

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



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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



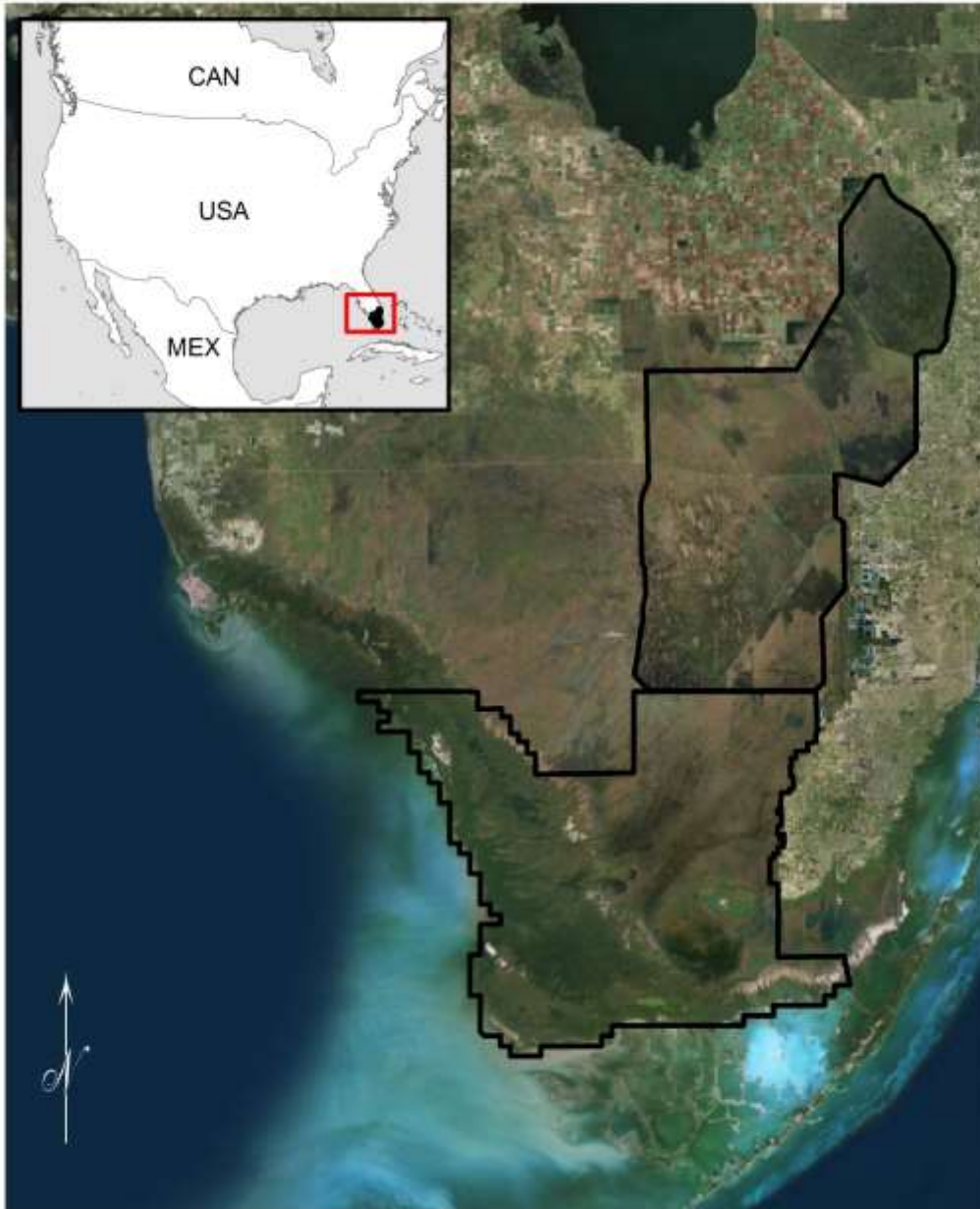
White Ibis



Wood Stork



Study Area



□ Everglades

0 10 20 40 60 Kilometers

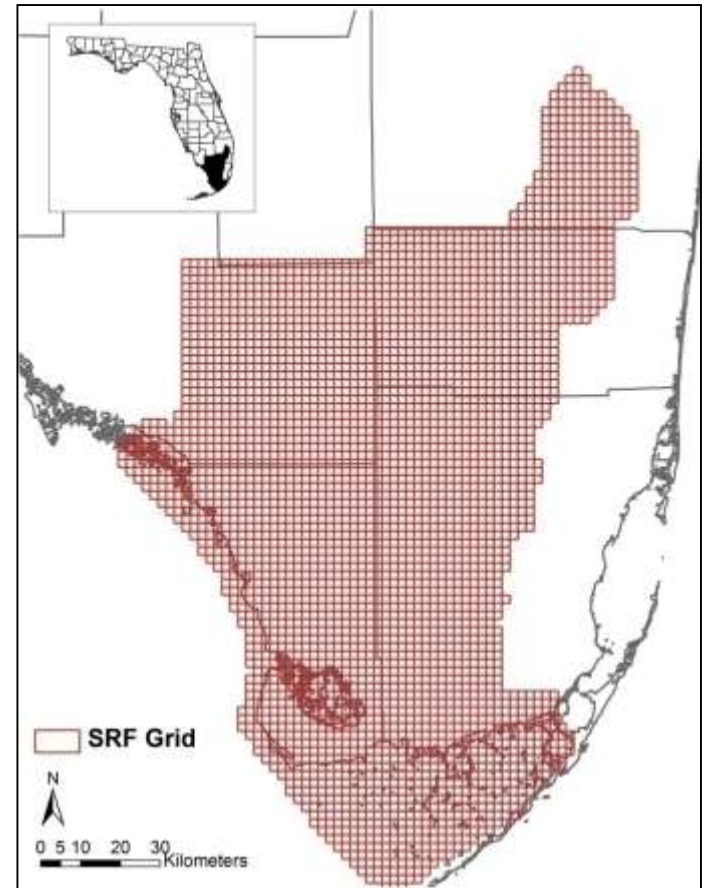
A priori Hypotheses

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	$Y = WD + REC$ $Y = WD + REV$ $Y = WD + REC + REV$

¹Survey 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



- $\text{Water Depth} + \text{Water Depth}^2 = \text{WD}$
- $\text{Days Since Drydown} + \text{Days Since Drydown}^2 = \text{DSD}$
- $\text{Recession Rate} + \text{Recession Rate}^2 = \text{REC}$
- $\text{Reversals} = \text{REV}$

