Climate change effects on animal presence in the Massaciuccoli Lake basin

LifeWatch ERIC

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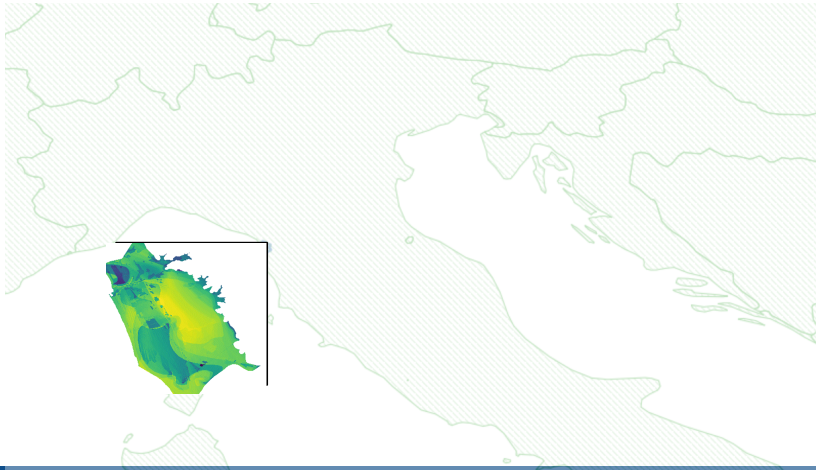
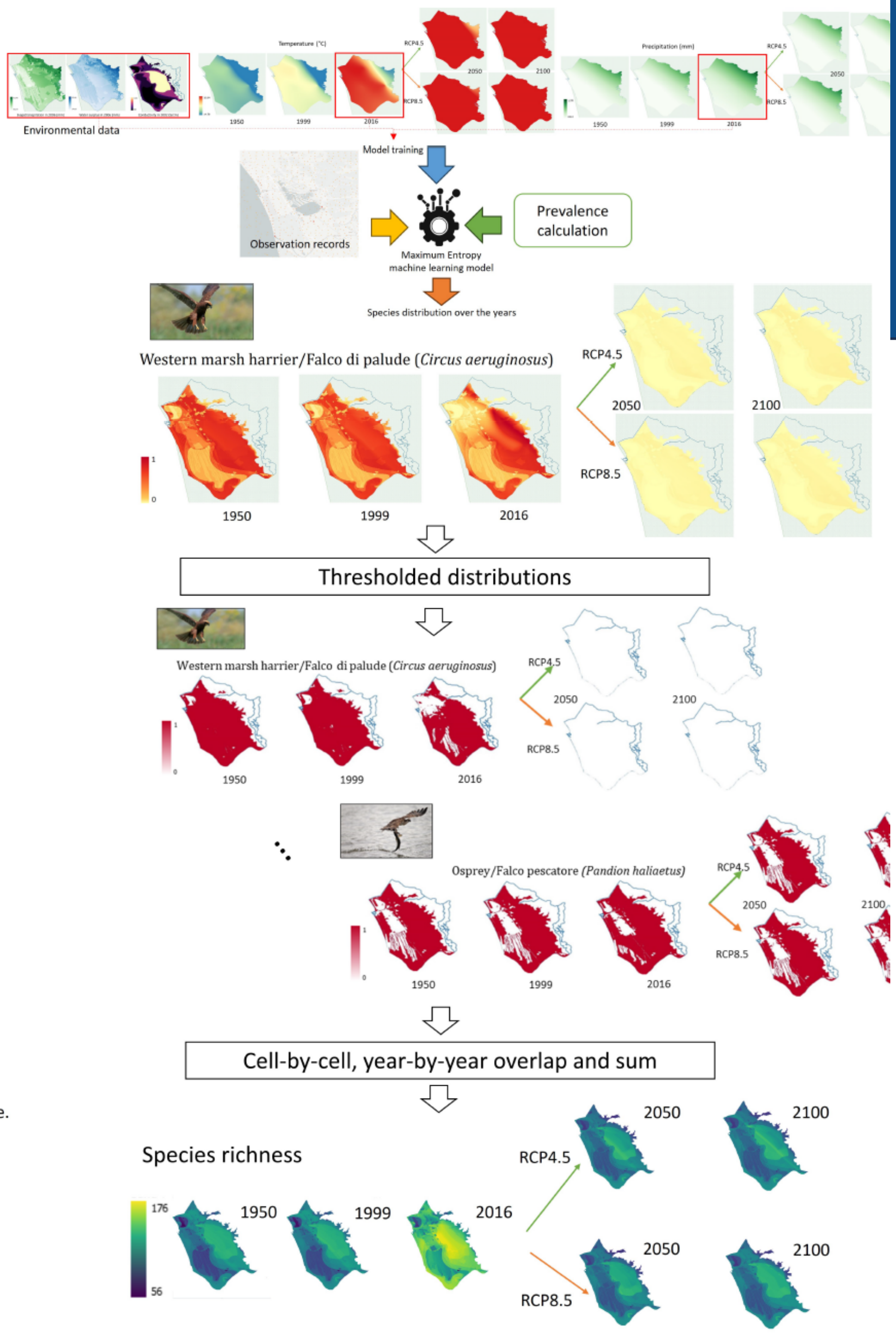


Climate Change Impact on Biodiversity Patterns | Lecce, Italy, 21-22 February 2024

Context

- Climate change poses severe risks to delicate ecosystems such as wetlands (~70% reduction in the 20th c.);
- Big-data mining through Artificial Intelligence models can help forecast macroscopic trends of future biodiversity change well ahead of the times;
- However, their results should be evaluated and considered in their macroscopic indications rather than as detailed answers.



Scope of this presentation

- Predict **overall climate change effects on macroscopic trends of animal presence** in the Massaciuccoli Lake basin under future medium- and high-greenhouse gas emission scenarios (Representative Concentration Pathways (RCP) 4.5 and 8.5)
- Model **species richness through machine-learning** models that learn from data and project species distributions and richness in the future
- Study how the **current species richness might have changed** with respect to 1999 and 1950.

❑**NOT IN THIS PRESENTATION:**

- ➢ **Detailed, pixelwise-reliable species distributions**
- ➢ **What will happen to the single species we study/like/love**
- ➢ **Ecosystem models**

The Massaciuccoli Lake basin

- *An important tourist attraction in Tuscany because of its varied biodiversity;*
- *The basin's hydrogeological, chemical, and environmental features directly influence the area's suitability for the presence and persistence of*
    - *native species*

(e.g., black bullhead, eel, tench, largemouth bass, carp, heron, kingfisher, etc.)

-
    - *non-native species*

(e.g., sheatfish, red swamp crayfish, etc.)

- *The principal water source depends on the pluvial regime of the eastern mountains and the neighbour soils;*
- *The lake water resources are connected with the intensity of human activities around the basin, which include agriculture (40%), farming, cereal and industrial production, horticulture and olive tree orchards, and train railways.*

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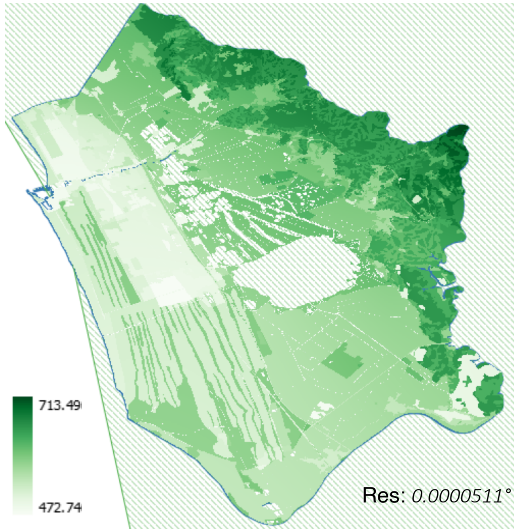
Methodology

Primary environmental data source: Autorità di bacino distrettuale dell'Appennino Settentrionale (Authority data)

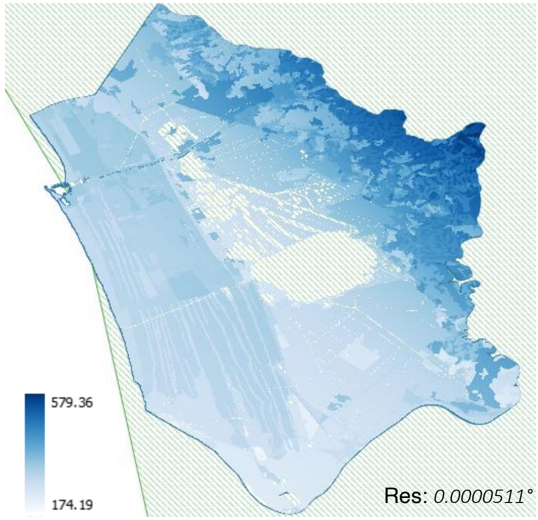
Autorità di bacino distrettuale dell'Appennino Settentrionale

www.appenninosettentrionale.it

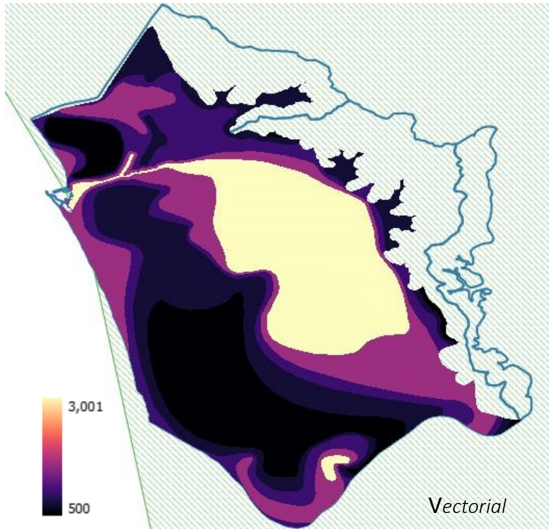
We selected the most recent authoritative environmental data.



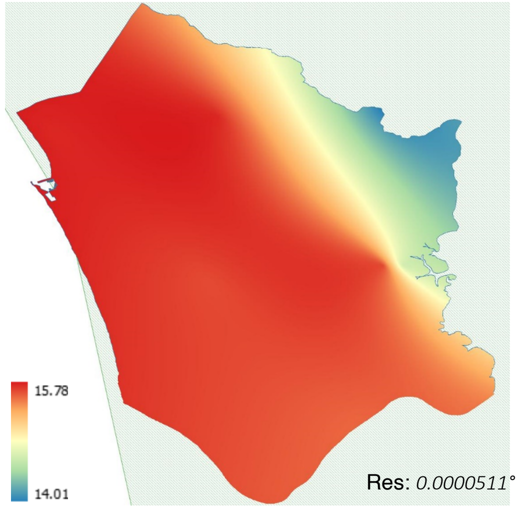
Evapotranspiration in 2006 (mm)



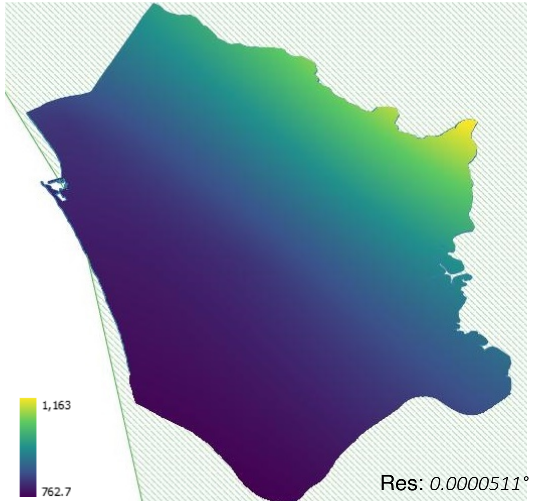
Water surplus in 2006 (mm)



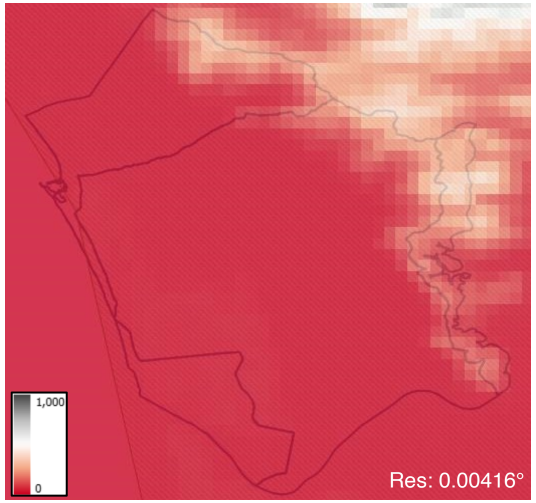
Conductivity in 2002 (S/cm)



Average temperature between 1980 and 1999 (°C)



Average precipitation between 1980 and 1999 (mm)

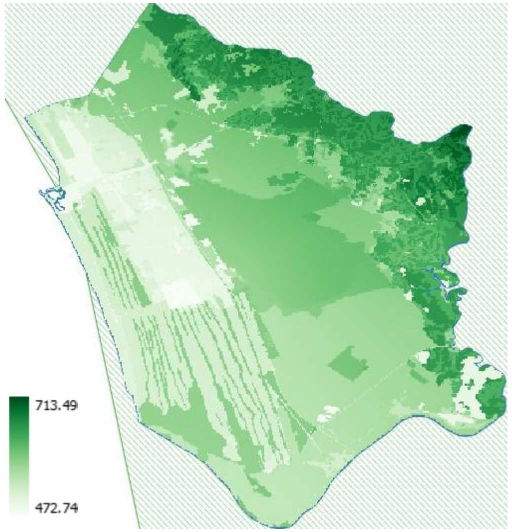


Bathymetry in 2023 (m)

