



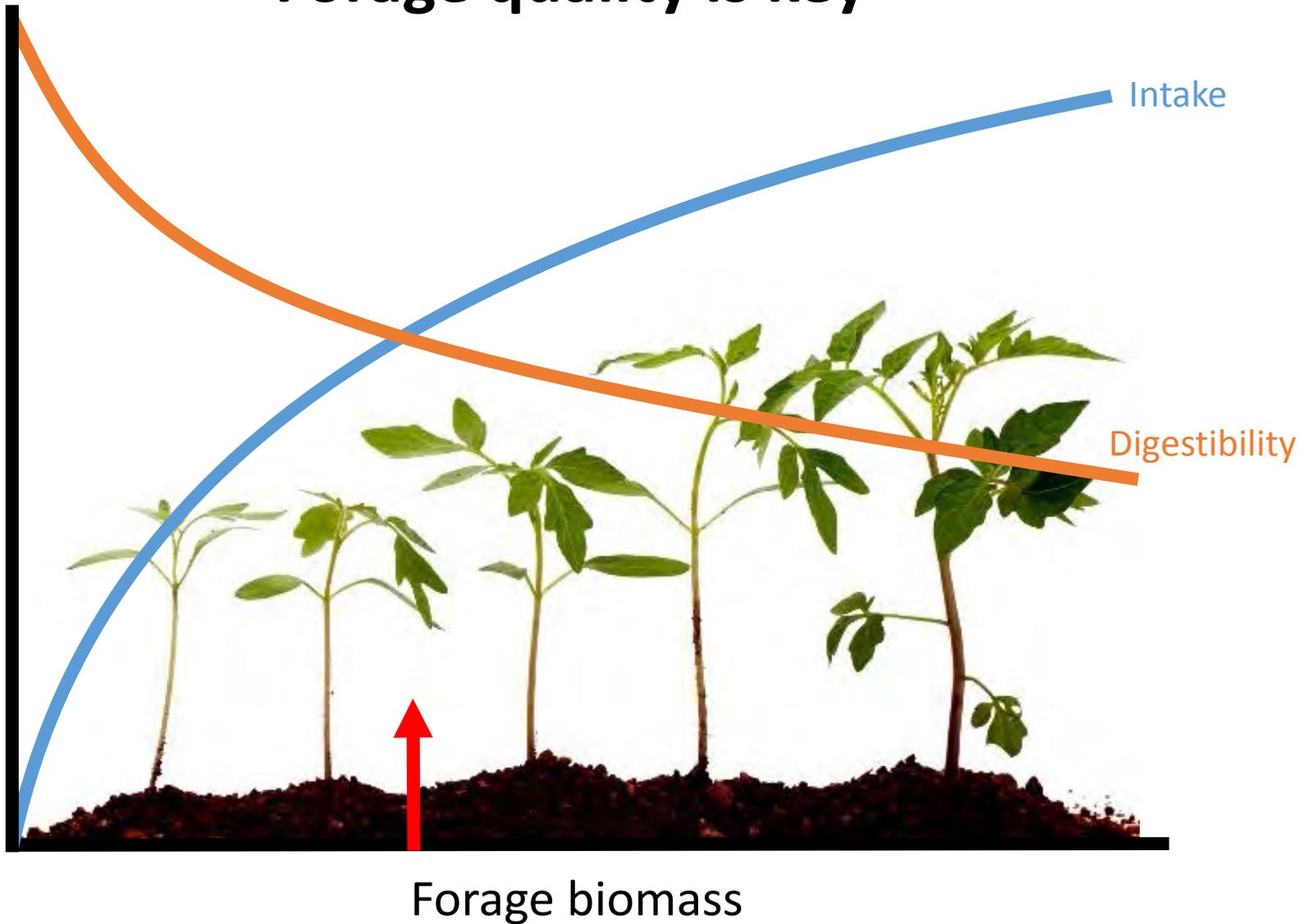
Quantifying greenscapes: spatiotemporal patterns of phenology shape green wave surfing in migratory mule deer

Ellen O. Aikens, Matthew J. Kauffman, Jerod A. Merkle, Samantha P. Dwinell, Geneva W. Chong, Gary Fralick and Kevin L. Monteith

Photo credit: Joe Riis



Forage quality is key



Fitness benefits of migration

Topographic Diversity

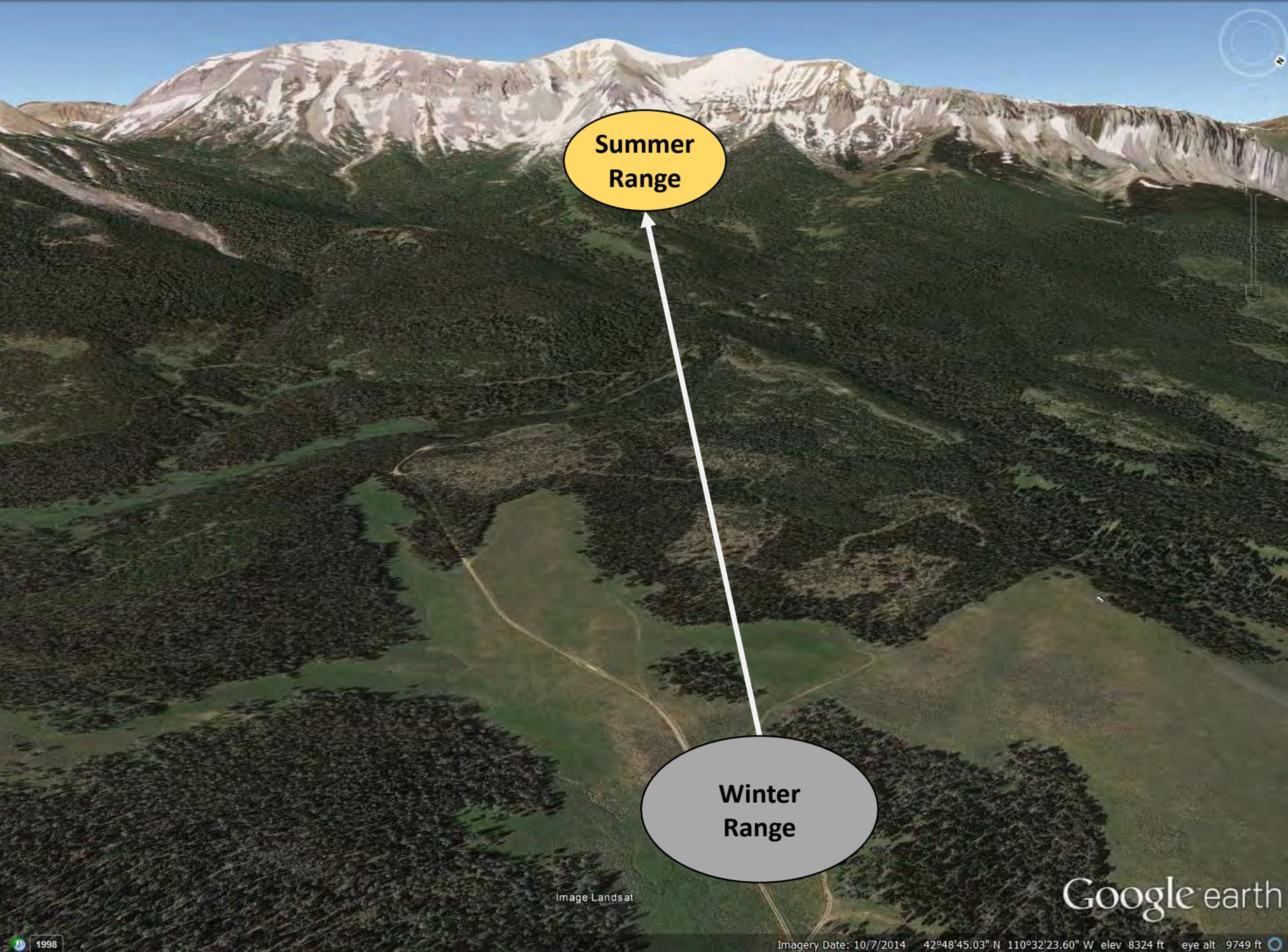
Albon and Langvatn 1992, Mysterud et al. 2001



Resident vs Migratory

Hebblewhite et al. 2008



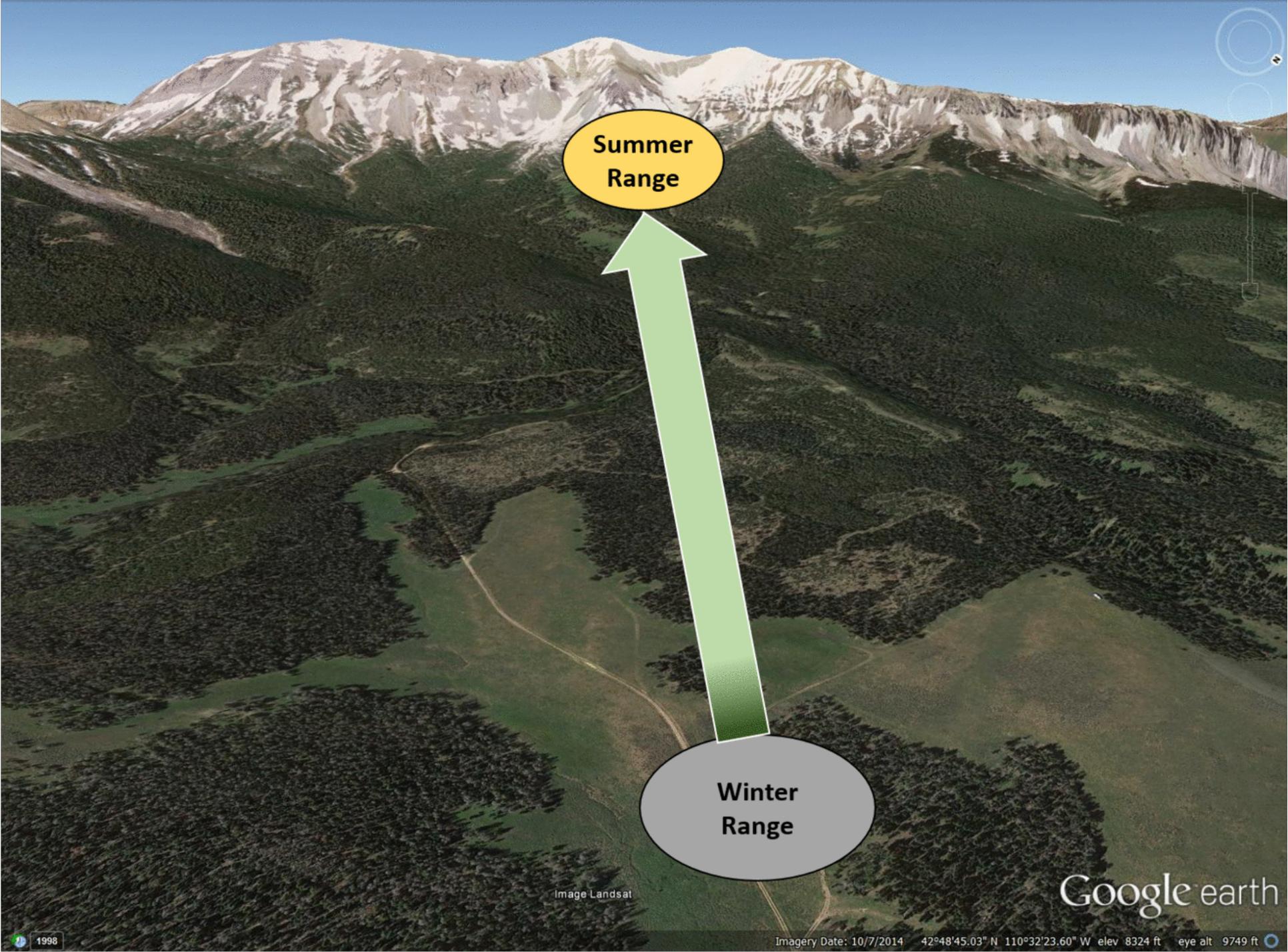


**Summer
Range**

**Winter
Range**

Image Landsat

Google earth



Summer Range

Winter Range

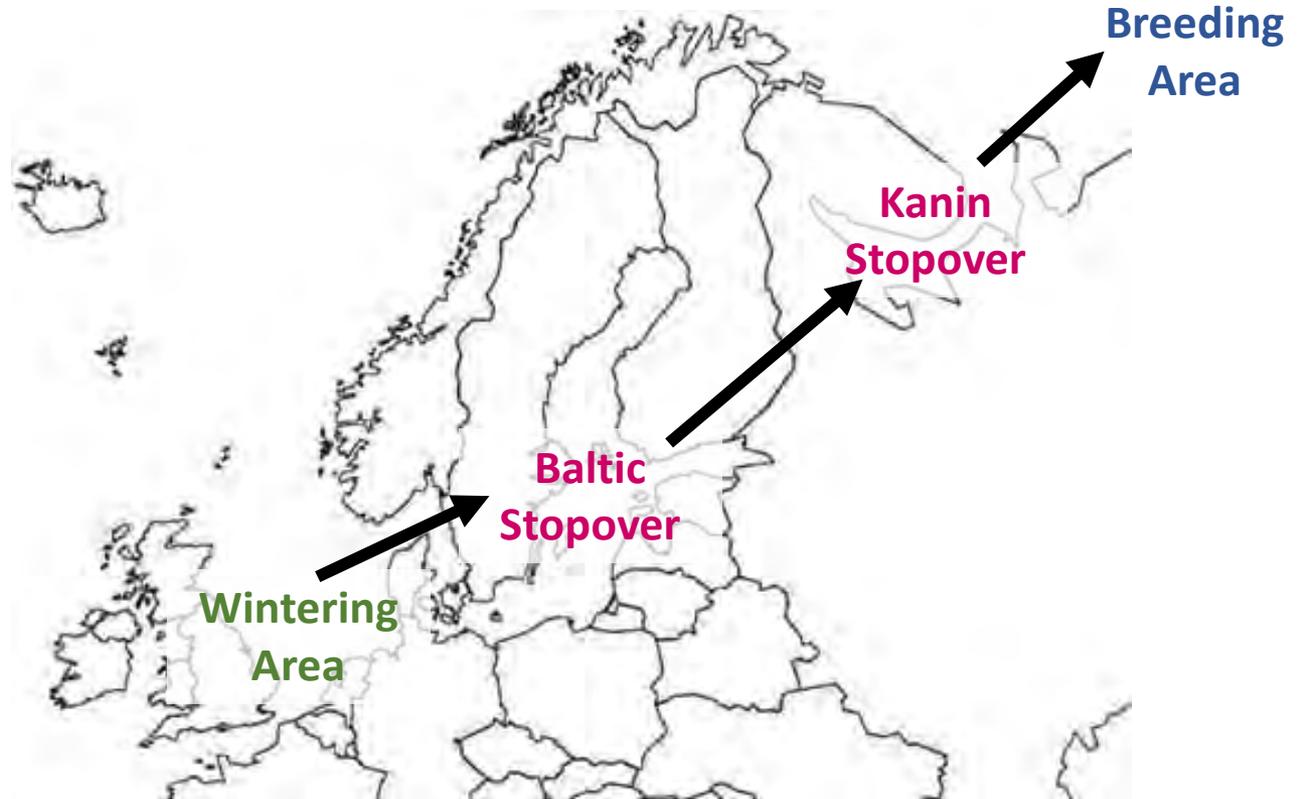
Image Landsat

Google earth

1998

Imagery Date: 10/7/2014 42°48'45.03" N 110°32'23.60" W elev 8324 ft eye alt 9749 ft