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



- Resource 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

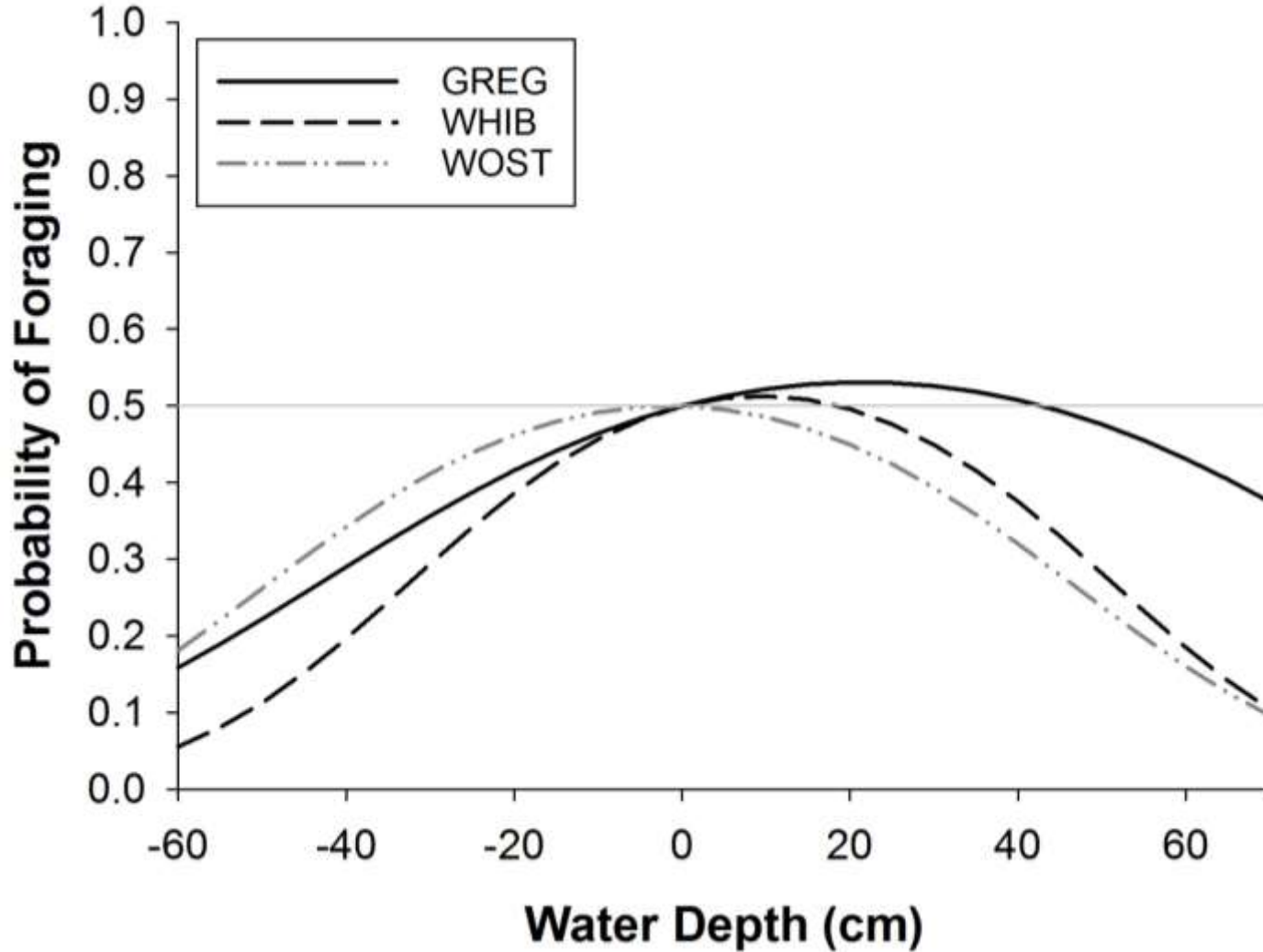
Wood Stork Top Models



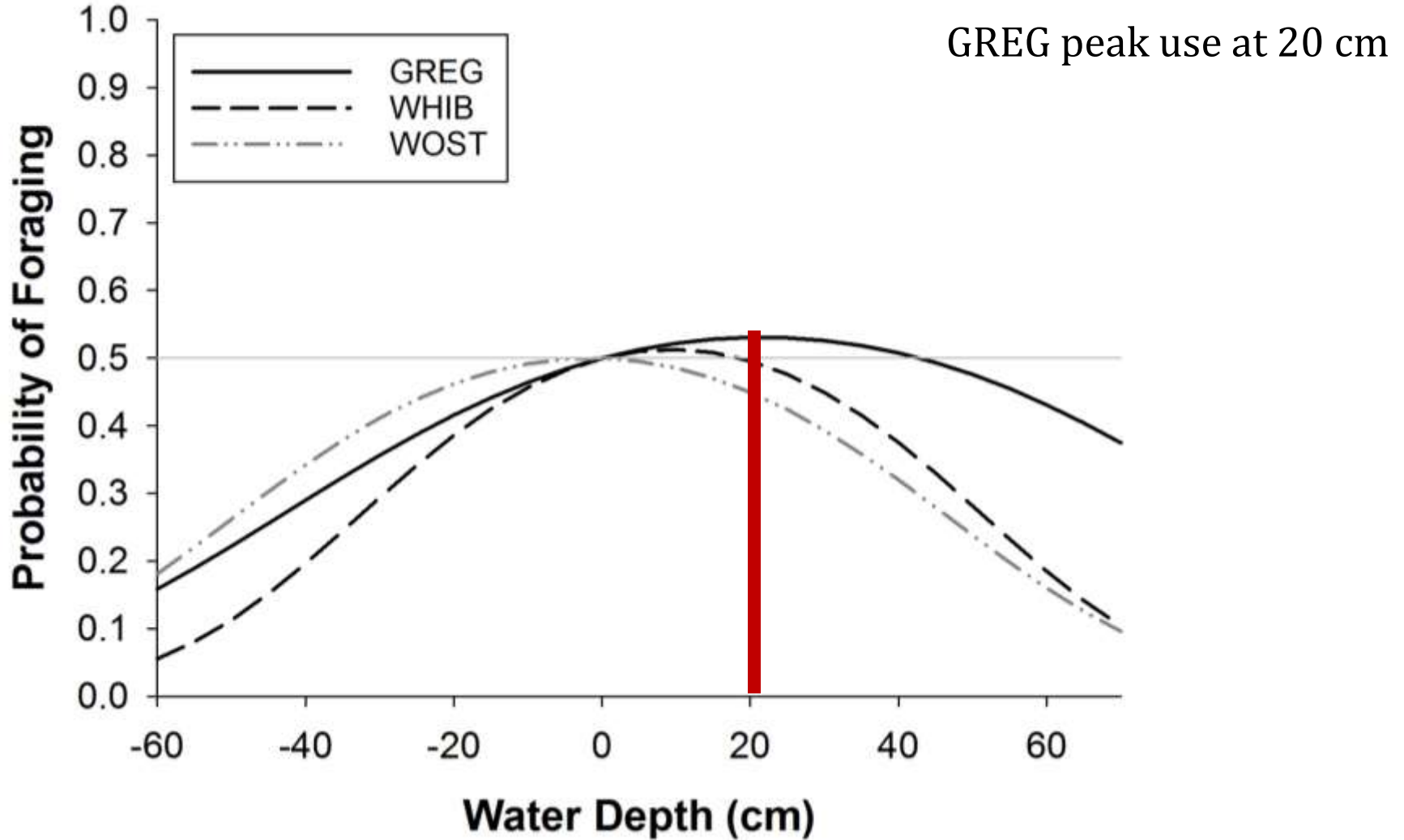
- Resource Selection Model
 - Global Model ($w_i = 1.0$, $R^2 = 0.25$)
 - water depth, recession rate, days since drydown, & reversal
 - Model Validation ($R^2 = 0.19$)