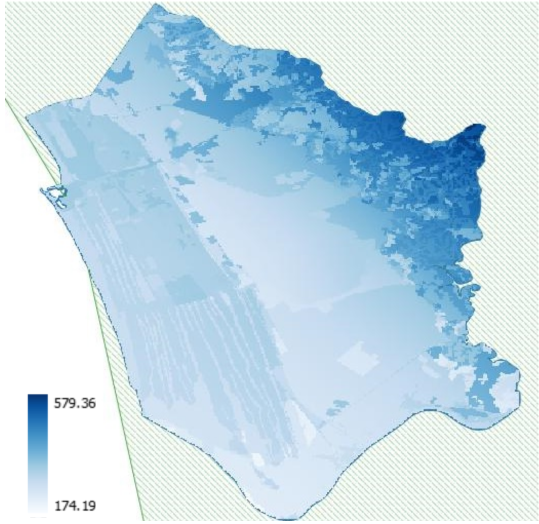
Phase 1: Data harmonisation

We processed authority data as follows:

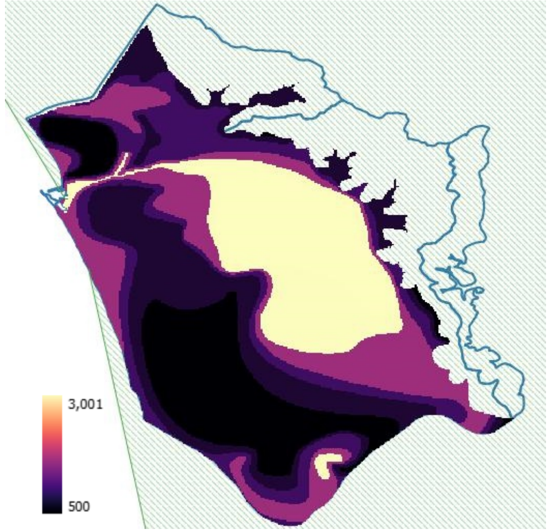
1. *Scaling to 0.0005° (~50 m) resolution*
2. *Spatially alignment*
3. *Holes filled through interpolation (BIMAC*)*



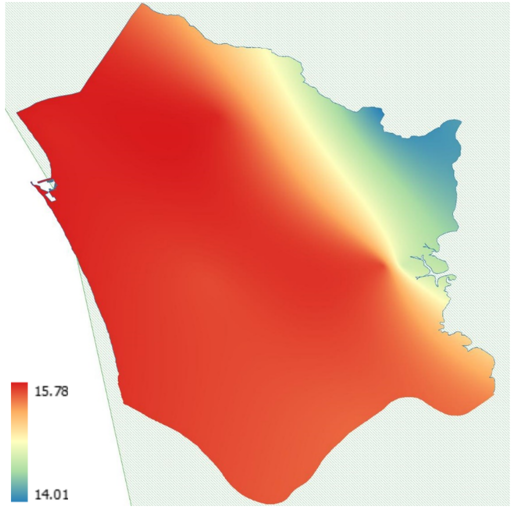
Evapotranspiration in 2006 (mm)



Water surplus in 2006 (mm)



Conductivity in 2002 (S/cm)



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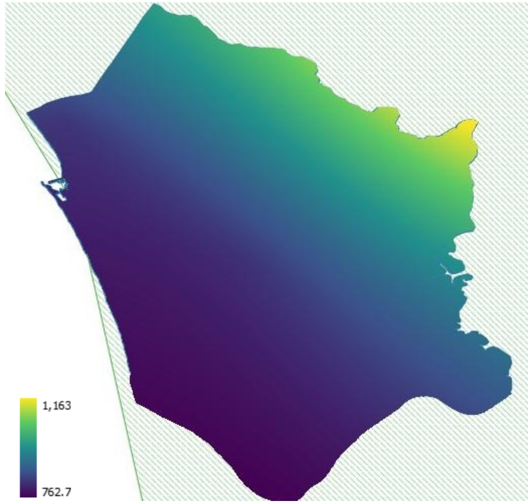
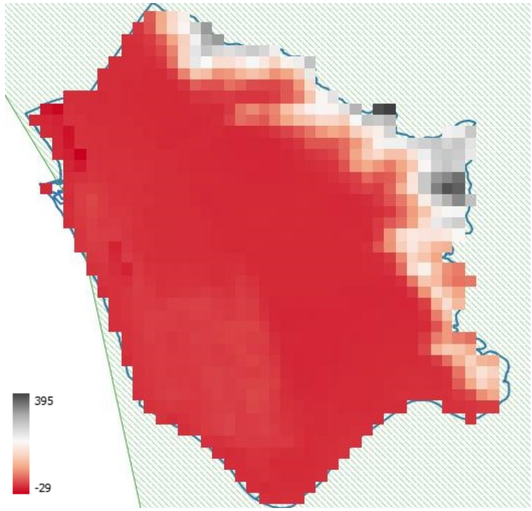


Average precipitation between 1980 and 1999 (mm)



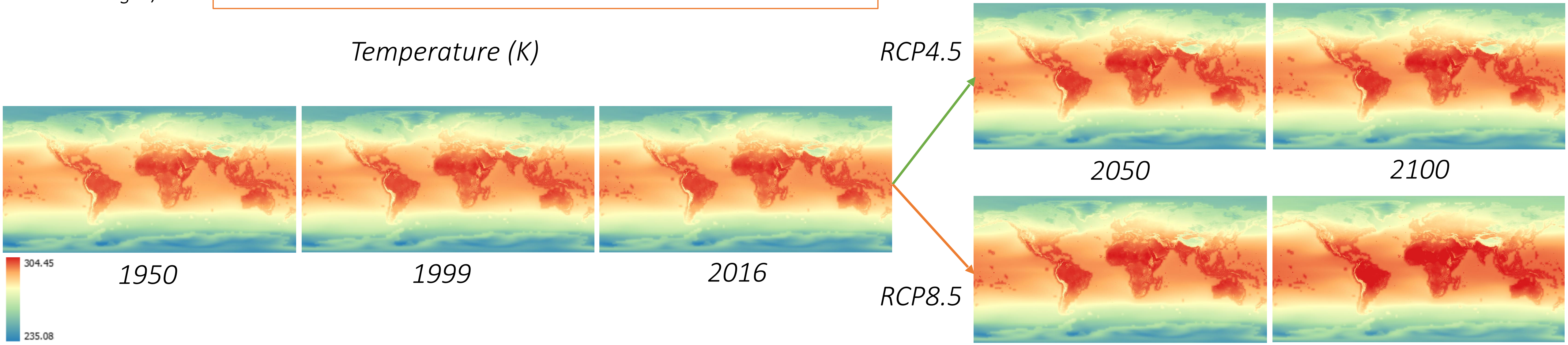
Bathymetry in 2023 (m)

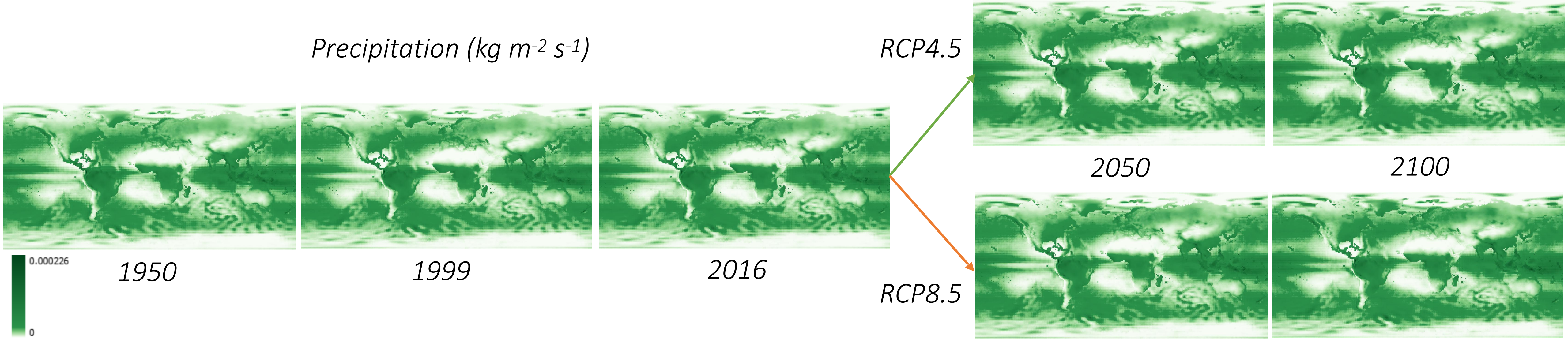
*Coro, G. (2024). An Open Science oriented Bayesian interpolation model for marine parameter observations. *Environmental Modelling & Software*, *172*, 105901.

Phase 2: NASA Earth Exchange data and future climatic projections (Resolution: 0.25°)

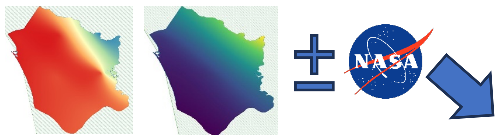
www.nasa.gov/nex

NASA provides long-term environmental data projections under medium (RCP4.5) and high (RCP8.5) greenhouse gas emission scenarios.



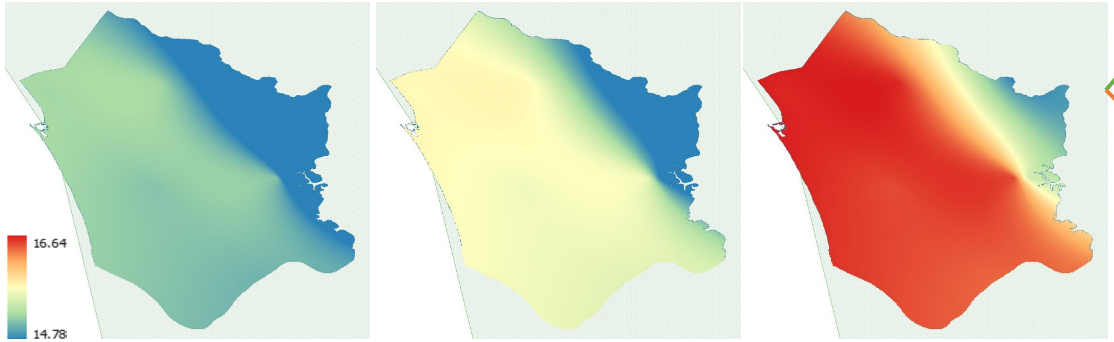


Phase 3: Massaciuccoli Lake data-projection over time

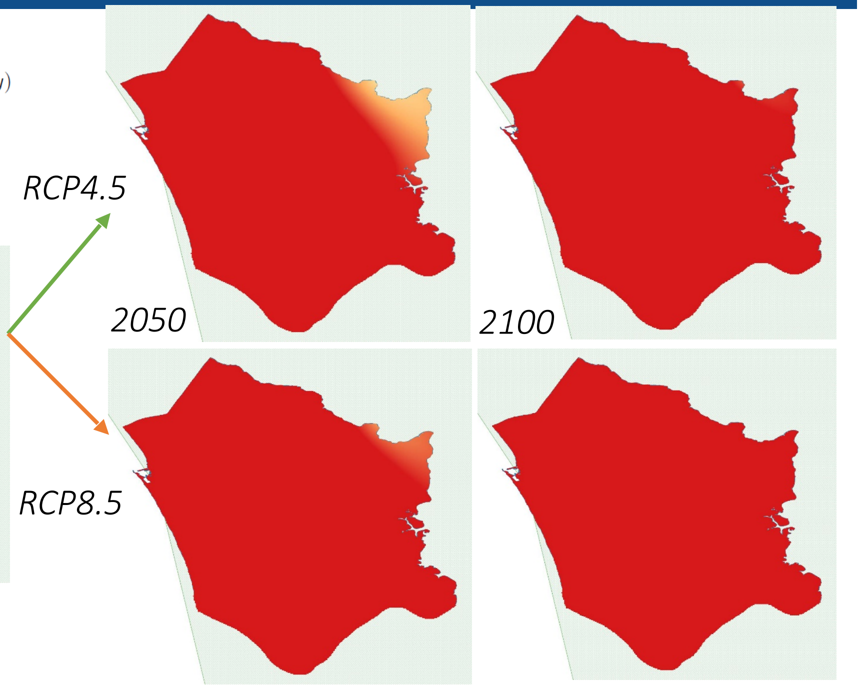


$$A_Y(x,y) = A_{1999}(x,y) + \left(\frac{N_Y(x,y) - N_{1999}(x,y)}{N_{1999}(x,y)}\right) \cdot A_{1999}(x,y)$$

Temperature (°C)