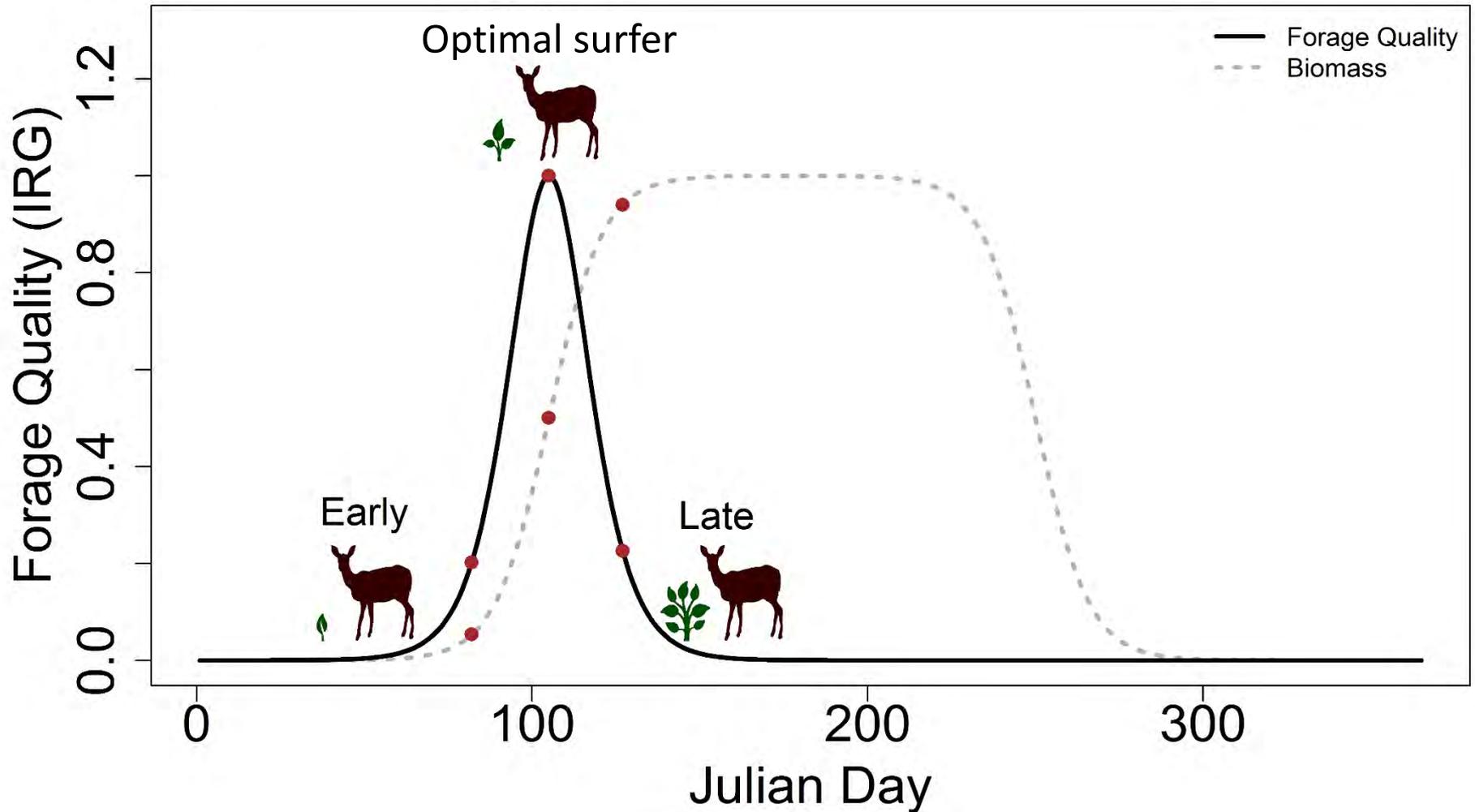
The Green Wave Hypothesis



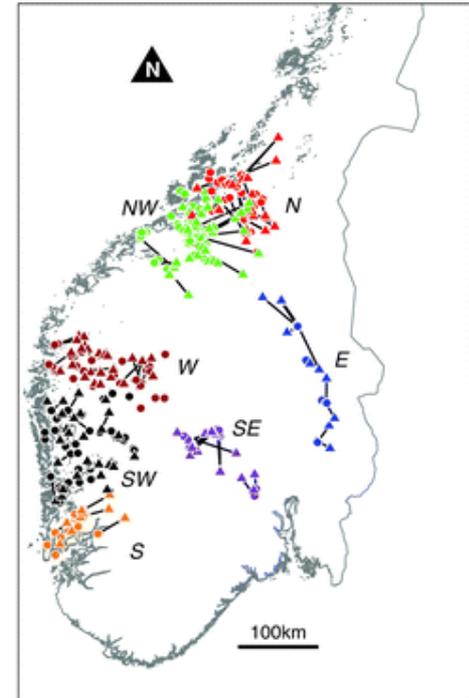
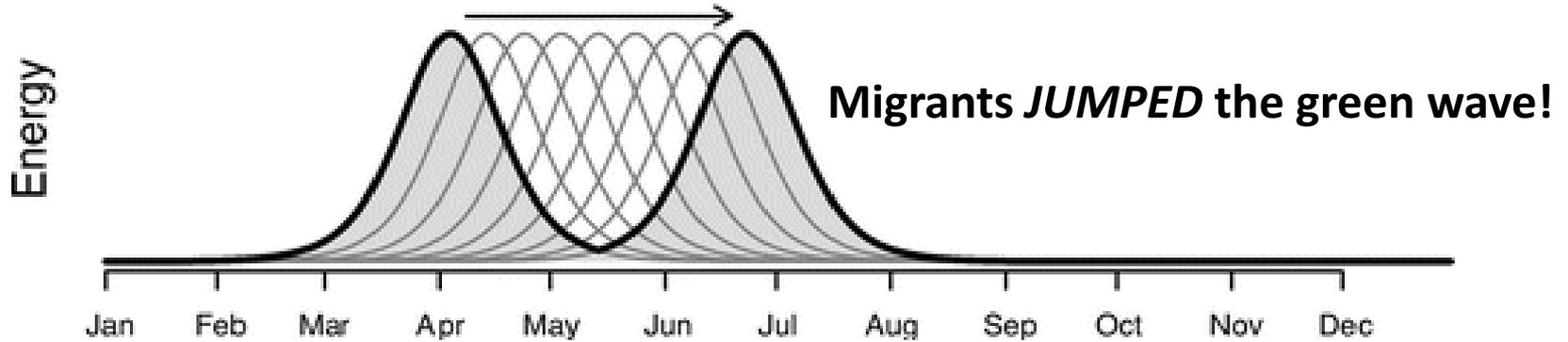
Drent et al. 1978,
Owen 1980,
Van der Graaf et al. 2006

Quantifying the green wave

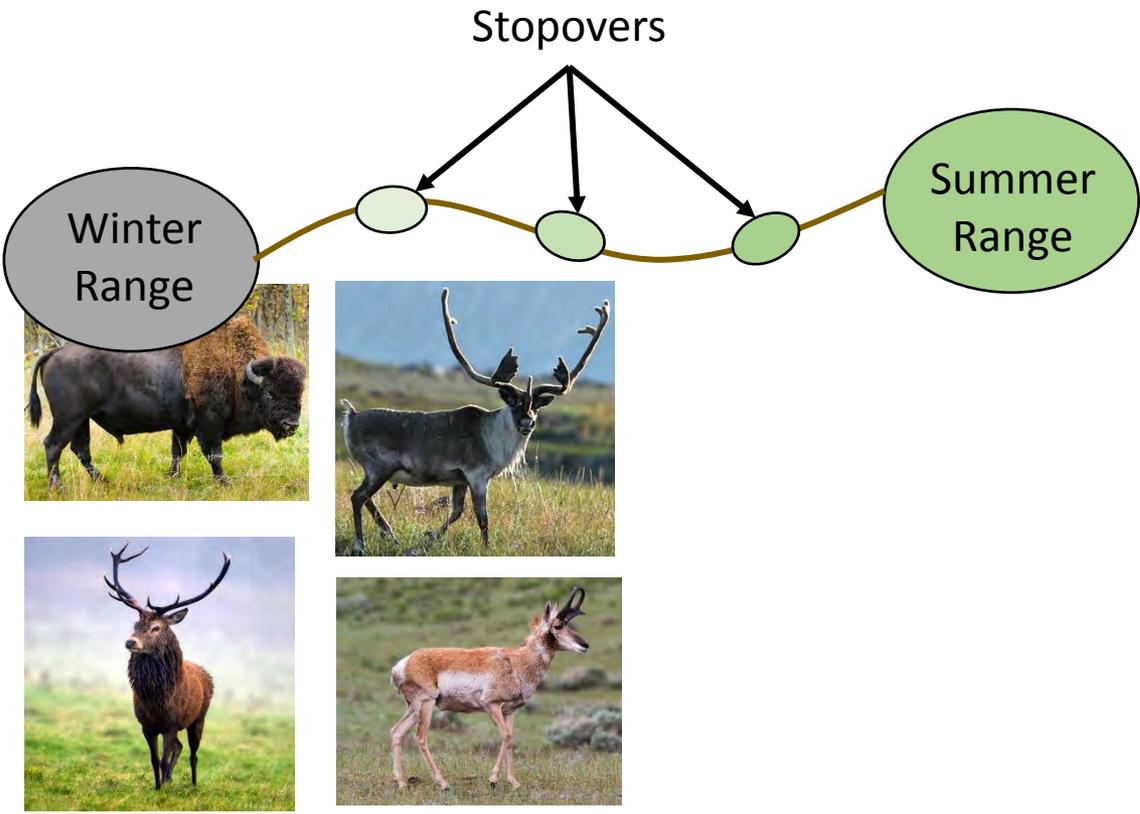
Intergenerational Biomass - Range of Quality forage



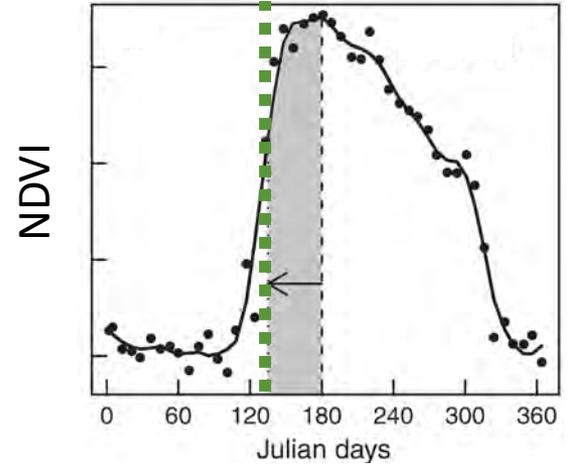
Testing the green wave hypothesis: red deer



Does green wave surfing occur across a spectrum?



Stopover use in Mule deer



?