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

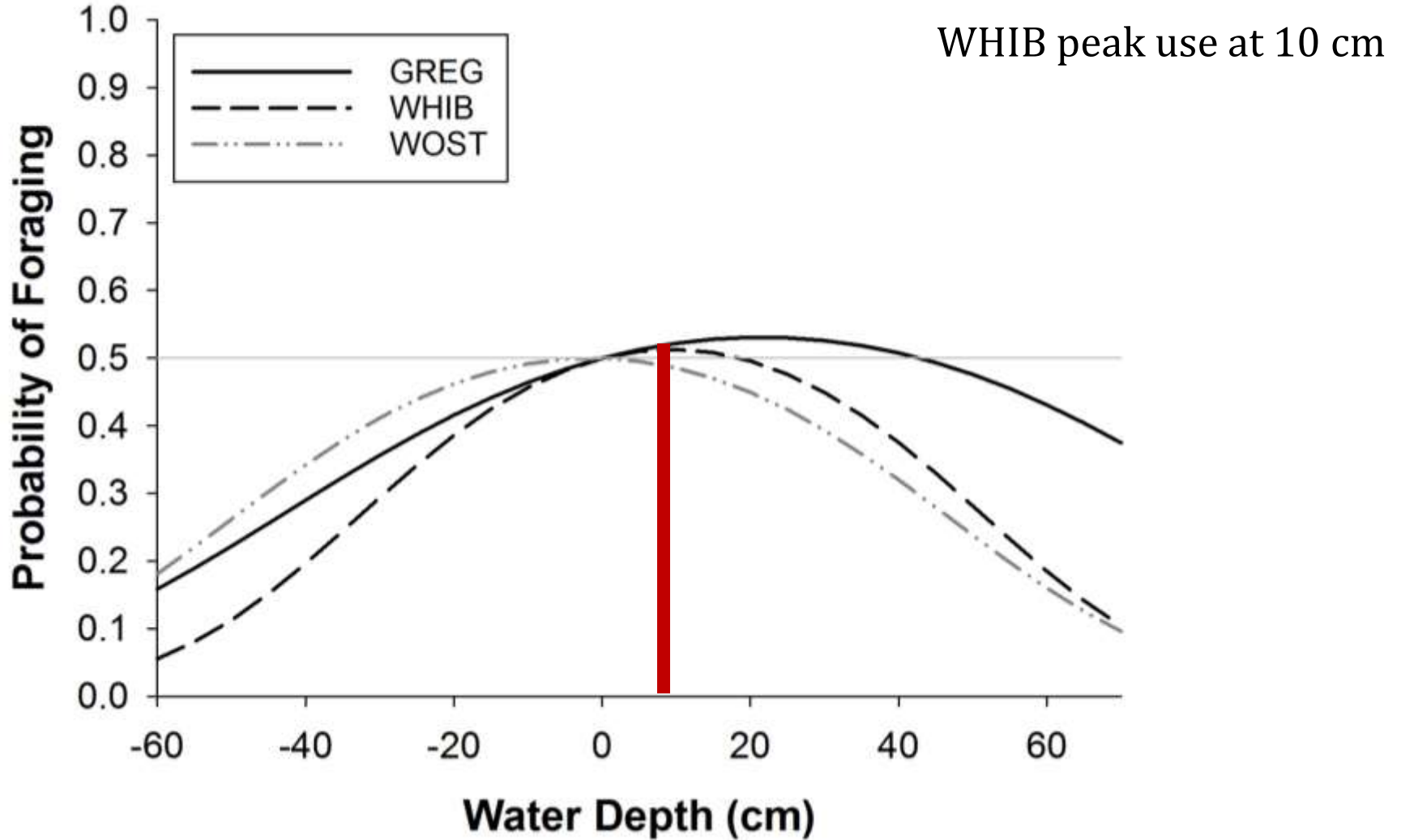
Water Depth



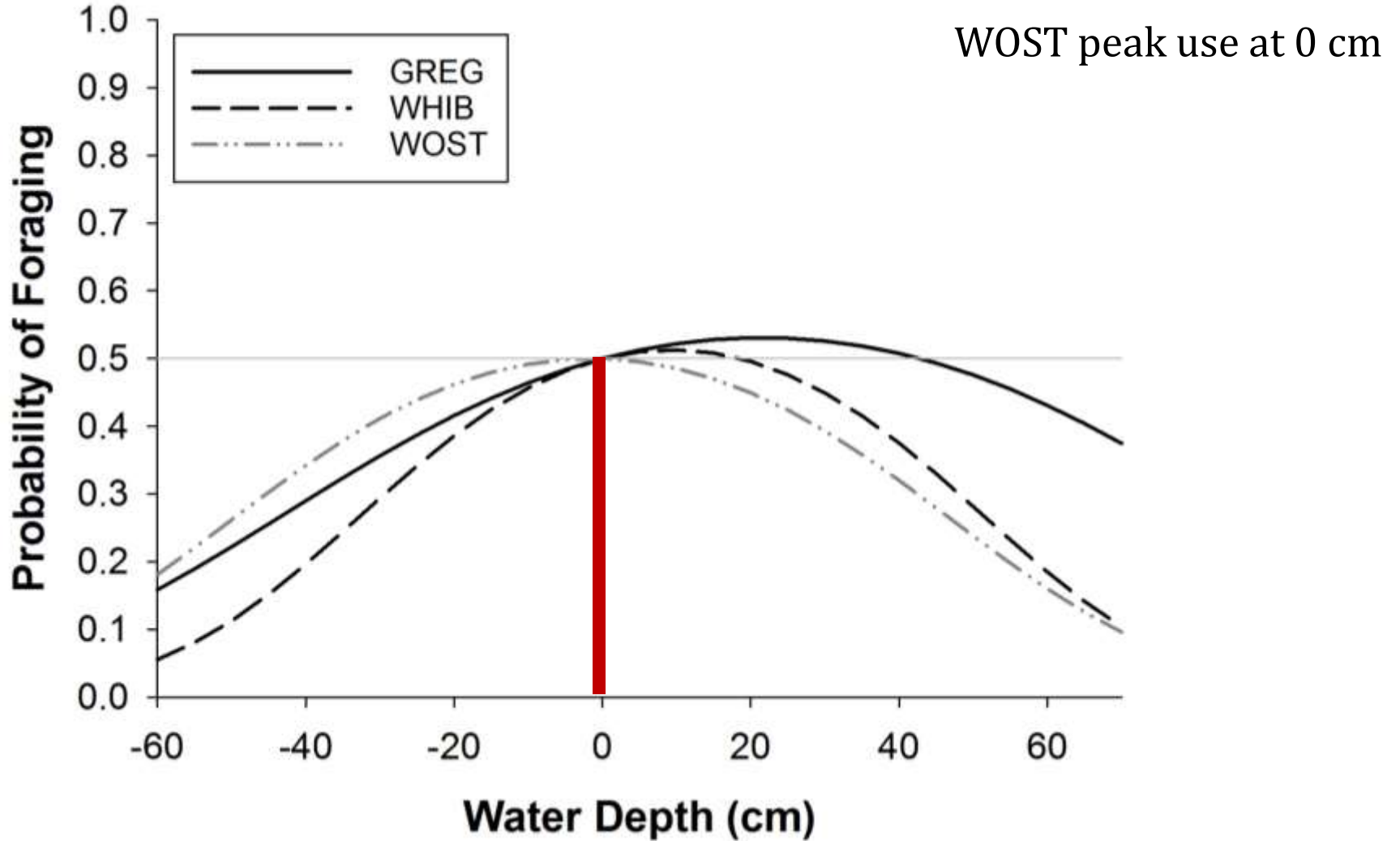
Water Depth



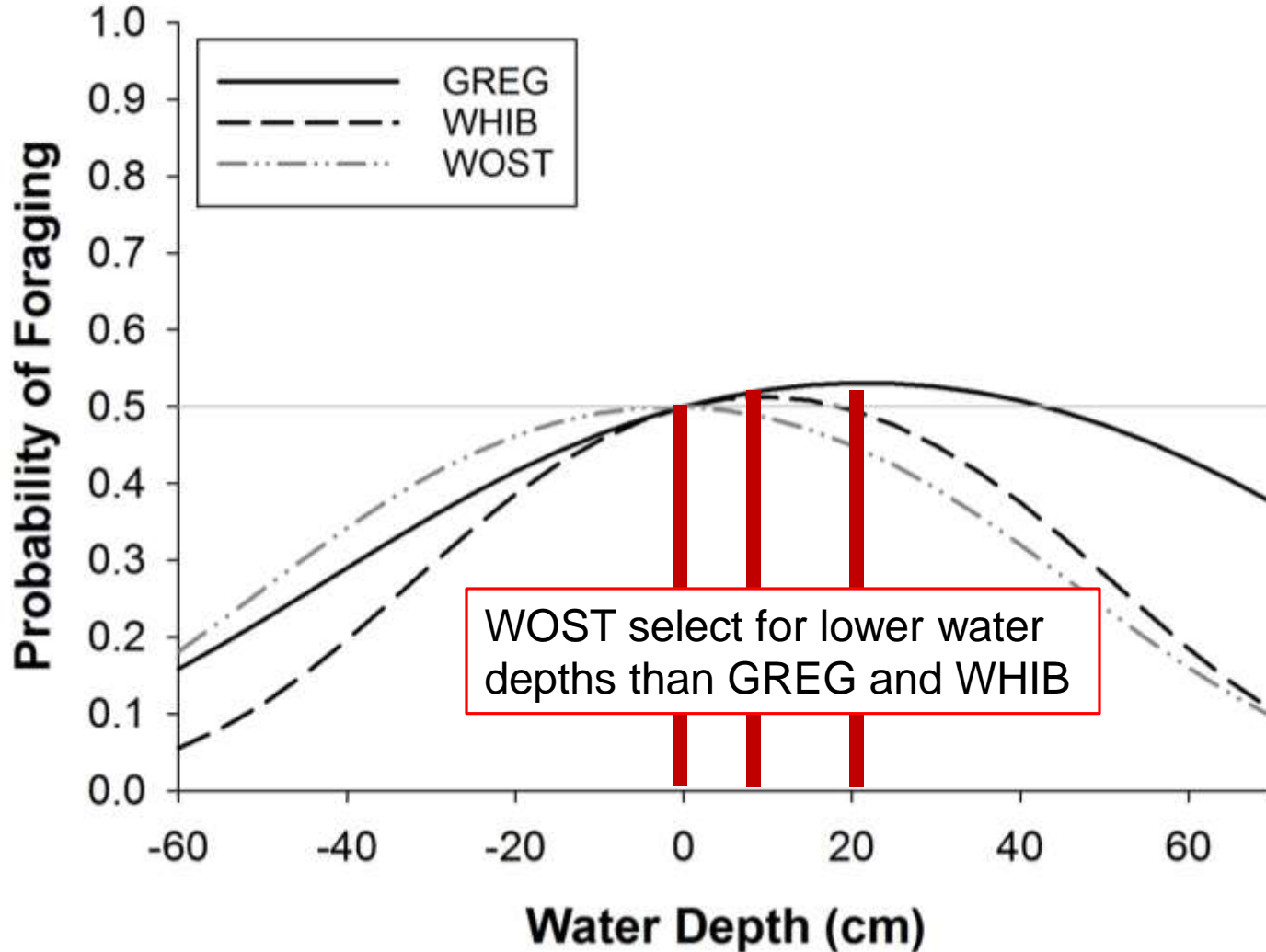
Water Depth



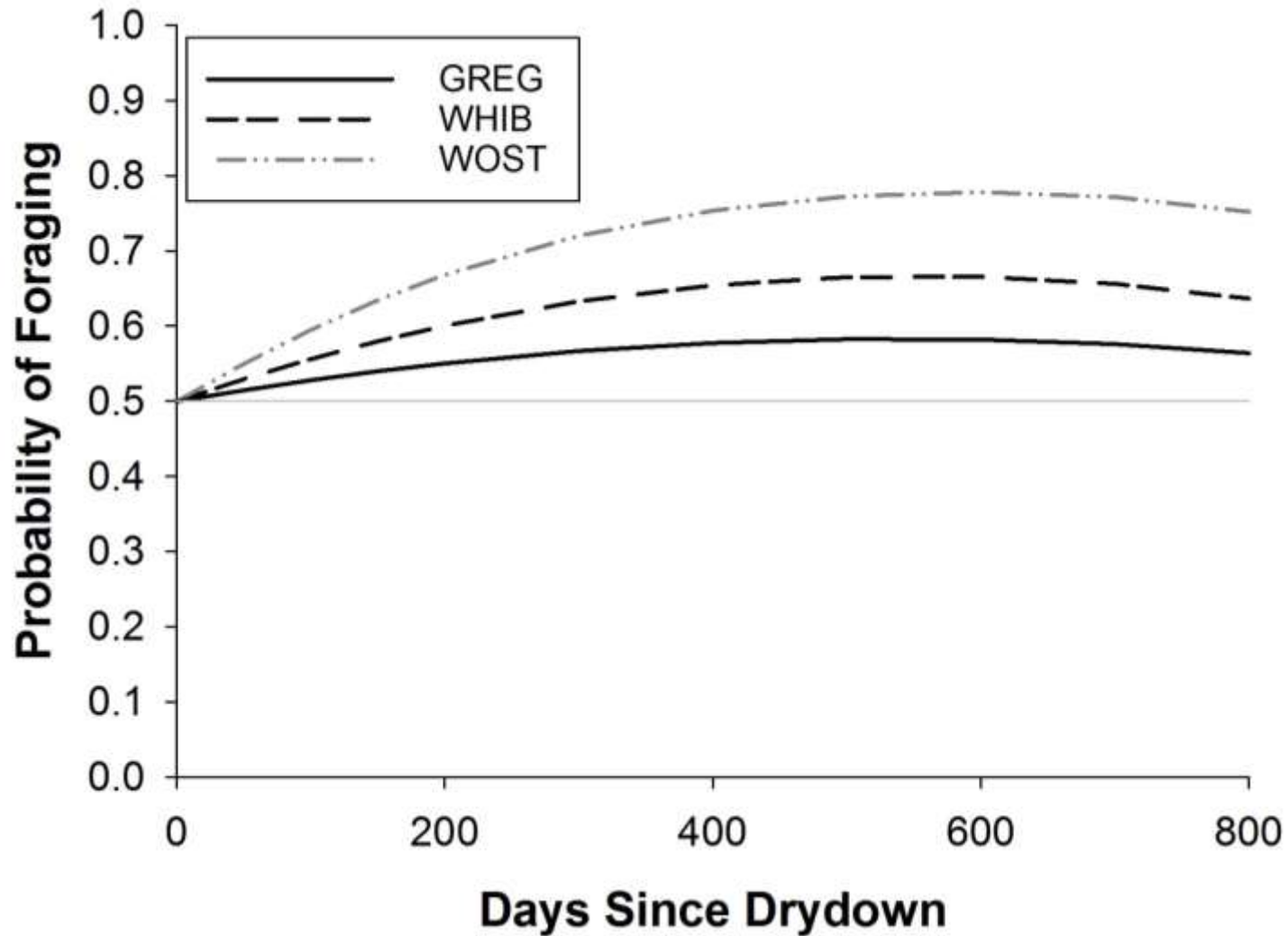
Water Depth



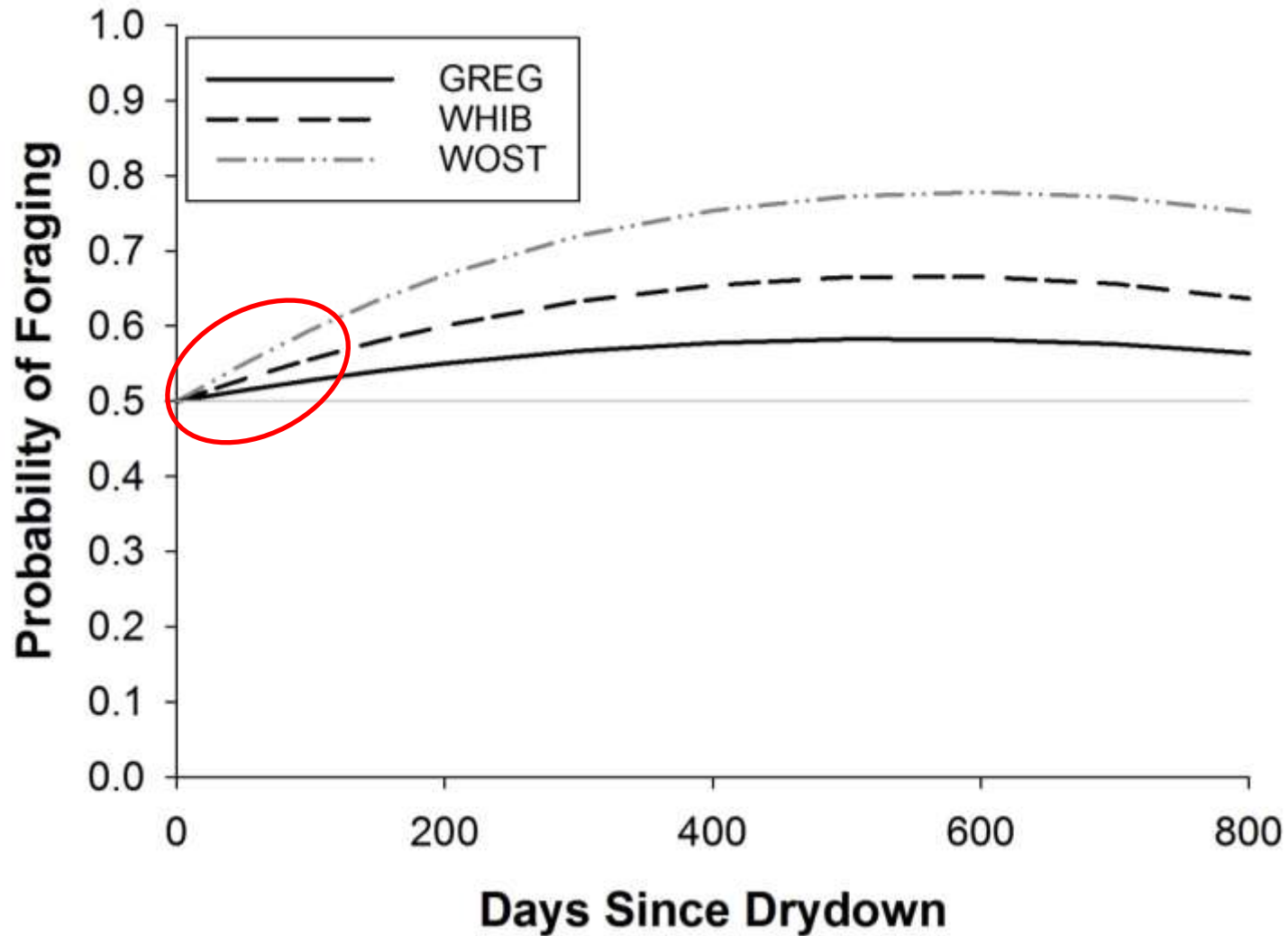
