Tundra vegetation change has no net impact on litter decomposability

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E³ DTP Edinburgh, Earth and Environment Doctoral Training Partnership
NERC SCIENCE OF THE ENVIRONMENT

How will climate warming affect tundra vegetation?

composition

function

What are the consequences of these changes for **ecosystem function**?

Introduction

Introduction

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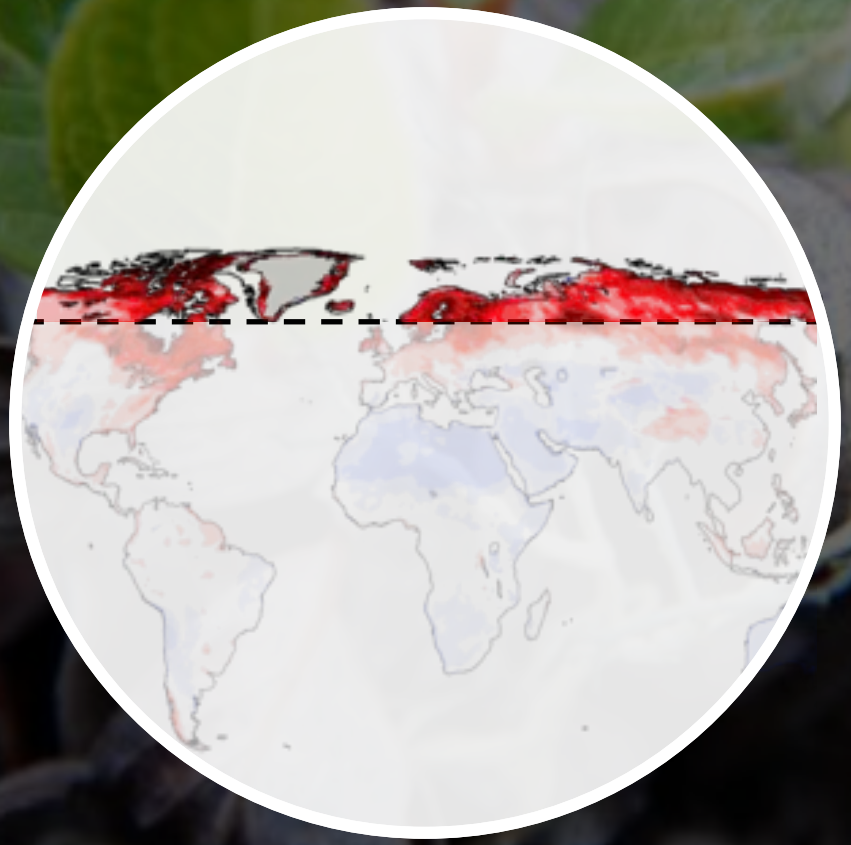
Introduction



Crowther *et al.* (2016) Nature

Introduction

Introduction

Introduction

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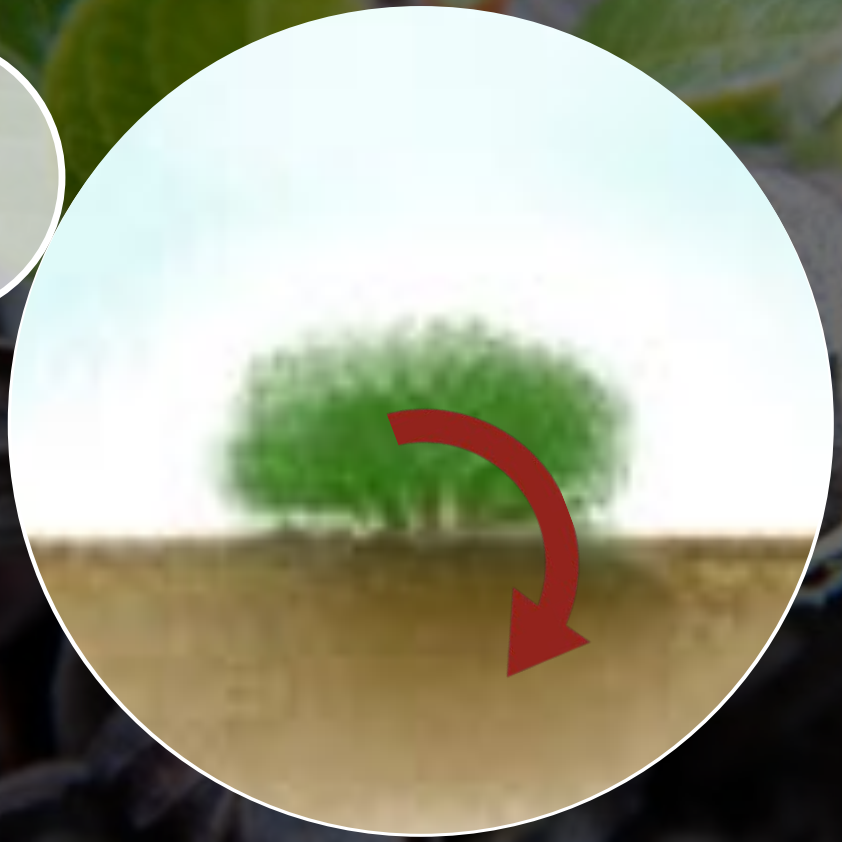

Introduction

1

Cornelissen *et al.* (2007) Ecology Letters

Introduction

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Introduction

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Introduction

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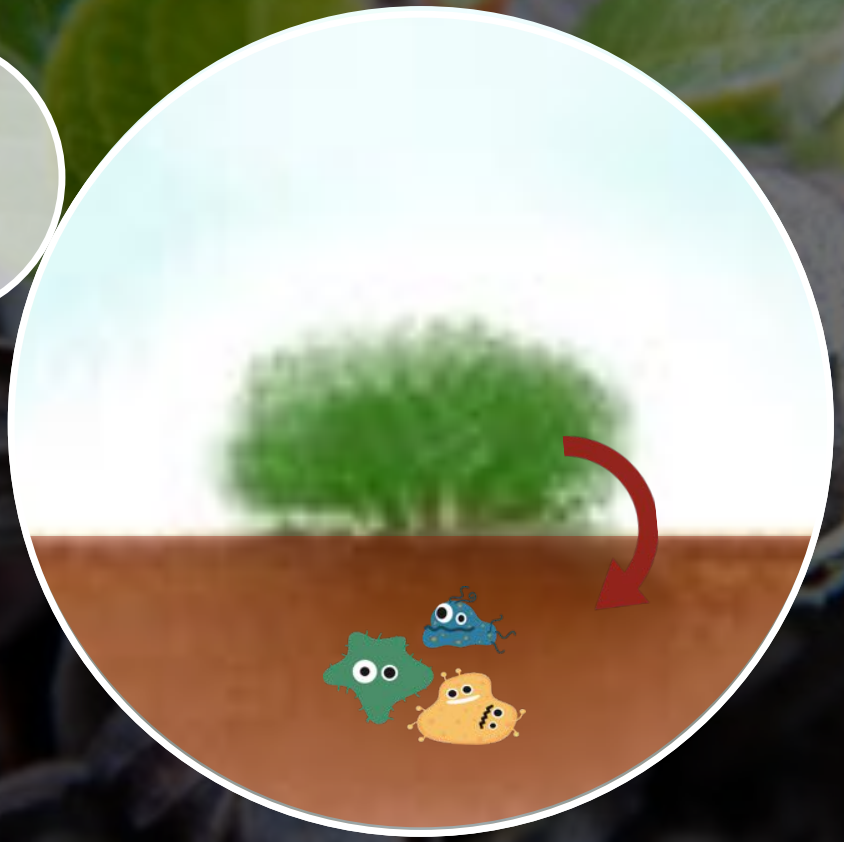

Sistla *et al.*, (2013) Nature

Introduction

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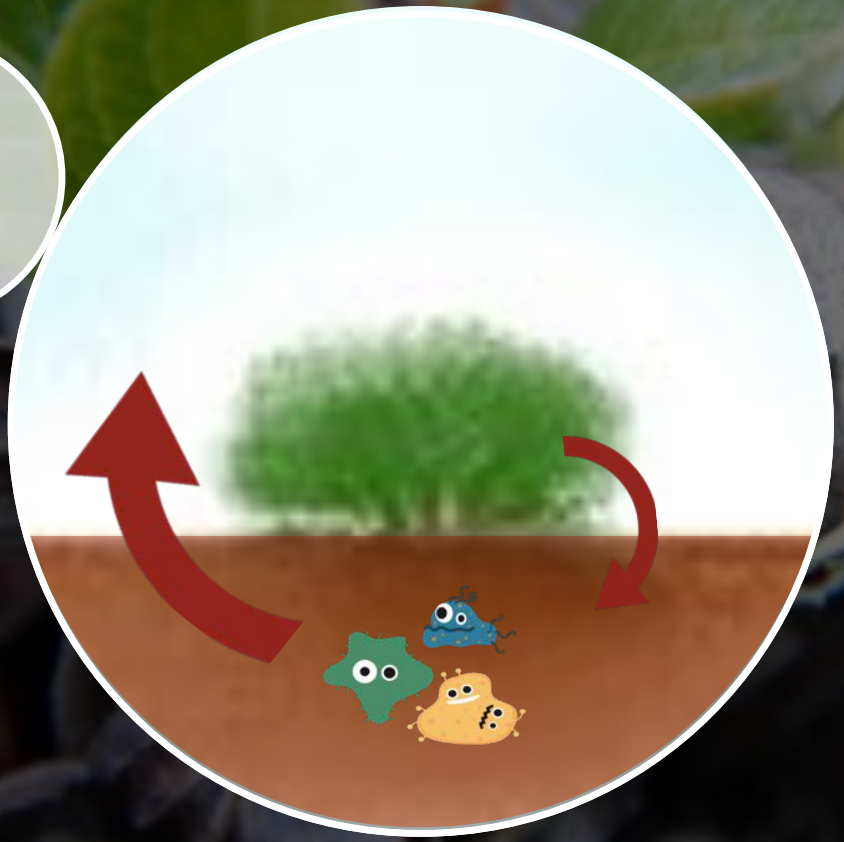

