

PhD Course in Molecular, Cellular and Environmental Biology, XLI cycle

THE RESPONSE OF PLANTS TO CLIMATE CHANGE IN MOUNTAIN ENVIRONMENTS

Supervisor: Prof. **Marta Carboni**

Co-supervisor: Dr. **Marco Andrello**

External tutor: Dr. **Greta La Bella**

PhD Candidate: **Aurora Forniti**



Roma Tre



SCIENZE
Dipartimento di Eccellenza

High biodiversity in mountain environments



① Climate change → Temperature increase

② Alien plants invasion

REVIEWS REVIEWS REVIEWS

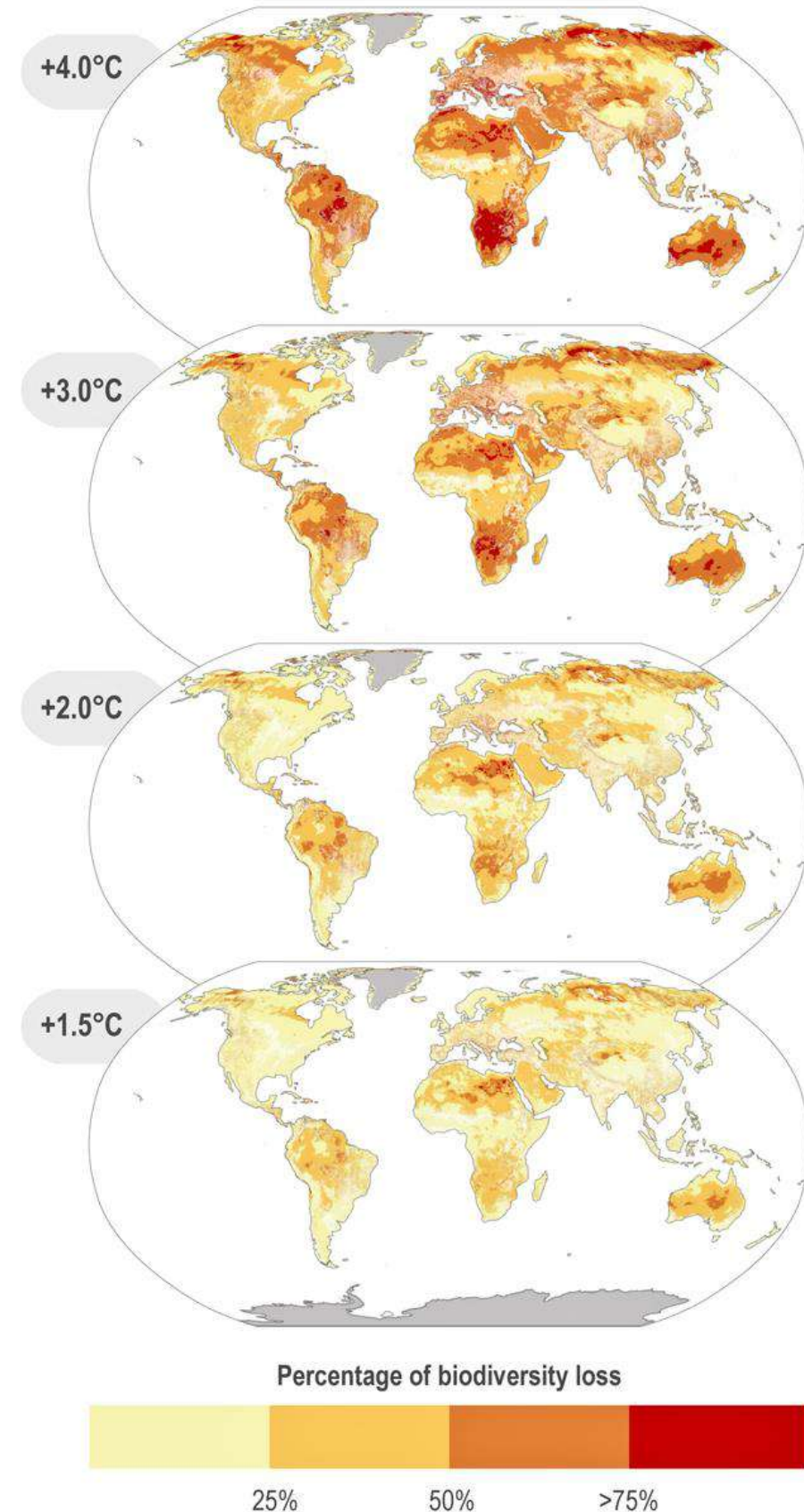
Ain't no mountain high enough: plant invasions reaching new elevations

Aníbal Pauchard^{1*}, Christoph Kueffer², Hansjörg Dietz³, Curtis C Daehler², Jake Alexander³, Peter J Edwards³, José Ramón Arévalo⁴, Lohengrin A Cavieres¹, Antoine Guisan⁵, Sylvia Haider⁶, Gabi Jakobs², Keith McDougall⁷, Constance I Millar⁸, Bridgett J Naylor⁹, Catherine G Parks⁹, Lisa J Rew¹⁰, and Tim Seipel¹⁰

Front Ecol Environ 2009; 7(9): 479–486, doi:10.1890/080072 (published online 31 Oct 2008)

479

Projected loss of terrestrial and freshwater biodiversity
compared to pre-industrial period