Water Depth



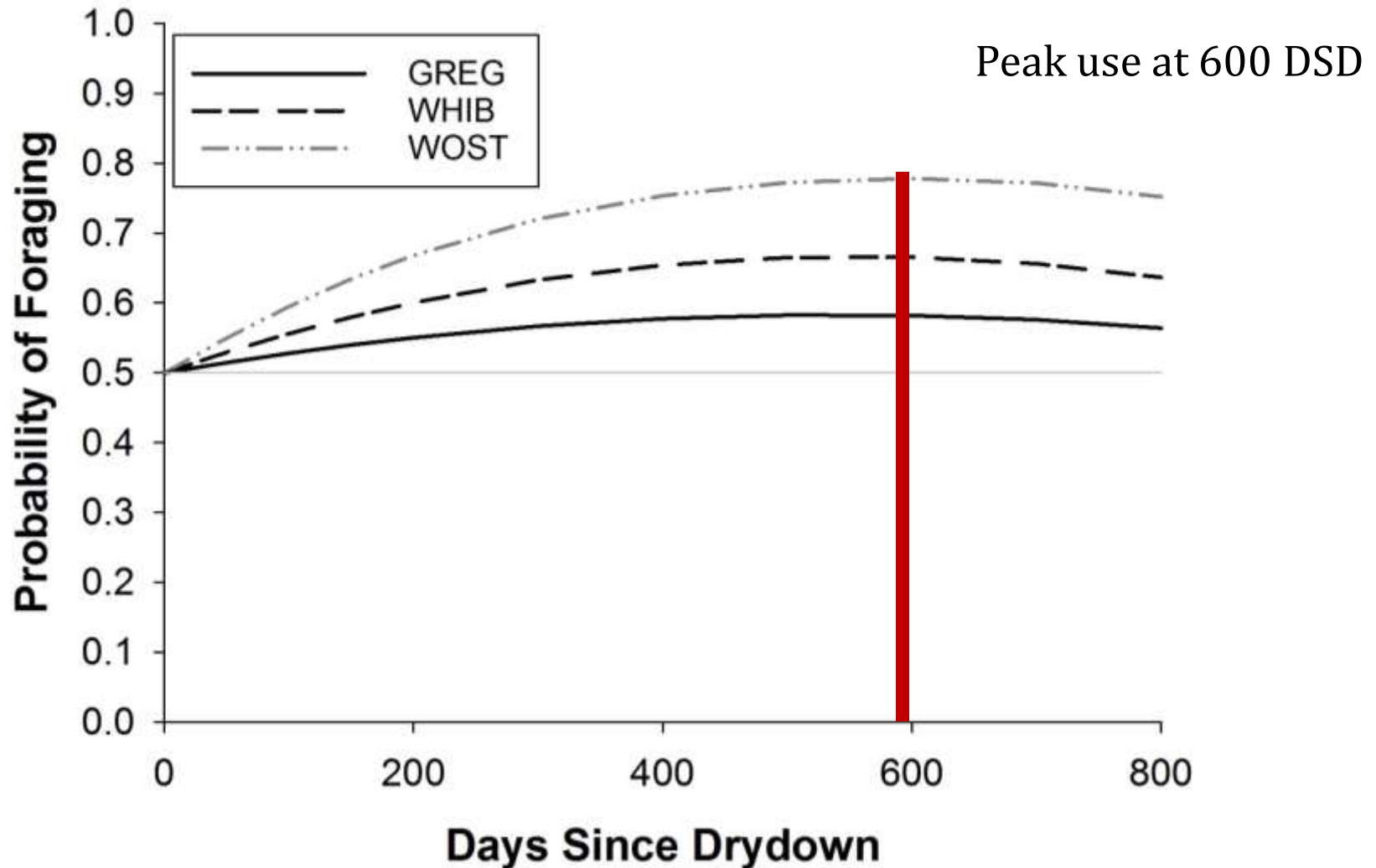
Days Since Drydown



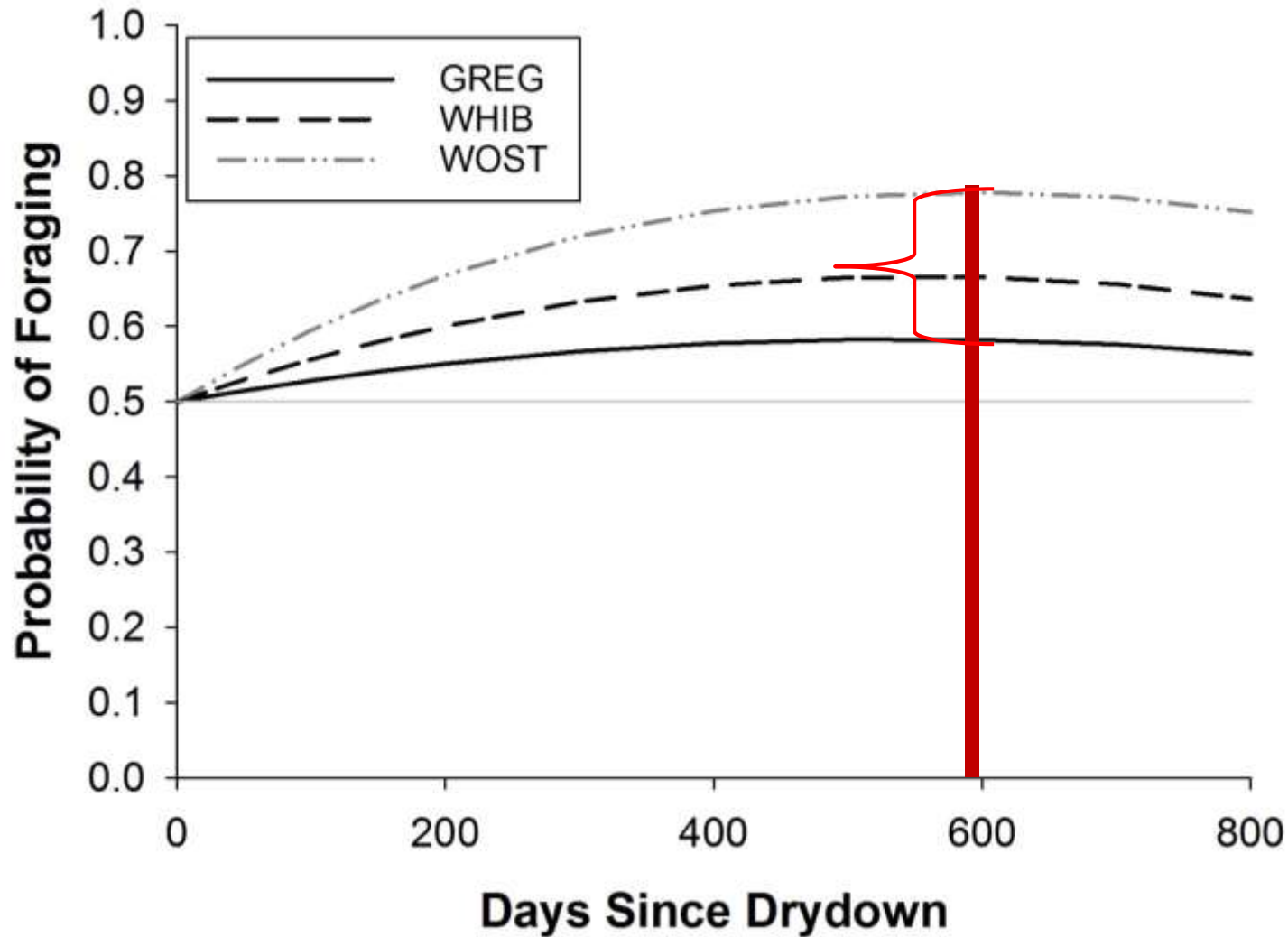
Days Since Drydown



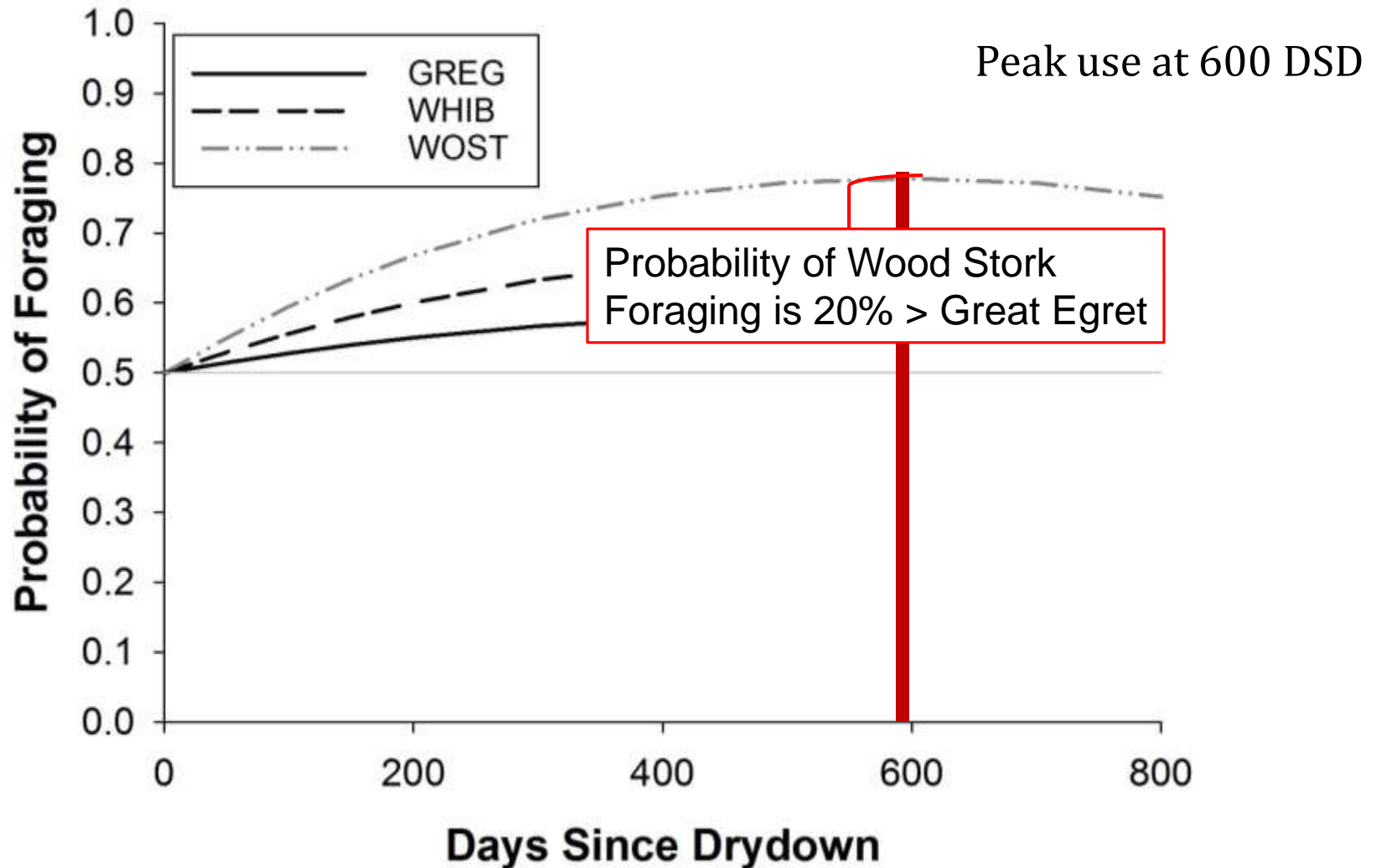
Days Since Drydown



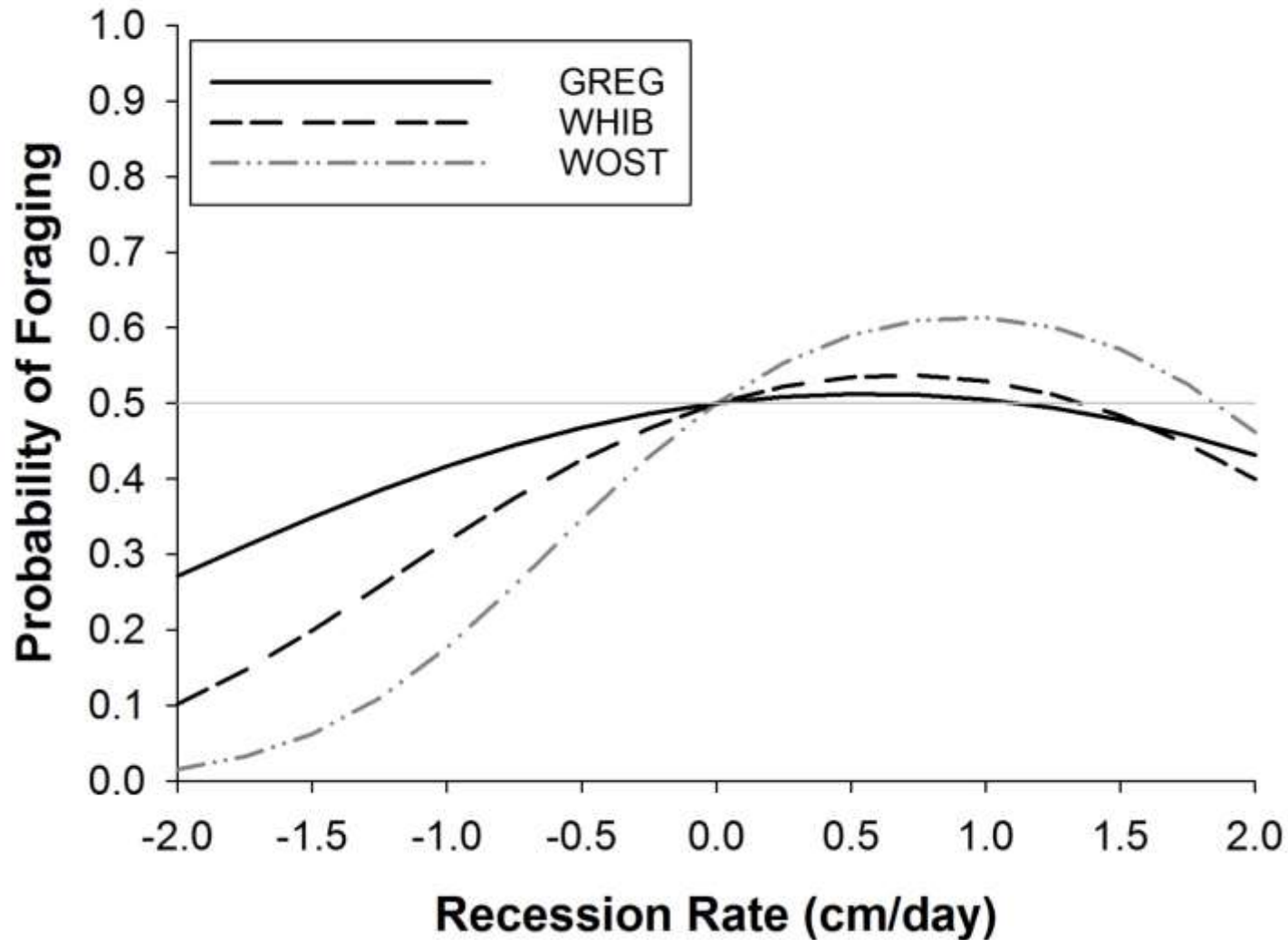
Days Since Drydown



Days Since Drydown



Recession Rate

