Turin University – Dept Life Sciences and Systems Biology

30 Year Changes In Alpine Butterfly Communities

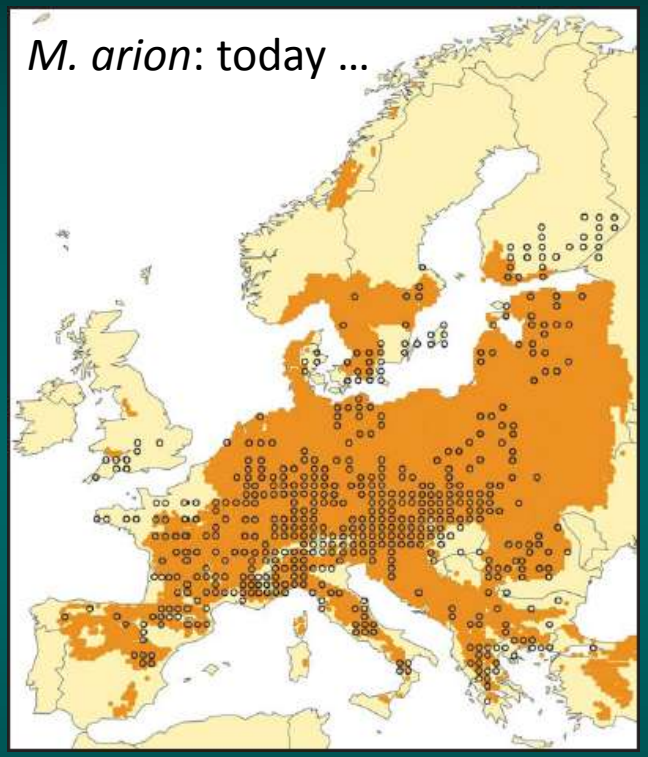


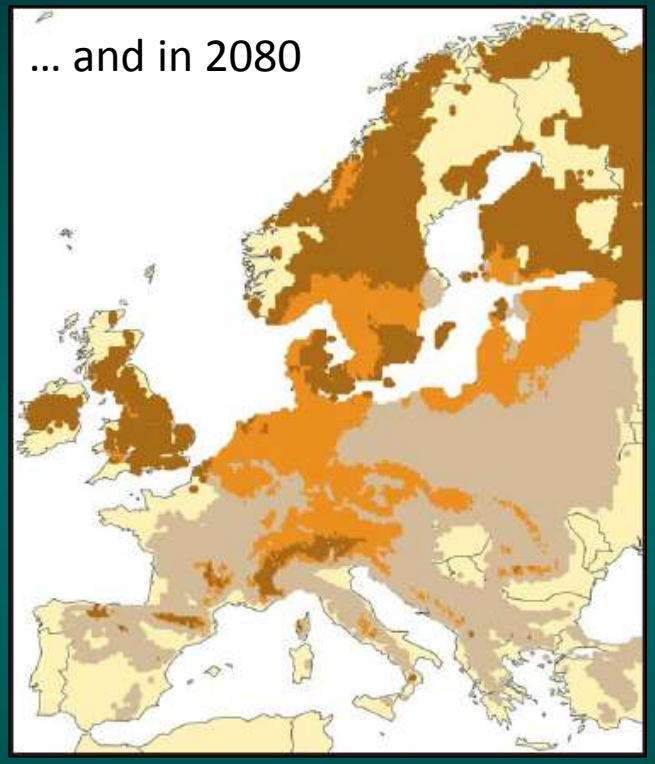
Simona Bonelli
simona.bonelli@unito.it

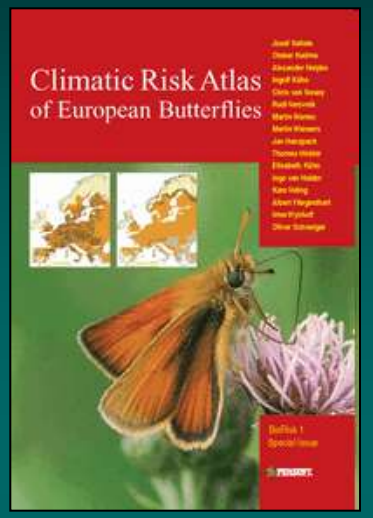
Future of Butterflies in Europe III – 29-31 March 2012

The role of the Alps for biodiversity

In the recent Atlas of Climate Risk, Settele *et al.* (2008) predict important losses in climatically suitable areas for 294 European butterfly species.







suitable habitat
new habitat
lost habitat

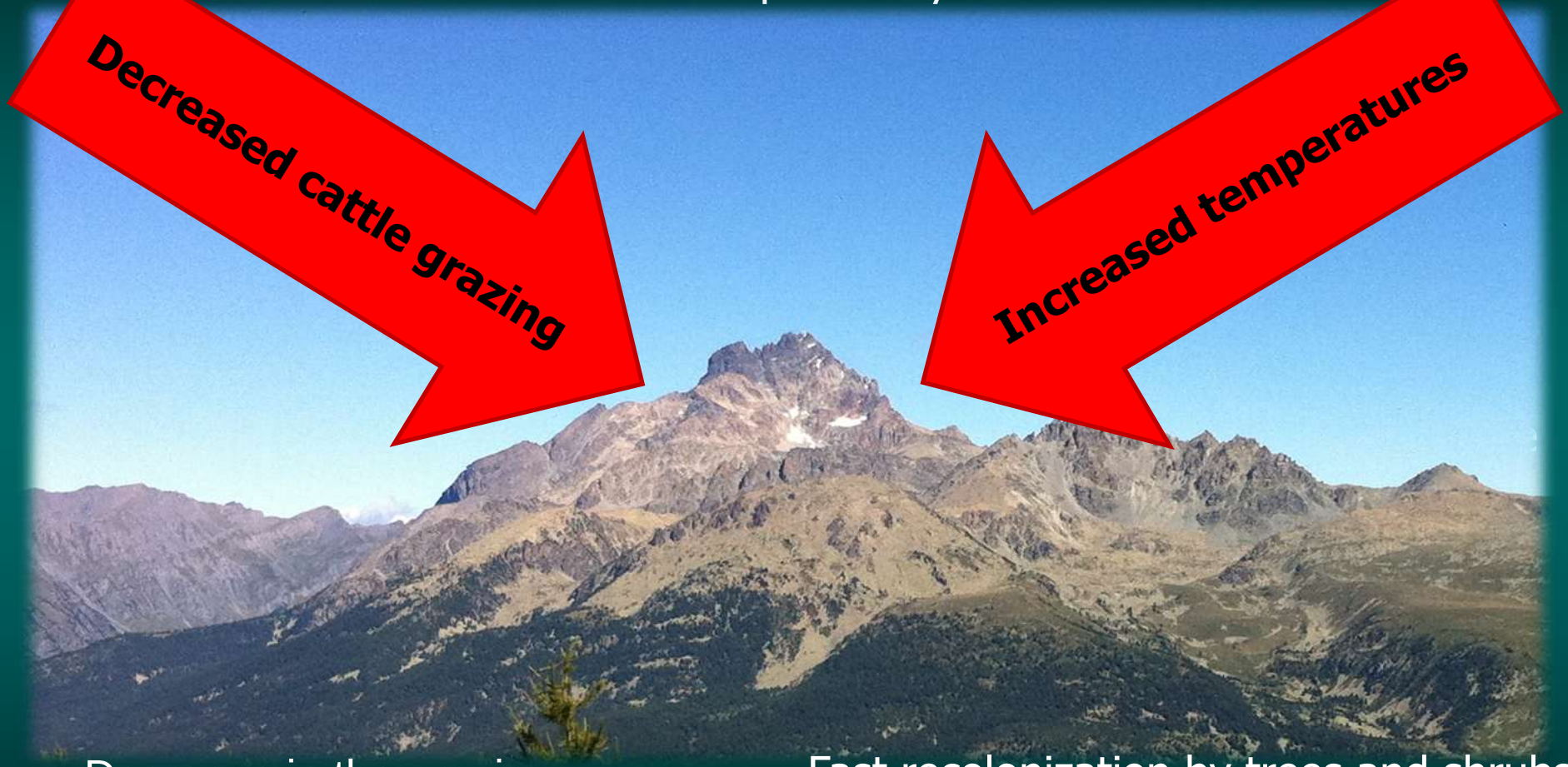
The study reveals the future role of the Alps as a "biodiversity reservoir" since this area will further increase its importance for biological conservation. Many stenotopic species, in fact, are expected to become concentrated in this area.