STATE OF
THE ART

GAPS AND
AIMS

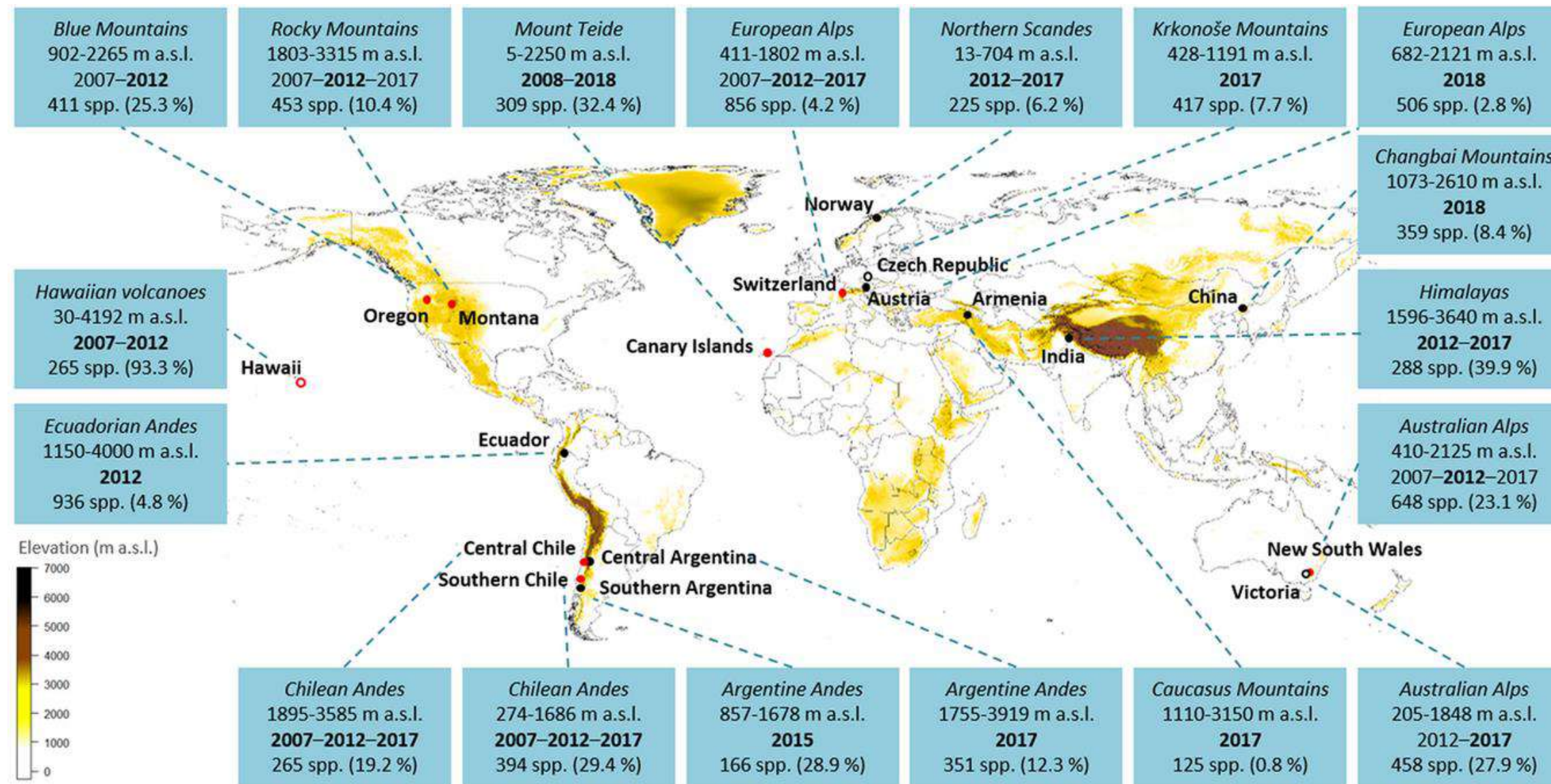
FIRST
CHAPTER

SECOND
CHAPTER

THIRD
CHAPTER

EXPECTED
RESULTS

AIM: global monitoring of mountain plant species
since **2007**, with specific focus to **alien species**



In Italy: central Appennines
site since **2022**



STATE OF
THE ART

**GAPS AND
AIMS**

FIRST
CHAPTER

SECOND
CHAPTER

THIRD
CHAPTER

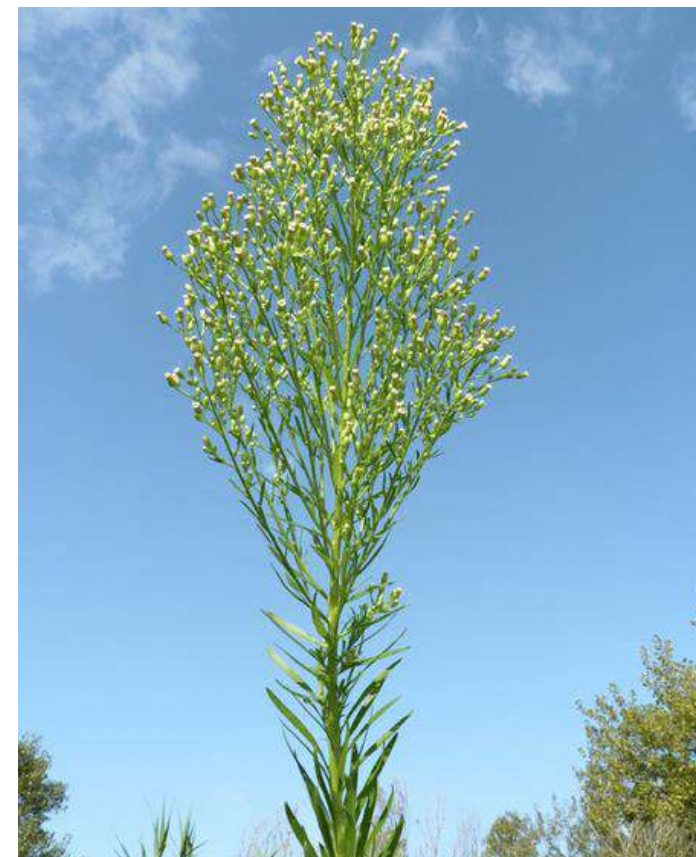
EXPECTED
RESULTS

KNOWLEDGE GAPS:

What type of species are shifting upwards?

1. ARE THERE SPECIFIC **FUNCTIONAL STRATEGIES** THAT HELP TRACK CLIMATE CHANGE?
2. ARE MORE **PLASTIC SPECIES** BETTER TRACKING CLIMATE CHANGE?
3. WHAT ARE THE DEMOGRAPHIC RESPONSES OF SPECIES TO CLIMATE CHANGE?