Sistla *et al.*, (2013) Nature

Introduction

3

Thomas et al, *in prep*

Introduction

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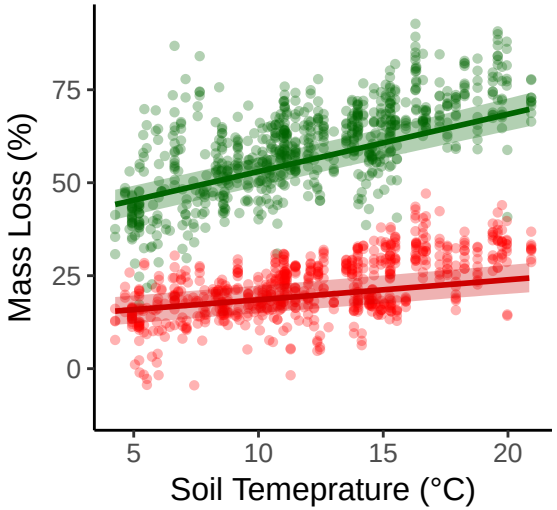

Thomas et al, *in prep*

Introduction

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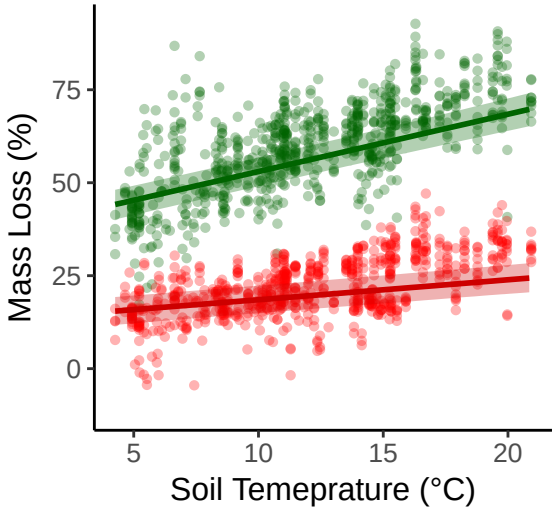

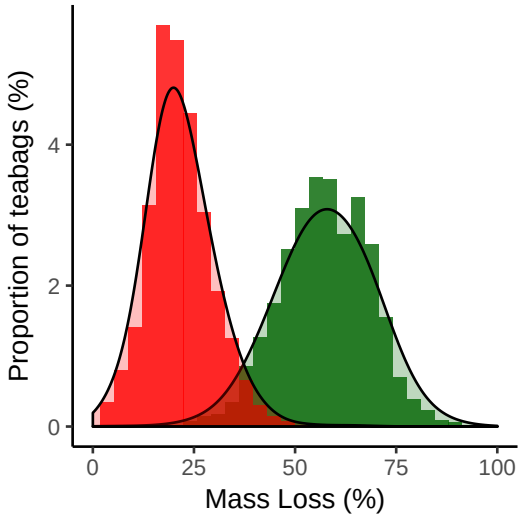

Thomas et al, *in prep*

Introduction

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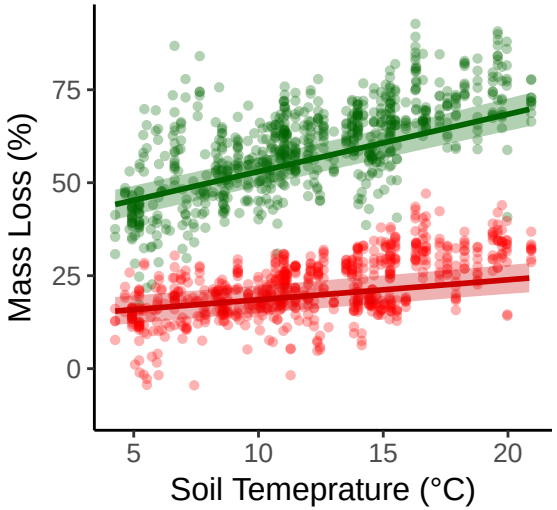

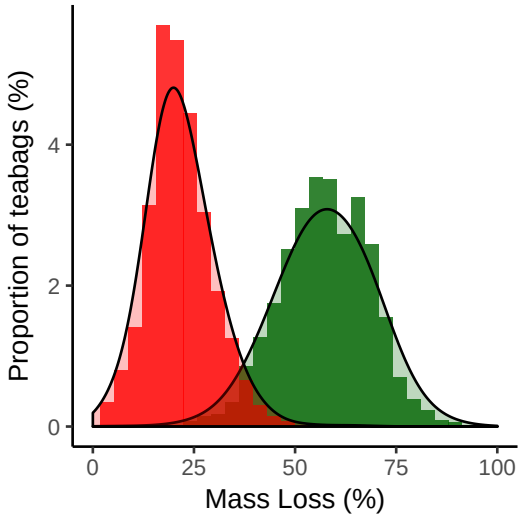

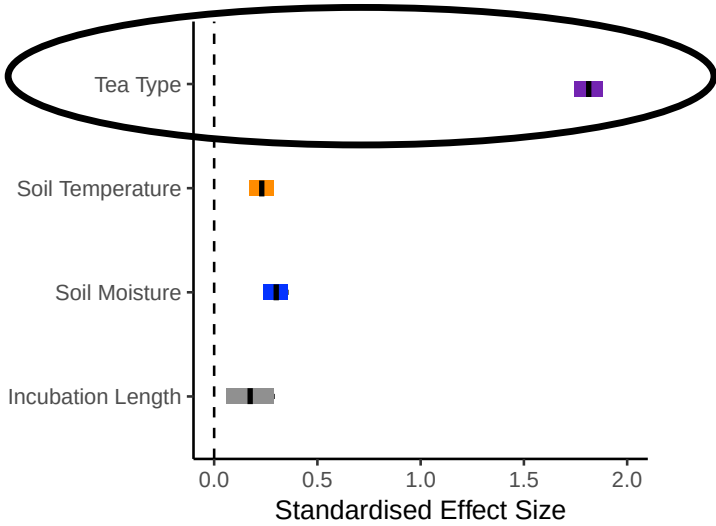

Thomas et al, *in prep*

Introduction

Hypotheses

Hypotheses

More decomposable
Faster decomposition
Smaller litter carbon pool

Hypotheses

More decomposable
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Less decomposable
Slower decomposition
Larger litter carbon pool

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Hypotheses

Ecology Letters, (2007) **10**: 619–627 doi: 10.1111/j.1461-0248.2007.01051.x

LETTER

Global negative vegetation feedback to climate warming responses of leaf litter decomposition rates in cold biomes

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Less decomposable
Slower decomposition
Larger litter carbon pool

Cornelissen *et al.* (2007) Ecology Letters

Hypotheses

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LETTER

Global negative vegetation feedback to climate warming responses of leaf litter decomposition rates in cold biomes

Hobbie (1996) Ecological Monographs

Less decomposable
Slower decomposition
Larger litter carbon pool

Hypotheses

Elmendorf et al., (2015) PNAS; Steinbauer et al., (2018) Nature

PNAS

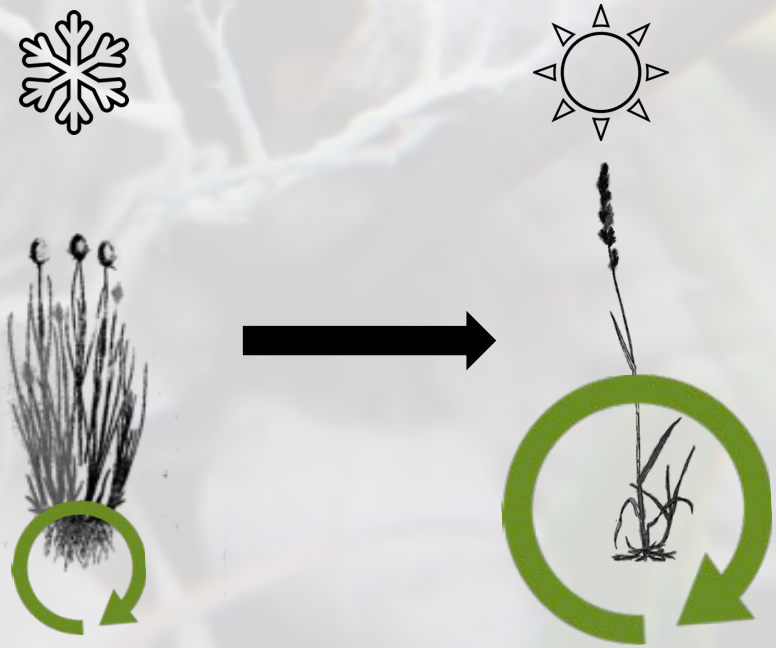
Experiment, monitoring, and gradient methods used to infer climate change effects on plant communities yield consistent patterns

Sarah C. Elmendorf[a,b,1], Gregory H. R. Henry[c], Robert D. Hollister[d], Anna Maria Fosaa[e], William A. Gould[f], Luise Hermanutz[g], Annika Hofgaard[h], Ingibjörg S. Jónsdóttir[i,j], Janet C. Jorgenson[k], Esther Lévesque[l], Borgþór Magnusson[m], Ulf Molau[n], Isla H. Myers-Smith[o], Steven F. Oberbauer[p], Christian Rixen[q], Craig E. Tweedie[r], and Marilyn D. Walker[s]

More decomposable

Faster decomposition

Smaller litter carbon pool



Hypotheses

Bjorkman *et al., in revision*

PNAS

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More decomposable
Faster decomposition
Smaller litter carbon pool

Hypotheses

More decomposable
Faster decomposition
Smaller litter carbon pool

Less decomposable
Slower decomposition
Larger litter carbon pool

Research Questions

- Are tundra plant communities becoming more decomposable?

