Long-term effects of mowing and mineral fertilization for the restoration of a Brachypodium rupestre-invaded grassland in Western Alps

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>> SYNTHESIZE MOUNTAINS OF KNOWLEDGE <<

Focus Session 39

Mountain grasslands under global change I

Long-term effects of mowing and mineral fertilization for the restoration of a *Brachypodium rupestre*-invaded grassland in Western Alps

Pittarello M.[1], *Gorlier A.*[2], *Ravetto Enri S.*[3], *Lonati M.*[3], and *Lombardi G.*[3]

1 Department of Veterinary Sciences (DSV), University of Torino, Turin, Italy

2 Department of Agricultural, Forest and Food Sciences (DISAFA), University of Torino, Turin, Italy

3 School of Natural Resources and the Environment, University of Arizona, Tucson, AZ 85721, USA

Background

Millennial agro-pastoral activities in mountain environments (mowing, grazing, fertilization, etc)

Semi-natural and specie-rich mountain grasslands

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Background

Land abandonment in the last half century

Coarse tall grasses invasion

Brachypodium rupestre

(Host) Roem. & Schult.

- highly competitive
  - ➢ **loss of biodiversity**
- silica-rich and hairy leaves
  - ➢ **low-quality forage** species for livestock.

Threat to semi-natural grasslands

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Objectives

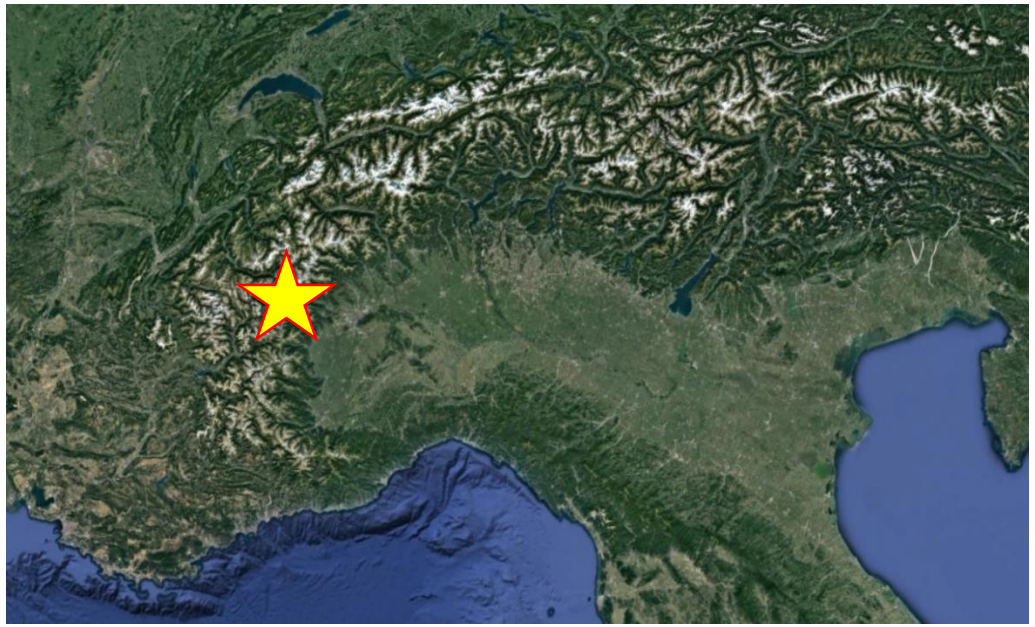
The aim of this research was to assess, over the long-term (10 years), the single and combined effects of **MOWING** and **MINERAL FERTILIZATION** on the:

