LONG-TERM IMPACT OF CLIMATE CHANGE AND GRAZING MANAGEMENT ON VEGETATION DYNAMICS OF ALPINE PASTURES

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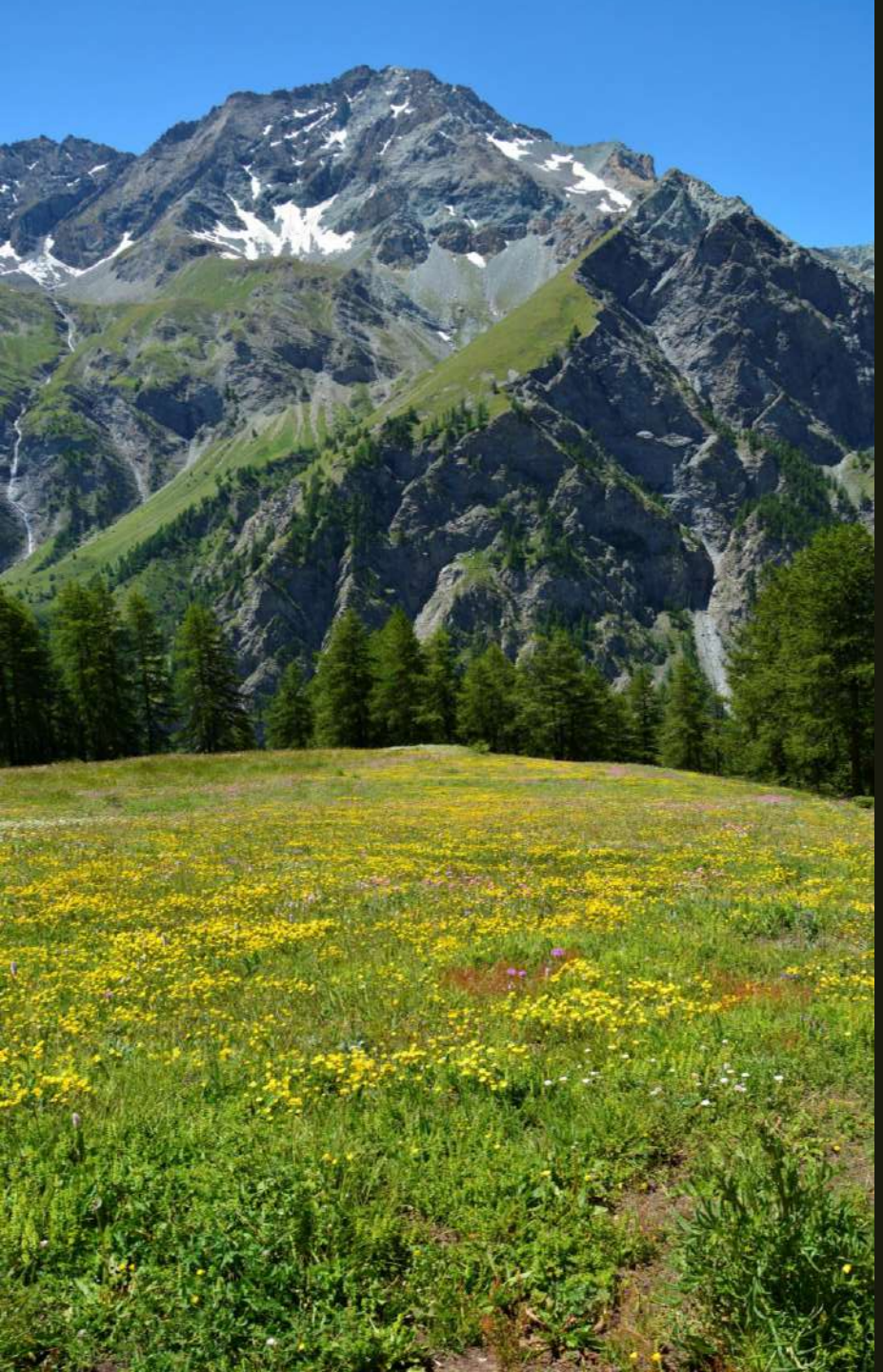
Context

- Many studies have assessed climate change effects on Alpine vegetation
- Others have focused on grazing management effects
- **Combined effects** of climate change and grazing management over long time periods → poorly quantified
  - *Climate data → 'easy to retrieve'*
  - *Management data → difficult to retrieve*

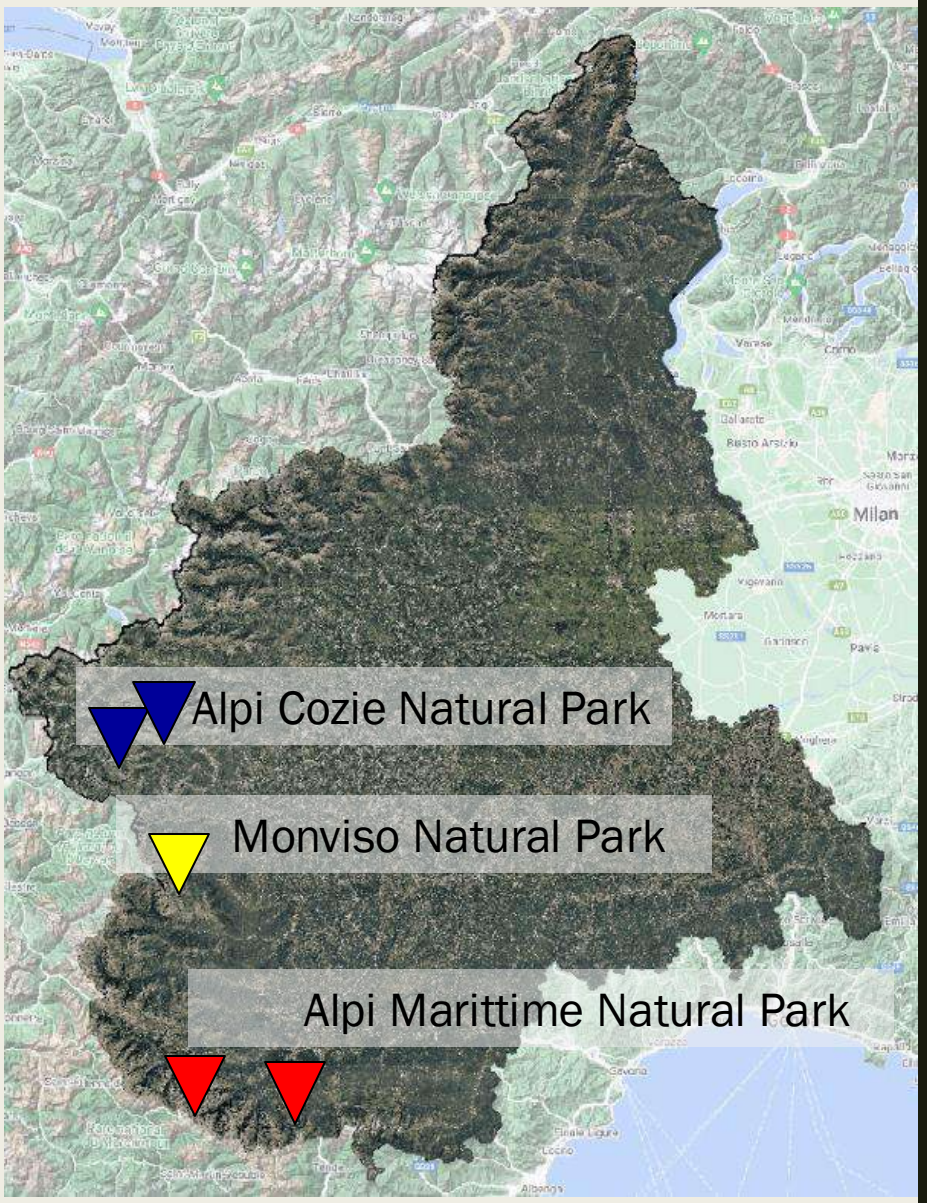


Objectives

- The aim of this study was to assess vegetation changes in Alpine pastures over two decades
- Specific objectives were:

