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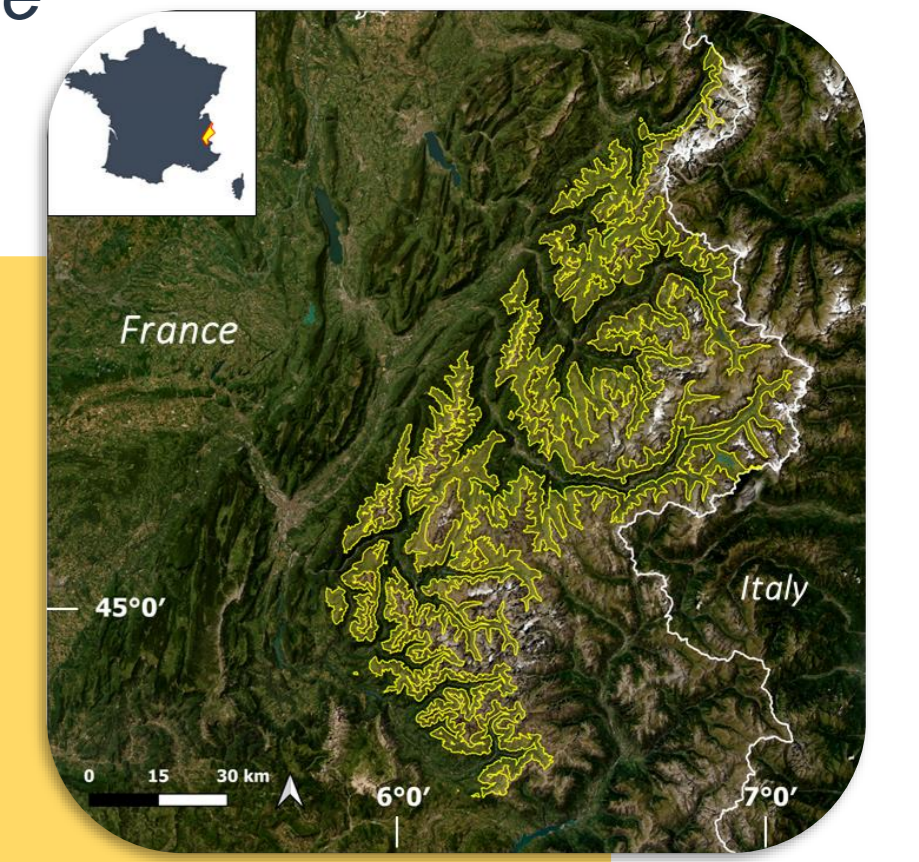
# Comprehensive regional assessment of brood habitat suitability for Alpine black grouse (*Lyrurus tetrix*)

Samuel ALLEAUME<sup>1</sup>, Alexandre DEFOSSEZ<sup>1</sup>, Marc MONTADERT<sup>2</sup>, Dino IENCO<sup>1</sup>, Nadia GUIFFANT<sup>1</sup>, Sandra LUQUE<sup>1</sup>

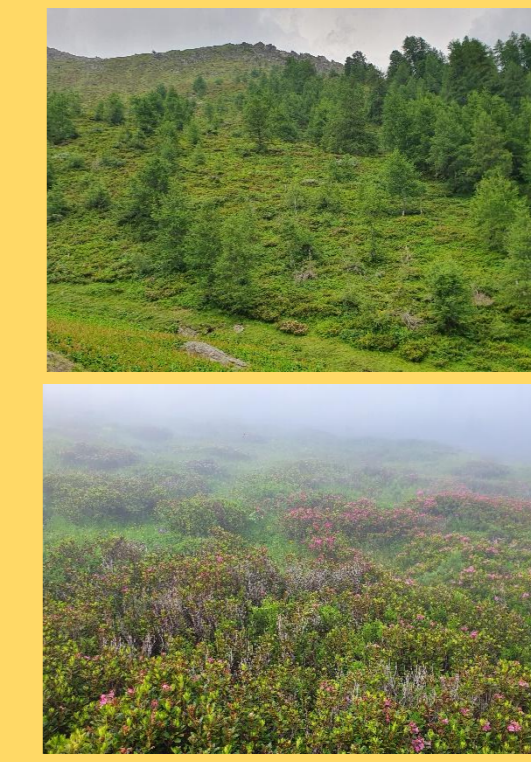
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Bertrand Nuffré-Joly OFB



• Priority area: Northern Inner Alps (7660 km<sup>2</sup>)  
• Altitudinal range: 1600-2400m  
• Studied year: 2020