Climatic Risk Atlas of European butterflies (Settele *et al.* 2008)

Butterfly CONSERVATION EUROPE

Habitat vulnerability in the Alps

Climate change in the alpine region - during the 20th century was accompanied by:



Decrease in the grazing regimes of pastures

Fast recolonization by trees and shrubs where artificial lowering of the treeline had occurred *(Vittoz et al. 2008)*

(Beniston 2005)

Vulnerability of butterflies to climate changes

ADAPTATIONS

Lycaena helle

dinal nor … al. 2002; Pa …

elevation … et al. 2006)

traction … san et al. 1…

modificati… 00; Stefane…

Lopinga achine

Zerinthia polyxena

One-third of the Italian butterfly population **extinctions were not** clearly related to **habitat destruction**, but linked to some more subtle degradation of environmental quality.

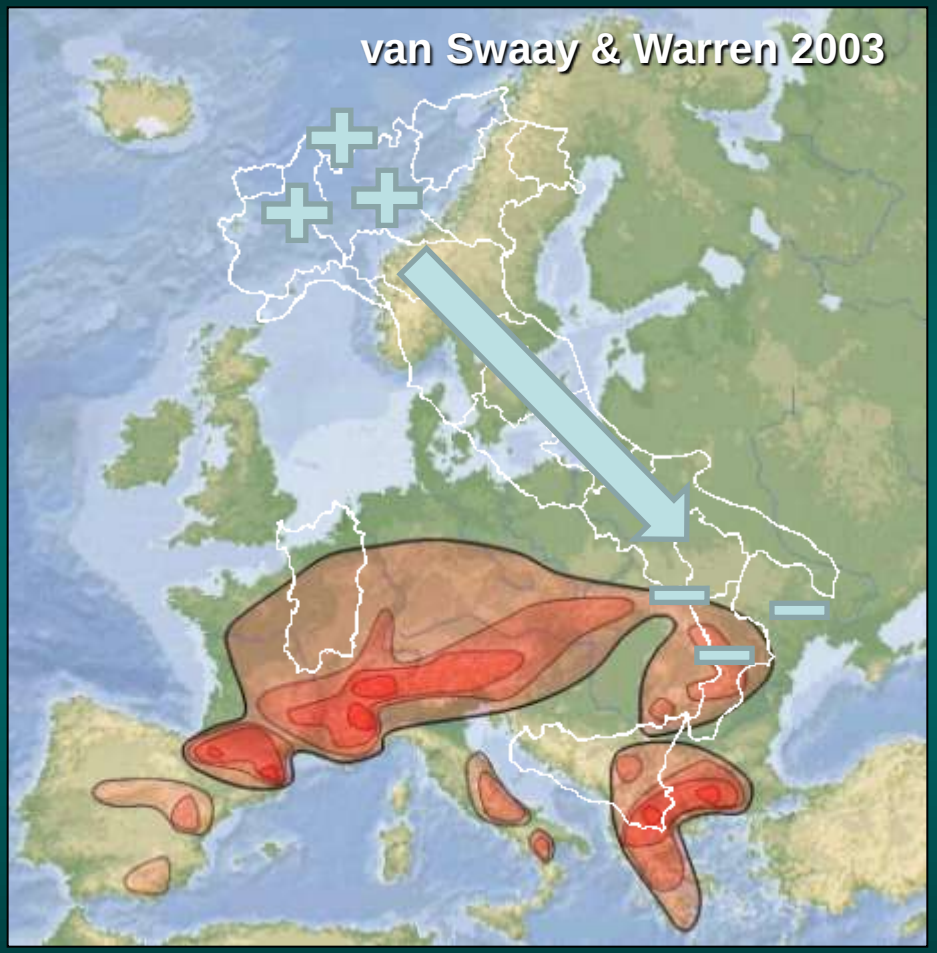
LOCAL EXTINCTIONS!

Populations extinctions due to unknown causes affect more severely species that occur **above or close to the timber line** than the others (χ^2=85.334, p<0.001).

Bonelli S, Cerrato C, Loglisci N, Balletto E (2011) Population extinctions in the Italian diurnal lepidoptera – J Insect Conserv 15: 879-890

The Italian butterfly fauna represents 37% of the total Euro-Mediterranean fauna

- ✓ **283** species
- ✓ **106** spp. in the Alps
- ✓ **25** exclusively or primarily above the tree line
- ✓ **64** typical of the upper montane vegetational level



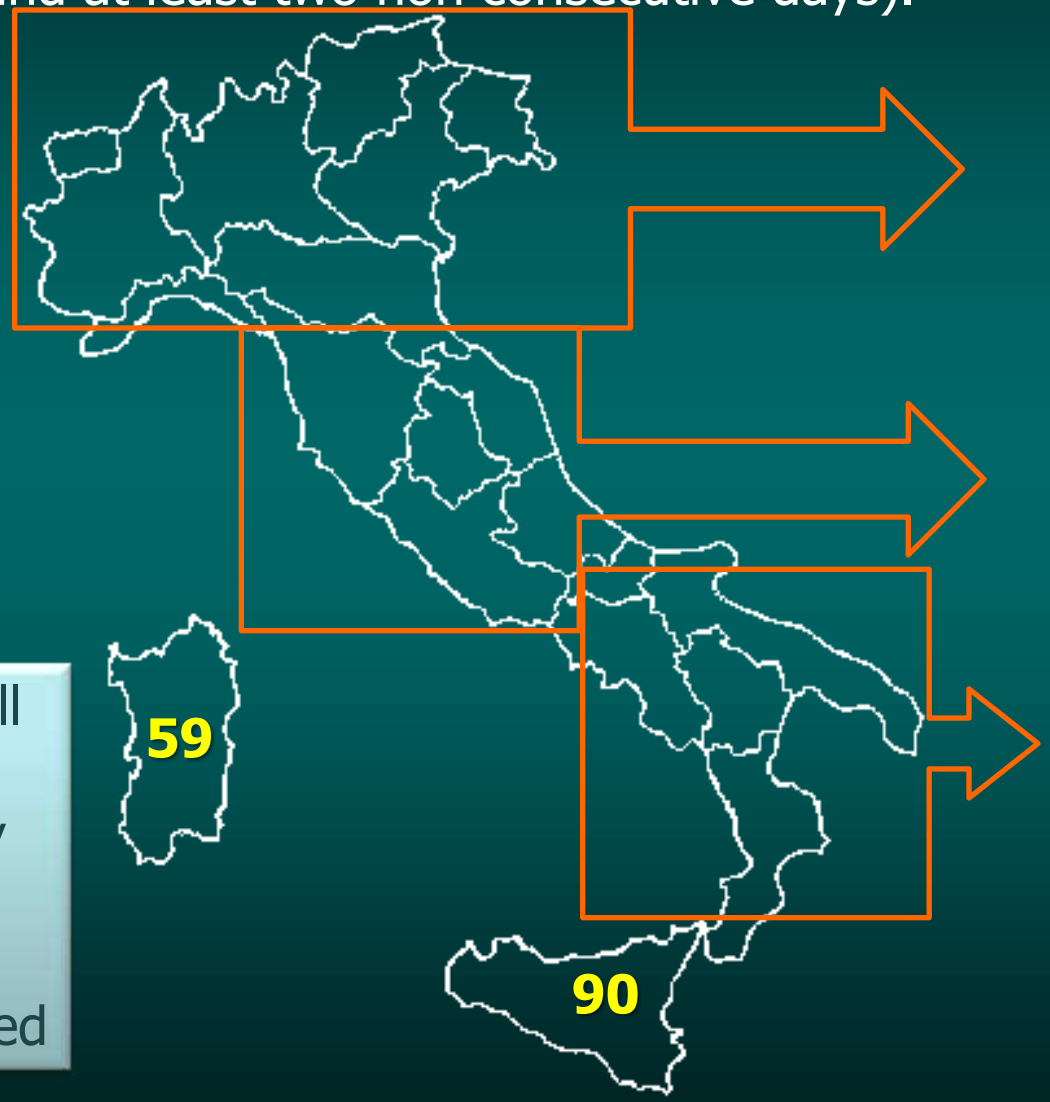
Hotspot and reservoir!!