1. *To evaluate changes in*
   - vegetation composition
   - plant diversity
   - agronomic value

2. *To identify the relative contribution of climate and management drivers to vegetation dynamics*



Study area

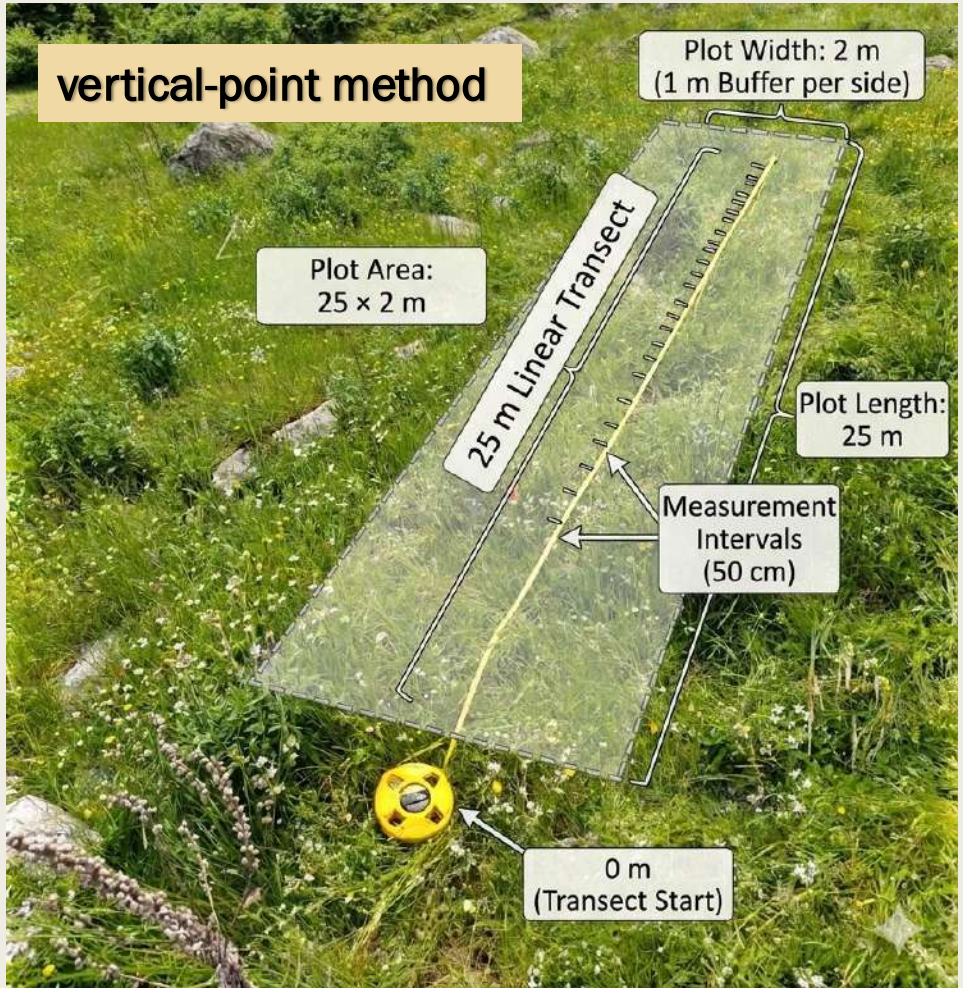
- The study was conducted in the Western Italian Alps, Piedmont Region
- **Five summer pastures** were selected across three protected areas:
  - *Alpi Marittime Natural Park*
  - *Monviso Natural Park*
  - *Alpi Cozie Natural Park*
- The pastures were located in montane to subalpine belts and were traditionally grazed during summer

Interreg
Cofinancé par l'Union Européenne
Cofinanziato dall'Unione Europea
France – Italia ALCOTRA
Biodiv'ALP
Alpage Sentinelles

Vegetation data

51 paired vegetation plot

2003 — Resurvey approach — 2022



Vegetation data

VEGETATION COMMUNITY

Attribution of **Phytosociological optimum** (Aeschimann et al 2004) at the **CLASS** level

13 Groups of Classes with ecological similarities (Theurilliat 1994)
Social Behaviour Types (SBT)

SBT retained (cover > 10%)

- **Meso-eutrophic grassland species** *(Molinio-Arrhenatheretea)*
- **Oligotrophic acidophile montane sward** *(Nardetea strictae)*
- **Oligotrophic subalpine and alpine basophile sward species** *(Carici rupestris–Kobresietea bellardii, Elyno-Seslerietea variae)*
- **Oligotrophic subalpine and alpine acidophile sward species** *(Juncetea trifidi)*
- **Dry grassland species** *(Festuco-Brometea)*
- **Woodland species** *(Carpino-Fagetea sylvaticae, Pyrolo-Pinetea, Quercetea pubescentis, Quercetea robori-sessiliflorae, Vaccinio-Piceetea excelsae)*

Total species cover (SC%) for each SBT

PLANT DIVERSITY

Species richness

Effective Number of Species (ENS)

AGRONOMIC VALUE

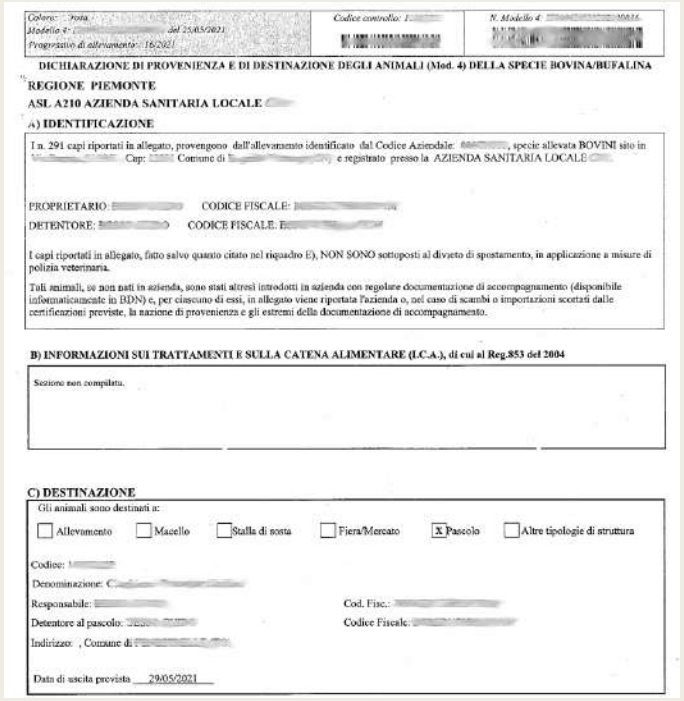
Forage Pastoral Value (PV)

- synthetic index ranging from 0 to 100
- It derives from vegetation composition and summarizes forage yield, quality, and palatability for livestock

Management data

Grazing management was assessed using two complementary indicators

Yearly Stocking Rate (SR)
described the overall grazing pressure at pasture scale



DICHIARAZIONE DI PROVENIENZA E DI DESTINAZIONE DEGLI ANIMALI (Mod. 4) DELLA SPECIE BOVINA/BUFALINA

REGIONE PIEMONTE

ASL A210 AZIENDA SANITARIA LOCALE

A) IDENTIFICAZIONE

I n. 291 capi riportati in allegato, provengono dall'allevamento identificato dal Codice Aziendale: , specie allevata BOVINI sito in Cap: Comune di e registrato presso la AZIENDA SANITARIA LOCALE

PROPRIETARIO CODICE FISCALE:

DETENTORE: CODICE FISCALE:

I capi riportati in allegato, fatto salvo quanto citato nel riquadro E), NON SONO sottoposti al divieto di spostamento, in applicazione a misure di polizia veterinaria.