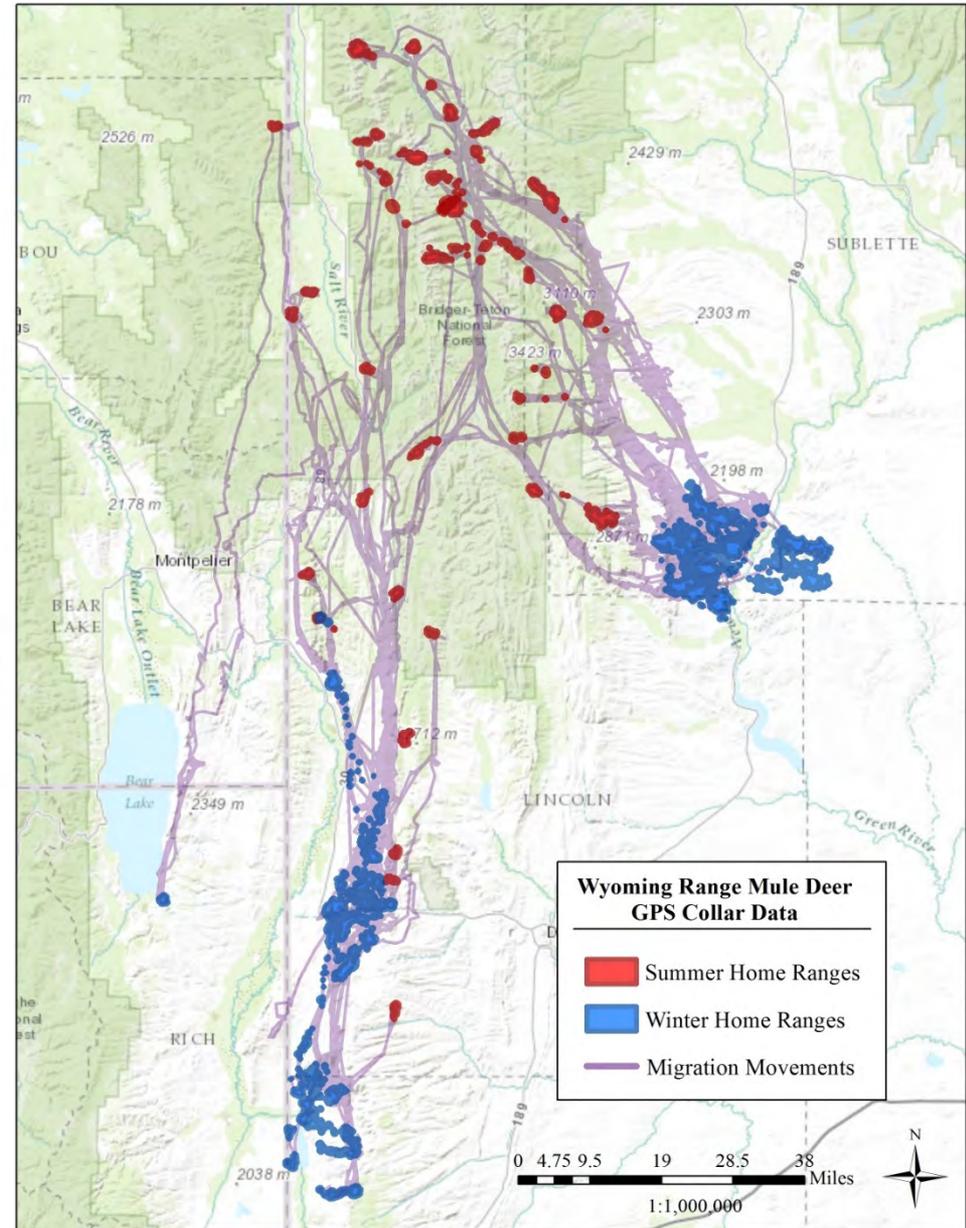
Jumpers

Surfers

Bischof et al. 2012

Sawyer and Kauffman 2011

Testing the green wave hypothesis: mule deer



Elevational gradient = gradient in plant green-up

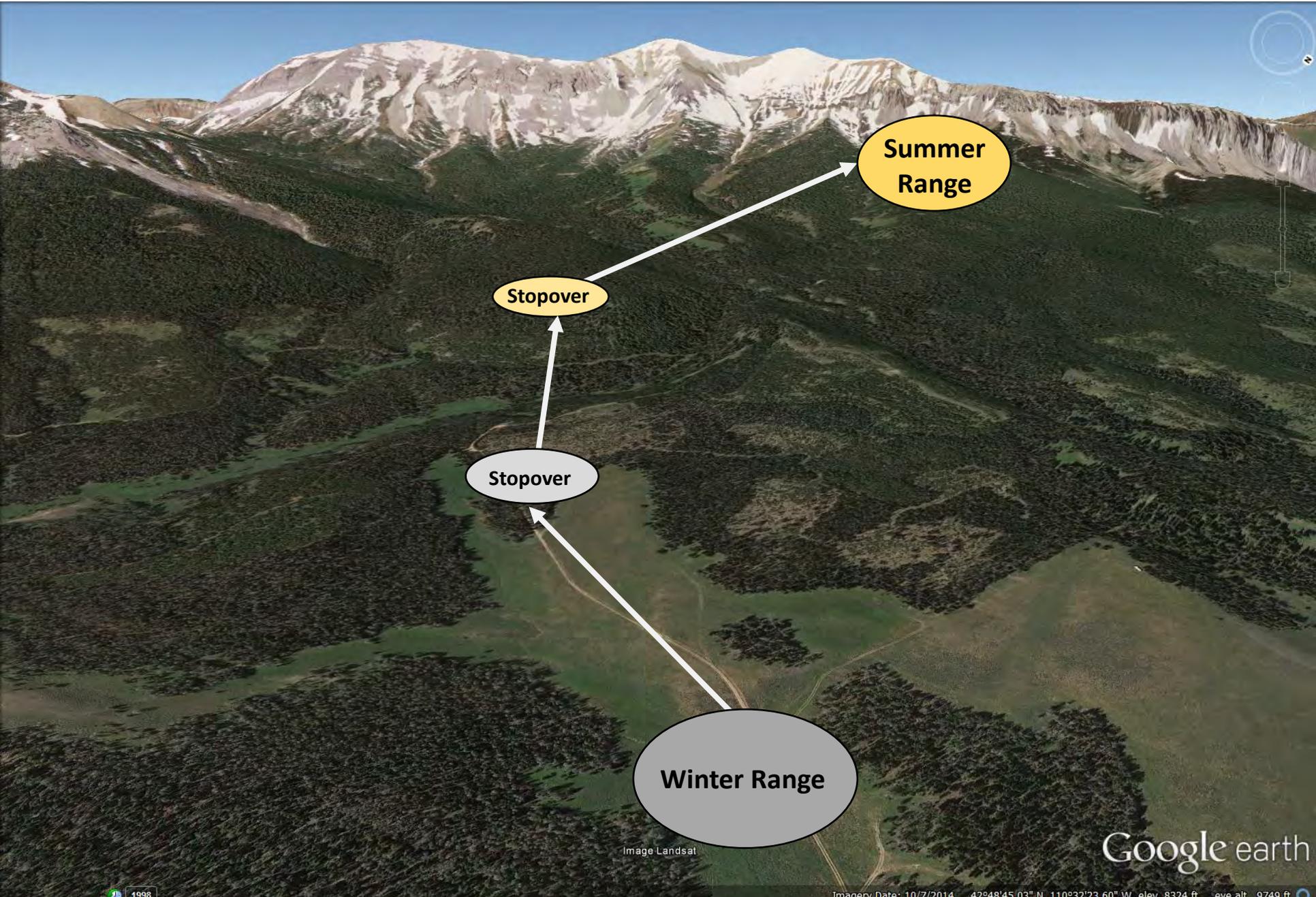
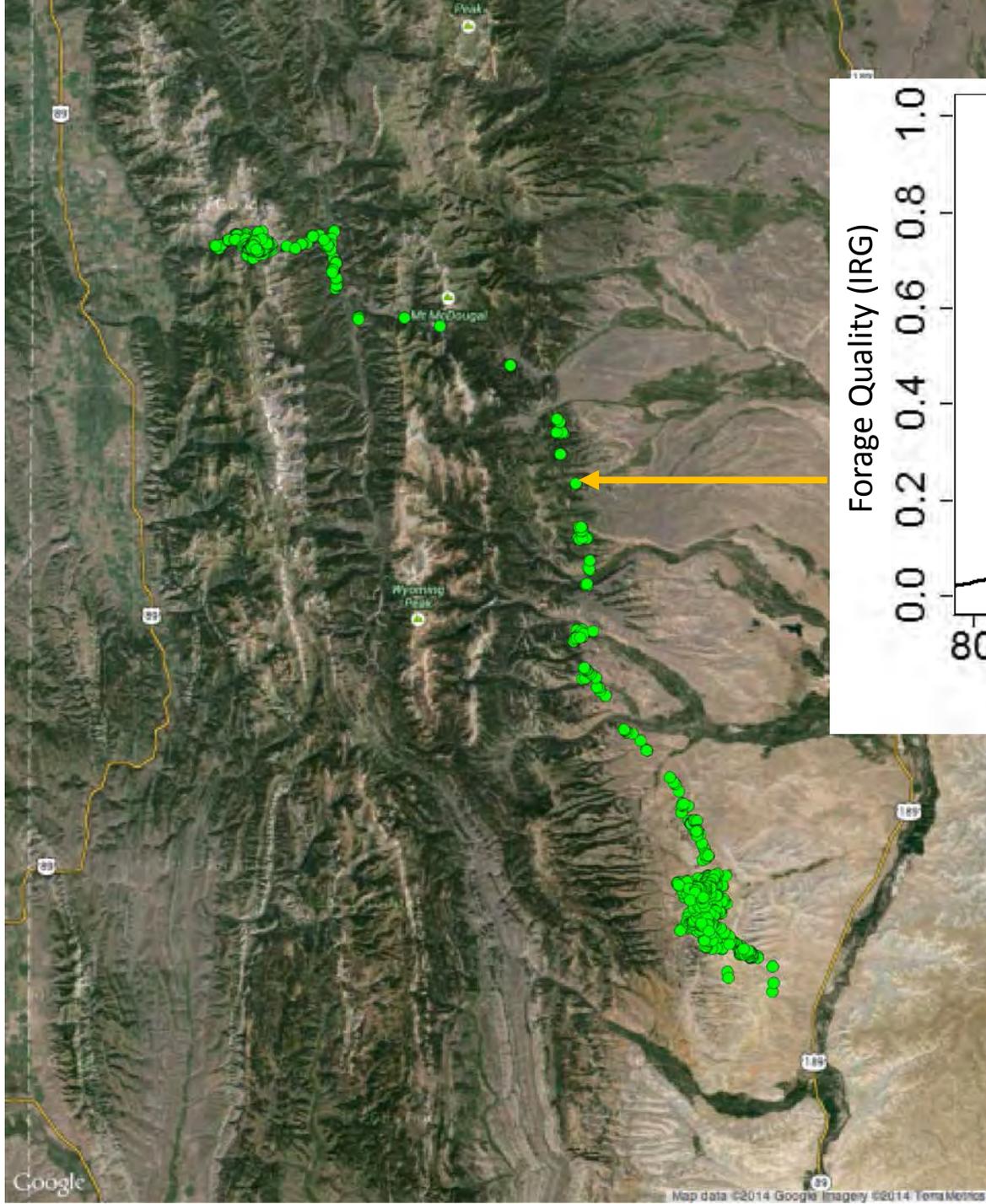