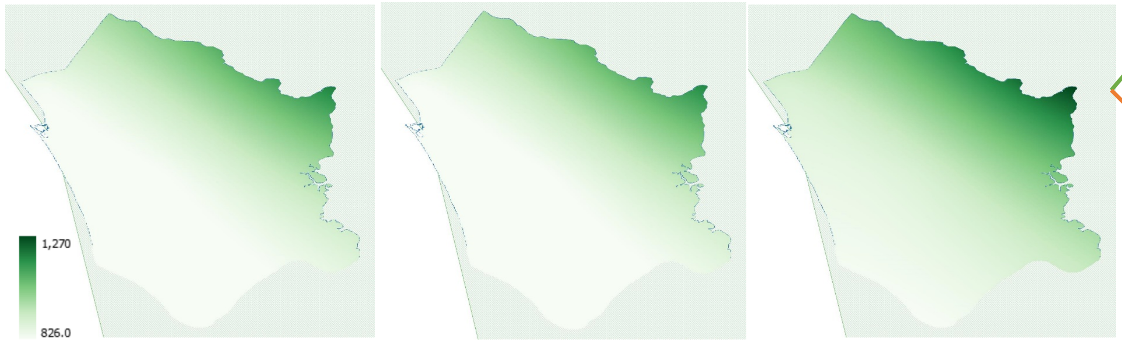


1950 1999 2016

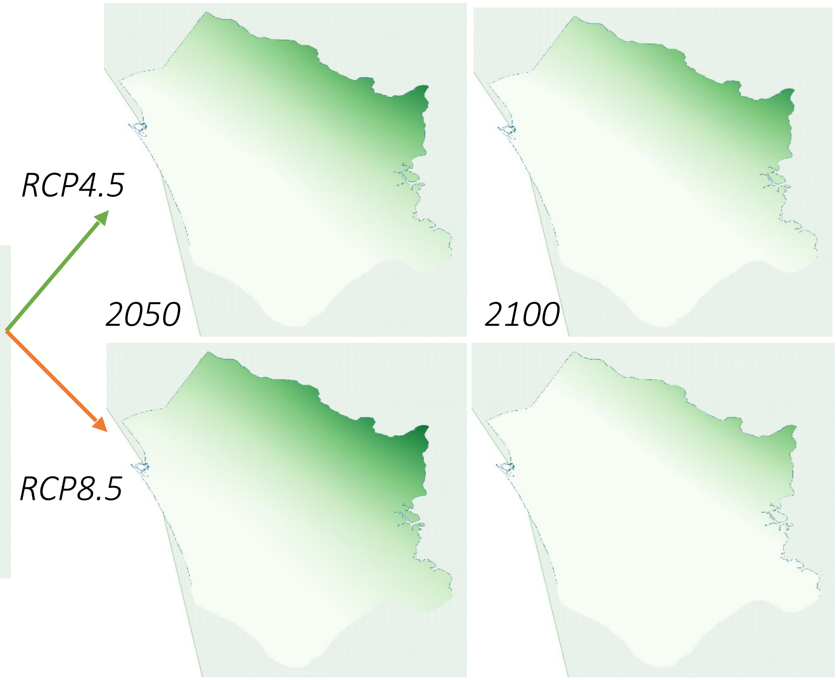


We used NASA data to project authority data in the past and the future.

Precipitation (mm)



1950 1999 2016



Animations

Massaciuccoli Lake data-projection over time – parameter statistics

Trend: extension change of high temperatures						
	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	expansio	expansion	expansion	expansion	expansion	expansion
1999		expansion	expansion	expansion	expansion	expansion
2016			expansion	expansion	expansion	expansion
2050 RCP4.5				expansion	expansion	expansion
2050 RCP8.5					expansion	expansion
2100 RCP4.5						stationary

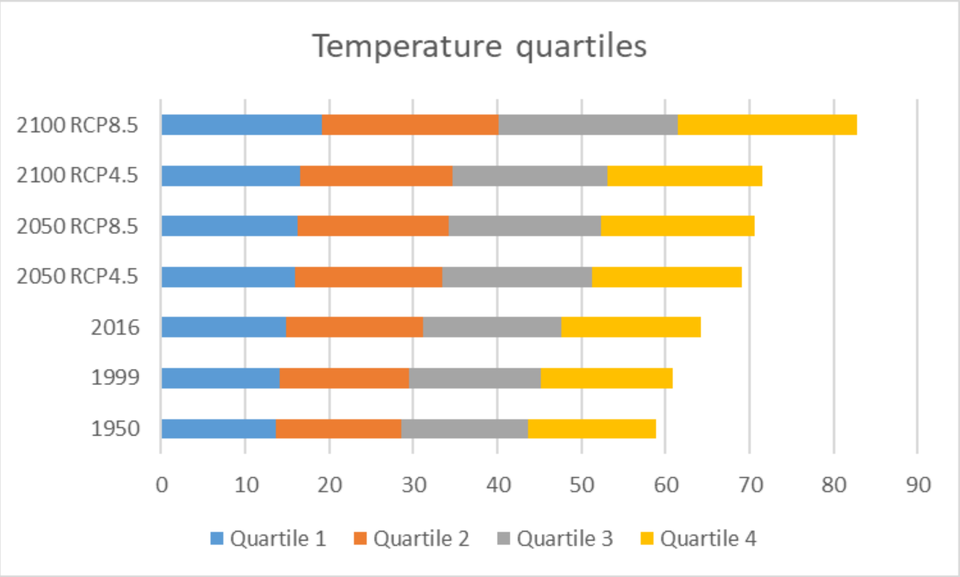
Trend: extension change of heavy precipitation						
trend	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	contraction	expansion	contraction	expansion	contraction	contraction
1999		expansion	expansion	expansion	contraction	contraction
2016			contraction	contraction	contraction	contraction
2050 RCP4.5				expansion	contraction	contraction
2050 RCP8.5					contraction	contraction
2100 RCP4.5						contraction

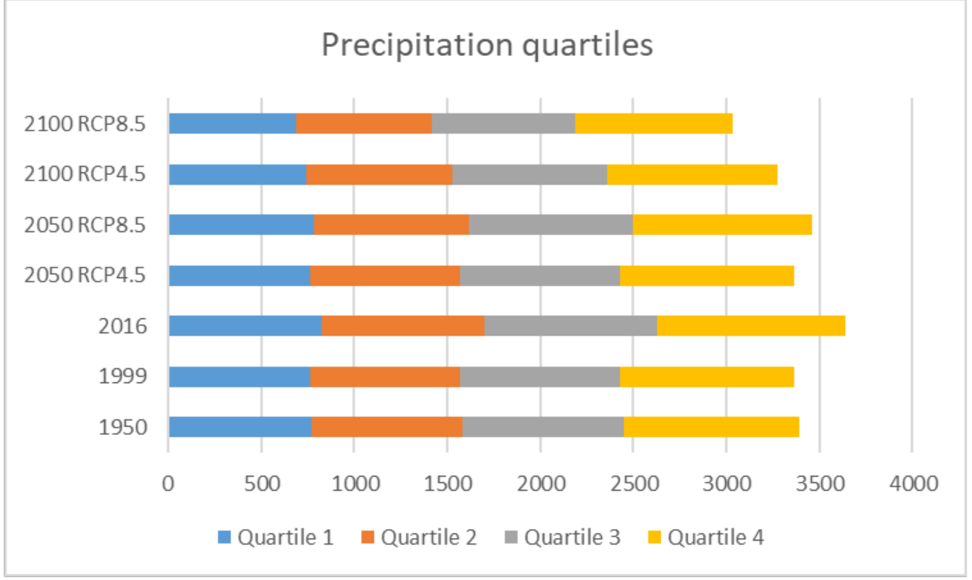
Extension growth of high temperature areas (%)						
	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	-	-	-	-	-	-
1999		-	-	-	-	-
2016			28.5	33.0	33.3	33.3
2050 RCP4.5				3.7	3.7	3.7
2050 RCP8.5					0.02	0.02
2100 RCP4.5						0.00

Extension growth of heavy precipitation areas (%)						
	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	-6.1	61.2	-5.9	14.2	-23.9	-61.0
1999		71.6	0.1	21.5	-19.0	-58.5
2016			-41.7	-29.2	-52.8	-75.8
2050 RCP4.5				21.4	-19.1	-58.5
2050 RCP8.5					-33.3	-65.8
2100 RCP4.5						-48.7

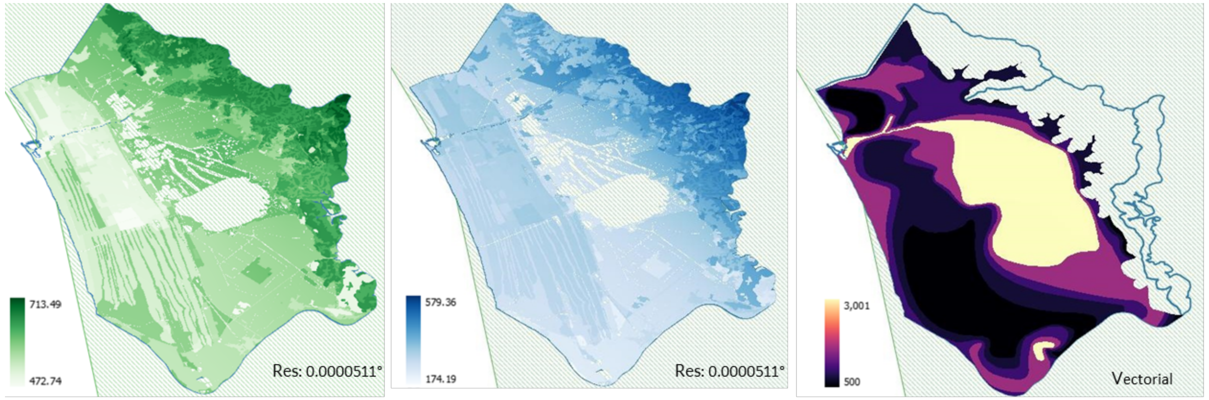
1. *High-temperature areas will constantly increase in the entire basin. Lower temperatures will be present near the mountains in 2050. high-temperature would saturate the basin in 2100 under the RCP4.5 and RCP8.5 scenarios, reaching up to 300-400 m.*

2. *Heavy precipitation will generally decrease in 2100 but will have a different spatial distribution in 2050 wrt previous years, with heavier rains concentrating more and more over the mountains. A general higher aridity is expected.*





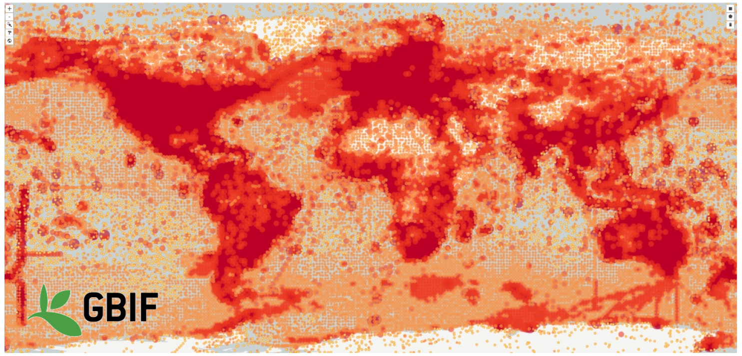
Evapotranspiration, Water Surplus, and Conductivity

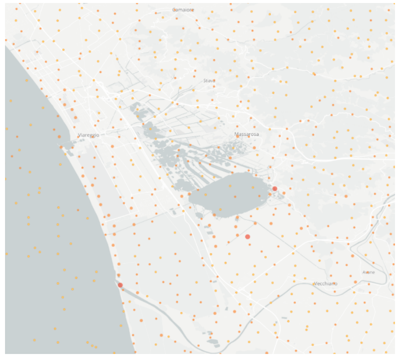


- Projections were unavailable for ET, WS, and C across the years;
- Accurately projecting ET, WS, and C over the years would have required knowledge of weather- and area-specific parameters unavailable for our study;

Phase 3: Species observation data

Large database with more than ~2.5 billion species observation records overall





6815 noisy records; 393 species (Animalia)

Citizen-science data from the field (February-September 2023)

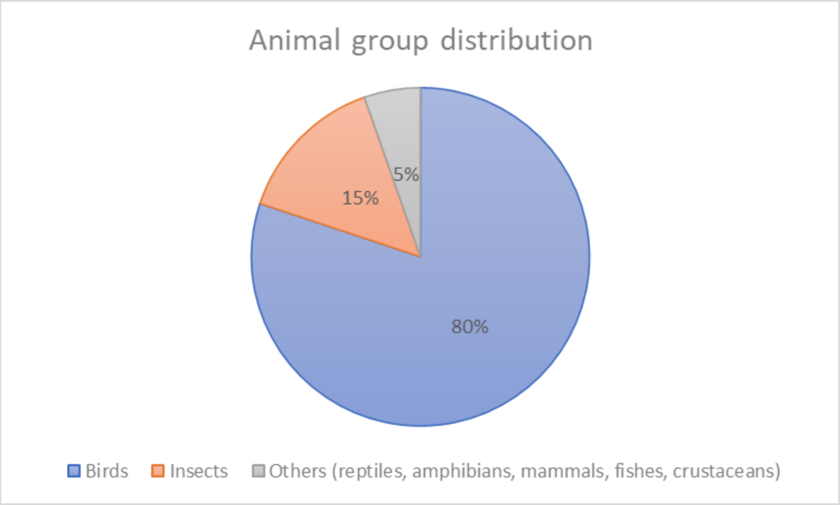
167 verified records; 43 species (Animalia)

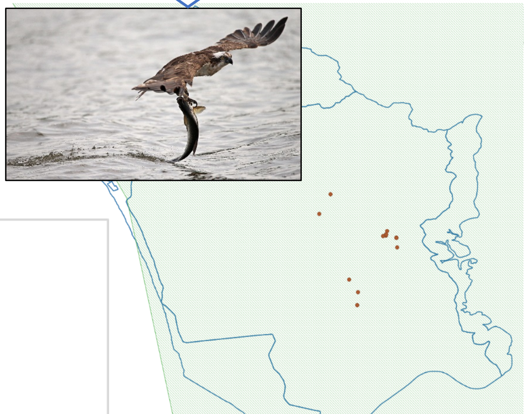
We collected last 10-year observation data from the GBIF large collector and added recent observations from the field.

