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Séminaire du

plan national d'actions

en faveur du Puffin des Baléares

24 au 26 juin 2024

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MIGRATION AND MOULT STRATEGY IN CLOSELY RELATED TAXA:

A POPULATION STUDY OF BALEARIC AND YELKOUAN SHEARWATERS BASED ON STABLE ISOTOPE ANALYSIS

DE TENA, C., KAPELIJ, S., LOUZAO, M., ARCOS, JM., GARCIA, D., GRÉMILLET, D., FORT, J., PERÓN, C., AUSTAD, M., BARBARA, N., PORTOLOU, D., BACETTI, N., ZENATELLO, M., AUSTIN, R., GUILFORD, T., BOURGEOIS, K., GONZÁLEZ-SOLÍS, J., MILITÃO, T., KARRIS, G., XIROUCHAKIS, S., & RAMOS, R.

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Introduction

- Stable Isotope Analysis (SIA) can aid in complementing the insights provided by GLS → Only one sample of tissue.

- Feathers maintain the isotopic signal of resources used during their growth (Pérez et al., 2008).

- We provide a method based on $\delta^{13}C$ and $\delta^{15}N$ to characterize individual migratory patterns of shearwaters of genus *Puffinus.* A previous work of Militão et al., (2013) already provided a discriminant to infer non-breeding grounds.

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Objectives

- Verify wing moult.
- Improve the method and accuracy of assignation to infer the non-breeding areas of seabirds which its origin is unknown.
- Individuals that can’t be tracked.

Methods

STUDY AREA & SPECIES

- **Balearic shearwater** (*P. mauretanicus; Lowe, 1921*)
- **Yelkouan or Mediterranean shearwater** (*P. yelkouan*, *Acerbi, 1827*)

- Hybridation
- Divergence
- Area of occupancy

(Ferrer Obiol et al., 2023)

Jorge López Álvarez, eBird

british-garden-birds.com

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Methods

MOULT PHENOLOGY

- Moult period begins in July for the Yelkouan, a month later than its relative the Balearic shearwater (Militão et al., 2013; Meier et al., 2017).

Yelkouan. France, 20th July

Yelkouan. Istambul,15th August

Balearic. Portugal, 4th September

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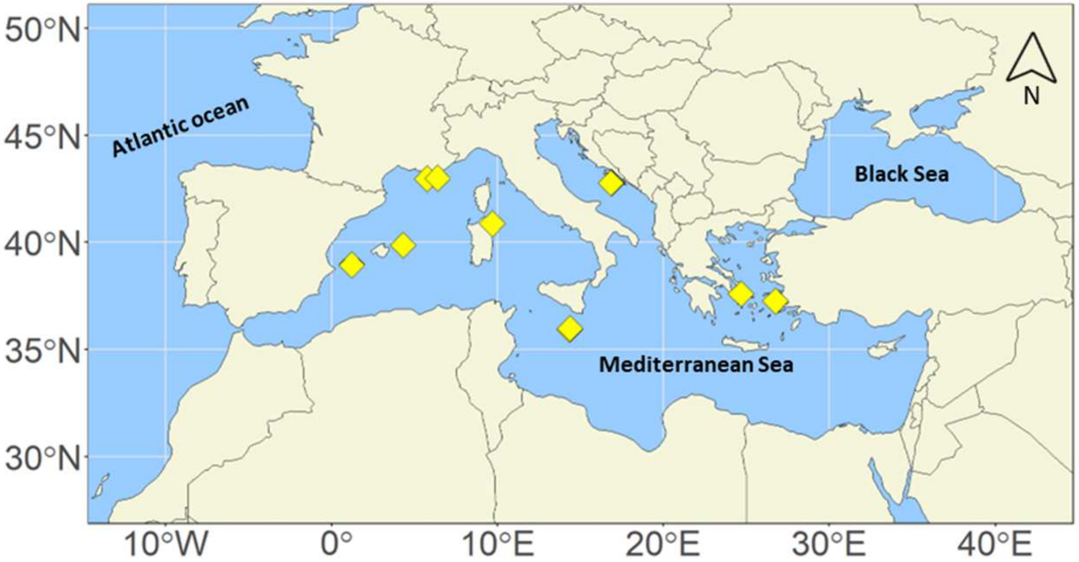
Methods

SAMPLING

- Light-level geolocators → Tracking data.
- P1-P3 sampled → Isotopic data.
- 10 breeding colonies.