A. reduction of *B. rupestre* coverage
B. forage quality and quantity
C. plant diversity
D. plant species composition

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Study area

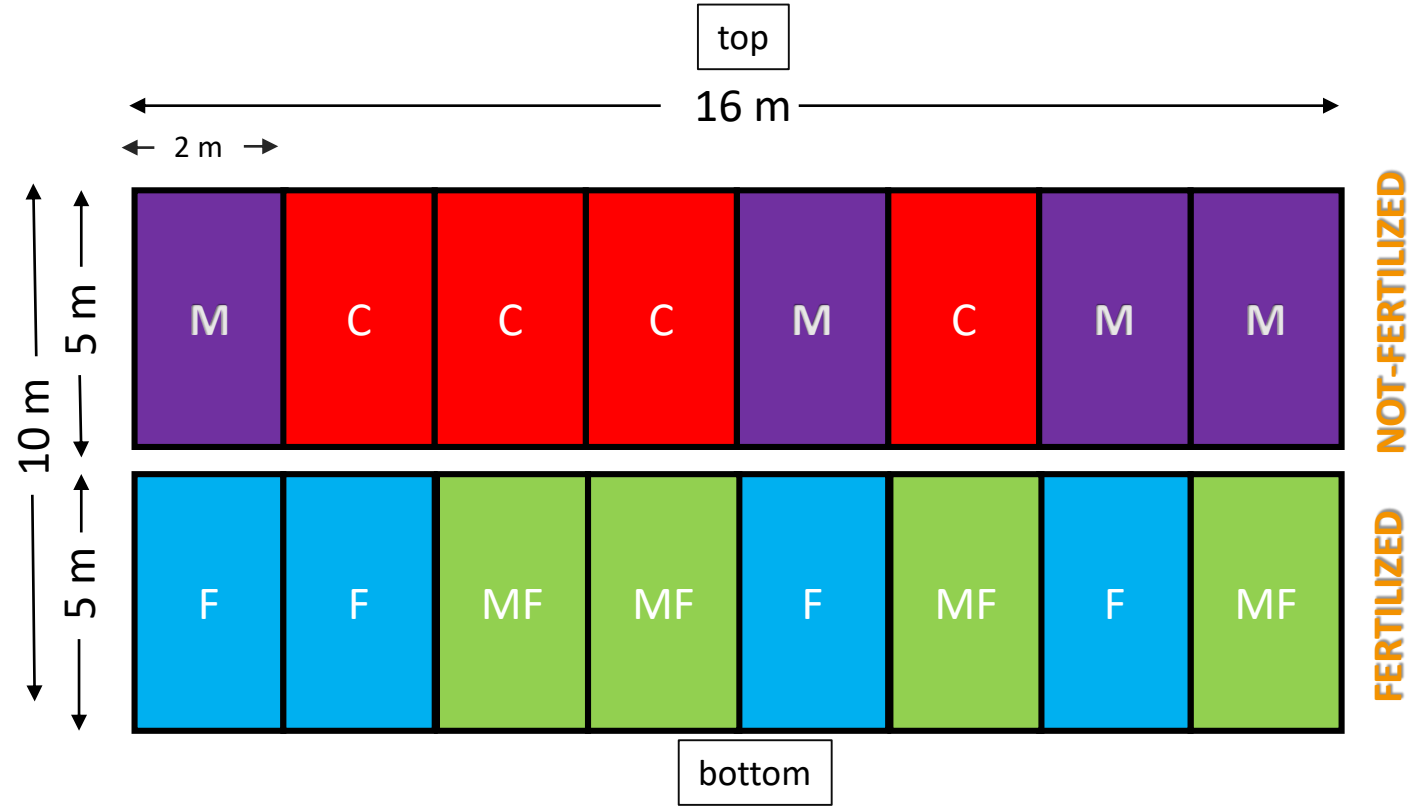
- The study area was a secondary grassland (*Festuco-brometea)* dominated by *B. rupestre* located at Gran Bosco di Salbertrand Natural Park (NW-Italian Alps), at 1360 m a.s.l.



