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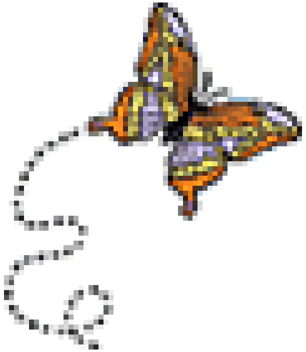
Life BEEadapt – A pact for pollinator adaptation to climate change

LIFE21-CCA-IT-LIFE BEEadapt/101074591

Effects of climate change on wild pollinators: the case of butterflies in Central Italy



Marina Baldi, Dino Biancolini
CNR - Institute of Bioeconomy, Rome, Italy
marina.baldi@cnr.it

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Background

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- In recent decades, wild pollinators in the EU have ***declined in abundance and diversity***
- Increasing threat from human activity (conversion to intensive agriculture and the use of pesticides and fertilisers) and ***climate change***
- The most affected insect species are ***butterflies***, moths, bees and beetles.
- Improving scientific knowledge about pollinator decline
- The LIFE project BEEadapt aims to enhance climate ***resilience*** of wild pollinators in Central-Italy

Project 101074591

LIFE21-CCA-IT-LIFE BEEadapt:

a pact for pollinator adaptation to climate change

LIFE21-CCA-IT-LIFE BEEadapt/101074591

BEEadapt MAIN OBJECTIVE

Contribute to improving the conservation status of pollinators by minimizing the negative effects of climate change.

Implement a "global" climate change adaptation strategy for pollinators through the testing of concrete adaptation and governance actions in natural, agricultural, peri-urban and urban areas.

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WP3 – In depth collaborative analysis
Impact of climate on wild pollinators

The aim of the study is twofold:

Part I

Historical climate analysis and analysis of extreme temperature occurrences in central Italy

Part II

Impact of future climate on wild pollinators

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Part I and Part II: The Pilot areas

Four pilot areas in Central-Italy:

- Appennino Tosco-Emiliano National Park (Tuscany and Emilia-Romagna) – PNATE/ATENP
- Torricchio Natural Reserve (Marche) - TNR
- Roma Natura Authority (Lazio) - RNPA
- Pontine Plain and Aprilia Municipality (Lazio) – PP

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Part I - Historical climate analysis

Historical ***climate data*** extracted from the following sources:

Copernicus Data Store - https://cds-beta.climate.copernicus.eu/

SCIA – Sistema Nazionale per l'Elaborazione e Diffusione di Dati Climatici - https://scia.isprambiente.it/

CMCC DDS - Data Delivery System - https://dds.cmcc.it/

Copernicus Europe's eyes on Earth
Climate Change Service
ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale
Sistema Nazionale per la Protezione dell'Ambiente
cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

Part I - Historical climate analysis
Temperature anomalies 1979-2023

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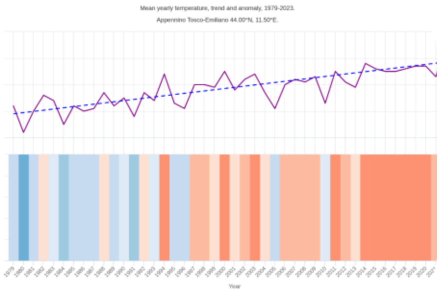
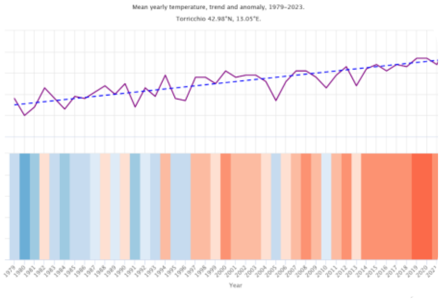
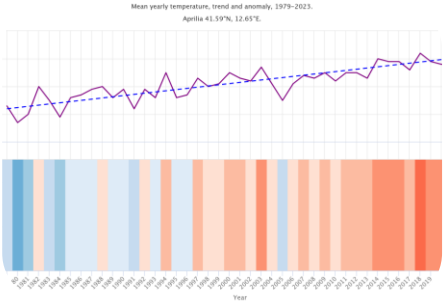