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Are tundra plant communities becoming more decomposable?

1. Does decomposability vary over space?

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2. Has decomposability changed over time?

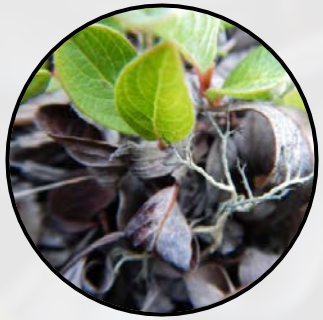
Research Questions

Are tundra plant communities becoming more decomposable?

1. Does decomposability vary over space?
2. Has decomposability changed over time?
3. Has decomposability changed with warming?

Methods

Methods



1. Litter collection

Methods

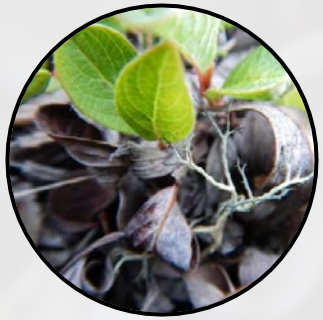
1. Litter collection

Methods

37 litter origin sites

63 tundra plant species
(24 forbs, 16 graminoids, 12 deciduous shrubs,
6 evergreen shrubs, 4 mosses, 1 lichen)

Leaf (63 species) and stem litter (6 species)



1. Litter collection

Litter Collection Sites

Methods

2. Decomposition Experiments

1. Litter collection

Methods

2. Decomposition Experiments

1. Litter collection

Methods

2. Decomposition Experiments

1. Litter collection

2 years of decomposition

3 Decomposition Sites:

Abisko, Sweden (68.35°N, 18.82°E)

Latnjajure, Sweden (68.36°N, 18.49°E)

Kluane Lake, Canada (61.03°N, -138.41°E)

Methods

3. Trait-decomposition relationships

2. Decomposition Experiments

1. Litter collection

Methods

3. Trait-decomposition relationships

2. Decomposition Experiments

1. Litter collection

Methods

3. Trait-decomposition relationships

2. Decomposition Experiments

'Tundra Trait Team' Database:

Examined 12 traits

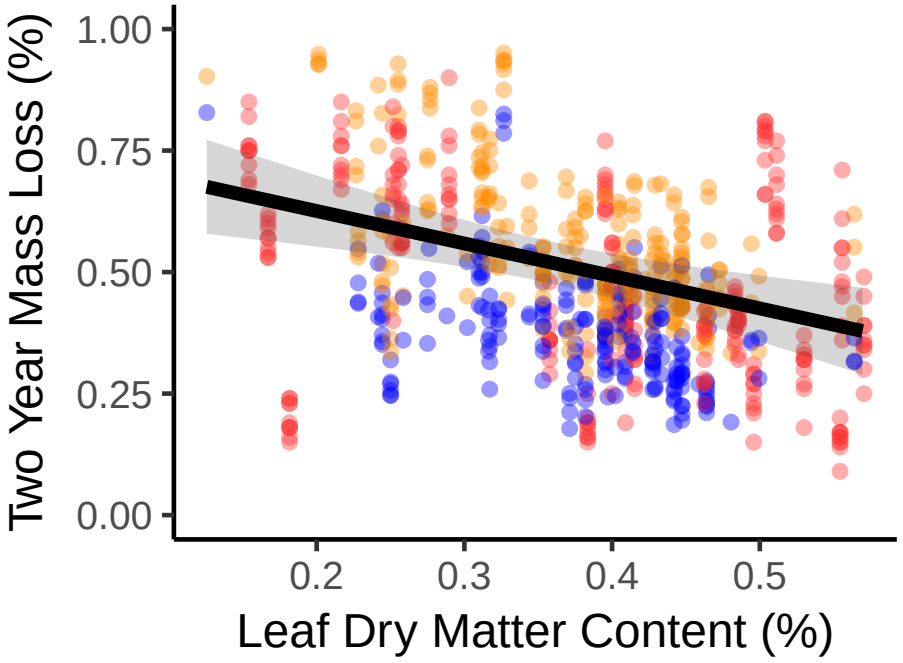
SLA, LDMC, leaf N, leaf C, leaf P, C:N ratio, leaf area, fresh mass, dry mass, leaf lifespan, stem density, leaf δ15N

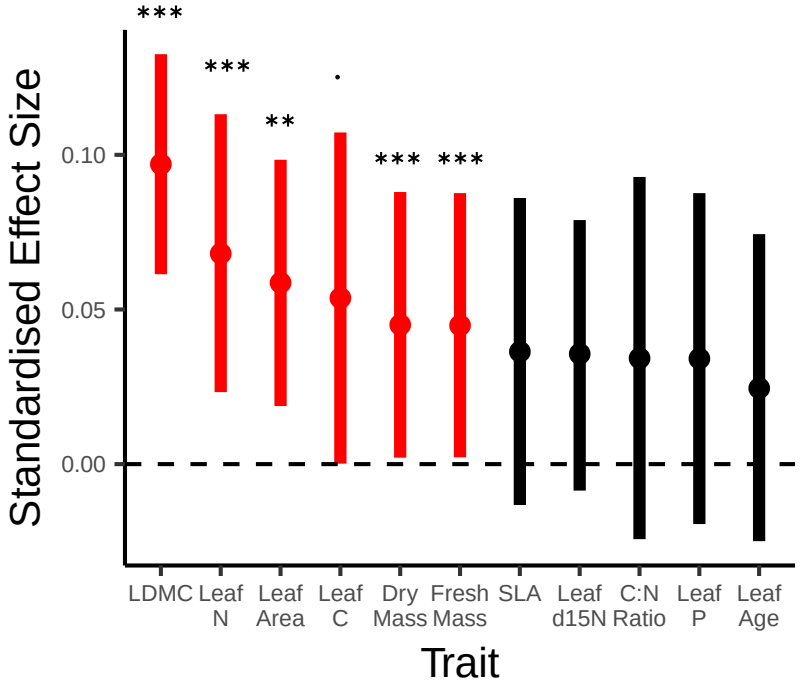
79,509 trait observations

median: 6,858 traits per species,
max: 17,610 - SLA
min: 1,290 - C:N ratio)

1. Litter collection

Methods


Two Year Mass Loss (%)
1.00
0.75
0.50
0.25
0.00
0.2
0.3
0.4
0.5
Leaf Dry Matter Content (%)


***
***
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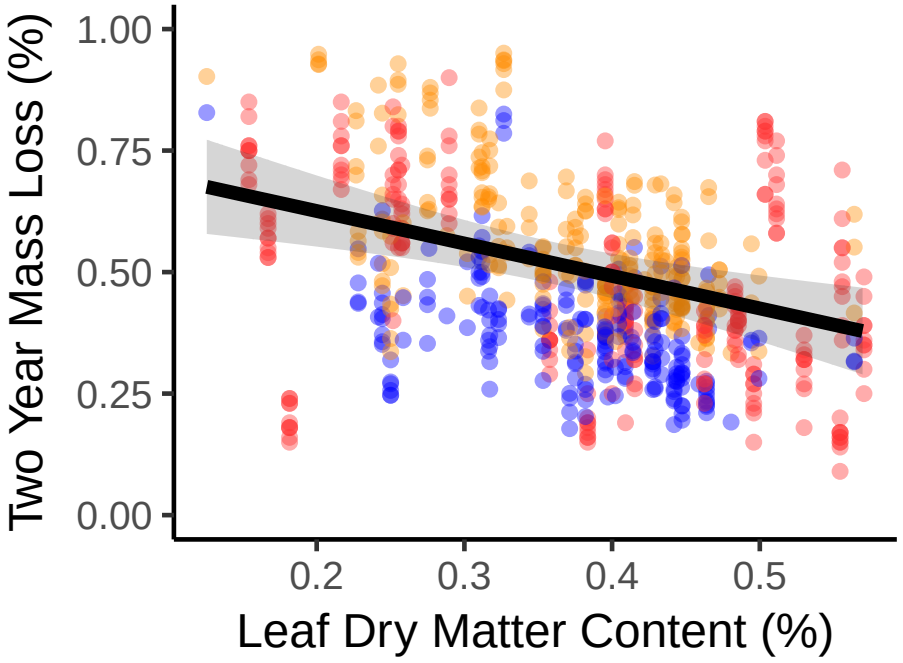
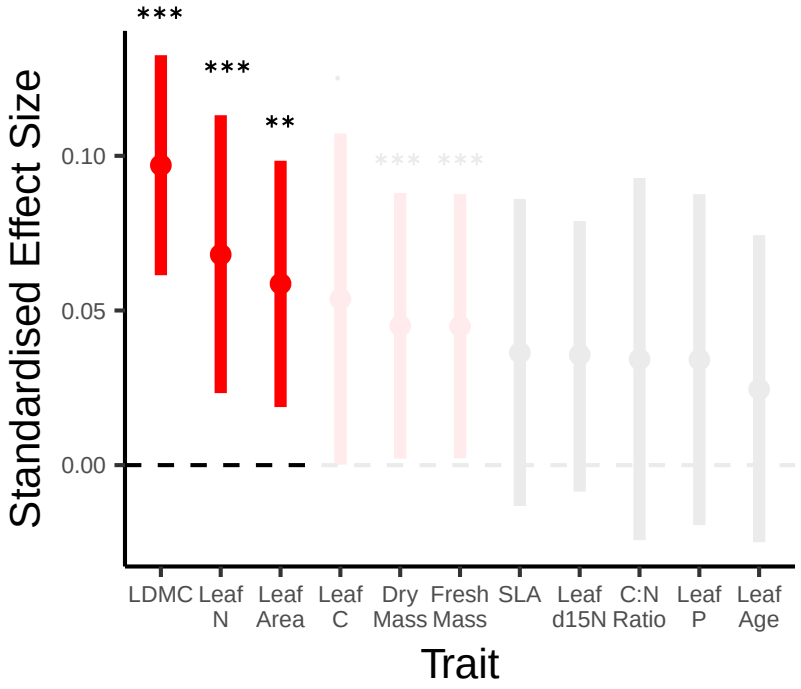
***
***
Standardised Effect Size
0.10
0.05
0.00
LDMC
Leaf N
Leaf Area
Leaf C
Dry Mass
Fresh Mass
SLA
Leaf d15N
C:N Ratio
Leaf P
Leaf Age
Trait