Marco Pittarello
Department of Veterinary Sciences,
University of Torino

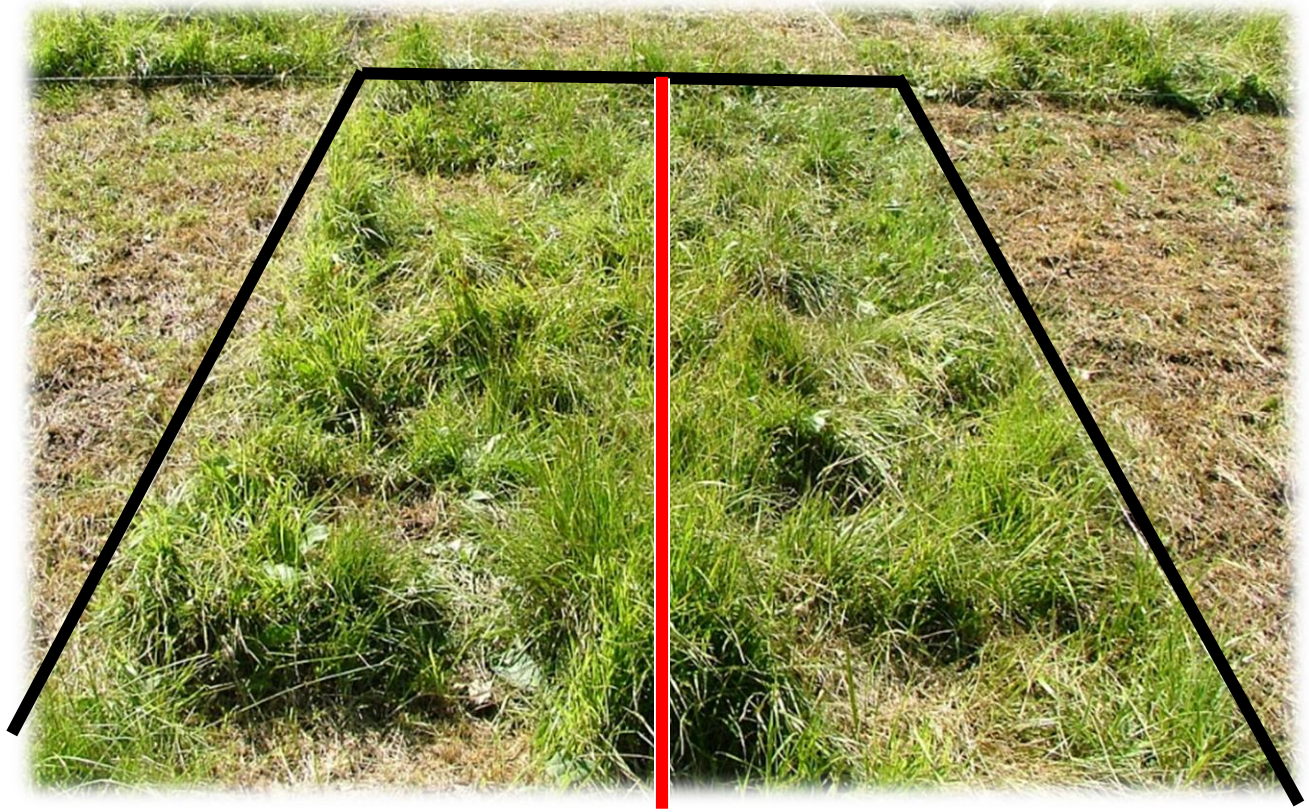
Experimental desing

- A split-plot experimental design was used to test **4 treatments**:
  - mowing (M)
  - mineral fertilization (F)
  - mowing coupled with mineral fertilization (MF)
  - control (C): not mown and not fertilized).
- **Main plots**: mineral fertilization (120 kg/ha N - 80 kg/ha P_2O_5 - 80 kg/ha K_2O)
- **Subplots**: mowing
- 4 replicates per each treatment
- Treatments applied once a year from 2006 to 2015 (i.e. for ten years)



Vegetation surveys

- botanical composition within each subplot was surveyed before treatment application
  (vertical point-quadrat method on 25 points along the vertical axis of symmetry)
- complete list of all other species within each subplot
- Survey years: 2006, 2007, 2008, 2011, 2013, and 2015.



