Effects of Invasive Species Management on Ecosystem Composition & Function in a Deciduous Hardwood Forest

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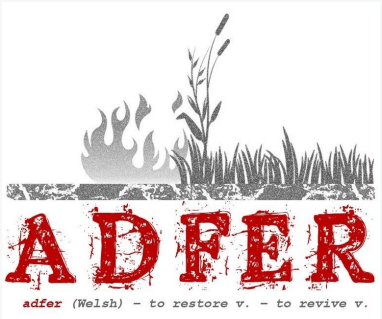
November 27, 2023

OSU School of Environment and Natural Resources

Thanks & Acknowledgements



Advisor Dr. G. Matt Davies

Committee members Dr. Steve Matthews and Dr. Horacio Lopez-Nicora

ADFER lab members past and present including Jeremy Block, Wanderson Novais, Kirsten Packer

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Land Back

This research takes place on occupied land seized by the 1795 Treaty of Greenville

Chippewa, Delaware, Eel River, Kaskaskia, Kickapoo, Ottawa, Potawatomie, Shawnee, Wea, Wyandot

Ecosystem restoration cannot succeed without reparations, decolonization, and the rematriation of this land.

Introduction

Overview

- Background & Research Context
- Ch. 1 - Invasive plant management
- Ch. 2 - Litter decomposition under invasion
- Key Conclusions followed by Q & A

Goat browsing a research plot.
Photo credit: ADFER Lab 2019

Background - Invasion

Invasive plants disrupt forest functions

- Aggressive growth
- Allelopathy
- Phenology

Invasive Lonicera morrowii in Ohio.
Photo Credit: Sixflashphoto, Wikimedia Commons

Majority of Ohio forests surveyed by USFS contain at least one invasive plant species.

Background - Invasion

Invasion in woodlands may be addressed using…

- Mechanical removal of vegetation
- Targeted browsing to remove vegetation
- Herbicide
- Prescribed burns

MK Klenkar, Kirsten Packer, and Ellen Kieser clearing and herbiciding an invaded forest, 2022

Dr. Matt Davies clearing an invaded forest before applying herbicide, 2022.

Background - Invasion

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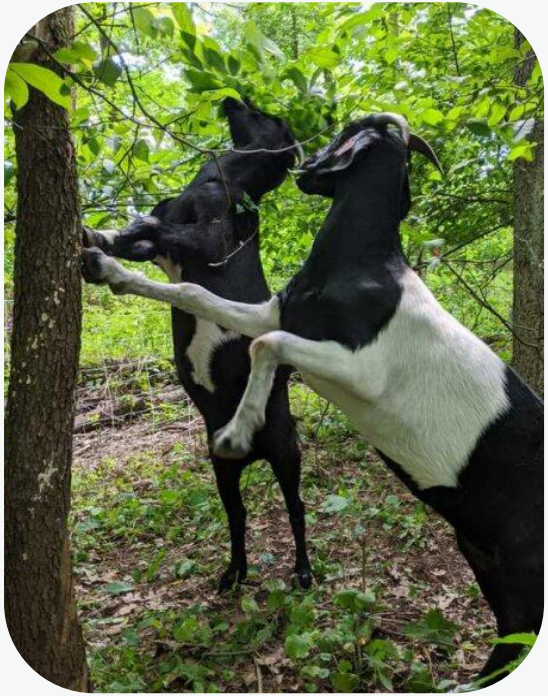


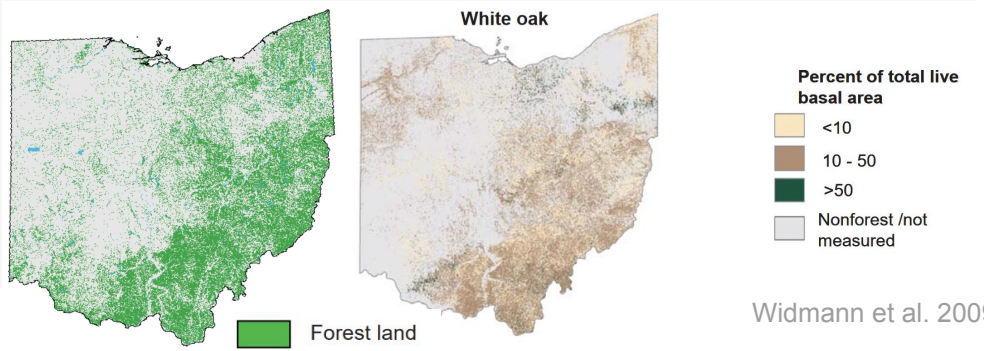
Goat browsing a research plot.
Photo credit: ADFER Lab 2019

Background

Oak-hickory forests characterized by…

- Xerophytic deciduous *Quercus* spp. and *Carya* spp.
- Shade-intolerant, relatively open understory
- Indigenous land management, cyclical burning

Illustration by Pierre Joseph Redouté 1819



Widmann et al. 2009

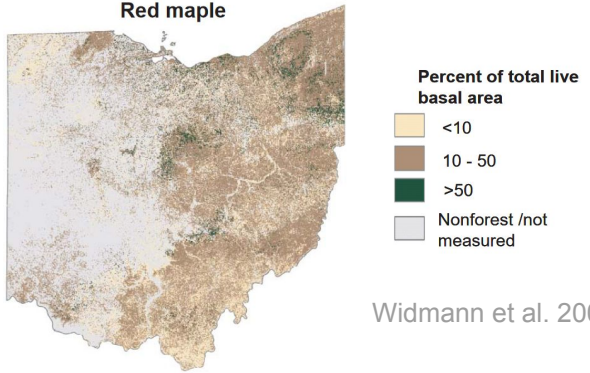
Background

Oak-hickory forests threatened by

- Invasion
- Clear Cutting Era
- Fire Suppression

→ Mesophication

Forest clear-cutting in West Virginia circa 1910.
Photo credit: West Virginia Public Broadcasting



Widmann et al. 2009

Research Context

Oak-hickory forest in Coshocton, Ohio

- Previously managed by OSU for timber
- Invasion
- Mesophication

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Invasive *Celastrus orbiculatus* at Pomerene Forest Laboratory, 2022

Research Context

Oak-hickory forest in Coshocton, Ohio

- Previously managed by OSU for timber
- Invasion
- Mesophication

Sarah Francino and Kirsten Packer in an invaded oak-hickory stand, 2022

Ch. 1 - Invasive plant management

Application of clearing and browsing treatments to forest plots.

Research Objectives

- Investigate how woody plant communities shift with time from treatment
- Determine if treatment effect is contingent upon the passage of time

Ch. 1 - Invasive plant management

Application of **clearing and browsing** treatments to forest plots.

...What about fire?

Research Objectives

- Investigate how woody plant communities shift with time from treatment
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Research Design

23 forest plots (10m radius)

- Pre-treatment vegetation assessment (2019)
- Treatment application (2019)
- Post-treatment monitoring (2020, 2021)

Treatment Application

High Intensity Grazing (6)
- 8 goats x 4 days

Low Intensity Grazing (6)
- 8 goats x 2 days

Mechanical Clearing (7)
- Targeting invasive species

Control (4)

Goat browsing a research plot.
Photo credit: ADFER Lab 2019

Vegetation Assessment

Woody plants recorded

- Trees
- Shrubs
- Vines & Scramblers

Sarah Francino, Kirsten Packer, Adriana Dacres in an invaded research plot collecting data, 2022

Vegetation Assessment

FLN *Forest Structure & Composition Monitoring Protocol Standard*

- large saplings (1.5-4m) recorded across plots
- seedlings (0-50cm) and saplings (50-150cm) in subplots

Control plots *not* assessed in 2020 due to COVID-19 limitations.