Image Landsat

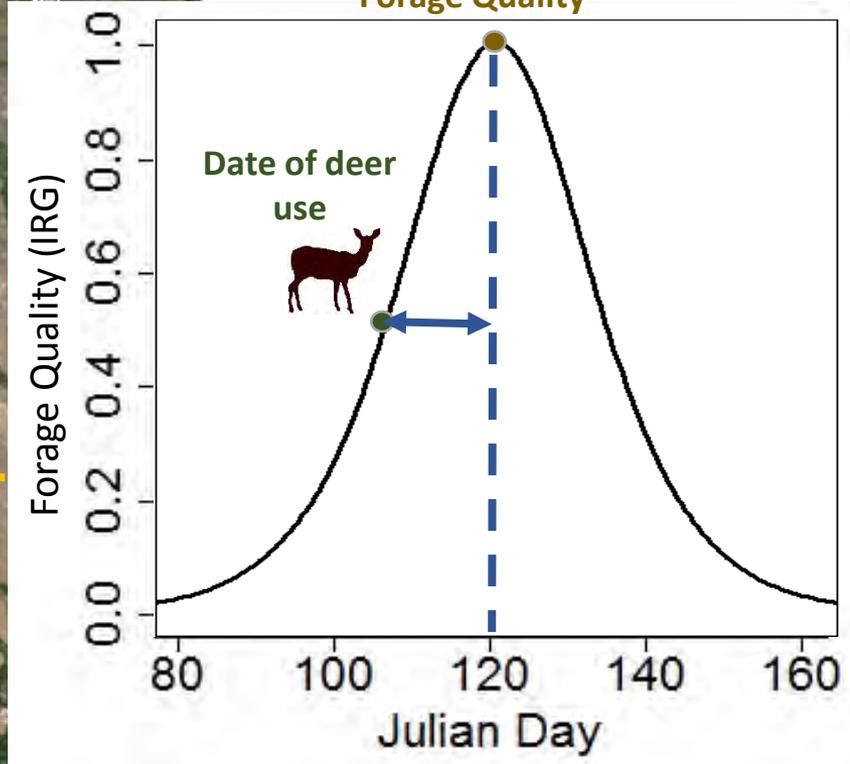
Google earth

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1998

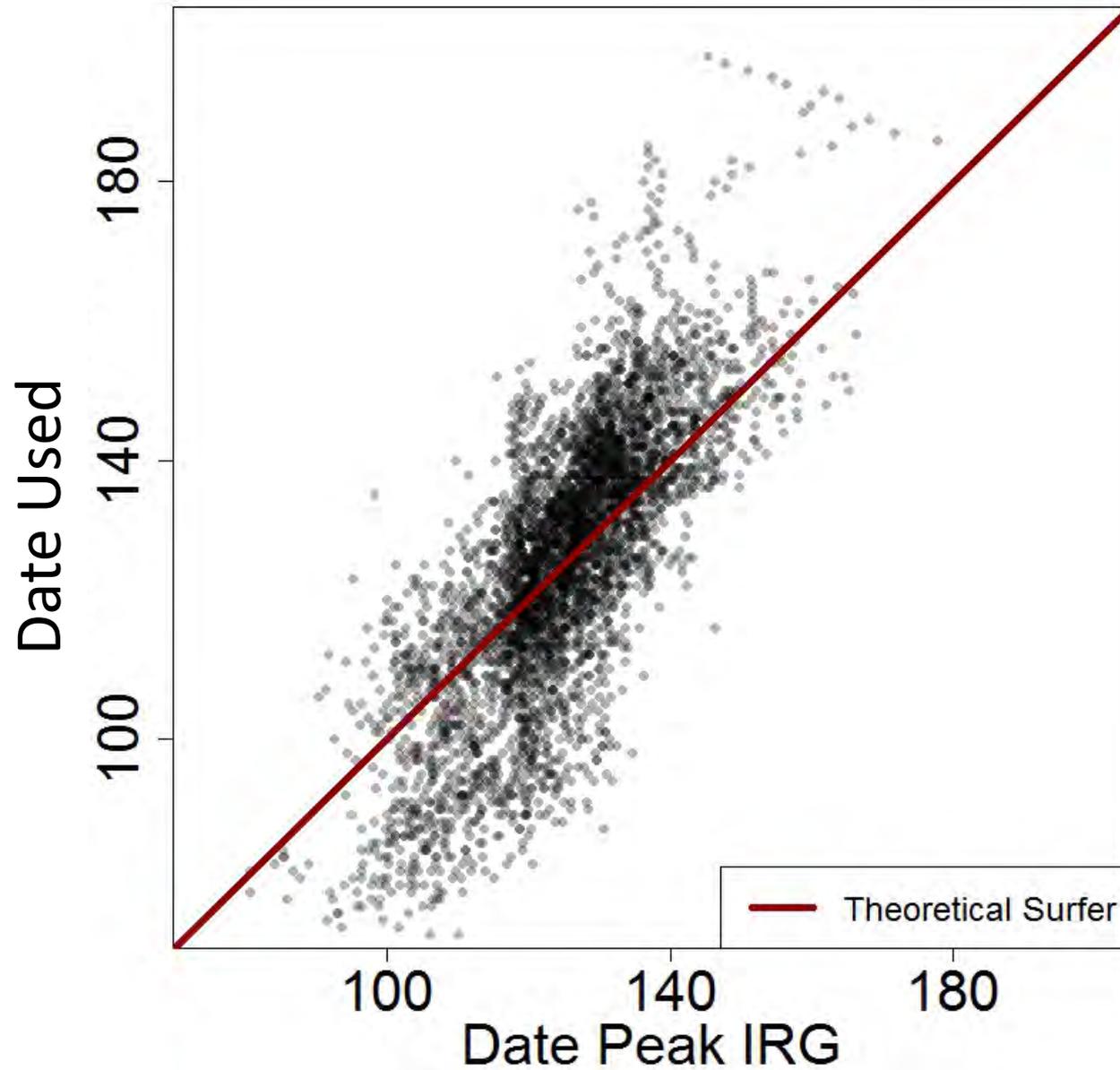


Date of Peak Forage Quality



Days from peak IRG
0 = surfing

Mule deer surf the green wave



Green wave surfing occurs across a spectrum

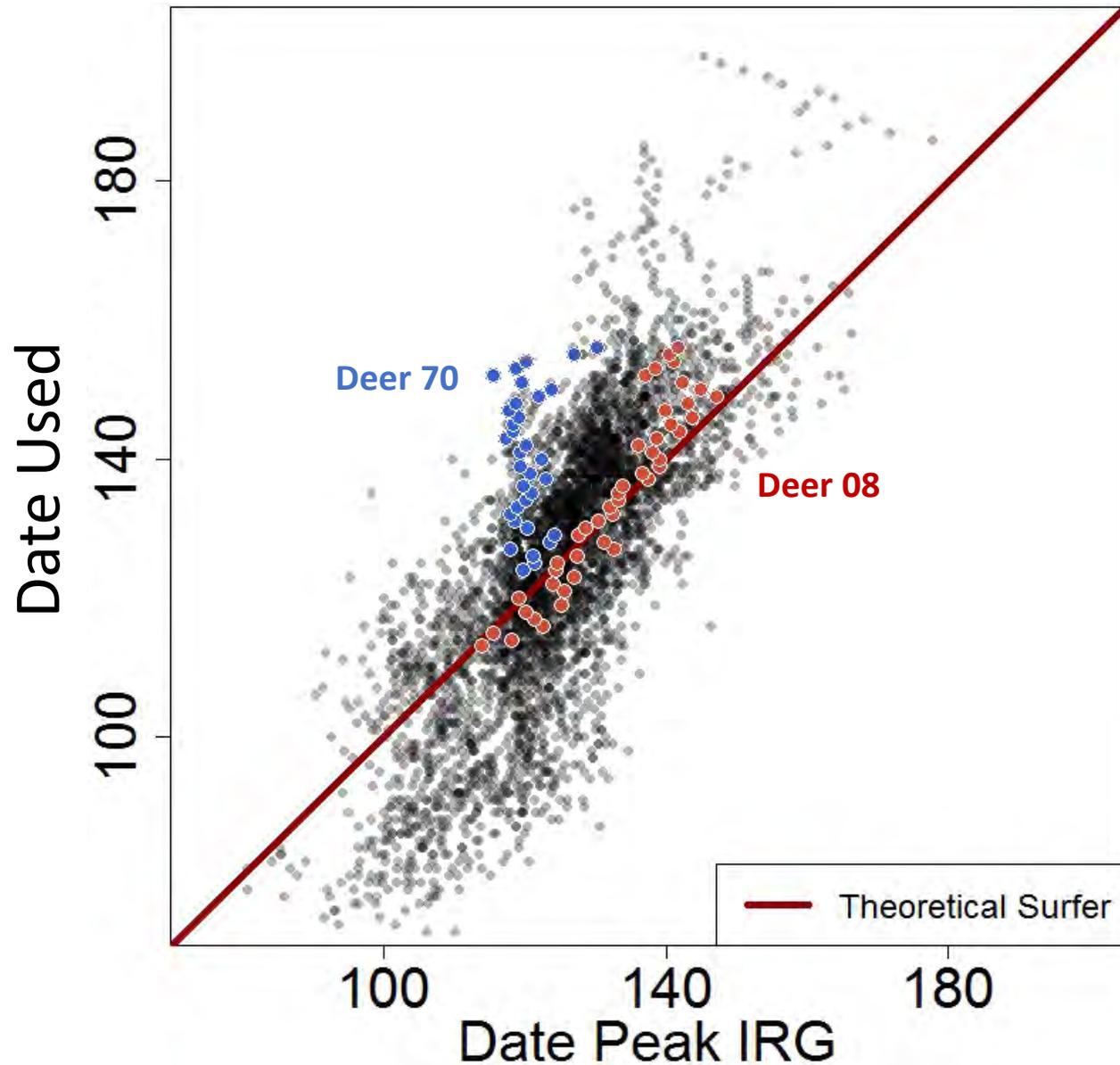


Jumpers



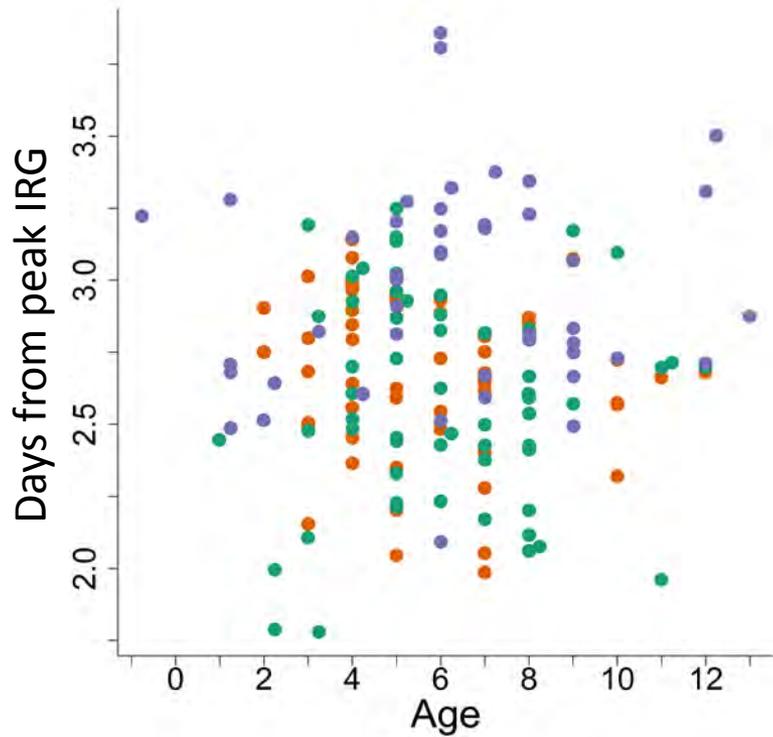
Surfers

Mule deer surf the green wave...but there is variability

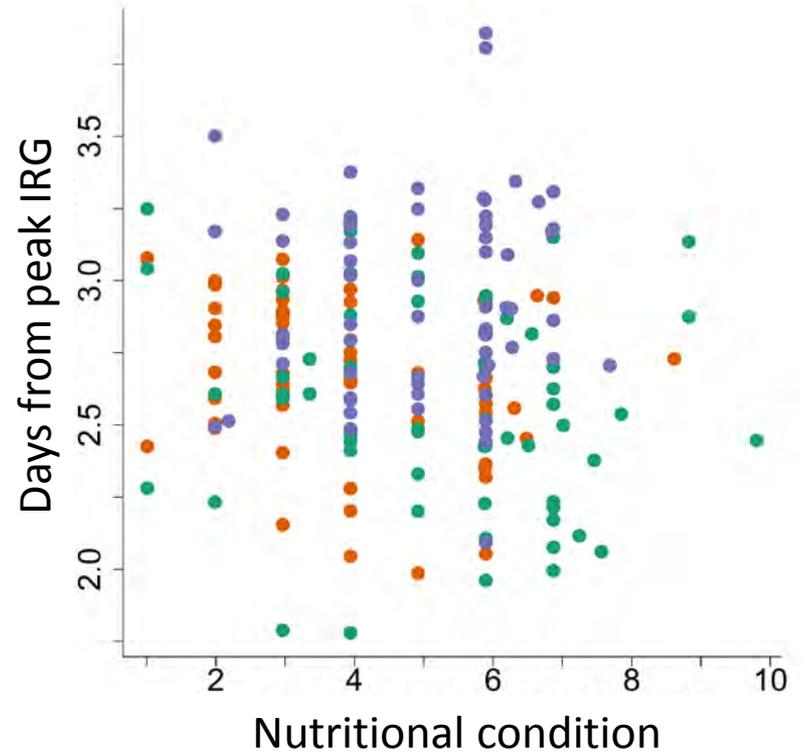


Learning hypothesis

The Learning hypothesis



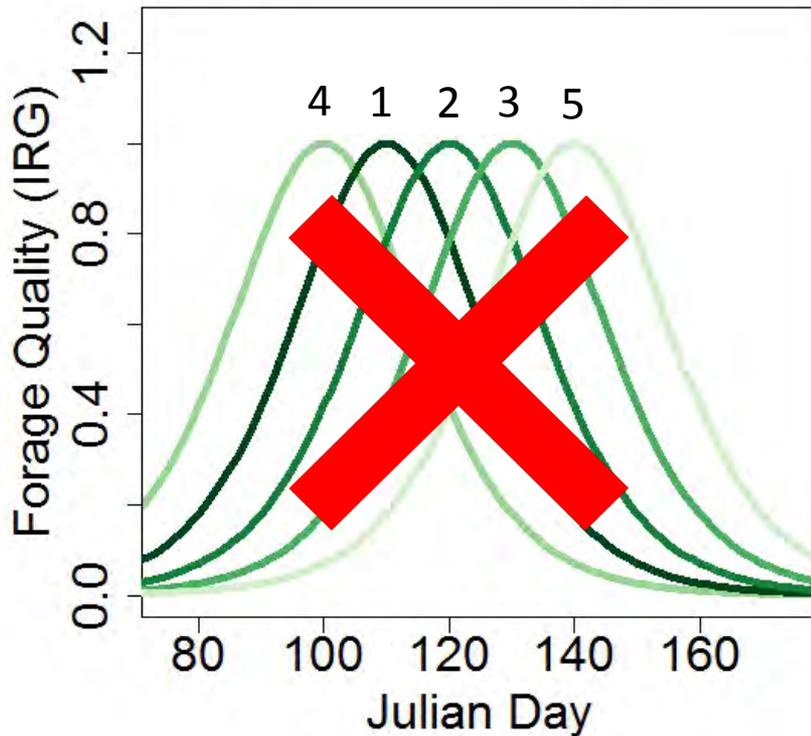
State-dependent hypothesis



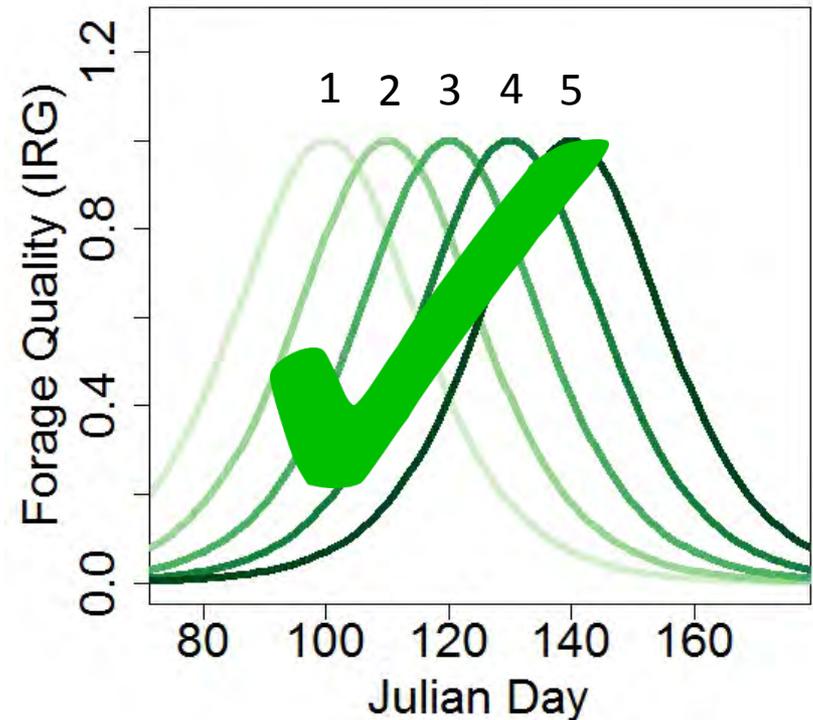
The greenscape hypothesis

- **Duration** of green-up
- **Order** of green up

Non-consecutive Green-up



