Invasion to restoration: using ecology to expand across disciplines and systems

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What is Ecology and What Good is It?

- Ecology
  - The scientific study of the distributions and relationships of organisms and their interactions with the environment.

- Ecology is broad like Physics

- We break it down

- Plants, animals, and their environment are <u>interdependent.</u>

- Ecological approach = better management!

Ecology in a Box

Aquatic Systems

Invasion Ecology

Experimental
Fisheries
Aquatic
Chemical
Stable Isotope
Trophic
Community
Plant

Terrestrial Systems

Restoration Ecology

Spatial
Evolutionary
Translocation
Reproductive
Wildlife
Movement
Population
Landscape

Ecological Approach

1. Ecological Theory

+

2. Life History Traits

+

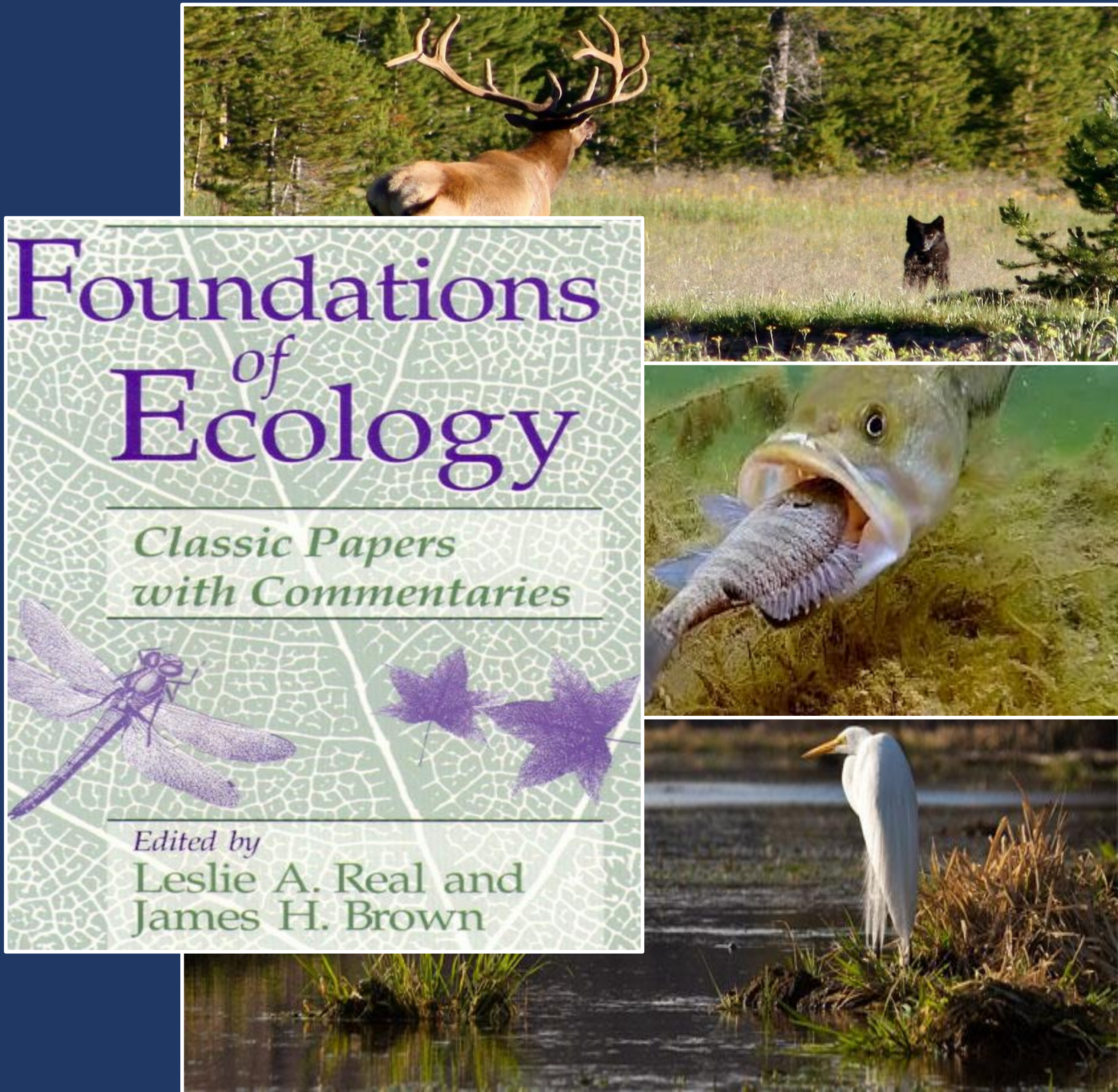
3. Collaboration

+

4. Study Design

+

5. Flexibility



Allelopathy of the Non-Native Macrophyte, *Myriophyllum spicatum* and its Influence on Trophic Dynamics in Aquatic Systems

GLIER

CLEMSON UNIVERSITY
SOUTH CAROLINA
1889

Introduction

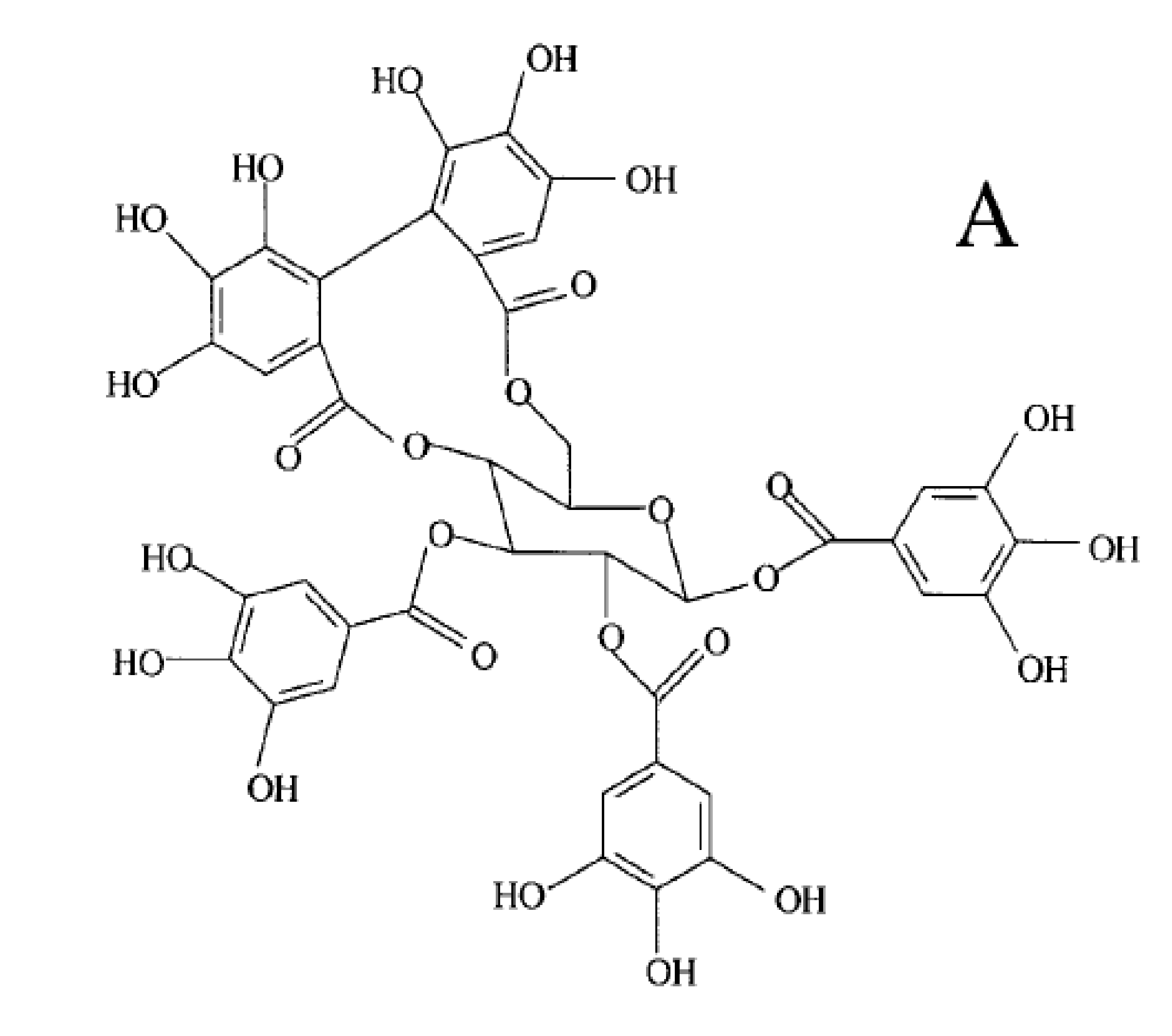
- Non-native plants
- Life history traits
- Habitat
- Trophic dynamics

Basic Trophic Level

- Lindeman (1942)
- Plants and associated organisms
- Epiphyton (Goldsborough et. al 2005)
- Competition of resources
- Allelopathy (Molisch 1937)

Allelopathy

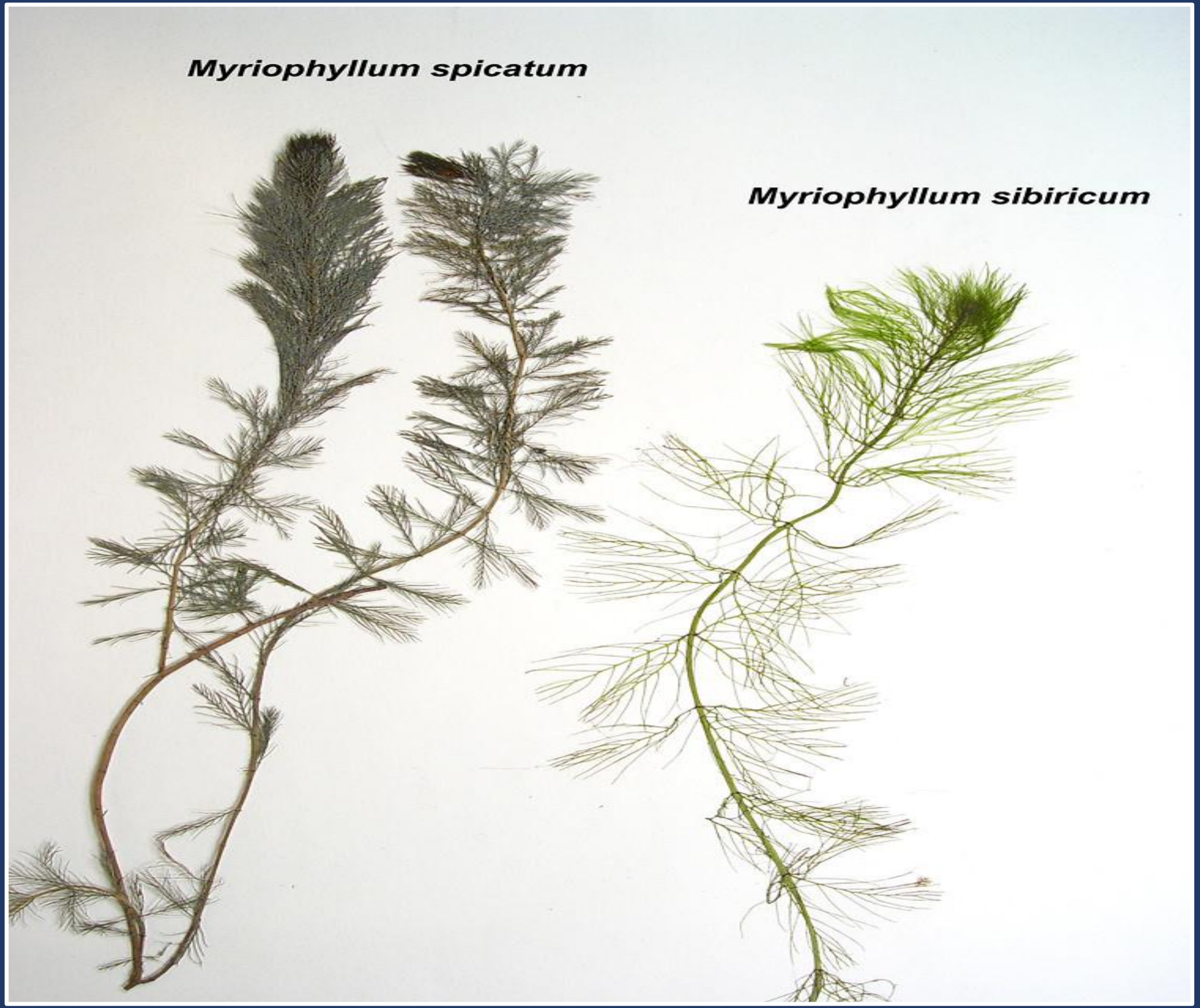
- Gross et. al (1996)
- Hydrolysable tannins (allelochemicals)
- 3 main inhibitory compounds
    1. Tellimagrandin II
    2. Gallic acid
    3. Ellagic acid