Tali animali, se non nati in azienda, sono stati altresì introdotti in azienda con regolare documentazione di accompagnamento (disponibile informaticamente in BDN) e, per ciascuno di essi, in allegato viene riportata l'azienda o, nel caso di scambi o importazioni scortati dalle certificazioni previste, la nazione di provenienza e gli estremi della documentazione di accompagnamento.

B) INFORMAZIONI SUI TRATTAMENTI E SULLA CATENA ALIMENTARE (I.C.A.), di cui al Reg.853 del 2004

Sezione non compilata.

C) DESTINAZIONE

Gli animali sono destinati a:

☐ Allevamento ☐ Macello ☐ Stalla di sosta ☐ Fiera/Mercato ☒ Pascolo ☐ Altre tipologie di struttura

Codice:

Denominazione:

Responsabile: Cod. Fisc.:

Detentore al pascolo: Codice Fiscale:

Indirizzo: , Comune di

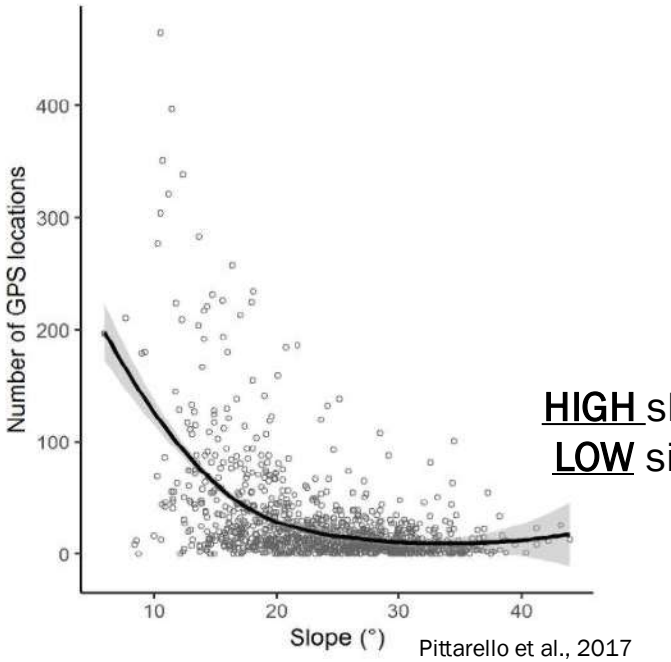
Data di uscita prevista 29/05/2021

Stocking Rate retrieved for each single year

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

Site-use intensity (SUI)
described the local spatial distribution of grazing pressure at the plot scale

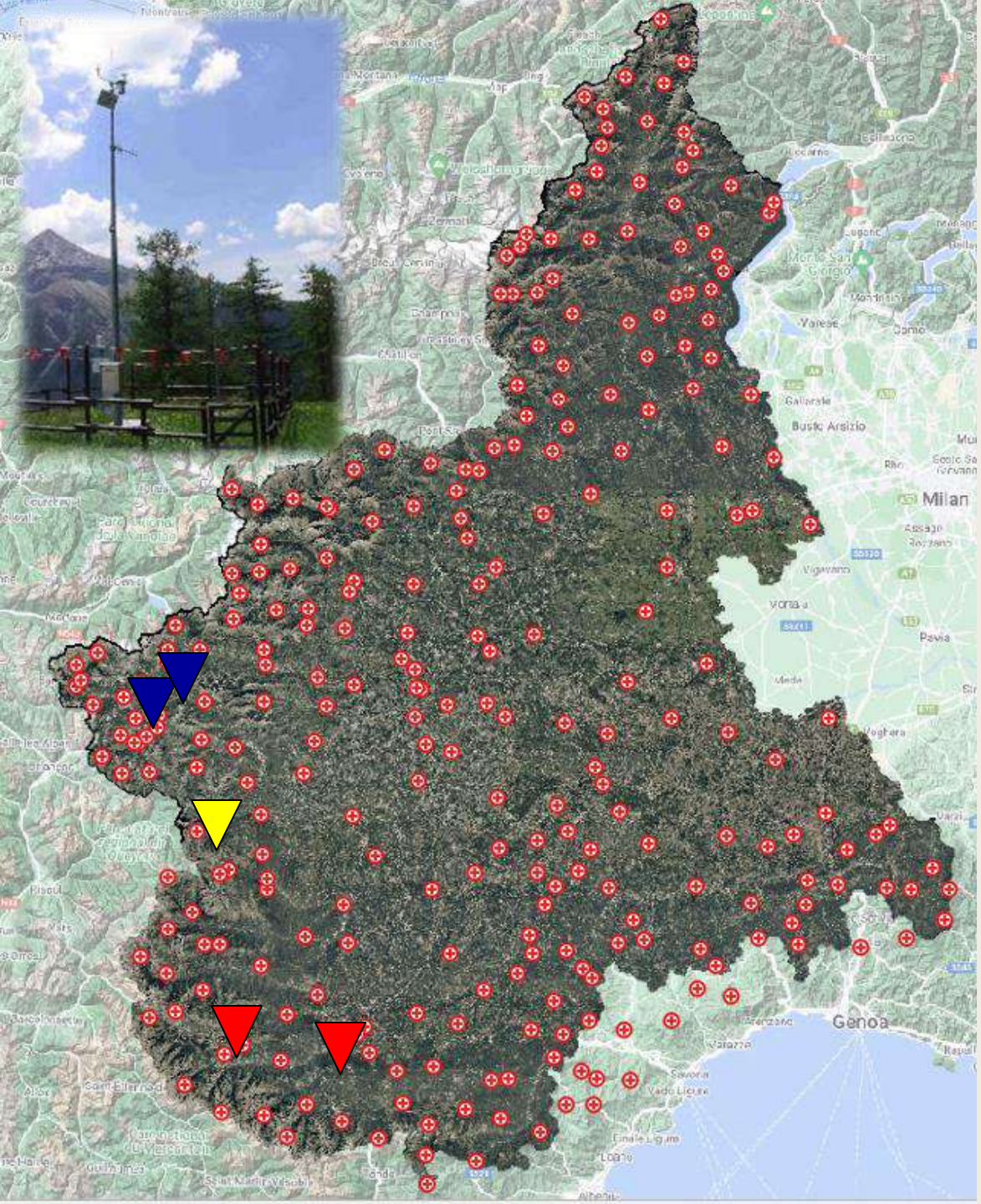
slope as a (inverse) proxy



Pittarello et al., 2017

HIGH slopes ➔
LOW site-use intensity

LOW slopes ➔
HIGH site-use intensity



Climate data

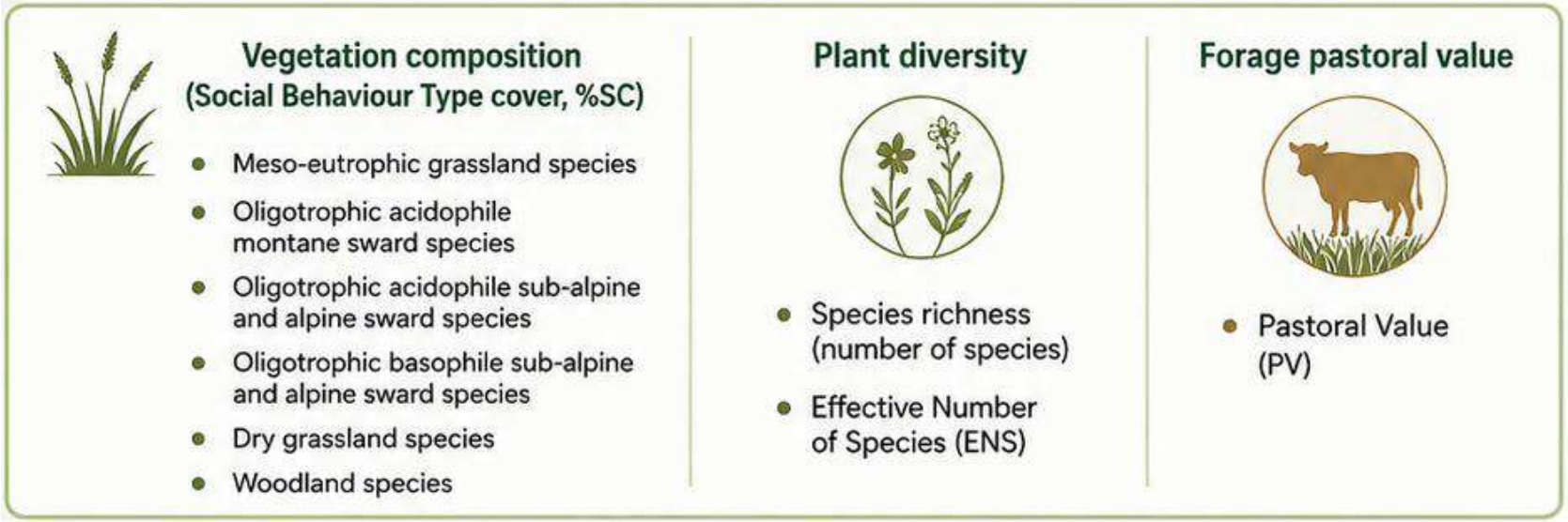
- Climate data were obtained from nearby weather stations