Marco Pittarello
Department of Veterinary Sciences,
University of Torino

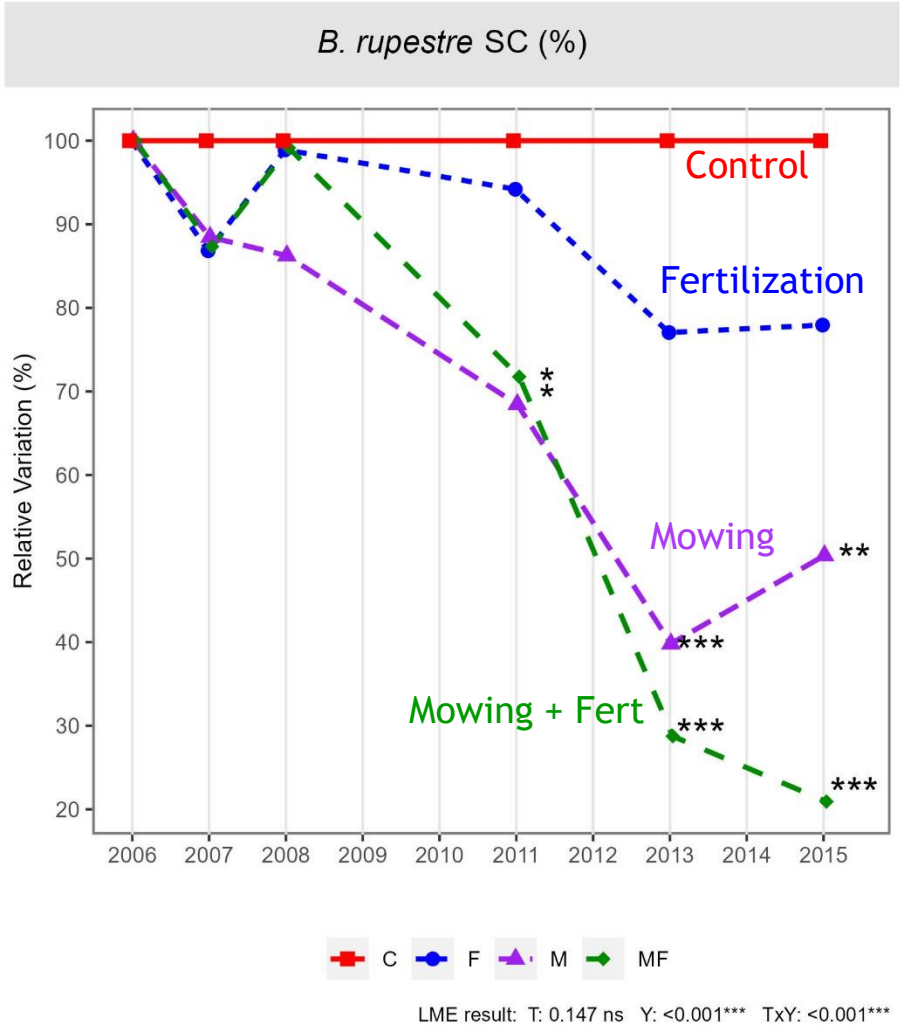
Data analysis overview

Target variable	Measured variable	Description	Statistical analyses
B. rupestre cover	Species Cover (SC)	Estimation of species canopy cover, obtained by the conversion of the frequency of occurrence of each plant species recorded along the transect to 100 measurements	Linear Mixed Effect models (LME): Y = Year + Treatment + Year x Treatment + (1|id_subplot)
Forage quality and quantity	Pastoral Value (PV)	Synthetic index derived from sward botanical composition summarizing forage yield, quality, and palatability for livestock. It ranges from 0 (low) to 100 (high)	
Plant diversity	Effective Number of Species (ENS)	Number of species in equivalent community	
Botanical composition	Species Cover (SC)		Principal Response Curve (PRC): Species SC = Year x Treatment; Covariate = Year