Structure of Tellimagrandin II compound
(figure taken from Glomski et. al 2002)

Chemical Profile

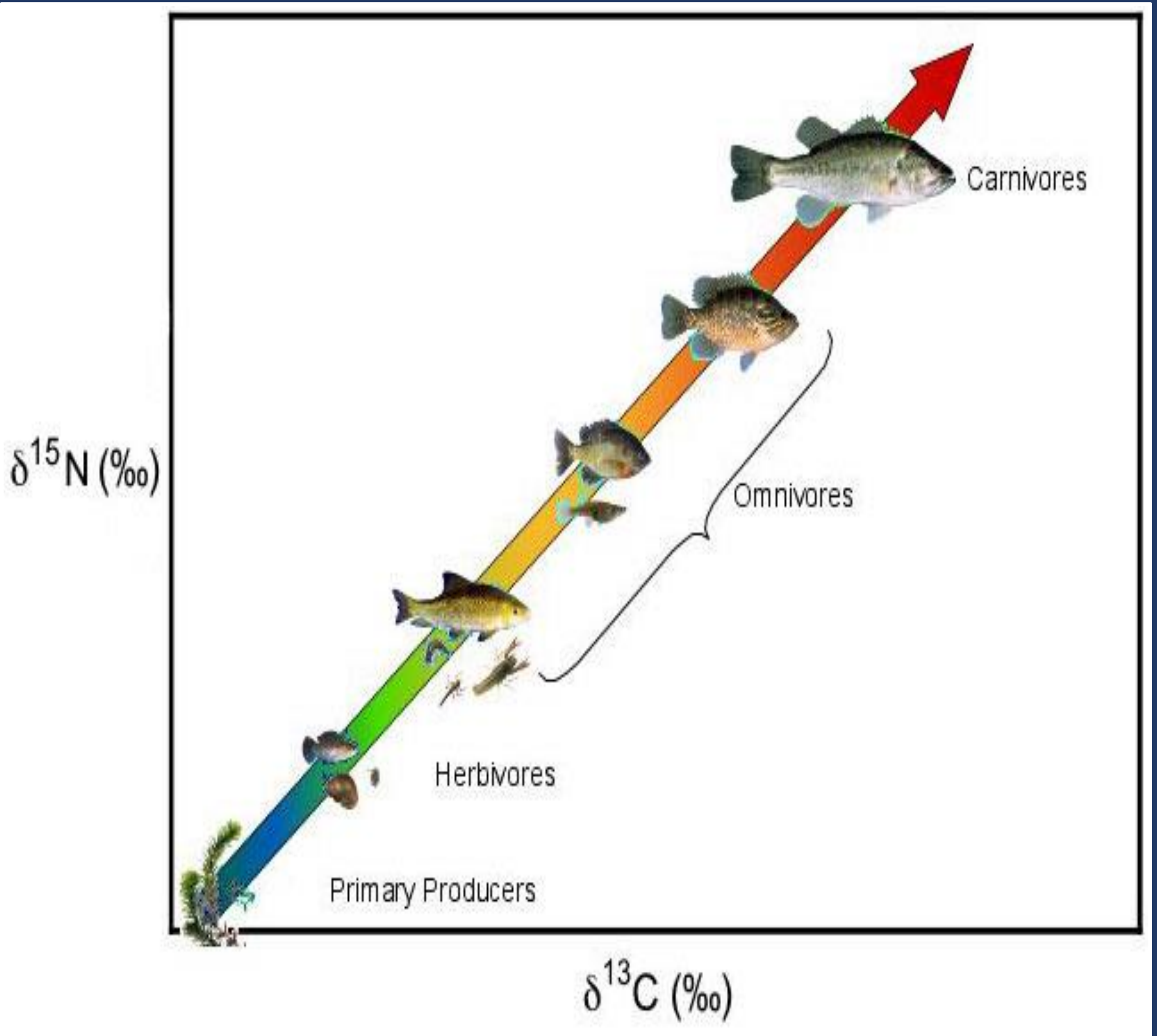
- Marko et. al (2008)
- Apical meristem concentrations
- Tellimagrandin II
- 2x greater total polyphenol content (TPC)



https://gobotany.newenglandwild.org/species/myriophyllum/sibiricum/

Trophic Decoupling

- Kovalenko & Dibble (2013)
- Investigated the effects on trophic structure and energy flow
- Macroinvertebrate $\delta^{13}C$ values
- Fish $\delta^{13}C$ values

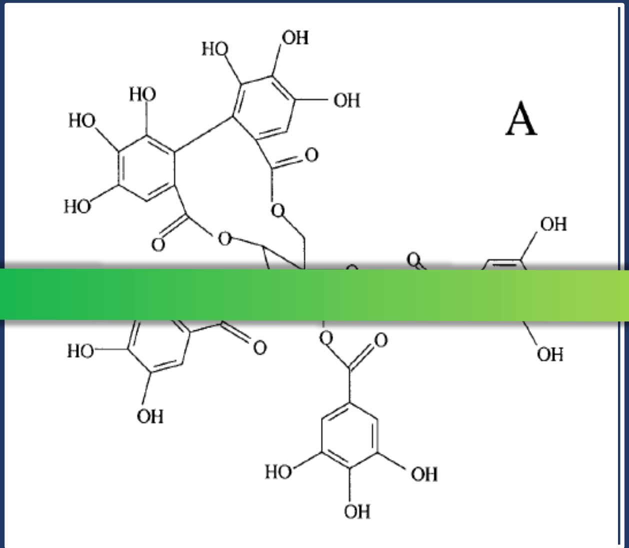


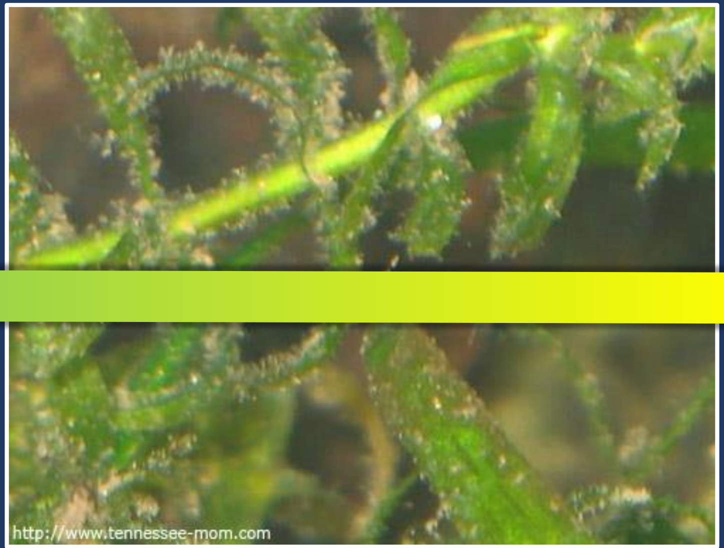
http://www.ansto.gov.au/ResearchHub/IER/Research/IsotopesforWater/AquaticEcosystems/index.htm

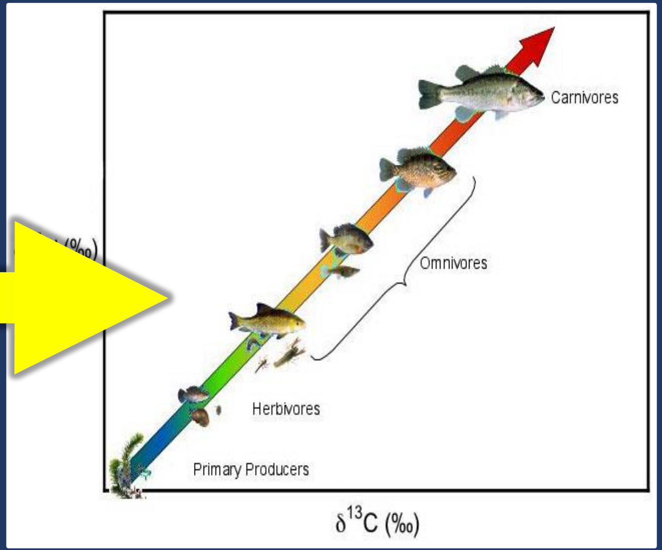
Alternative Hypotheses to Decoupling

- Structure
  - Many have identified how structure impacts foraging success
    - (Savino & Stein, 1982; Dibble et al., 1996; Crowder et al., 1998; Warfe & Barmuta, 2004)