- Moult series (P1,P3,P5,P7,P9) of 21 individuals from Minorca, Sardinia & Greece.
- By-catch animals from the Catalan coast.

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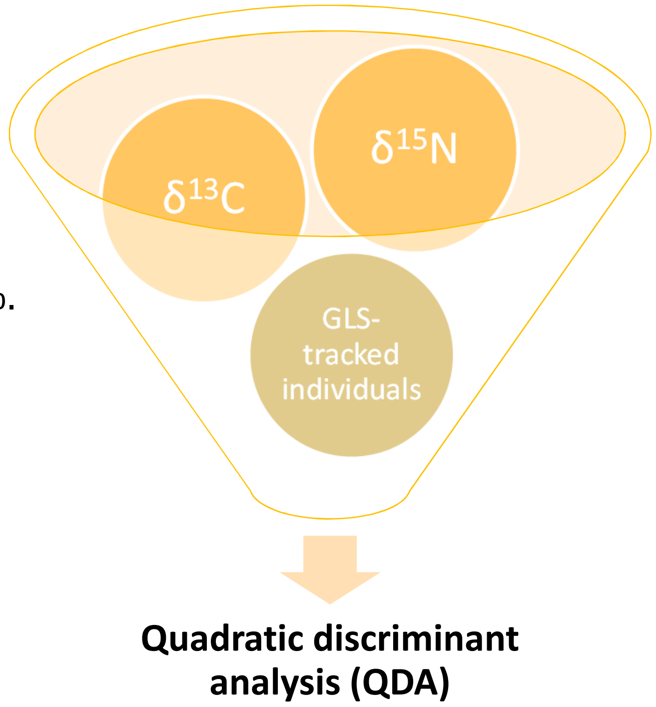
Methods

PROCESSING DATA

- **Isotopic signatures** of $\delta^{13}C$ & $\delta^{15}N$.
- **Distribution** of the individuals → estimated using Kernel 50%.
- Period efect ? → GLM.
- Quadratic discriminant analysis (Qin, 2018).