Balletto, Bonelli, Cassulo 2005. *In: Studies on the ecology and conservation of butterflies in Europe.* pp: 71 – 76

Balletto E., Bonelli S., *et al.* 2010. *Italian Journal of Zoology,* 77(1): 2–13

1978-79

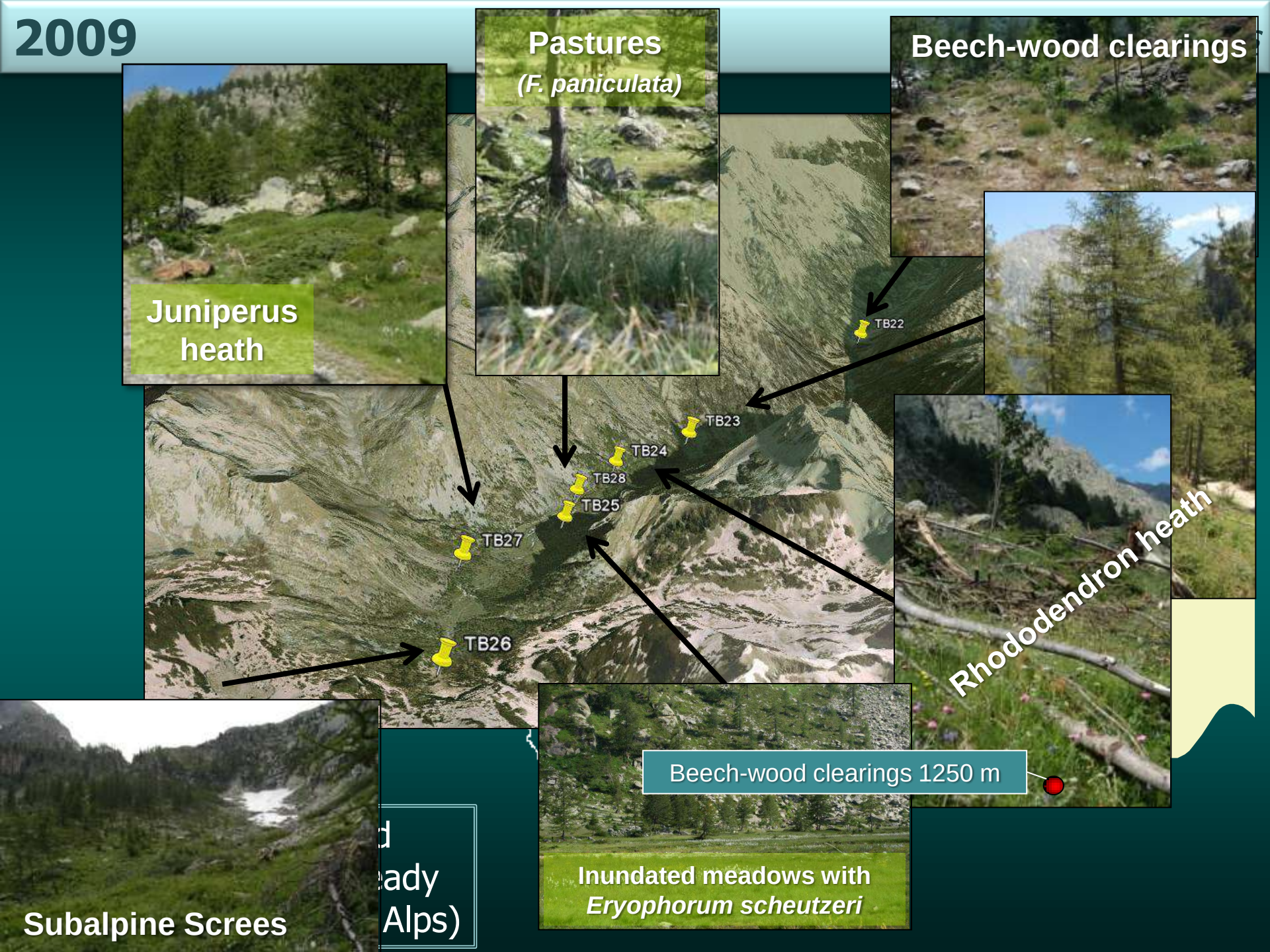
In **1978-79 Balletto & Toso sampled 480 butterfly communities from all over Italy** (for two years and at least two non consecutive days).



REGIONS	N
Valle d'Aosta	19
Piemonte	47
Liguria	26
Lombardia	25
Friuli Venezia G.	22
Veneto	21
Trentino	41
Toscana+Romagna	21+5
Marche	6
Umbria	4
Lazio	22
Abruzzo	43
Molise	1
Calabria	15
Puglia	13
Basilicata	10

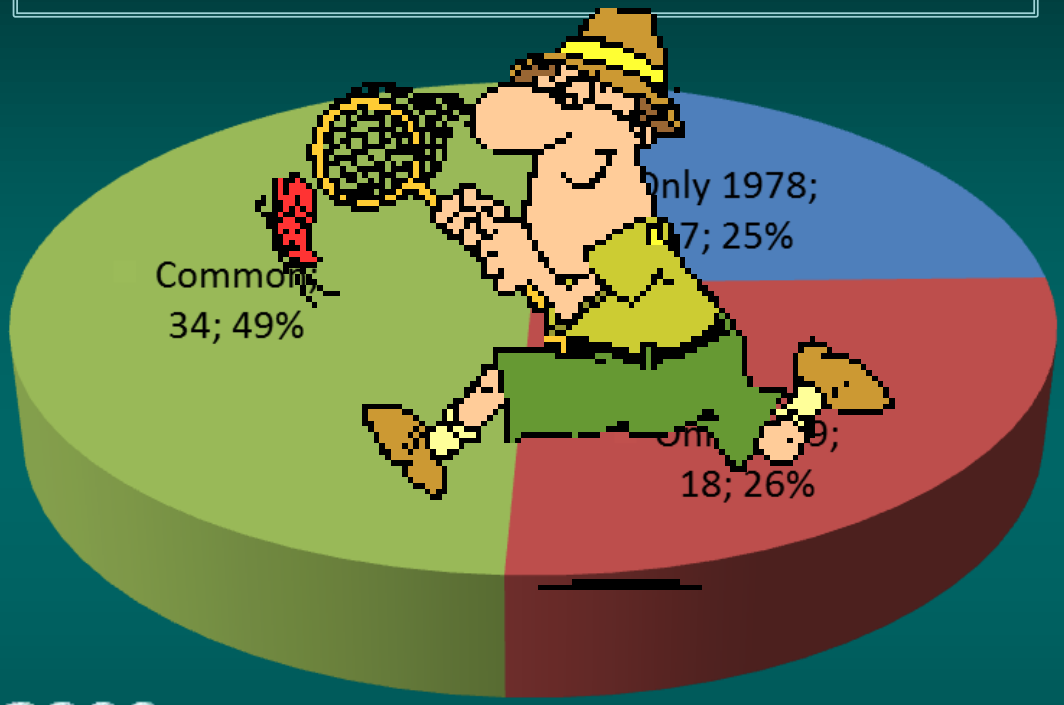
Almost all Italian butterfly habitats were represented

