

ABUNDANCE AND DISTRIBUTION OF THE BLUE SHARK IN THE BAY OF BISCAY

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With all our thanks to the observers

Cécile Dars, Sophie Laran, Olivier van Canneyt, Ghislain Dorémus, Jérôme Spitz, Paula Mendez Fernandez, Eléonore Meheust, Arianche Blanchard, Vincent Ridoux, Thierry Sanchez

AN OBSERVATION PROTOCOL

Transect sampling data were collected from an airplane, flying at 180 km/h at an altitude of 200 m, in the Bay of Biscay, of La Rochelle in France.

Four sessions took place in 2019 :

1 Winter	12/02 - 27/02	0 sharks observed
2 Spring	30/05 - 02/06	80 sharks
3 Summer	31/07 - 08/08	16 sharks
4 Fall	25/10 - 19/11	0 sharks



PRIONACE GLAUCA

IUCN status
Near threatened

Distribution
All the seas of the world, except the polar zones

Behaviour
Generally alone, except during migrations

Length
2.5 to 3 meters

INFLUENCED BY ENVIRONMENTAL CONDITIONS

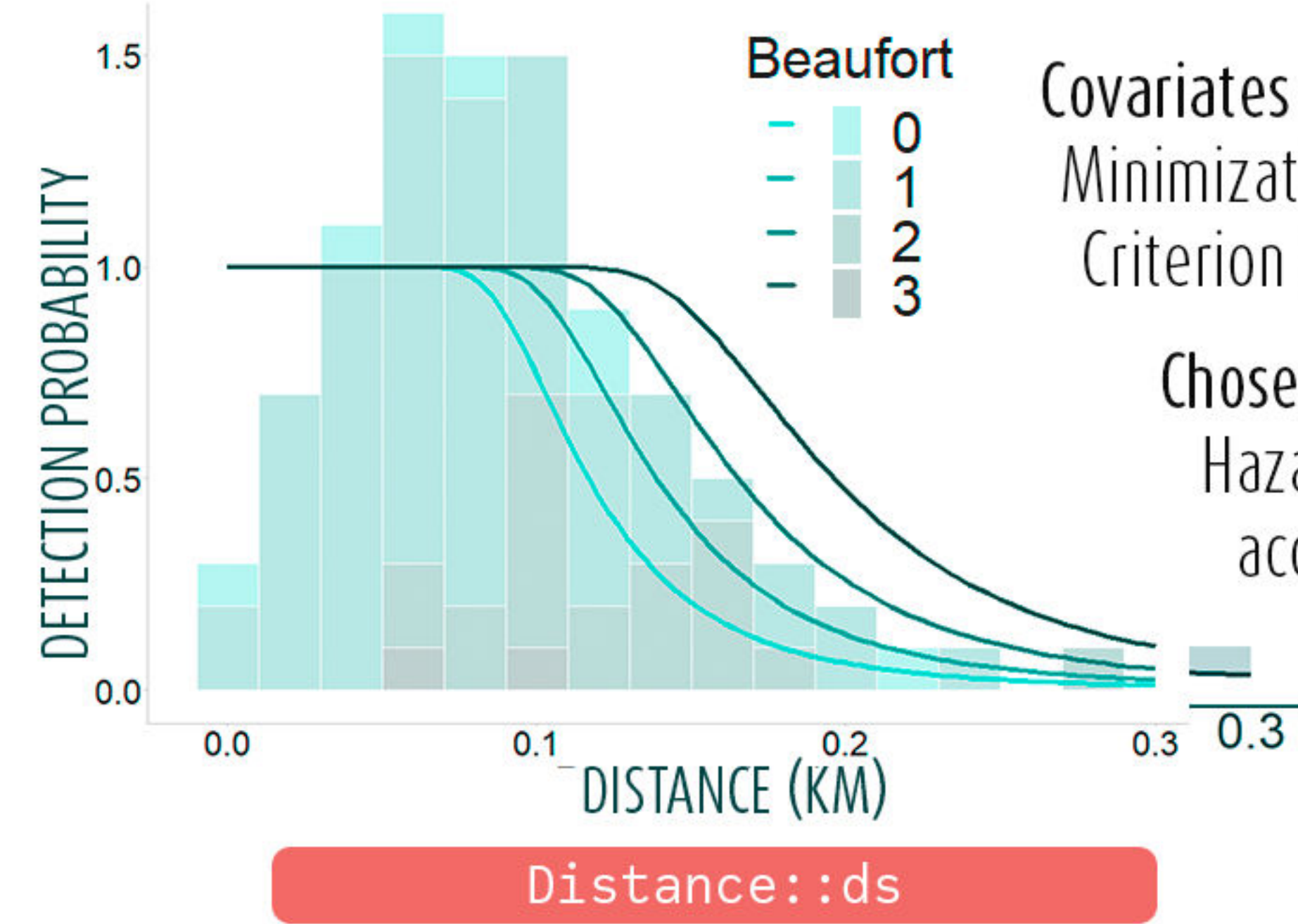
1. Detection covariates
Beaufort (sea state) and observer

2. Density covariates
Location (X and Y coordinates) | Distance to the coast
Distance to the continental slope | Depth
Chlorophyll A concentration*
Sea surface temperature (SST)*
Organic particles concentration*

* Mean and standard deviation from 4 weeks before each session

WITH AN IMPERFECT DETECTION

Probability of detection of a shark, depending on the distance to transect and detection covariates.