Methods

LDMC + Leaf nitrogen + Leaf Area

($R^2 = 0.41$)





Methods

3. Trait-decomposition relationships

2. Decomposition Experiments

4. Trait change models

ITEX Plots:

117 sites, 38 regions

1,781 unique plots

Surveyed 1989 – 2015

5-21 years of monitoring

5,507 plot-year combinations

1. Litter collection

Methods

3. Trait-decomposition relationships

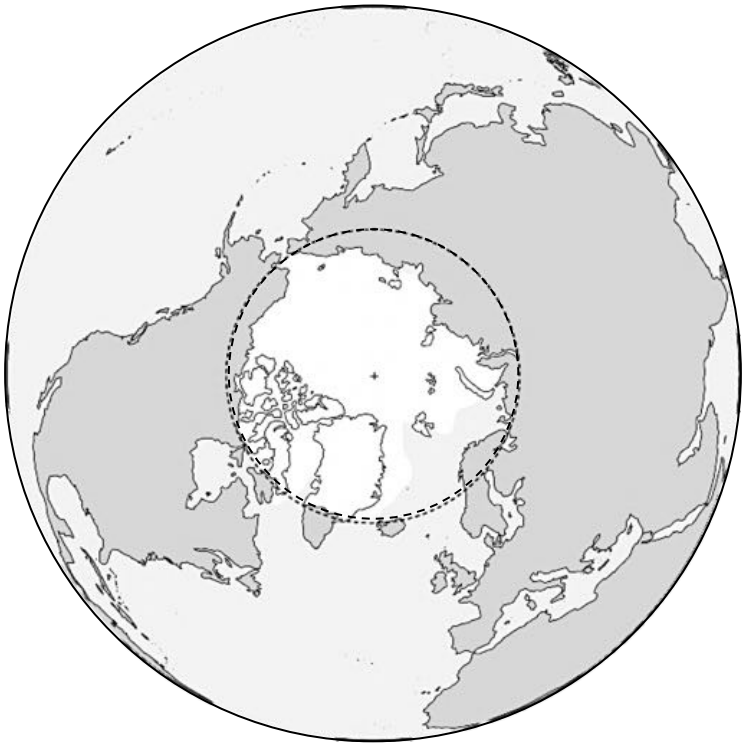
2. Decomposition Experiments

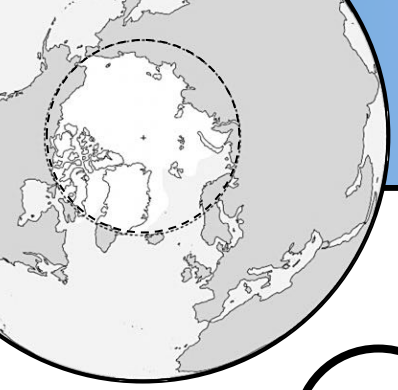
4. Trait change models

1. Litter collection

5. Decomposability Model

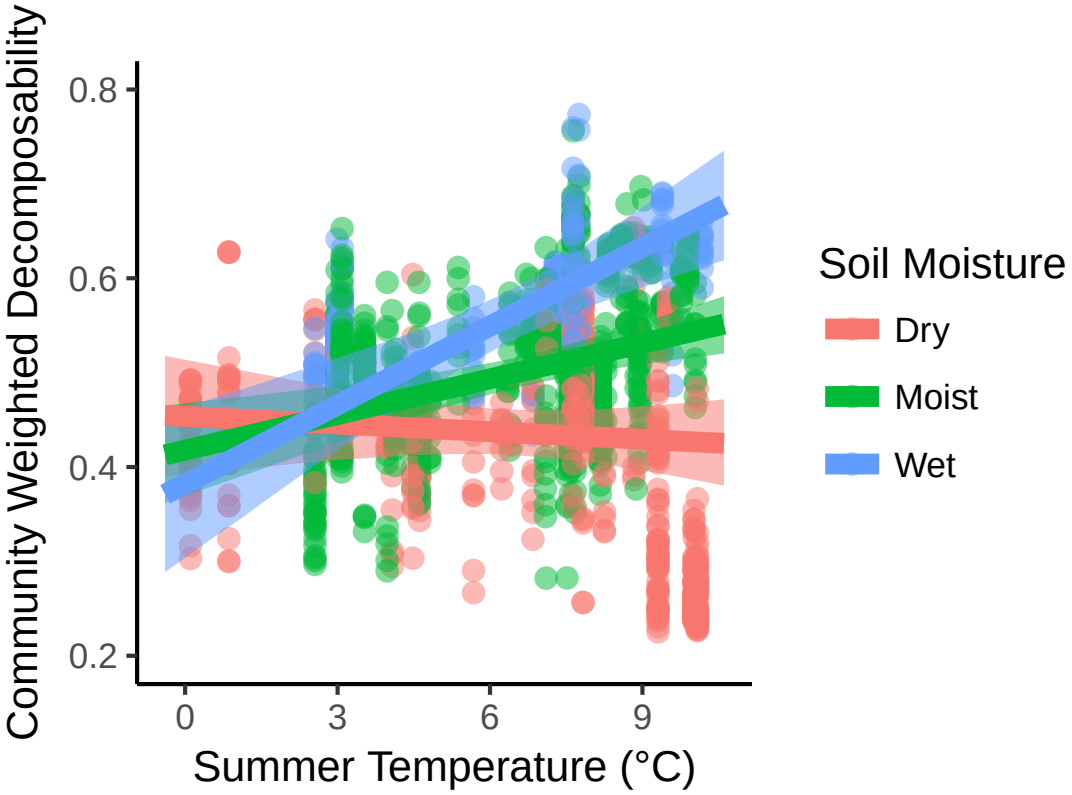
Results

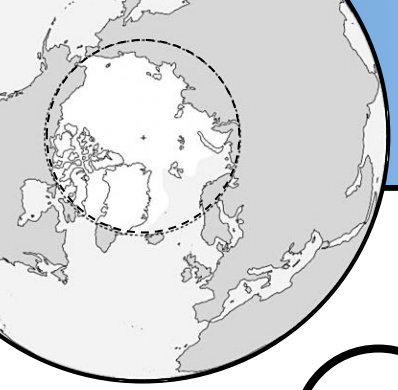




Results

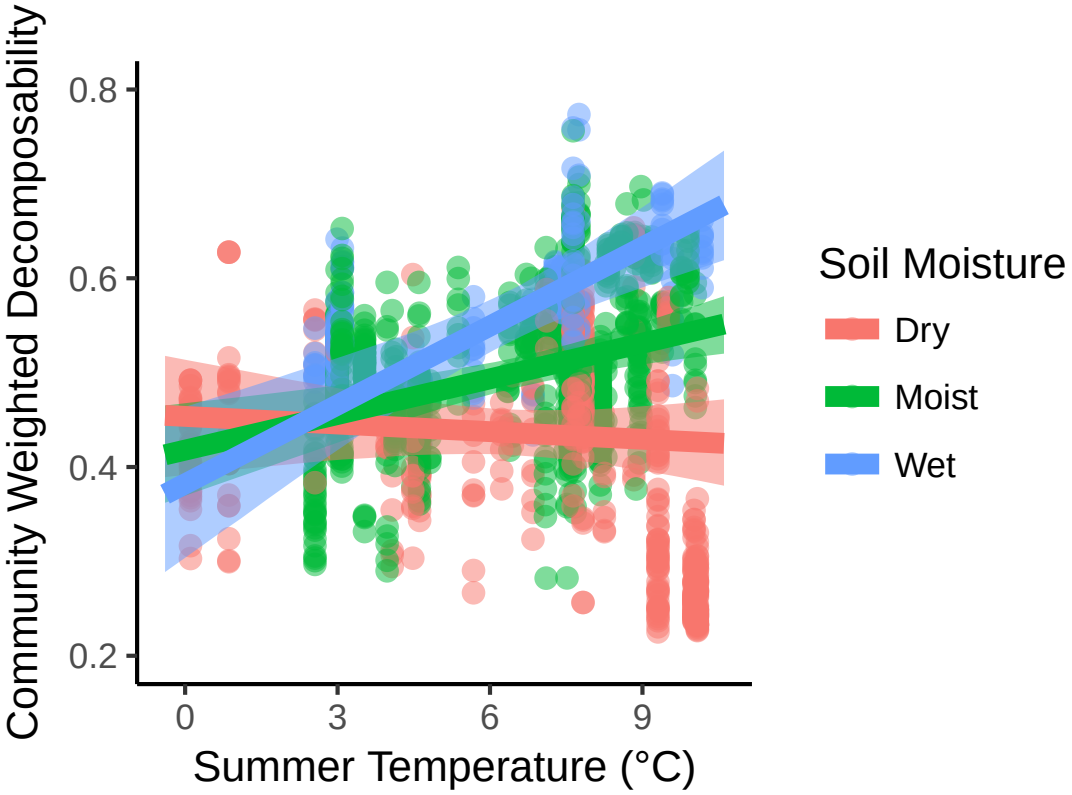
1 Warmer communities have more decomposable litter