Balletto E, Barberis G, Toso GG (1982). In: quaderni sulla struttura delle zoocenosi terrestri 2 (II): 11-96


2009
Pastures
(F. paniculata)
Beech-wood clearings
Juniperus heath
TB22
TB23
TB24
TB28
TB25
TB27
TB26
Rhododendron heath
Beech-wood clearings 1250 m
Inundated meadows with
Eryophorum scheutzeri
Subalpine Screes

1978 *vs.* 2009

In total **69 species** were observed:
51 in 1978 *vs.* 52 in 2009



2009

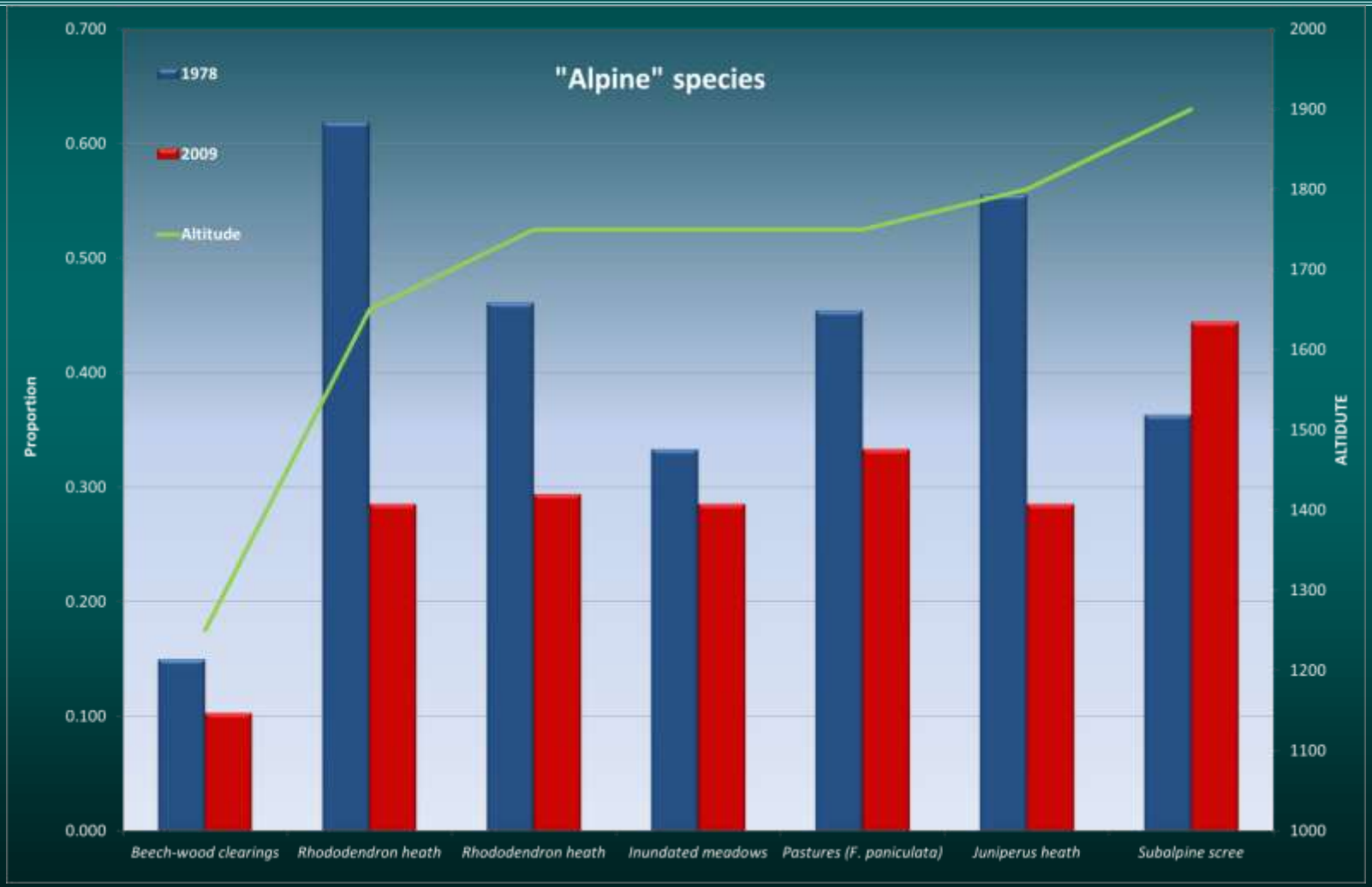
June	July	August

1978

30th July	8th Aug

Changes in the communities

Comparing the ecological requirements of species between years, we observed a **decrease in the proportion of "alpine" (close or above timberline) species** per site (nearly significant: Wilcoxon Test, N=7, V=25, p=0.078), **which changed from 0.420 ± 0.059 in 1978 to 0.290 ± 0.038, in 2009**