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Results

A) reduction of *B. rupestre* coverage



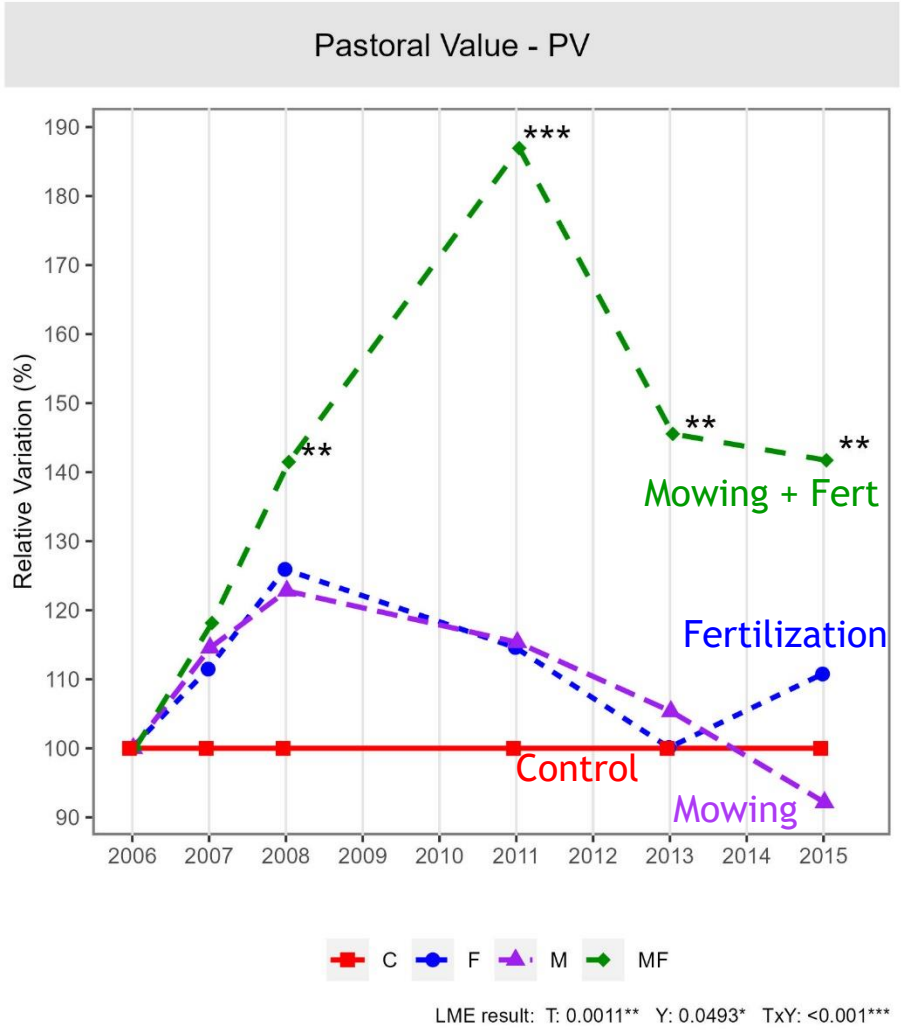
	TREATMENT (*B. rupestre* SC%)			
YEAR	Control	Fertilization	Mowing	Mowing+Fert.
2006	69.0±9.85	75.0 ± 6.61	78.0 ± 6.22	87.0 ± 11.70
2007	89.0±4.73	84.0 ± 5.66	89.0 ± 4.43	98.0 ± 2.00
2008	80.0±4.90	86.0 ± 2.58	78.0 ± 5.29	100.0 ± 0.00
2011	84.0±6.73	86.0 ± 3.46	65.0 ± 7.19	76.0 ± 7.12
2013	80.0±4.32	67.0 ± 13.70	36.0 ± 12.11	29.0 ± 1.00
2015	72.0±4.90	61.0 ± 11.00	41.0 ± 10.50	19.0 ± 2.52

- Most effective practice: MF (-78% in 2015), followed by M (-47% in 2015)
- F alone determined a negligible reduction