- Allelopathy





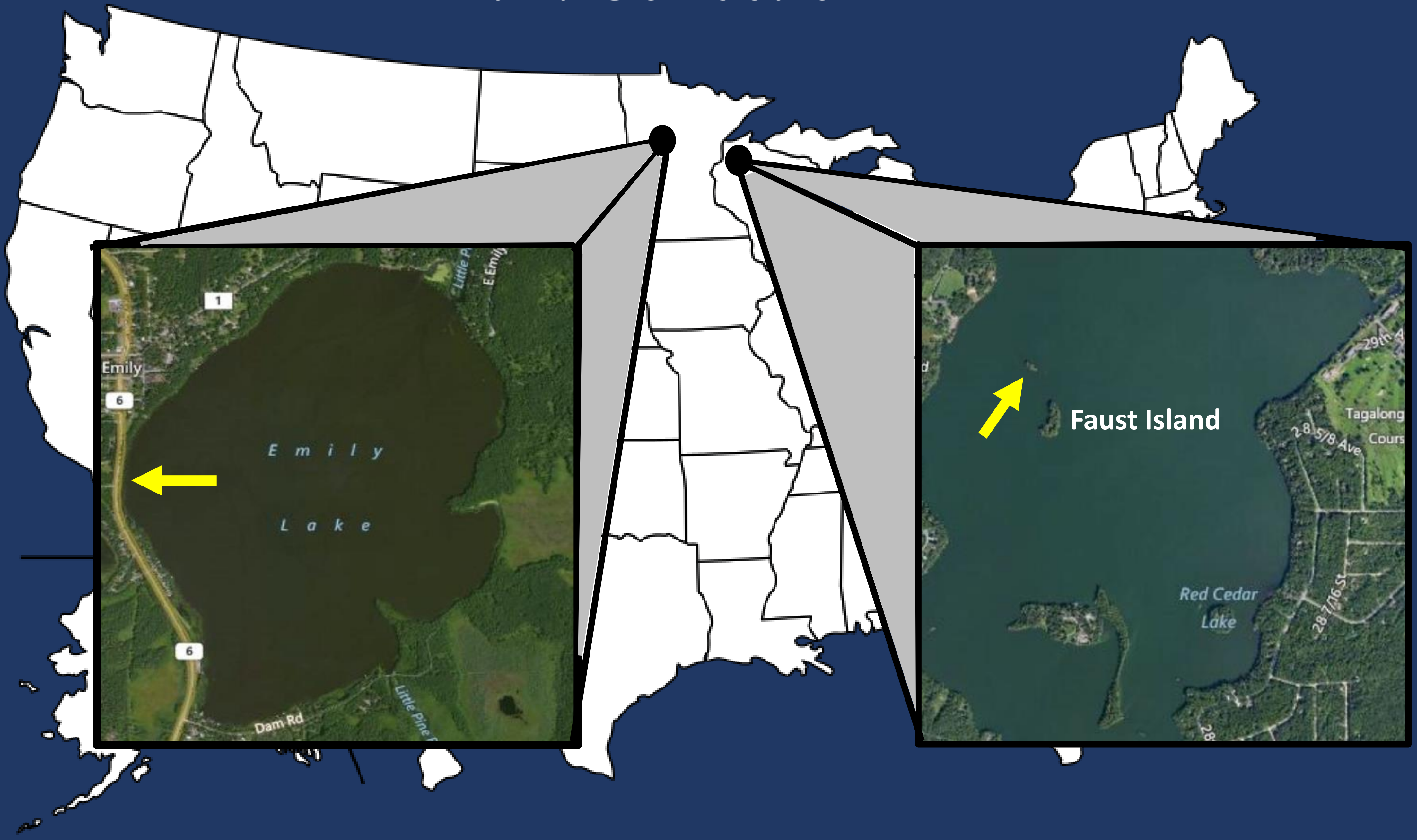


Experimental Hypotheses

Experiment 1 Hypothesis: Differences in allelochemicals between non-native *M. spicatum* and native *M. sibiricum* influence the community structure of colonizing epiphyton.

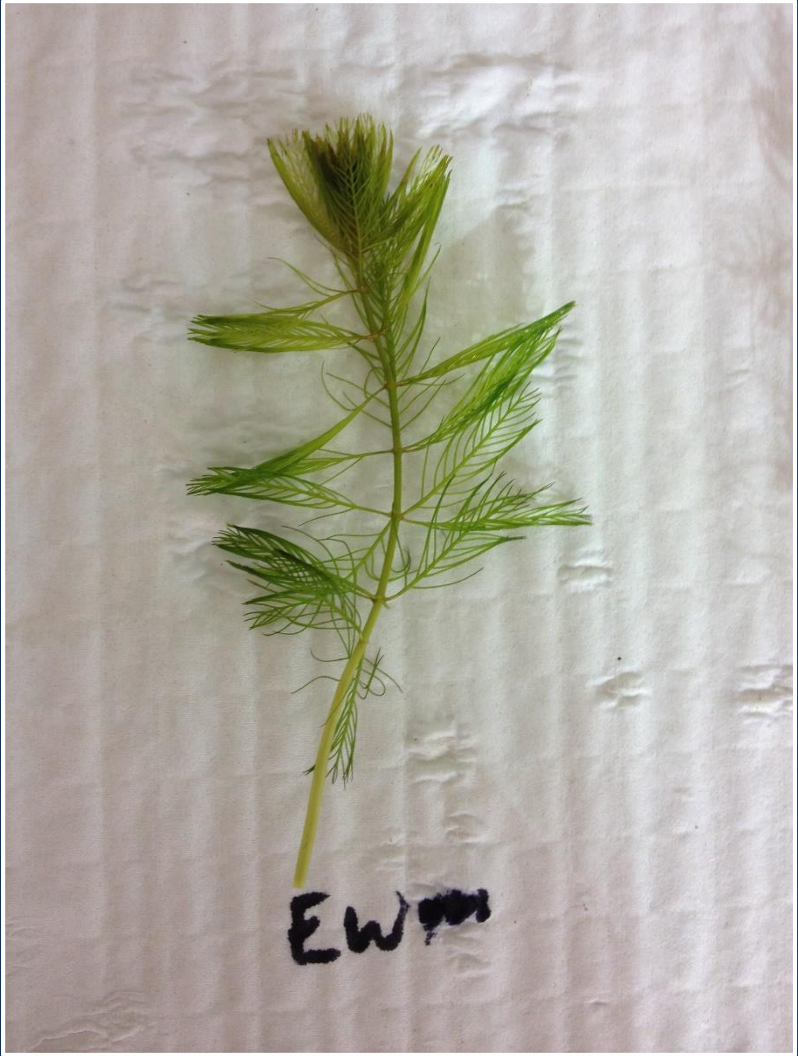
Experiment 2 Hypothesis: Differences in the community structure of colonizing epiphyton between non-native *M. spicatum* and native *M. sibiricum* influence trophic dynamics in aquatic systems.

Plant Collection



Species? - Genetic Analysis

M. spicatum



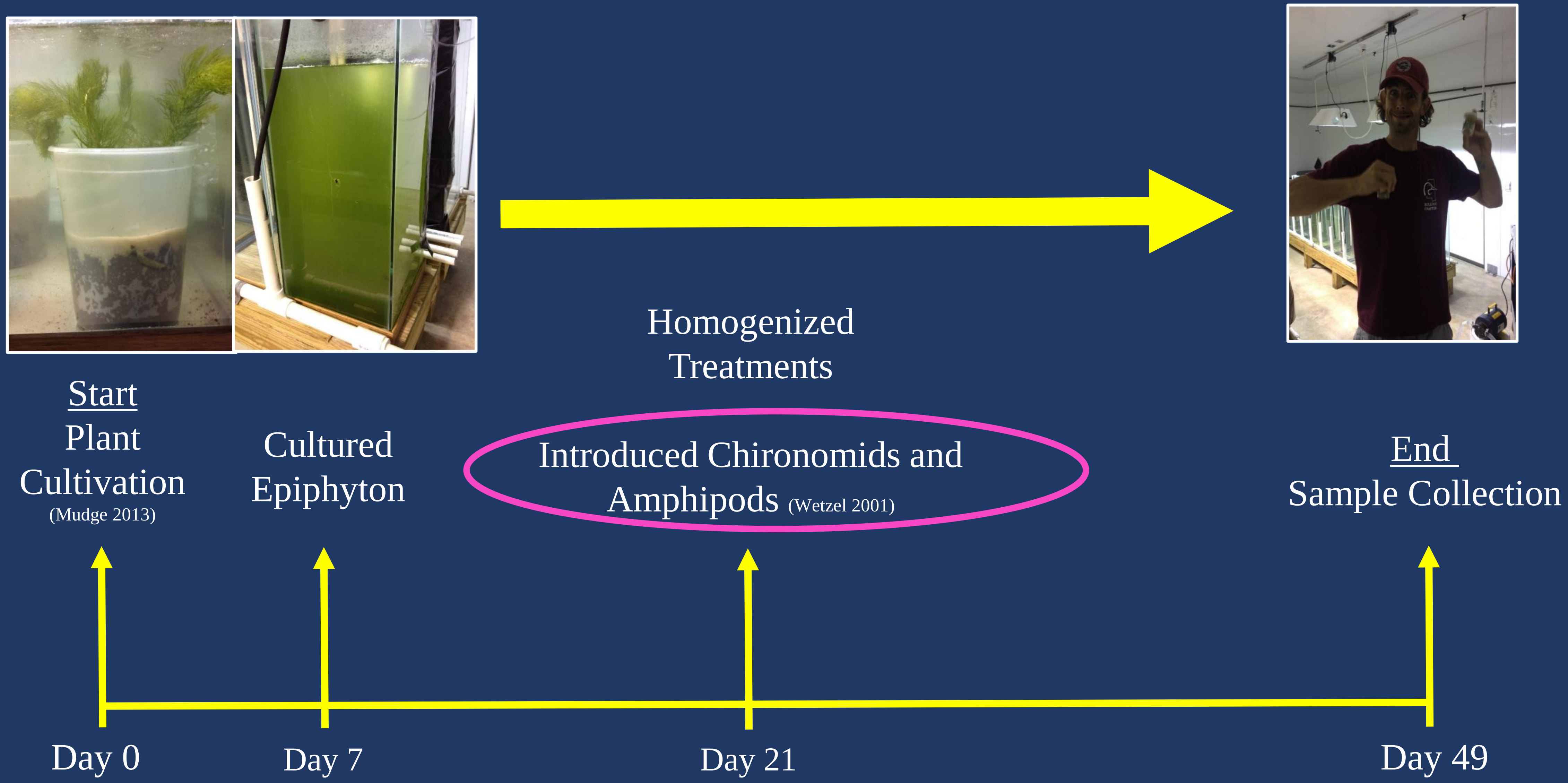
M. spicatum x *M. sibiricum*

M. sibiricum

ERDC Controlled Environment Growth Chamber

- Ambient temperature 22ºC
- 16:8 light:dark photoperiod

Sampling Schedule



Epiphyton Composition

Epiphyton		Non-Native *M. spicatum*		Native *M. sibiricum*	
Phyla	Genera	Relative Composition (%)		Relative Composition (%)	
Cyanophyta	Aphanothece	7.37	n = 7	—	n = 5
	Chroococcus	0.04		—	
	Gomphosphaeria	0.68		—	
	Oscillatoria	2.34		0.54	
	Anabaena	**51.00**		1.64	
	Calothrix	0.21		12.28	
	Leptolyngbya	2.68		—	
	Nostoc	—		3.69	
	Rivularia	—		5.22	
Chlorophyta	Bulbochaete	0.85	n = 8	—	n = 3
	Spirogyra	**26.29**		6.95	
	Ankistrodesmus	1.66		0.36	
	Cosmarium	0.04		—	
	Oocystis	0.34		—	
	Zygnema	4.69		—	
	Cladophora	0.04		—	
	Stigeoclonium	0.17		—	
	Scenedesmus	—		0.54	
Xanthophyta	Tribonema	0.34		**68.01**	
Bacillariophyta	Diatoma	1.24		0.79	