Total species (Animalia): 393
Total occurrence records: 6815

Suitable species for modelling were selected after filtering those with statistically meaningful data (>5 obs.) and present in other wetlands:

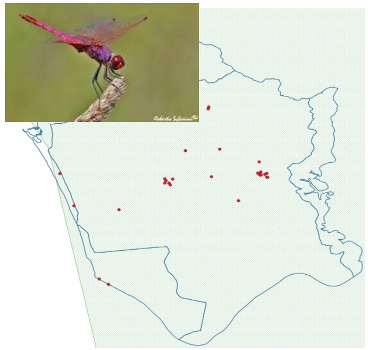
Total species: 180 species
(~ 46% of the total reported species)
Total occurrence records: 6540



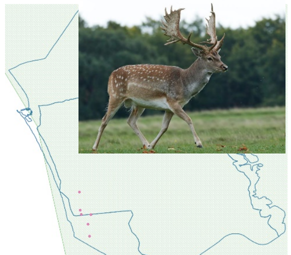


Osprey/Falco pescatore
(Pandion haliaetus)

Western marsh harrier/Falco di palude
Circus aeruginosus

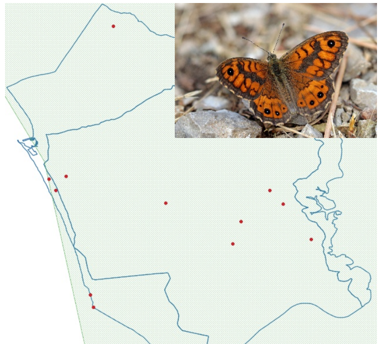


Trithemis annulata



Dama dama

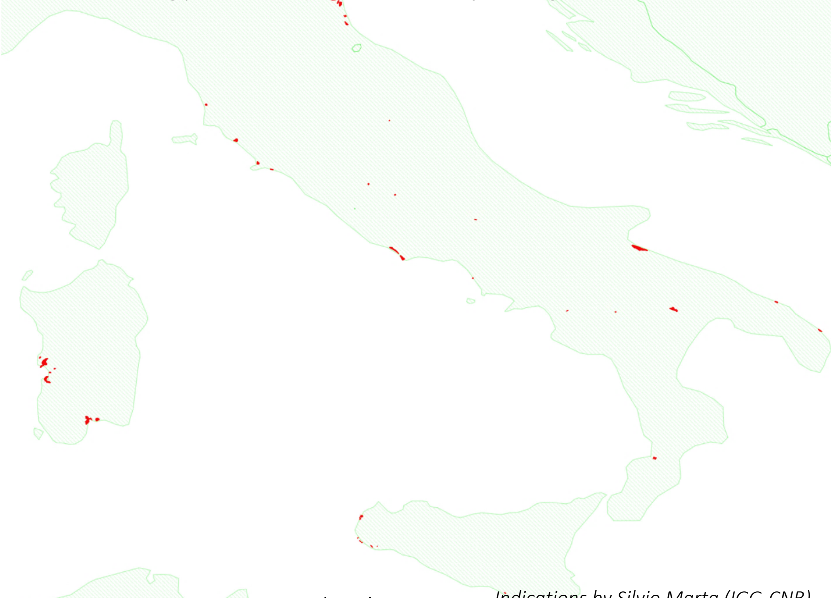
Procambarus clarkii



Lasiommata megera

Phase 4: Species prevalence assessment

Simulates questions like “Is the Eurasian coot easily observable in the Massaciuccoli Lake basin?” posed to an Italian-wetland expert before visiting the basin.
This strategy reduces data overfitting risk.

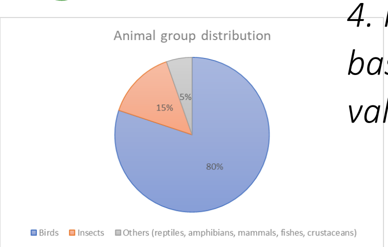


Ramsar Convention on Wetlands
(Zone umide di importanza internazionale ai sensi della Convenzione di Ramsar)

Indications by Silvio Marta (IGG-CNR)

Feature	Analytic definition
Abundance	$A = \frac{\sum_{All\ areas} \frac{No.\ occurrences}{area\ extent}}{No.\ areas}$
Intra-area commonness	$Intra = \frac{\sum_{All\ areas} No.\ occurrences}{No.\ areas}$
Inter-area commonness	$Inter = \frac{No.\ areas\ with\ occurrences}{No.\ areas}$
Observation extent	$E = \frac{\sum_{All\ areas\ with\ occurrences} \frac{No.\ cells\ with\ occurrences}{No.\ cells}}{No.\ areas\ with\ occurrences}$
Observation frequency	$F = \frac{\sum_{All\ areas\ with\ occurrences} \frac{No.\ years\ with\ occurrences}{No.\ years}}{No.\ areas\ with\ occurrences}$
High observation frequency	$Fthr = \frac{\sum_{All\ areas\ with\ occurrences} \frac{No.\ years\ with\ occurrences>5}{No.\ years}}{No.\ areas\ with\ occurrences}$

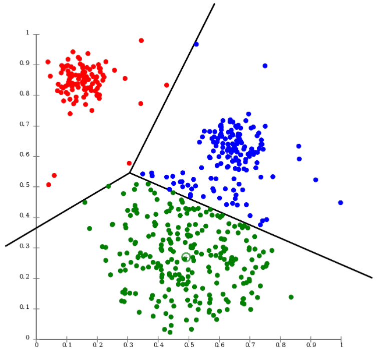
GBIF



Prevalence calculation

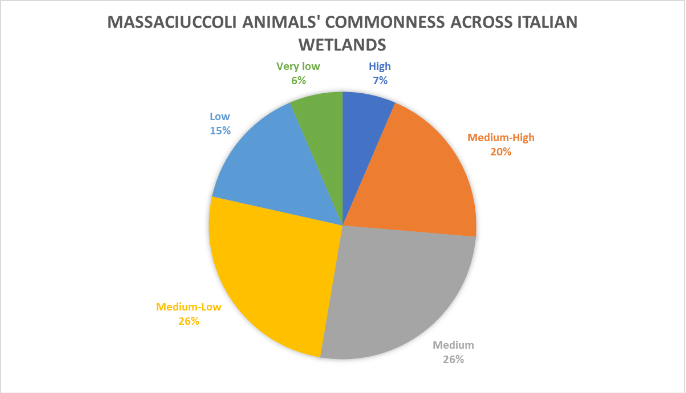
We run cluster analysis to infer expected species presence in wetlands.

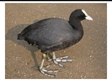
X-Means cluster analysis



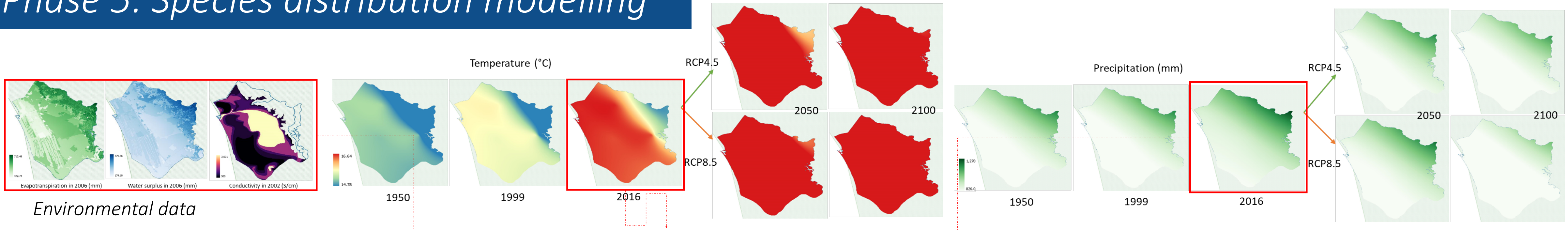
1. *Range: 1-50 clusters*
2. *clusters = commonness*
3. *6 clusters found*
4. *Interpretation assigned based on cluster centroid values*

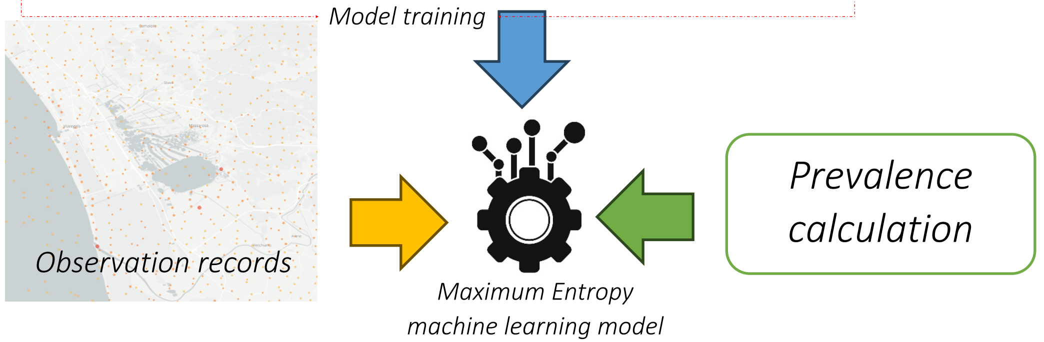
Prevalence = prior probability of species presence in an area (wetlands in this case)



Commonness	*Description*	*Example*	*Assigned Prevalence*
High	*Abundant in most areas, widespread, and frequently observed across many wetlands*	 *Eurasian coot/Folaga (Fulica atra)*	*0.8*
Medium-High	*Abundant in several areas, averagely widespread, and frequently observed across several wetlands*	 *Great tit/Cinciallegra (Parus major)*	*0.7*
Medium	*Averagely abundant and observed with moderate frequency in several wetlands*	 *Pintail/Codone (Anas acuta)*	*0.5*
Medium-Low	*Poorly abundant and unfrequently observed but seen in several wetlands*	*Dunnock/Passera sc*  *(Prunella modularis)*	*0.4*
Low	*Poorly abundant, localised, and unfrequently observed*	 *Hummingbird haw /Sfinge colibrì (Macroglossum stellatarum)*	*0.3*
Very low	*Nonabundant, localised, present in some wetlands, and rarely observed*	 *Red avadavat/Ben moscato (Amandava amandava)*	*0.2*

Phase 5: Species distribution modelling

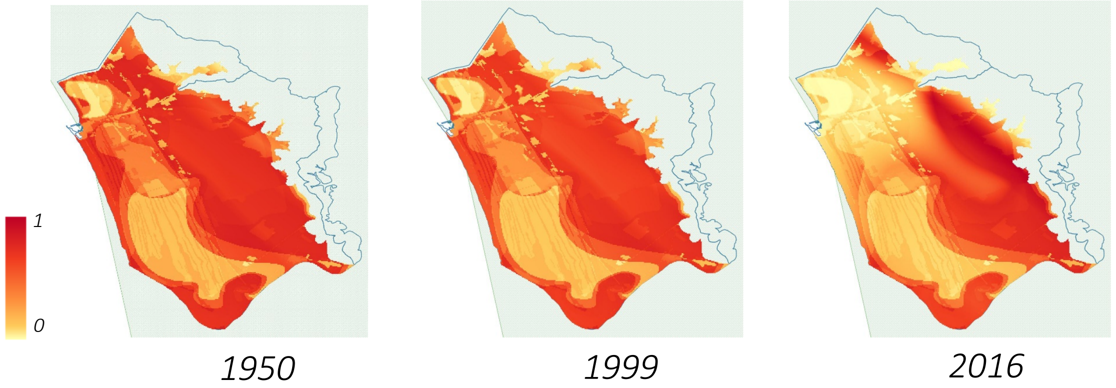


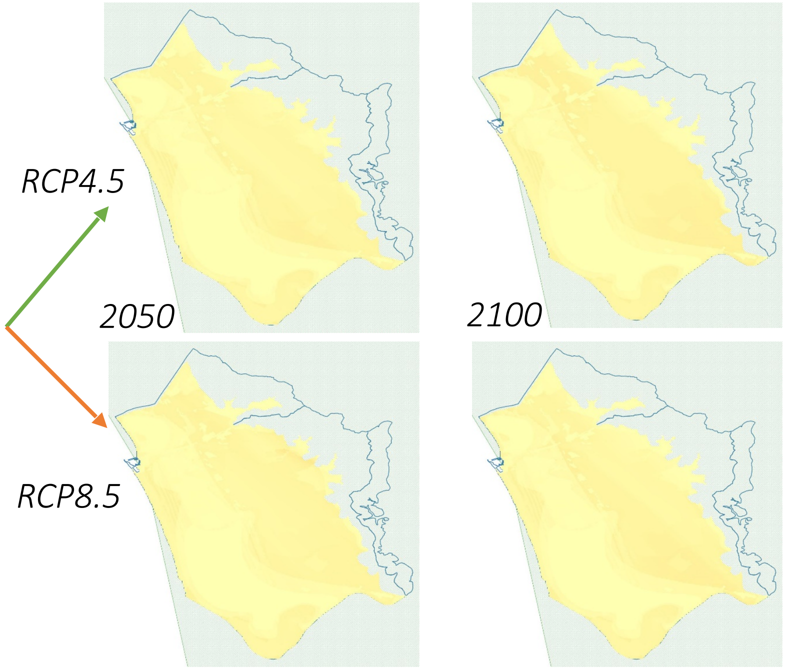


We trained and projected a MaxEnt ecological niche model to simulate the relation between observed species' presence and environmental conditions.