Data Analysis

Plant community composition

- Non-metric MultiDimensional Scaling (NMDS) Ordinations

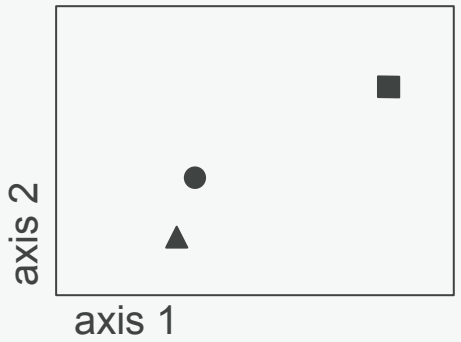
Treatment and Year effects

- Linear model and ANOVA

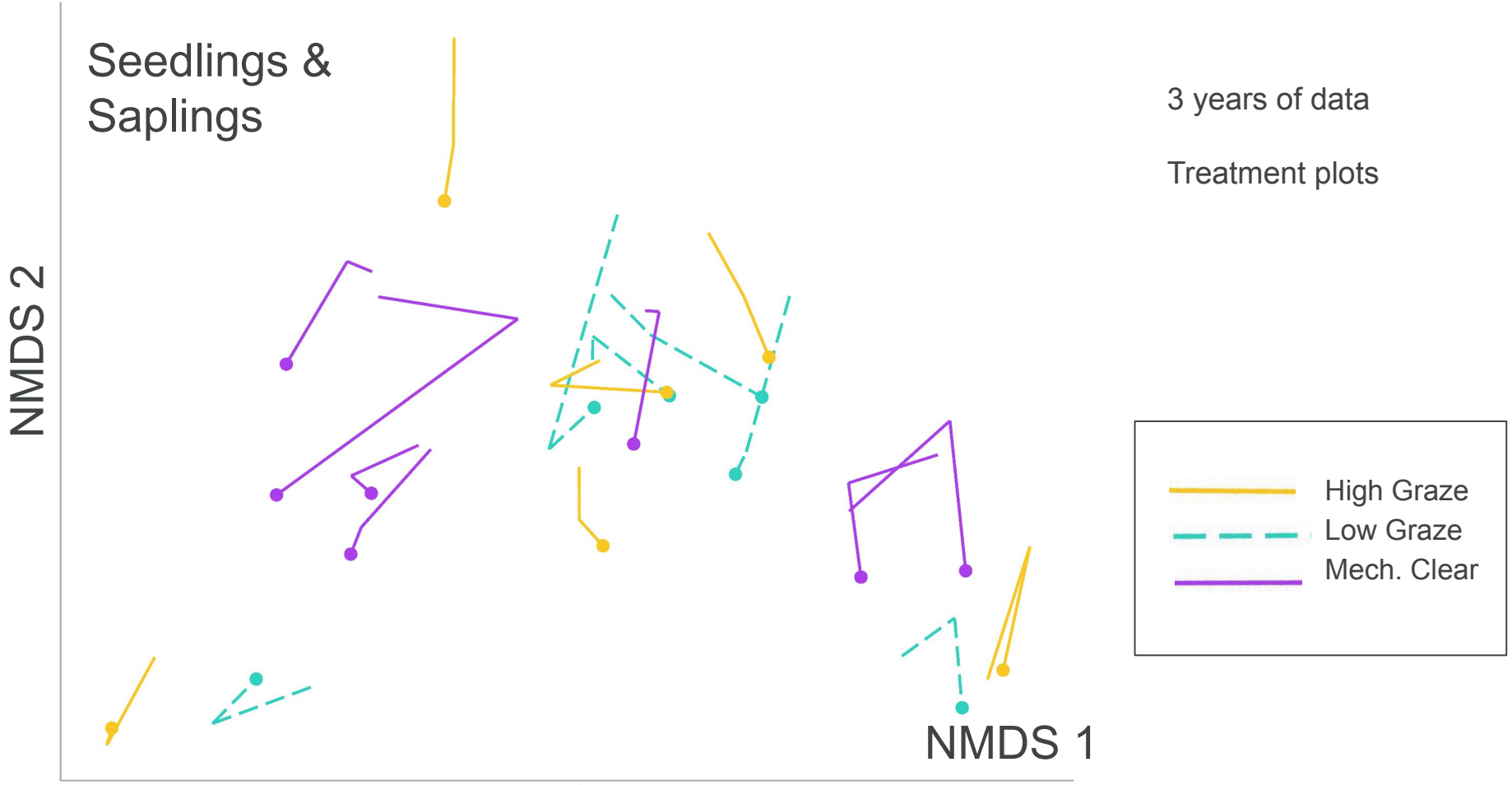
Data Analysis - Community Composition

NMDS Ordinations

- graph wherein axes represent compositional gradients
- proximity of points in the graph suggest compositional similarities
- separate ordinations for…
  - large saplings
  - seedlings & saplings



Results - Community Composition



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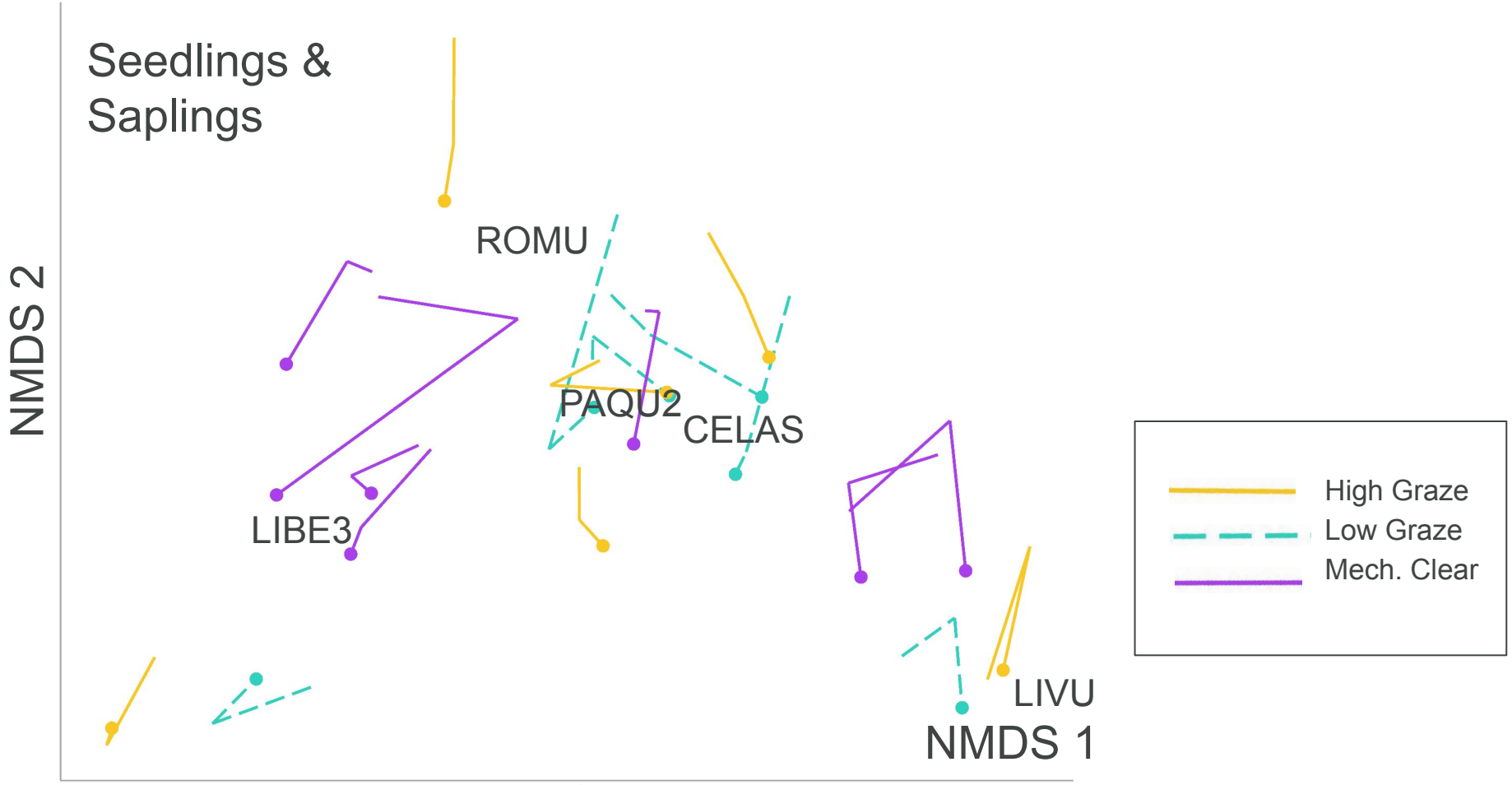

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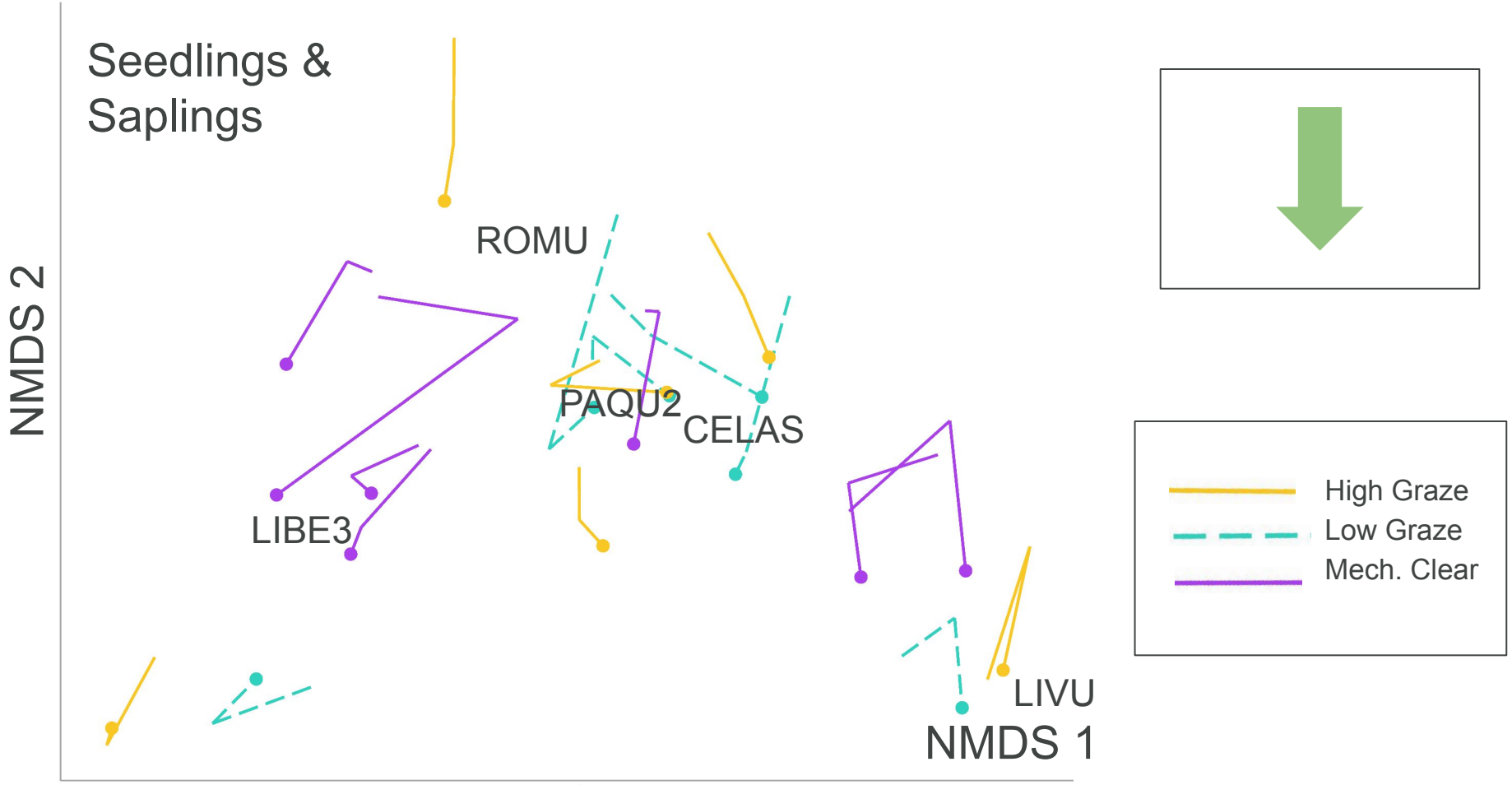