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

- Five agro-climatic indicators were calculated:
  - *Mean annual temperature (P)*
  - *Total annual precipitation (T)*
  - *Precipitation Concentration Index (PCI)*
  - *Length of Dry Spell (LDS)*
  - *Growing Degree Days (GDD)*

1. Have vegetation composition, plant diversity, and forage pastoral value changed between past and present?

Y =

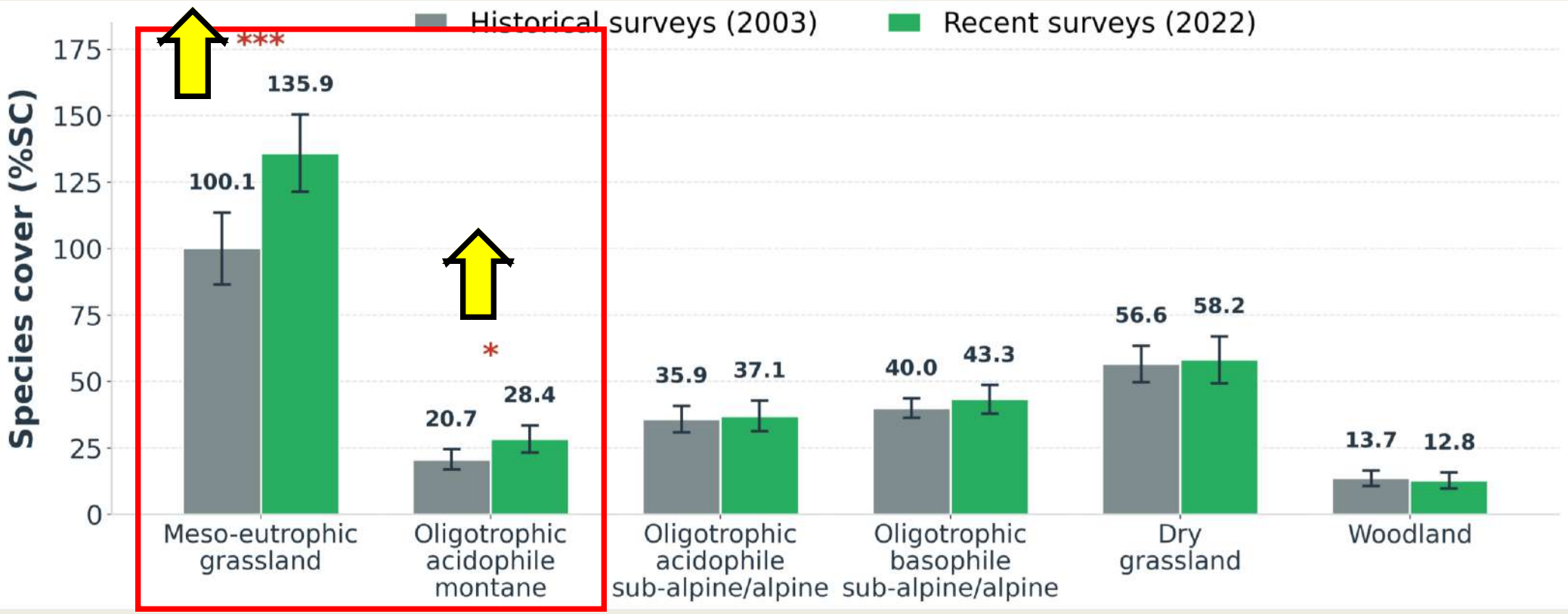


Past (2003) vs Present (2022)

Y = f(survey period)

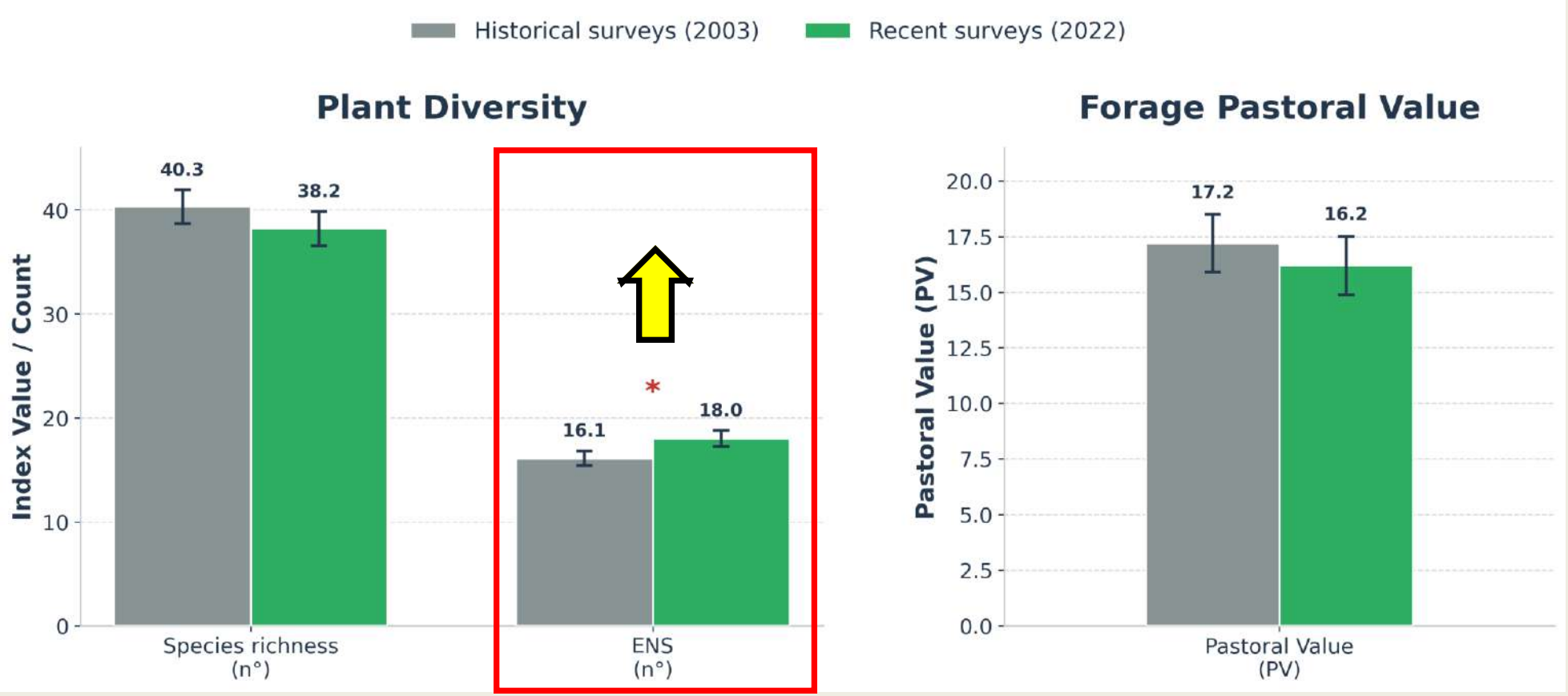
Linear Mixed Models / Generalized Linear Mixed models (repeated measure)