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Results

B) Forage quality and quantity



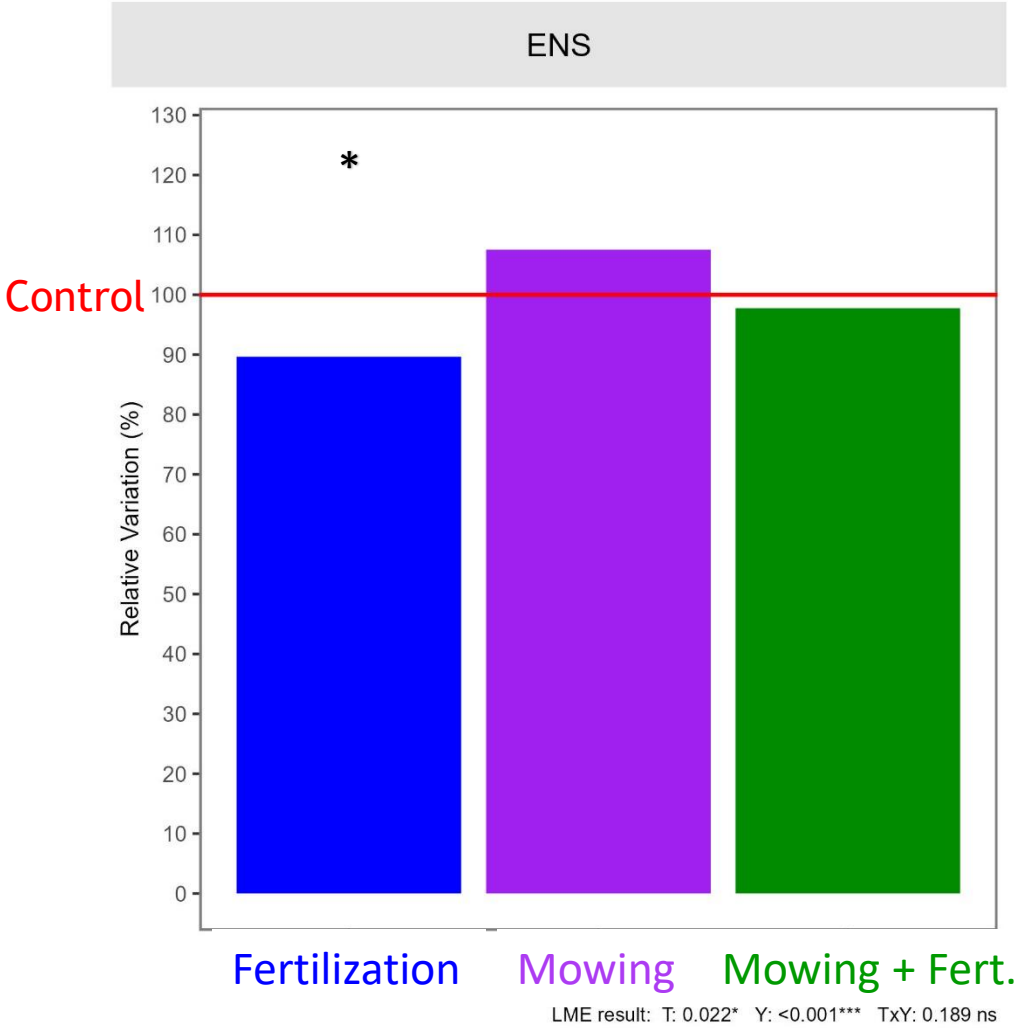
	TREATMENT (Pastoral Value - PV)			
YEAR	Control	Fertilization	Mowing	Mowing+Fert.
2006	28.4 ±0.81	29.7 ±0.73	25.4 ±1.61	24.7 ± 1.21
2007	24.3 ±1.62	28.3 ±1.64	24.8 ±1.74	24.9 ± 0.95
2008	21.5 ±1.83	28.2 ±1.03	23.5 ±0.87	26.4 ± 1.39
2011	22.2 ±1.52	26.6 ±2.15	22.9 ±0.97	36.0 ± 1.55
2013	22.7 ±0.48	23.8 ±3.48	21.4 ±1.38	28.7 ± 2.24
2015	25.4 ±1.20	29.4 ±1.61	20.9 ±1.19	31.2 ± 2.79

- Most effective practice: MF (+26% in 2015)

