

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

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With all our thanks to the observers

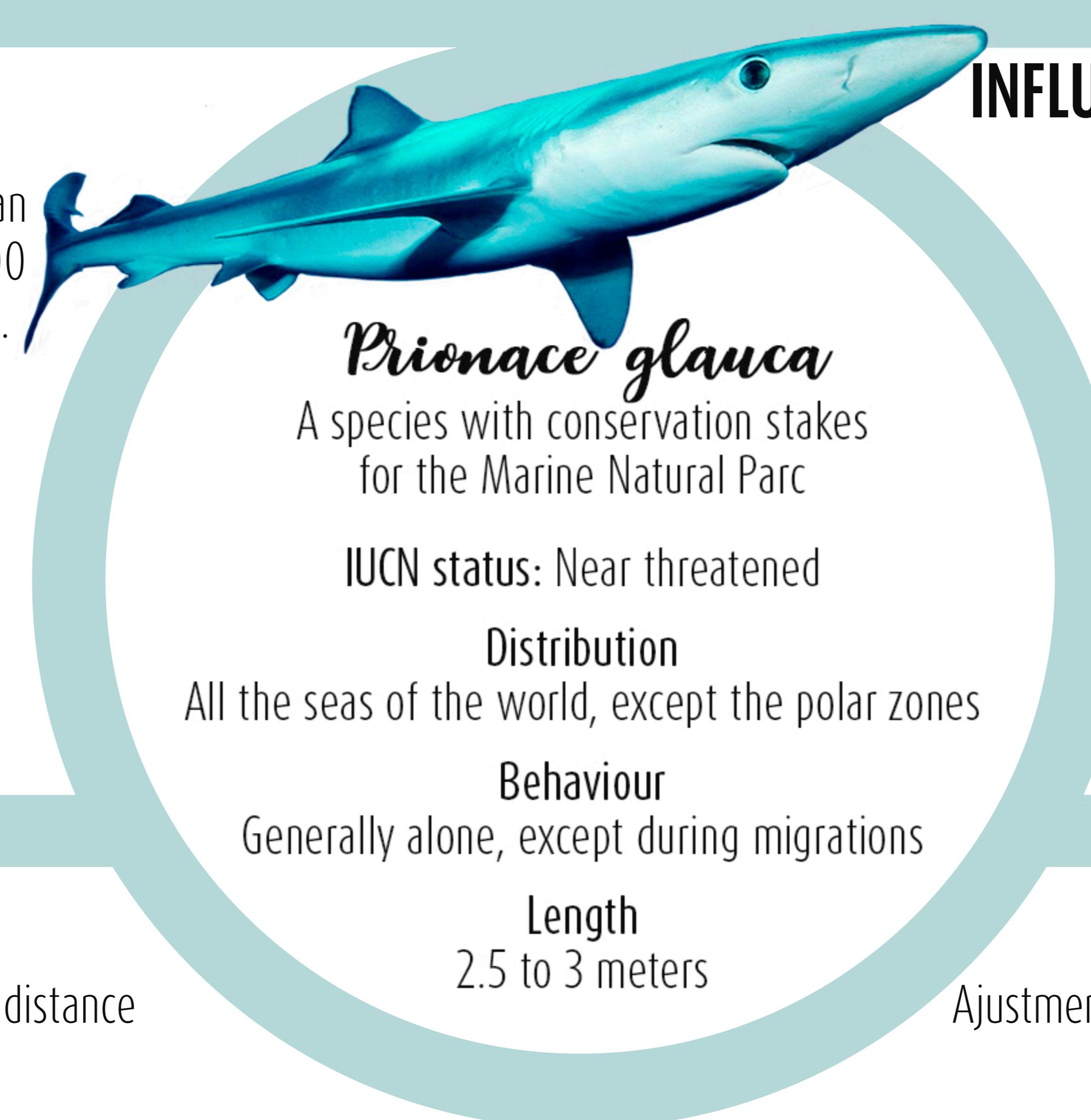
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AN OBSERVATION PROTOCOL