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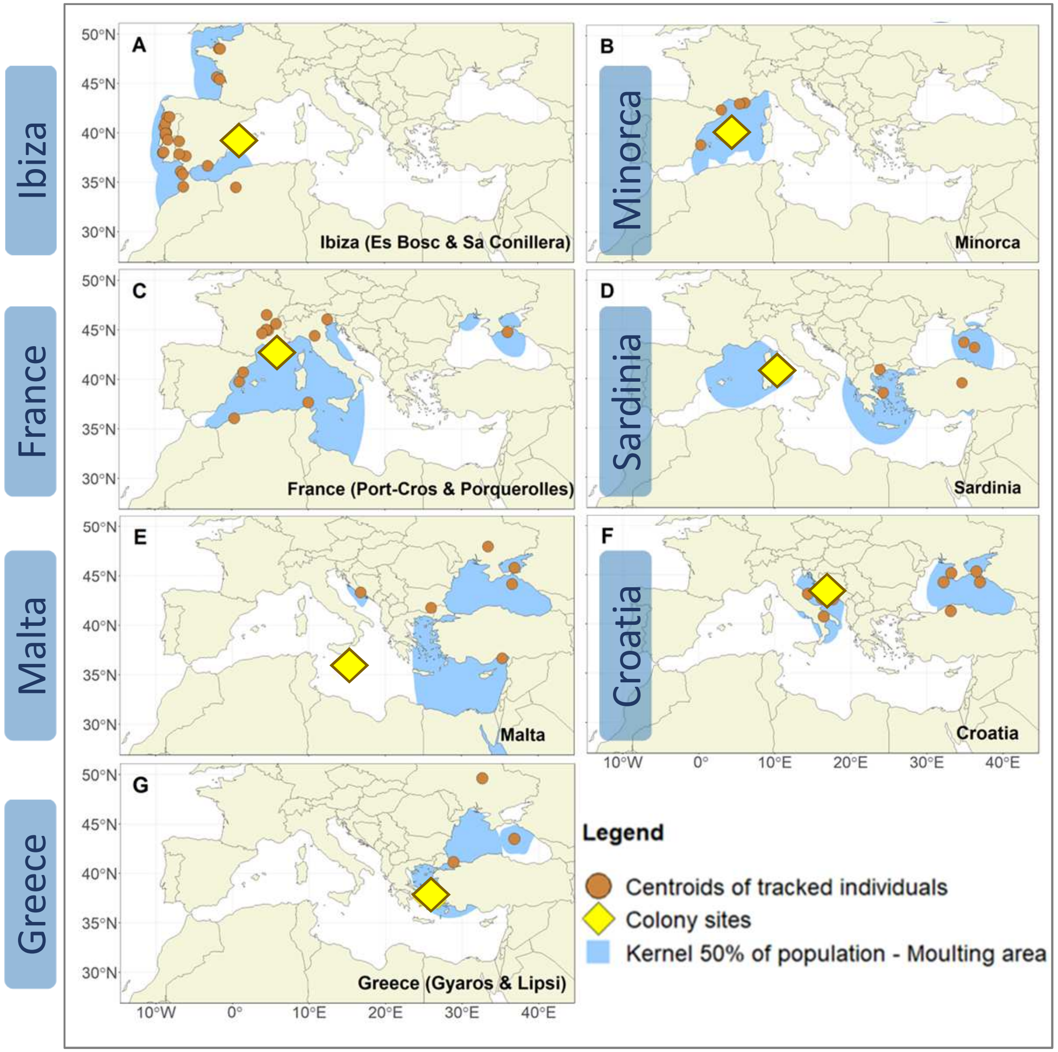
Results & discussion

MOULTING & WINTERING

- Primary feather moult of the species starts between July and **August**.

At individual level:

- Our three areas were assigned with baseline data.
- Identify moulting area → define the most probable wintering area.



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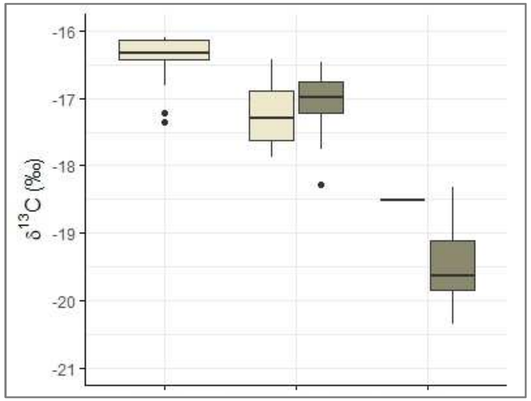
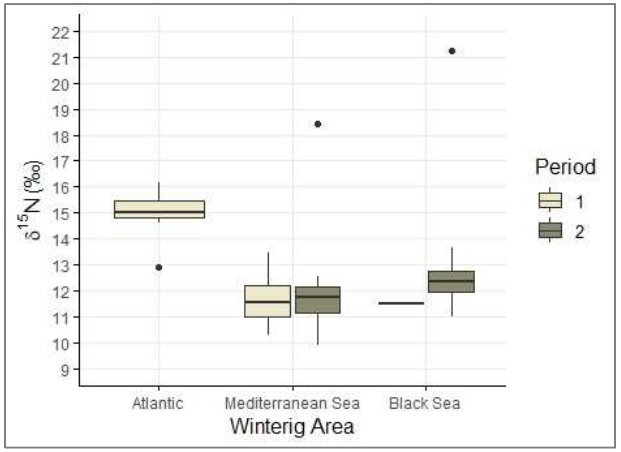
Results & discussion

EFFECTS OF THE SUBSAMPLING

- Two models selected by AICc.