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Results

C) Plant diversity



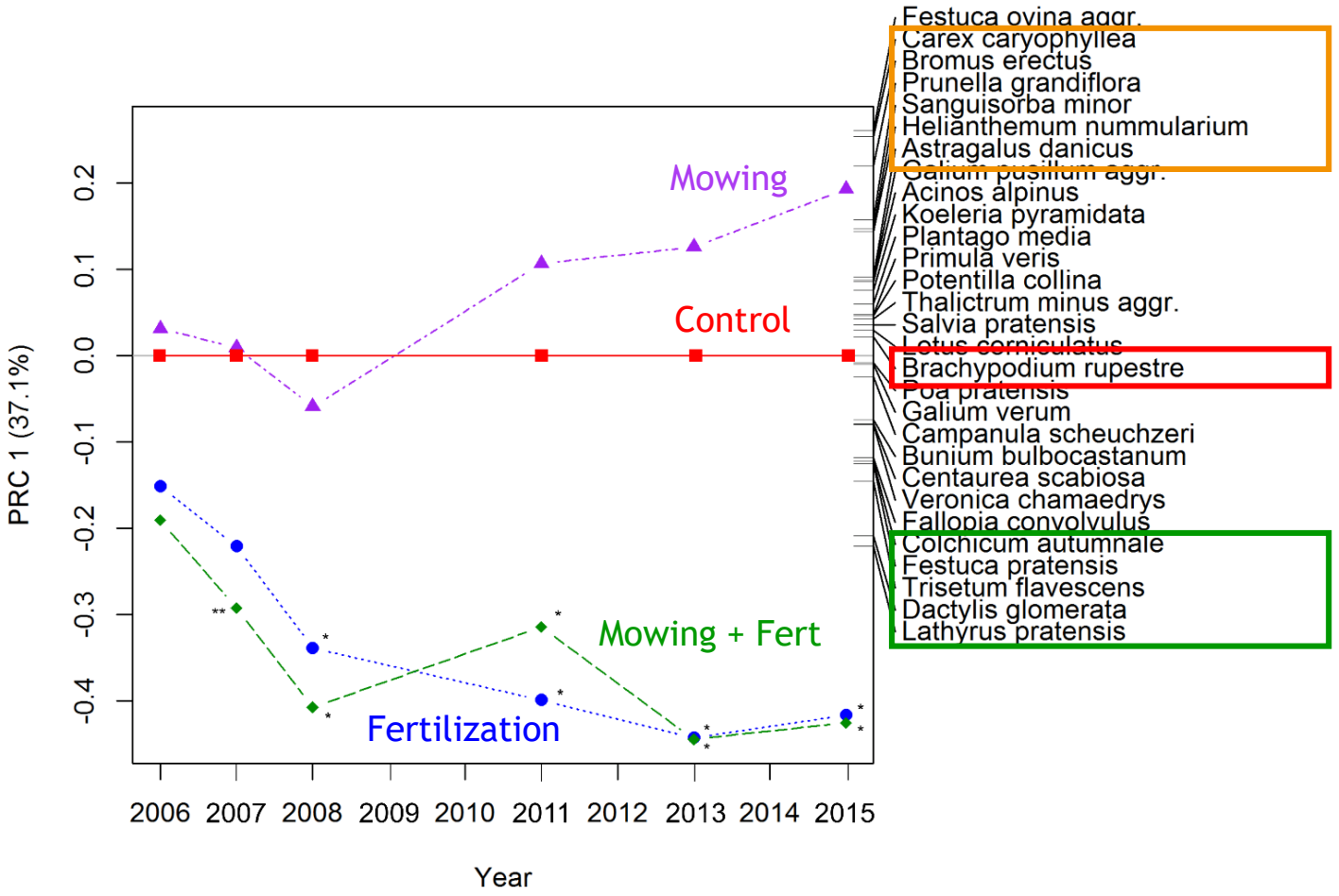
TREATMENT (ENS)			
Control	Fertilization	Mowing	Mowing+Fert.
13.7 ±0.56	12.0 ±0.48	14.4 ±0.66	13.4 ±0.70

- Only F affected the ENS, but in a negative way

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Results

D) Plant species composition



Dry grassland
(Festuco-brometea)

Increased with MOWING

Meso-eutrophic grassland
(Molinio-Arrhenateretea)

Increased with MOWING+FERTILIZATION and FERTILIZATION

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Conclusions

- tested treatments significantly affected vegetation composition of the *B. rupestre*-encroached grassland over the ten-years monitoring
- effects on vegetation were evident only **after six years** of treatment application.

Marco Pittarello
Department of Veterinary Sciences,
University of Torino

Conclusions

- Fertilization alone can not represent a valuable solution for the management semi-natural (and species-rich) dry grasslands
- Mowing alone successfully counteract *B. rupestre* and can preserve the forage quality and plant diversity
- Mowing coupled with Fertilization to both reduce *B. rupestre* cover, enhance forage quality while preserving plant diversity ➔ optimal solution in species-rich mountain grasslands

TARGET VARIABLE	TREATMENT		
	Fertilization	Mowing	Mowing + Fertilization
B. rupestre cover		-	--
Forage quality and quantity			+
Plant diversity	-		
Botanical composition (meso-eutrophic grassland species)	+		+

- → reduction
+ → increase
→ Positive effect
→ Negative effect
→ No effect

Marco Pittarello
Department of Veterinary Sciences,
University of Torino



Thank you for your attention

marco.pittarello@unito.it

Departement of Veterinary Sciences, University of Torino