COMPARISON
BETWEEN **ALIEN** AND
NATIVE PLANTS



Erigeron canadensis

vs



Trifolium alpestre

STATE OF
THE ART

**GAPS AND
AIMS**

FIRST
CHAPTER

SECOND
CHAPTER

THIRD
CHAPTER

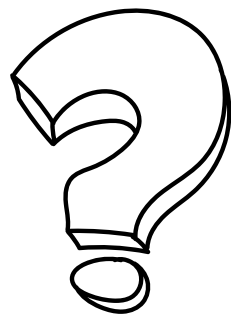
EXPECTED
RESULTS

FUNCTIONAL TRAITS:

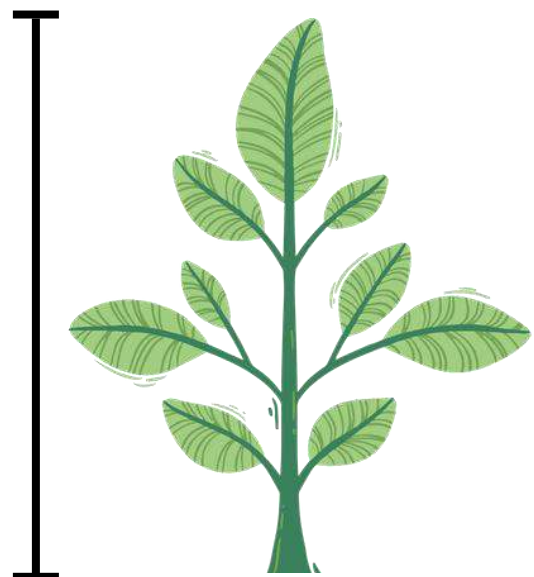
Morpho-physiological features measurable at the individual level that provide information on:



1. MEAN FUNCTIONAL STRATEGY
2. INTRASPECIFIC VARIABILITY



Which traits promote upward shifts?
Does greater functional variability facilitate range shifts?



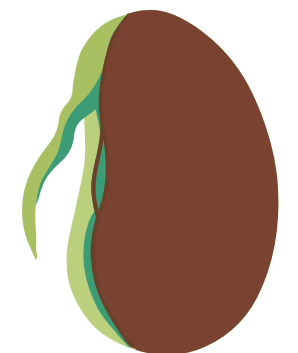
Height



Specific Leaf Area



Number of Flowers



Seed mass

STATE OF
THE ART

**GAPS AND
AIMS**

FIRST
CHAPTER

SECOND
CHAPTER

THIRD
CHAPTER

EXPECTED
RESULTS

1

Global **RANGE SHIFTING SPECIES** and their mean **FUNCTIONAL SYNDROME**



2

MIREN sampling in the central Apennines,
FUNCTIONAL SYNDROME and **INTRASPECIFIC TRAIT
VARIABILITY** of range shifting species



3

DEMOGRAPHIC STUDY of target alien and native
species in Mount Terminillo



STATE OF
THE ART

GAPS AND
AIMS

**FIRST
CHAPTER**

SECOND
CHAPTER

THIRD
CHAPTER

EXPECTED
RESULTS

AIM: **Global range shifting species** and their mean functional syndrome

Study scale



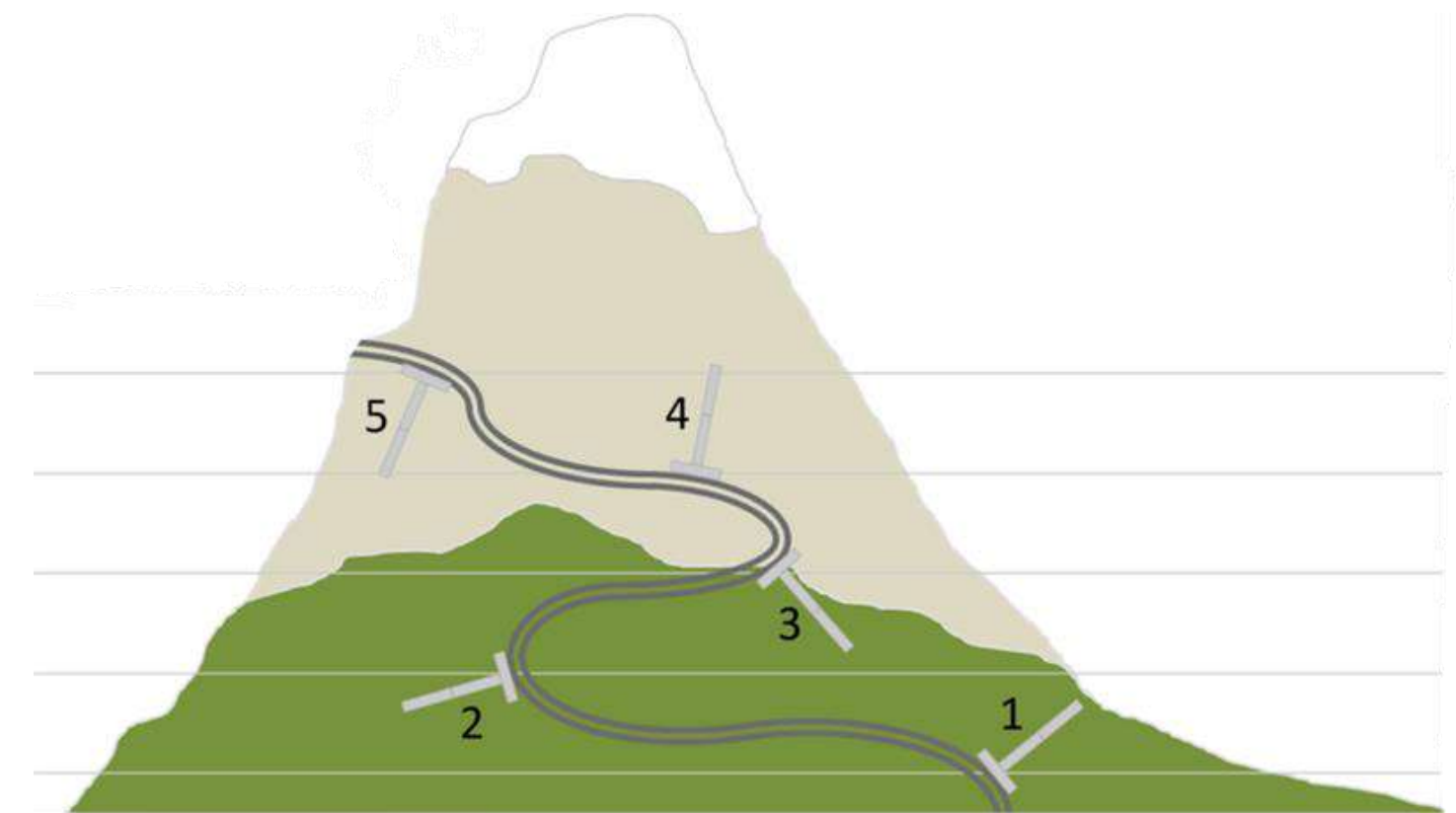
MIREN database about
road surveys

20 years data —→ From **2007** to **2026**

Equidistant sampling points, T-shaped transects



- Species Presence
- Species Cover



Have **alien** species shifted more than **native** species?

Are alien species more abundant near **roads**?