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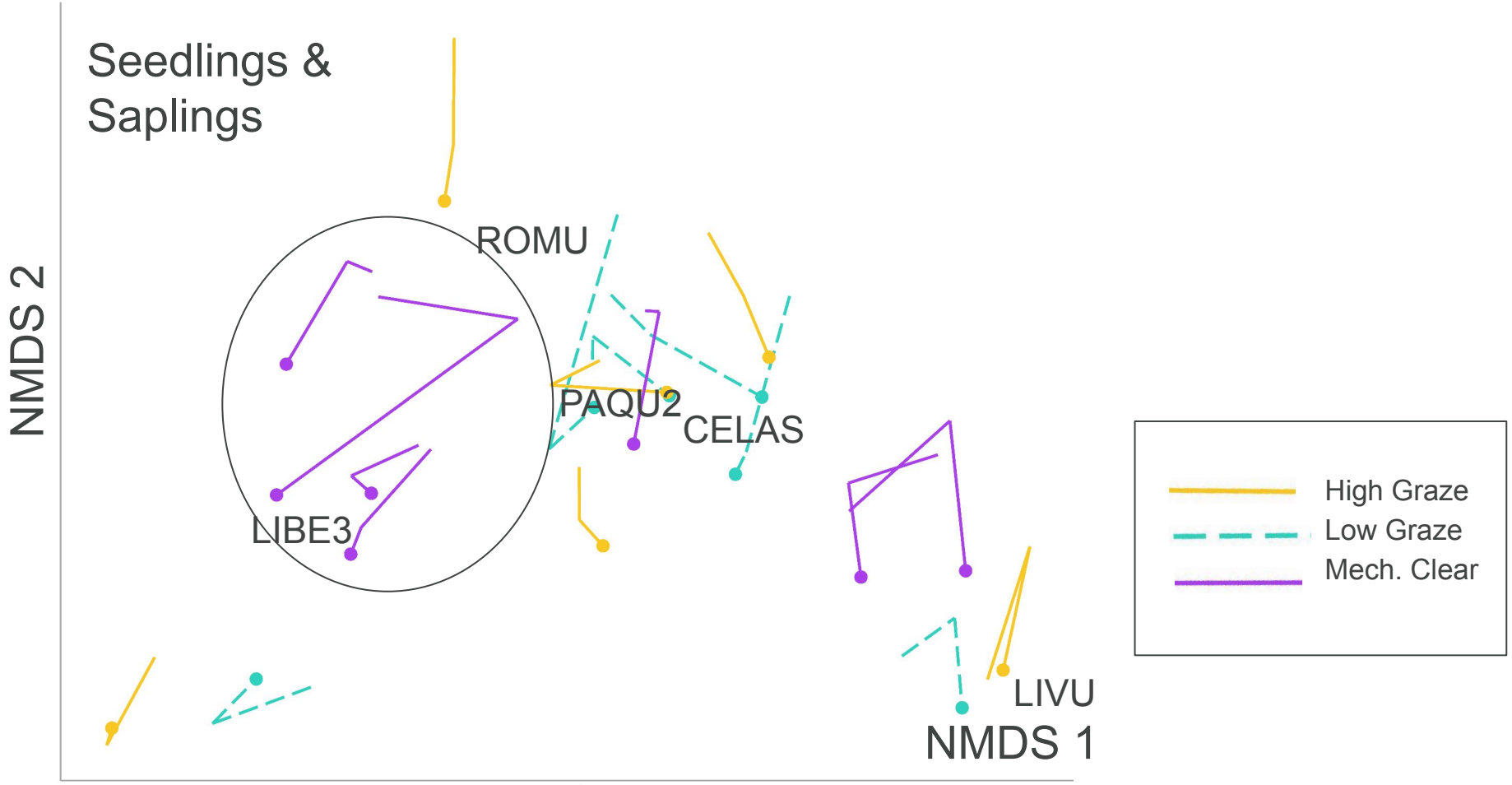

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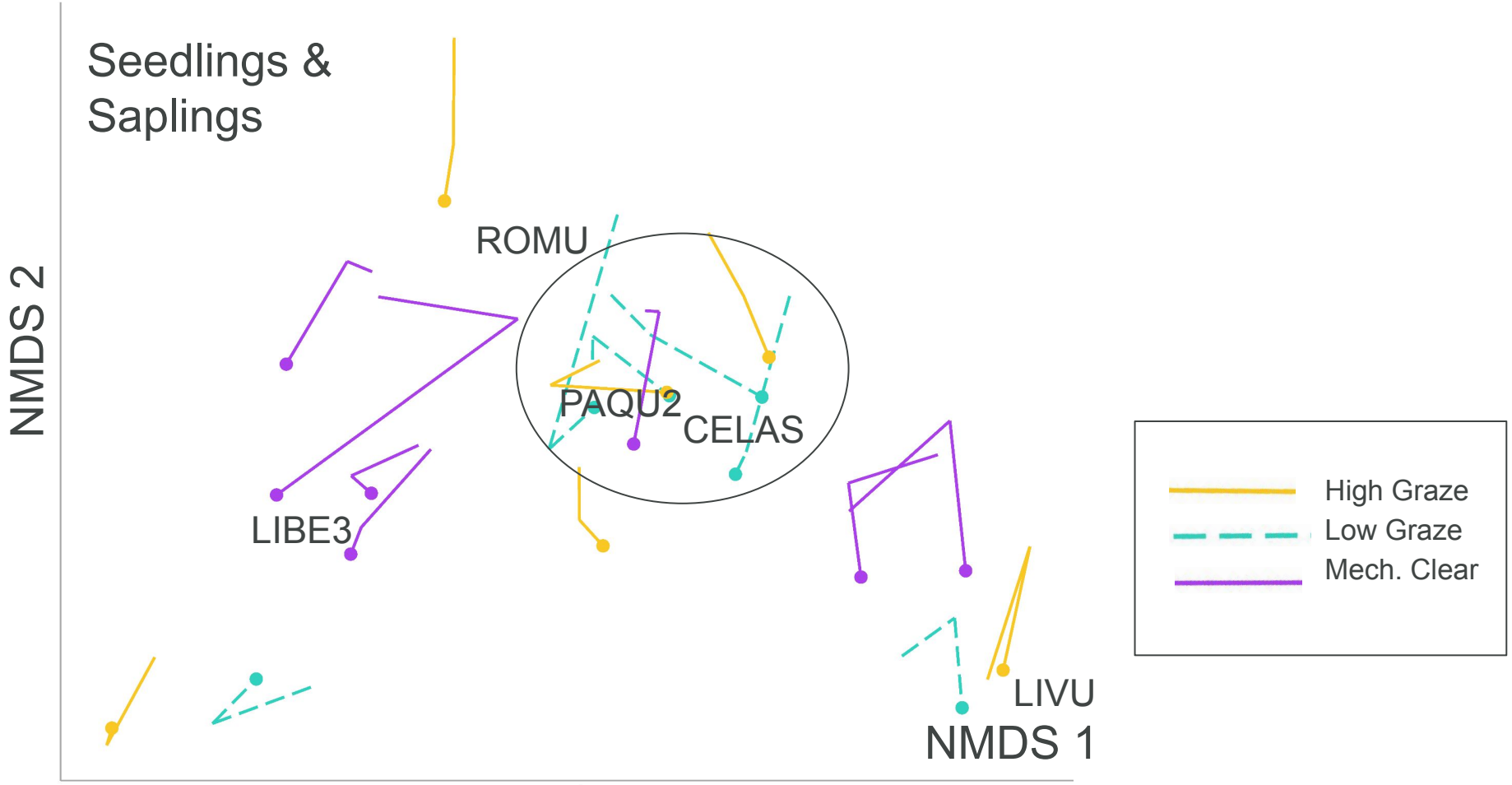

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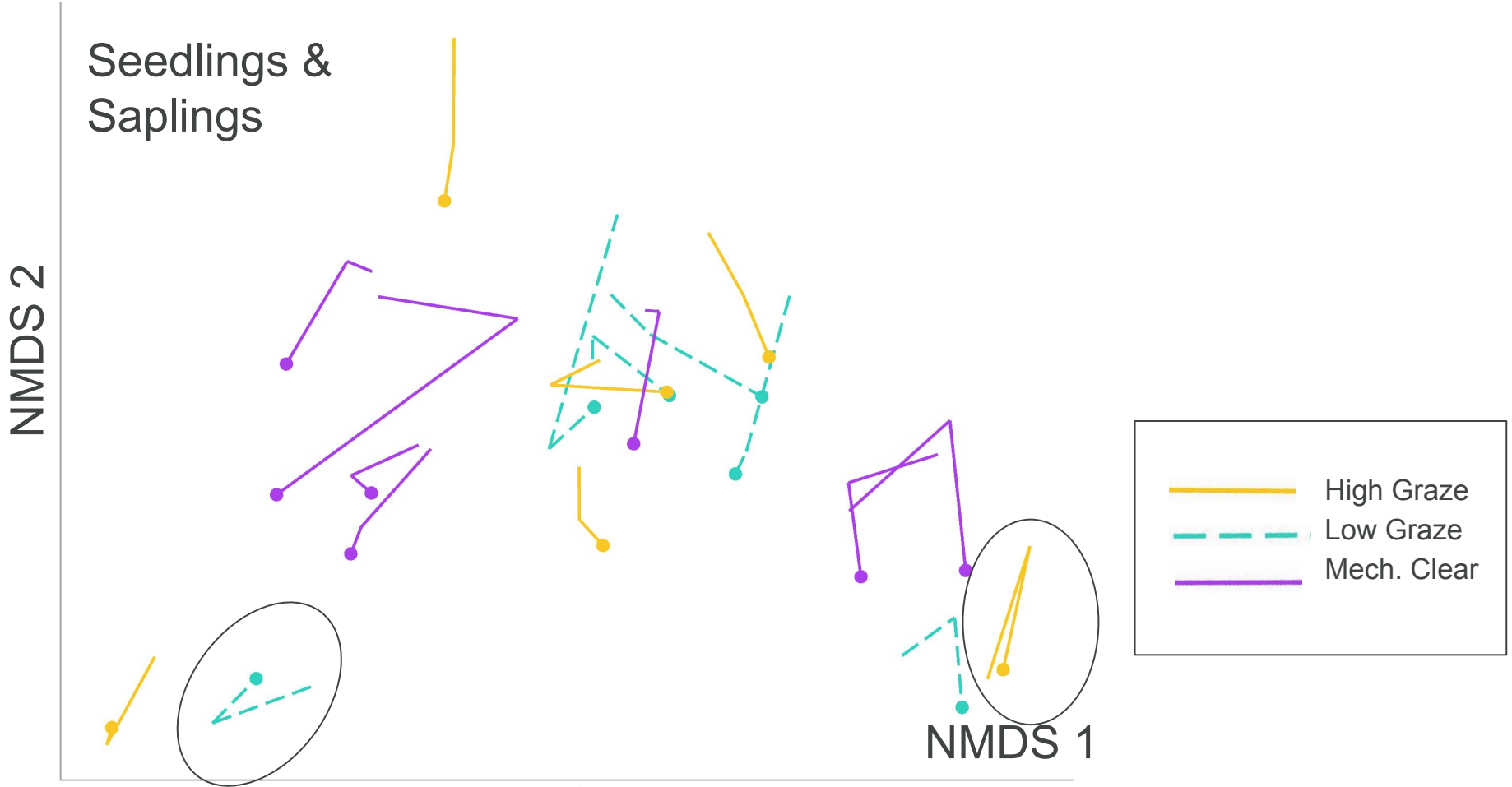