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



INFLUENCED BY ENVIRONMENTAL CONDITIONS

1. Detection covariates
Beaufort (sea state) and observer

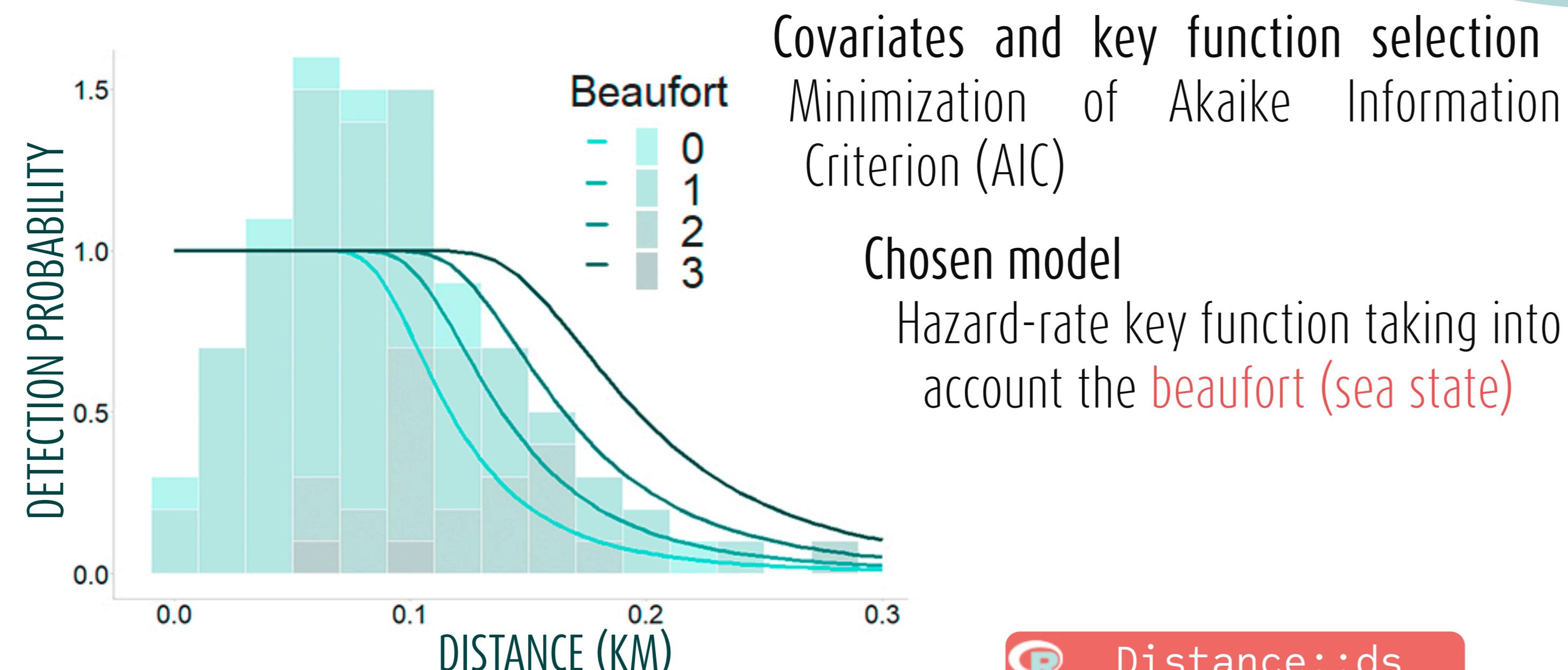
2. Density covariates

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.



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 ± 0.41^1 | depending on the continental shelf(on-shelf/off-shelf)¹

Chosen model
 $\text{Abundance} \sim s(\text{mean SST}) + s(X, Y) + s(\text{mean chlorophyll A})$
Distribution: negative binomial