1. Have vegetation composition, plant diversity, and forage pastoral value changed between past and present?



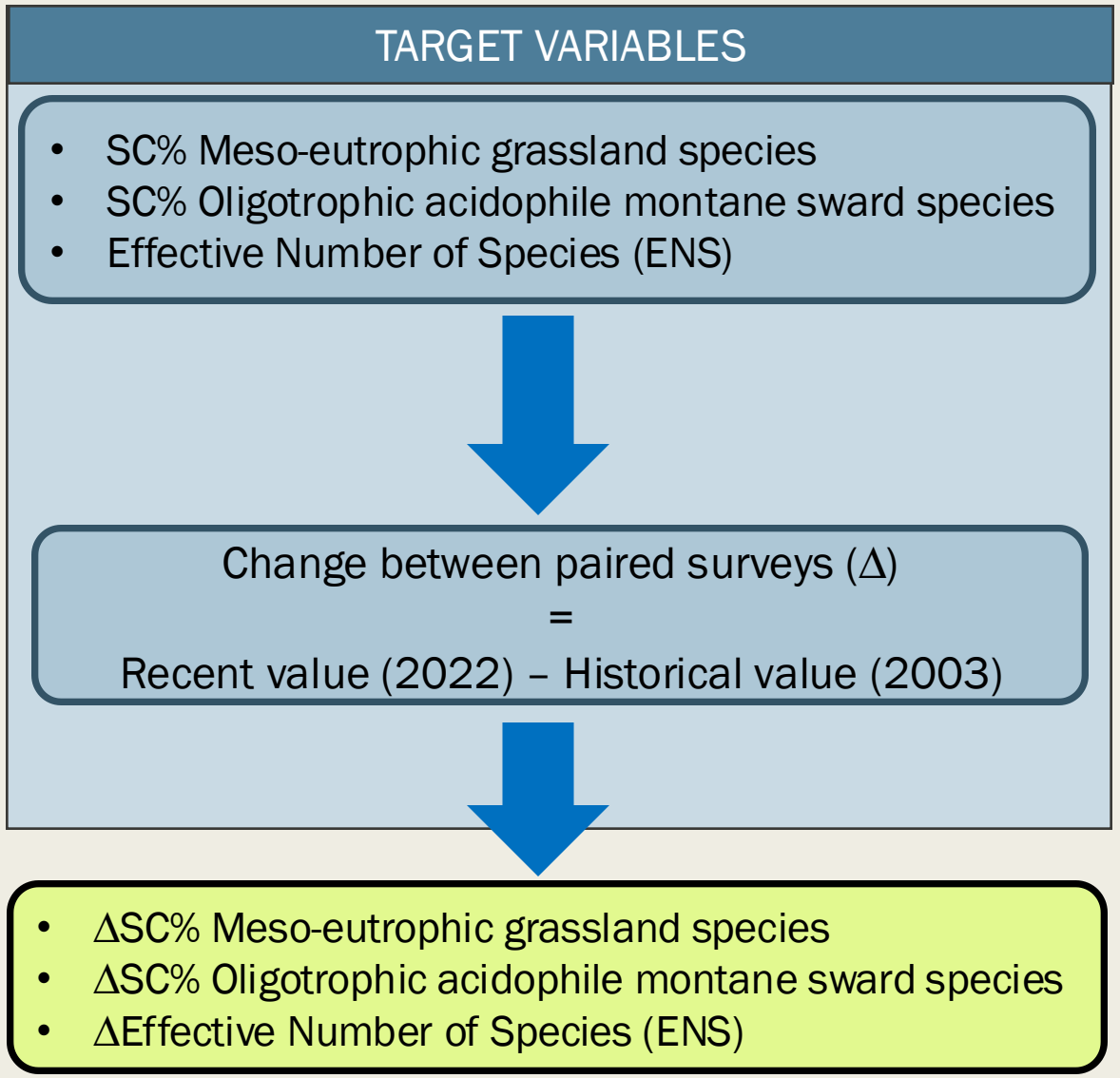
- Meso-eutrophic grassland species increased significantly over time
- Oligotrophic acidophile montane sward species also increased significantly
- No significant changes were detected for dry grassland species, subalpine and alpine oligotrophic species, or woodland species
- The low and stable cover of woodland species suggests that continued grazing limited shrub and tree encroachment

1. Have vegetation composition, plant diversity, and forage pastoral value changed between past and present?



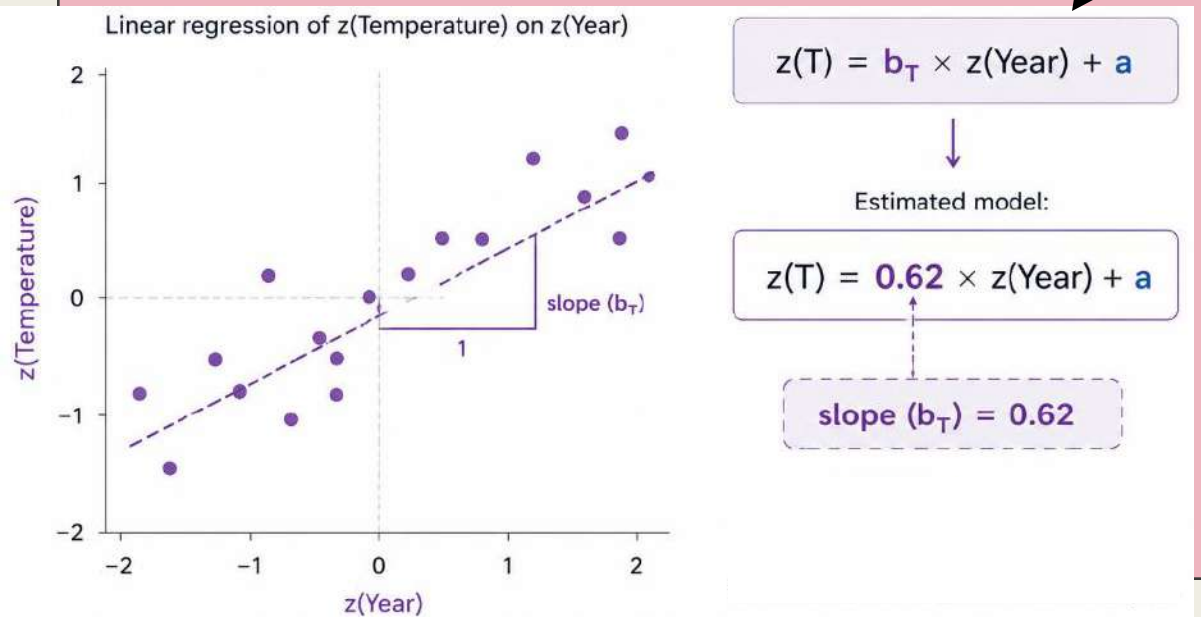
- **Species richness** and **Pastoral Value** did not significantly change between 2003 and 2022
- The **Effective Number of Species (ENS)** increased ➔ higher evenness within vegetation communities

