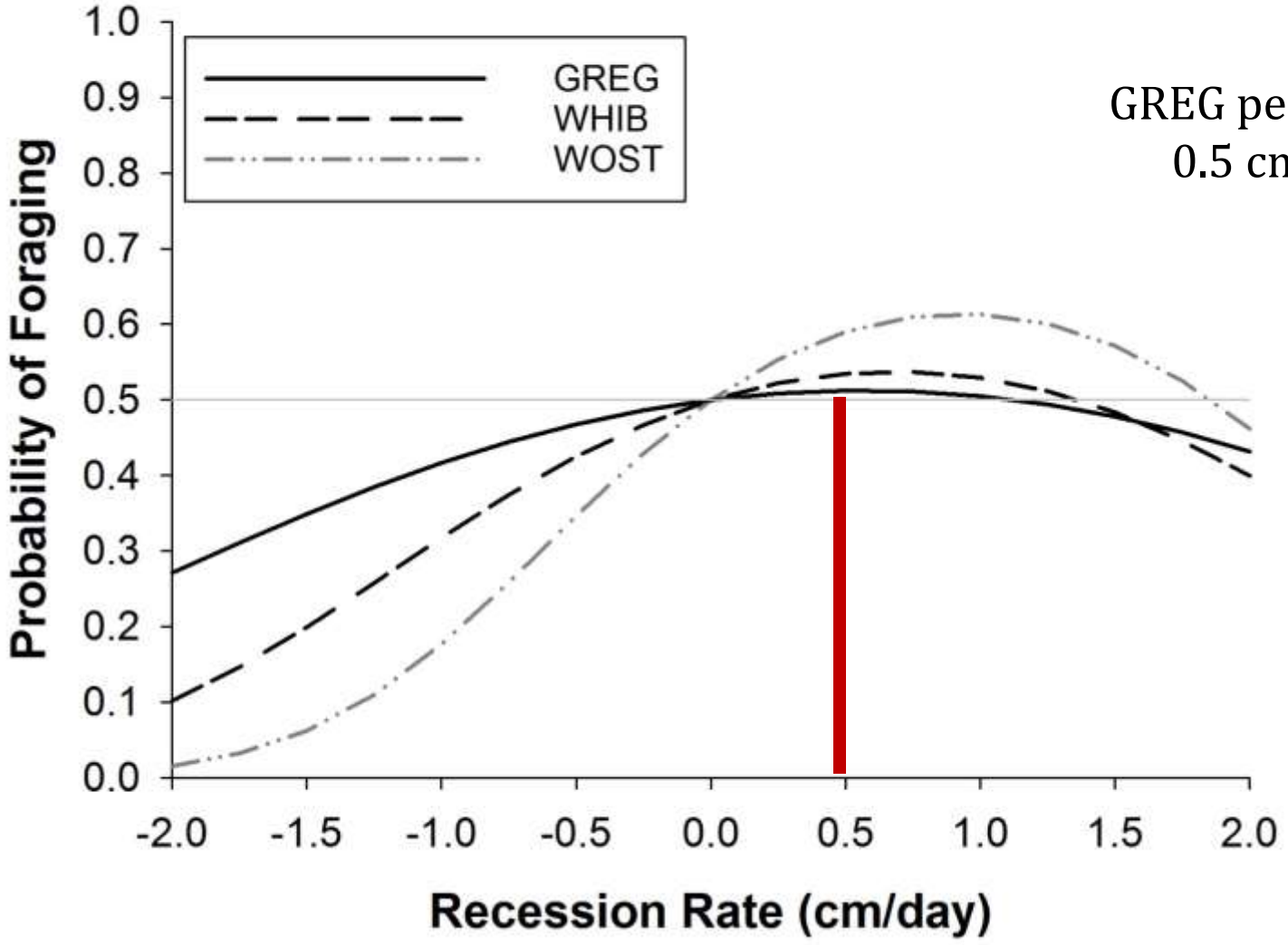