STATE OF
THE ART

GAPS AND
AIMS

**FIRST
CHAPTER**

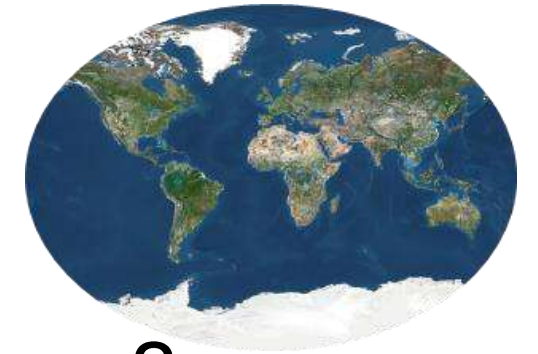
SECOND
CHAPTER

THIRD
CHAPTER

EXPECTED
RESULTS

AIM: Global range shifting species and their **mean functional syndrome**

Study scale



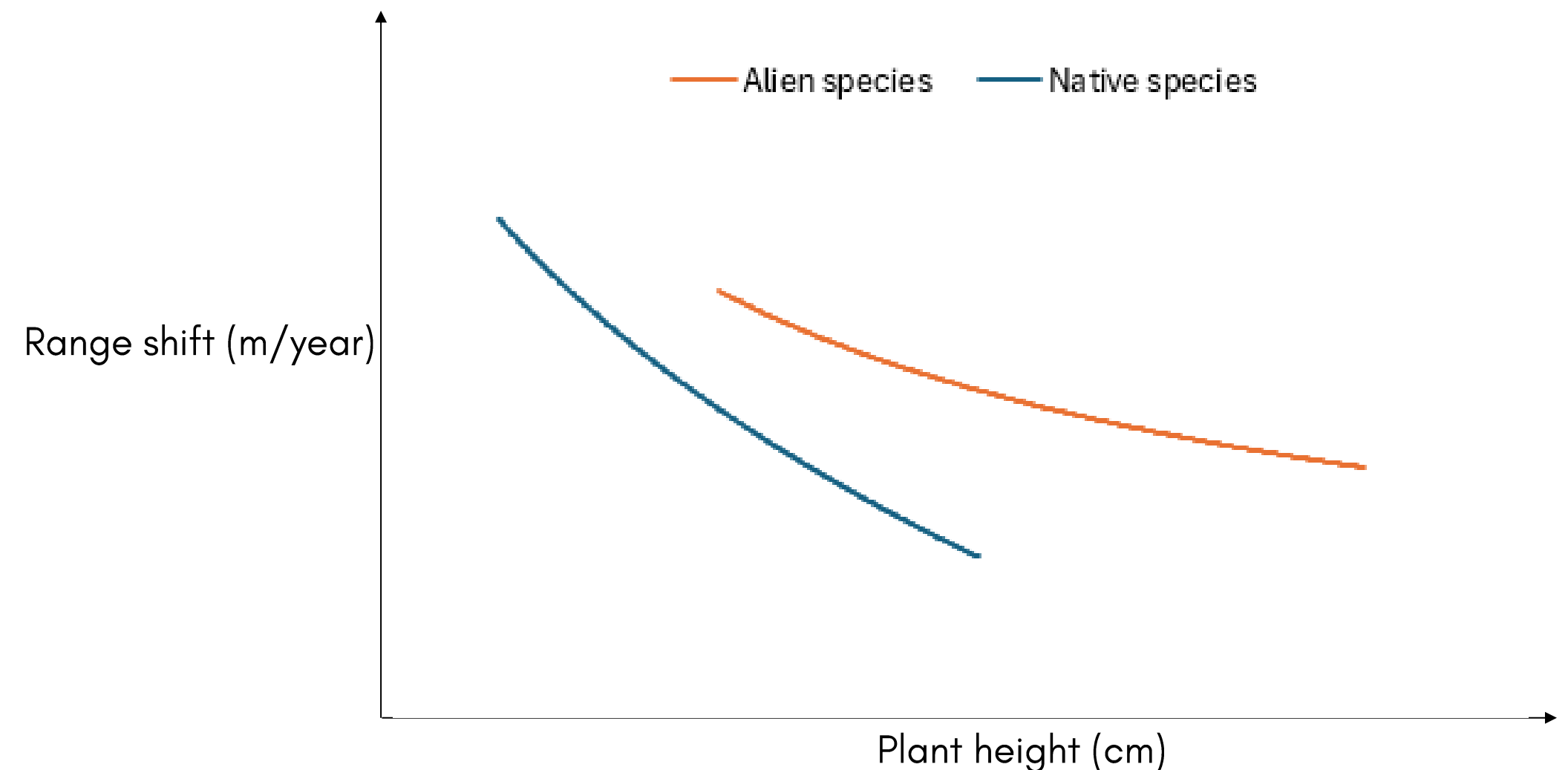
Which traits facilitate the shift?

Is the mean functional strategy different between **alien** and **native** plants?



Mean functional traits

Word cloud of functional traits. The trait **MaxPlantHeight** is circled in red. Other visible traits include: PhotosyntheticPathway, LeafArea, NfixationCapacity, Respiration, RegenerationCapacity, PlantLifespan, SLA, WoodDensity, GrowthForm, PhenologyType, LeafN, LeafP, LeafLongevity, PhotosyntheticCapacity, and SeedMass.