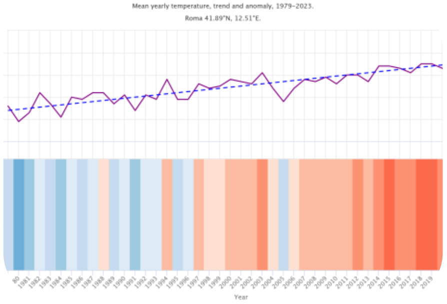
Apennines Tosco-Emiliano



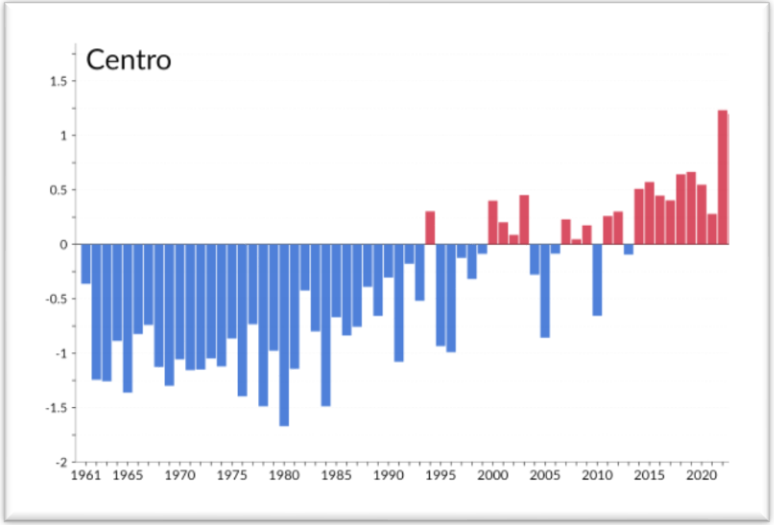
Montagna di Torricchio



Pontine Plain and Aprilia



Roma Natura



Central Italy – Annual mean temperature

Positive anomalies since year 2000

Trend: +0.41±0.05 °C/decade

Source: ISPRA

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Part I - Historical climate analysis
Temperature anomalies 1979-2023

Temperature - Anomaly stripes 1979-2023 Base period (1980-2010)		
Pilot area	Min anomaly	Max anomaly
Appennino Tosco-Emiliano National Park	-1.4°C (year 1980)	+1.8°C (year 2022, 2023)
State Natural Reserve “Montagna di Torricchio”	-1.3°C (year 1980)	+2.0°C (year 2022)
Pontine Plain and Aprilia Municipality	-1.3°C (year 1980)	+1.7°C (year 2022)
Roma Natura Authority	-1.4°C (year 1980)	+2.0°C (year 2022)

Part I - Historical climate analysis

Temperature extremes

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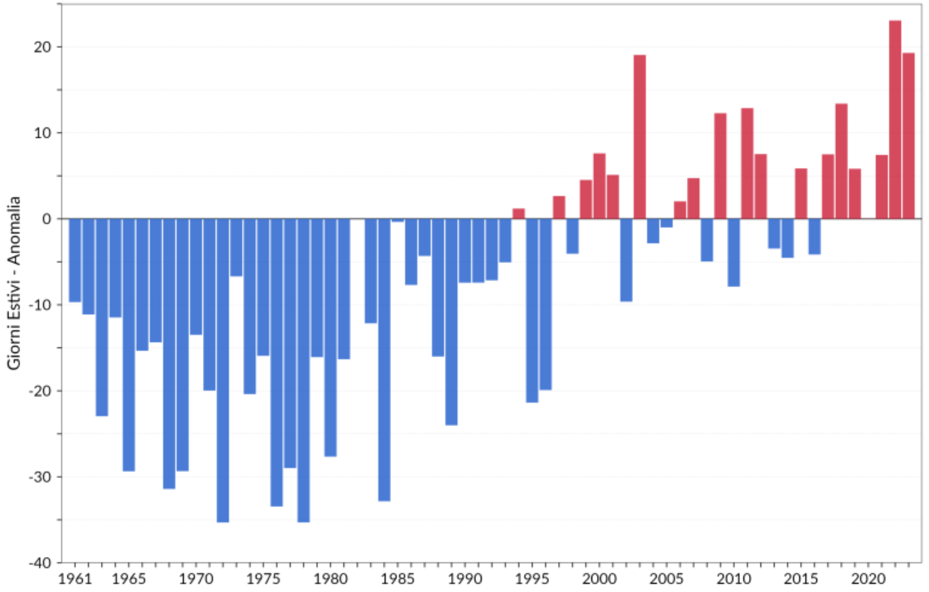
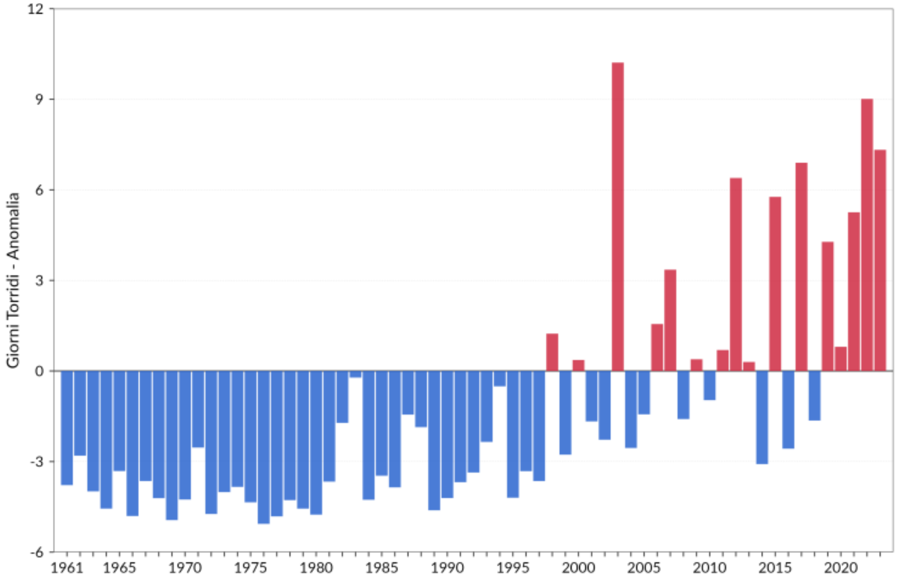