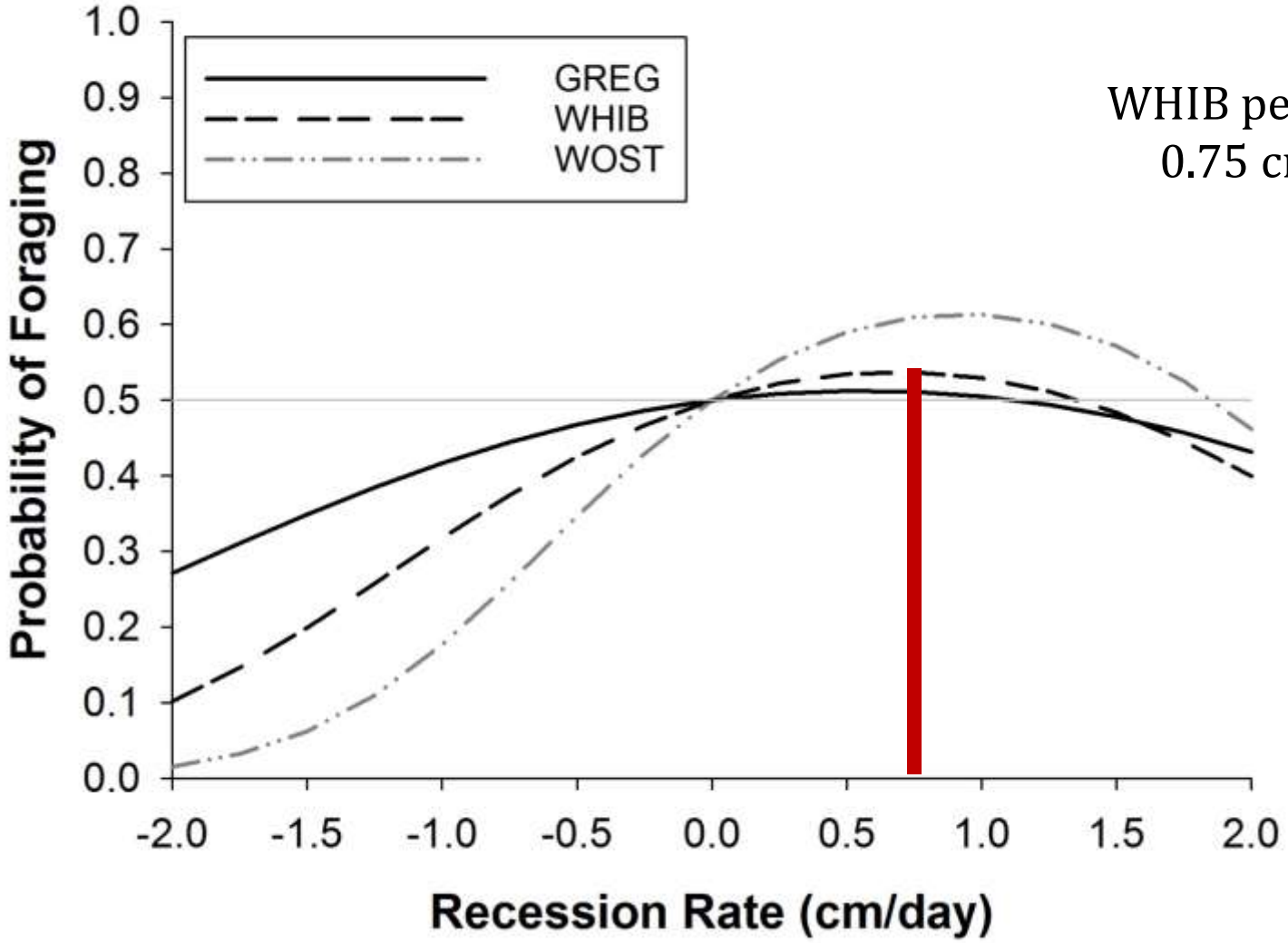
Use declines as water-levels rise