STATE OF
THE ART

GAPS AND
AIMS

FIRST
CHAPTER

**SECOND
CHAPTER**

THIRD
CHAPTER

EXPECTED
RESULTS

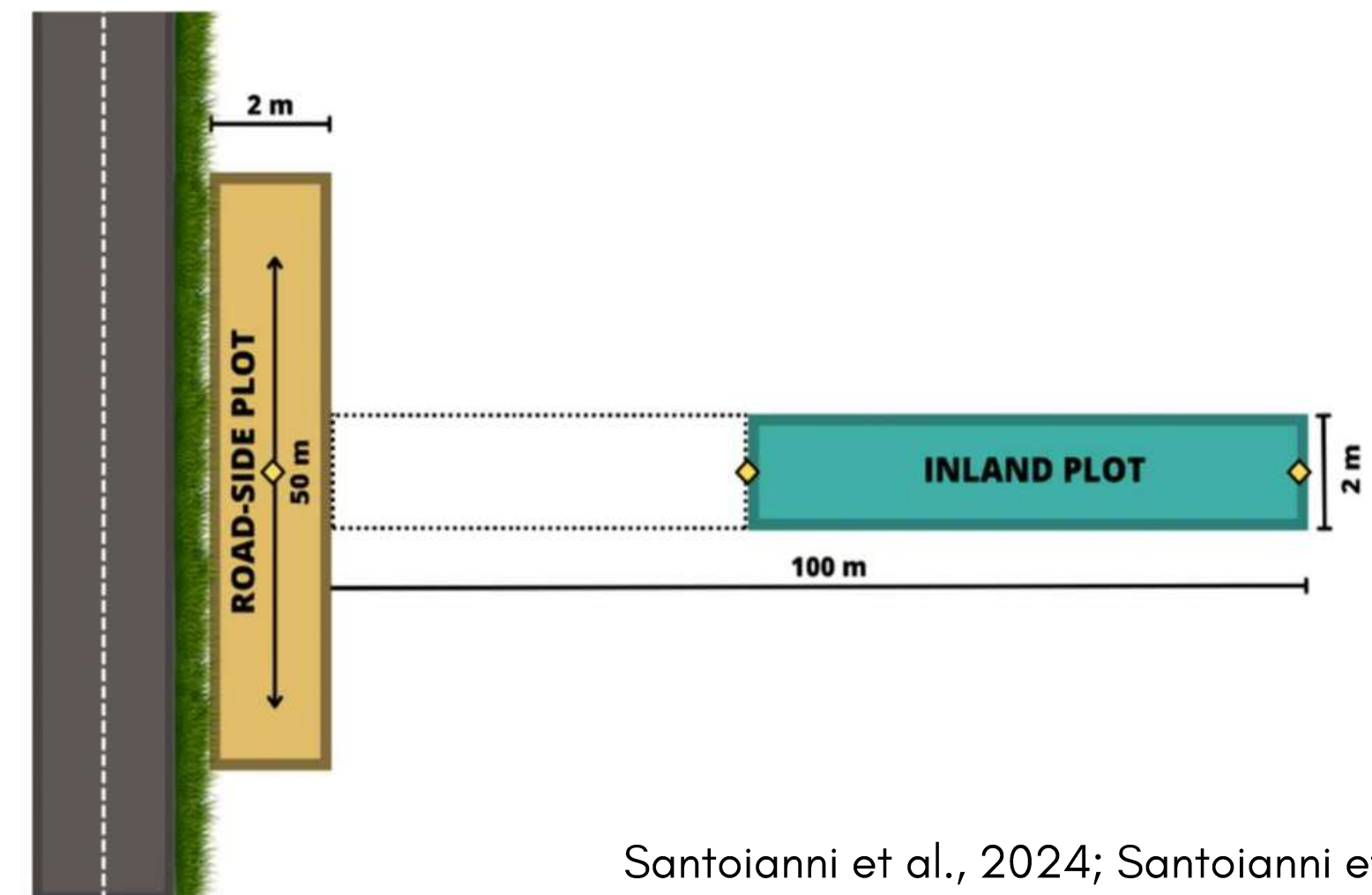
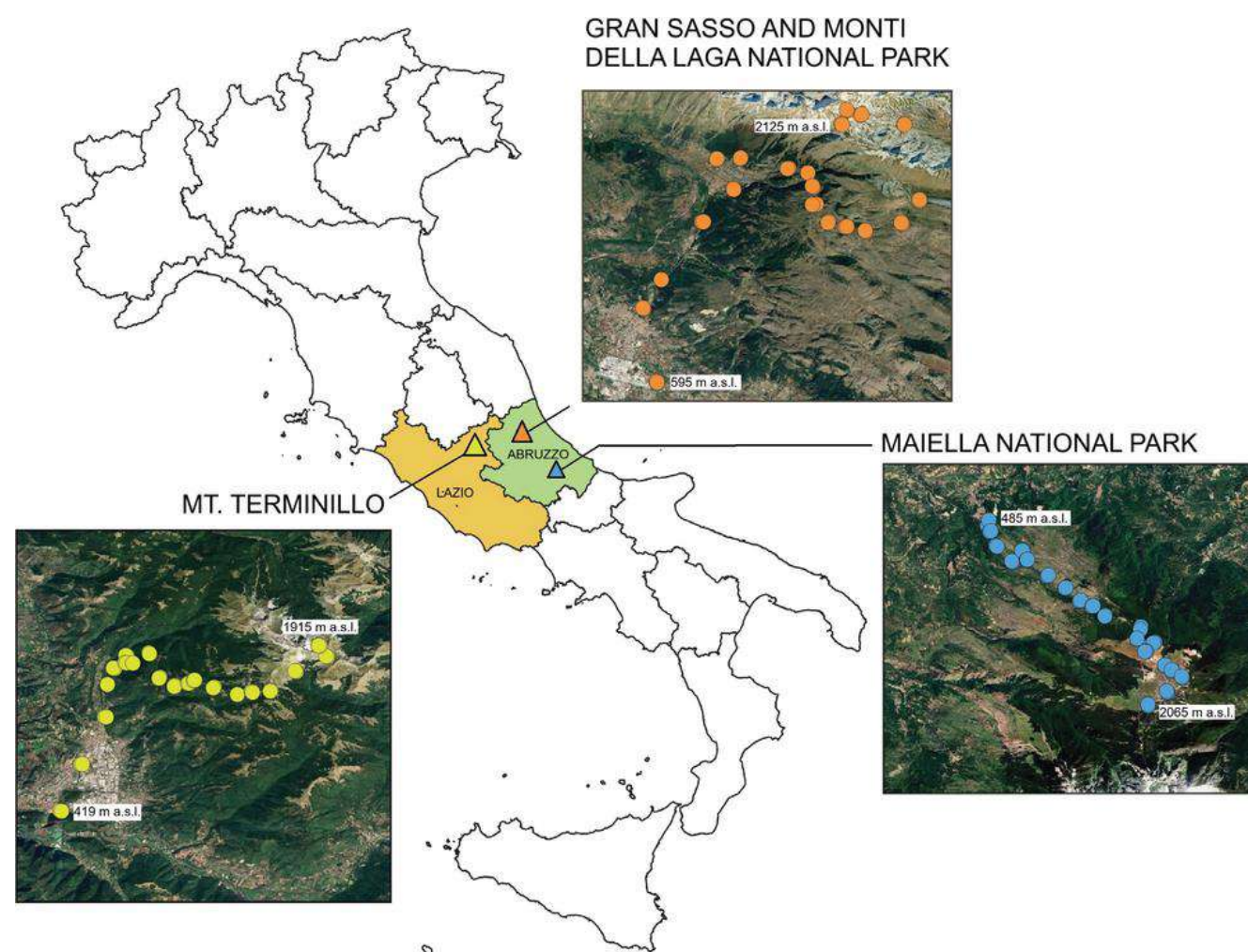
AIM: **MIREN sampling in the central Apennines**, mean functional syndrome and intraspecific trait variability of range shifting species

5 years data —→ From **2022** to **2027**

Are there any species that have shifted upwards?