Model ~ $\delta^{13}C$	df	AICc	ΔAICc	wAICc
(1) Moulting area	4	109.1	0.0	0.538
(4) Moulting area:Period	6	110.3	1.2	0.295
(3) Moulting area + Period	5	111.4	2.3	0.167
(2) Period	3	184.9	75.8	0.000
(5) Null	2	224.6	115.6	0.000
Model ~ $\delta^{15}N$				
(1) Moulting area	4	247.9	0.0	0.558
(3) Moulting area + Period	5	248.9	1.0	0.334
(4) Moulting area:Period	6	251.1	3.3	0.108
(5) Null	2	280.1	32.3	0.000
(2) Period	3	280.7	32.8	0.000





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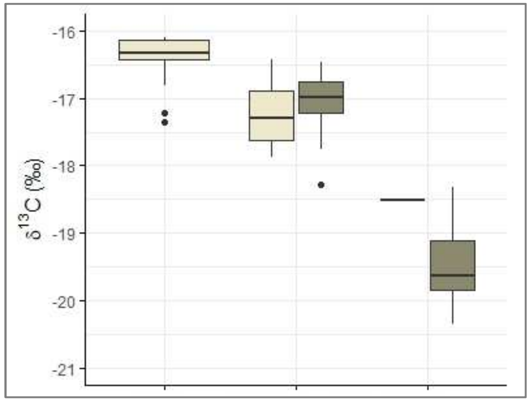
Results & discussion

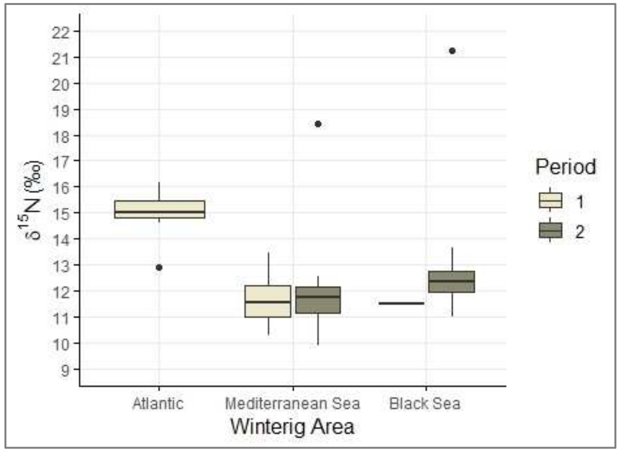
EFFECTS OF THE SUBSAMPLING

- Two models selected by AICc → Model averaging.

Model averaged $\delta^{13}C$	Estimate	Adjusted SE	Pr (>|z|)
Intercept	-16.19	0.12	<0.001
AreaBlackSea	-2.91	0.57	<0.001
AreaMediterraneanSea	-1.04	0.17	<0.001
Period21-22	0.05	0.15	0.752
Period21-22: AreaBlackSea	-0.39	0.64	0.542
Period21-22: AreaMediterraneanSea	0.00	0.00	0.00
Model averaged $\delta^{15}N$			
Intercept	15.07	0.37	<0.001
AreaBlackSea	-2.52	0.73	<0.001
AreaMediterraneanSea	-3.31	0.51	<0.001
Period21-22	0.26	0.52	0.612