Covariates and key function selection
Minimization of Akaike Information Criterion (AIC)

Chosen model
Hazard-rate key function taking into account the beaufort (sea state)

TO ESTIMATE A DENSITY OF SHARKS

Ajustment of a generalized additive model (GAM) to estimate shark density, from the observations and covariates.

Selection of density covariates
Forward selection, minimizing the Akaike Information Criterion (AIC)

Availability bias
= percentage of sharks potentially visibles
1 | 0.41¹ | depending on the continental shelf(on-shelf/off-shelf)¹

Chosen model
Abundance ~ s(mean SST) + s(X, Y) + s(mean chlorophyll A)
Distribution: negative binomial

dsm::dsm

ABUNDANCE AND DISTRIBUTION AREA OF BLUE SHARKS DEPENDING ON SEASON

The estimation was made from density covariates selected in the generalized additive model, associated to a grid of 2x2 km cells.

dsm::predict.dsm

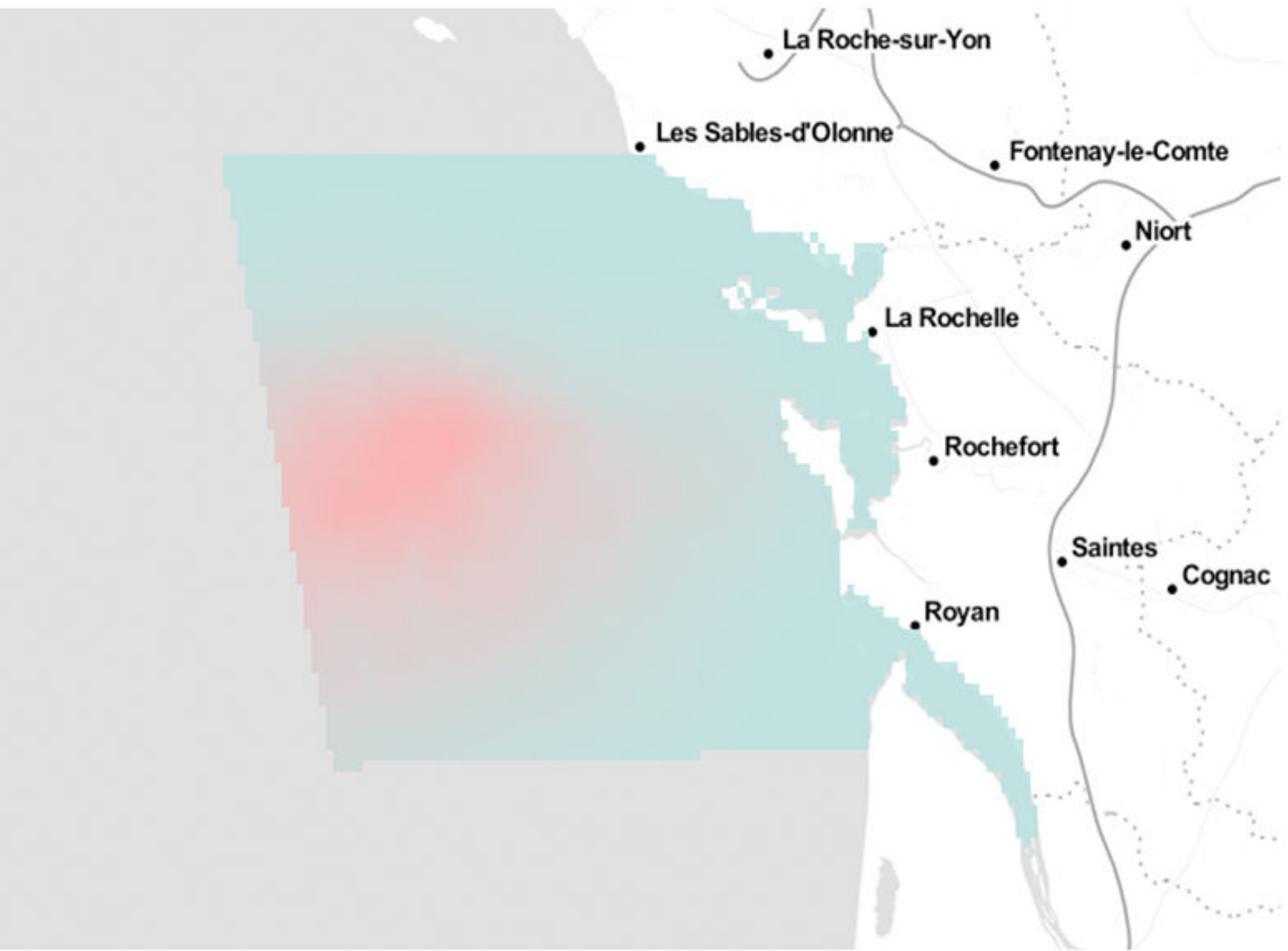
SPRING

AVAILABILITY BIAS

1
0.41
on-shelf/off-shelf