Have **alien** species shifted more or less than **native** species?

Study scale



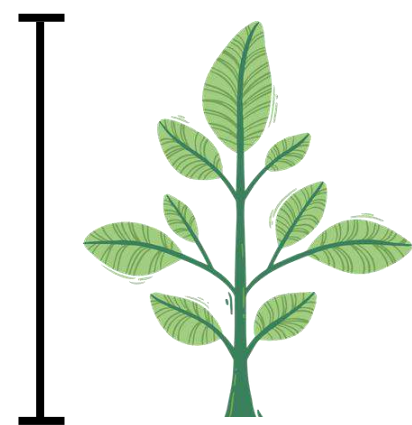
AIM: MIREN sampling in the central Apennines, **mean functional syndrome** and intraspecific trait variability of range shifting species

Which traits facilitate the shift at a **local scale**?

Which functional traits are more related to **temperature**?

- Traits and temperature measured on field

Study scale



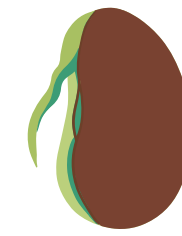
Height



Specific Leaf Area



Number of flowers



Seed mass



TOMST Datalogger:
Temperature

STATE OF
THE ART

GAPS AND
AIMS

FIRST
CHAPTER

**SECOND
CHAPTER**

THIRD
CHAPTER

EXPECTED
RESULTS

AIM: MIREN sampling in the central Apennines, mean functional syndrome and **intraspecific trait variability** of range shifting species

Study scale

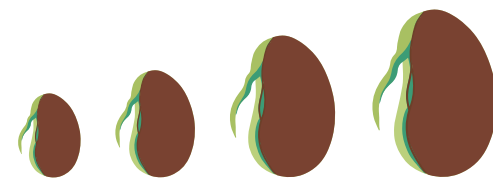


Does the intraspecific trait variability facilitate upward shift?

- Standard deviation (SD) of the individual traits

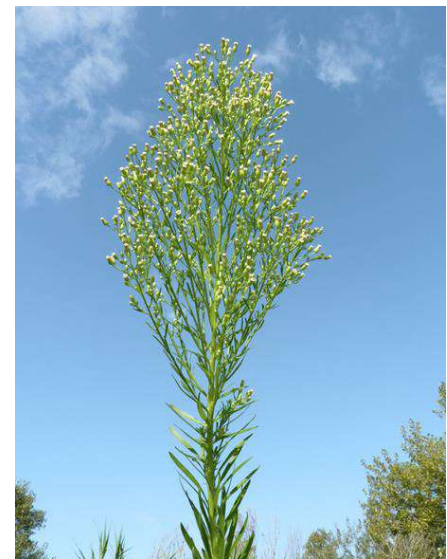


Range shift (m/year)



AIM: **Demographic study** of target alien and native species in Mount Terminillo

Study scale



Erigeron canadensis



Matricaria discoidea



Euphorbia prostrata



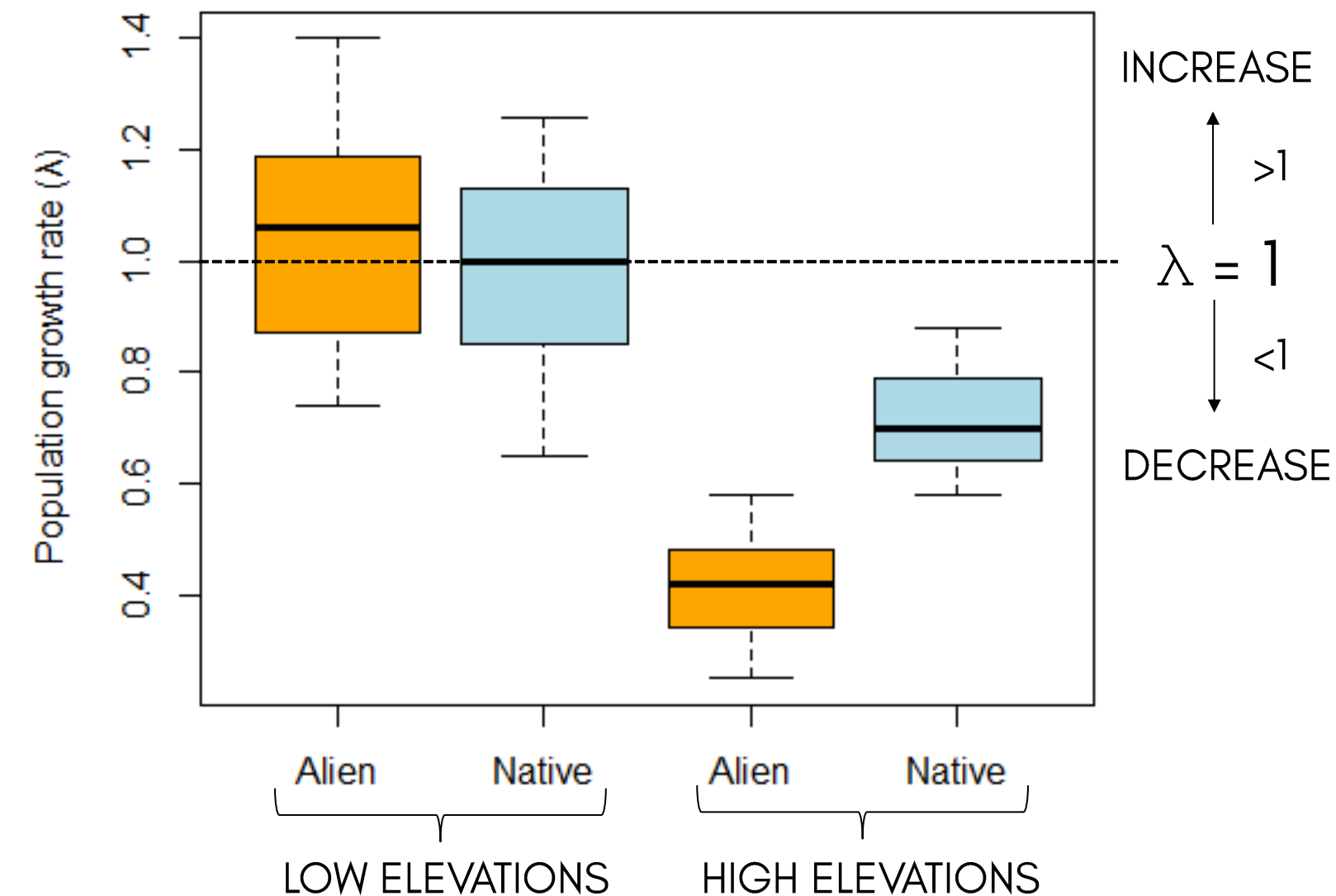
Erigeron annuus

- Population growth rate (λ) $\rightarrow \frac{N_{(t+1)}}{N_{(t)}}$

Is λ different between **low and high elevation**?