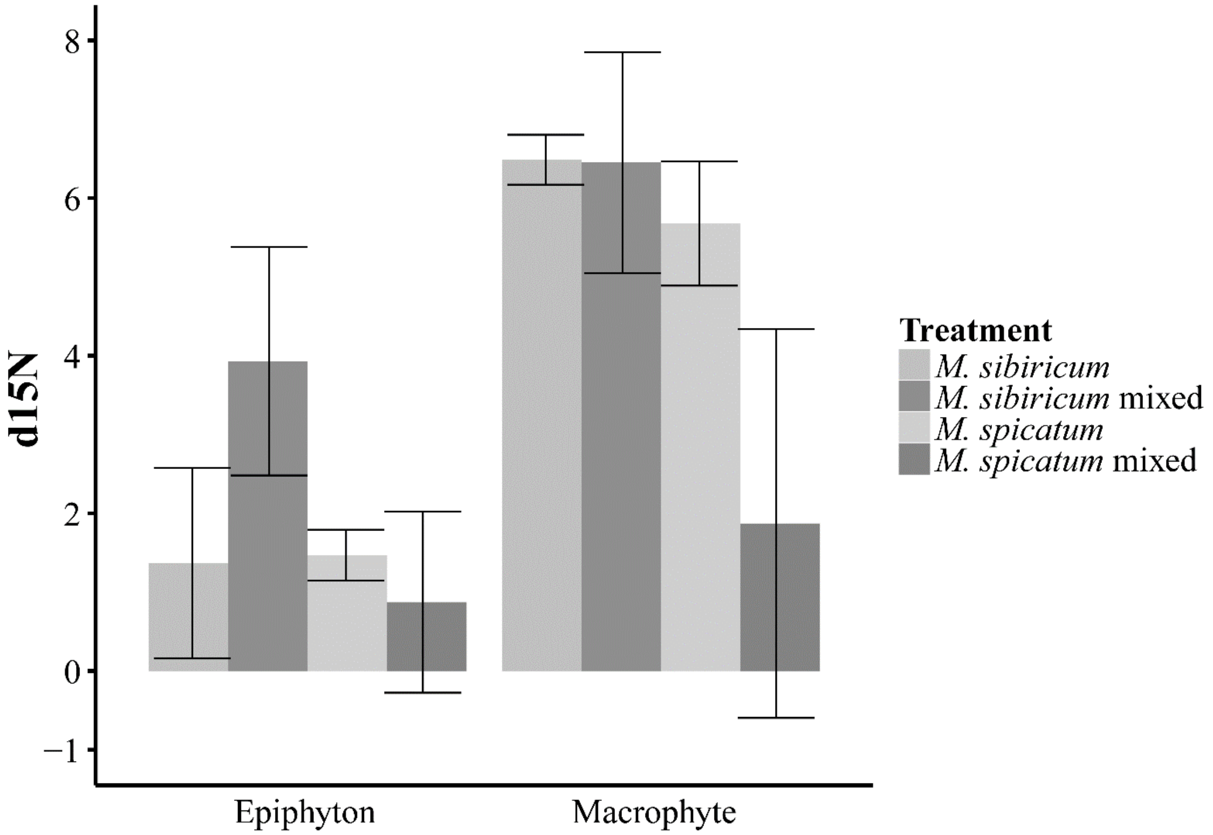
Experiment 1– Need this little bit of info!

- Allelochemicals
  - Greater concentrations of Gallic acid and Ellagitannins in *M. spicatum* when grown alone; $p < 0.05$

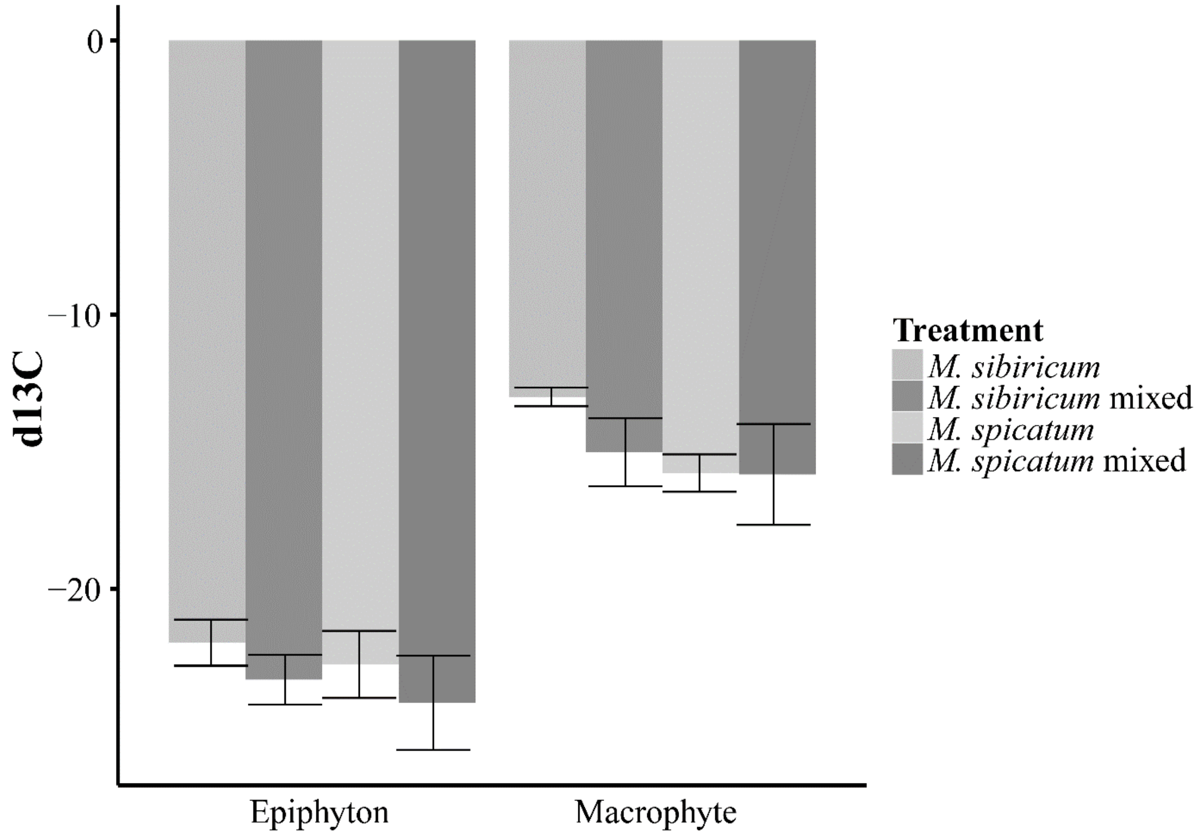
- CCA
  - Limited effect of allelochemicals on epiphyton genera