Consecutive Green-up

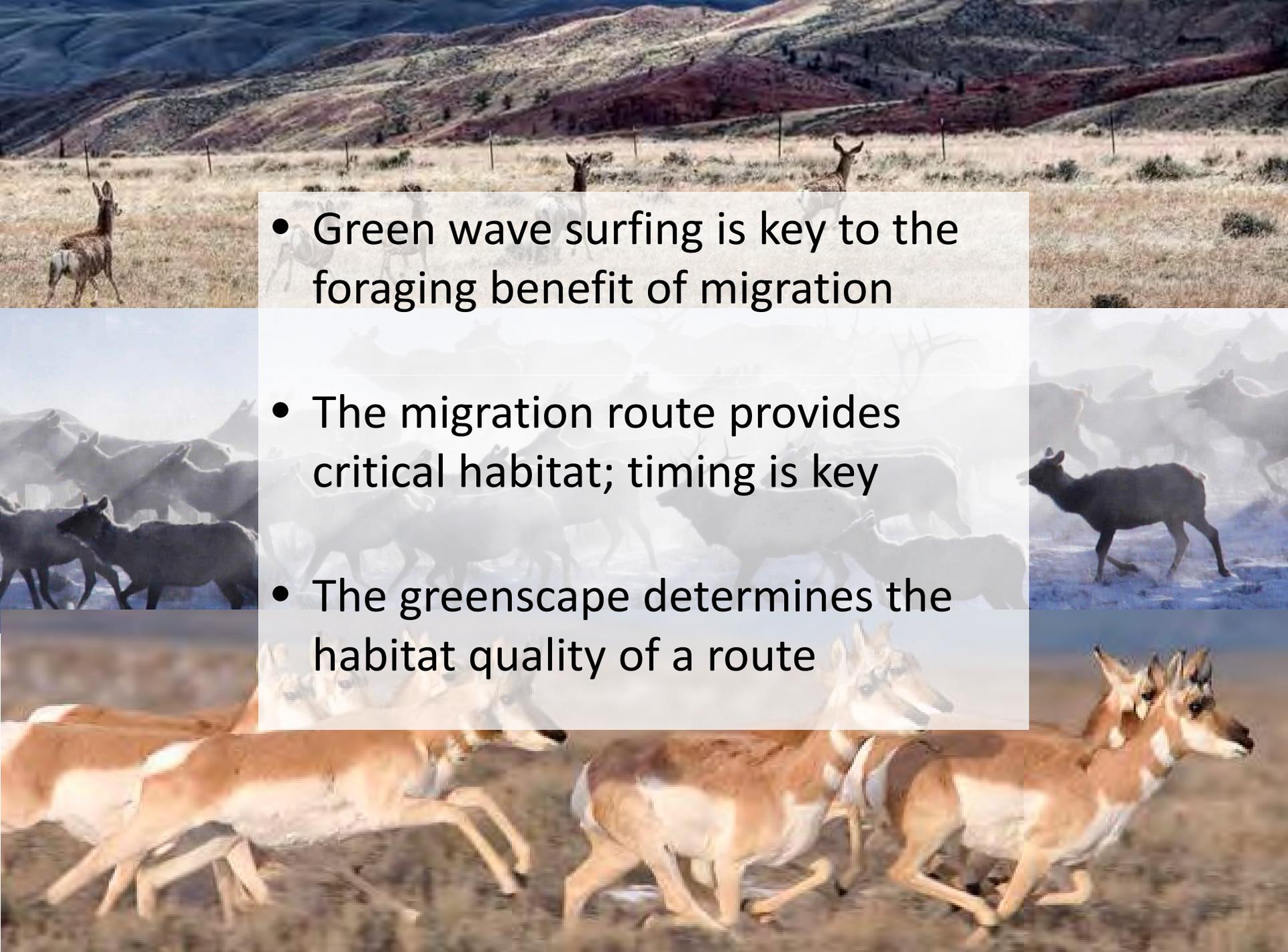




The Greenscape

Poor Surfer

Good Surfer



- Green wave surfing is key to the foraging benefit of migration
- The migration route provides critical habitat; timing is key
- The greenscape determines the habitat quality of a route

Acknowledgments



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Kaylan Hubbard

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Bowhunters of Wyoming
Wyoming Wildlife and Natural Resource Trust

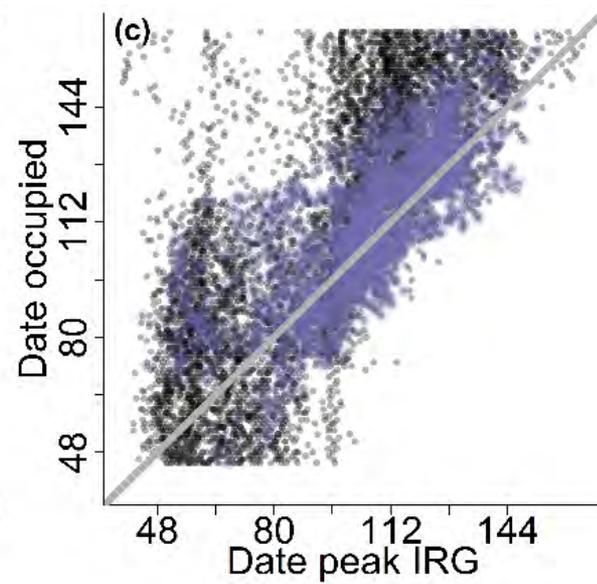
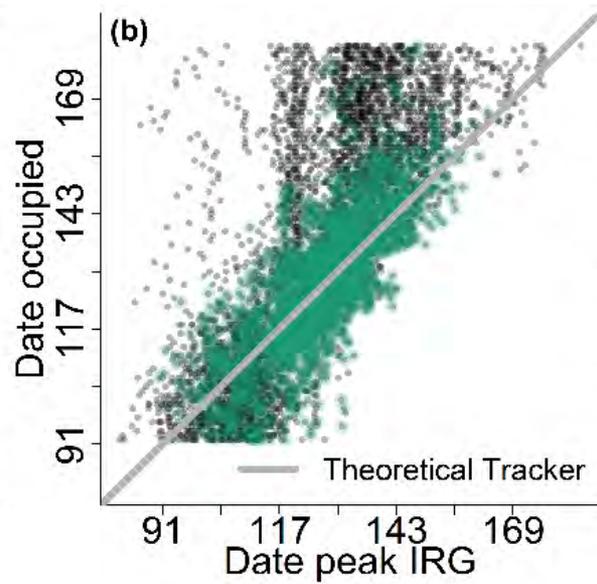
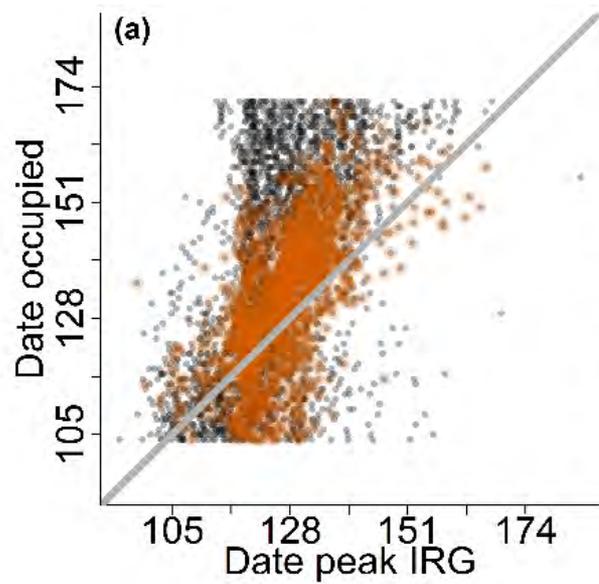
Knobloch Family Foundation
Boone and Crockett Club
Wyoming Outfitters and Guides Association
US Bureau of Land Management
Wyoming Animal Damage Management Board

Questions?