Species distribution over the years (with AUC>0.75)

Western marsh harrier/Falco di palude (*Circus aeruginosus*)

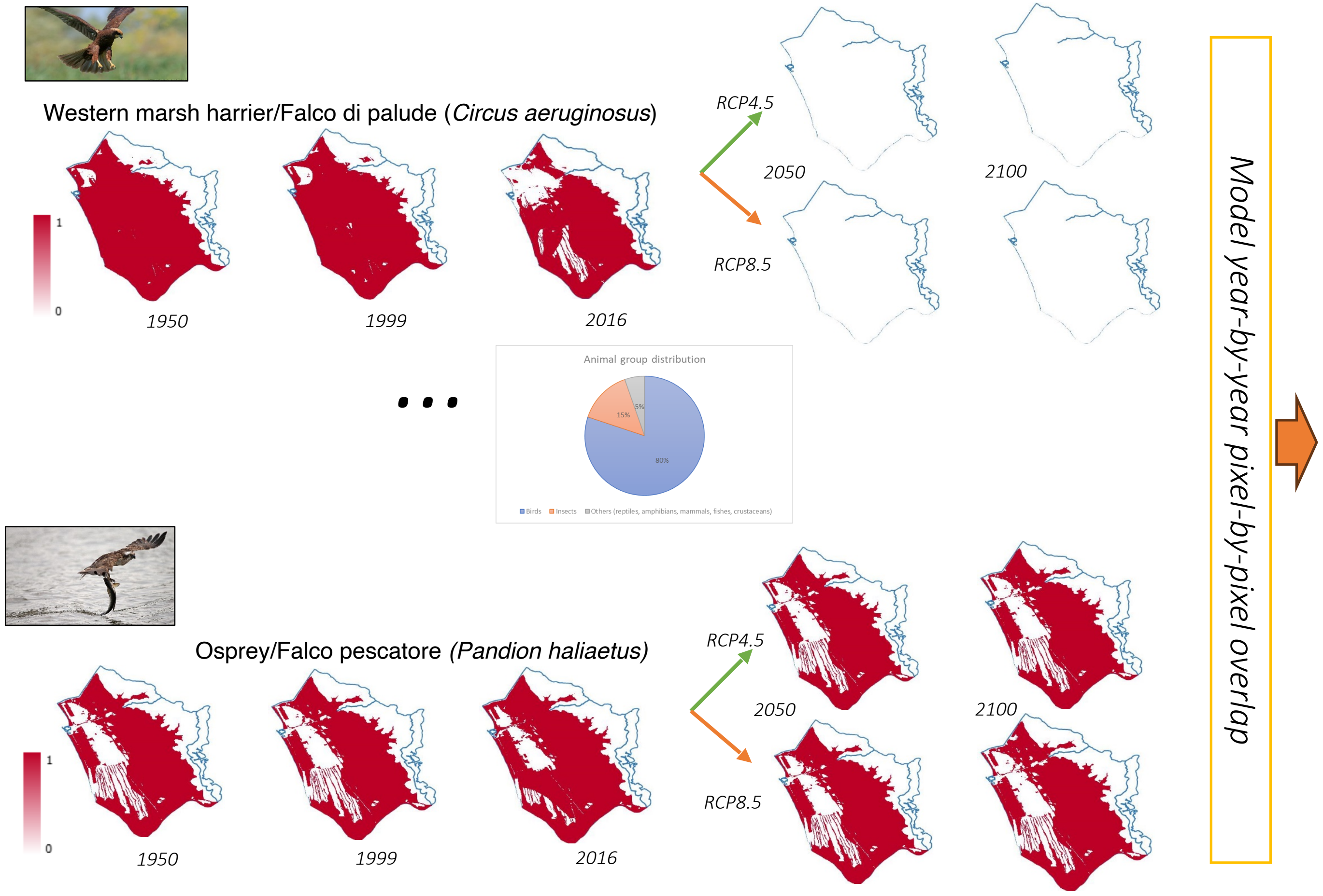


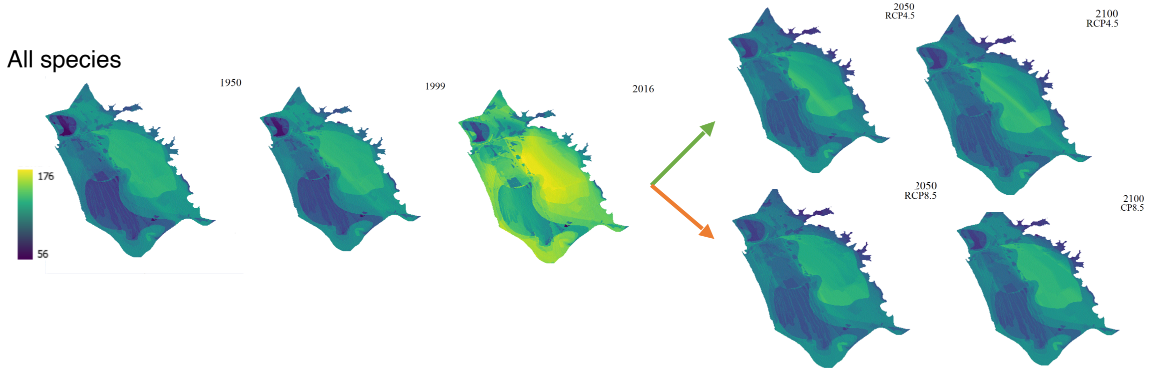


Total projections: 1260 (180 species x 7 years)

Phase 6: Species richness as species models' overlap

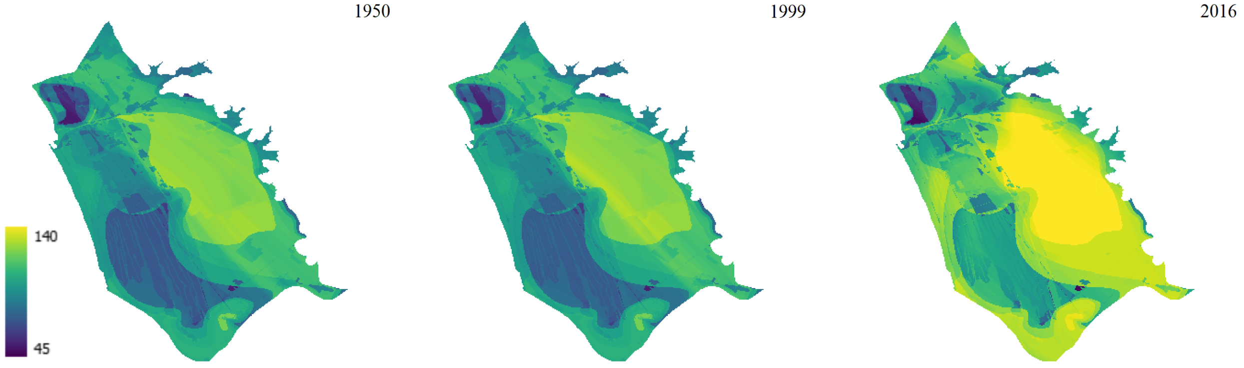
Species distributions were first binarized (present/absent) and then summed:
We merged all species distributions over the time by summing the pixel-by-pixel habitat suitability assessment.

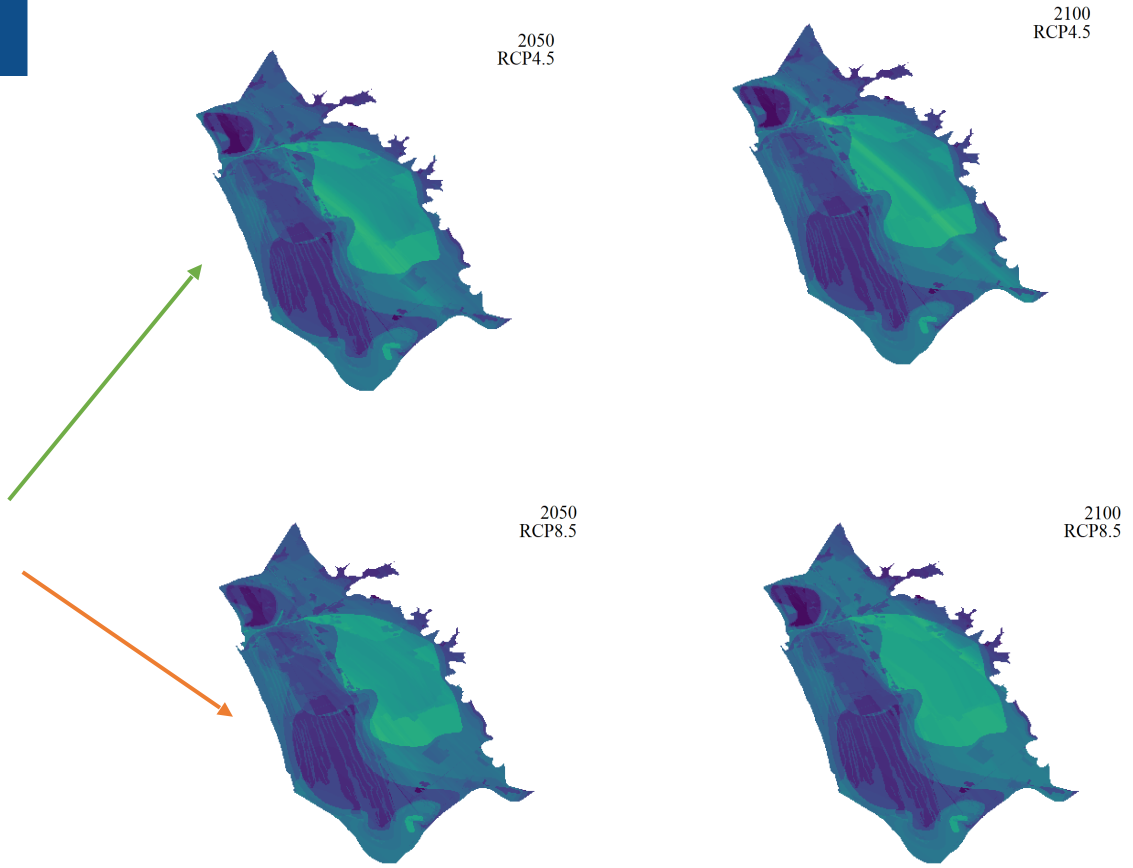




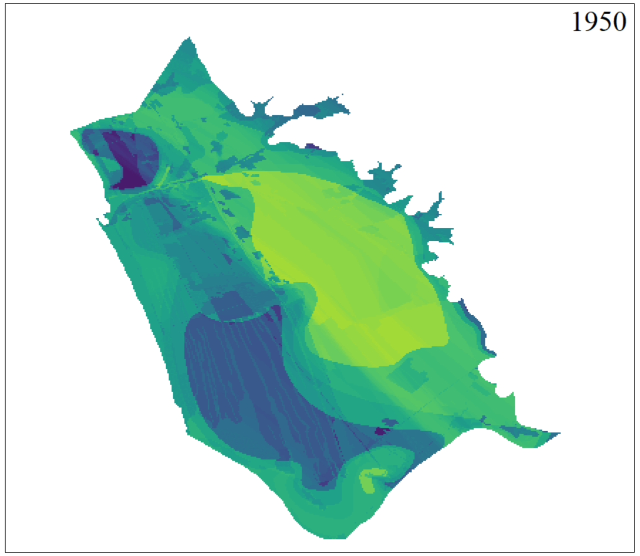
Optimal dichotomic threshold: the value over which the model correctly predicted all training presence locations threshold.