Summer days (T>25°C) in Italy relative to the base period 1991-2020.
(Source: ISPRA)



Very hot days (T>35°C) in Italy relative to the base perios1991-2020.
(Source: ISPRA)

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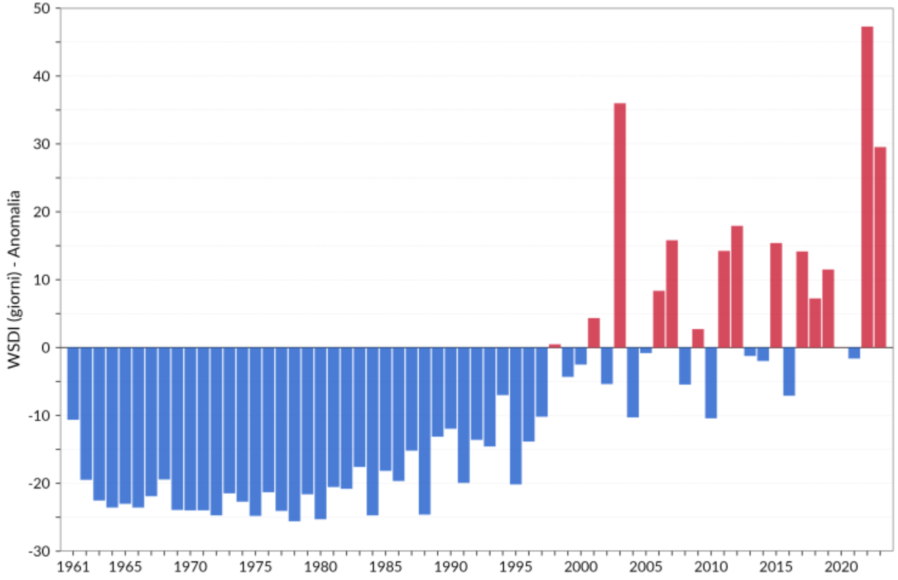
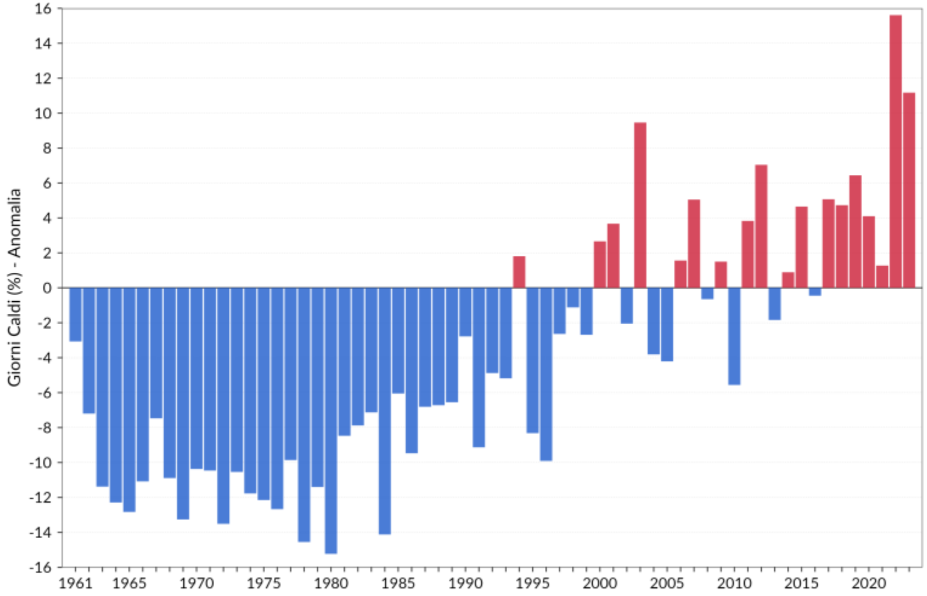
Part I - Historical climate analysis