dsm::dsm

ABUNDANCE AND DISTRIBUTION AREA OF BLUE SHARKS DEPENDING ON SEASON

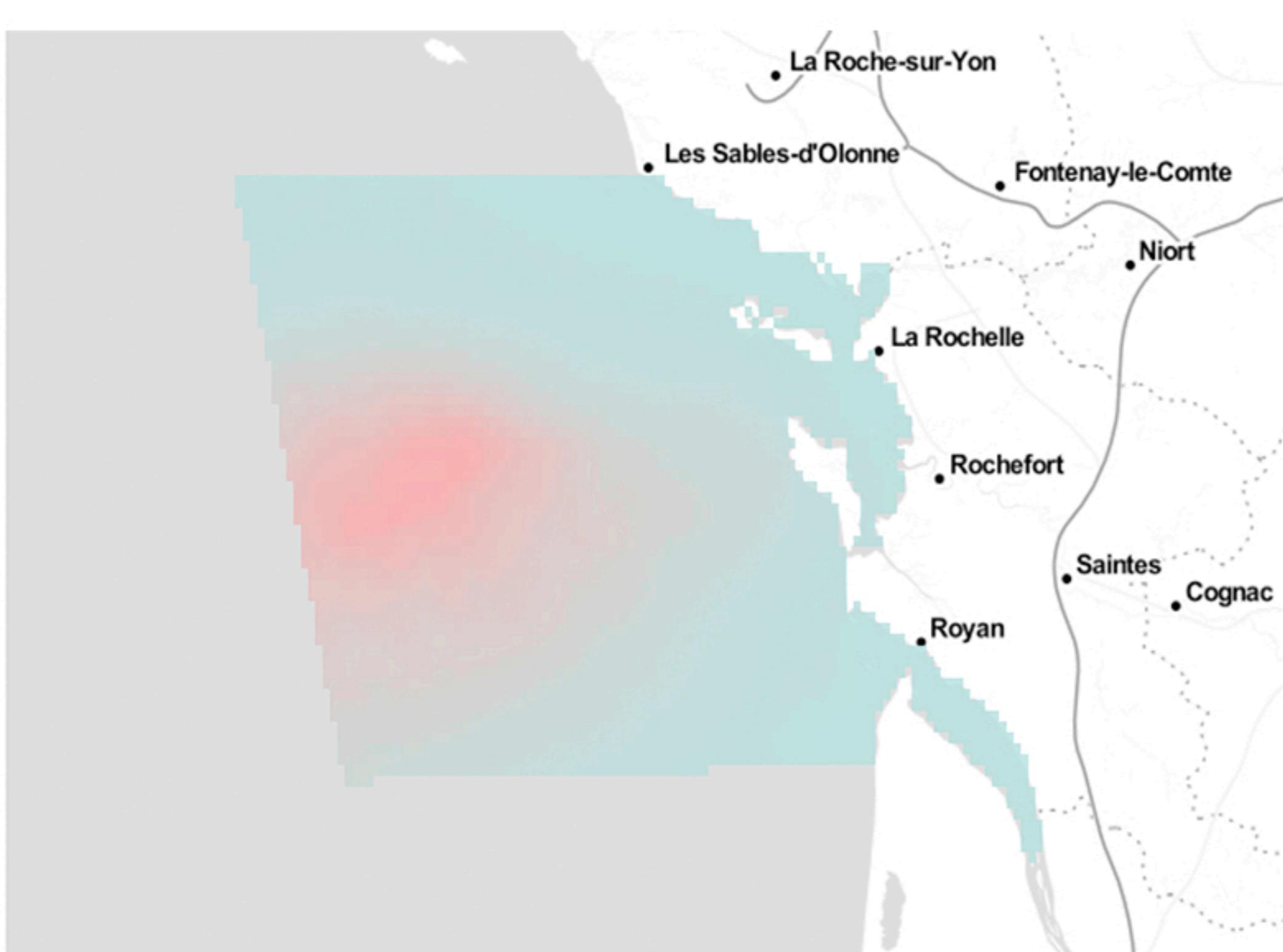
The estimation was made from density covariates selected in the generalized additive model, associated to a grid of 2x2 km cells.

dsm::predict.dsm

SPRING

AVAILABILITY BIAS ESTIMATED ABUNDANCE IN THE AREA

1	4386 sharks \pm 1463
0.41	10507 sharks \pm 4182
on-shelf/off-shelf	6848 sharks \pm 2480