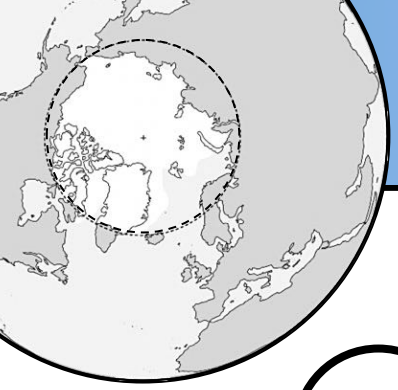




Results

1 Warmer **and wetter** communities are more decomposable





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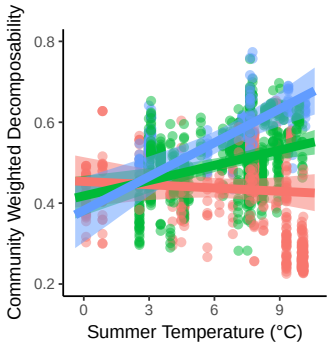
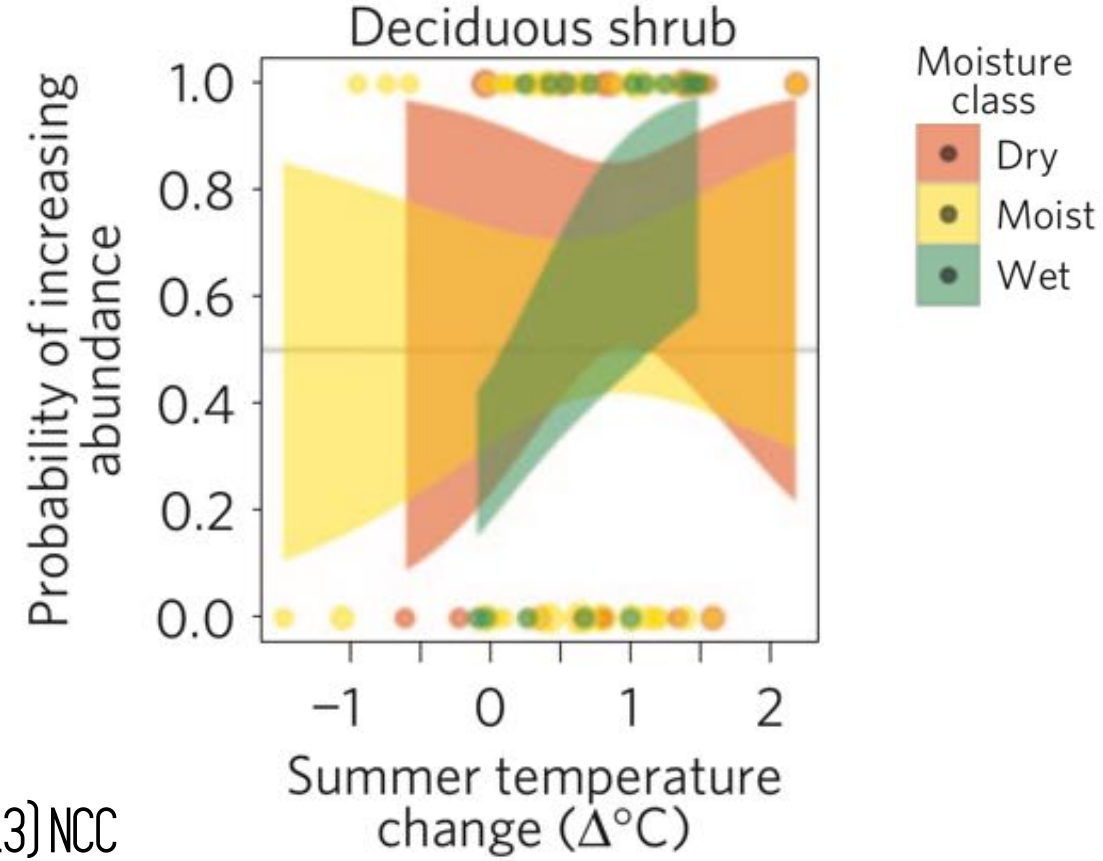
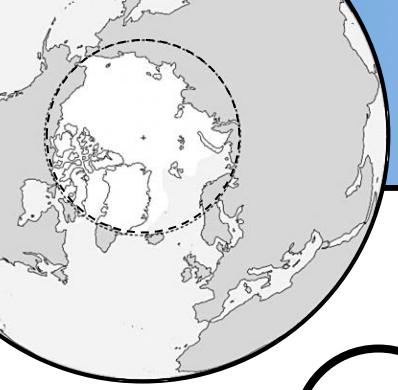




Elmendorf *et al.* (2013) NCC



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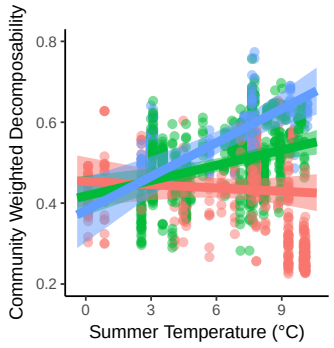
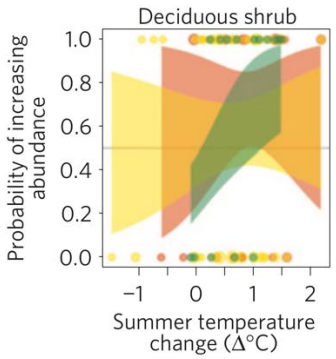
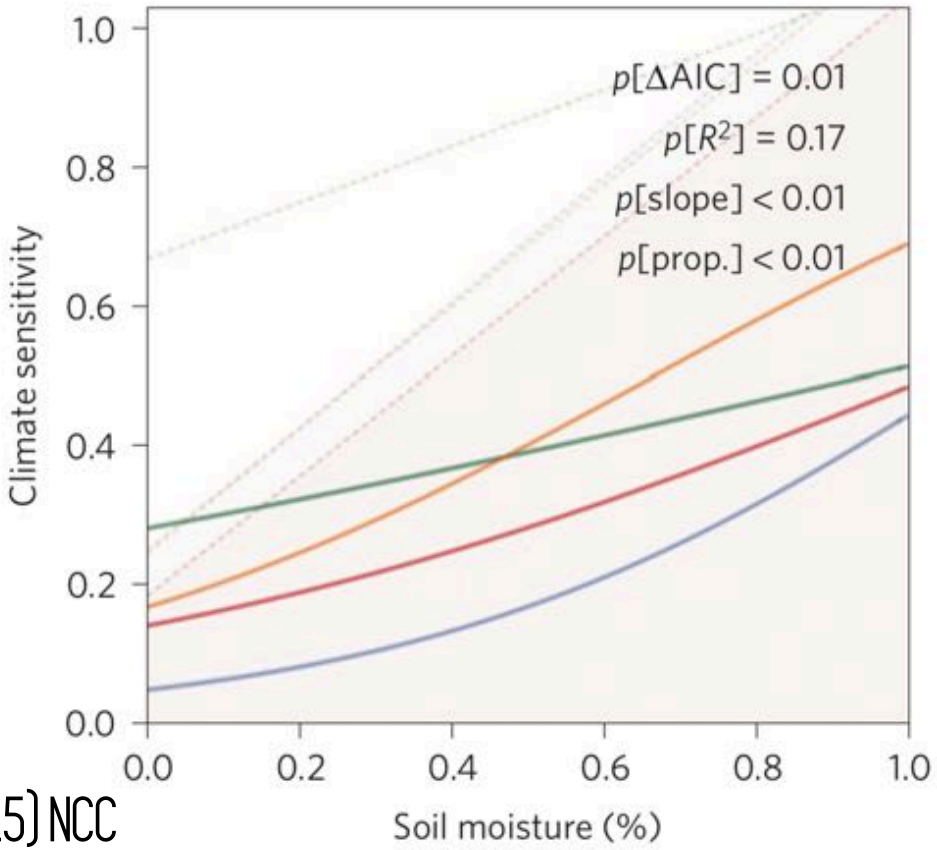
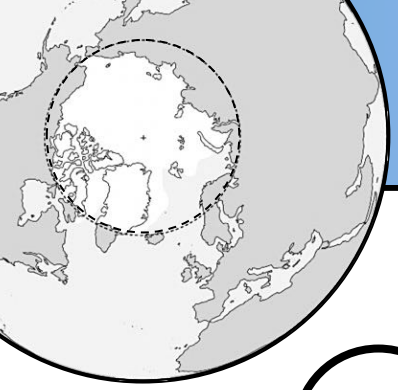






Myers-Smith *et al.* (2015) NCC



Results

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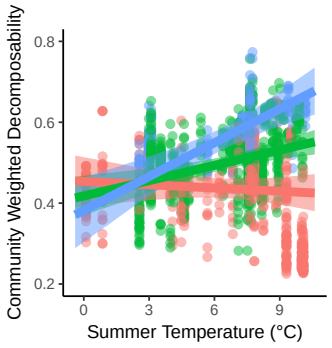