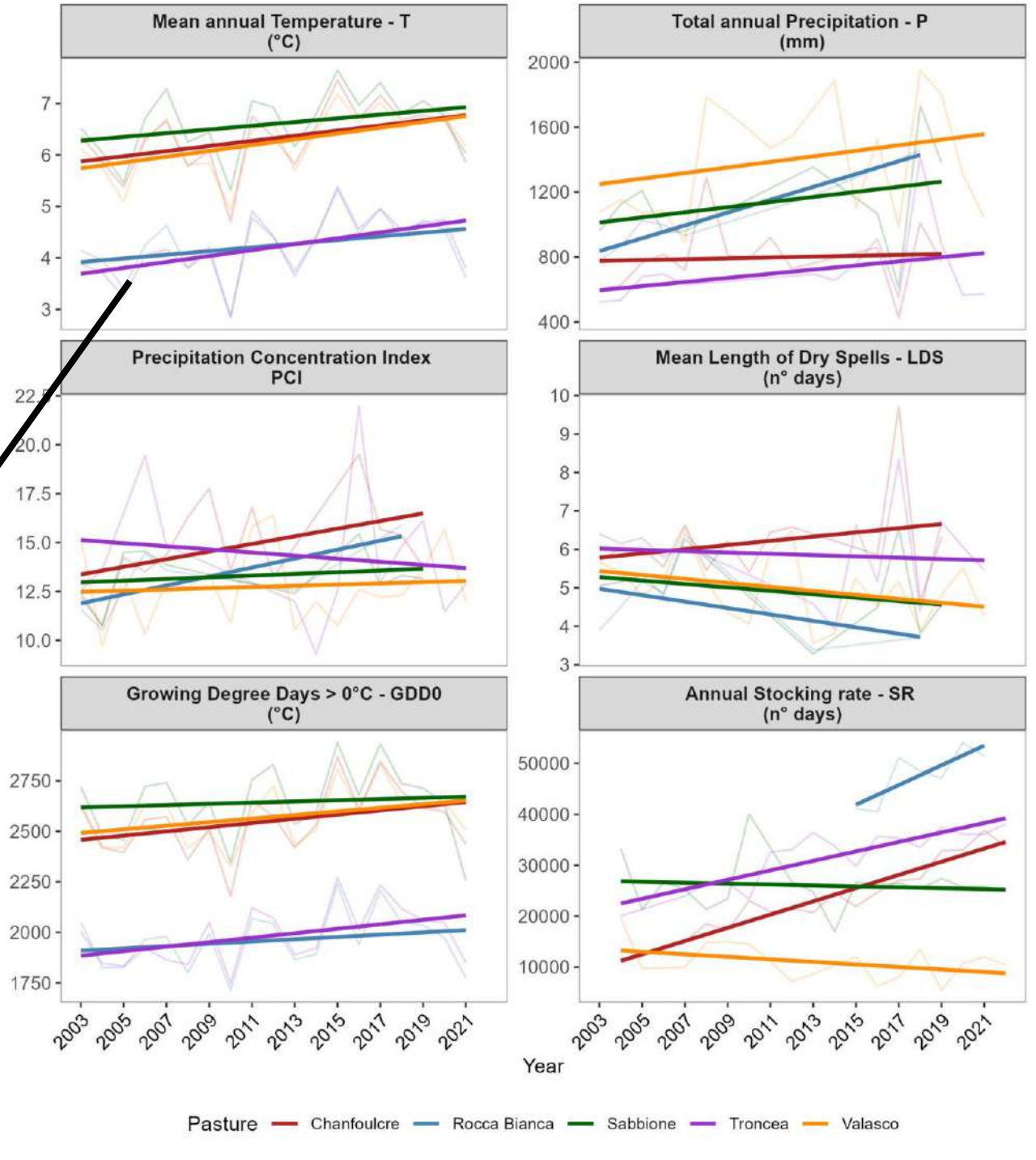
2. How have management and climate influenced vegetation composition and plant diversity?



RESPONSE VARIABLES

- Variables and years were standardized as **z-scores**
- Linear regressions were fitted for each variable over time.
- The **slope coefficient** was used as the **magnitude of change**:
  - positive values → increases
  - negative values → decreases





2. How have management and climate influenced vegetation composition and plant diversity?

- ΔSC% Meso-eutrophic grassland species
- ΔSC% Oligotrophic montane sward species
- ΔEffective Number of Species (ENS)

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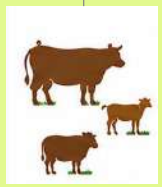
Magnitude of change


Stocking rate (SR)


Mean annual temperature (T)


Total annual precipitation (P)

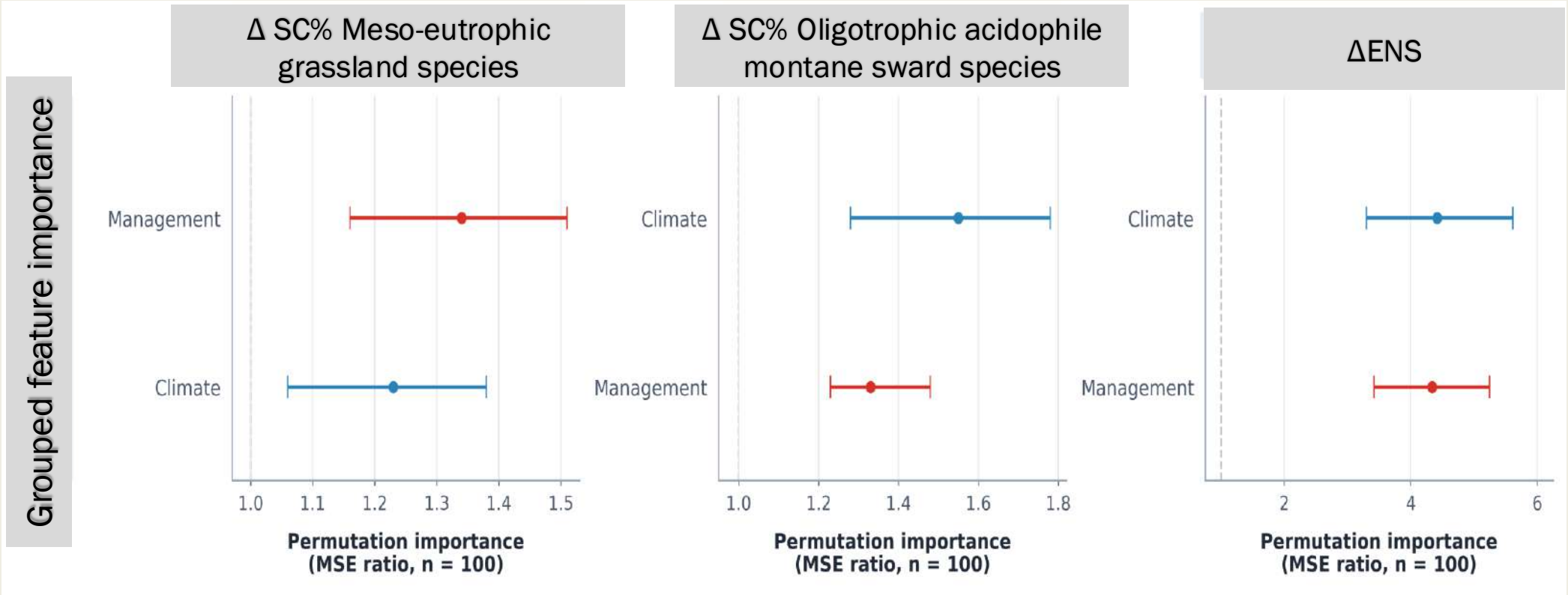

Precipitation Concentration Index (PCI)


Length of Dry Spell (LDS)


Growing Degree Days (GDD)


Site-Use Intensity (SUI)

Extreme Gradient Boosting (XGBoost)