Is λ different between **alien** and **native** plants?

& 1/2 functionally
similar native species



AIM: **Demographic study** of target alien and native species in Mount Terminillo

Study scale



How do the vital rates change **along the elevational gradient**?

Which vital rate is most sensitive to **temperature**?

$$N_{(t+1)} = \underbrace{f \times g}_{\lambda \rightarrow \text{Population growth rate}} \times N_{(t)}$$

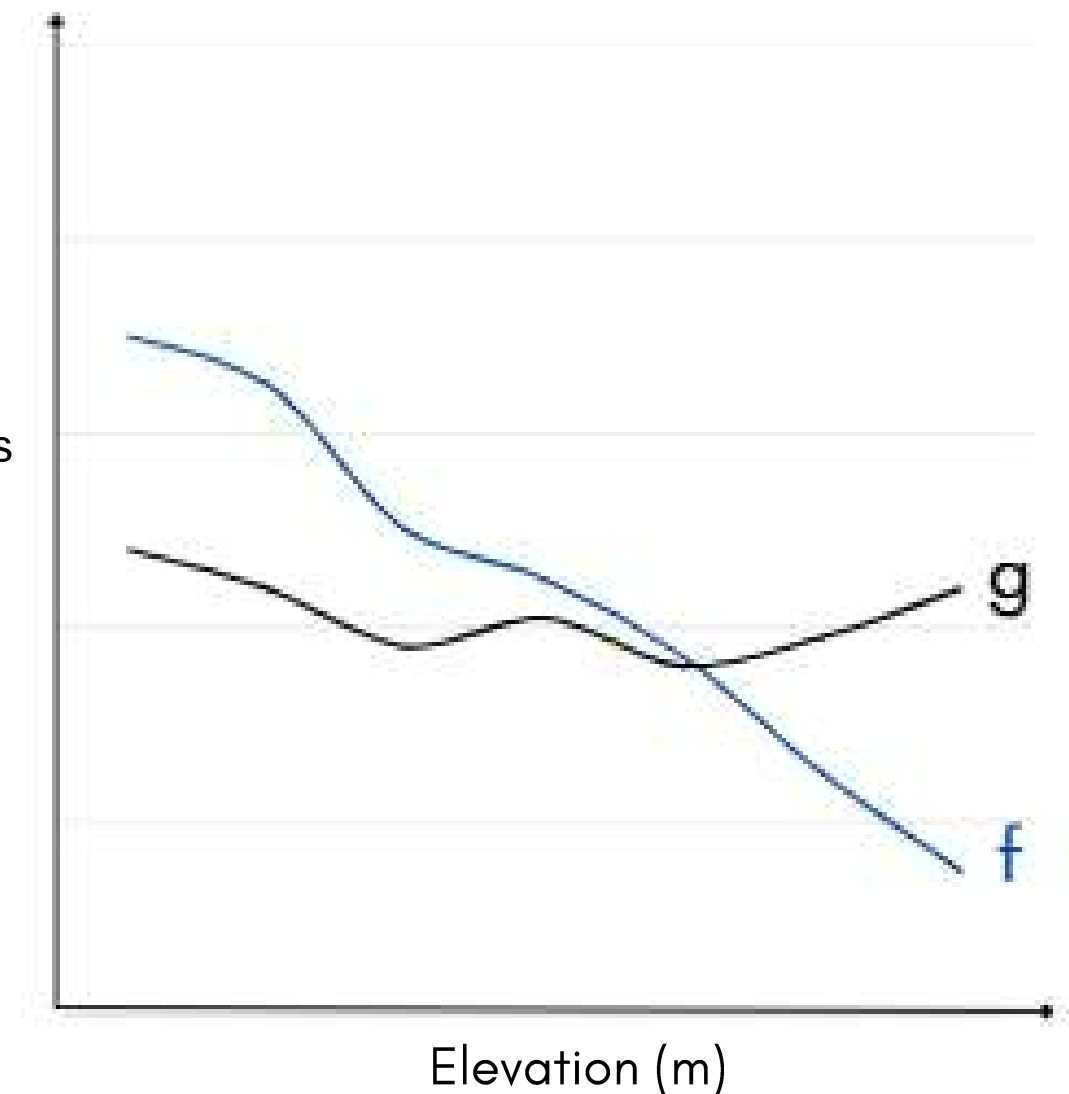
- Fecundity (f) $\rightarrow$
 - N° flower heads/ind.
 - N° seeds/flower head