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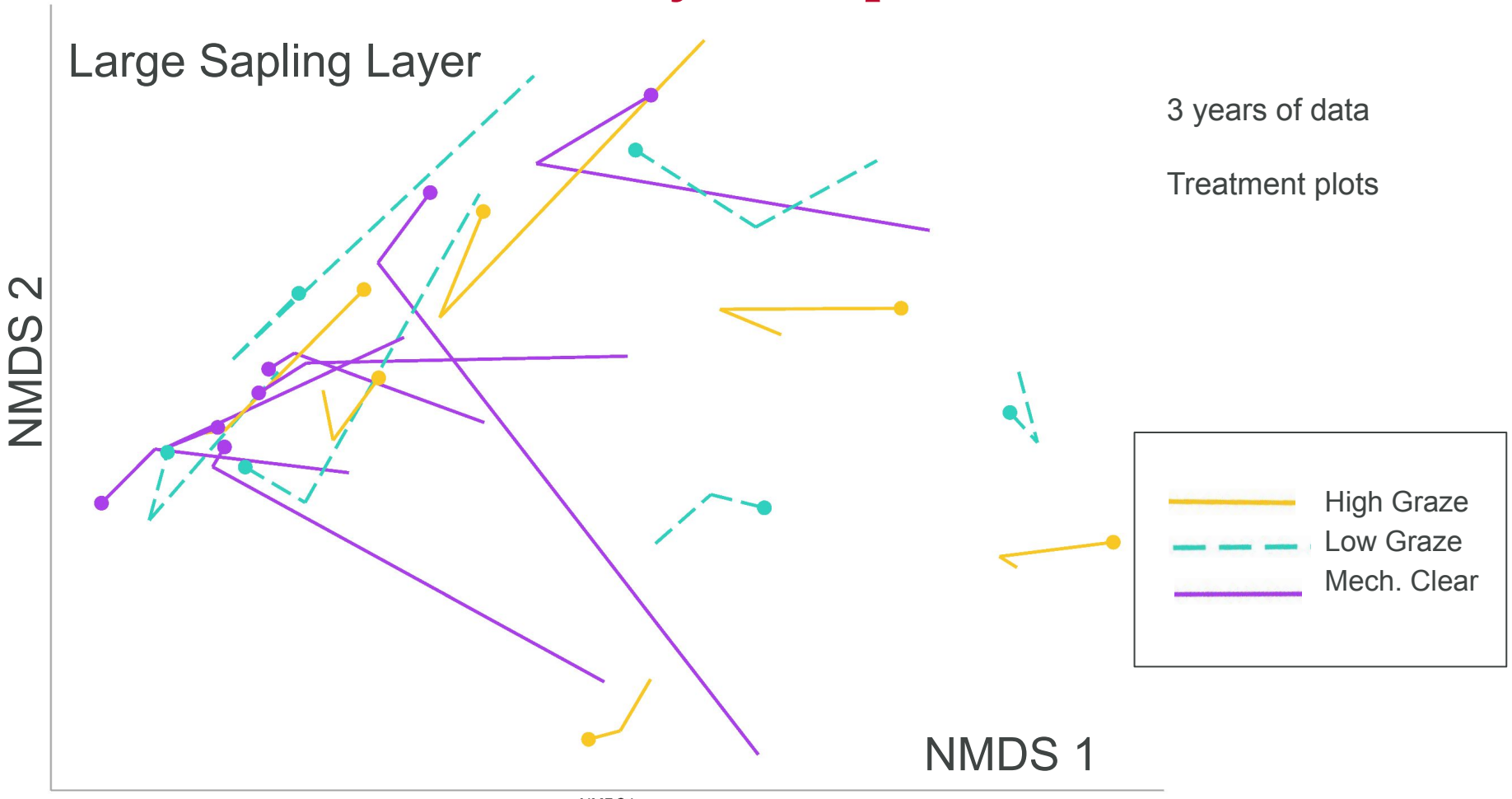

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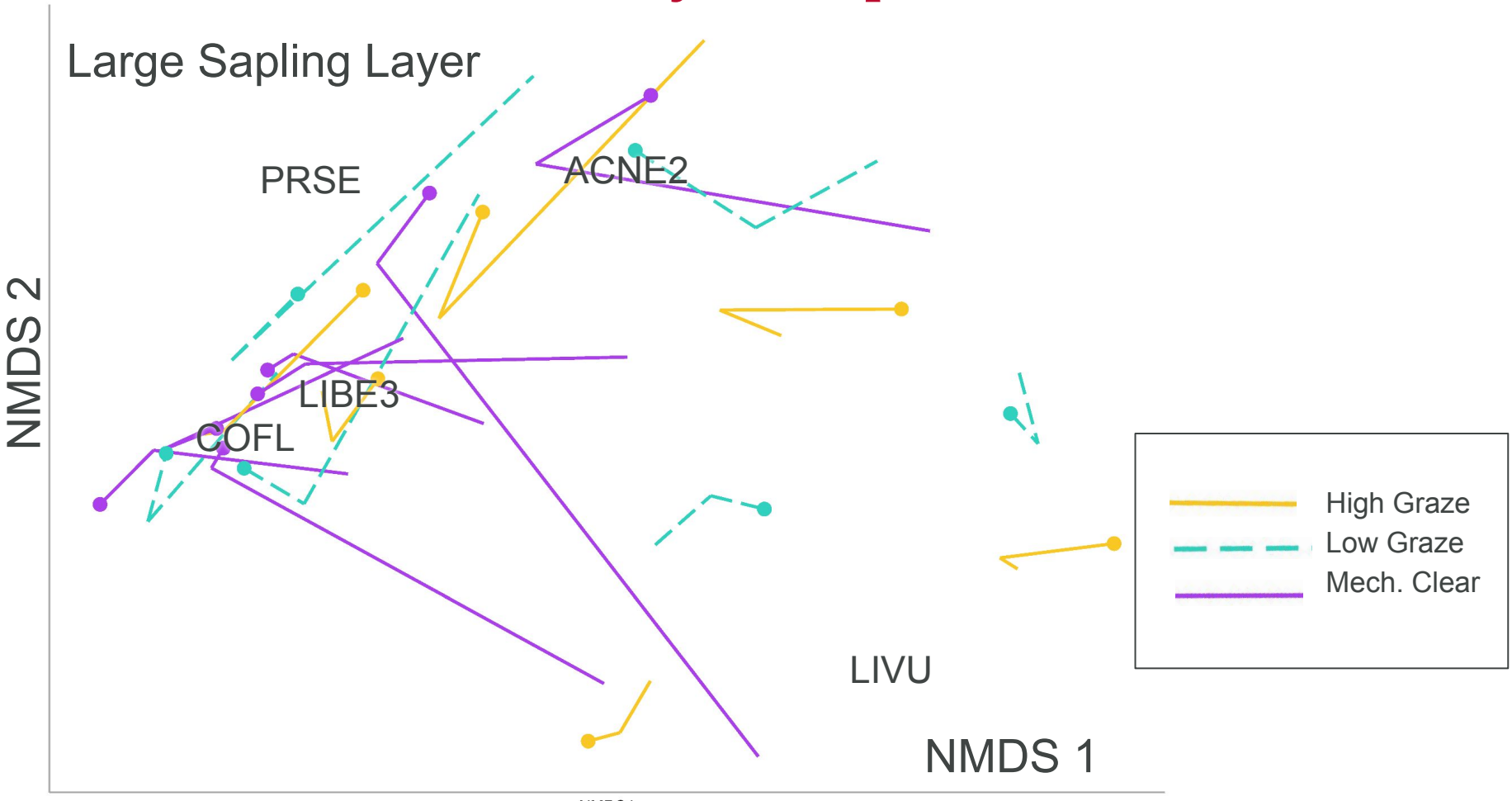

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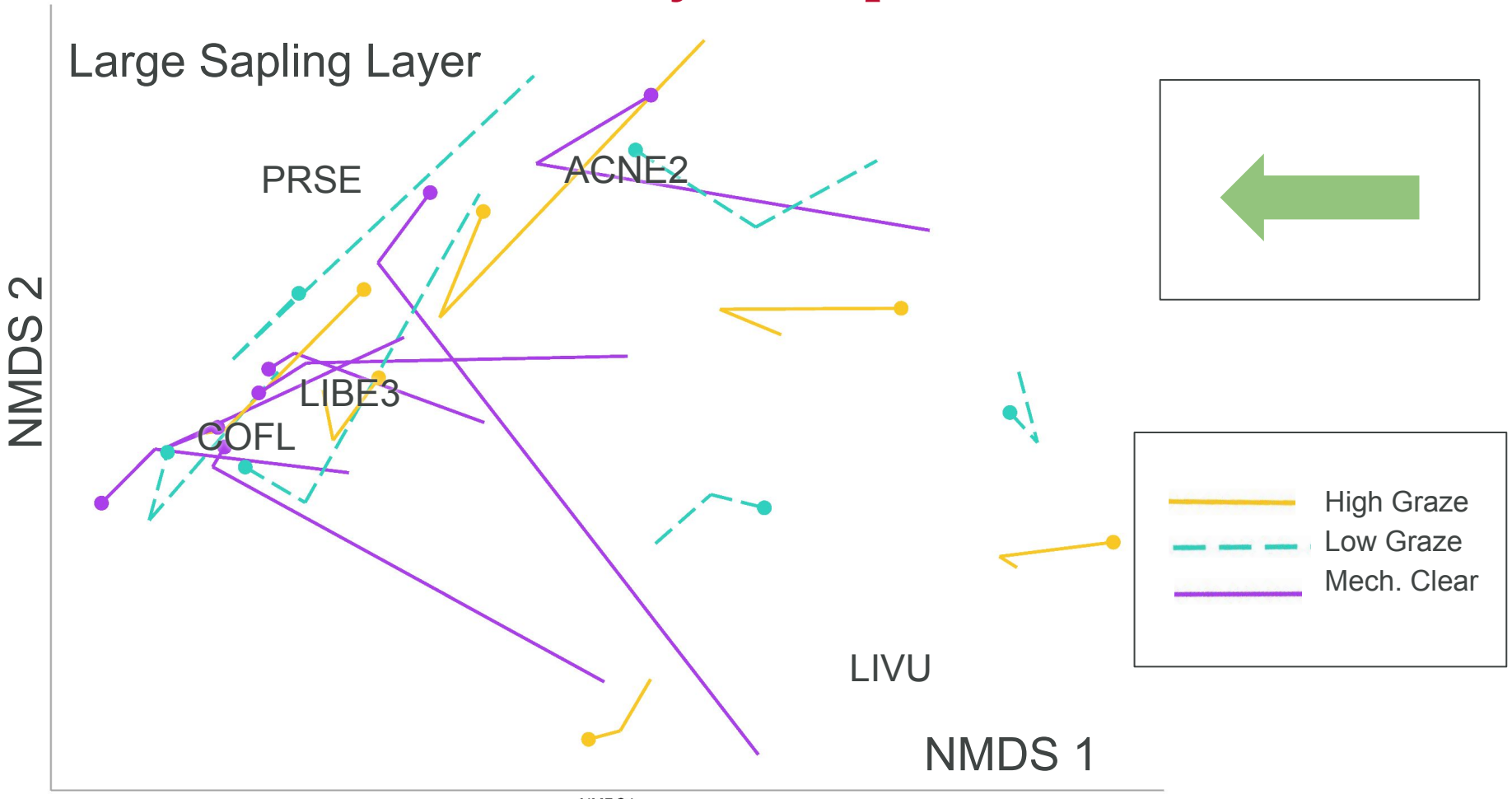