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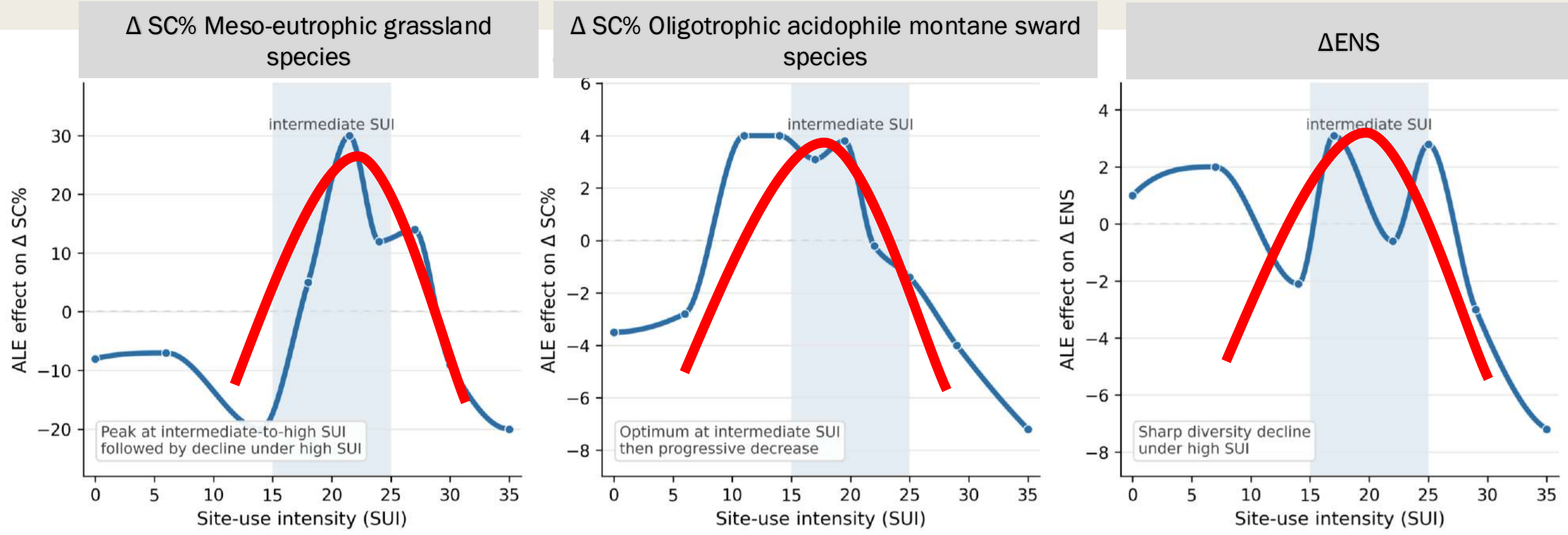
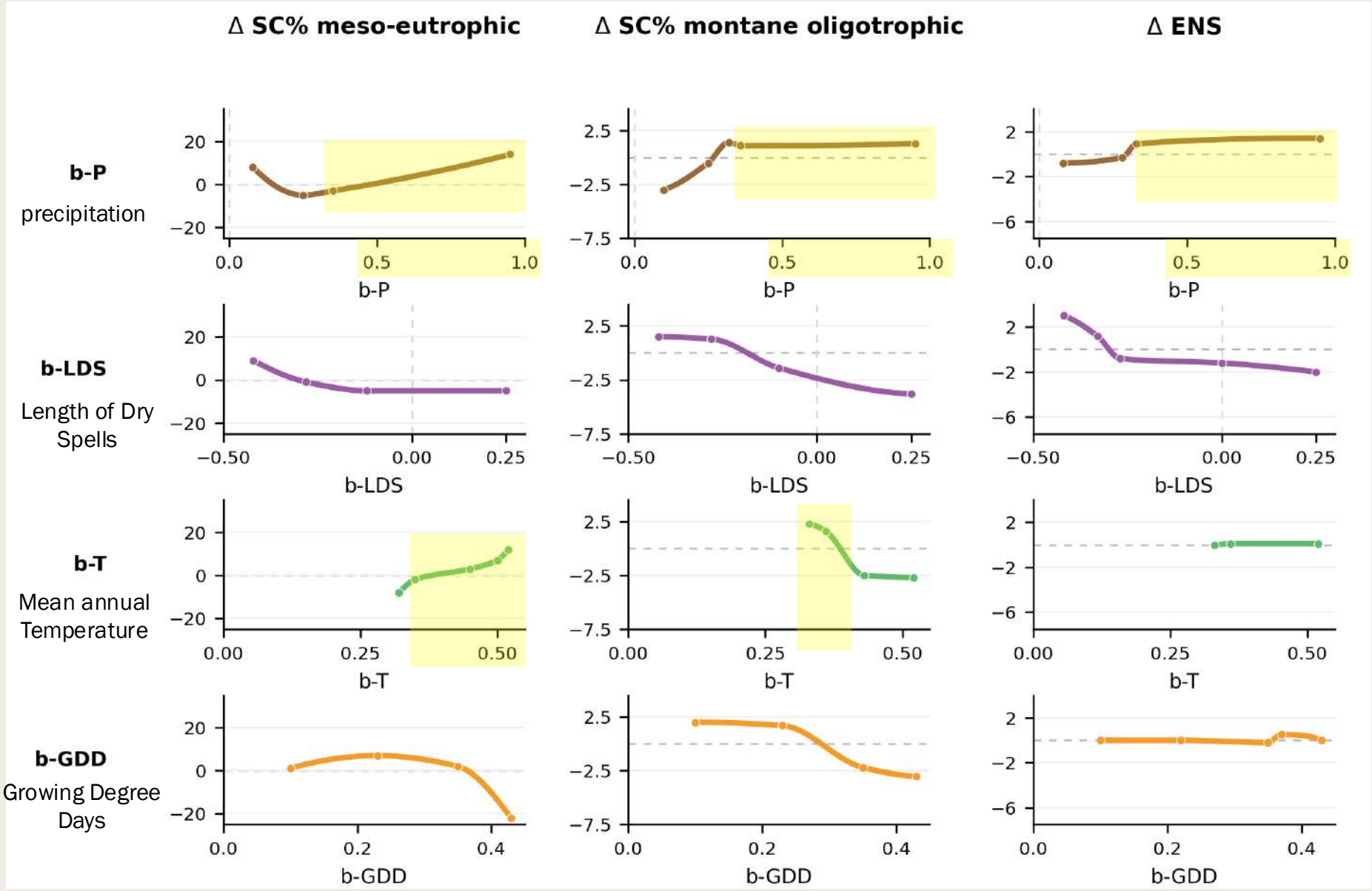


Intermediate Site-Use Intensity promoted the increase of meso-eutrophic and montane oligotrophic species while maximizing community evenness (ENS).