- **Obviate** the period effect**.**





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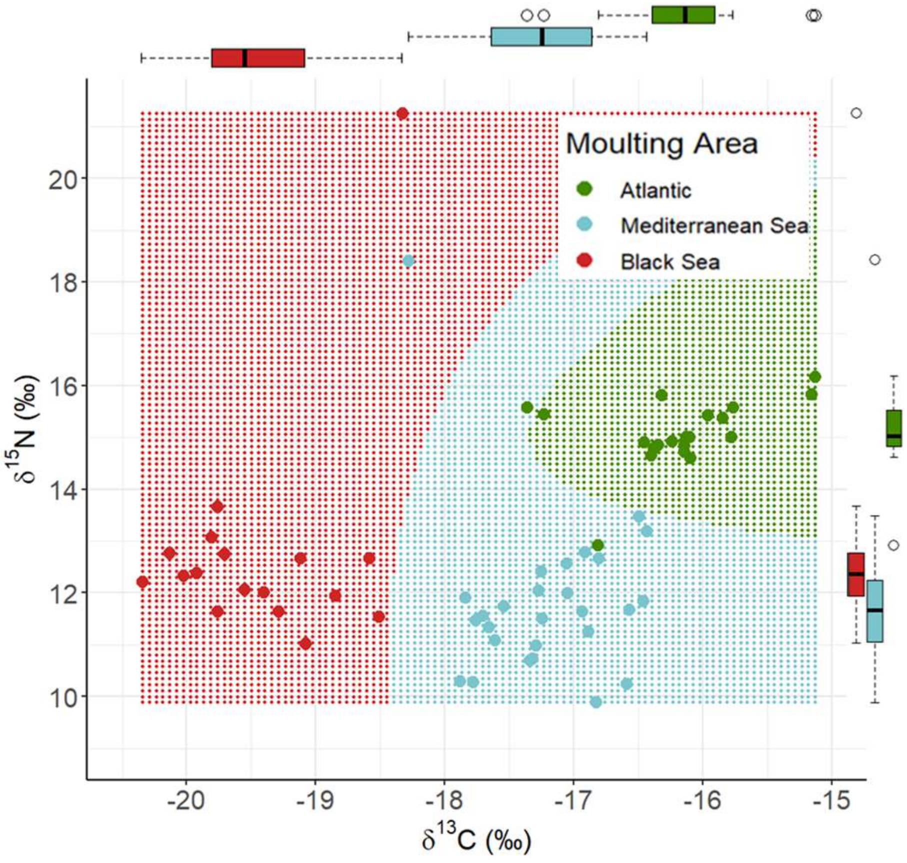
Results & discussion

DISCRIMINANT ANALYSIS AND ASIGNATION

- >91% accuracy.
- Decision boundary to assign the areas. N = 64 vs N= 7 (GLS+Feather).
- Three non-breedingareas are isotopically distinct (Militão et al., 2013).
- Diferenciated patterns between species.
- $\delta^{13}C$ → Atlantic and Mediterranean Sea ⇧
- $\delta^{15}N$ → Atlantic ⇧