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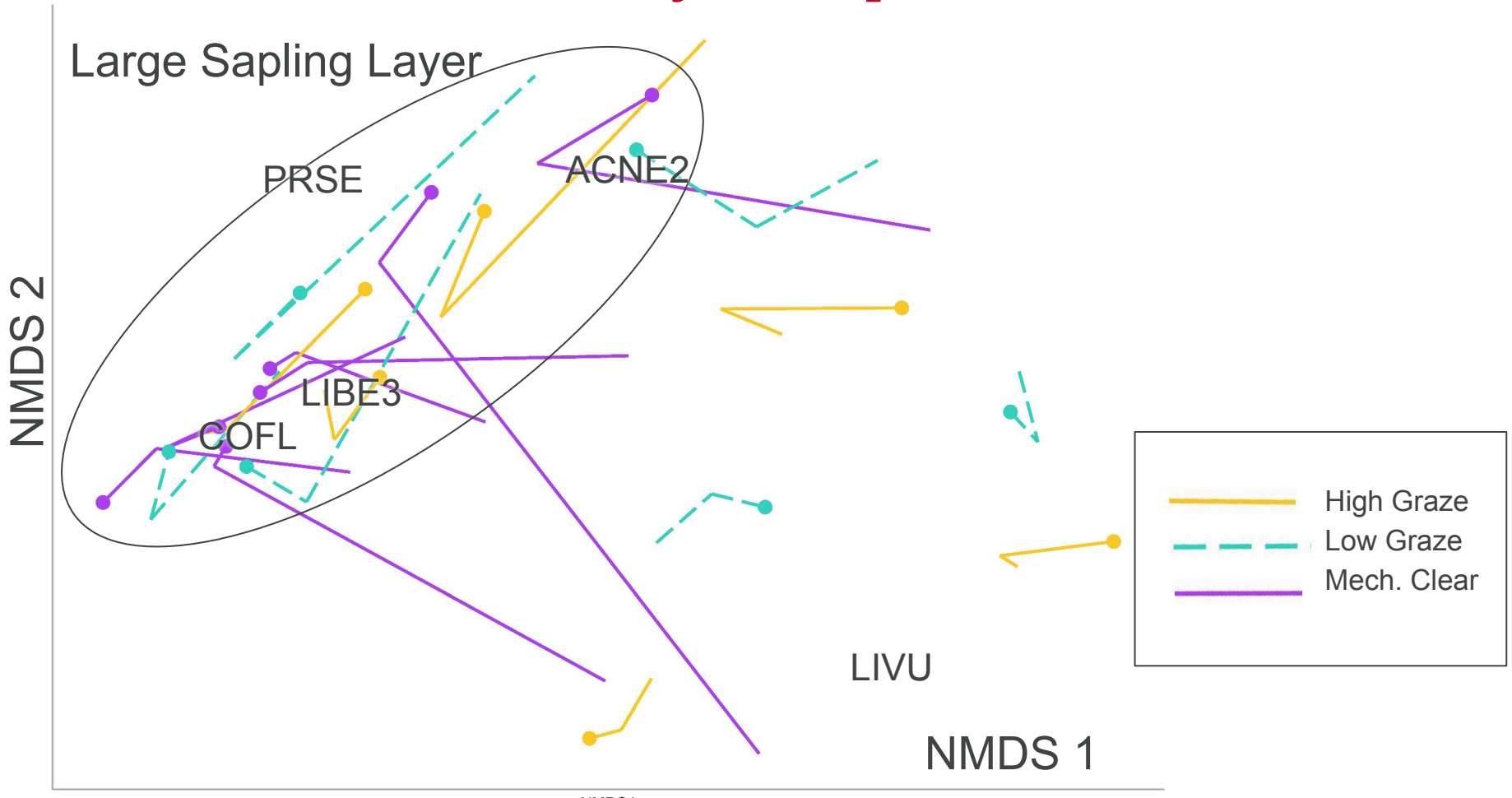

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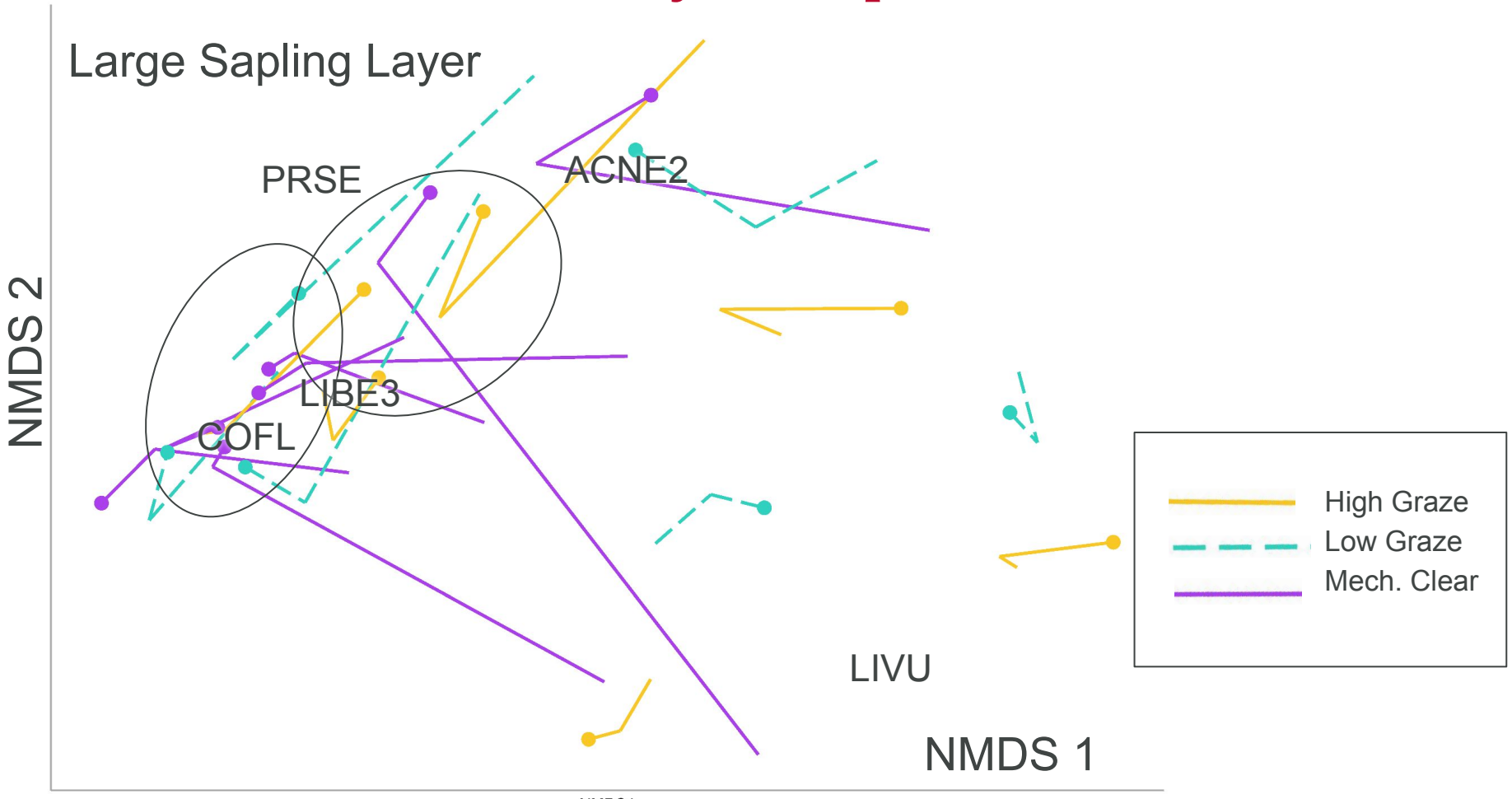

Data Analysis

How does community composition shift with time from treatment?

- **NMDS ordinations**

Is treatment effect contingent upon passage of time?

- Linear model and ANOVA

Data Analysis

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- NMDS ordinations

Is treatment effect contingent upon passage of time?

- **Linear model and ANOVA**

Data Analysis - Treatment and Year Effects

Plot densities summed by Plant Functional Types (PFTs)

- e.g., Invasive Shrub Seedlings

Linear models and ANOVA

- first model (BACI) to maximize plots analyzed
- second model (BA) to maximize years analyzed
- third model (BA) with proportional densities

Results - Treatment and Year Effects

Proportional density model detected evidence for…

PFT	Effect	Strength of Evidence	*P*-value
Native Shrub Saplings	Treatment	Weak	0.073
Invasive Shrub Seedlings	Year	Weak	0.059
Invasive Shrub Saplings	Treatment	Strong	<0.001
Native Vines & Scramblers	Year	Moderate	0.022
Invasive Vines & Scramblers	Year	Weak	0.072

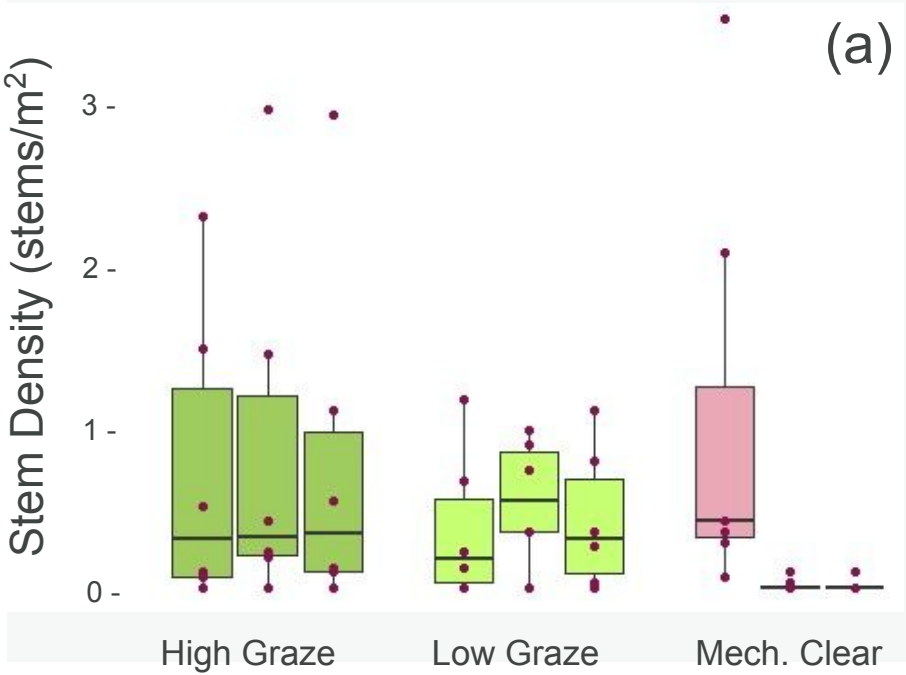
(No effect evidence found in remaining PFTs)