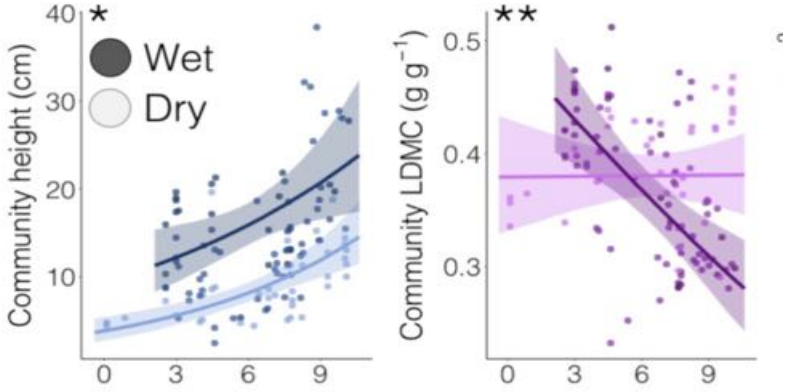

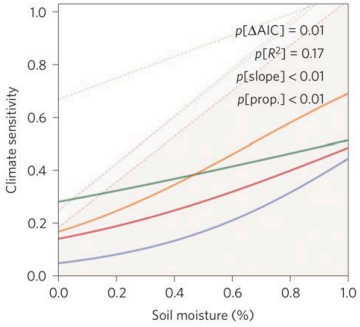

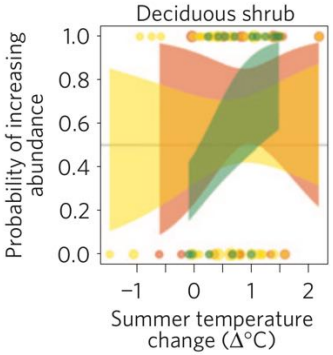

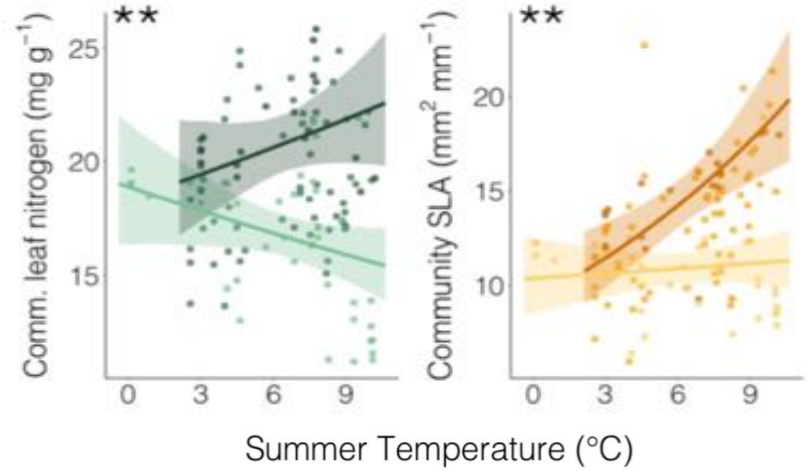

Bjorkman *et al.* in revision

Results

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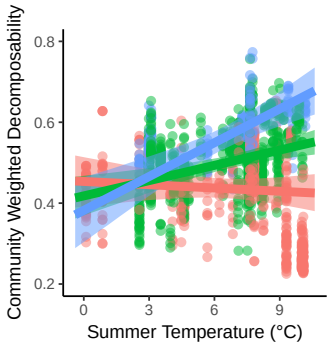
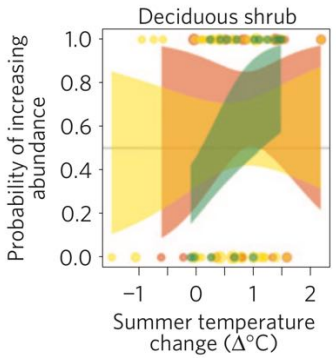
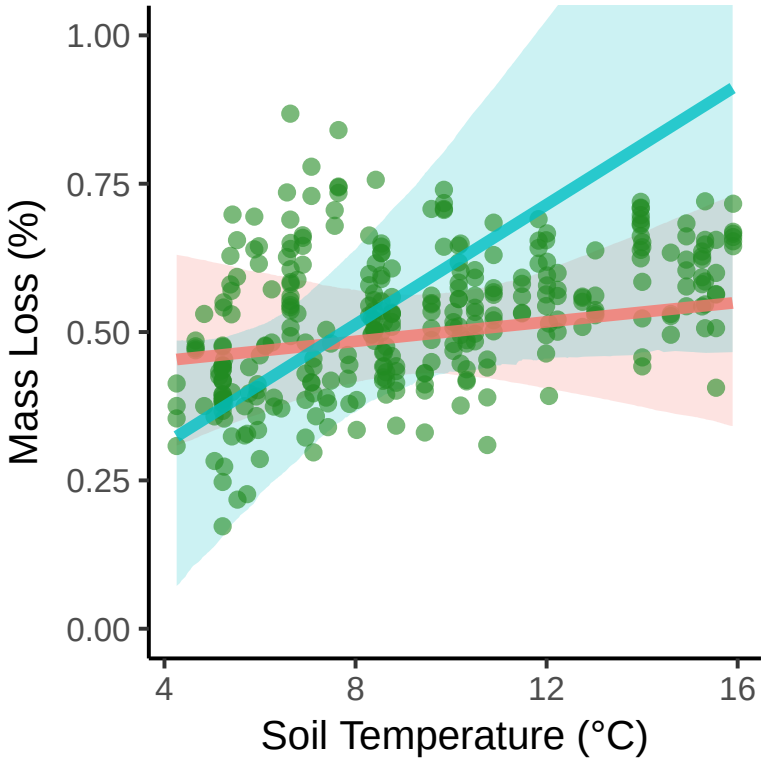
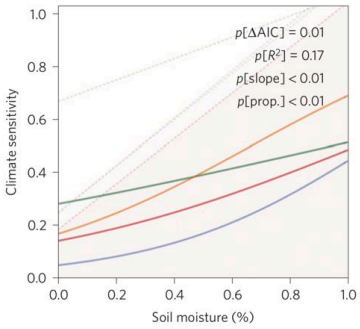
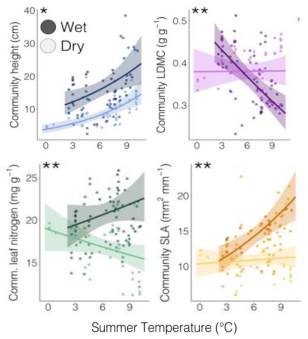