Primary Producers: Epiphyton and Macrophytes

$\delta^{15}N$ values



$\delta^{13}C$ values

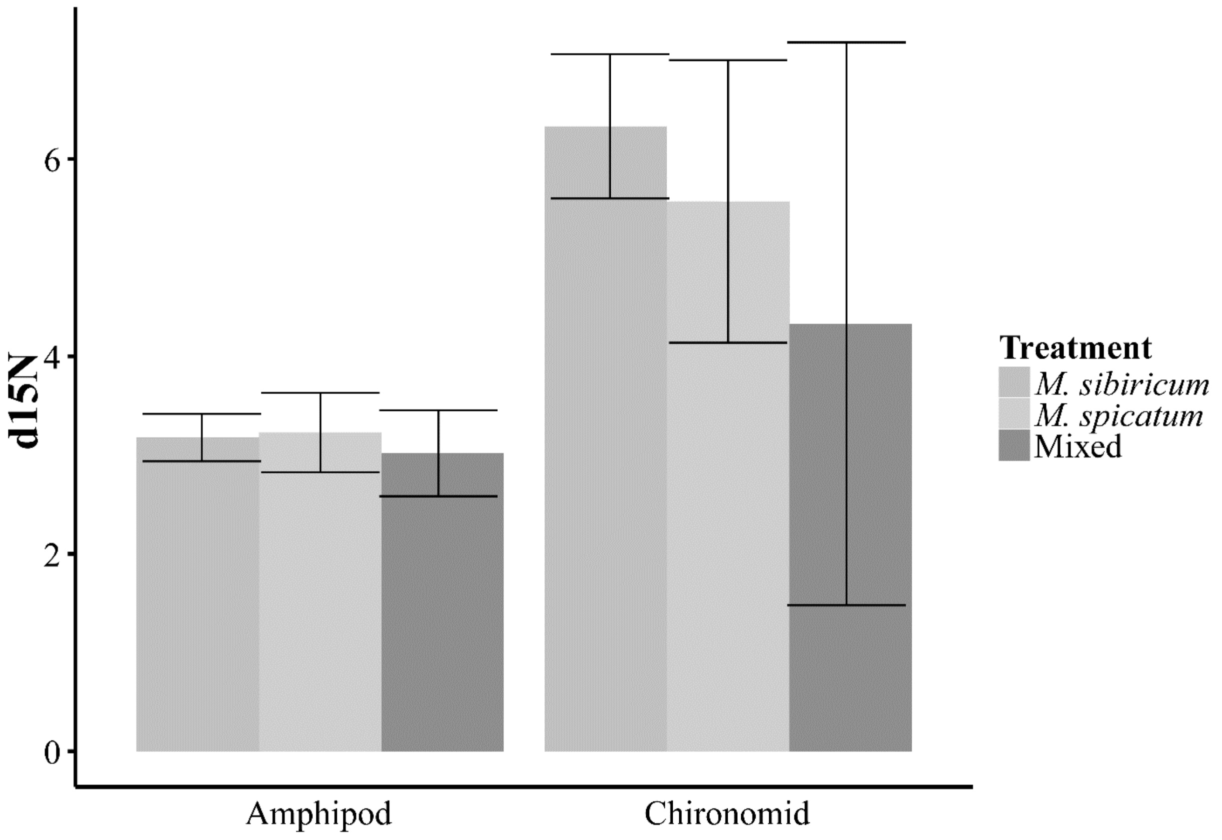


Epiphyton: Not statistically different
Macrophyte: Not statistically different

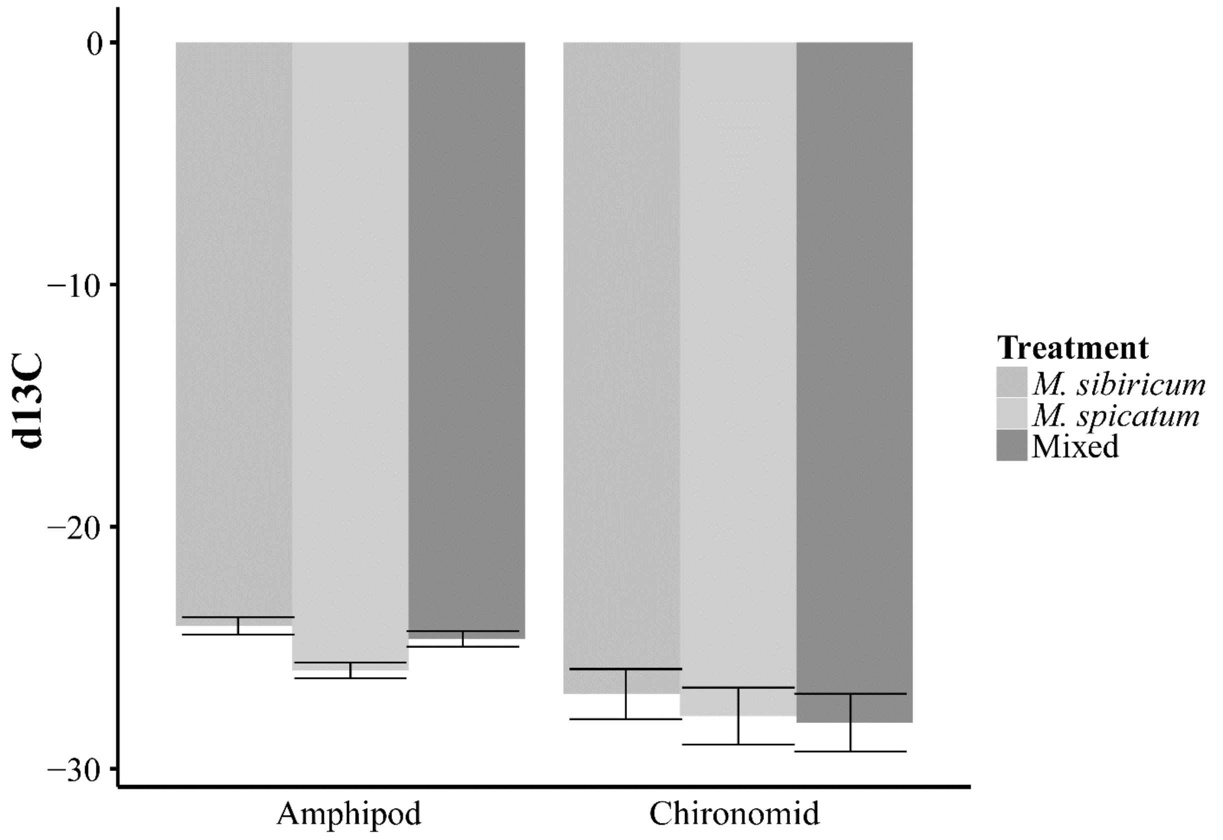
Epiphyton: Not statistically different
Macrophyte: Not statistically different

Primary Consumers: Amphipods and Chironomids

$\delta^{15}N$ values



$\delta^{13}C$ values



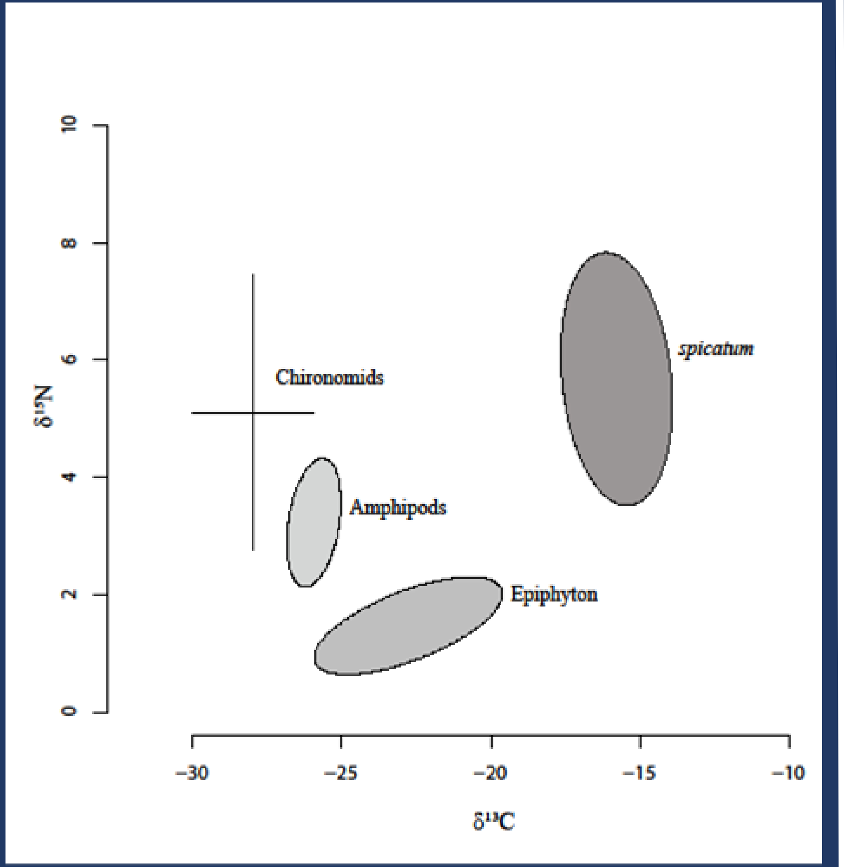
Amphipods: Not statistically different
Chironomids: Not statistically different