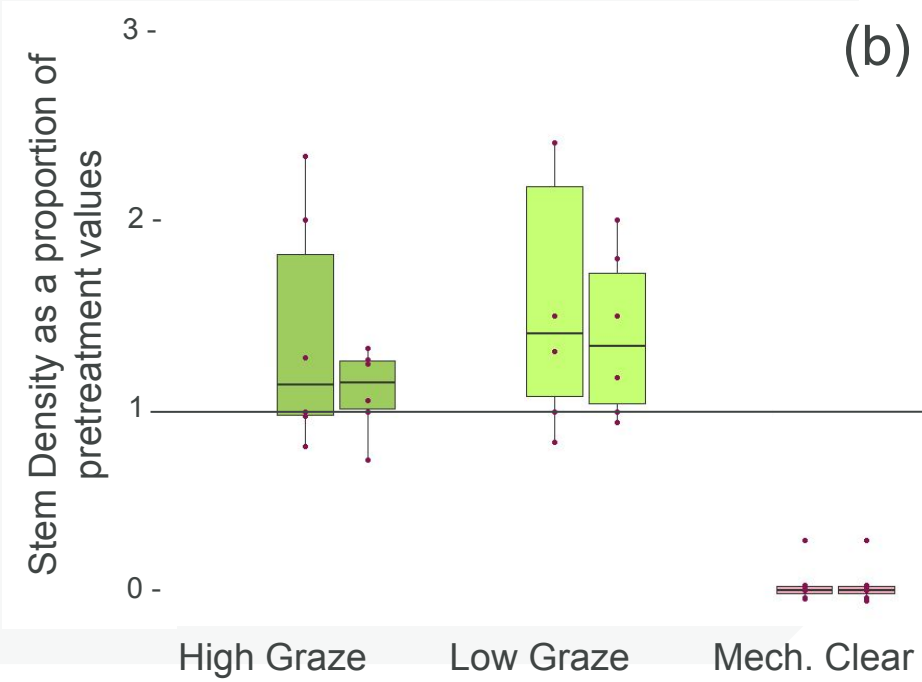
Results - Treatment x Year Interactions

Density models detected interaction in only one PFT

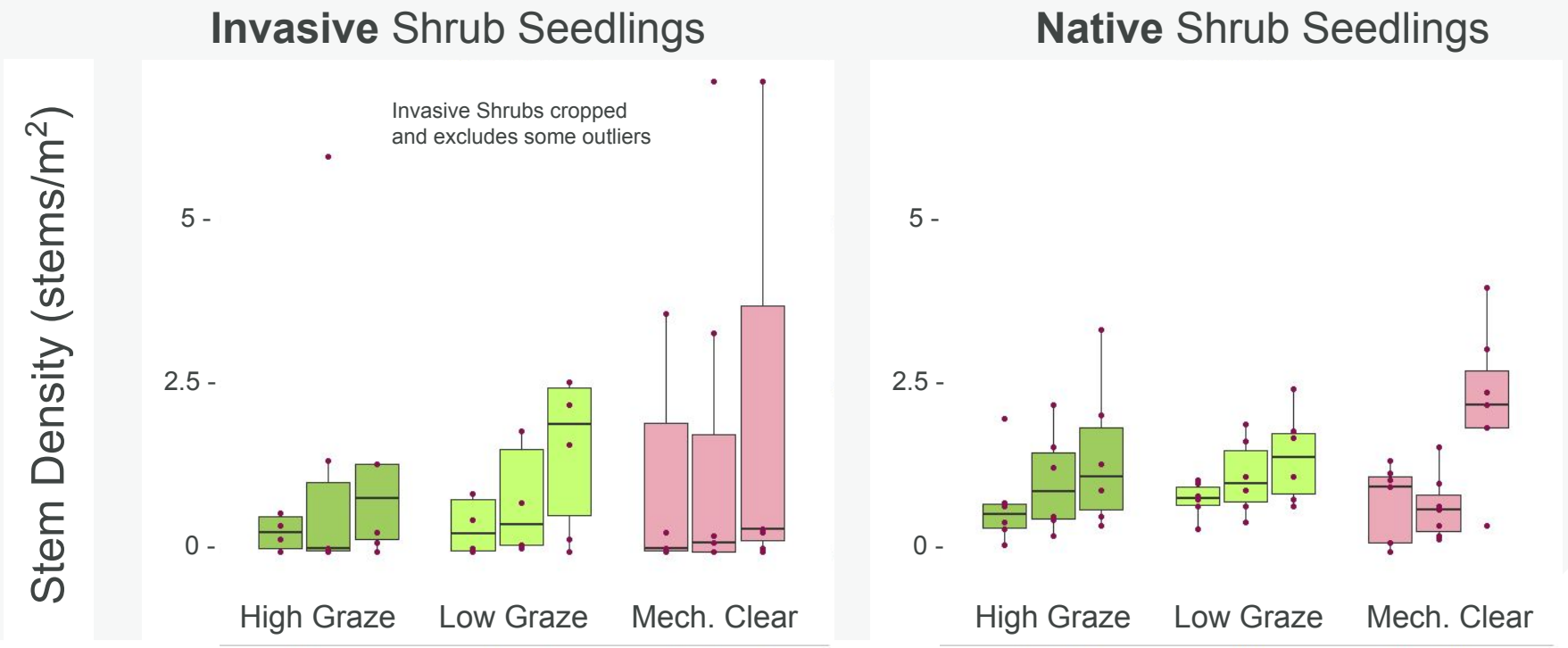
PFT	**Model**	**Strength of Evidence**	***P*-value**
Invasive Shrub Large Saplings	BACI	Moderate	0.014
”	BA	Strong	0.009

Invasive Shrub Large Saplings (1.5-4m)

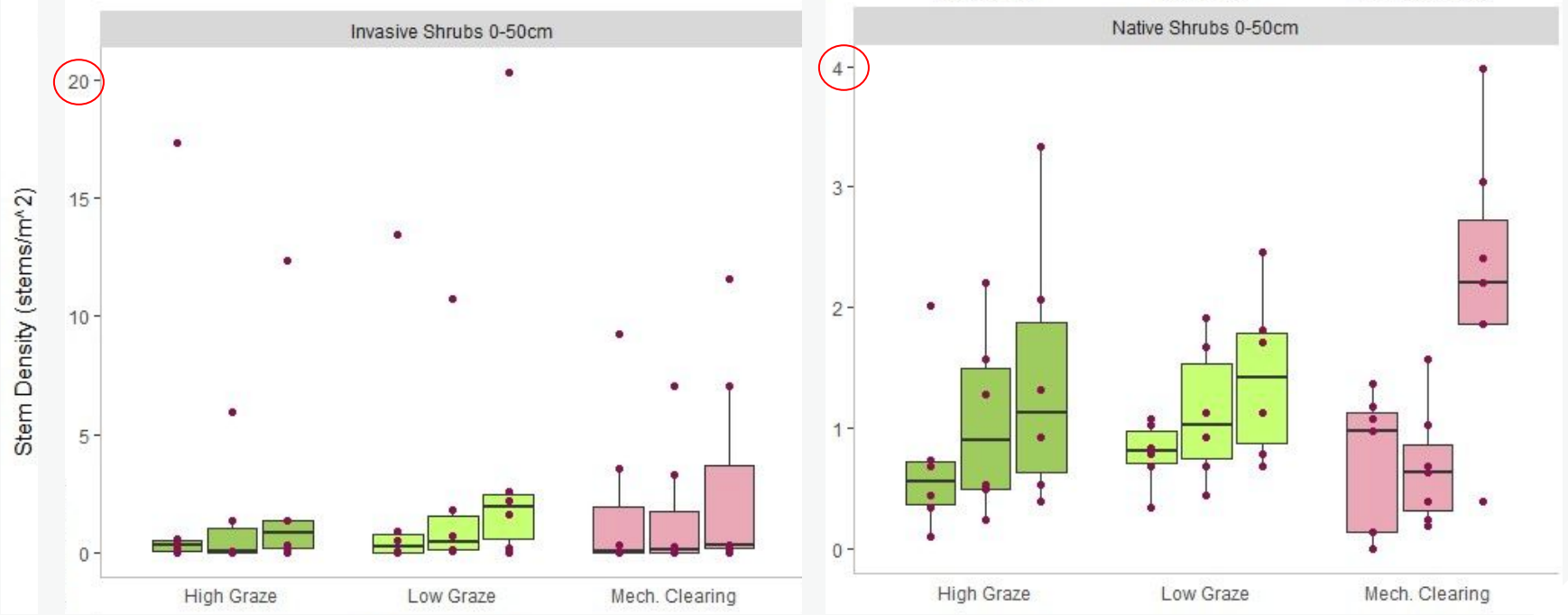




Seedling Size Class (0-50cm)