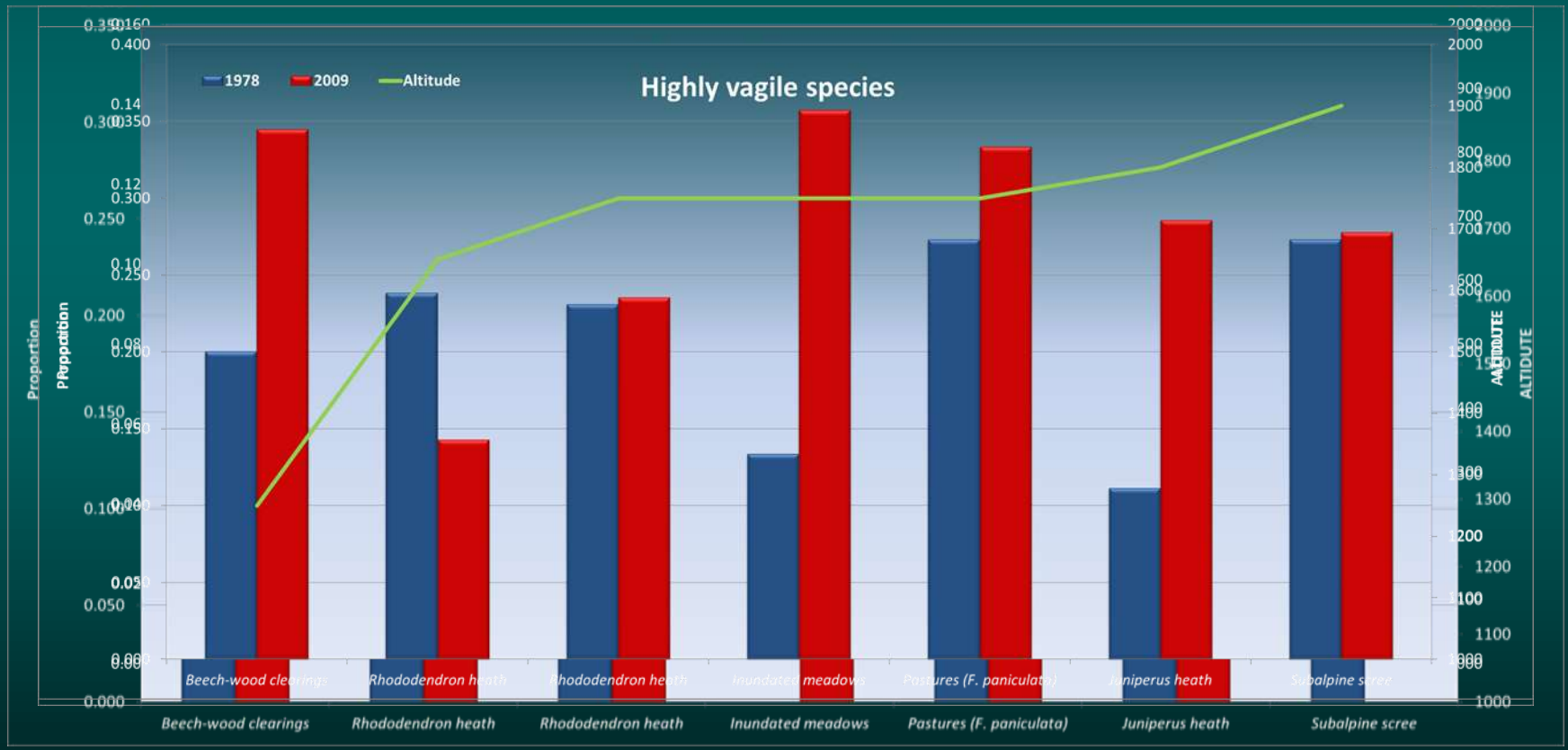


Changes in the communities

On the contrary, a pattern of **increase** was observed for:

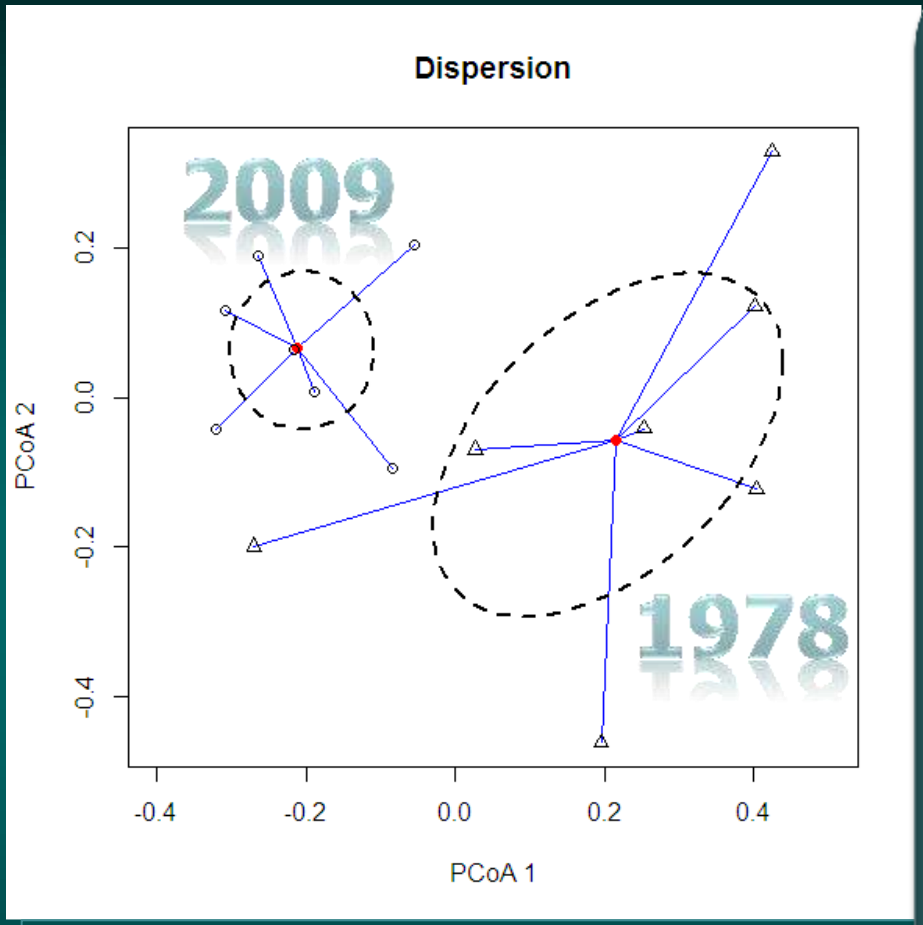
- ❑ **woodland species**
- ❑ **thermophilous species**
- ❑ **highly vagile species**

(Wilcoxon Test, V=1, p=0.05)



Number of plots occupied by each species increased from 1978-79 to 2009

Biotic homogenisation



Principal Coordinates Analysis of communities sampled in 1978 (triangles) and 2009 (circles). Each sampling site is connected to its group centroid, ellipses show the 95% confidence interval.

Biotic homogenisation: we observed the replacement of local biotas (the losers) by expanding ubiquitous species (the winners), as well as the expansion of generalist natives.

This caused an increase in biotic similarity among sites.

(e.g. Olden et al. 2005, Stachowicz et al. 2002, Pino et al. 2009).

Indicator species

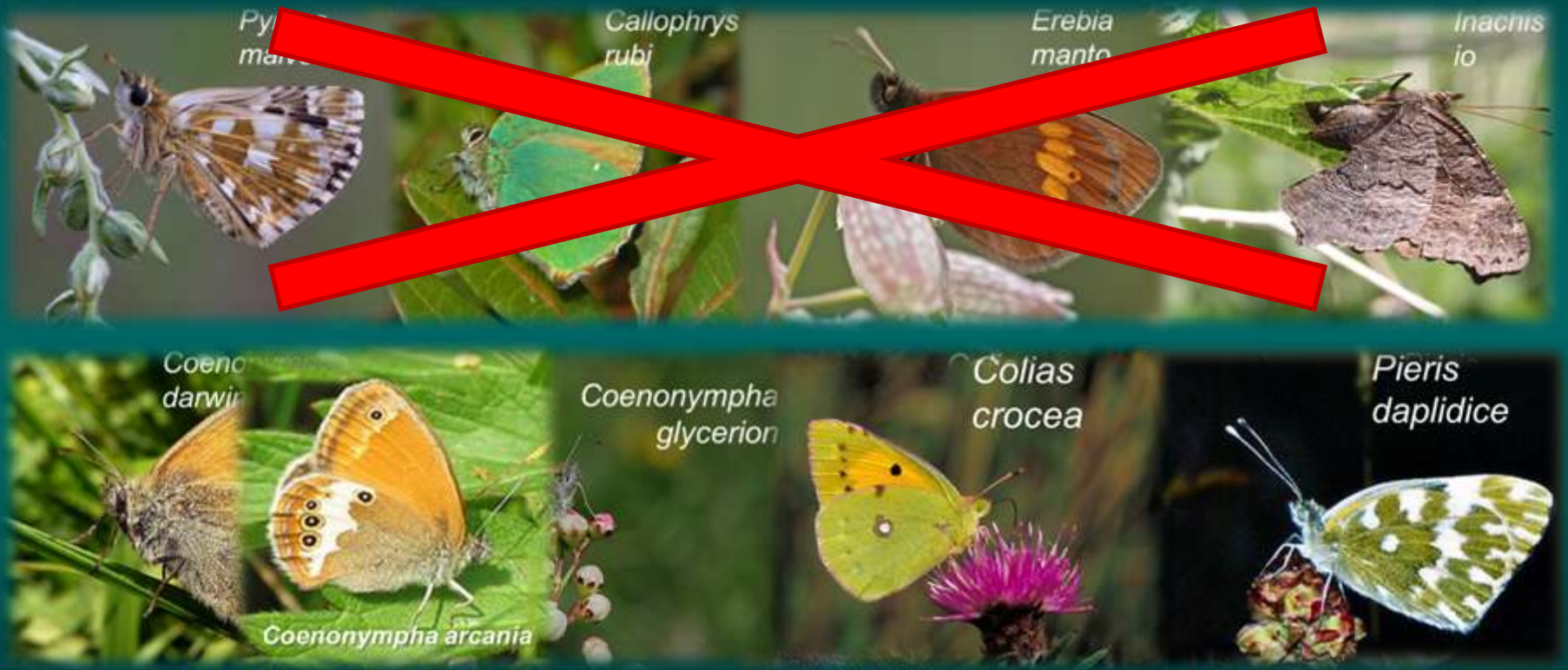
Species	2009	1978	Both	p-value	Year
Anthocharis cardamines	*0.000*	***0.845***	*0.598*	*0.025*	1978
Pyrgus carthami	*0.000*	***0.845***	*0.598*	*0.024*	1978
Parnassius mnemosyne	0.000	**0.756**	0.535	0.078	1978
Argynnis paphia	***0.845***	*0.000*	*0.598*	*0.024*	2009
Brenthis daphne	***0.845***	*0.000*	*0.598*	*0.024*	2009
Aricia nicias	**0.772**	0.154	0.655	0.101	2009
Coenonympha arcania	**0.756**	0.000	0.535	0.064	2009
Polyommatus icarus	**0.772**	0.154	0.655	0.089	2009
Satyrus ferula	**0.772**	0.154	0.655	0.112	2009