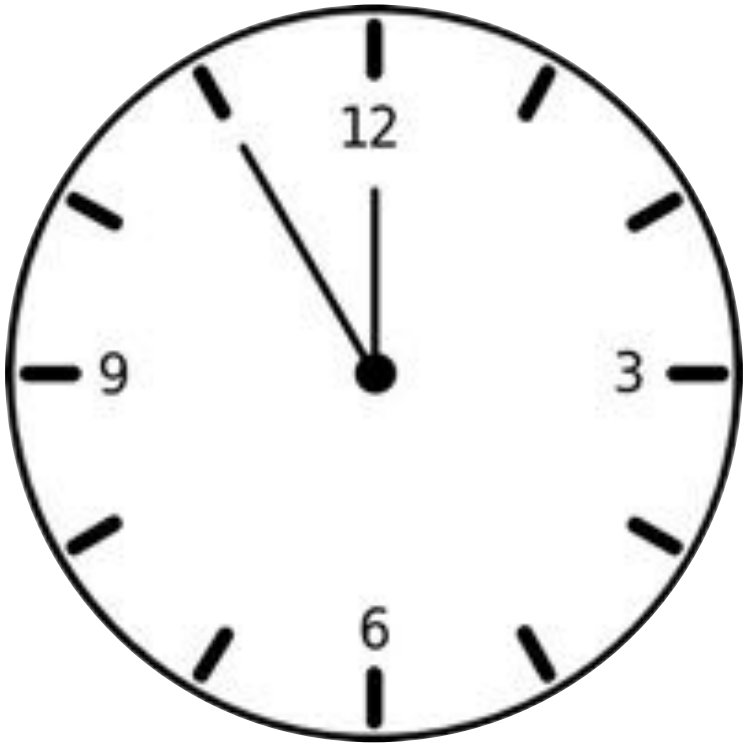






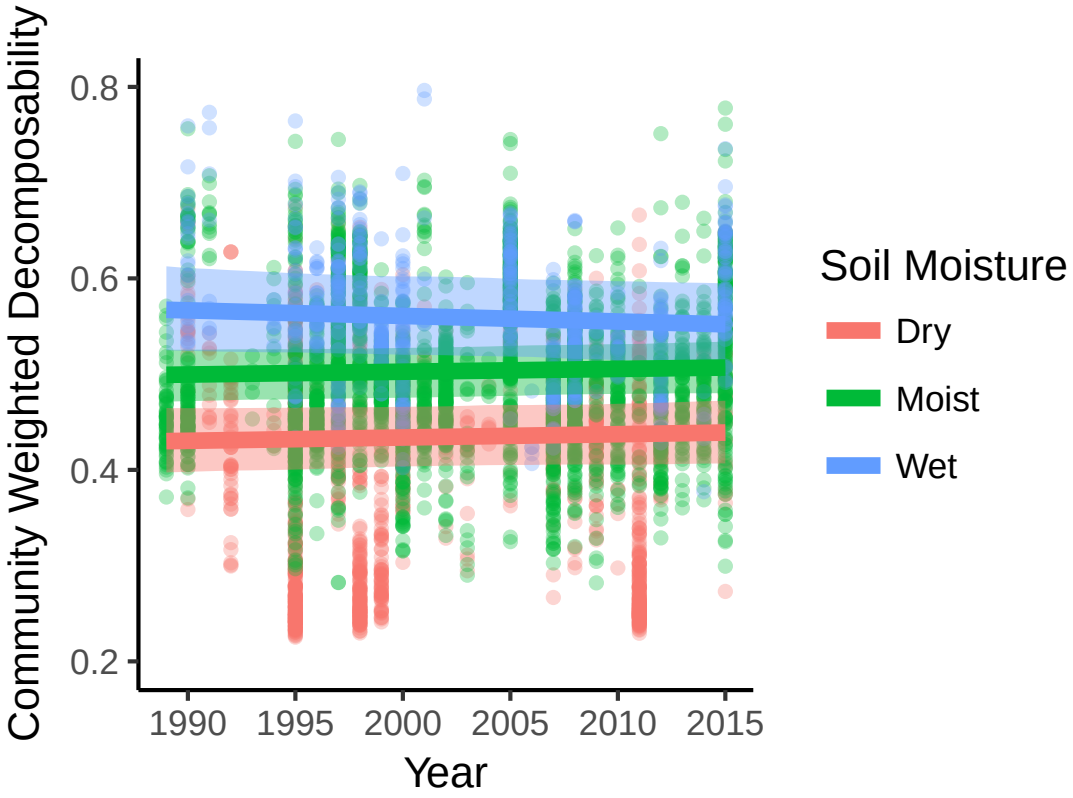
Thomas *et al.* in prep

Results



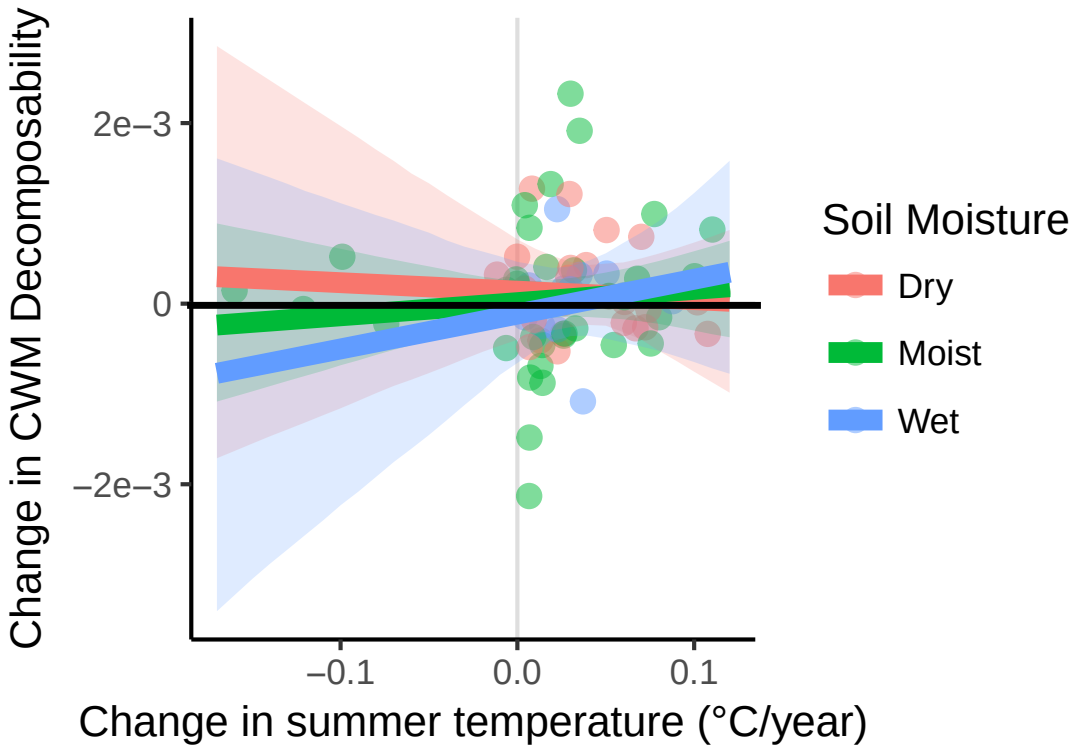
Results

2 Decomposability has not changed over time



Results

3 Decomposability has not changed with warming



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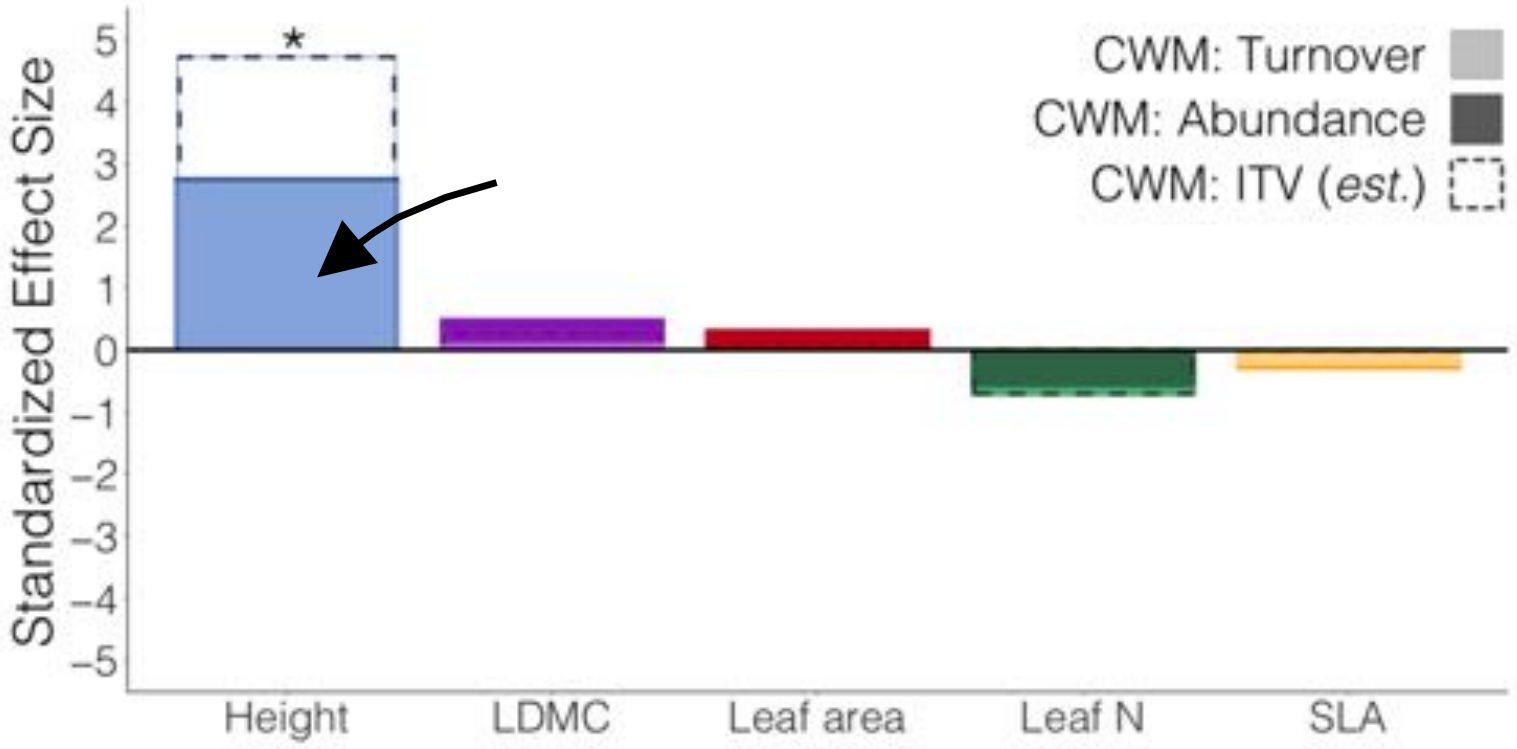