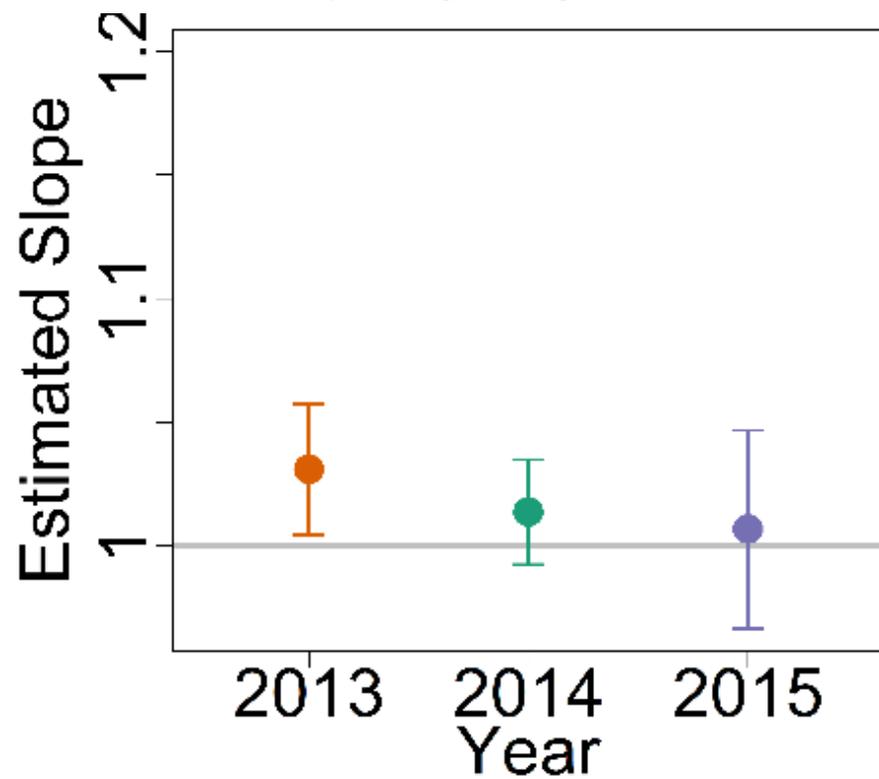


Contact information

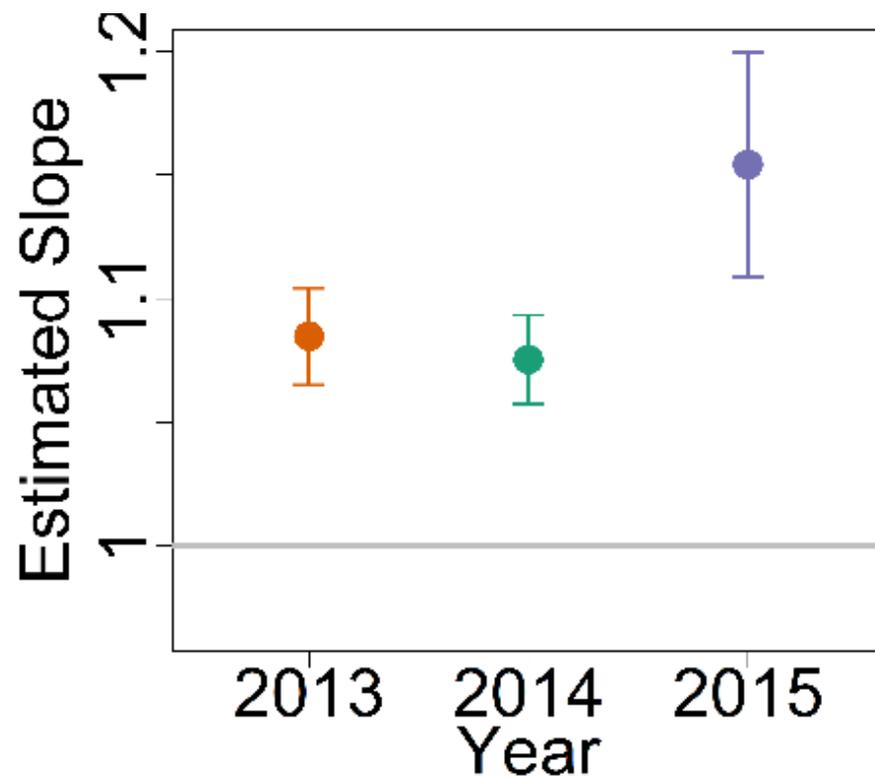
Ellen Aikens – eaikens@uwyo.edu



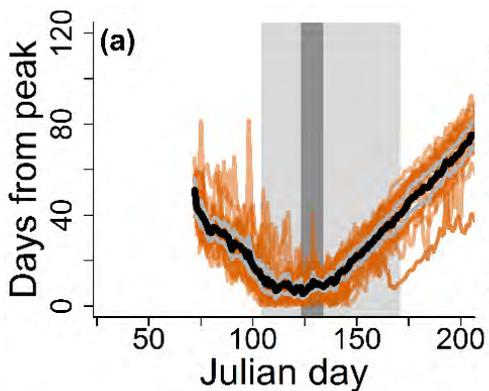
Spring Migration



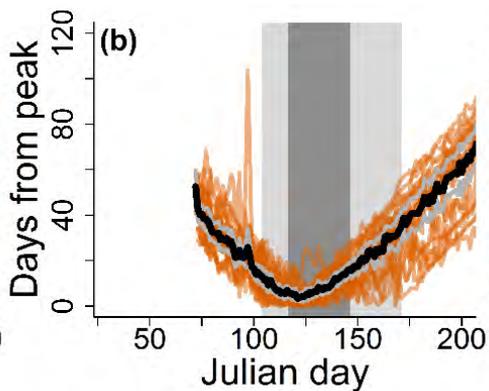
Growing Season



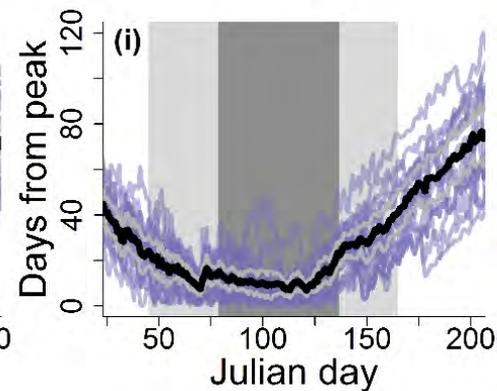
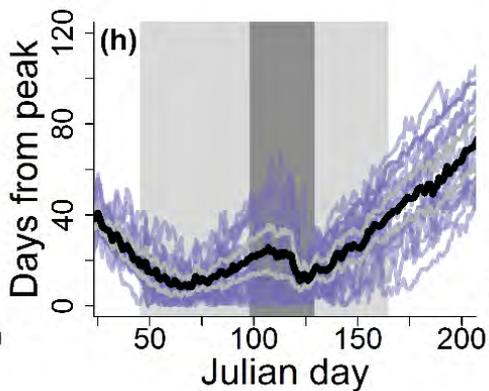
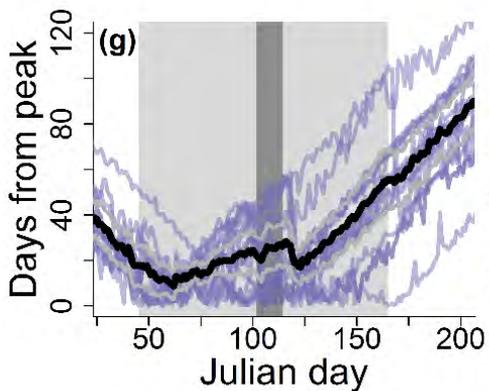
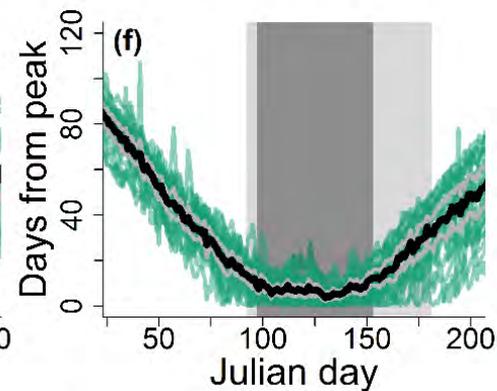
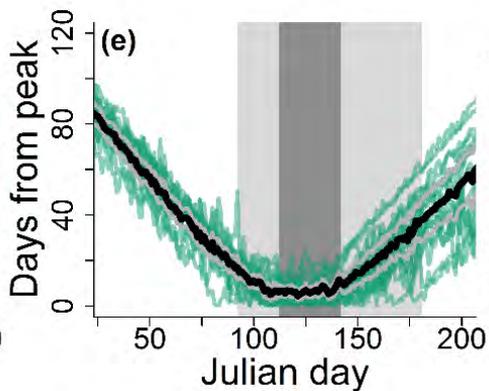
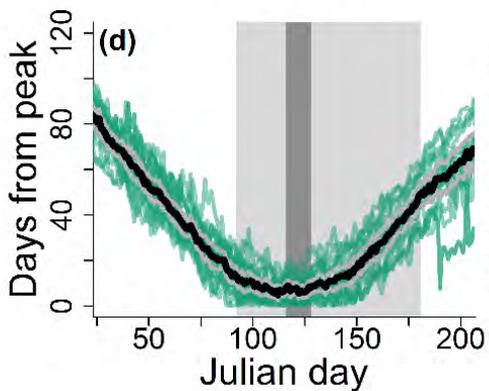
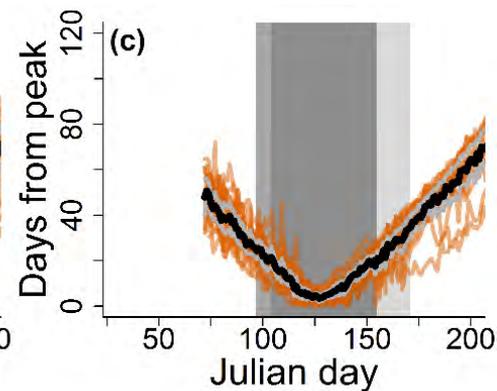
Short Duration



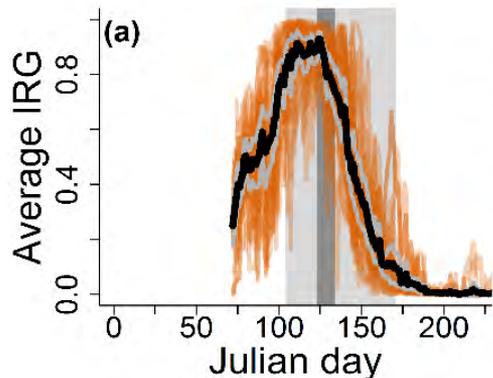
Mid Duration



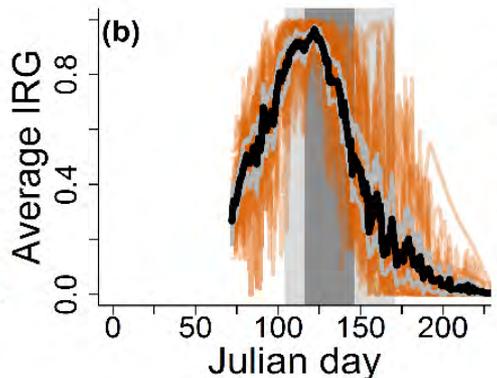
Long Duration



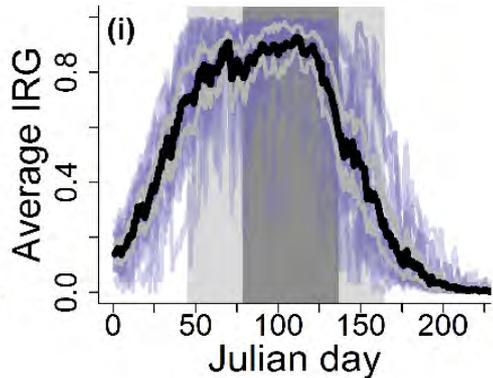
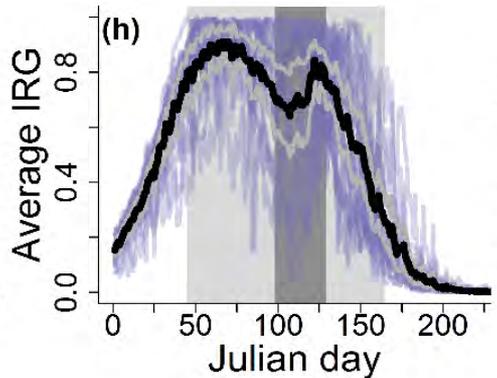
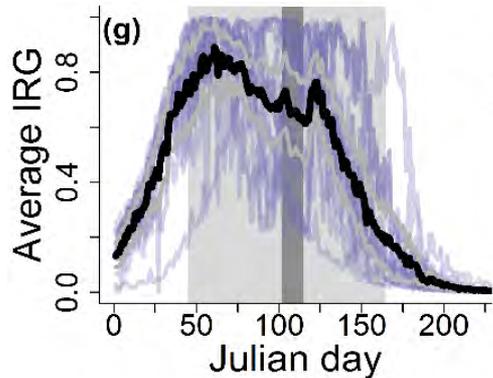
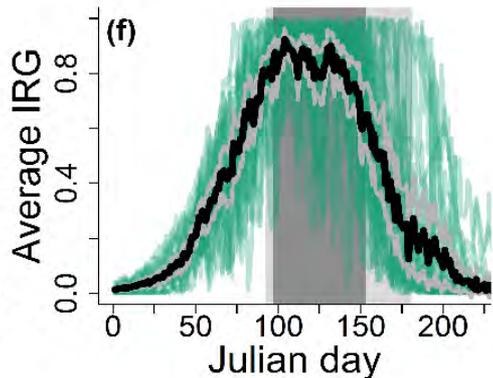
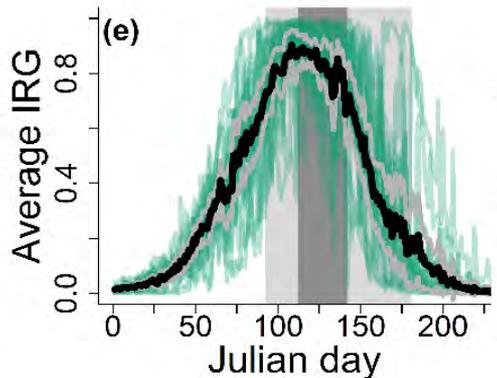
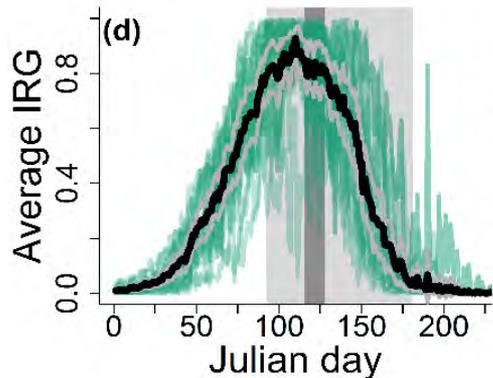
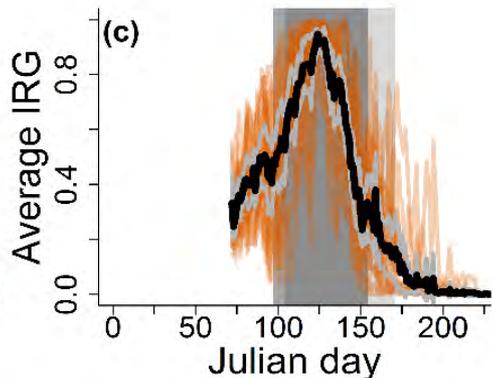
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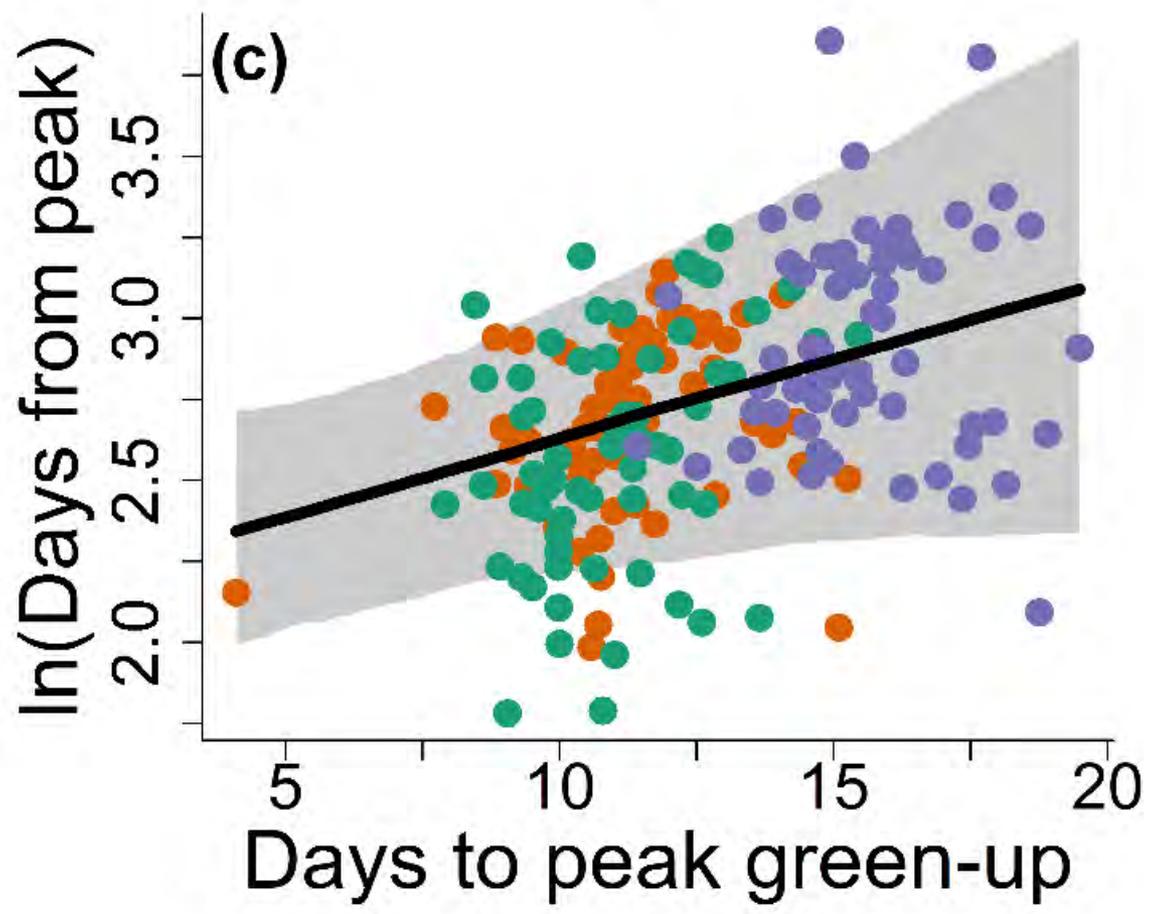