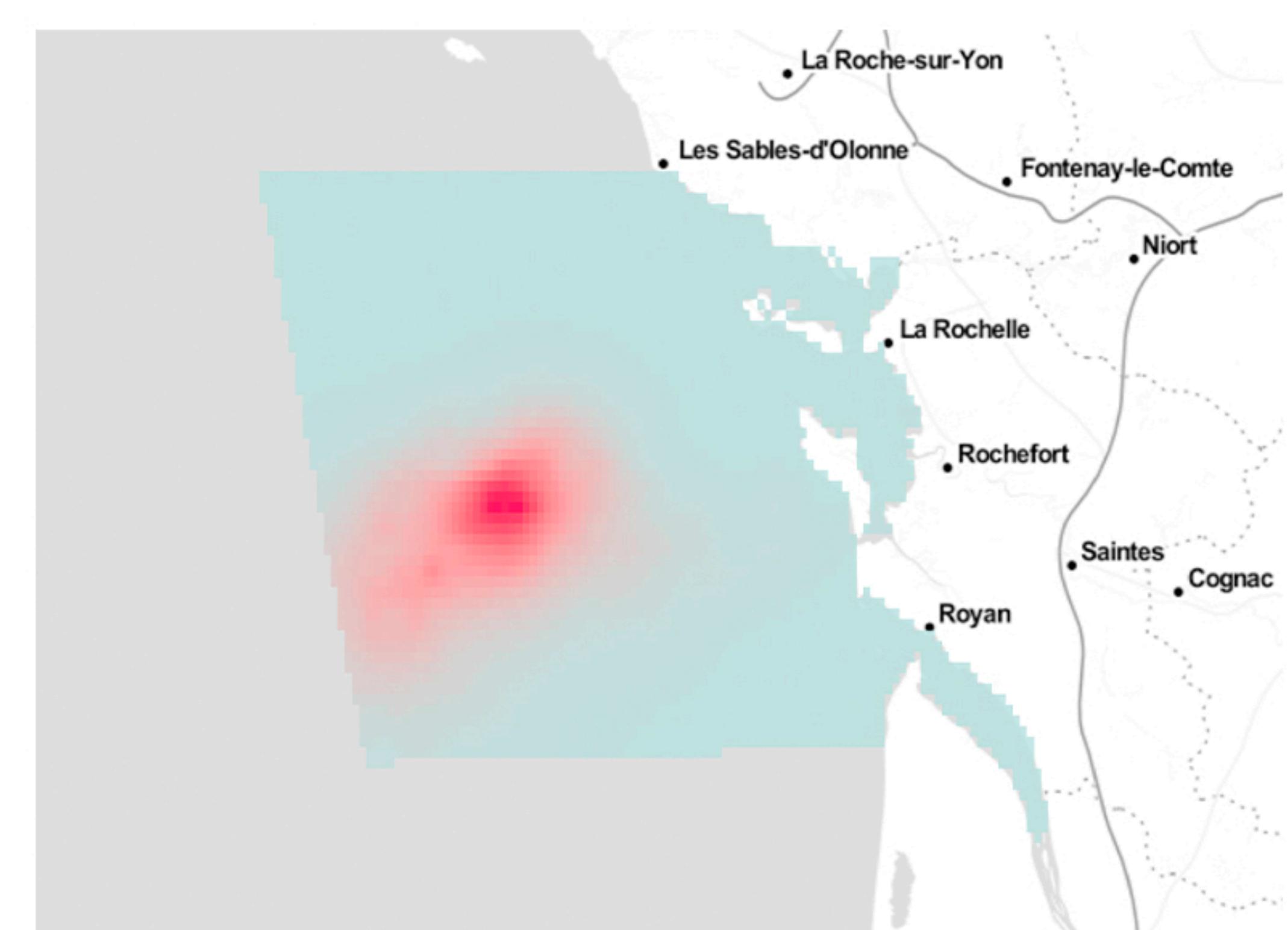
% de requins de la zone par cellule ($\text{de } 4 \text{ km}^2$)

0.35 %
0.28 %
0.21 %
0.14 %
0.07 %
0.00 %

SUMMER

BIAIS DE DISPOBILITÉ ABONDANCE ESTIMÉE DANS LA ZONE

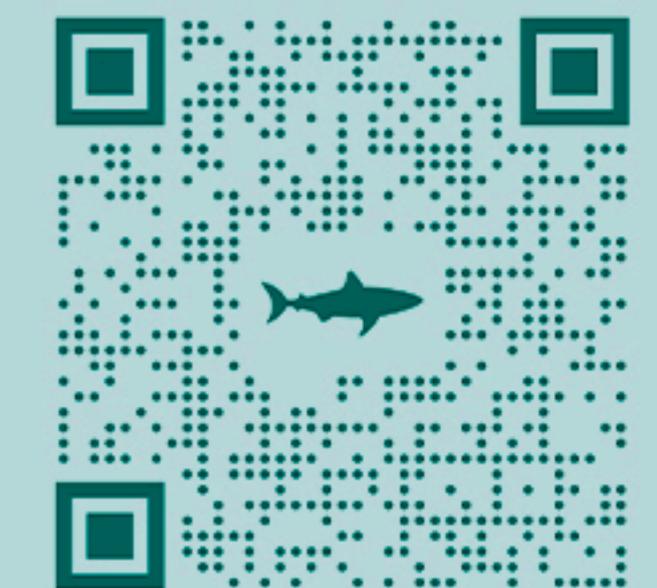
1	1456 requins \pm 1125
0.41	3508 requins \pm 3378
on-shelf/off-shelf	2257 requins \pm 1965



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

MORE INFO'S



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