Temperature extremes





Warm spell duration index in Italy reltive to the base period 1991-2020.
WSDI = Number of days with Tmax> 90° percentile for at least six consecutive days. *(Source: ISPRA)*

TX90p – Daily Tmax >90° percentile - in Italy, as % of days per year relative to the base period 1991-2020.
(Source: ISPRA)

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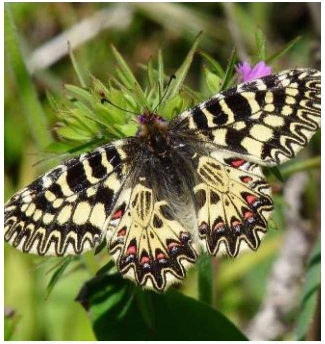
Part II - Impact of future climate on wild pollinators

Celastrina argiolus

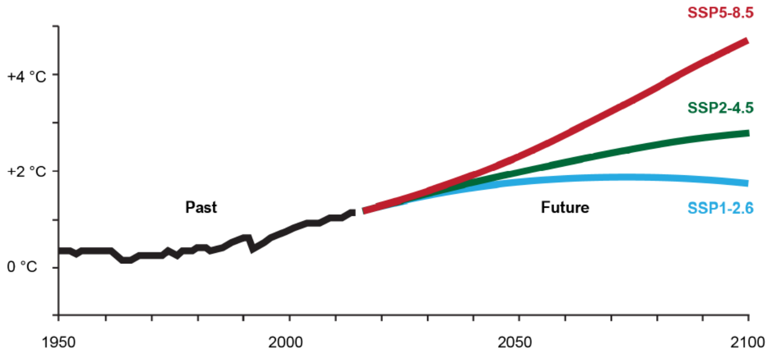
Vanessa atalanta



Zerynthia cassandra

Colias crocea

Global Surface Temperature Change



Evaluate possible impacts of climate change on diurnal butterflies in pilot areas using species distribution modelling and (high resolution) climate scenarios, and assess possible trends in:

- Species-specific suitability
- Species richness

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Why butterflies? Butterfly Pollination

Butterflies are very active during the day and visit a variety of wildflowers. They are less efficient than bees at moving pollen between plants, and do not pick up much pollen on their bodies and lack specialized structures for collecting it.

Butterflies probe for nectar, their flight fuel, and typically favour the flat, clustered flowers that provide a landing pad and abundant rewards. Butterflies have good vision but a weak sense of smell. Unlike bees, butterflies can see red.