2. How have management and climate influenced vegetation composition and plant diversity?



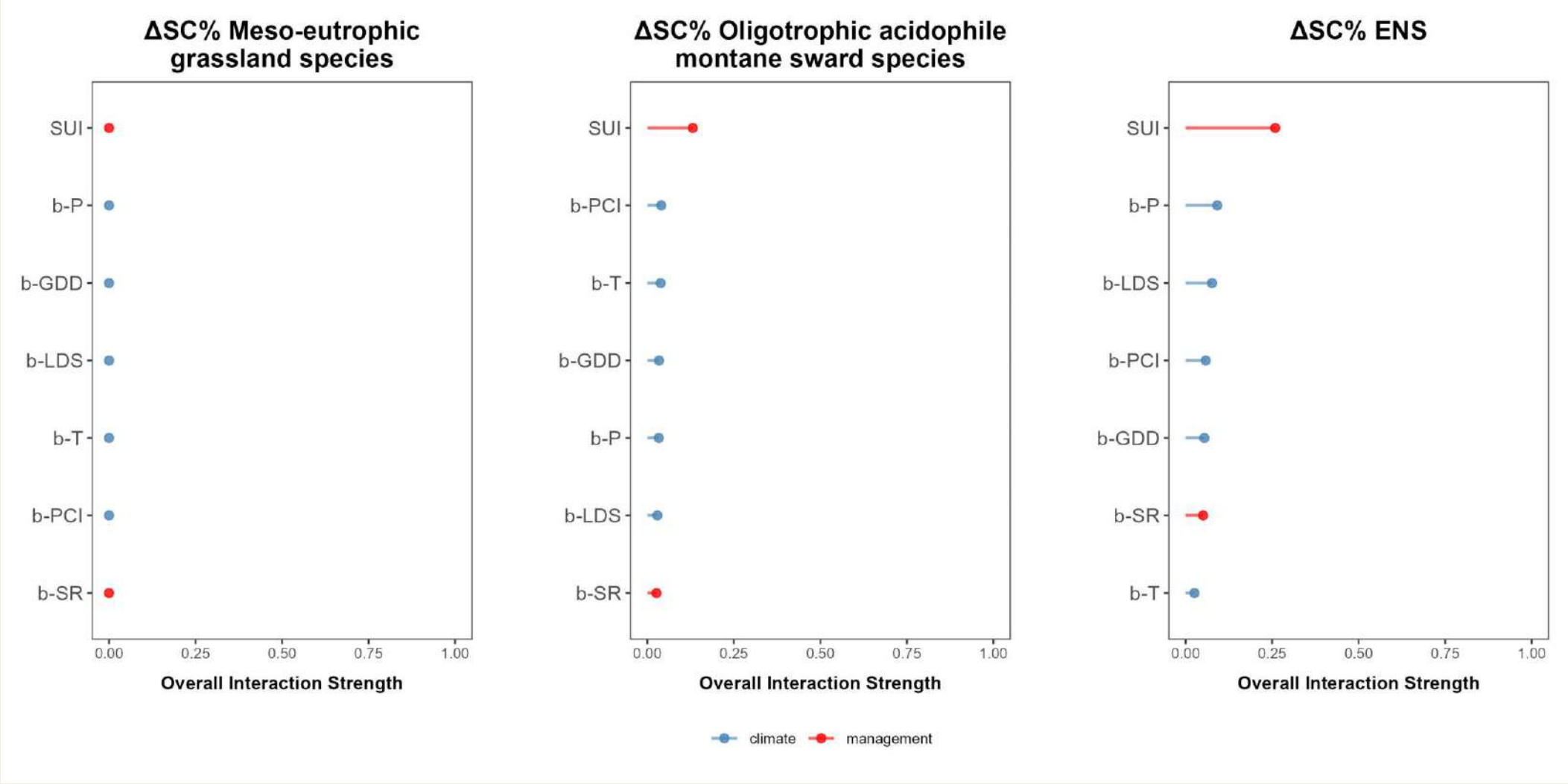
Species typical of **meso-eutrophic grasslands** benefited from faster increases in temperature and precipitation,

Species typical of **montane oligotrophic swards** increased only under moderate warming and sufficient water availability.

ENS increased under a faster increase in precipitation

Water availability is a key factor for vegetation dynamics

2. How have management and climate influenced vegetation composition and plant diversity?



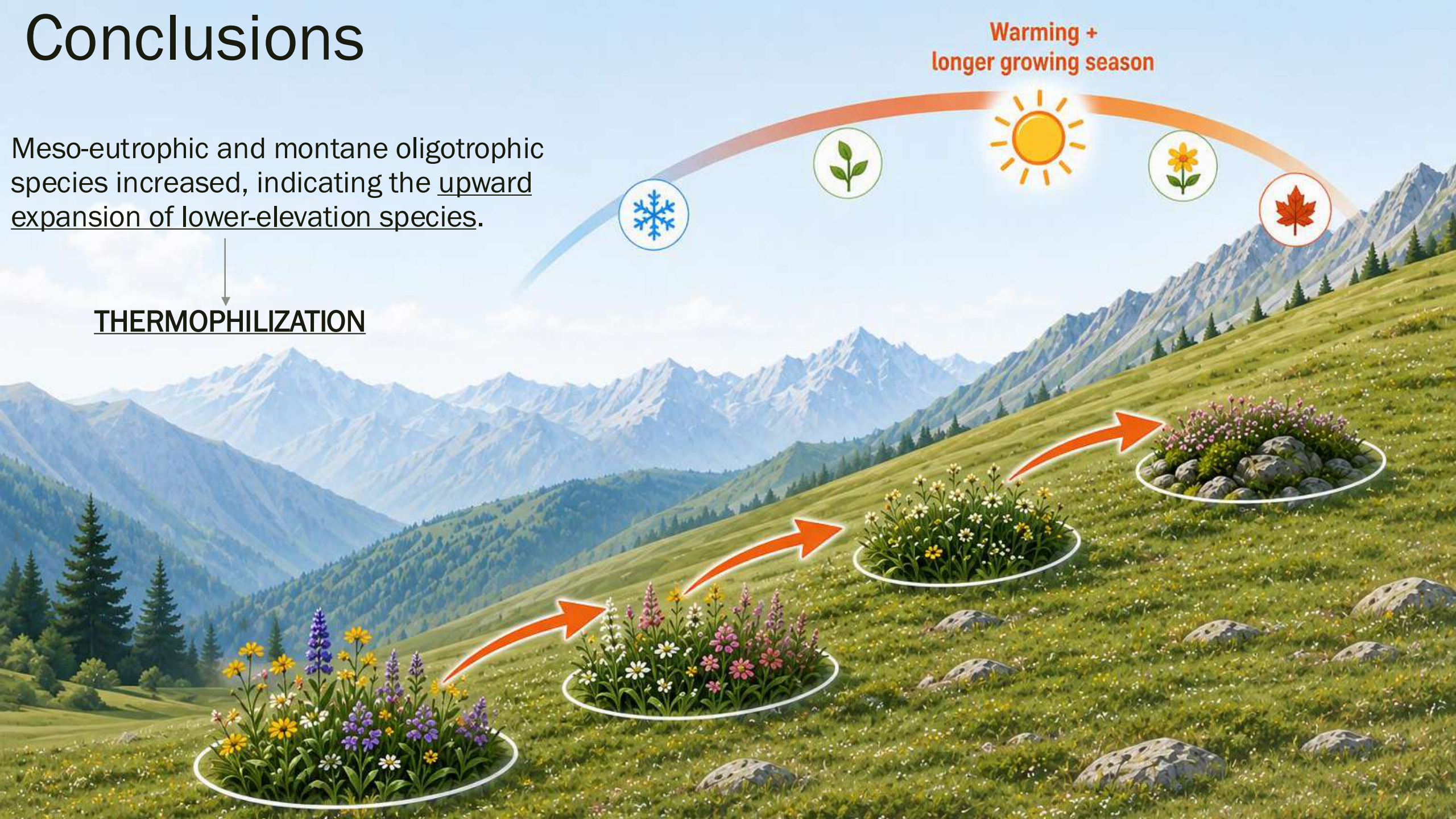
Low interaction (negligible) among variables

Conclusions

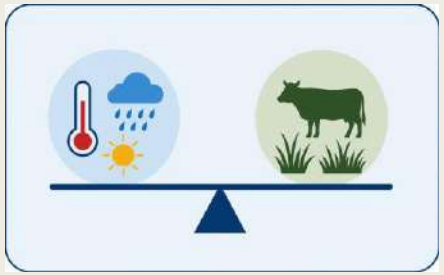
Meso-eutrophic and montane oligotrophic species increased, indicating the upward expansion of lower-elevation species.

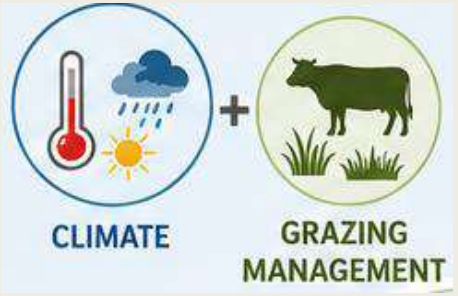
↓

THERMOPHILIZATION



Conclusions





Effects on vegetation dynamics should be assessed by considering both drivers together

SC% meso-eutrophic species
SC% montane oligotrophic species
community evenness

Intermediate site-use intensity

Drought and rapid warming

Management implications

CLIMATE cannot be directly controlled

GRAZING MANAGEMENT represents the main tool to regulate vegetation dynamics under climate change

Need to balance site-use intensity with vegetation and climate conditions

(e.g. Grazing Management Plans)

THANK YOU FOR YOUR ATTENTION