Results: Bird species richness index over the years

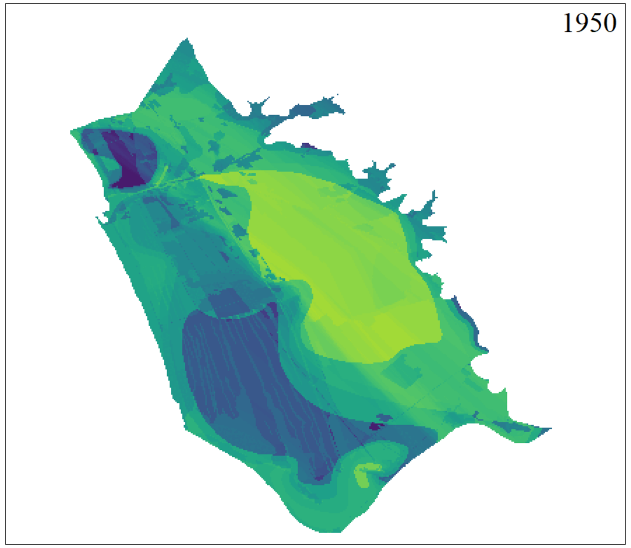




RCP4.5 animation

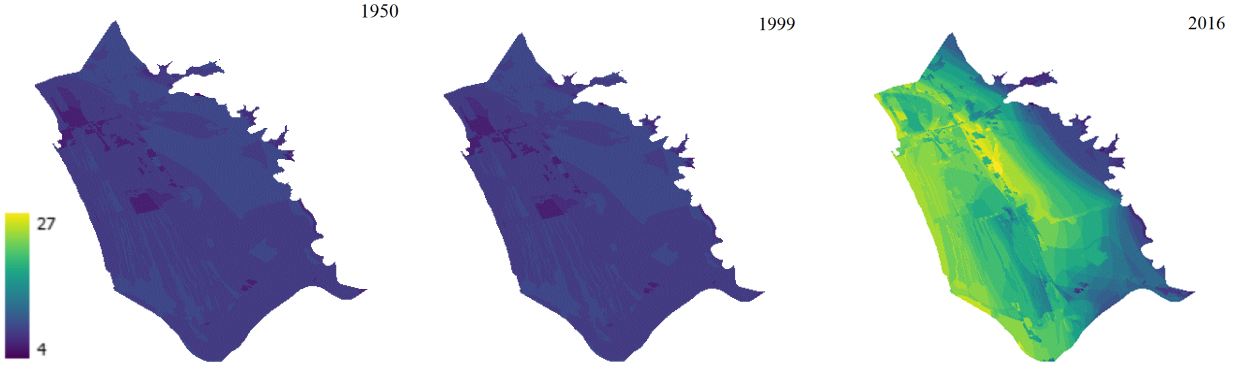


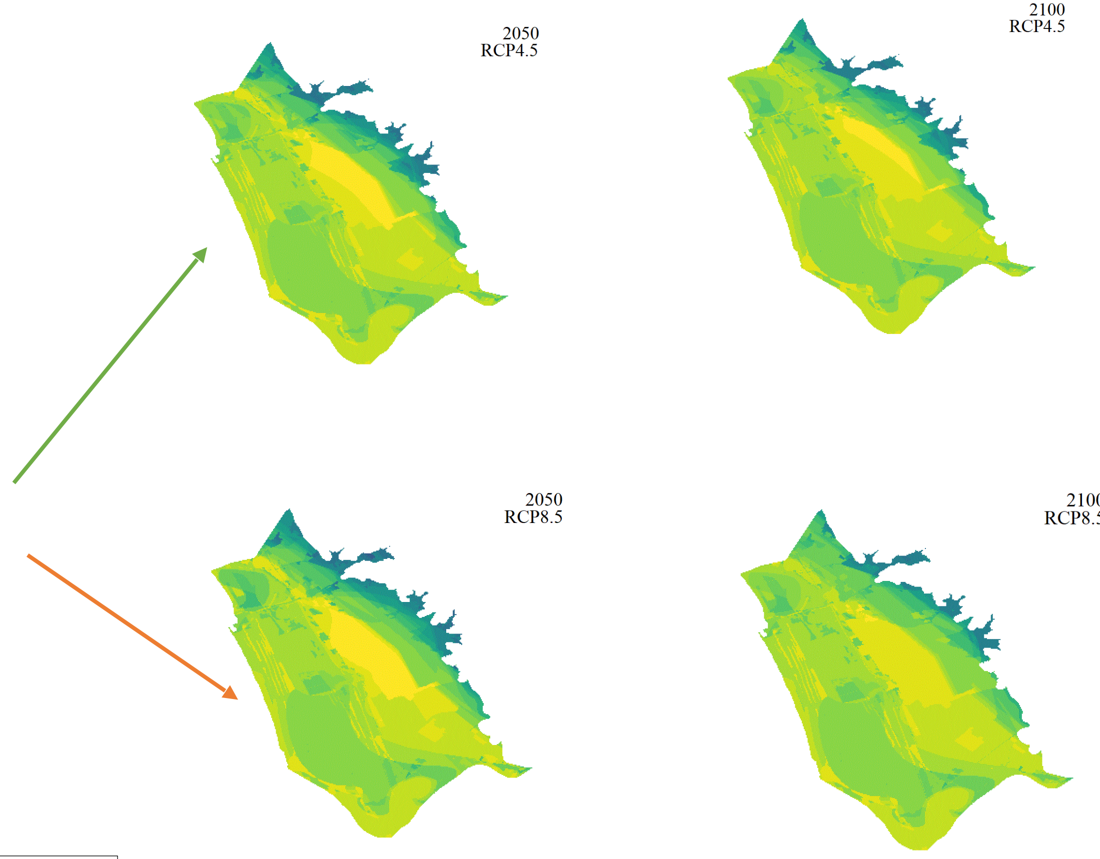
RCP8.5 animation



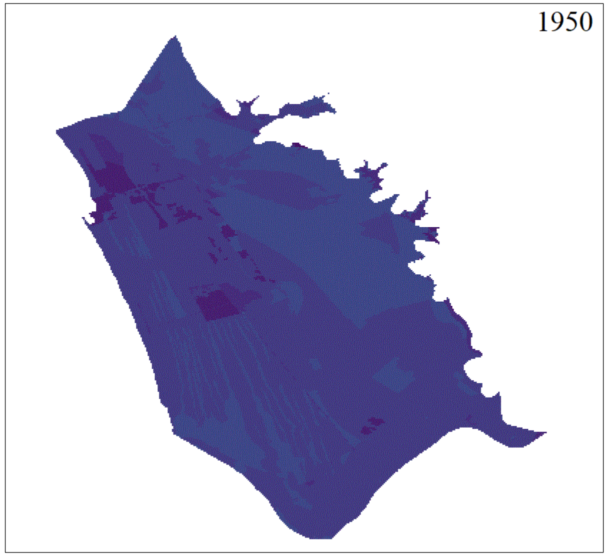
- *Similar or increasingly suitable conditions from 1950 to 1999 and 2016, with a constant expansion trend;*
- *Bird richness would strongly decrease with habitat loss and distribution change, even under RCP4.5;*
- *A slight shift towards the mountains is observable.*

Results: Insect species richness over the years

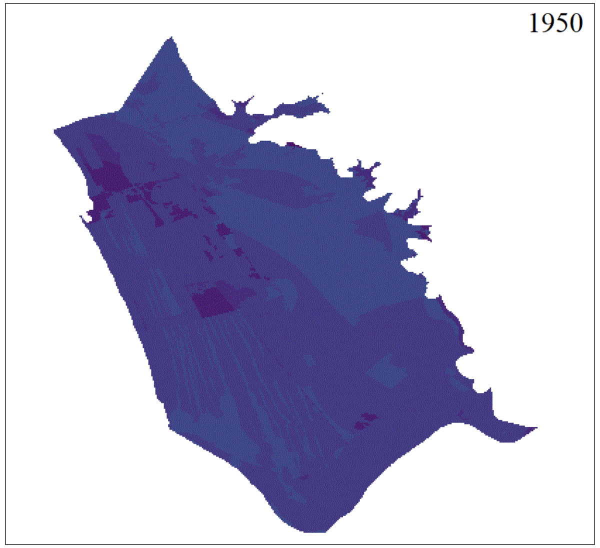




RCP4.5 animation



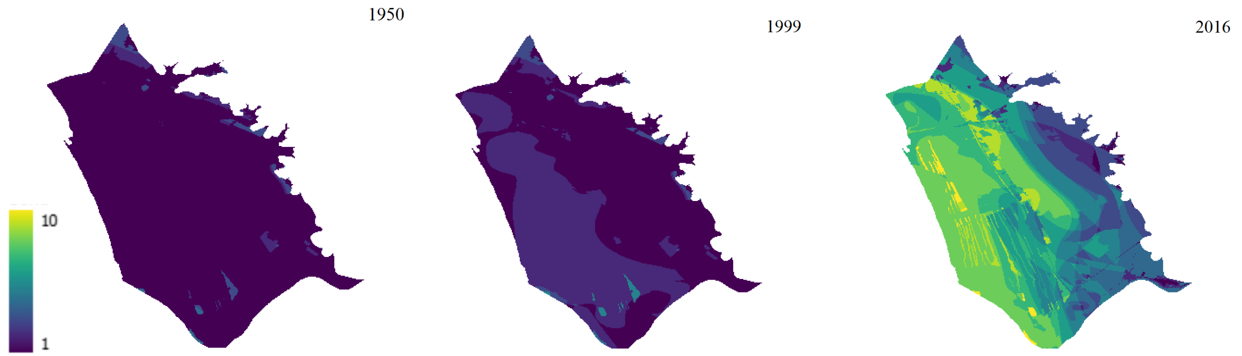
RCP8.5 animation

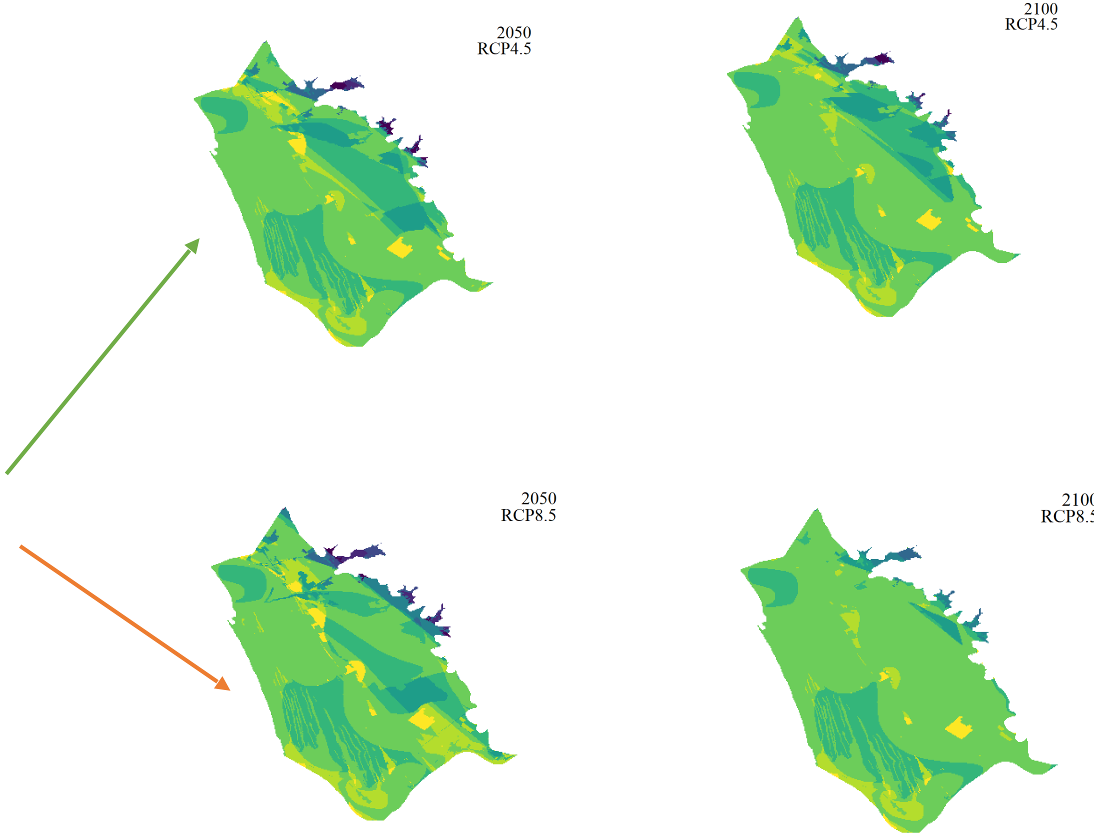


- *Many insects have undergone spatial distribution increases or change;*
- *Future trends indicate expansion between 32-33%;*
- *A considerable change is foreseen already for 2050.*

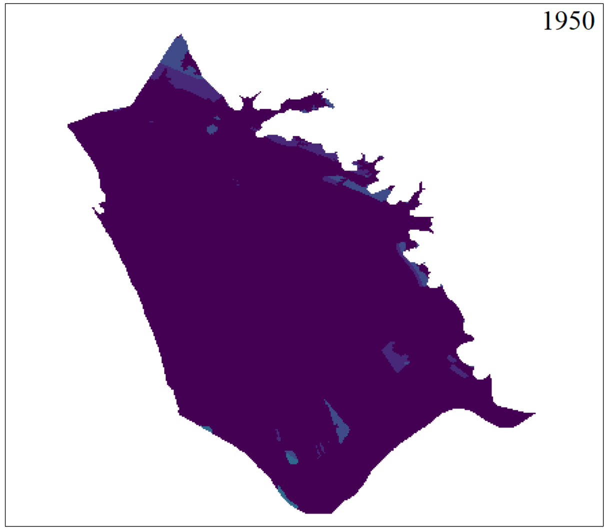
Note: This general trend might not be valid for individual species!