Amphipods: $p < 0.01$, *M. spicatum*
Chironomids: Not statistically different

Niche Breadth and Space

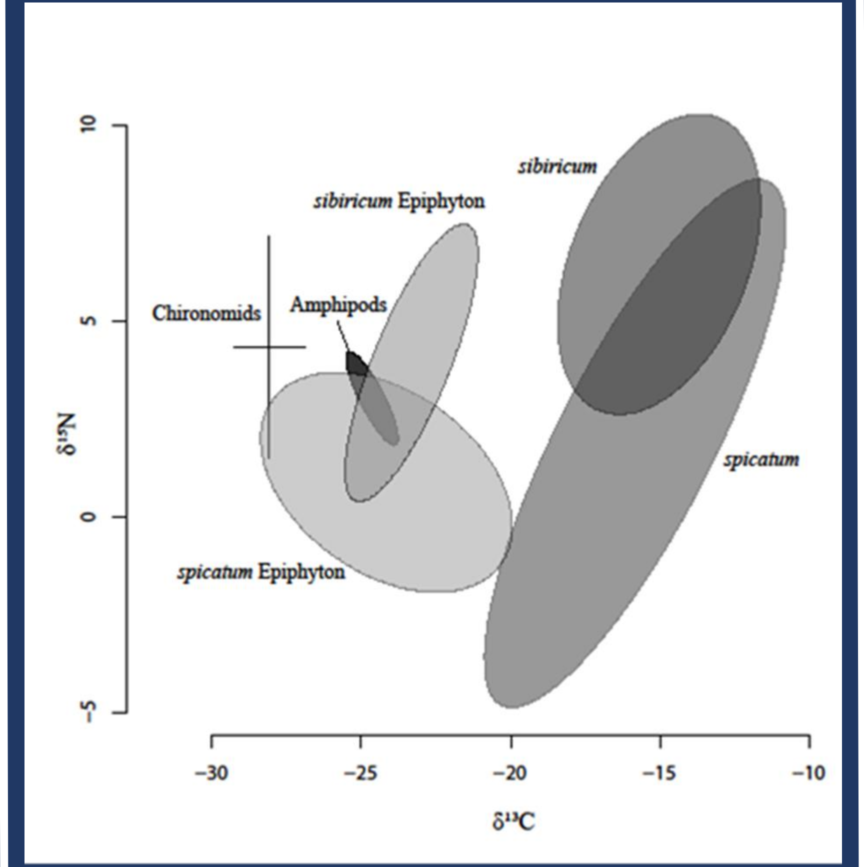
Treatment 1
Non-Native

M. spicatum



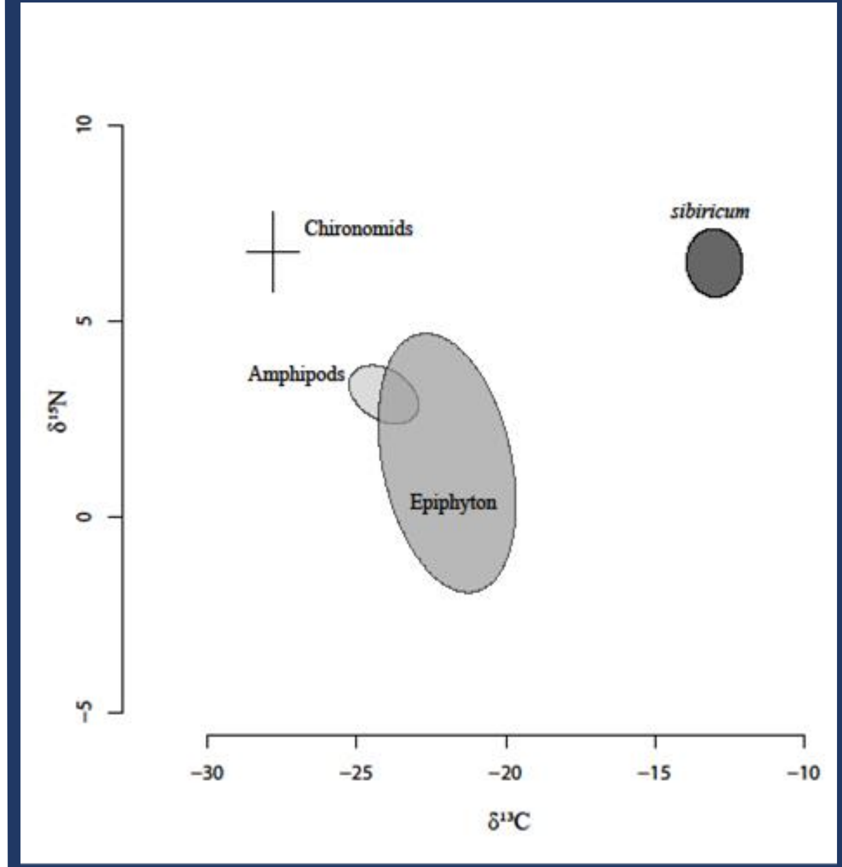
Treatment 2
Mixed

M. spicatum & M. sibiricum

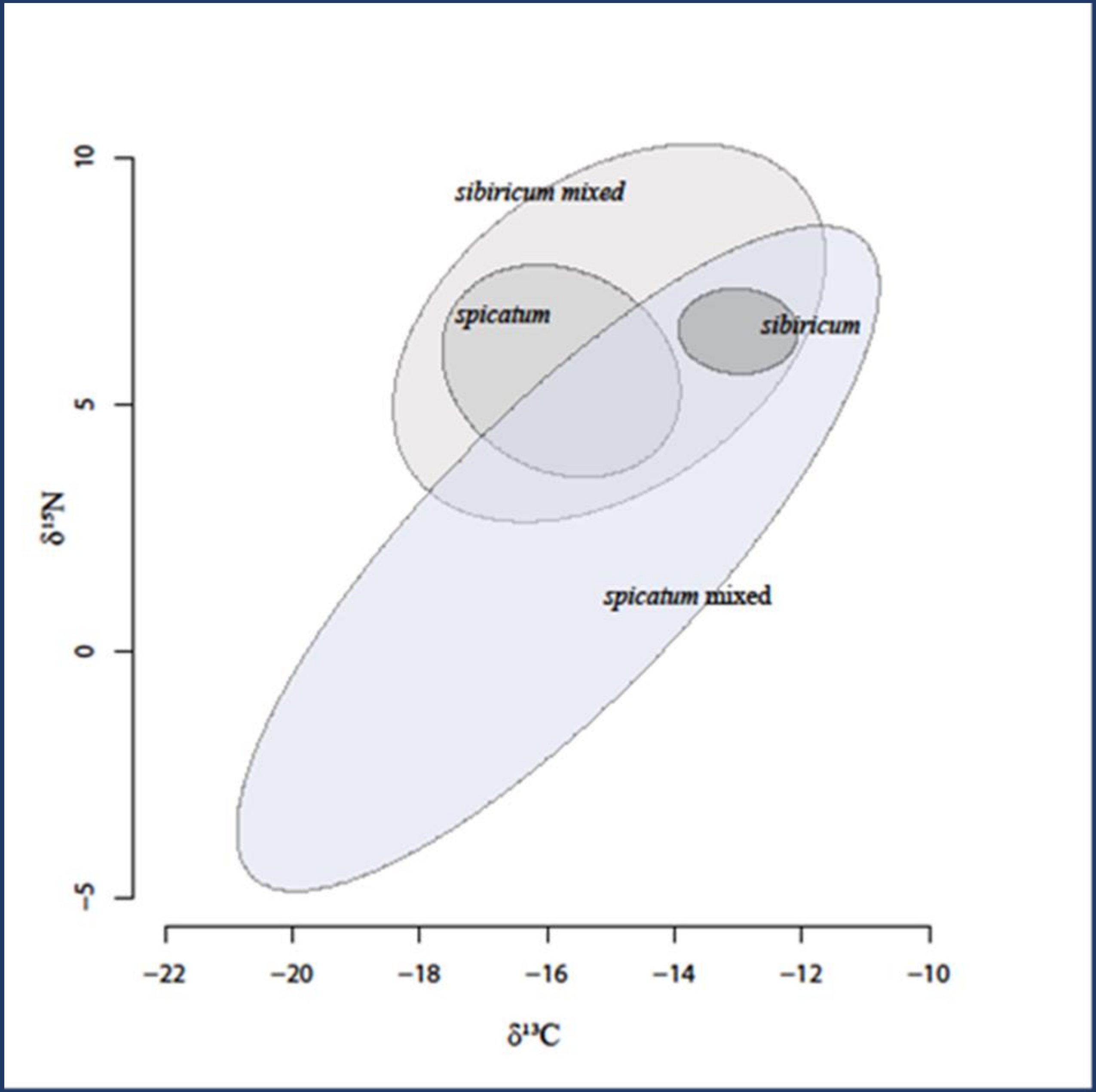


Treatment 3
Native

M. sibiricum



Interesting pattern, what is the mechanism?



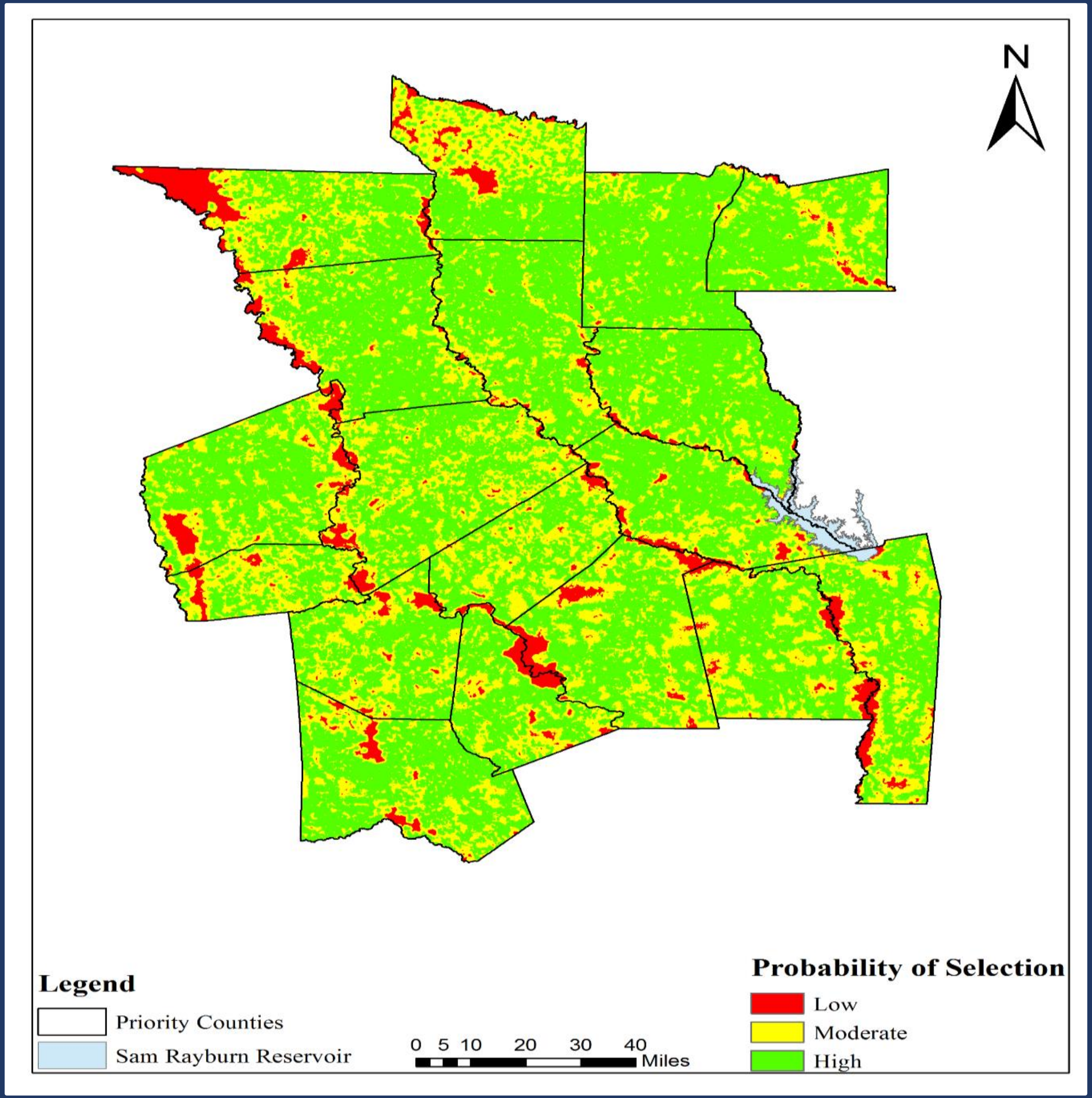
Translocation and Reproductive Ecology of Wild Turkeys in East Texas

Eastern Wild Turkey (*M. g. silvestris*)

- 1 of 5 subspecies
- Historical distribution
- Extirpation/Restoration
- Texas
- Fragmented populations

Eastern Wild Turkey in Texas

- TPWD Priority Region
- Translocation
- Habitat availability
- Habitat management
- Predator-rich environment

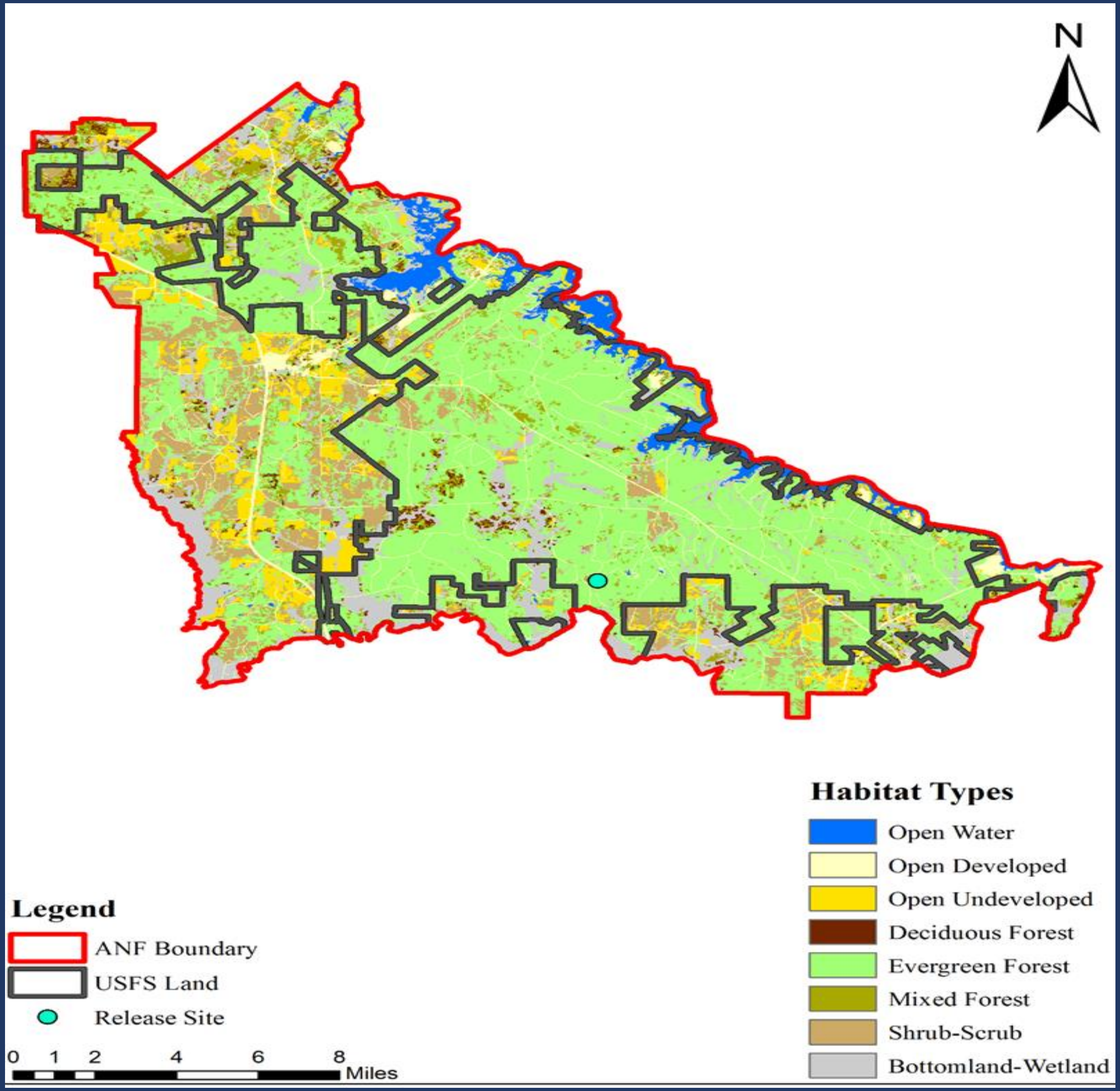


Daily space use, movement, and survival

- Knowledge development
- Exploration – Exploitation
- Influence of Conspecifics
- Survival
- Improve our knowledge of behavior