Mid Duration

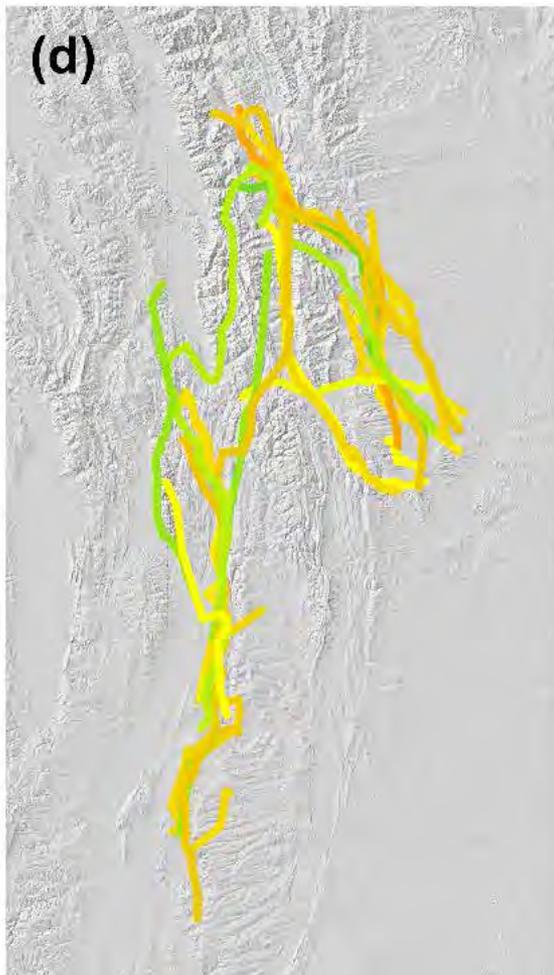


Long Duration

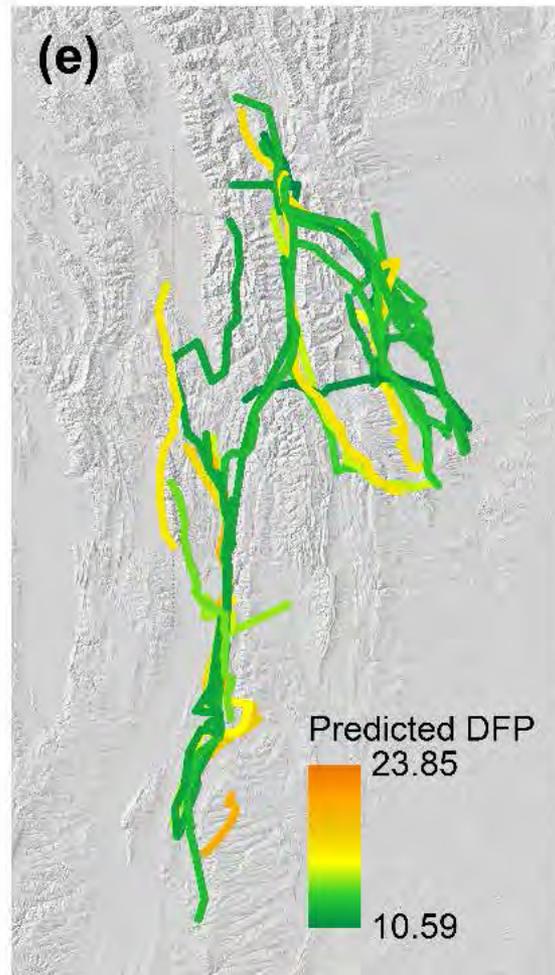




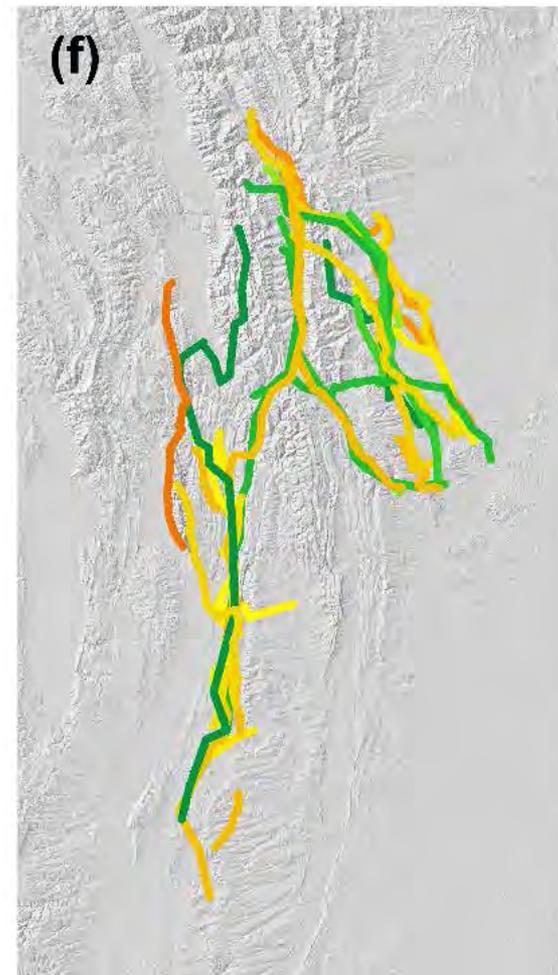
Dry year

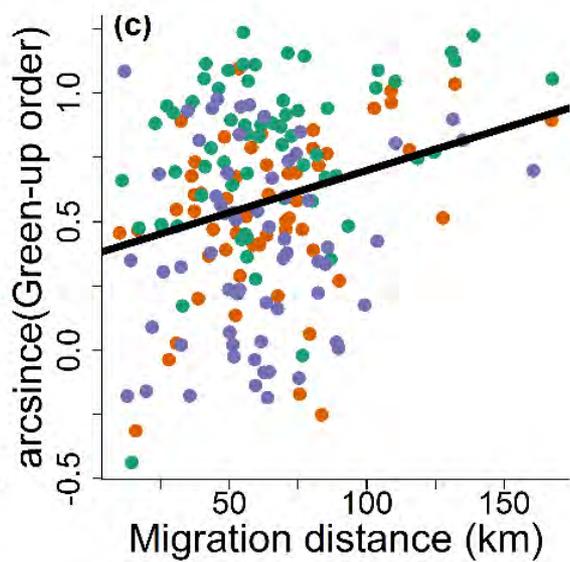
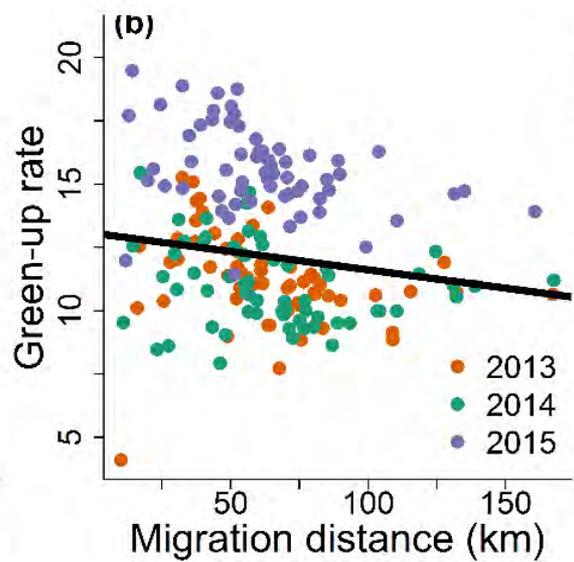
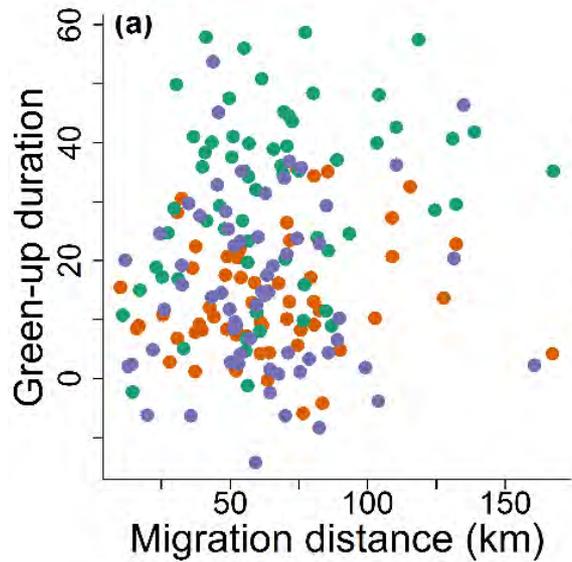


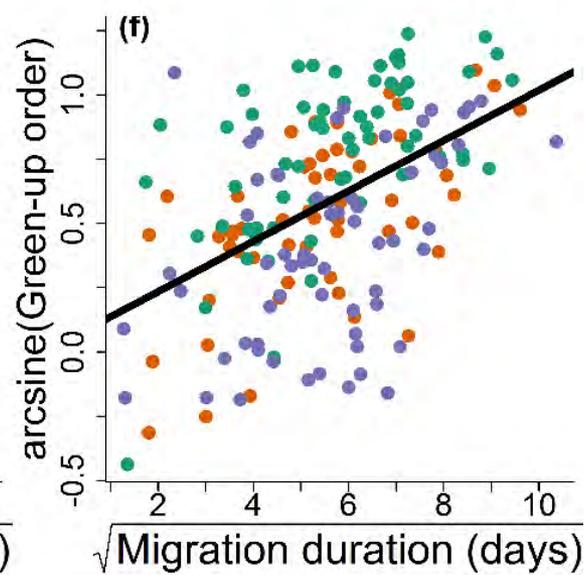
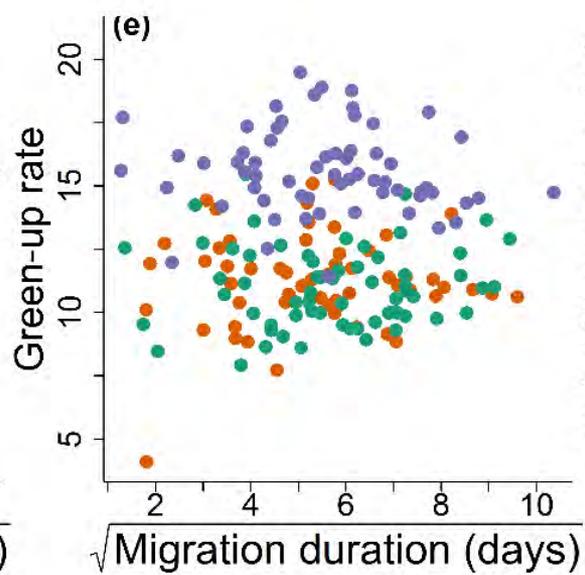
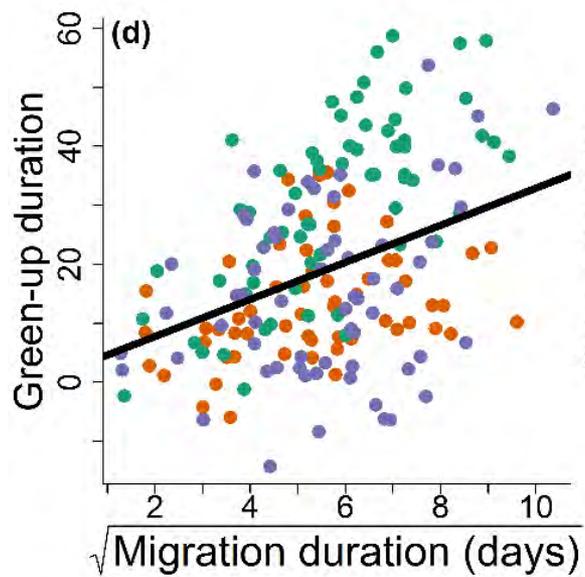
Wet year



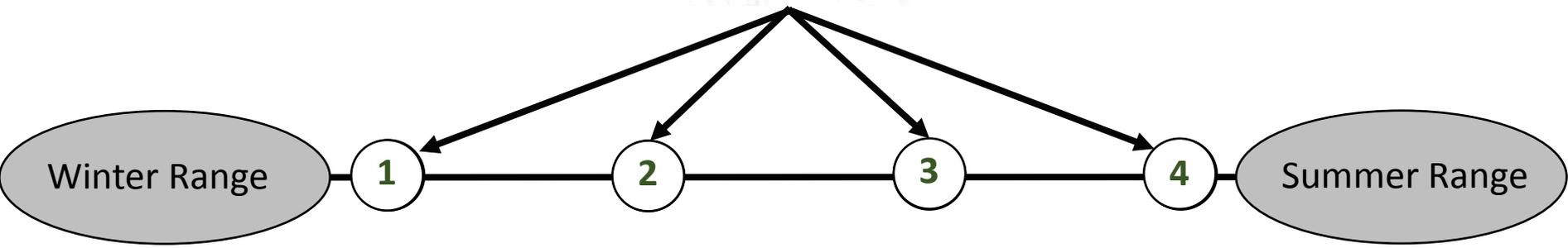
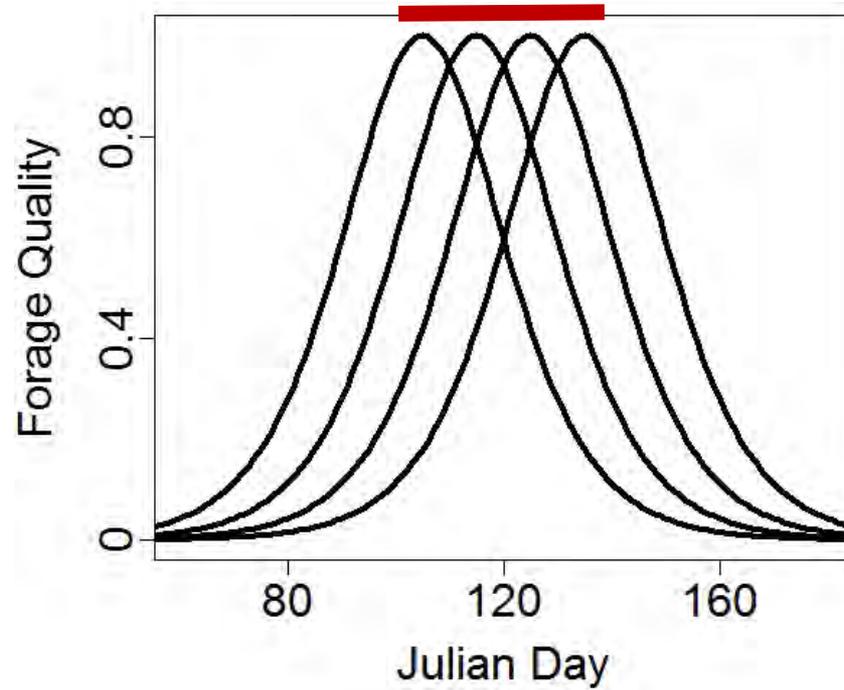
Low snowpack, wet spring





