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

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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

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

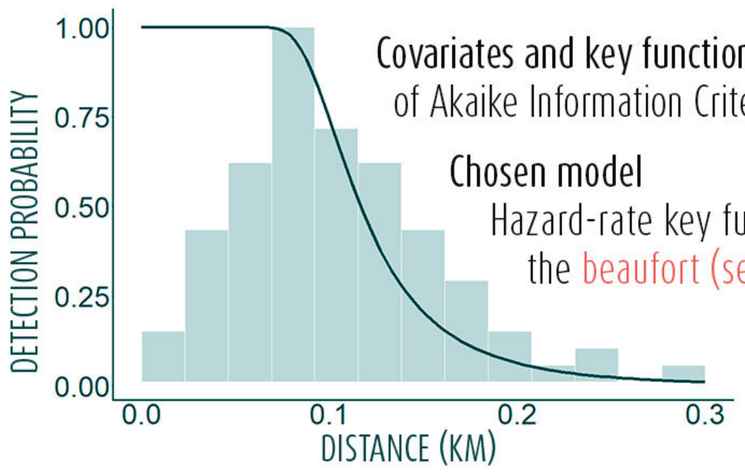
1. Detection covariates
Beaufort (sea state) and observer

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)

`Distance::ds`

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

`dsm::dsm`

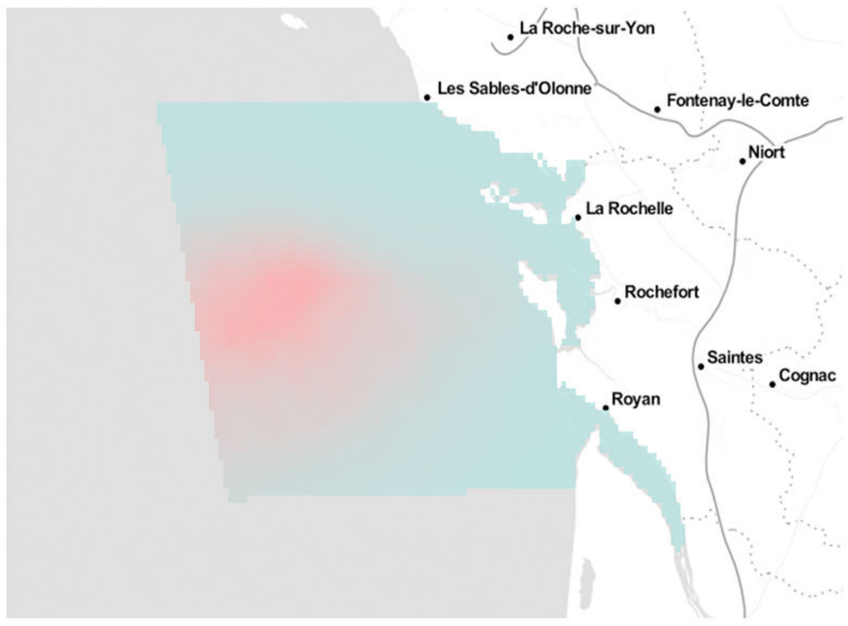
ABUNDANCE AND DISTRIBUTION AREA OF BLUE SHARKS DEPENDING ON SEASON

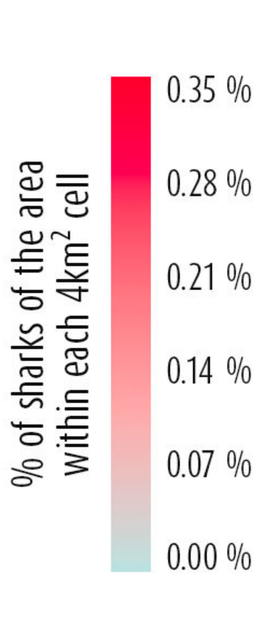
The estimation was made from density covariates selected in the generalized additive model, associated to a grid of 2×2 km cells.

`dsm::predict.dsm`

SPRING

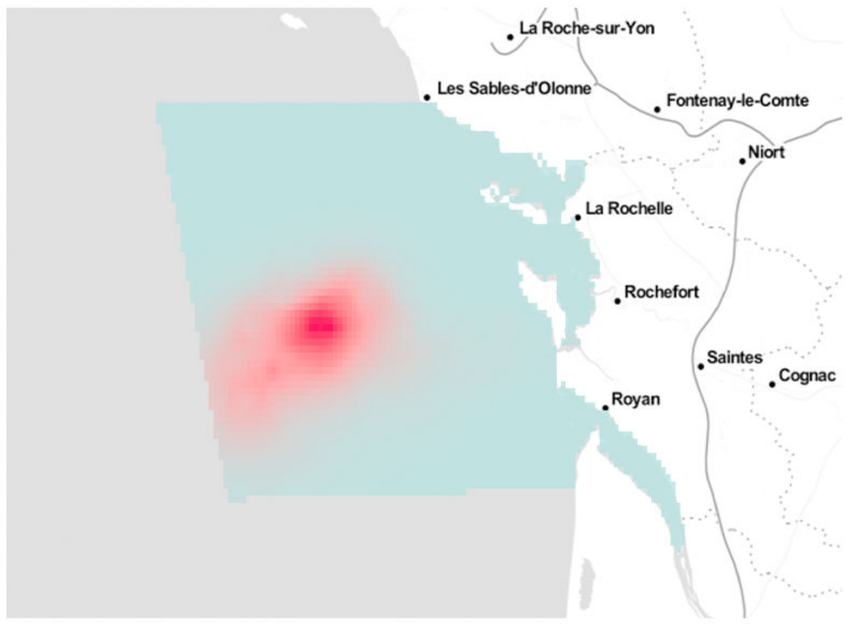
AVAILABILITY BIAS	ESTIMATED ABUNDANCE IN THE AREA
1	4386 sharks ± 1463
0.41	10507 sharks ± 4182
on-shelf/off-shelf	6848 sharks ± 2480





SUMMER

AVAILABILITY BIAS	ESTIMATED ABUNDANCE IN THE AREA
1	1456 sharks ± 1125
0.41	3508 sharks ± 3378
on-shelf/off-shelf	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