Recession Rate



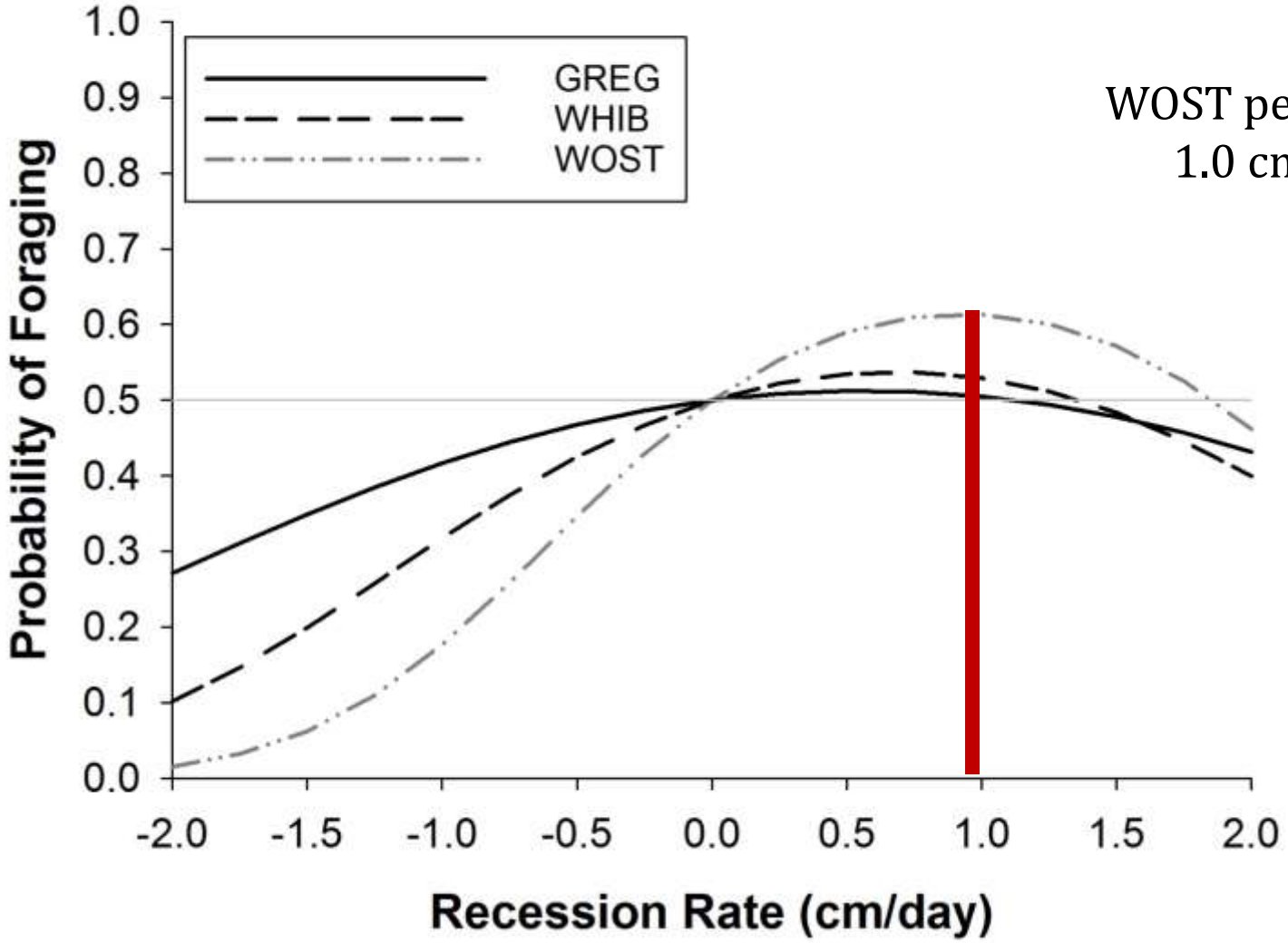
GREG peak use at
0.5 cm/day

Recession Rate



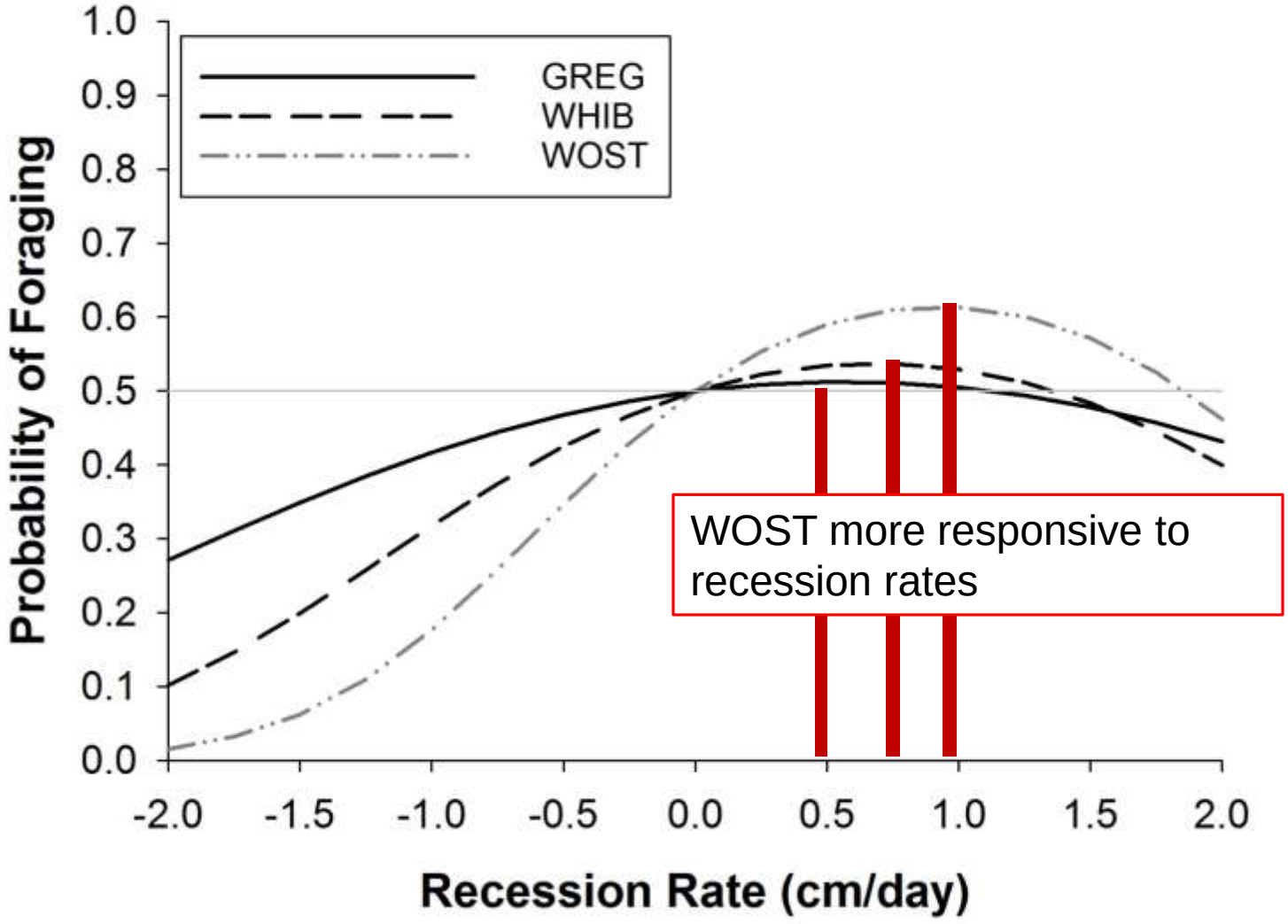
WHIB peak use at
0.75 cm/day

Recession Rate

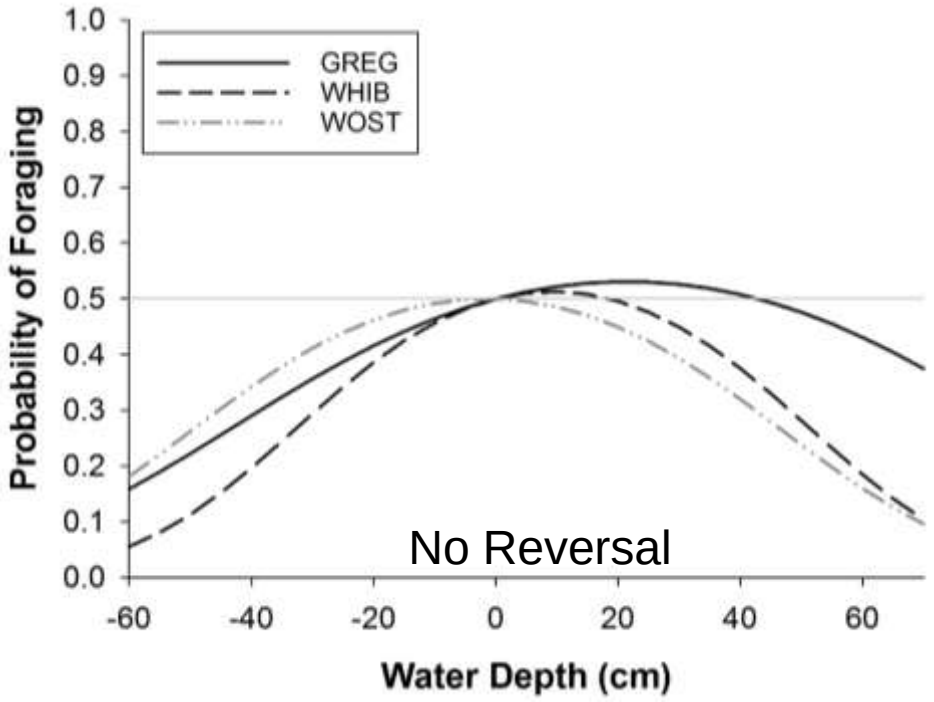


WOST peak use at
1.0 cm/day

Recession Rate



Reversal


Probability of Foraging
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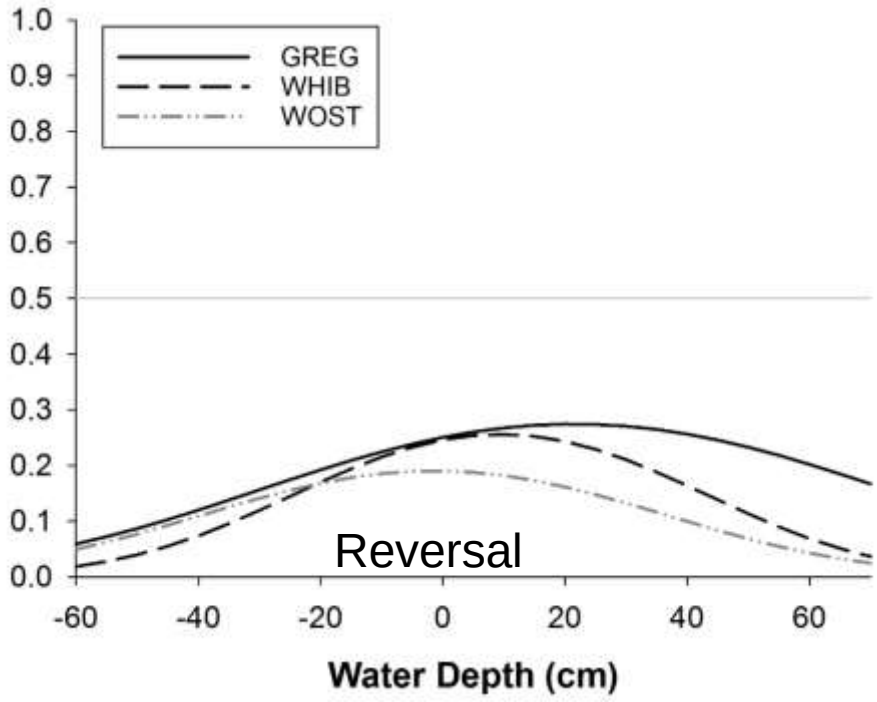