Results: Other species richness over the years

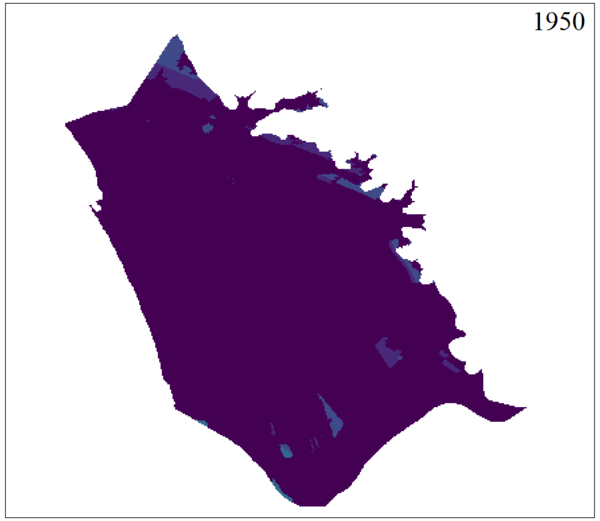




RCP4.5 animation

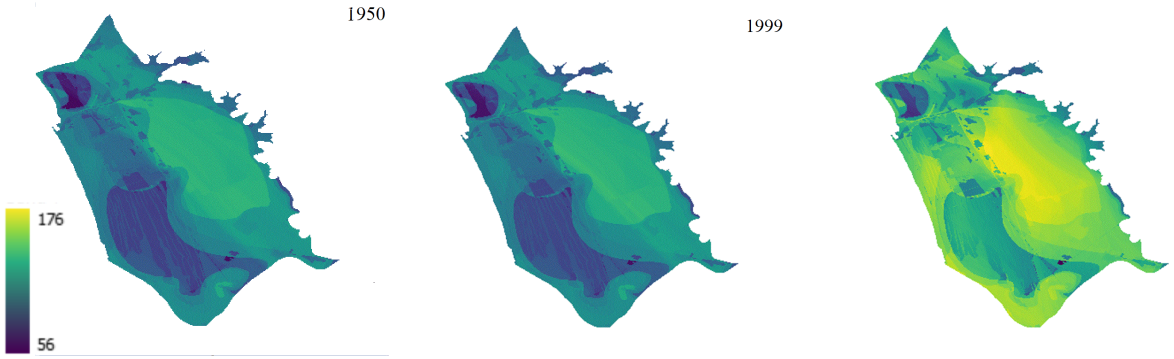


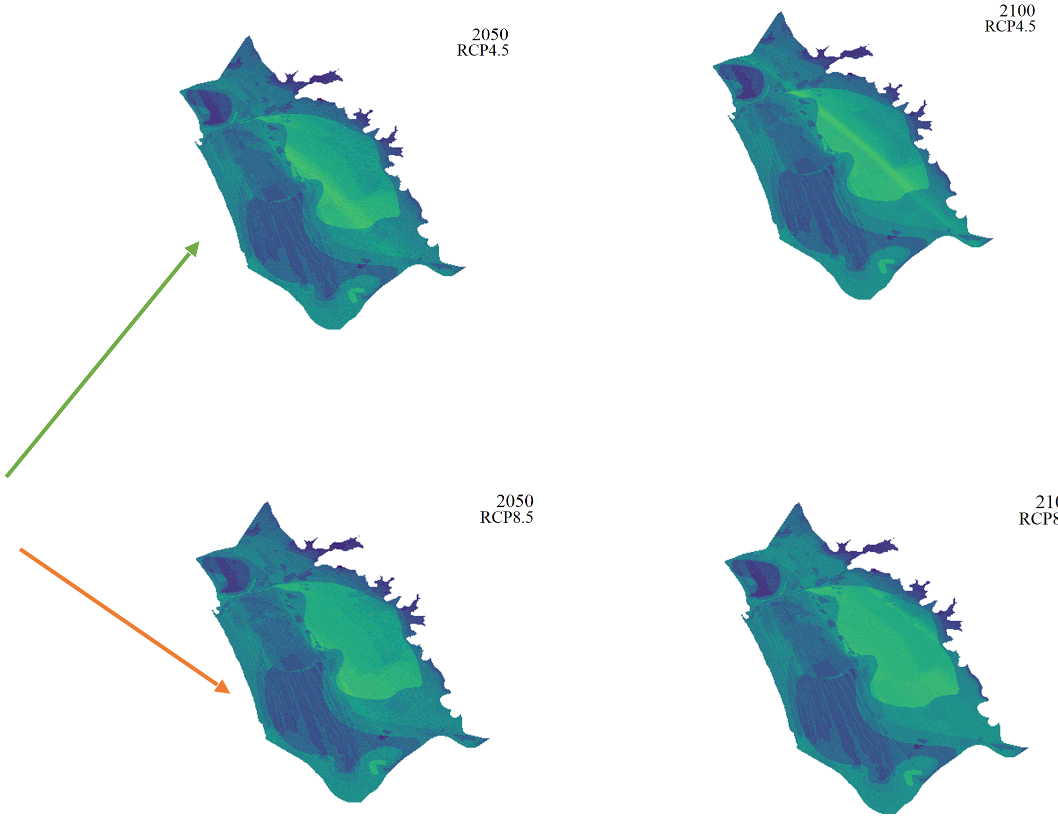
RCP8.5 animation



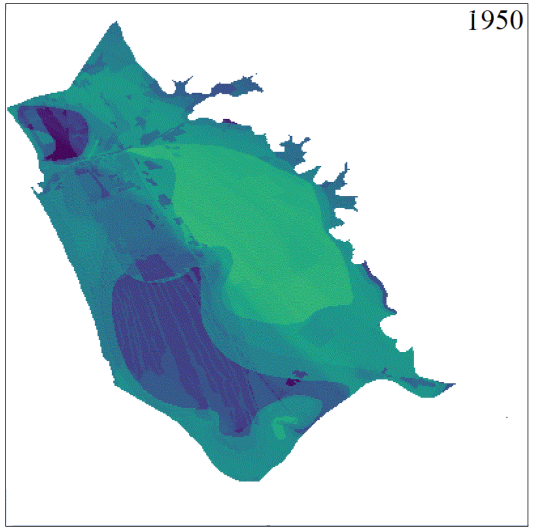
- *Past conditions generally less suitable than the 2016 ones (especially for terrestrial species);*
- *Habitat shift of suitable area locations for most species towards lower temperature areas with more water available.*

Results: All species richness over the years

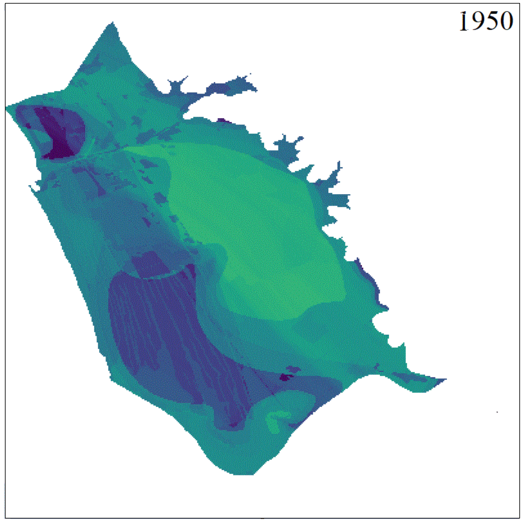




RCP4.5 animation



RCP8.5 animation



- *The overall species richness shows a general change in the future with an overall lower habitat suitability.*

Results: Numeric evaluation

$$Trend_{A\to B} = \left(\frac{|A_l B_h| - |A_h B_l|}{|A_l B_h| + |A_h B_l|}\right) \qquad Similarity_{A\to B} = \left(\frac{|A_l B_l| + |A_h B_h|}{|A|}\right)$$

$$Growth_{A\to B} = \left(\frac{|A_l B_h| - |A_h B_l|}{|A_h|}\right) \qquad Agreement_{A\to B} = \left(\frac{Similarity_{A\to B} - Chance\ Agreement}{1 - Chance\ Agreement}\right)$$

All

Similarity (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	97.2	42.2	89.9	87.6	92.6	95.6
1999		41.9	88.4	86.0	91.2	94.1
2016			34.8	32.8	37.6	41.6
2050 RCP4.5				97.5	97.1	93.2
2050 RCP8.5					94.7	90.9
2100 RCP4.5						96.0

Agreement (Landis & Koch, 1977)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	Almost perfect	Slight	Moderate	Fair	Substantial	Almost perfect
1999		Slight	Moderate	Fair	Substantial	Substantial
2016			Slight	Slight	Slight	Slight
2050 RCP4.5				Almost perfect	Almost perfect	Substantial
2050 RCP8.5					Substantial	Moderate
2100 RCP4.5						Almost perfect

Trend (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	contraction	expansion	contraction	contraction	contraction	contraction
1999		expansion	contraction	contraction	contraction	contraction
2016			contraction	contraction	contraction	contraction
2050 RCP4.5				contraction	expansion	expansion
2050 RCP8.5					expansion	expansion
2100 RCP4.5						expansion

Trend (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	-89%	100%	-73%	-76%	-63%	-14%
1999		100%	-61%	-65%	-49%	-5%
2016			-100%	-100%	-100%	-100%
2050 RCP4.5				-79%	96%	100%
2050 RCP8.5					90%	96%
2100 RCP4.5						100%

Growth (%) (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	-1.9	100.0	-46.5	-58.9	-28.9	-3.9
1999		100.0	-45.5	-58.1	-27.5	-2.0
2016			-88.4	-91.1	-84.6	-79.1
2050 RCP4.5				-23.2	32.9	79.7
2050 RCP8.5					73.0	133.9
2100 RCP4.5						35.2

Birds

Similarity (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	97.5	64.5	58.5	57.3	58.8	57.2
1999		64.9	57.8	56.7	58.1	56.6
2016			26.5	25.3	26.7	25.2
2050 RCP4.5				98.5	97.1	98.6
2050 RCP8.5					98.2	99.8
2100 RCP4.5						98.4

Agreement (Landis & Koch, 1977)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	Almost perfect	Fair	Slight	Slight	Slight	Slight
1999		Fair	Slight	Slight	Slight	Slight
2016			Slight	Slight	Slight	Slight
2050 RCP4.5				Poor	Poor	Poor
2050 RCP8.5					Poor	Poor
2100 RCP4.5						poor

Trend (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	expansion	expansion	contraction	contraction	contraction	contraction
1999		expansion	contraction	contraction	contraction	contraction
2016			contraction	contraction	contraction	contraction
2050 RCP4.5				contraction	expansion	contraction
2050 RCP8.5					expansion	contraction
2100 RCP4.5						contraction

Trend (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	27%	90%	-100%	-100%	-100%	-100%
1999		89%	-100%	-100%	-100%	-100%
2016			-100%	-100%	-100%	-100%
2050 RCP4.5				-78%	10%	-93%
2050 RCP8.5					82%	-54%
2100 RCP4.5						-94%

Growth (%) (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	1.5	74.8	-96.9	-99.6	-96.3	-99.9
1999		72.1	-97.0	-99.6	-96.3	-99.9
2016			-98.3	-99.8	-97.9	-99.9
2050 RCP4.5				-87.8	22.4	-96.4
2050 RCP8.5					903.3	-70.3
2100 RCP4.5						-97.0

Insects

Similarity (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	100.0	26.9	3.8	4.0	3.5	2.7
1999		26.9	3.8	4.0	3.5	2.7
2016			76.7	77.0	76.4	75.8
2050 RCP4.5				99.6	99.5	98.9
2050 RCP8.5					99.3	98.7
2100 RCP4.5						99.0

Agreement (Landis & Koch, 1977)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	Almost perfect	Slight	Slight	Slight	Slight	Slight
1999		Slight	Slight	Slight	Slight	Slight
2016			Slight	Slight	Slight	Slight
2050 RCP4.5				Almost perfect	Almost perfect	Almost perfect
2050 RCP8.5					Almost perfect	Substantial
2100 RCP4.5						Almost perfect

Trend (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	stationary	expansion	expansion	expansion	expansion	expansion
1999		expansion	expansion	expansion	expansion	expansion
2016			expansion	expansion	expansion	expansion
2050 RCP4.5				contraction	expansion	expansion
2050 RCP8.5					expansion	expansion
2100 RCP4.5						expansion

Trend (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	-	100%	100%	100%	100%	100%
1999		100%	100%	100%	100%	100%
2016			99%	99%	99%	100%
2050 RCP4.5				-55%	68%	100%
2050 RCP8.5					71%	100%
2100 RCP4.5						84%

Growth (%) (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	-	-	-	-	-	-
1999		-	-	-	-	-
2016			31.6	31.3	32.1	33.2
2050 RCP4.5				-0.2	0.3	1.2
2050 RCP8.5					0.6	1.4
2100 RCP4.5						0.8

Others species (fishes, mammals, crustaceans, reptiles, amphibians)

Similarity (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	99.5	25.8	2.2	2.4	2.0	0.5
1999		26.3	2.7	2.9	2.5	0.9
2016			76.4	76.6	76.2	74.7
2050 RCP4.5				99.8	99.8	98.3
2050 RCP8.5					99.6	98.1
2100 RCP4.5						98.5

Agreement (Landis & Koch, 1977)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	Slight	Slight	Slight	Slight	Slight	Slight
1999		Slight	Slight	Slight	Slight	Slight
2016			Poor	Slight	Slight	Slight
2050 RCP4.5				Almost perfec	Almost perfect	Fair
2050 RCP8.5					Almost perfect	Fair
2100 RCP4.5						Fair

Trend (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	expansion	expansion	expansion	expansion	expansion	expansion
1999		expansion	expansion	expansion	expansion	expansion
2016			expansion	expansion	expansion	expansion
2050 RCP4.5				contraction	expansion	expansion
2050 RCP8.5					expansion	expansion
2100 RCP4.5						expansion

Trend (%)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950	100%	100%	100%	100%	100%	100%
1999		100%	100%	100%	100%	100%
2016			100%	100%	100%	100%
2050 RCP4.5				-100%	100%	100%
2050 RCP8.5					100%	100%
2100 RCP4.5						100%

Growth (%) (extension change)

	1999	2016	2050 RCP4.5	2050 RCP8.5	2100 RCP4.5	2100 RCP8.5
1950.0	-	-	-	-	-	-
1999.0		-	-	-	-	-
2016.0			31.8	31.5	32.1	34.1
2050 RCP4.5				-0.2	0.2	1.8
2050 RCP8.5					0.5	2.0
2100 RCP4.5						1.5

The numeric analysis confirms the previous observations.
The worst case is the birds' species richness.