Butterflies typically visit flowers that are:

- In clusters and provide landing platforms. May be clusters of small flowers
- Brightly coloured (red, yellow, orange) and open during the day
- Ample nectar producers, with nectar deeply hidden, and nectar guides present

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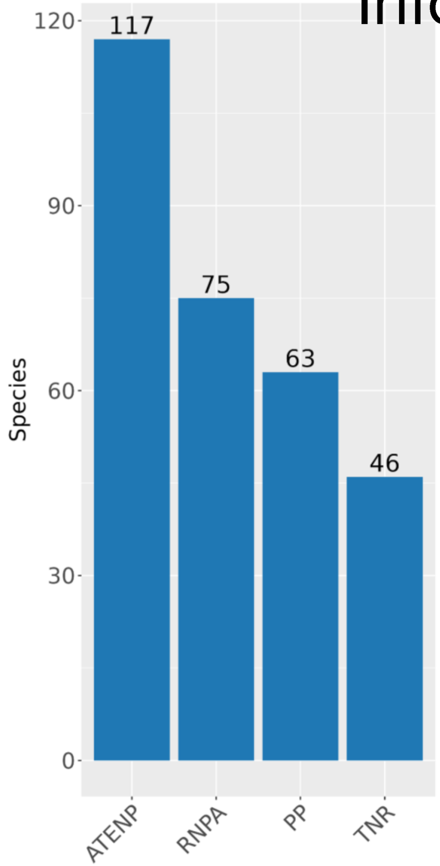
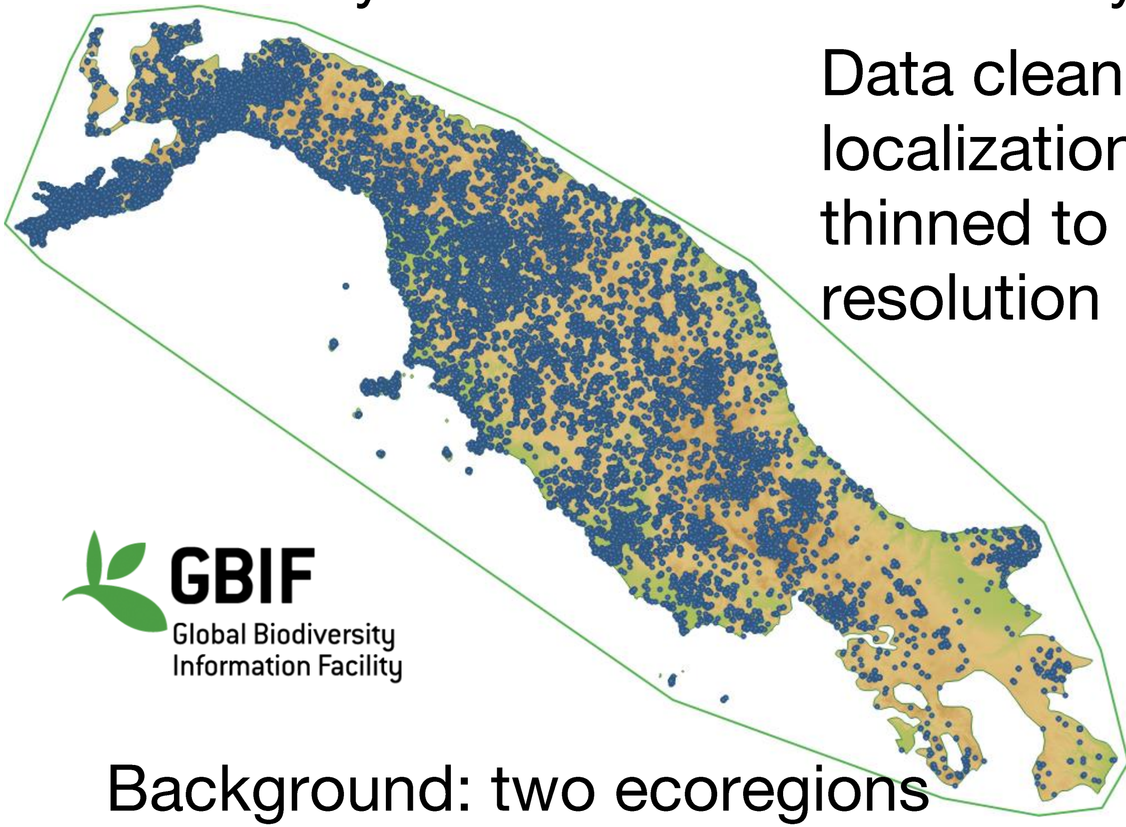
Part II - Impact of future climate on wild pollinators

Occurrences obtained from the Global Biodiversity Information Facility and fieldwork in the study areas