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Results & discussion

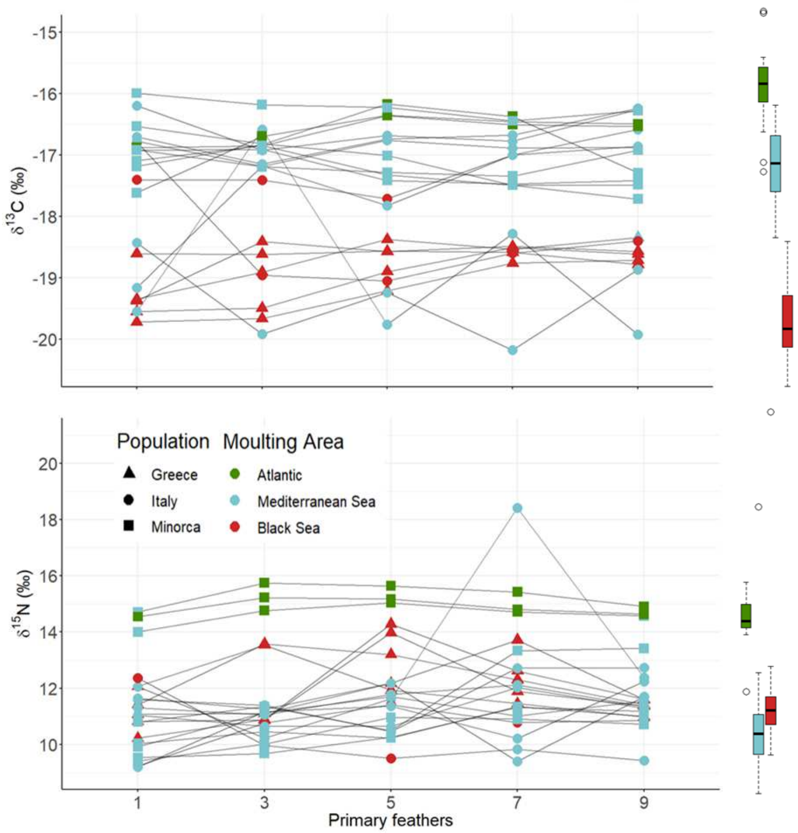
DISCRIMINANT ANALYSIS AND ASIGNATION

- 75% of the Yelkouan from Sardinia moult these feathers in the Mediterranean while 25% did it in the Black Sea.

- 100% of individuals from Greece moult in the Black Sea.

- Some individuals of Yelkouan shearwaters from Minorca spent the wintering period in the Atlantic as the Balearic shearwaters do.

- The outermost feathers show partial moults (Militão et al., 2013)
  ⇒ Moult after returning the non-breeding area.



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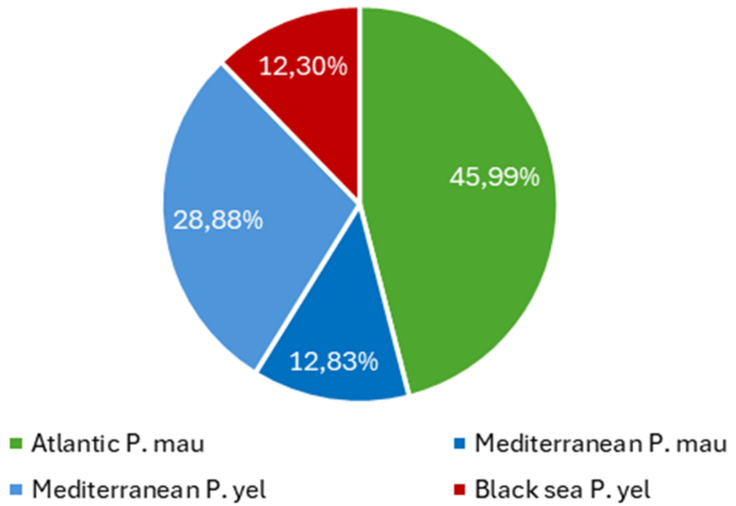
Results & discussion

DISCRIMINANT ANALYSIS AND ASIGNATION

- 42% of the birds were Mediterranean Sea residents.

- Balearic shearwaters are more than 50% of the by-catch animals in Spanish waters.

- Yelkouan migrating to the Black sea could be French or Italian shearwaters feeding in the Catalan coasts.



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Conclusions

- Same area to moult all the primary feathers ⇒ Only a piece of one feather is needed to infer the moulting area. **Single capture, less cost.**

- Differentiated migratory strategies:

  Minorca → Behaves as hybrid population (Austin et al., 2019), exhibited an intermediate behaviour between the two taxa. Migration to the **Atlantic** and Mediterranean Sea.

  France → Supports longitudinal gradient hypothesis related to the chain migration strategy.

- For species that are unable to carry a GPS or a GLS and to define Conservation Units.

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