- Germination and survival (g) $\rightarrow \frac{\lambda}{f}$



Vital rates



STATE OF
THE ART

GAPS AND
AIMS

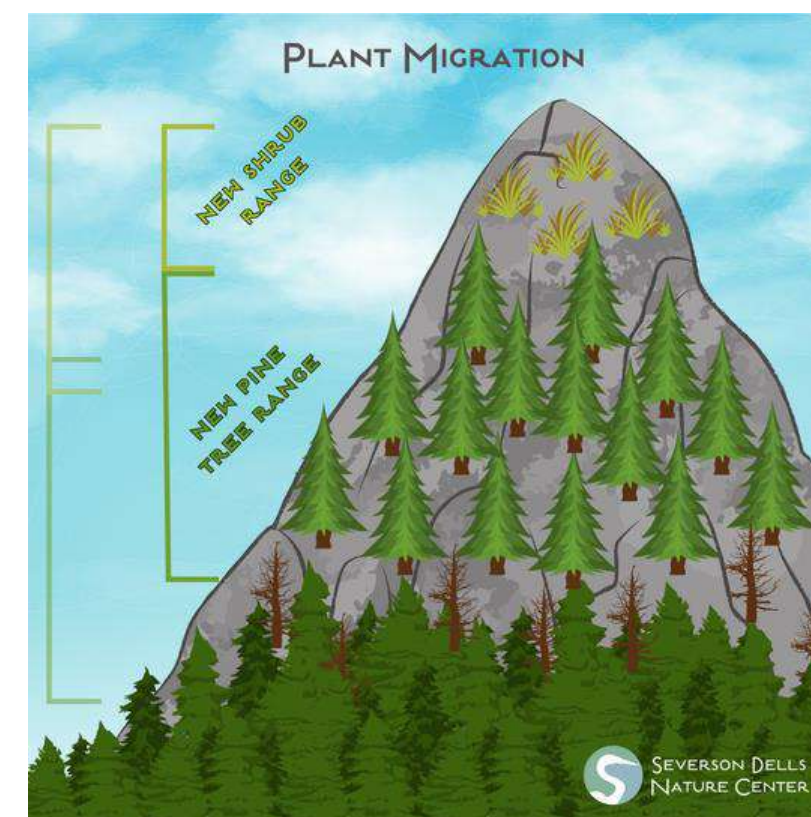
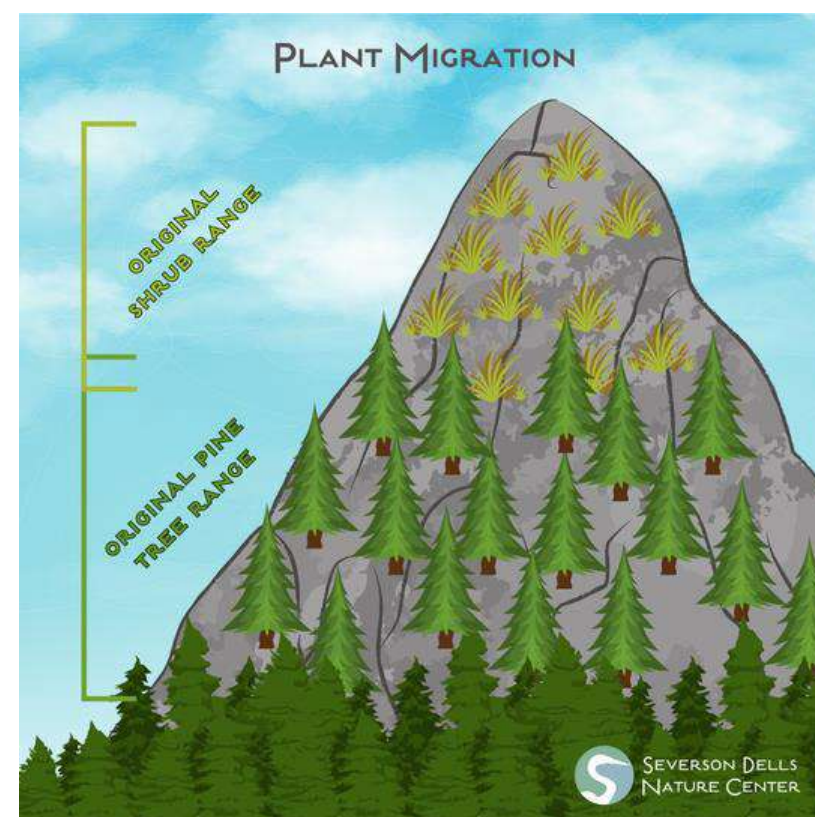
FIRST
CHAPTER

SECOND
CHAPTER

THIRD
CHAPTER

**EXPECTED
RESULTS**

- ① CHANGES IN THE COMPOSITION OF PLANT COMMUNITIES OVER TIME (ESPECIALLY AT A **GLOBAL** SCALE)
- ② FUNCTIONAL TRAITS THAT PROMOTE RANGE SHIFTING
- ③ GREATER INTRASPECIFIC TRAIT VARIABILITY OF RANGE SHIFTING SPECIES
- ④ VITAL RATE MOST SENSITIVE TO CLIMATE CHANGE



PROJECT TIMELINE

WP1

Global range shifting species and their mean functional syndrome



1° year

WP2

MIREN sampling in the central Apennines, functional syndrome and intraspecific trait variability of range shifting species



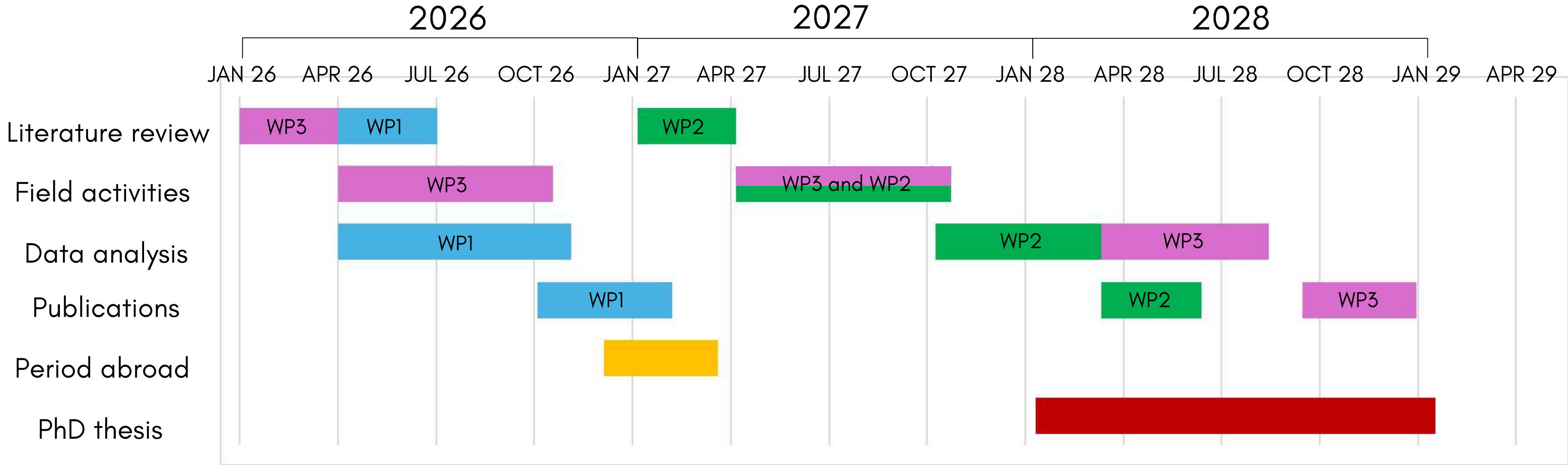
2° year

WP3

Demographic study of target alien and native species in Mount Terminillo



1°/2°/3° year



THANK YOU FOR YOUR ATTENTION!

PhD student: **Aurora Forniti**

PhD Course in Molecular, Cellular and Environmental Biology, XLI cycle

Crepis capillaris



Sonchus asper



Lapsana communis