GBIF
Global Biodiversity
Information Facility

Data cleaned of localization errors and thinned to 1 km resolution

Species > 20 points: 130

Points: 33,897

Background: two ecoregions

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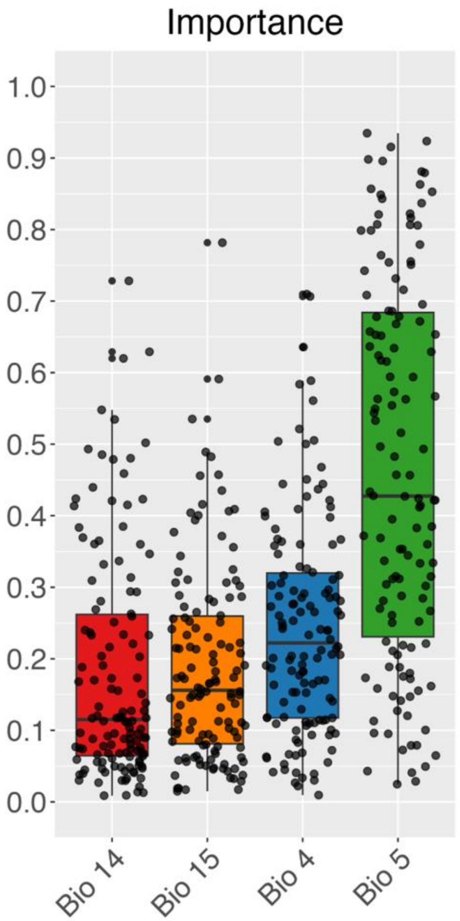
Part II - Impact of future climate on wild pollinators



Four bioclimatic variables (Worldclim 2.1, Fick et al. 2017):

temperature seasonality (Bio4),

max temperature of warmest month (Bio5),

precipitation of driest month (Bio14),

precipitation seasonality (Bio15)

Climate Scenarios SSP1-2.6 and SSP5-8.5 for 2050, ensemble of 3 GCM (Fick et al. 2017)

Results: climatic suitability

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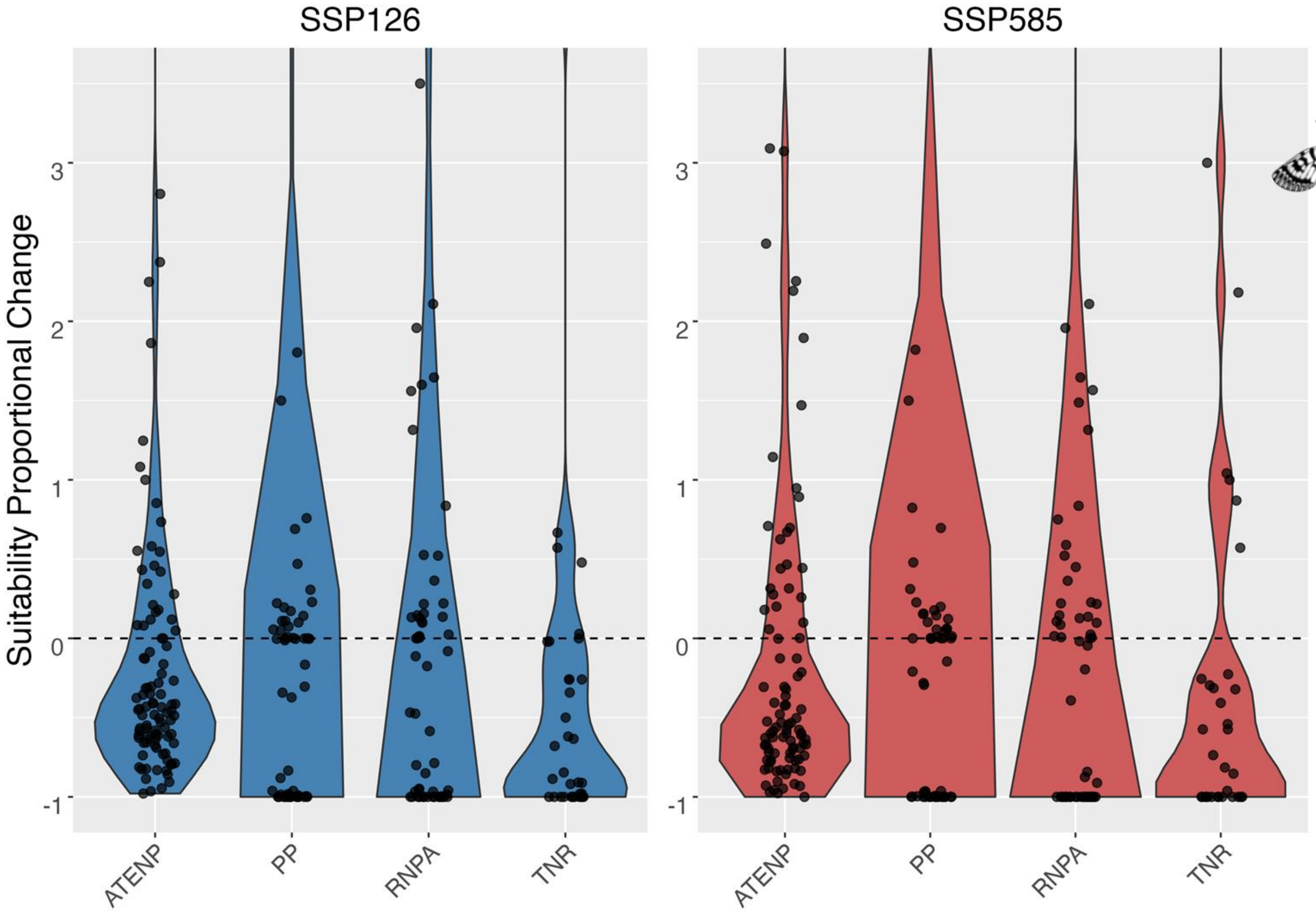
SDMs showed good performance according to ROC (median =0.685, sd =0.164) and Boyce (median = 0.926, sd = 0.153)