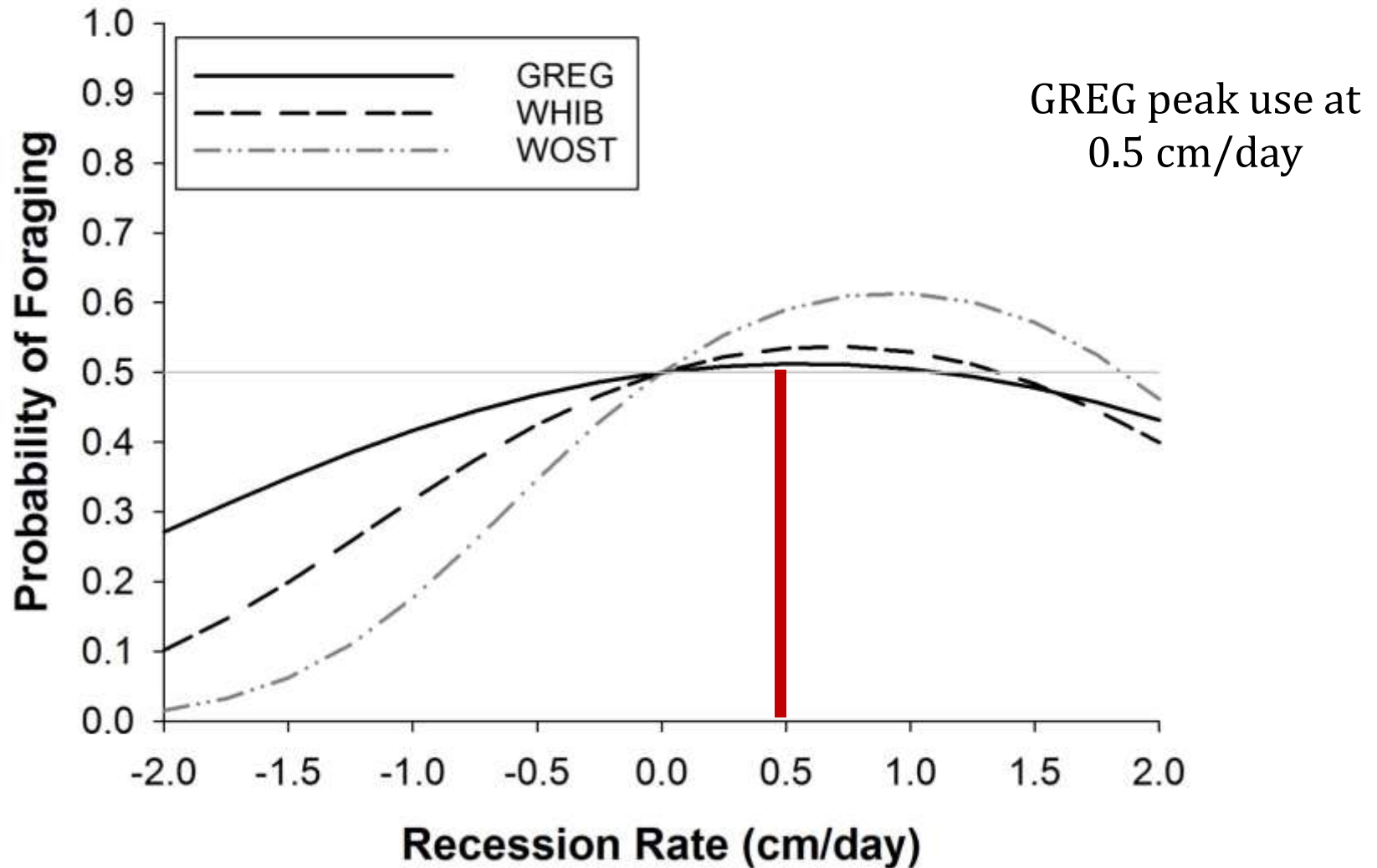


Recession Rate

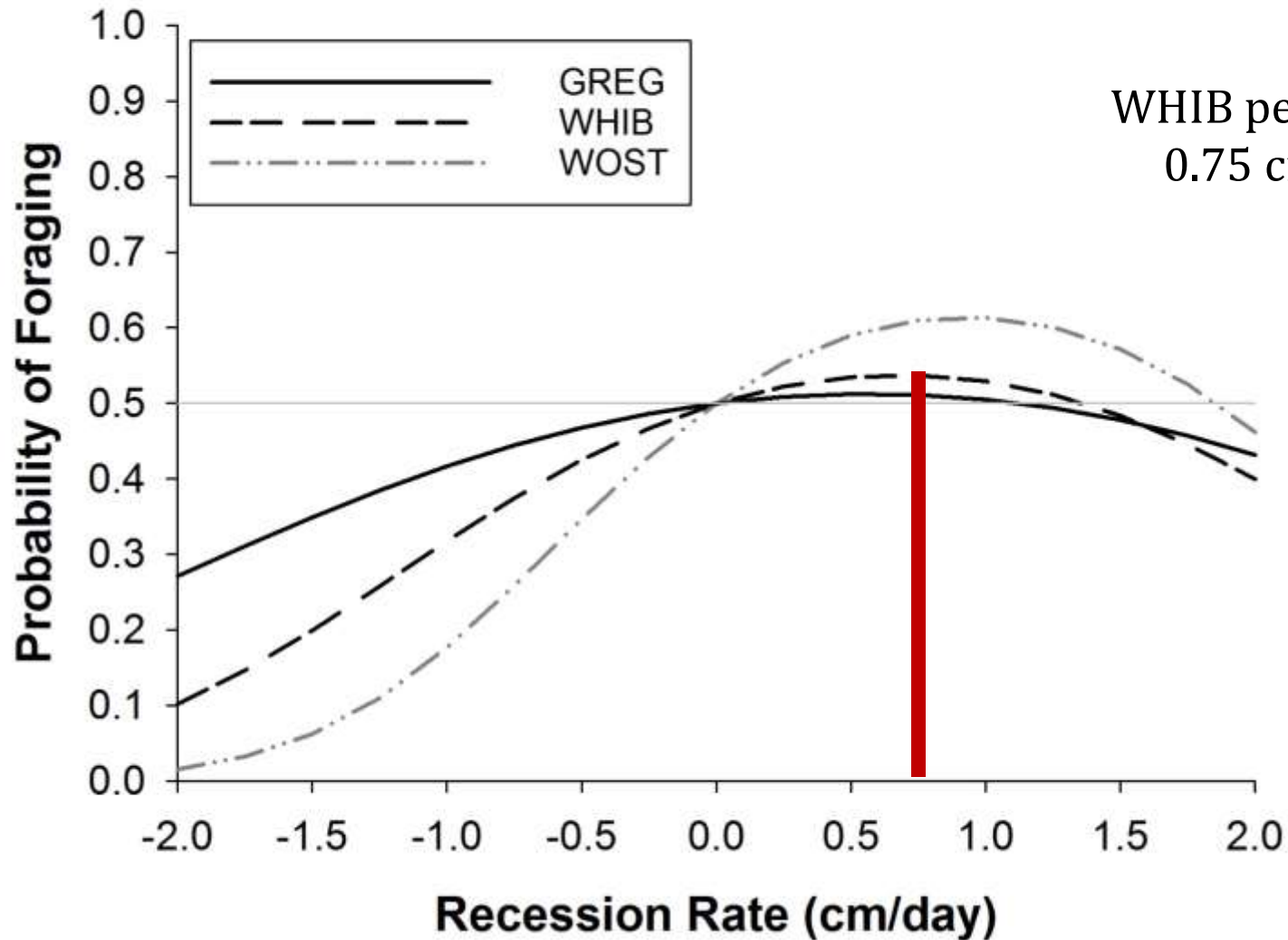


Use declines as water-levels rise

Recession Rate

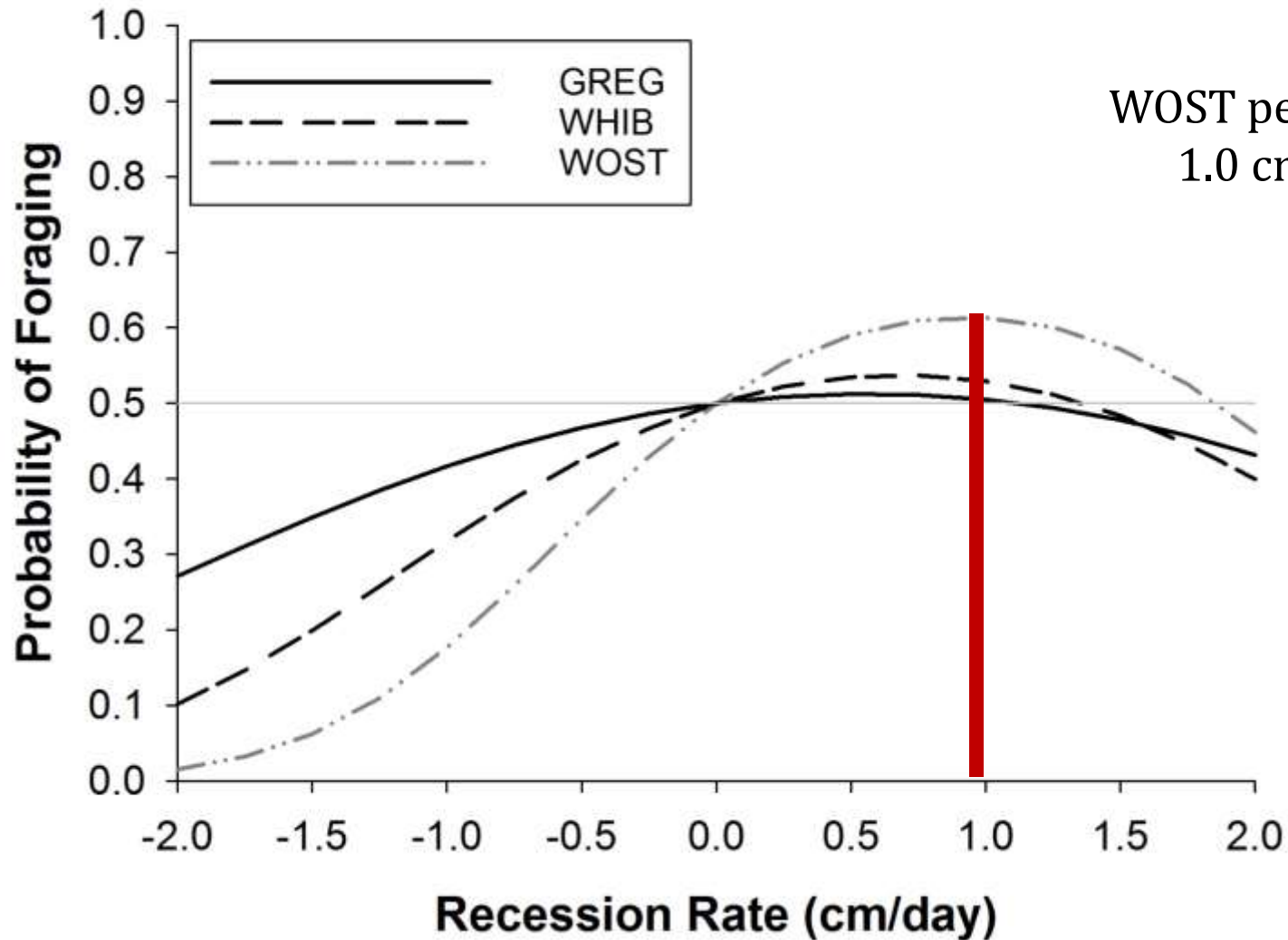


Recession Rate

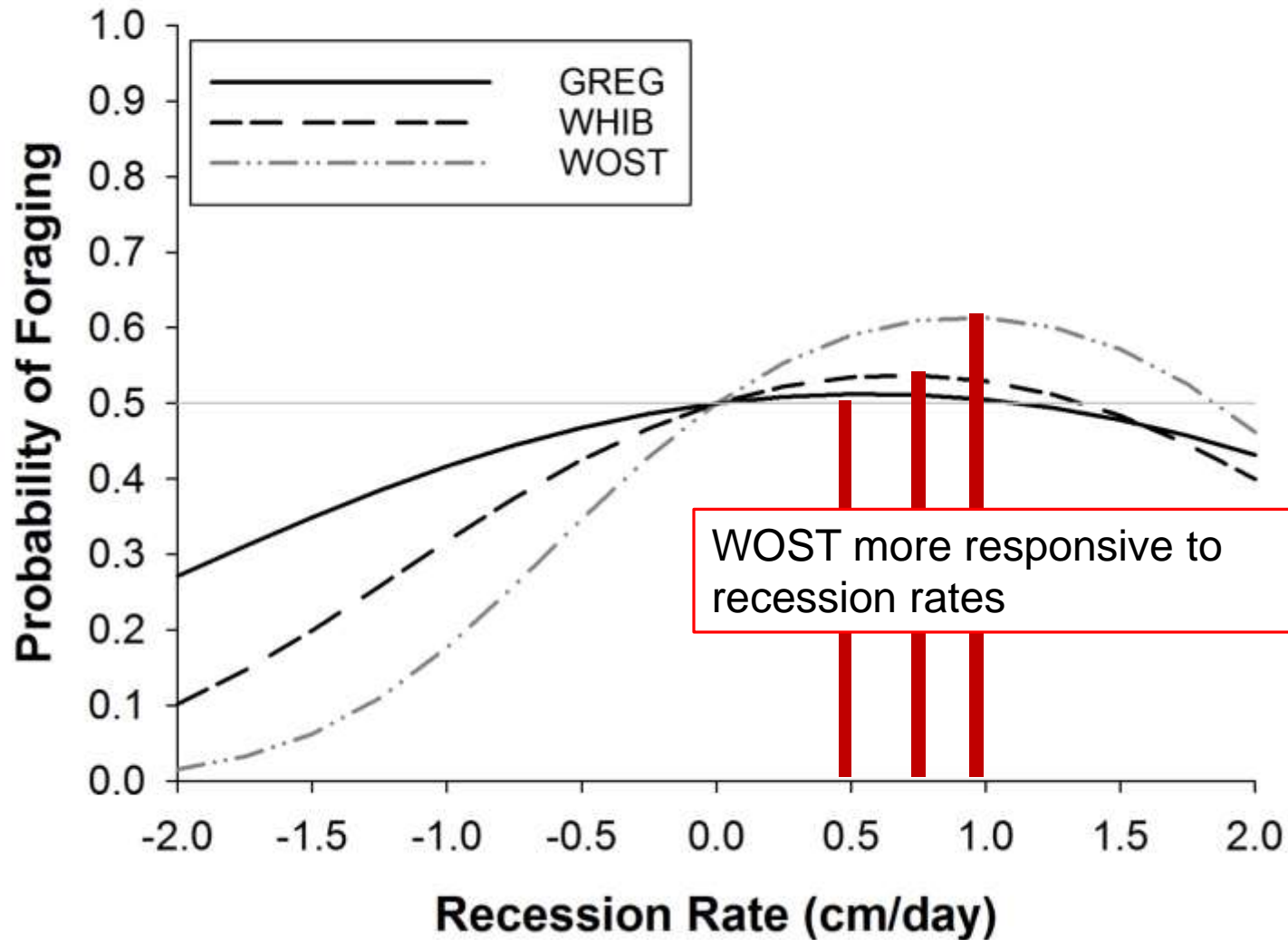


WHIB peak use at
0.75 cm/day

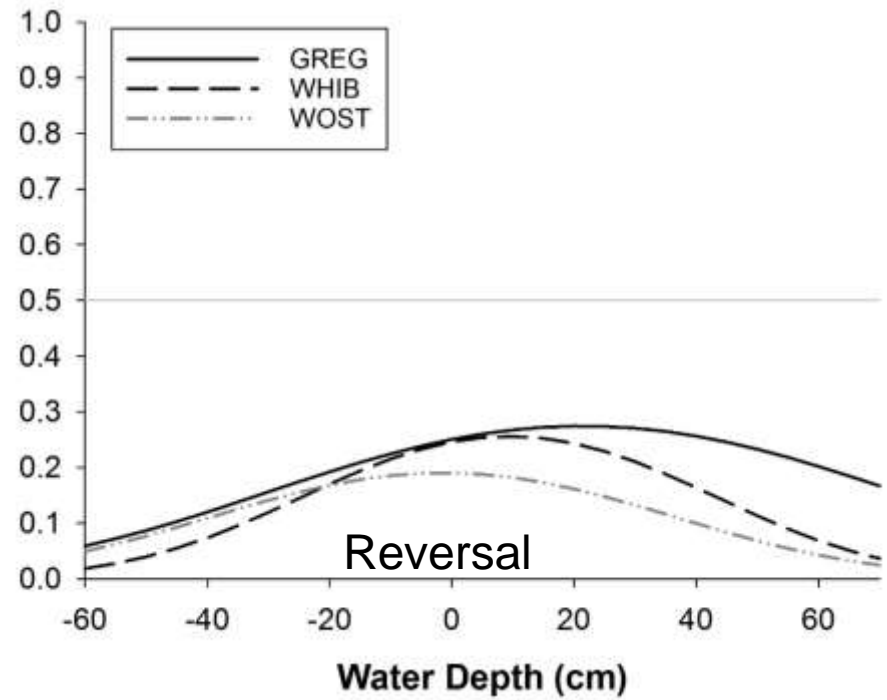