Bjorkman *et al.*, *in revision*

Results

Results

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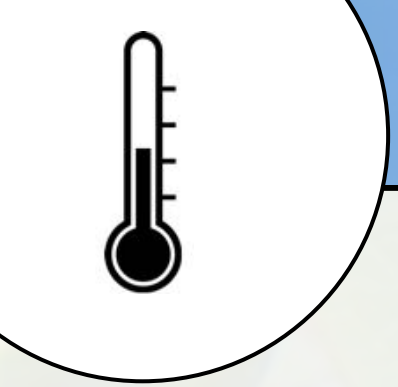
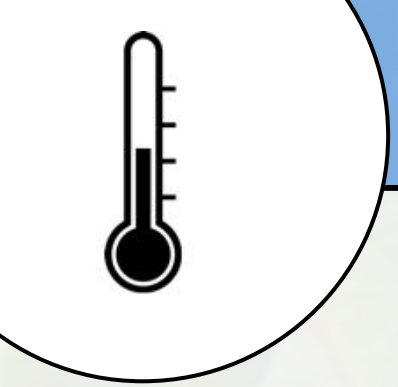
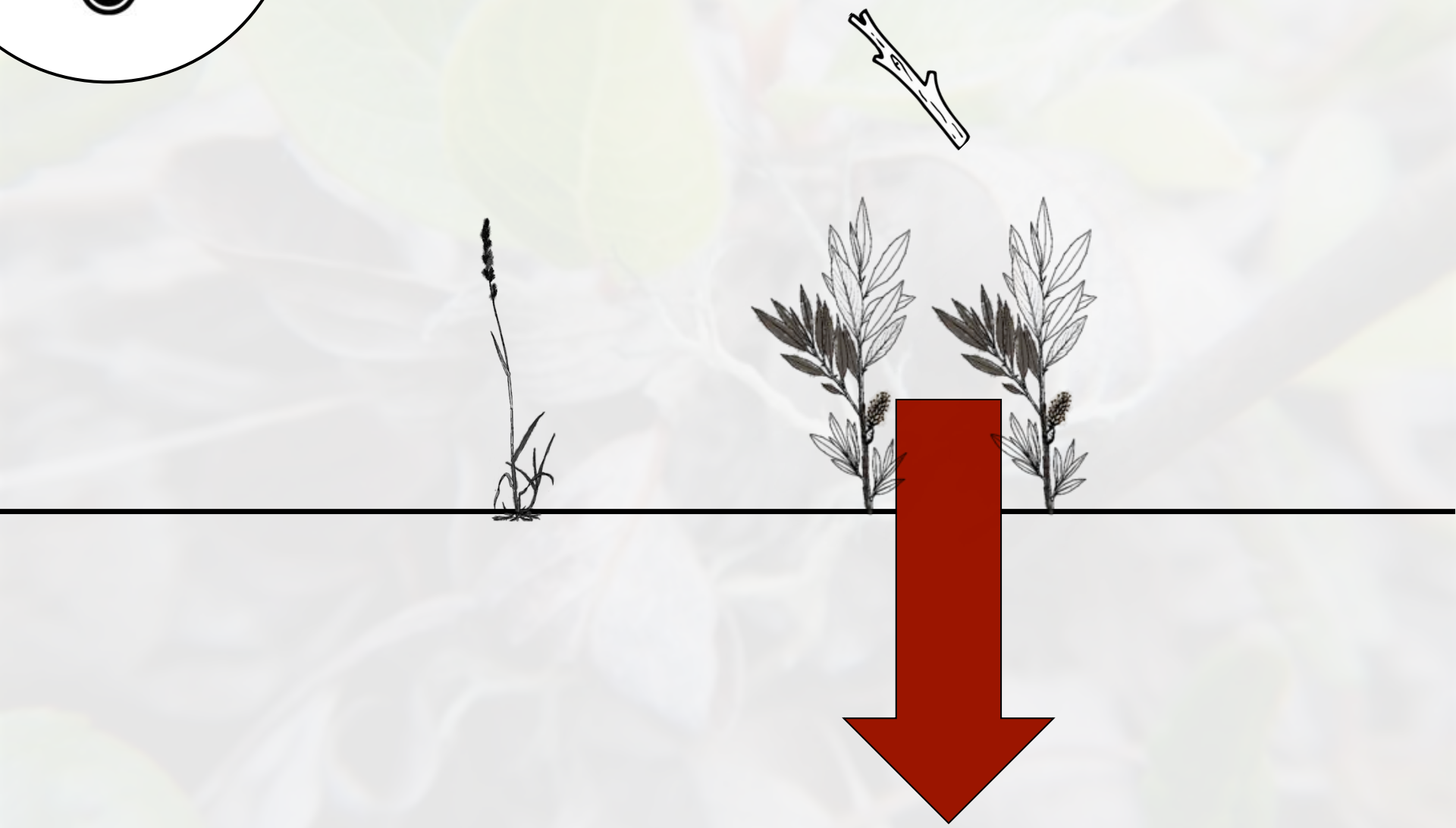
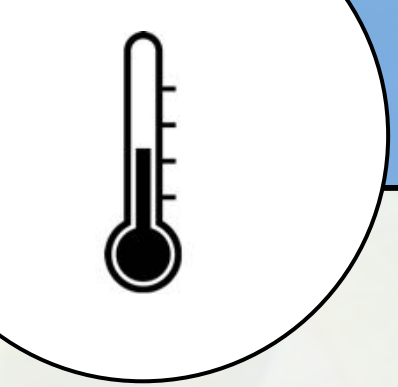


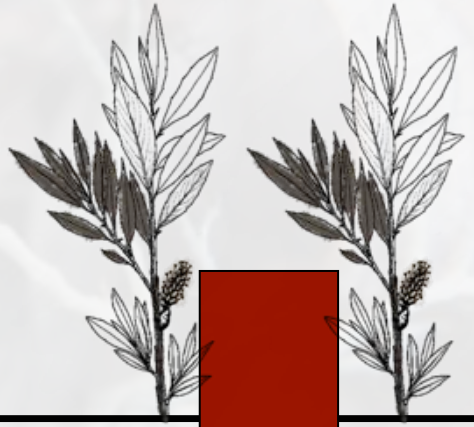
Results

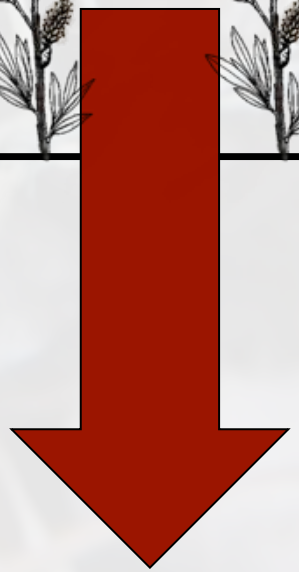




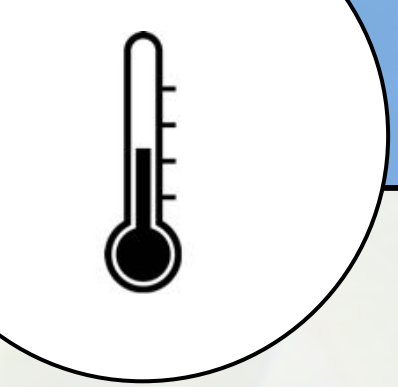
Results







Results



Conclusions

- Plant communities at warmer sites have more decomposable litter

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- No change over time in litter decomposability of tundra plant communities, despite vegetation change

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- No change in litter decomposability with warming

Conclusions

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Short term

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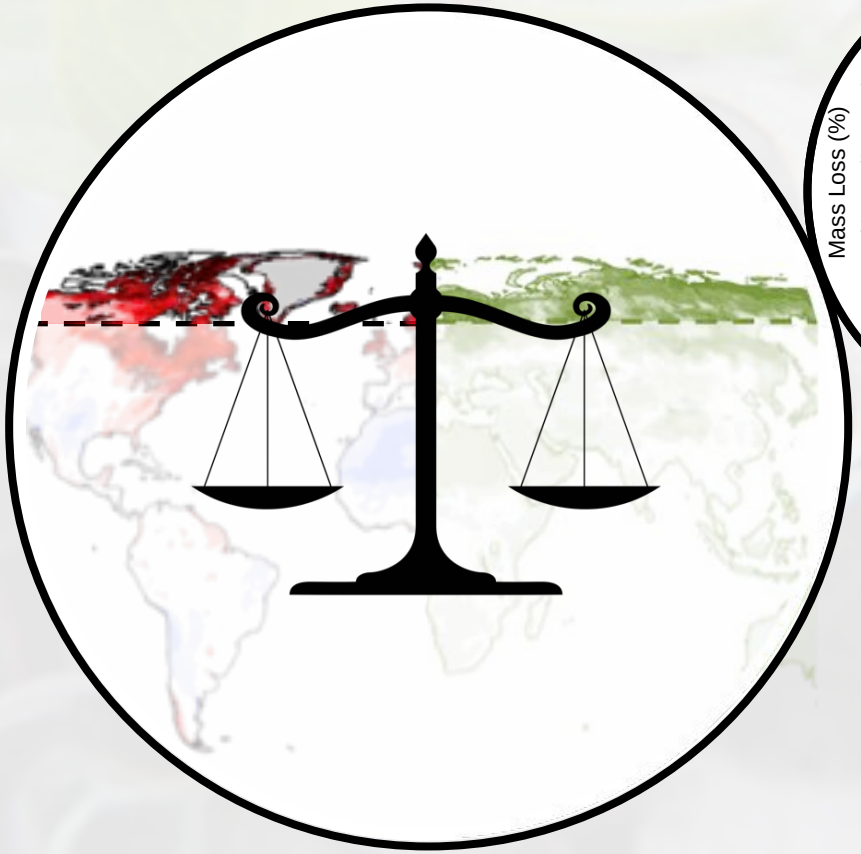
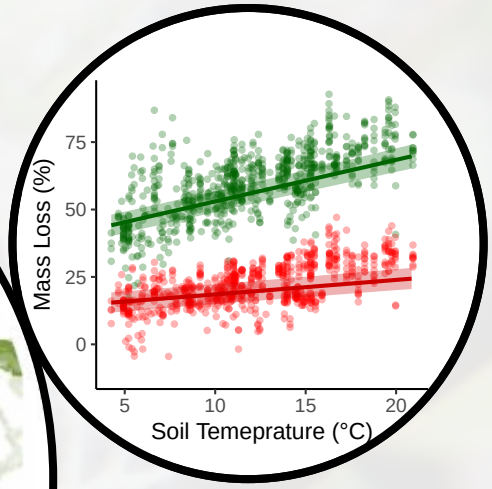
Short term





Conclusions

Long term

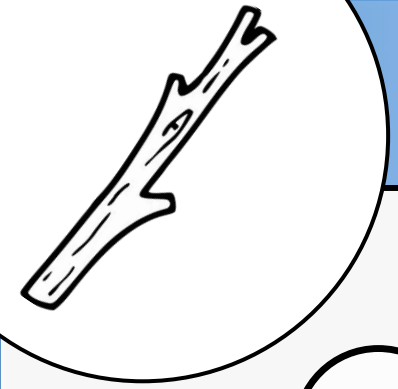
Conclusions

Long term

Thank you

and the 150+ TTT, TRY, sTUNDRA & ITEX contributors

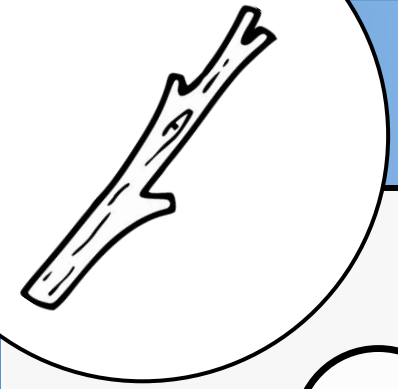
Thank you



Results

4 Decomposability change depends on woody inputs

Results



Results

4 Decomposability change depends on woody inputs