Climate suitability for butterflies (expressed as number of suitable grid cells) show a clear pattern in all the pilot areas and for the two selected SSP. In both cases, numerous species shos a decrease in the number of suitable cells, but the greatest declines in suitability is found for SSP5-8.5



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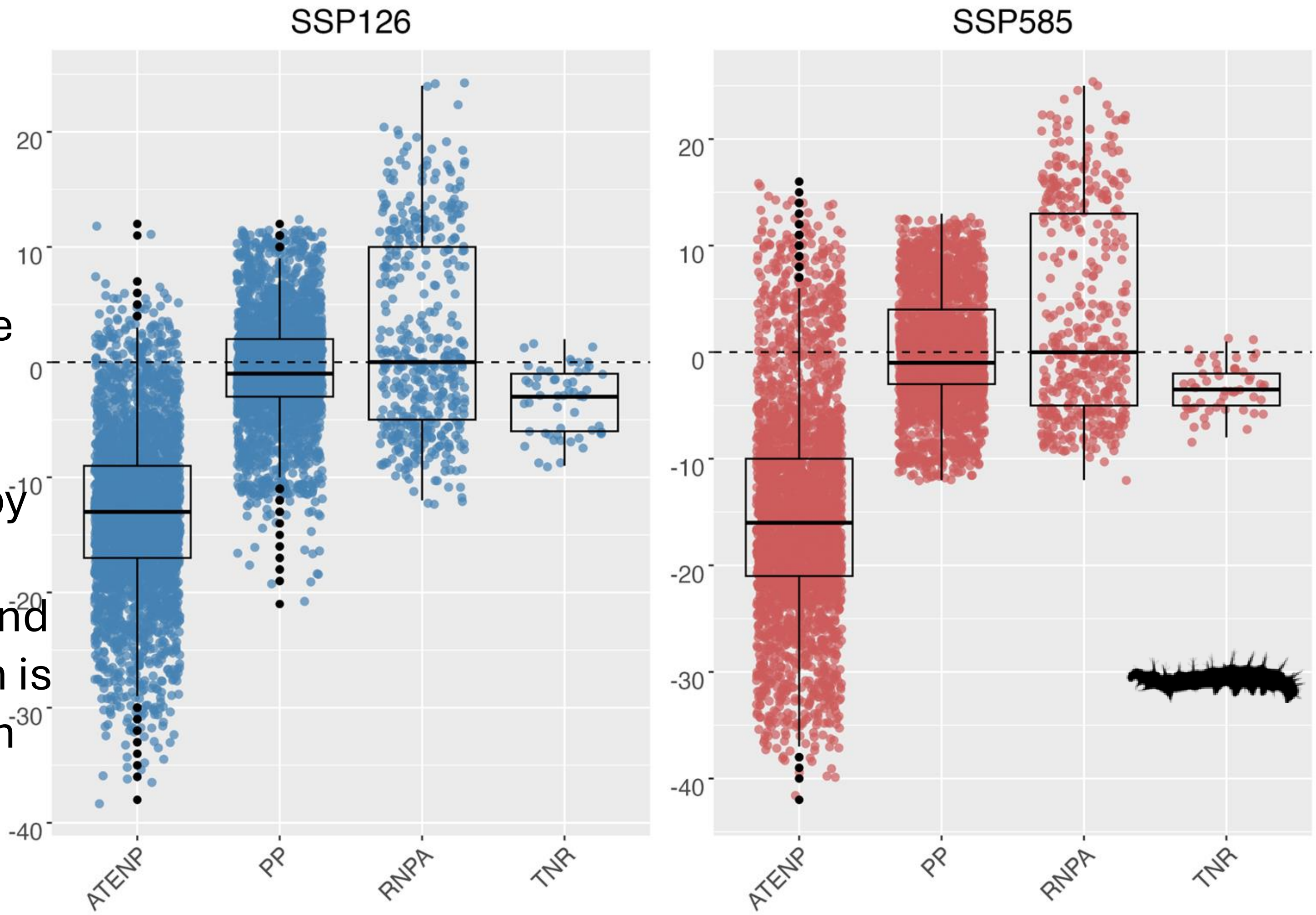
Results: richness change