-60
-40
-20
0
20
40
60
Water Depth (cm)
No Reversal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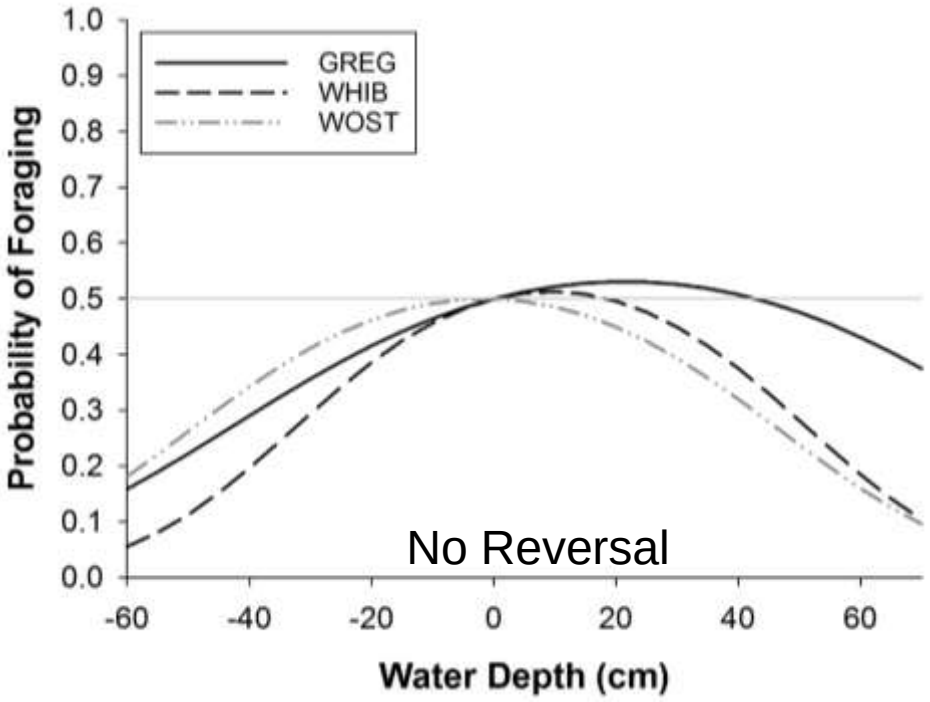
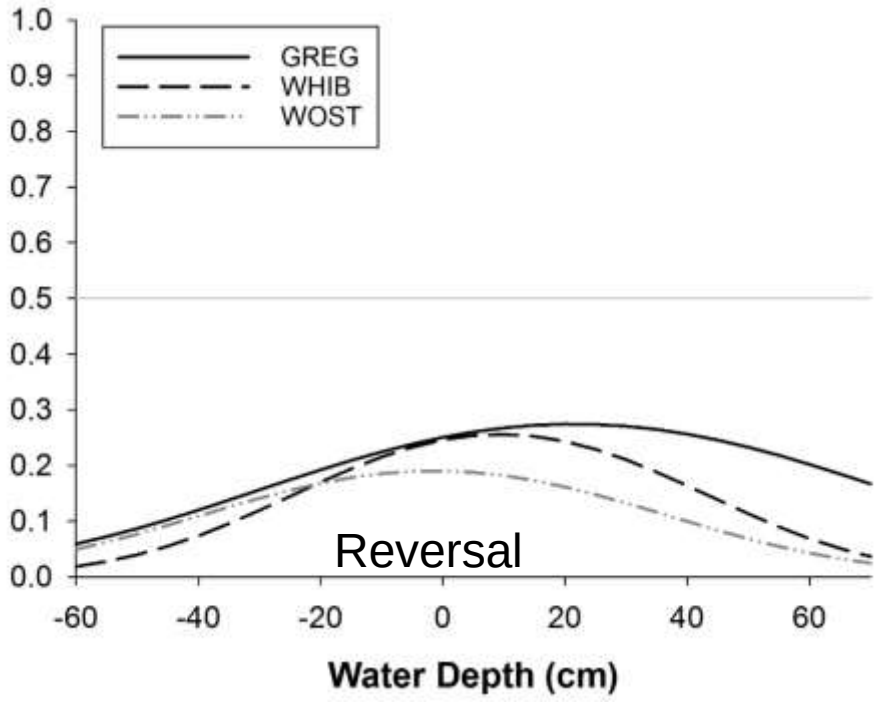
Reversal

Reversal





Three times less likely to forage following 3 cm reversal

Wading Birds and Hydrology

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- GREG and WHIB are hydrologically less constrained
  - GREG - morphological adaptations (Powell 1987), broad diet (Smith 1997), physiological tolerance (Herring et al. 2010)
  - WHIB - Crayfish diet (Kushlan 1979)
    - Concentrate in deeper water (Cook et al. 2014)

Implications for Management

- Spatial and temporal hydrologic heterogeneity

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  - Creates available foraging habitat throughout breeding season

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      - 1. Add additional habitat
      - 2. Operational planning
- Management for selective species will likely benefit other wading bird species

Acknowledgements

- **Mario Alvarado, Everglades National Park**
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