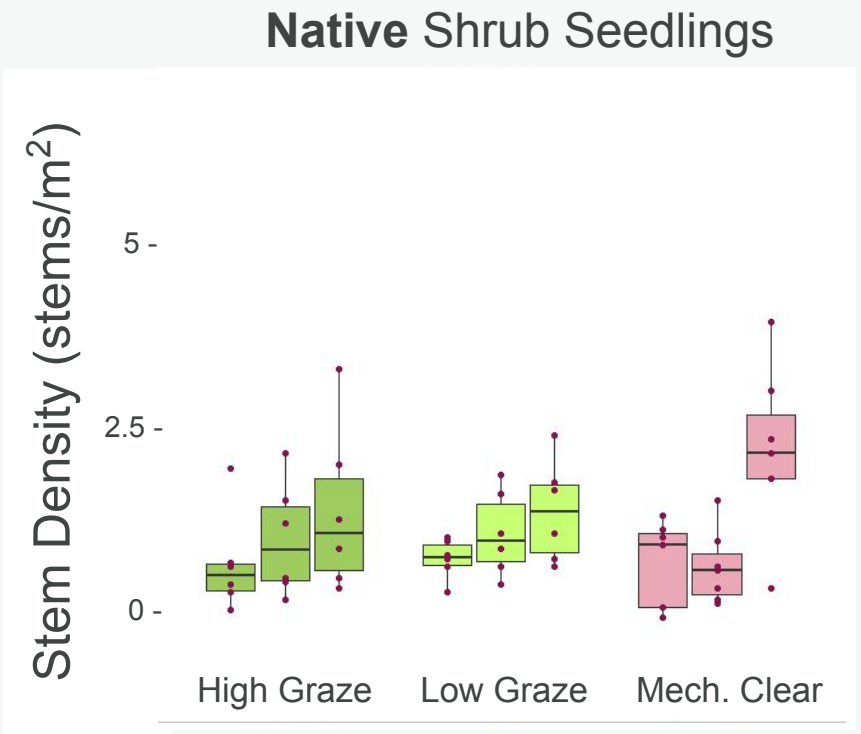
Seedling Size class



Seedlings - Shrubs

Native seedlings

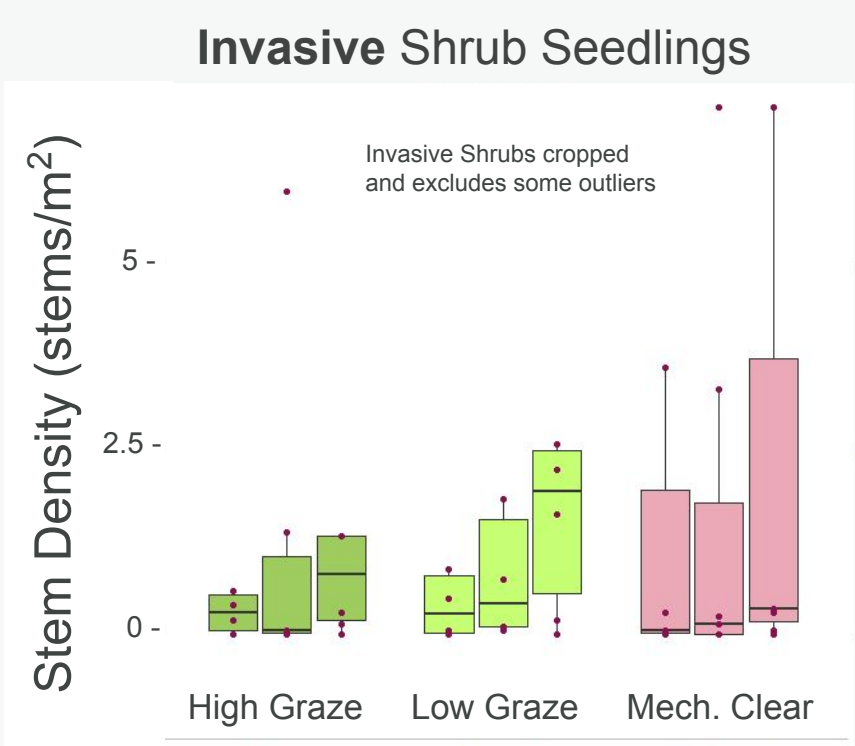
- Benefit from increased light availability?



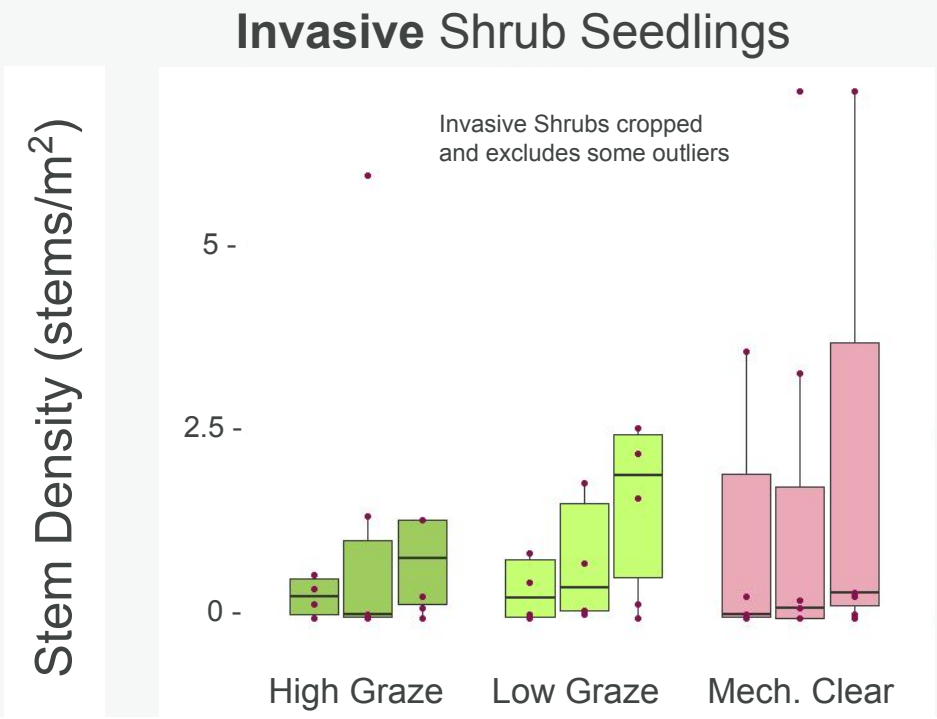
Seedlings - Shrubs

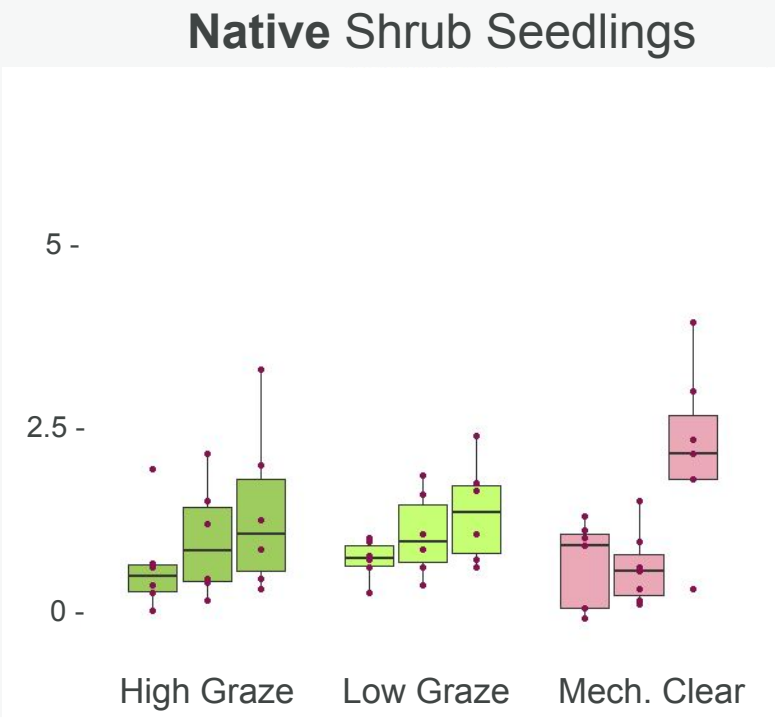
Invasive “seedlings”

- Likely includes resprouting from stems cut/browsed in all size classes.



Seedling Size Class





Limitations

Noisy data

Sample size

Covid interference

Pruning effect

Before and after browsing in a research plot.
Photo credit: ADFER Lab 2019

Limitations

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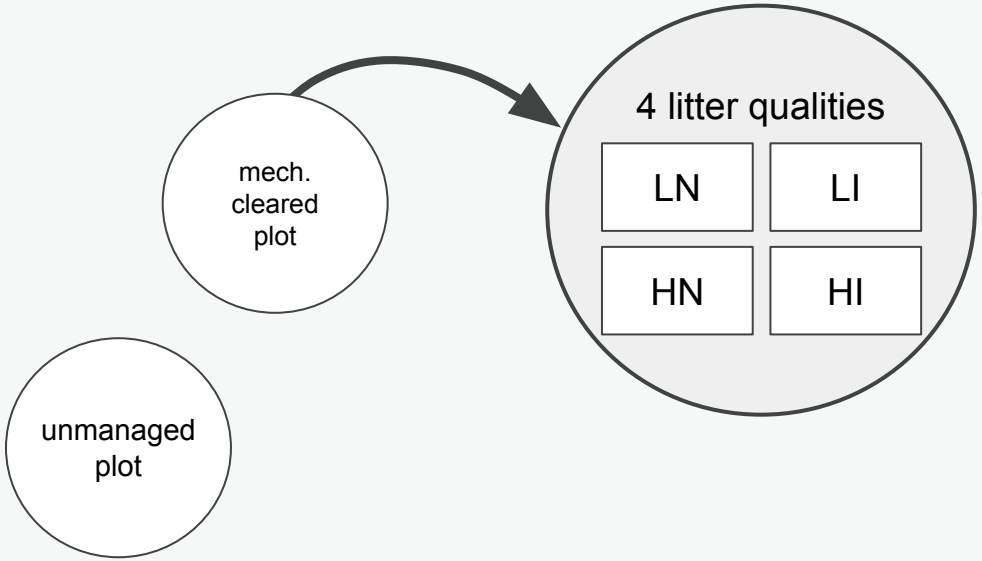
Ch. 2 - Litter decomposition under invasion

Burial of litter across invaded forest: managed & unmanaged plots.

Research Objectives

- Investigate how litter of different qualities decomposes over time
- Determine if invasive plant management affects decomposition of litter

Research Design



LN low C:N native
LI low C:N invasive

HN high C:N native
HI high C:N invasive

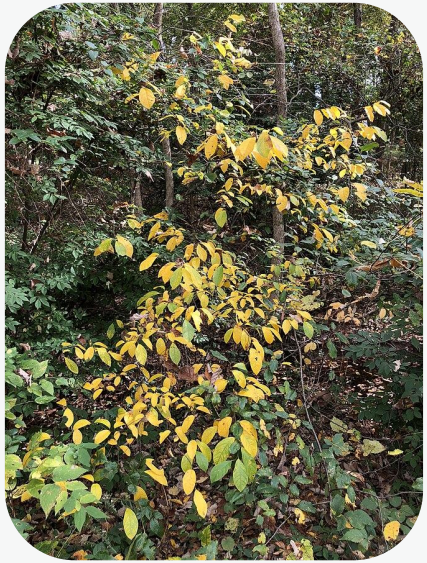
Species Sampled

Native:

- *Lindera benzoin* (low C:N)
- *Prunus serotina* (high C:N)