Study Area

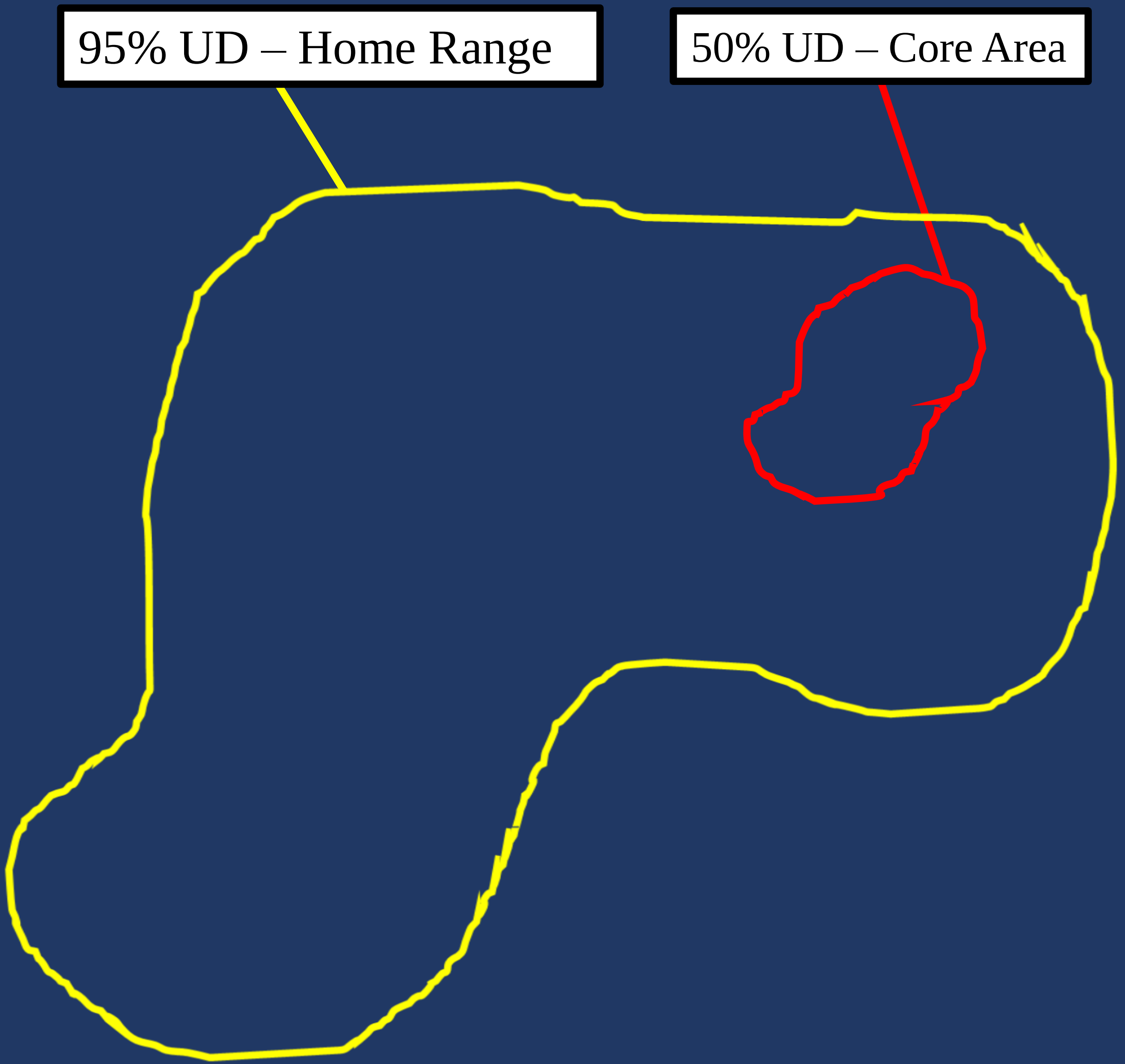
- Angelina National Forest
- Densely-forested habitat
- Frequent-large scale prescribed fire (+/- 1200 ha)
- Few available open vegetation communities
- Predator-rich environment



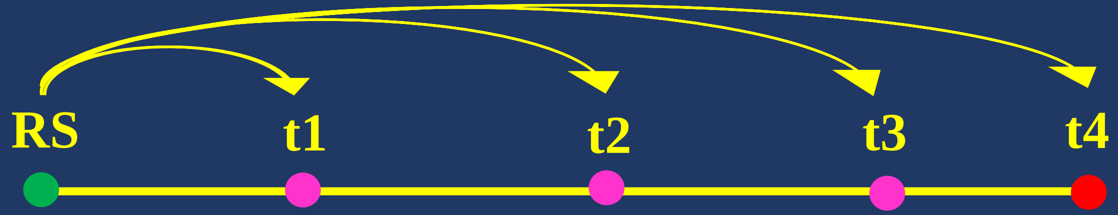
Translocation Effort

- Trapping effort
- Super-stocked 101 individuals
- μGPS transmitters
- Blood samples
- 1 release site on ANF
- Monitoring

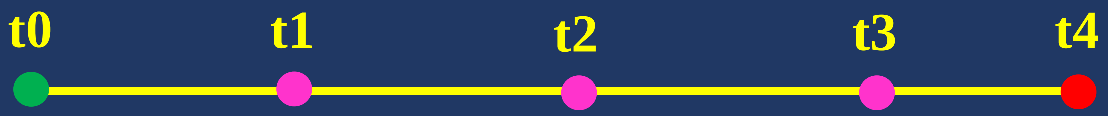
Daily Metrics of Space Use and Movement



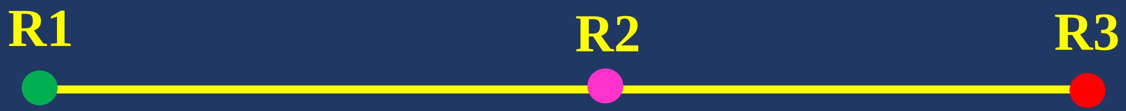
$$\text{Distance to release site} = \frac{d^{t1} + d^{t2} + d^{t3} + d^{t4}}{n^{t}}$$



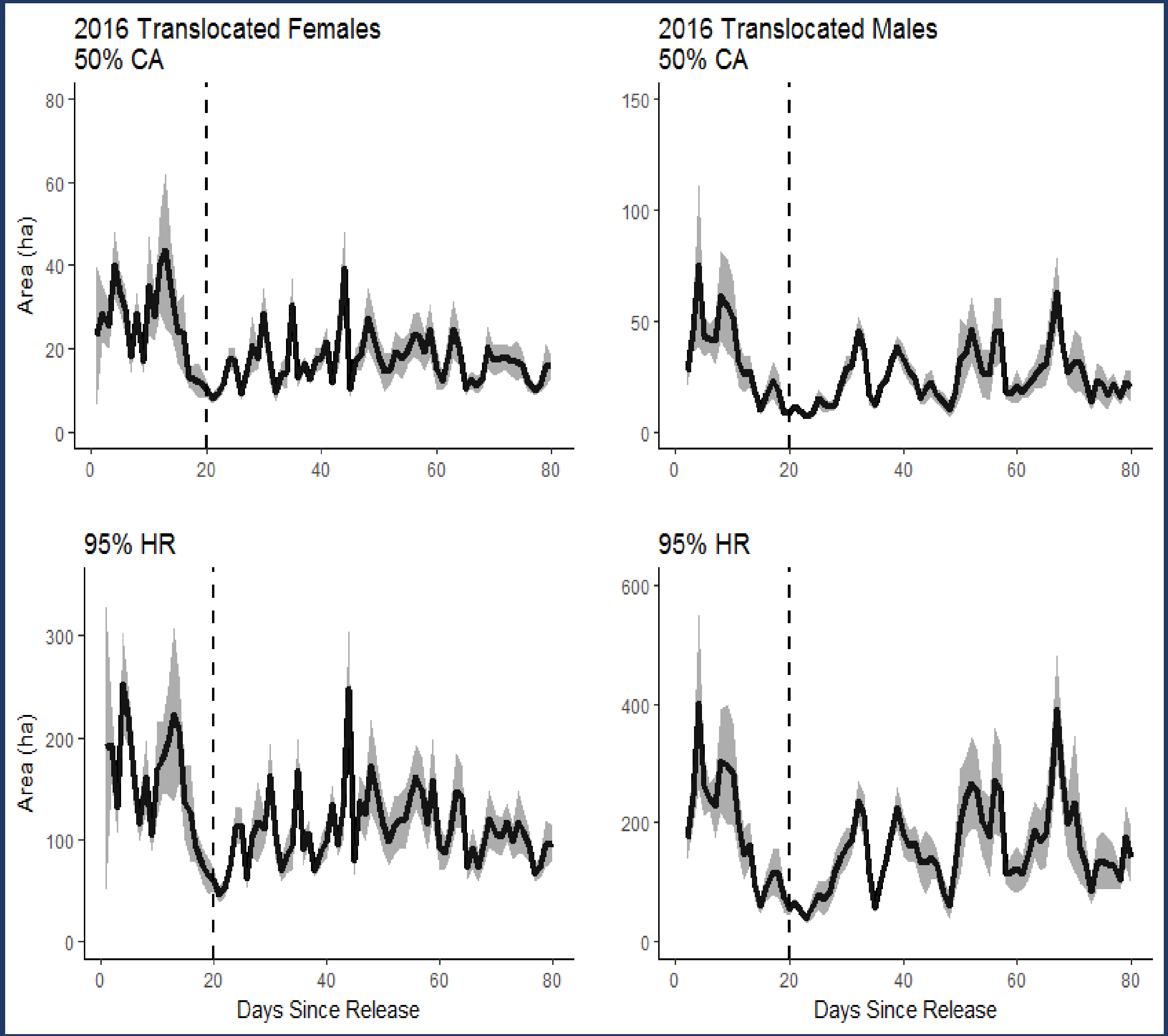
$$\text{Distance travelled} = \frac{d^{t1-t0} + d^{t2-t1} + d^{t3-t2} + d^{t4-t3}}{n^{t}}$$