Indicator species of the three groups. Values were tested using permutation (999), significant species are underlined. In **bold** is shown the highest value obtained for each species

Luoto *et al.* 2001- Determinants of distribution and abundance in the clouded apollo butterfly: a landscape ecological approach. *Ecography,* 24: 601-617.

Species loss/substitution

In 2009 **8 species** had disappeared

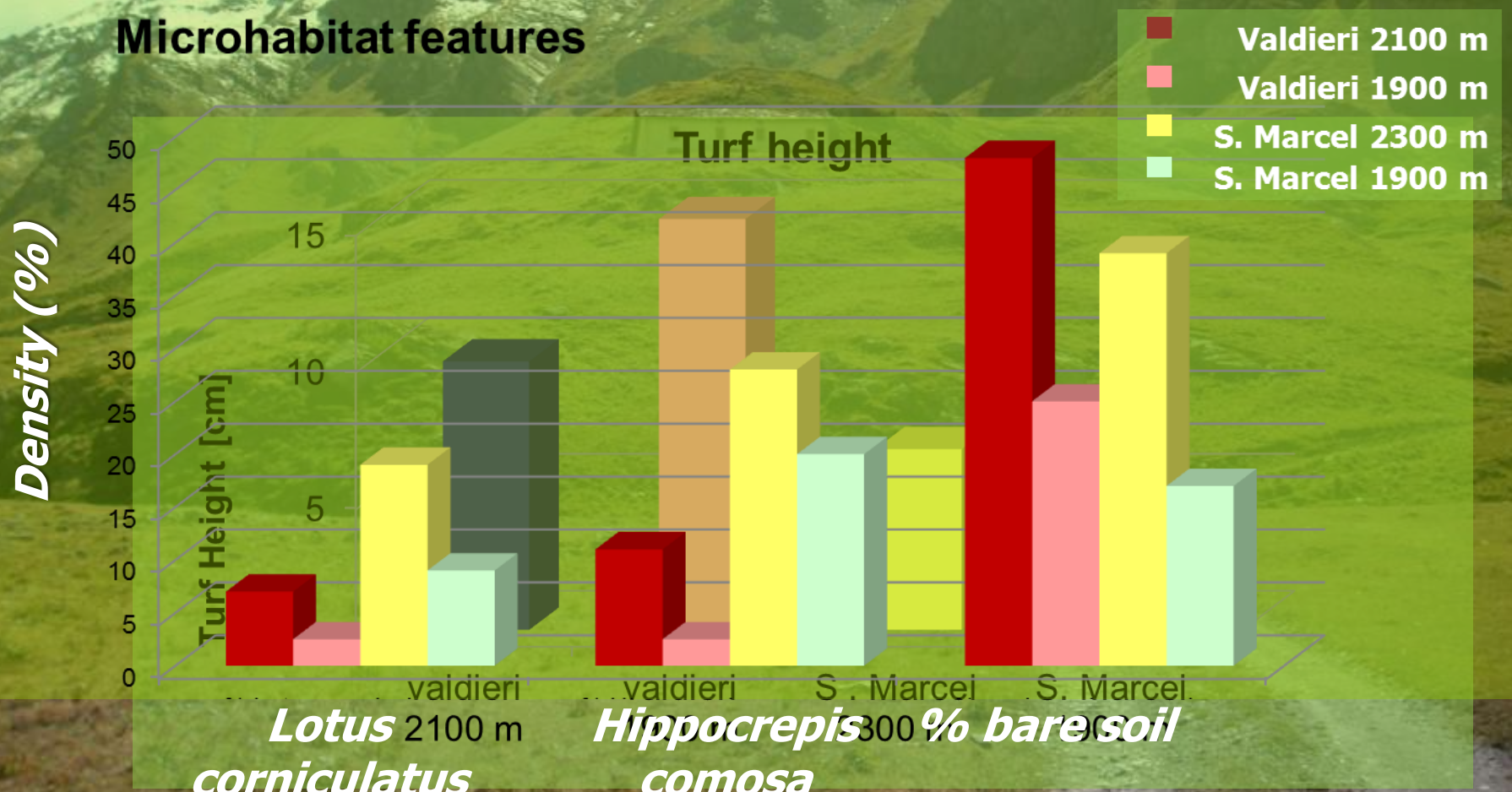


4 of these were replaced by widespread "relatives"

Altitudinal shift

Colias phicomone

1900 m: foodplants almost disappeared at the site where the population was present 30 years ago



Climate change

We decomposed the time series into:

1. **Seasonal component search for a recurrent pattern in the signal within each year**
2. **Trend component over the years**
3. **Residual component search for remaining variability**