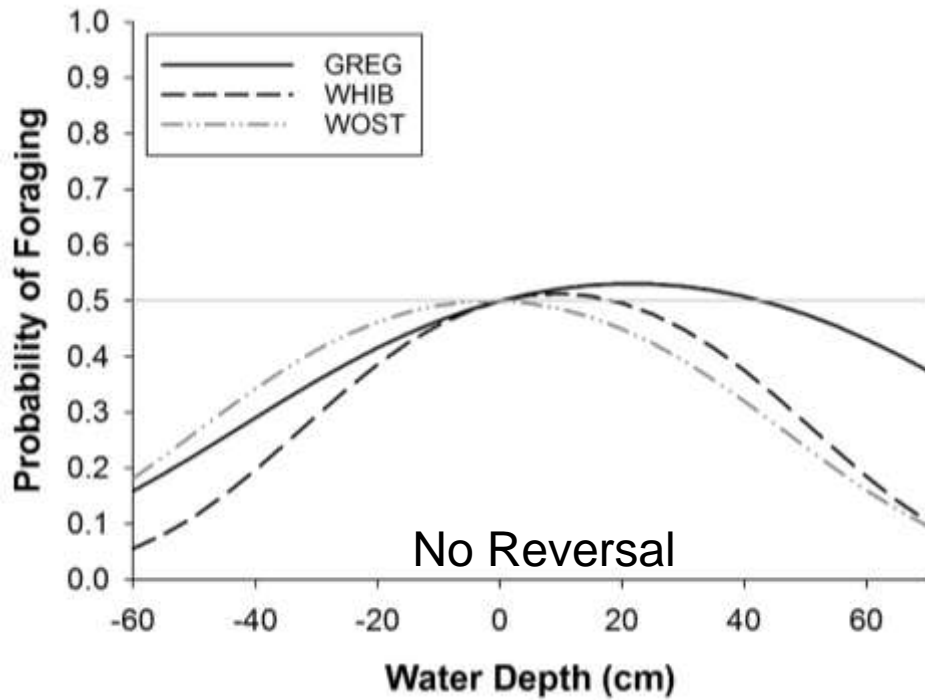
Recession Rate



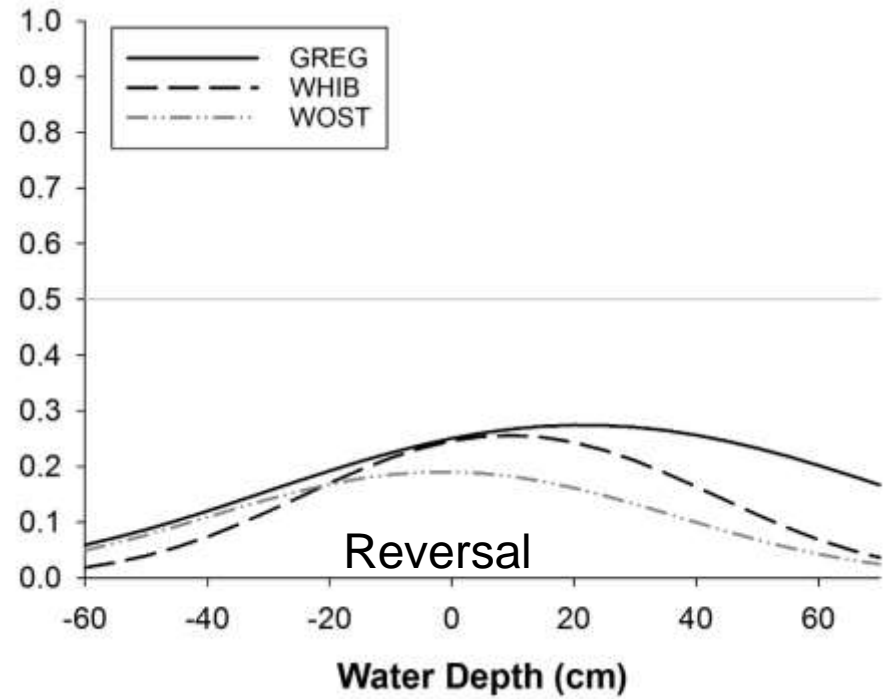
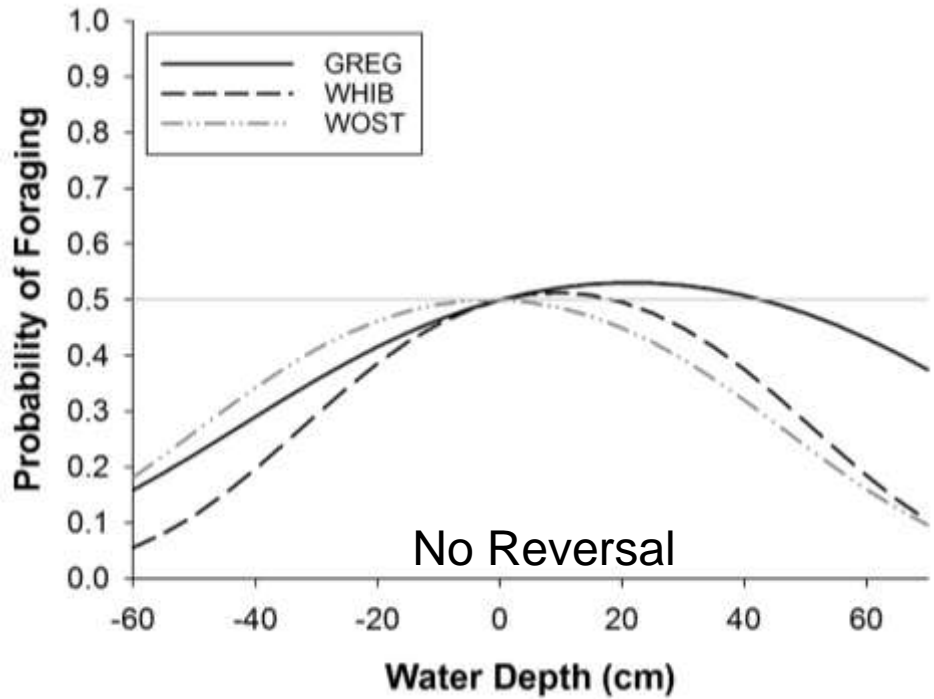
Recession Rate



Reversal



Reversal



Three times less likely to forage following 3 cm reversal

Wading Birds and Hydrology

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 - GREG - morphological adaptations (Powell 1987), broad diet (Smith 1997), physiological tolerance (Herring et al. 2010)



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- WOST highly selective foragers (Kahl 1964)
 - Foraging increases with \downarrow WD, \uparrow REC, \uparrow DSD (Beerens et al. 2015)
- 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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 - 1. Add additional habitat
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- Management for selective species will likely benefit other wading bird species



Acknowledgements

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