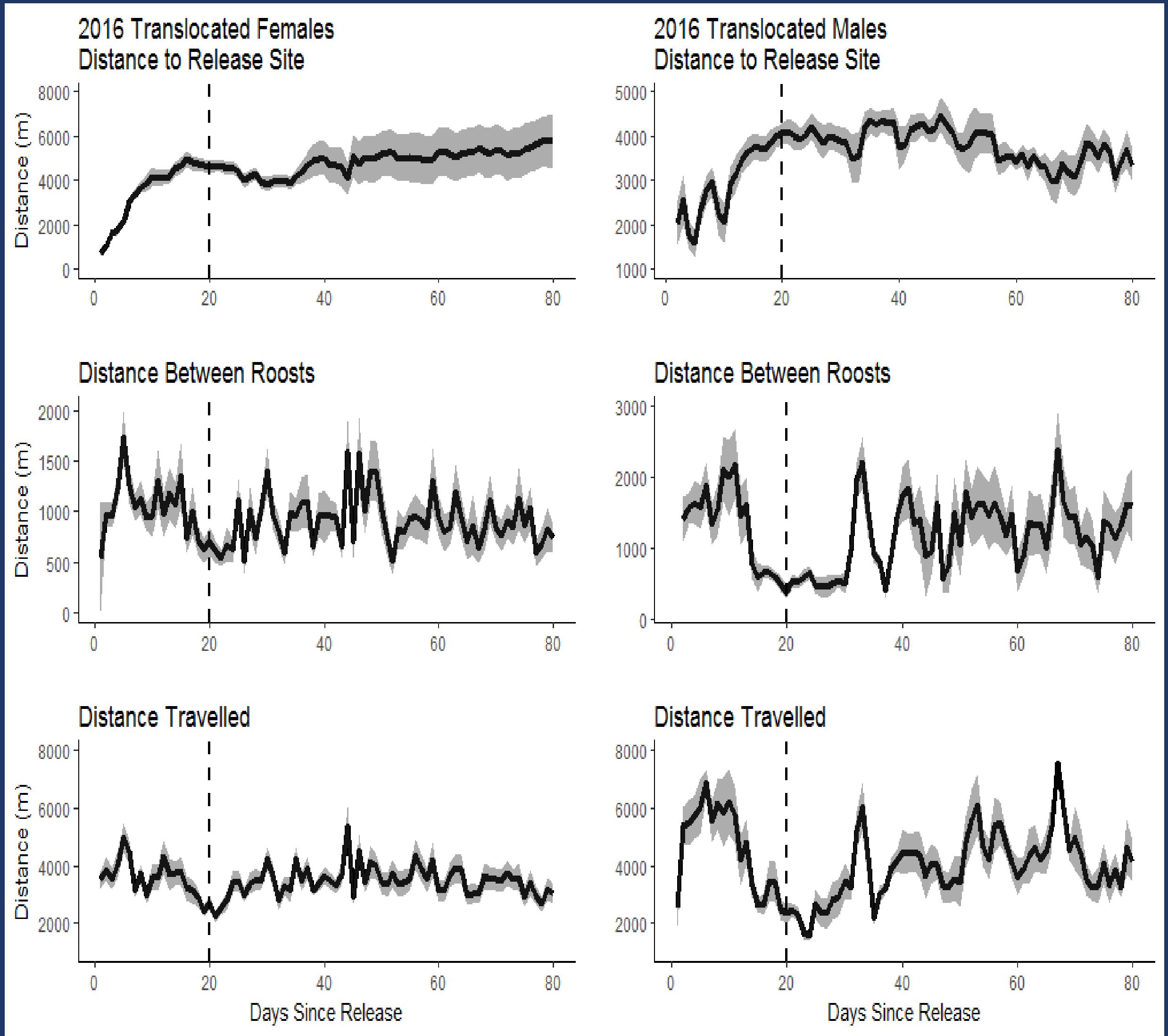


$$\text{Distance between roosts} = \frac{d^{R2-R1} + d^{R3-R2}}{n^{R}}$$

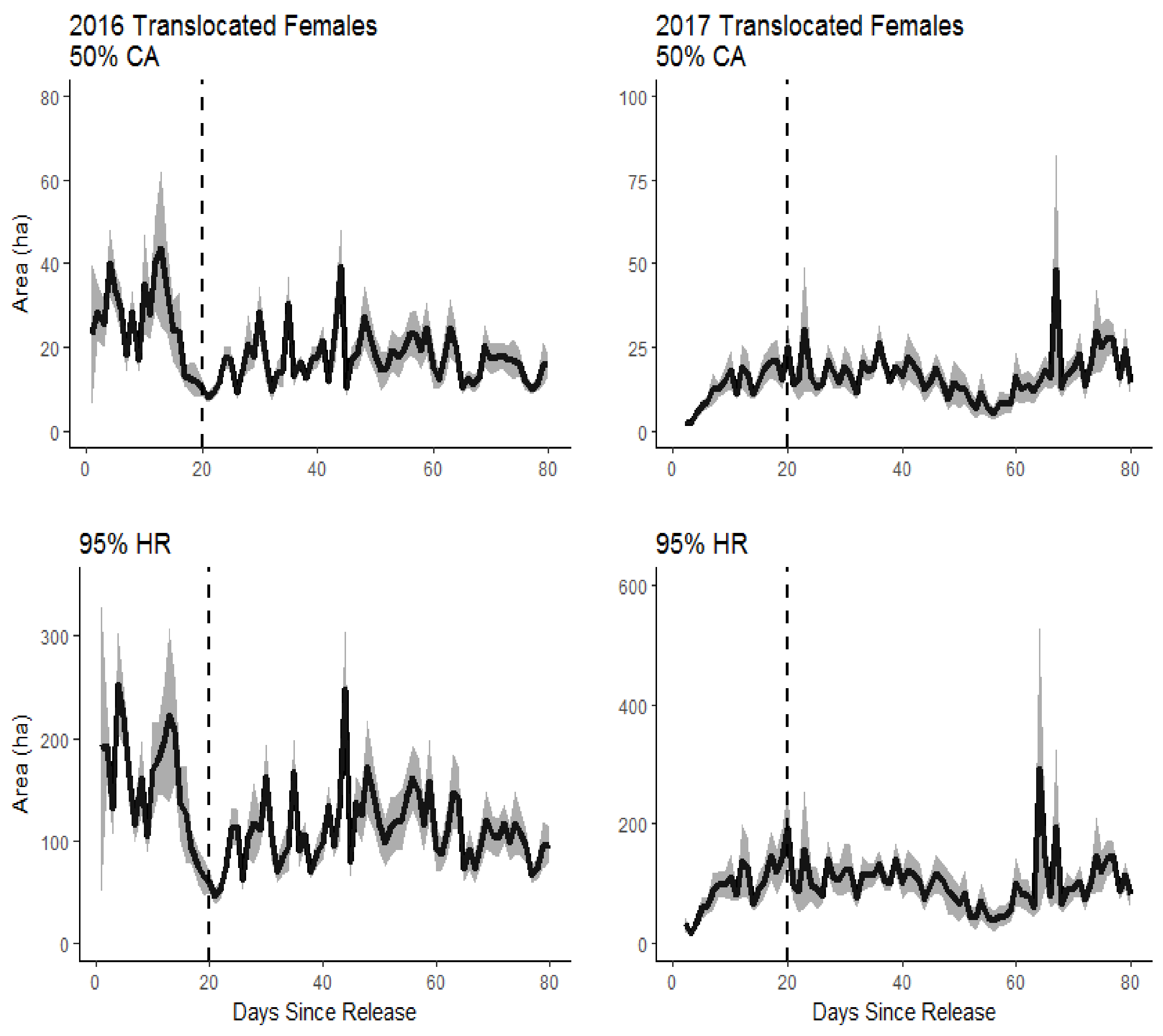


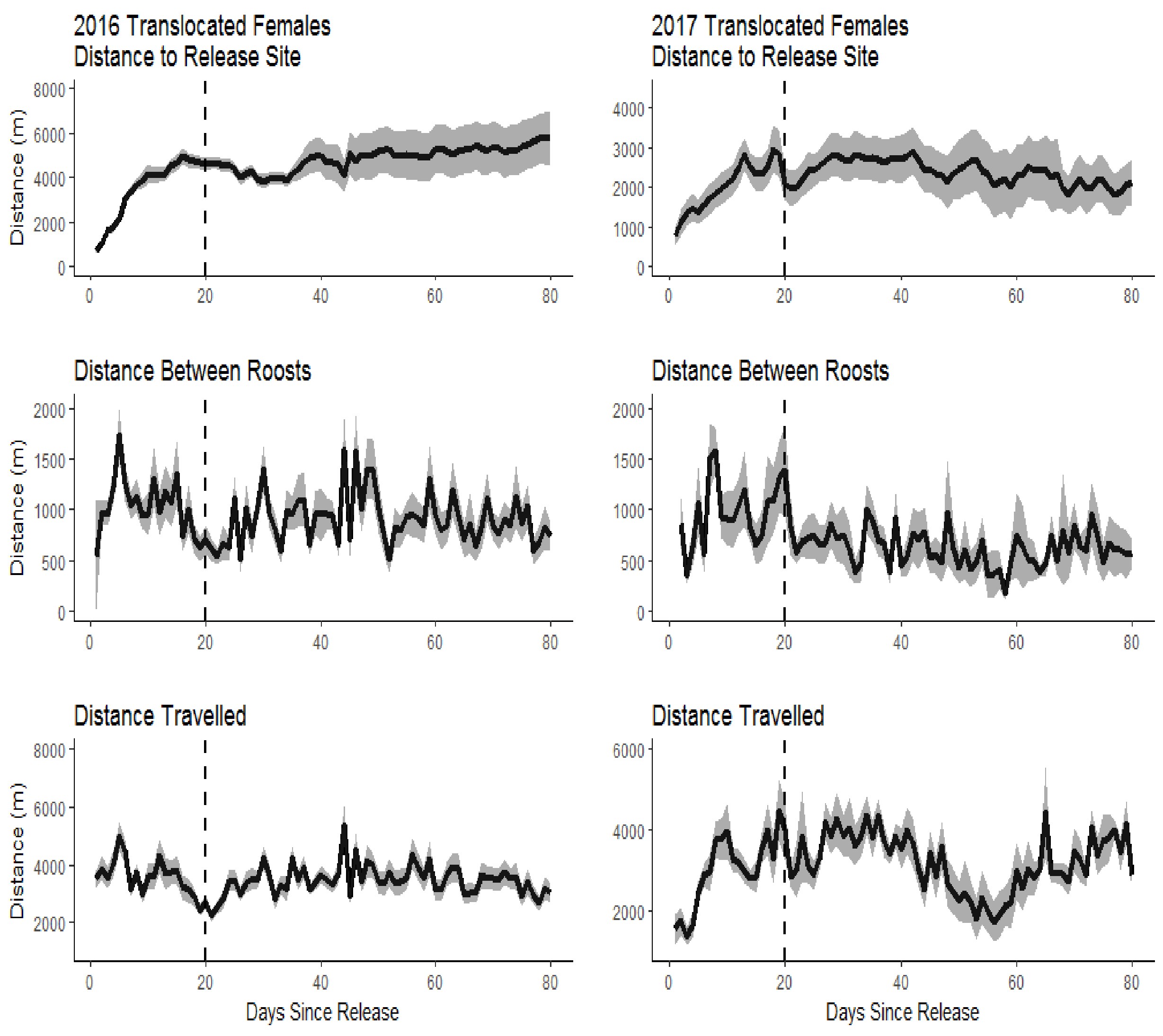
Exploration vs. Exploitation





Influence of Conspecifics





Survival Models

Model Name	Hypothesis	Model
Translocation Space Use Models		
Global	Survival is influenced by all covariates	$y = S^1 + CA^2 + HR^3$
Core Area	Survival is influenced by sex and CA size	$y = S + CA$
Home Range	Survival is influenced by sex and HR size	$y = S + HR$
Null	Survival is influenced by random covariates of turkey	$y = 0$
Translocation Movement Models		
Global	Survival is influenced by all covariates	$y = S^1 + DRS^4 + DT^5 + DBR^6$
Distance to Release Site	Survival is influenced by sex and DRS	$y = S + DRS$
Distance Travelled	Survival is influenced by sex and DT	$y = S + DT$
Distance between Roosts	Survival is influenced by sex and DBR	$y = S + DBR$
Null	Survival is influenced by random covariates of turkey	$y = 0$
Conspecific Space Use Models		
Global	Survival is influenced by all covariates	$y = YR^6 + CA^2 + HR^3$
Core Area	Survival is influenced by year and CA size	$y = YR + CA$
Home Range	Survival is influenced by year and HR size	$y = YR + HR$
Null	Survival is influenced by random covariates of turkey	y = 0
Conspecific Movement Models		
Global	Survival is influenced by all covariates	$y = YR^7 + DRS^4 + DT^5 + DBR^6$
Distance to Release Site	Survival is influenced by year and DRS	$y = YR + DRS$
Distance Travelled	Survival is influenced by year and DT	$y = YR + DT$
Distance between Roosts	Survival is influenced by year and DBR	$y = YR + DBR$
Null	Survival is influenced by random covariates of turkey	$y = 0$

Questions?

“And NUH is the letter I use to spell Nutches
Who live in small caves, known as Niches, for hutches.
These Nutches have troubles, the biggest of which is
The fact there are many more Nutches than Niches.
Each Nutch in a Nich knows that some other Nutch
Would like to move into his Nich very much.
So each Nutch in a Nich has to watch that small Nich
Or Nutches who haven’t got Niches will snitch.”

Dr. Seuss, community ecologist