$$X(t) = Seas(t) + Trend(t) + Residual(t)$$

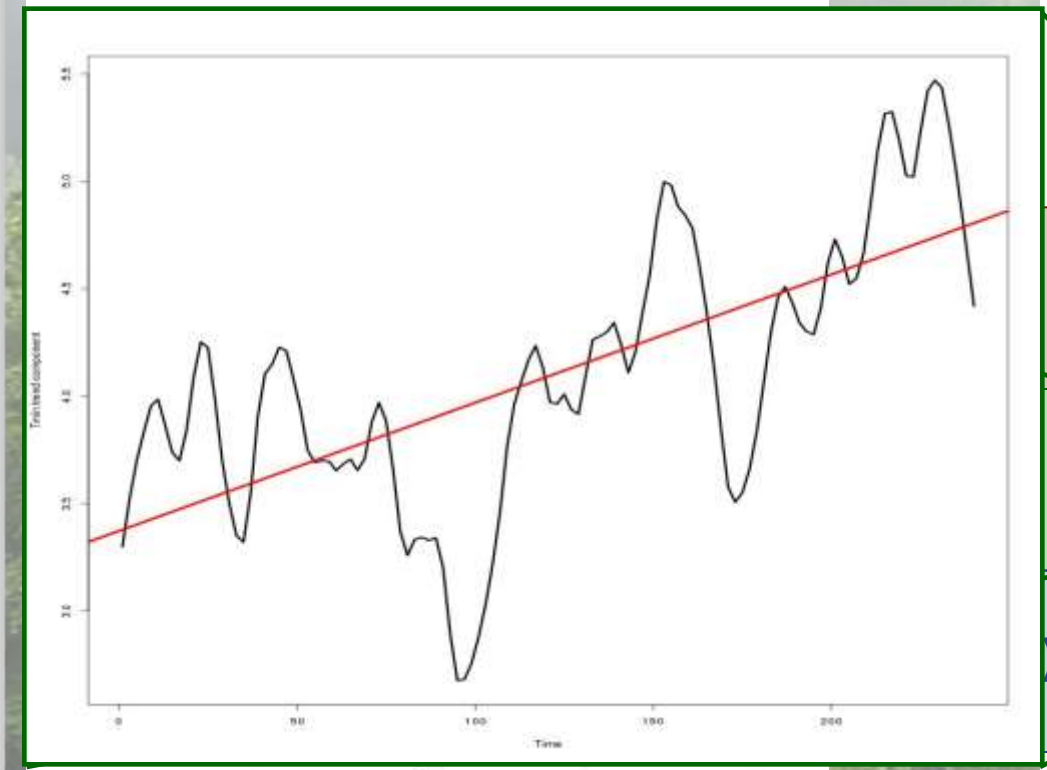
Lago Piastra (900 m asl, period 1970-2008): analysis of the decomposed signal:

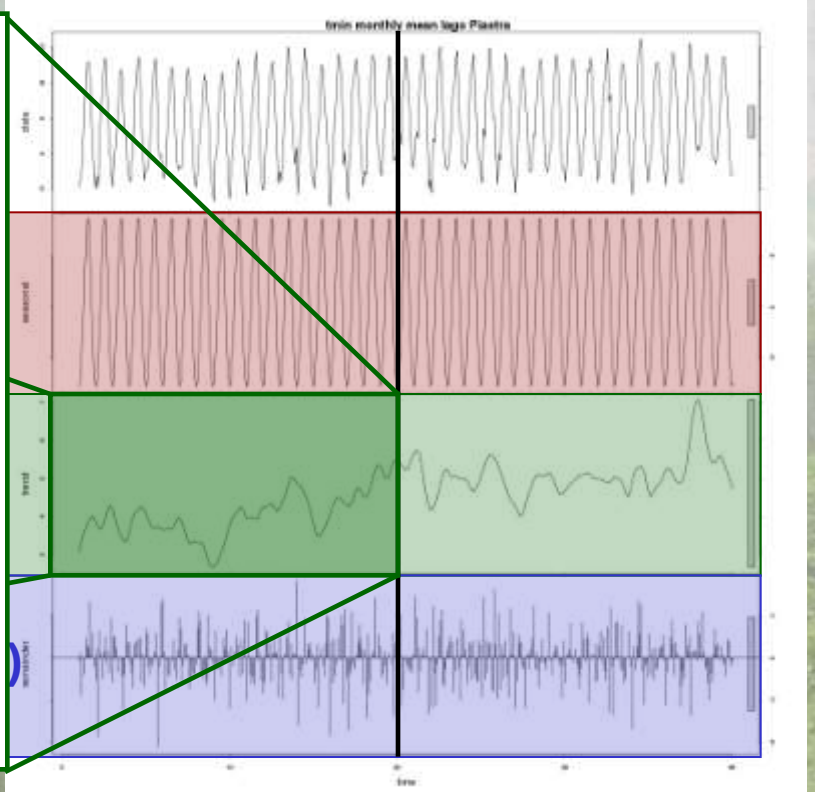
- Minimun temperature
- Maximum temperature
- Precipitation

→ Trend
→ R^2
→ normal distribution test

Climate change

Results





Tmax

Tmin

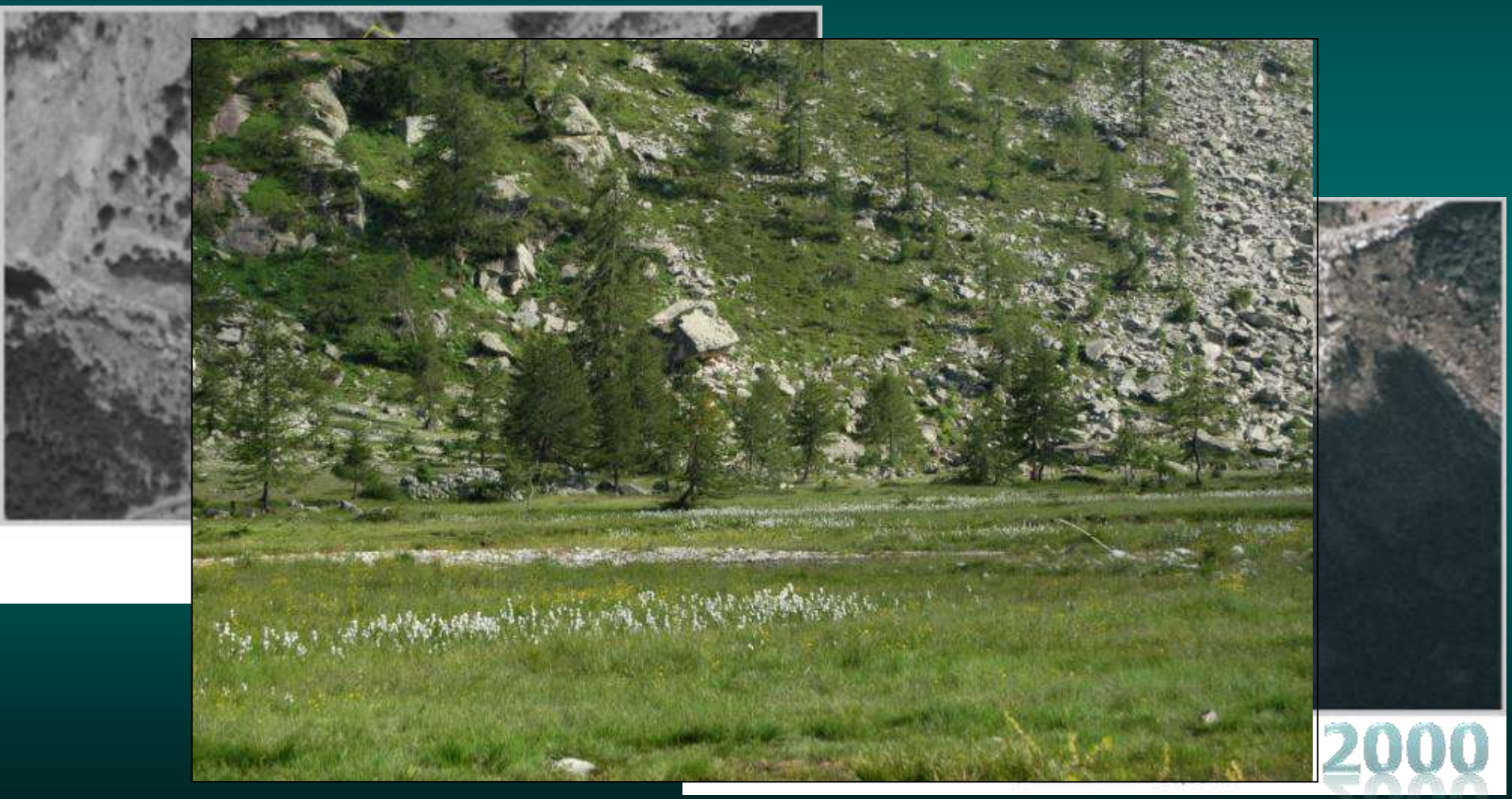
No trend for Precipitation and Maximum temperatures

Significantly positive trend for Minima

- 1970-2008 significant (R^2=0.58) 0.05 °C/year
- 1970-1988 significant (R2=0.44) 0.07 °C/year
- 1989-2008 not significant

Reforestation

Only for the wet areas we were able to asses a central role of grazing intensification. It produced a general modification of the site, which is now only patchily inundated and dominated by *Eriophorum* sp.