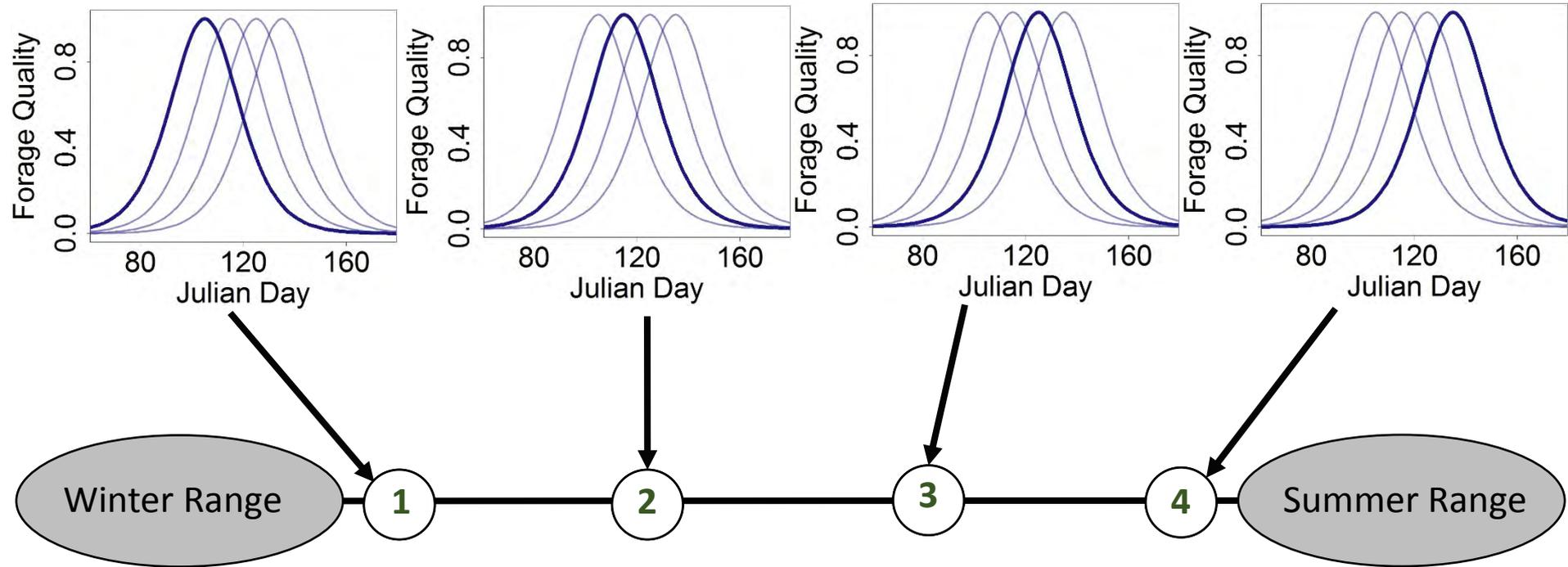


Green-Up Duration



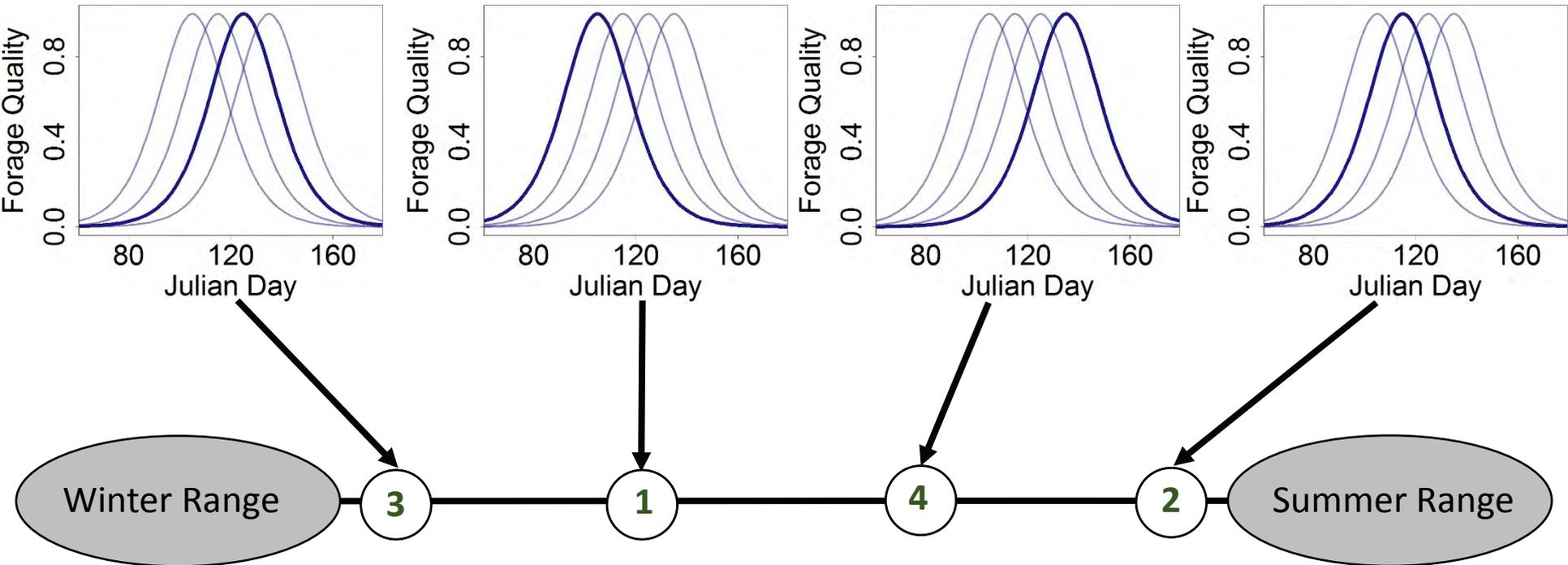
Green-Up Order

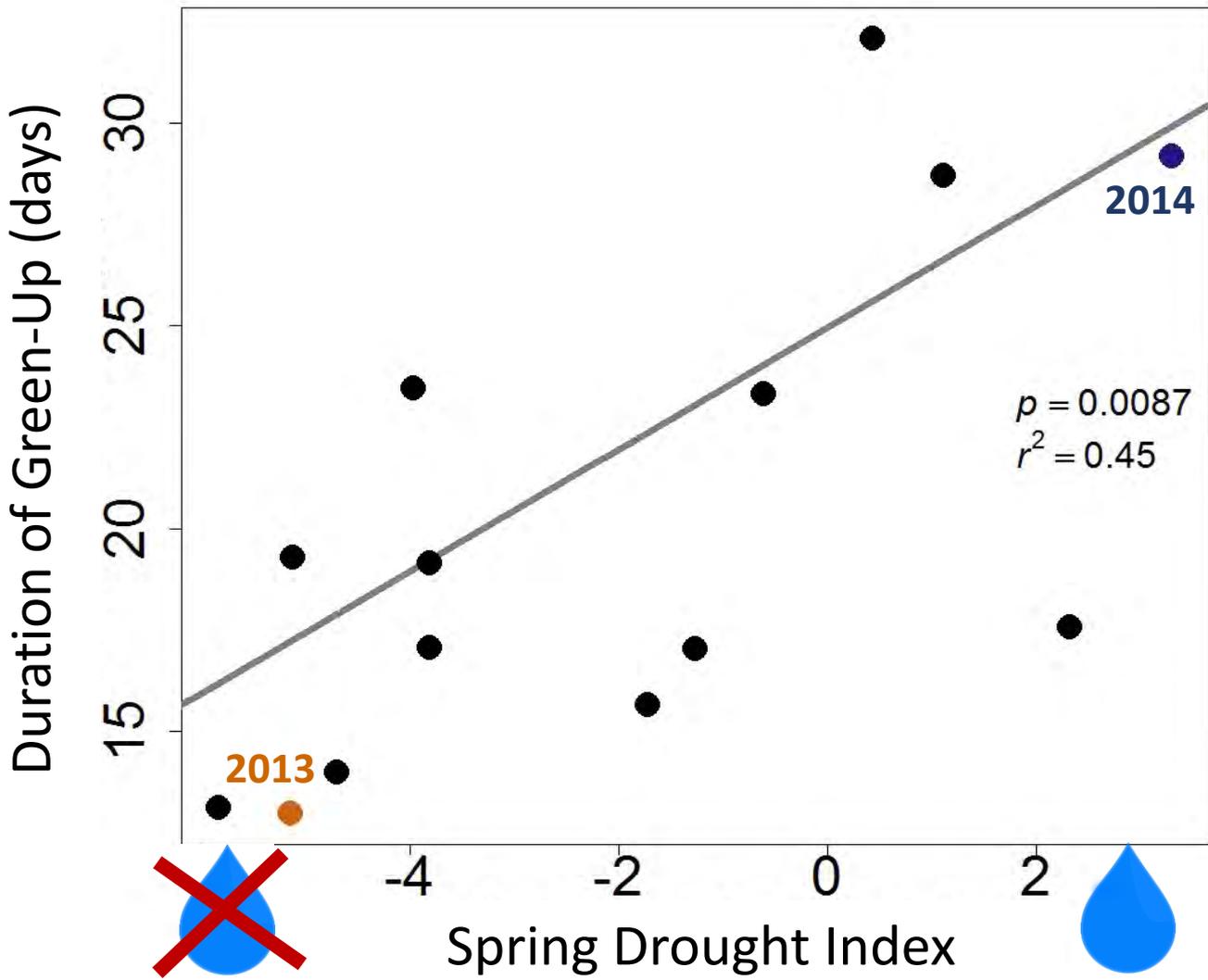
Consecutive Green-Up



Green-Up Order

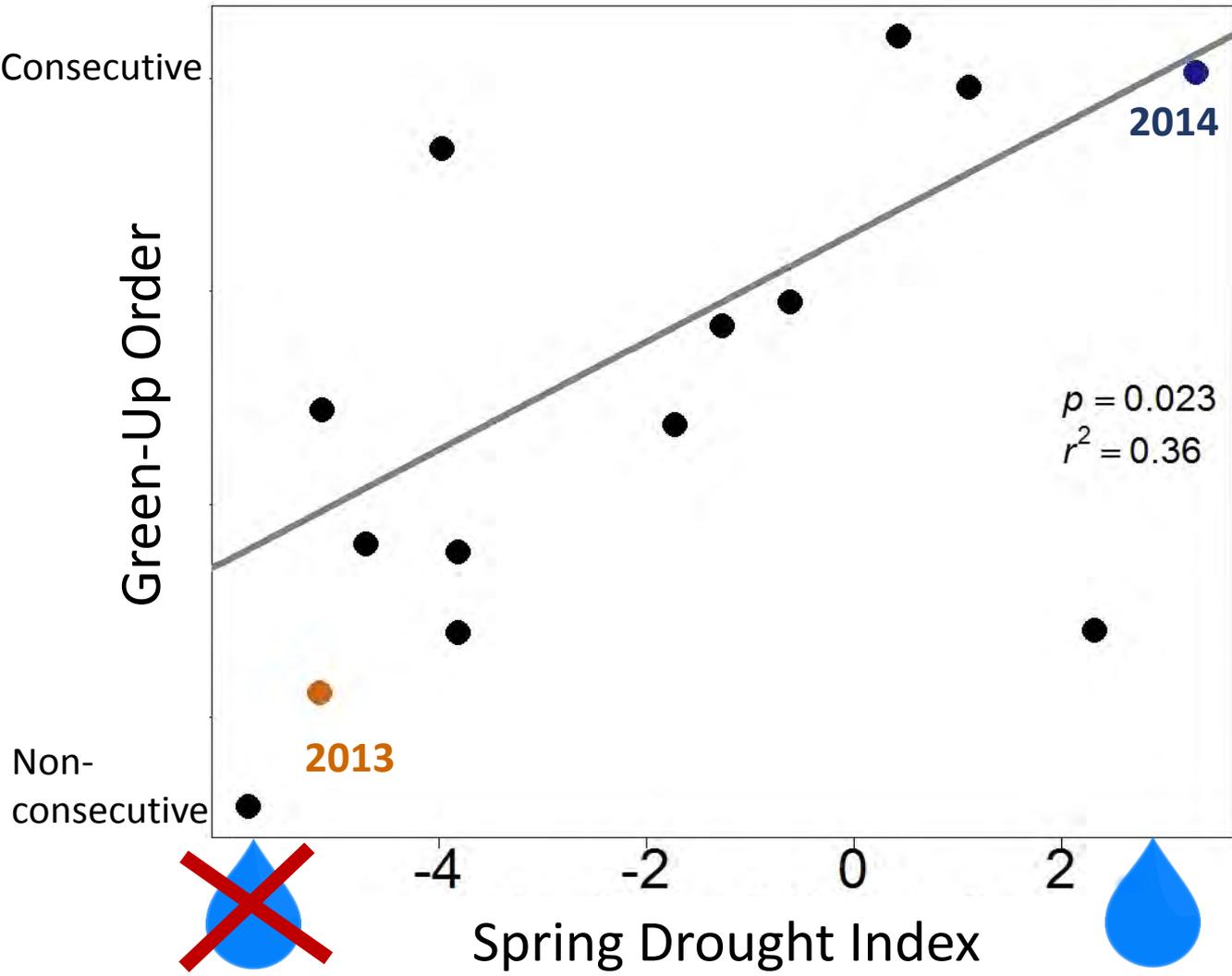
Non-Consecutive Green-Up





Drought =

Shorter duration
of green-up



Drought =

Shorter duration
of green-up

Non-consecutive
green-up

16 April