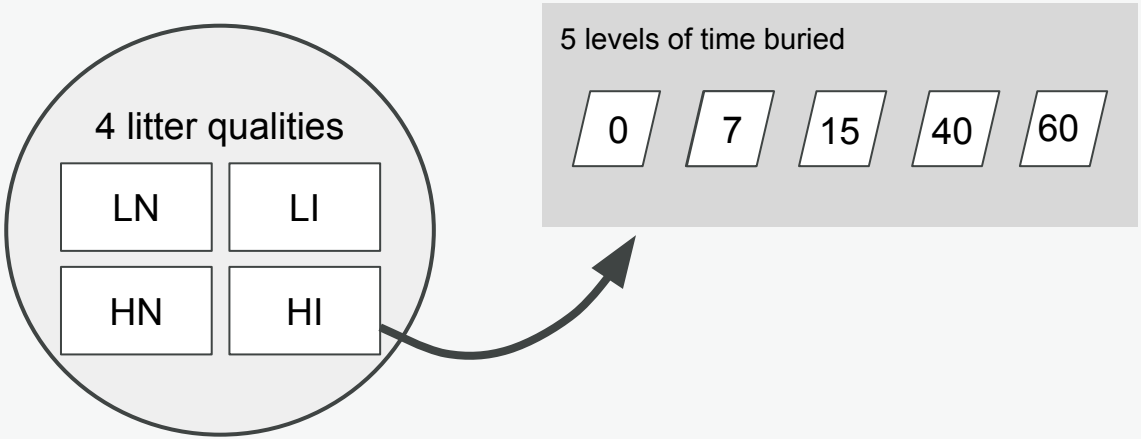
Invasive:

- *Celastrus orbiculatus* (low C:N)
- *Ligustrum vulgare* (high C:N)



Spicebush foliage in autumn.
Photo credit: Famartin, Wikimedia commons

Time-buried factor



LN low C:N native
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Adapting to sample loss

Sample disturbance by wildlife, 2022

Litter bag assembly/processing

Processing

- rinsing
- separating
- drying
- weighing

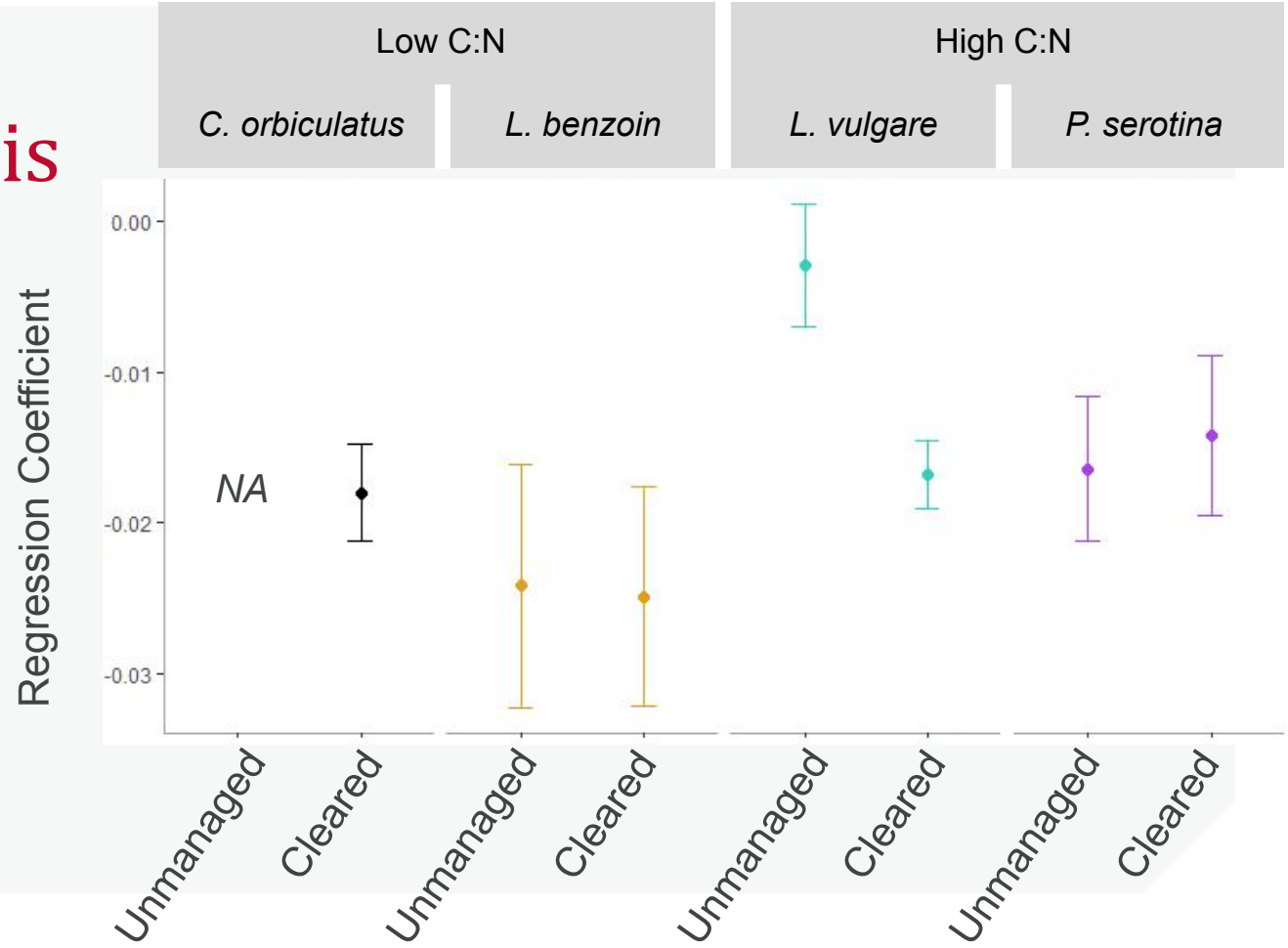
Sewing litter bags, exhuming buried bags, cleaning litter samples 2022

Data Analysis

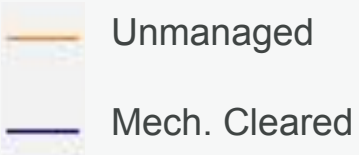
Linear models of log(% mass remaining) by time (days buried).

	Mechanically Cleared				Unmanaged			
	Estimate	SE	P	R2	Estimate	SE	P	R2
P. serotina Native High C:N	-0.014	0.003	0.002	0.793	-0.016	0.002	<0.001	0.846
L. vulgare Invasive High C:N	-0.017	0.001	<0.001	0.962	-0.003	0.002	0.196	0.086
L. benzoin Native Low C:N	-0.025	0.004	0.001	0.863	-0.024	0.004	0.001	0.808
C. orbiculatus Invasive Low C:N	-0.018	0.001	0.008	0.975		*NA*		

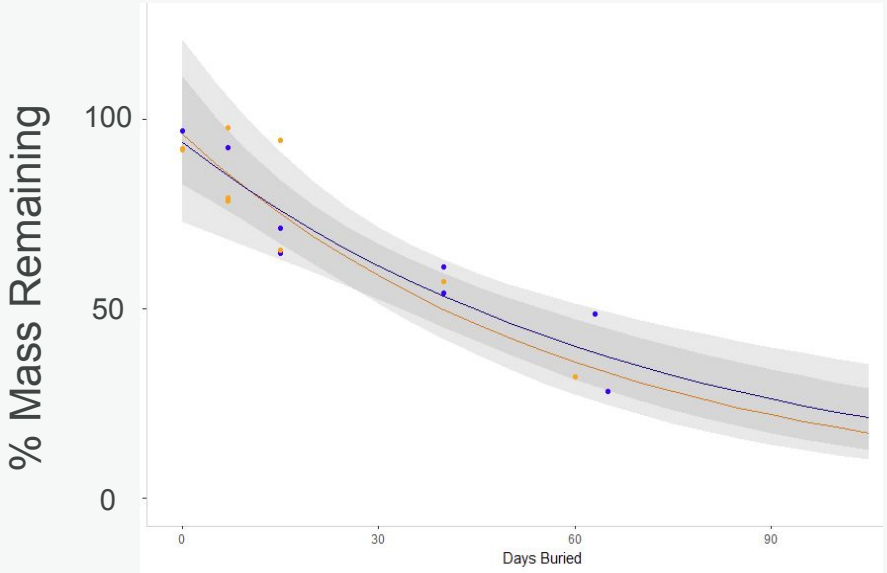
Data Analysis



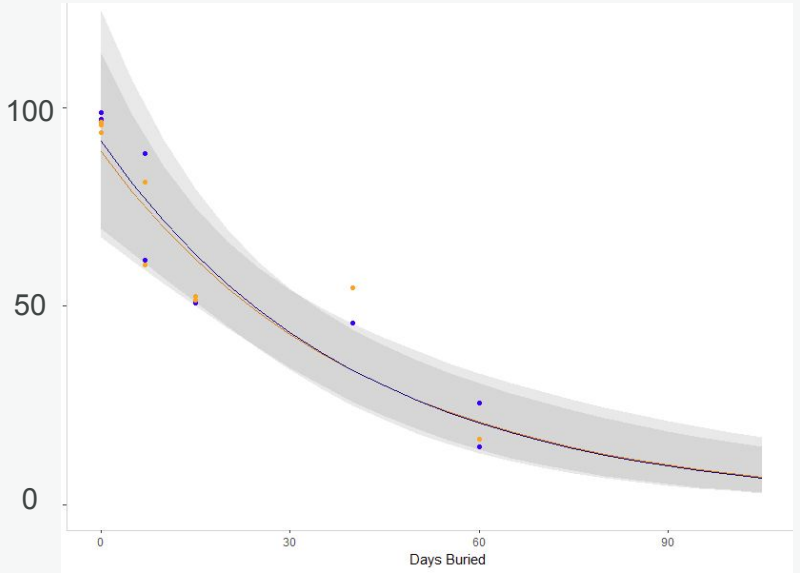
Decomposition Curves



P. serotina (high C:N native)



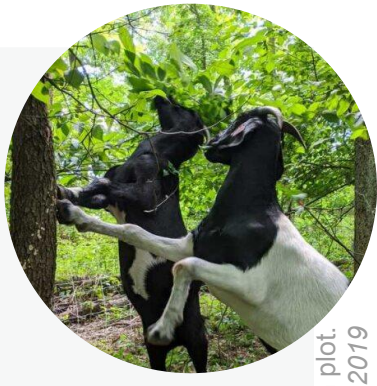
L. benzoin (low C:N native)



Limitations

- Litter in the study area does not resemble litter that has senesced
- Could be improved with more sample material
- Sample loss

Key Conclusions



Goat browsing a research plot.
Photo credit: ADFER Lab 2019

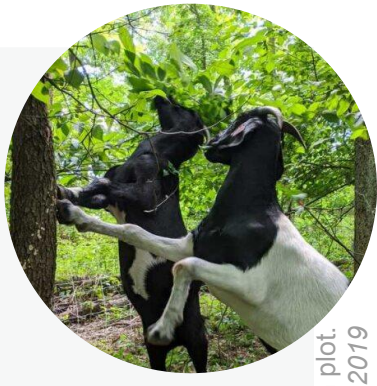
Ch. 1

- Additional variables could further illuminate browsing impacts.
- Mechanical Clearing most reliable for invasive removal.
- Resprouting necessitates long term management.

Ch. 2

- No clear differences between cleared and unmanaged decomp.
- Reiterates need for repeat and long term management to create desired change.

Key Conclusions



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Thank you!