Thank you!!

Zoology lab –Turin University

Emilio Balletto

Simona Bonelli

Francesca Barbero

Magdalena Witek

Luca P. Casacci

Cristiana Cerrato

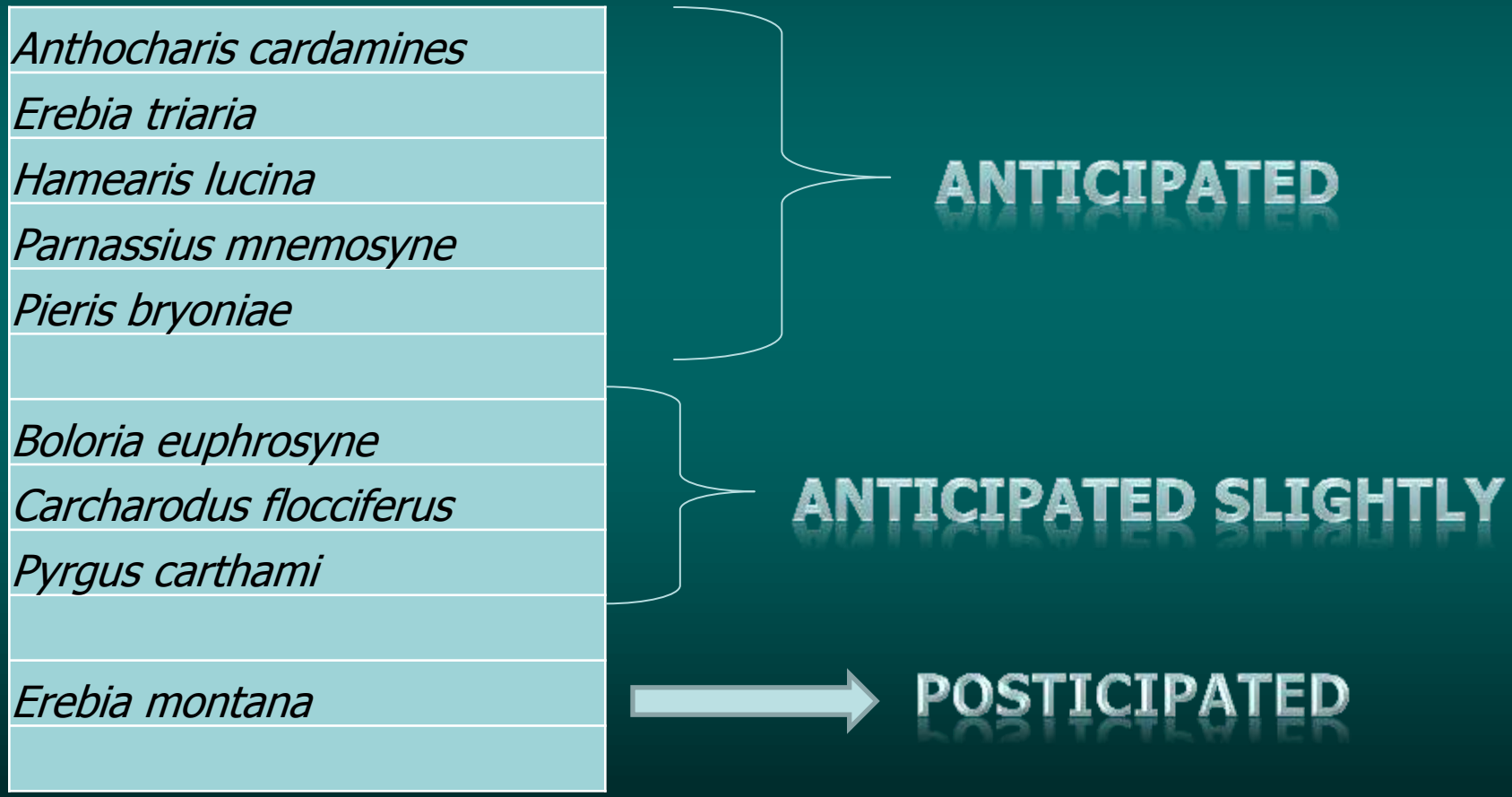
Dario Patricelli

Alessio Vovlas

Marco Sala

Phenology shift

Only **five species** have clearly **anticipated** their flight if compared with 1978; **three** species just slightly so; **only one posticipated** its flight period.



4. Phenological pattern of coenosis

In both years, highest number of species and individuals were recorded in July. Cumulative number of species increase smootly, reaching an asymptote by the second half of August.

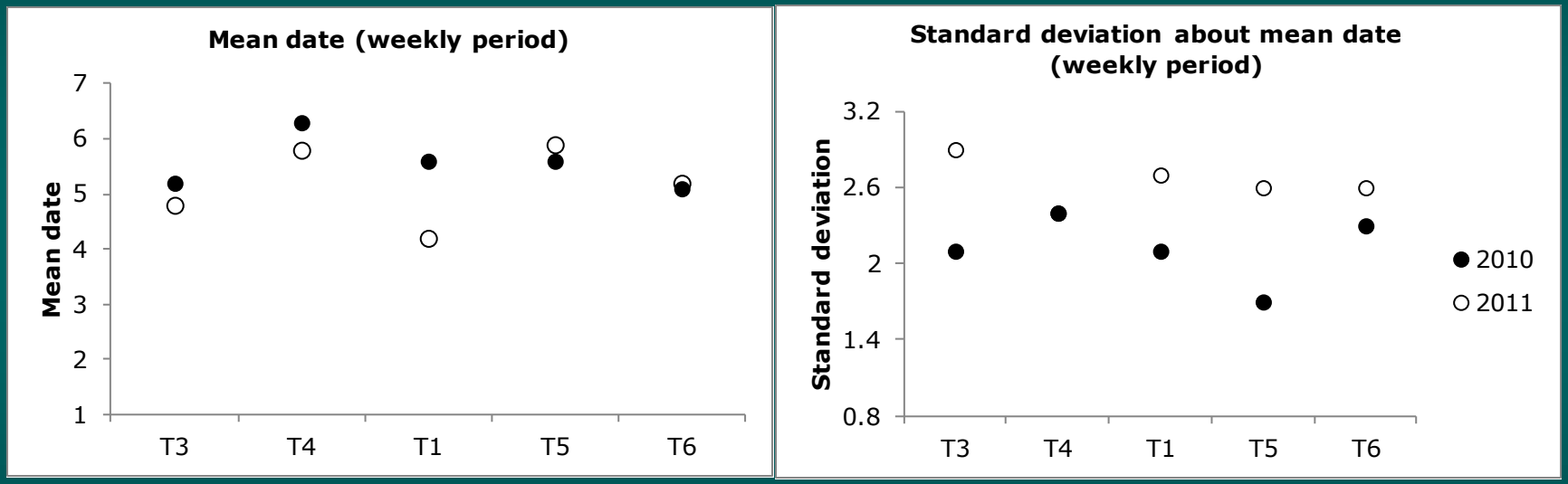


Fig.4. Mean date of flight period and its standard deviation.

SD about mean date range from 1.7 to 2.9 weekly period (Fig.4).
In 2011 we observed a slight anticipate mean flight date (differences between years NS; paired-sample t-test; t=1.285; df=4; p=0.268)