Future scenarios for species richness (SR), compared to 2016:

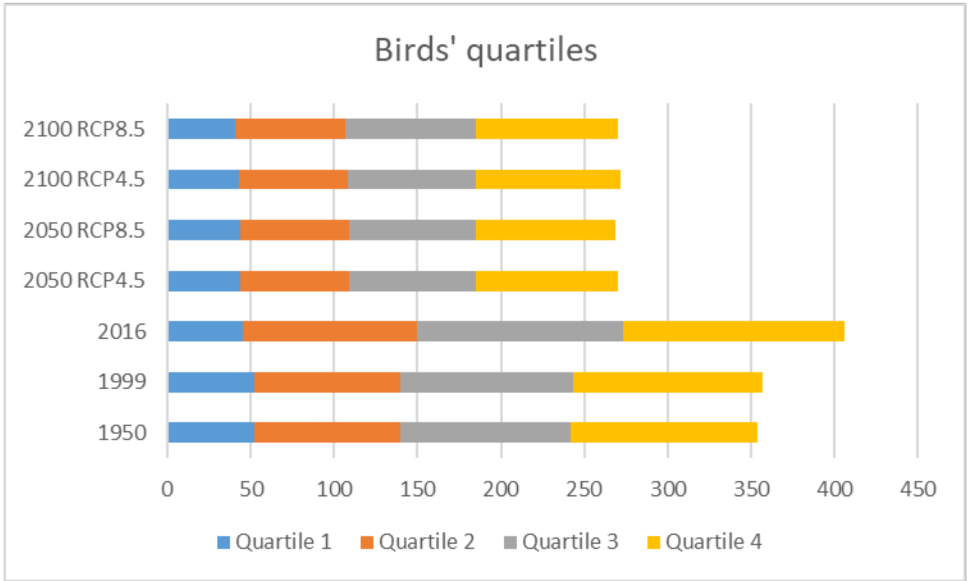
- *Birds' SR will decrease between 98.3% (2050 RCP4.5) and 99.9% (2100 RCP8.5)*
- *Insects' SR will increase between 31.6% (2050 RCP4.5) and 33.2% (2100 RCP8.5)*
- *Other species' SR will include between 23.6% (2050 RCP4.5) and 25.3% (2100 RCP8.5) new territory*

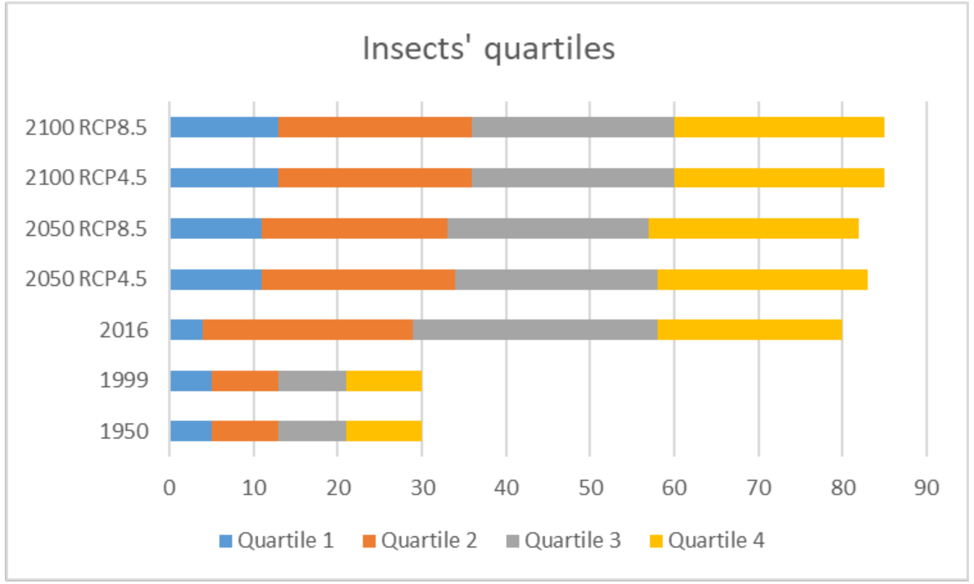
Past scenarios compared to 2016:

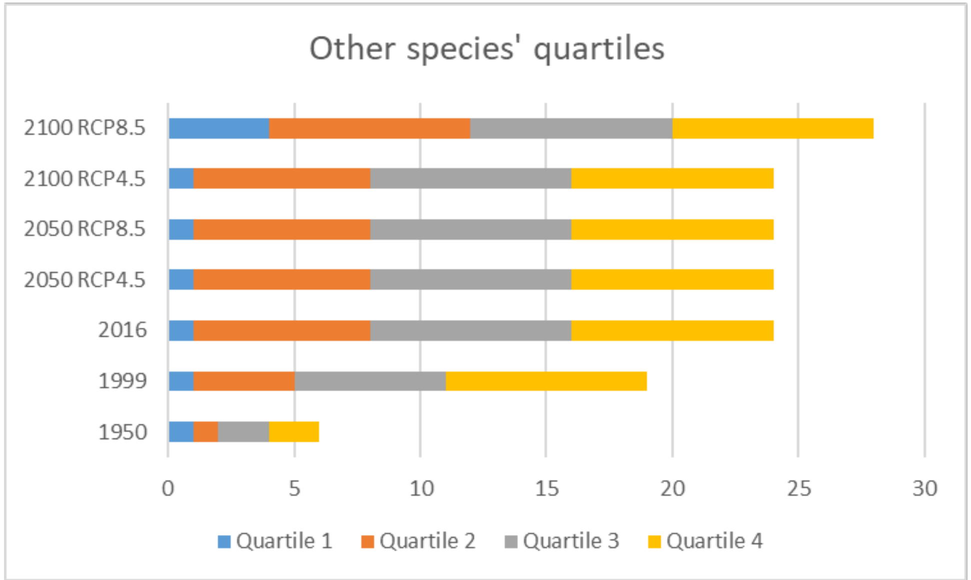
- *Birds' SR has increased between 74.75% (1950) and 72.09% (1999)*
- *Insects have occupied 73.1% new habitat previously unsuitable*
- *Other species have occupied between 74.2% (1950) and 73.7% (1999) new habitat previously unsuitable*

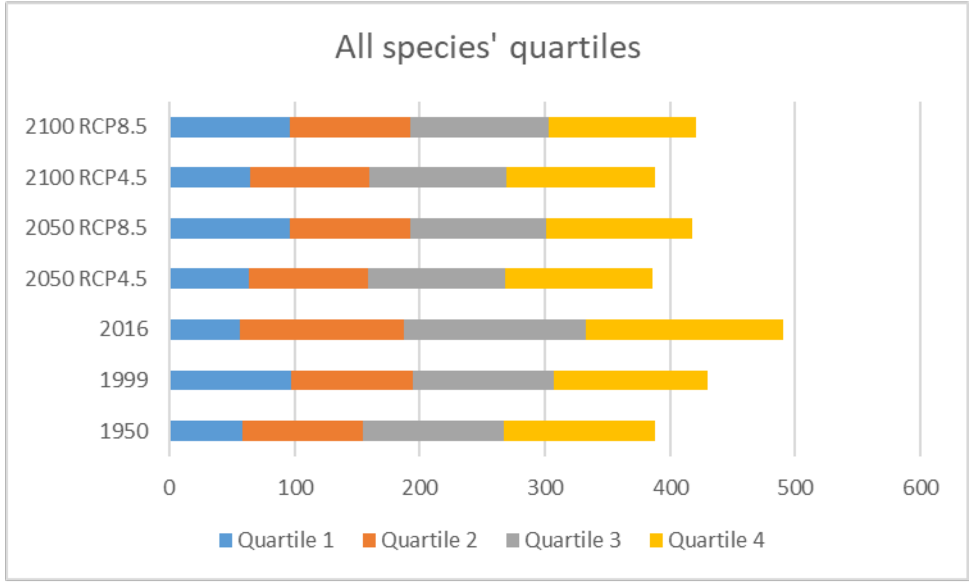
The overall species richness has improved from the past to today but will worsen in the near future.

Results: Quantile analysis









The quartile analysis confirms the previously observed trends.

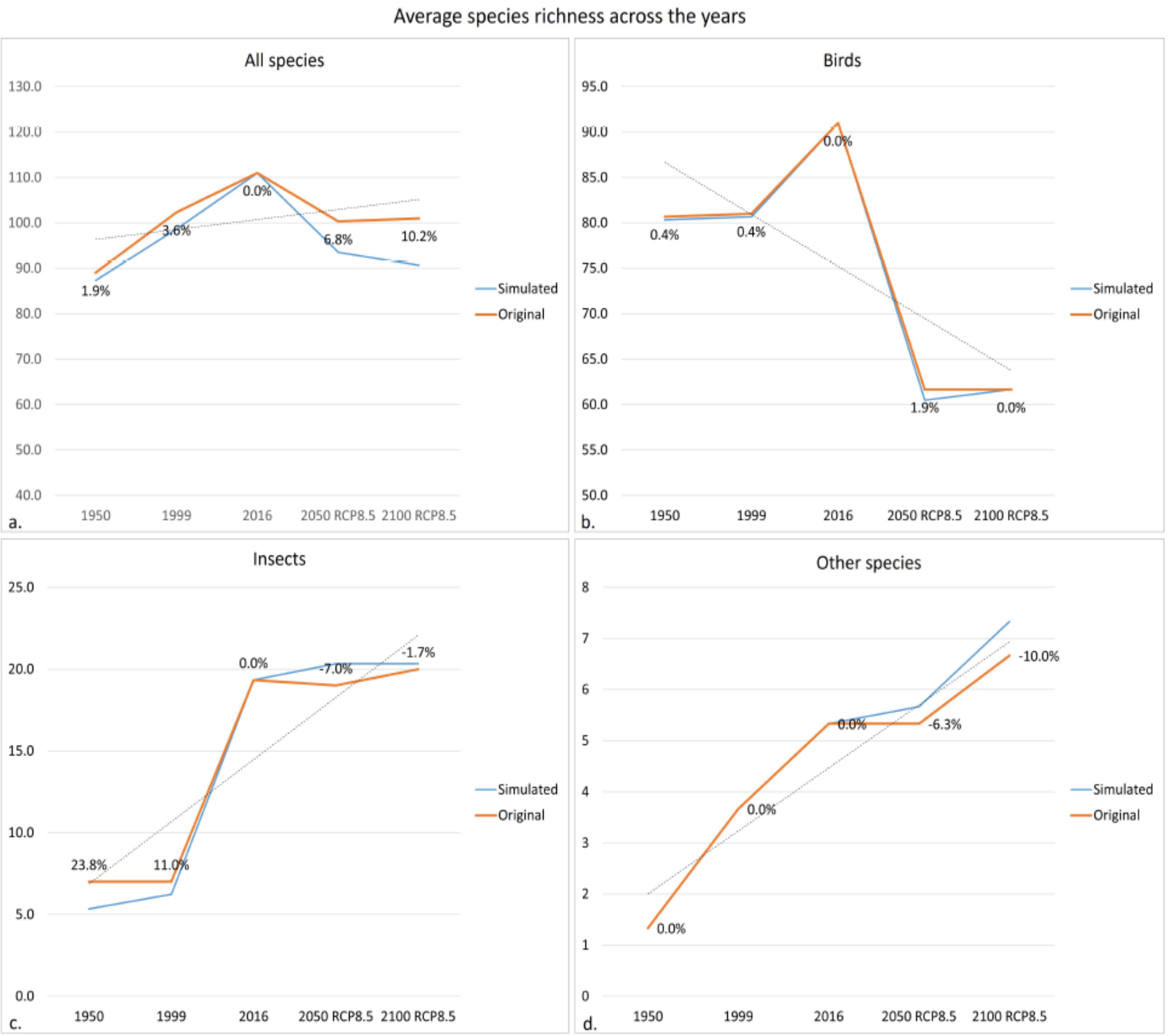
Model sensitivity

<u>*Hypotheses on ET, WS, C:*</u>

- *These parameters were influential in most models;*
- *Could substitute bathymetry and water presence in producing some consistent results (e.g., fish in waters);*
- *Based on the Thornthwaite formula and sea-close wetland analyses, we simulated their variation range over the years;*
- *The detected trends over the species groups were consistent with the ones assuming values fixed to 2016.*

<u>*Other assessments:*</u>

- *MaxEnt consistently extrapolated the probability outside of the training ranges* (16% extension required);
- *Species richness change was not an artefact of the models:*
    - ✓ *Habitat condition similarity between 2100-RCP8.5 and 2016 was ~20%* (Habitat Representativeness Score);
    - ✓ *They were dissimilar independently of the ENMs;*
    - ✓ *Species richness change was consistent with this dissimilarity.*



Conclusions

Model:

- We have presented a spatially-explicit Bayesian model combining unsupervised (X-Means clustering) and supervised (MaxEnt) models;
- All data and scripts are openly accessible on Zenodo: https://zenodo.org/record/8380273
- They are also available in the ITINERIS Critical Zone Virtual Research Environment.
- The results are ready to be used in ecosystem models and spatial planners.

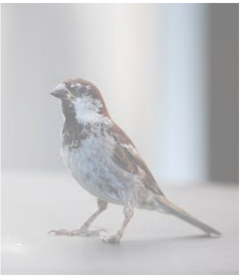
Results:

- There might have been benefits in the last 70 years to animal biodiversity. However, the expected drying of most of the basin, with heavy precipitation confined more and more to the mountain areas, would negatively affect species composition in the future (even under RCP4.5);
- Birds will likely be the most impacted group, with an extensive species-richness loss already foreseen for 2050;
- The insect group (22% of the total insects) will likely see habitat increase in the short- and long-term future;
- Terrestrial and water species will likely move towards water-richer and cooler areas, radically changing their presence in the basin;
- Generally, the species-groups trends do not exclude that some species representing a minor but very important percentage might go extinct because of future habitat unsuitability;
- We gave indication of the time frame of the risk (->2050) vs. current initiatives that aim to (slowly) guarantee water presence in the lake;
- The results agree with other studies* which have indicated general biodiversity and ecosystem service degradation, and eutrophication and drought. *Colombaroli et al. (2007), Giugliano et al. (2011), Colombini et al. (2013), Colombaroli et al. (2013), Bertacchi et al. (2015), Lastrucci et al. (2017).



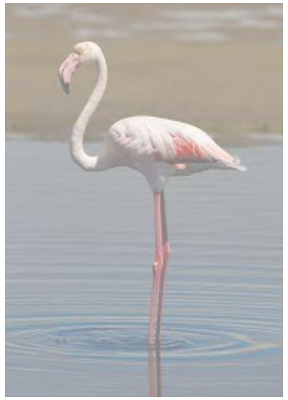







Thank you









For questions write to gianpaolo.coro@cnr.it

LifeWatch ERIC 2024 Thematic Service Workshop Series

Thank you for your attention!

Any questions?

Taxonomy | Brussels, Belgium, 30 January 2024

Climate Change Impact on Biodiversity Patterns | Lecce, Italy, 21-22 February 2024

Animal Movement and Biologging | Ostend, Belgium, 22 March 2024

Biogeography | Bologna, Italy, 4-5 April 2024

Biodiversity Observatory Automation | Ljubljana, Slovenia, 11 April 2024

Habitat Mapping | Aveiro, Portugal, 3 May 2024