ESTIMATED ABUNDANCE IN THE AREA

4386 sharks ± 1463
10507 sharks ± 4182
6848 sharks ± 2480



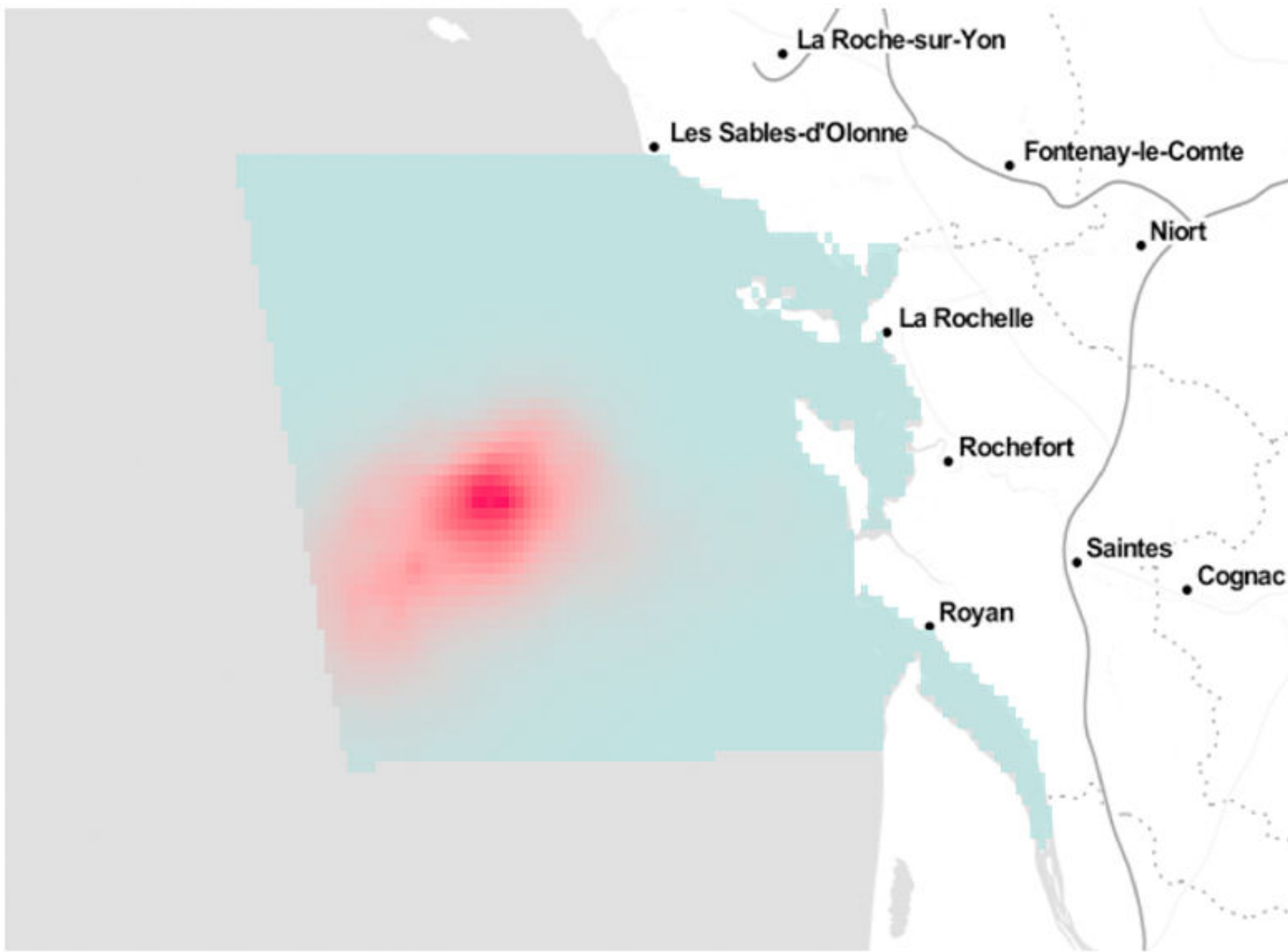
SUMMER

AVAILABILITY BIAS

1
0.41
on-shelf/off-shelf

ESTIMATED ABUNDANCE IN THE AREA

1456 sharks ± 1125
3508 sharks ± 3378
2257 sharks ± 1965



CONCLUSION

- › Shark observation depends on sea state
- › Shark presence depends on sea surface temperature, chlorophyll A concentration and location
- › Seasons : no sharks in winter nor fall. Possible impact of seasons on the presence of sharks on the surface and/or on migrations
- › Sharks more abundant in spring, more concentrated area in summer
- › Availability bias : impact on the estimated abundance, but not on the distribution area

¹ Nykänen M, Jessopp M, Doyle TK, et al. (2018) Using tagging data and aerial surveys to incorporate availability bias in the abundance estimation of blue sharks (Prionace glauca). PLOS ONE 13(9): e0203122. <https://doi.org/10.1371/journal.pone.0203122>