Regarding the species richness and its spatial patterns, the differences between plains, hills and mountains are even more evident. A clear species loss can be identified in coastal areas, followed by an increase in specific richness in the more inland and hilly lowlands, which is replaced by a decrease in diversity in mountainous areas.



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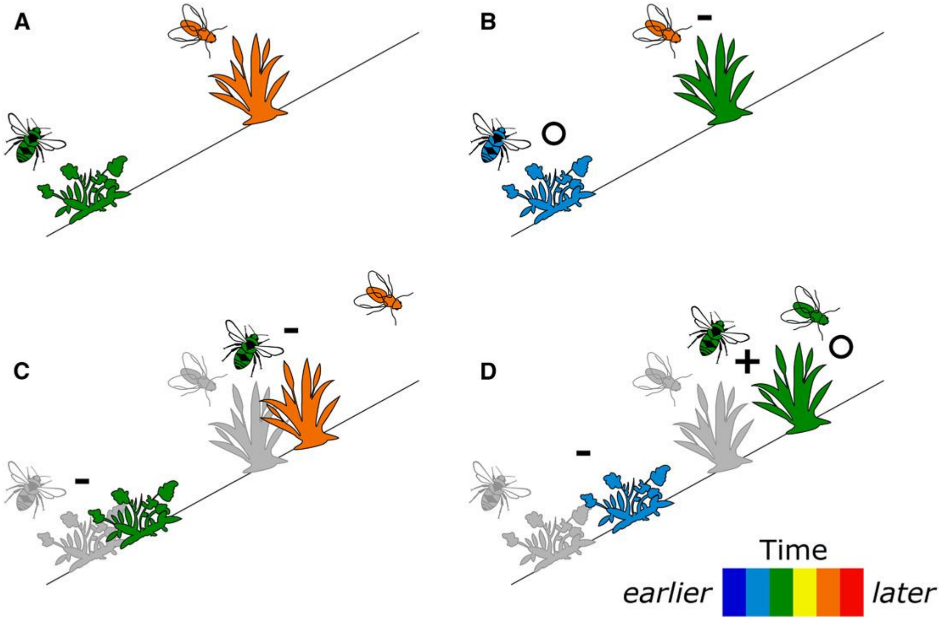
Suitability and richness

The results can be explained by a shift in the climatic suitability of lowland species moving towards the hills where the climate is more favorable, and hill species towards the mountains, while mountain species unfortunately no longer find their suitable climate because there are no areas at higher altitudes where they could take refuge.



Morton and Rafferty, 2017

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Discussion and conclusions

Climate analysis show increasing trend of mean temperature in all the pilot areas since year 2000, both at annual and seasonal scale, and an increase of hot and dry periods during summer

Highland species appear to be the most vulnerable, while lowland species could gain climatic suitability

Mountainous areas (PNATE and Torricchio) are more vulnerable than lowland and hilly areas (Pontine Plain and Roma Natura)

However, significant shifts in climatic suitability are projected for all species in both scenarios

Our results can guide BEEadapt conservation actions to ensure the long-term protection of butterflies within the study areas

Thank you for your attention!

marina.baldi@ibe.cnr.it
dino.biancolini@ibe.cnr.it

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