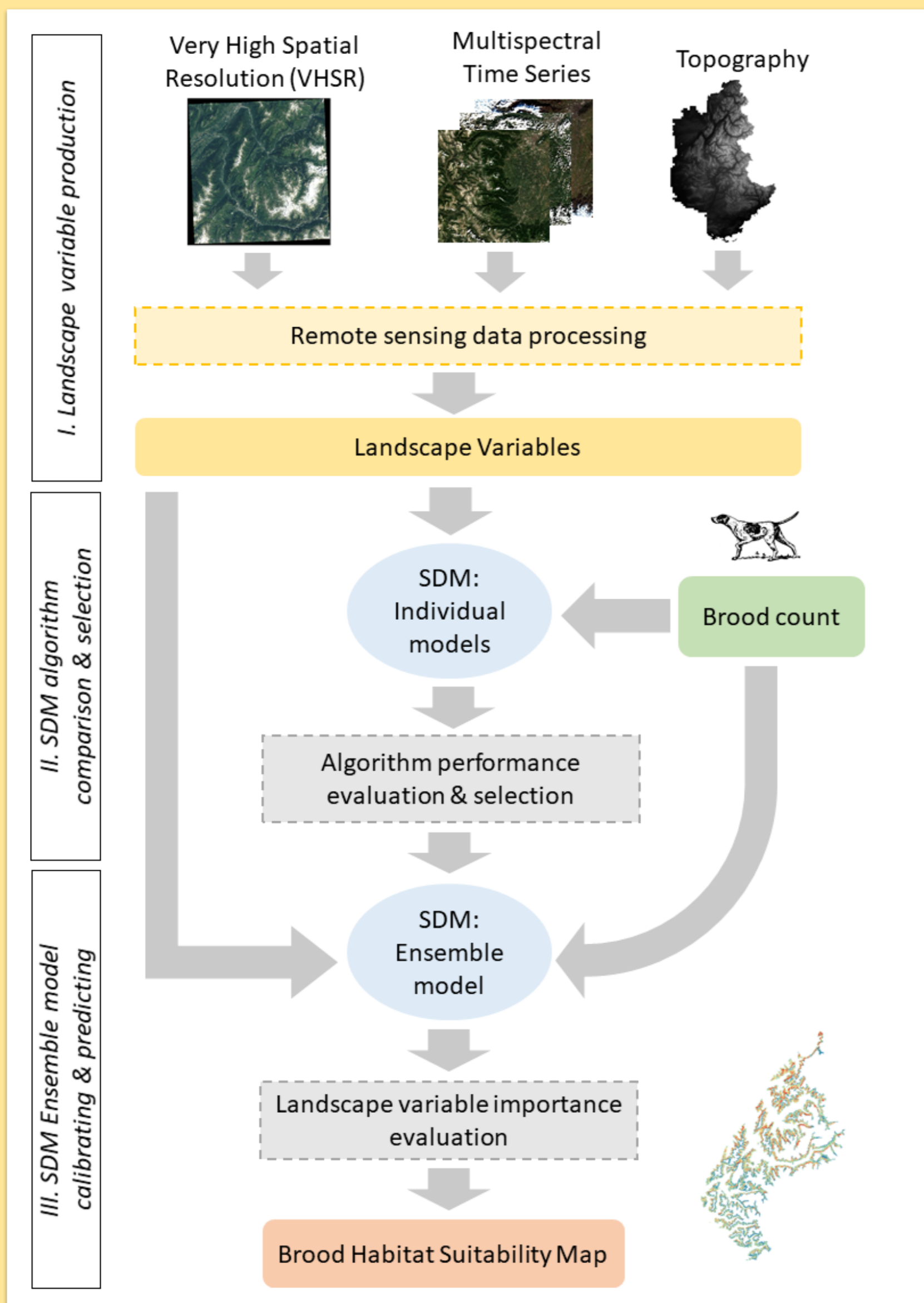
## Objectives

- Improving for knowledge of habitat suitability of black grouse breeding
- Combining Remote Sensing (RS) and modelling to map potential breeding habitat at the scale of the French Alps

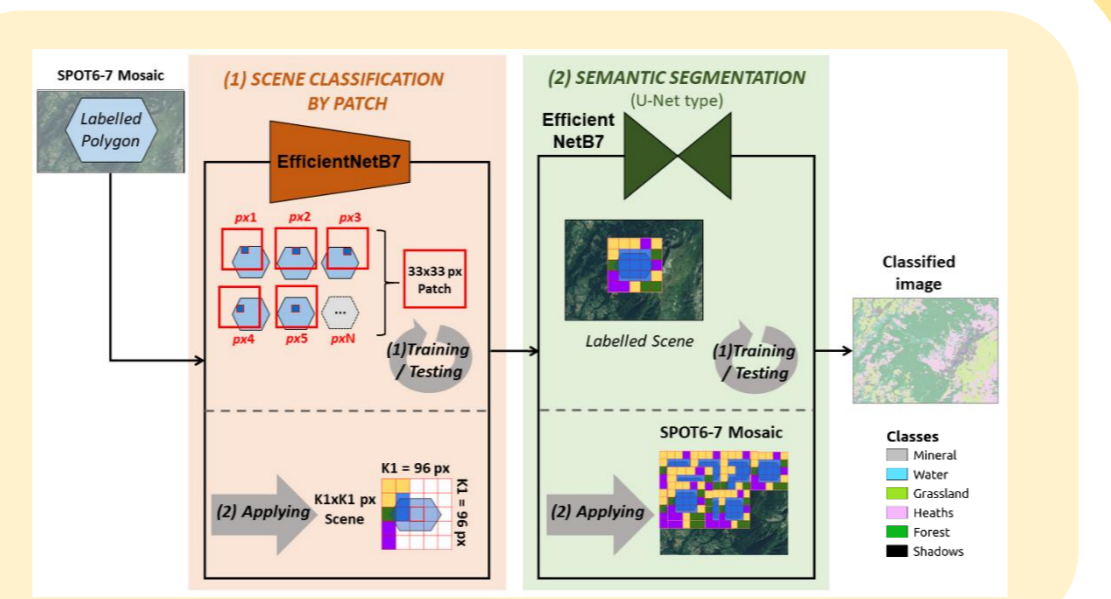
## Context

- Vulnerable species at regional scale:**
  - Main threats: degradation of environments,
  - Habitat closure, tourist infrastructures
  - Hunting management (quotas)
  - Model species revealing evolutions of subalpine environments
- Food availability is one of the main drivers for habitat suitability:**
  - Winter: wooded area (pine needles, buds...)
  - Summer: importance of ericaceous heaths (berries, flowers, young shoots...)

## Method



### Deep Learning vegetation strata classification



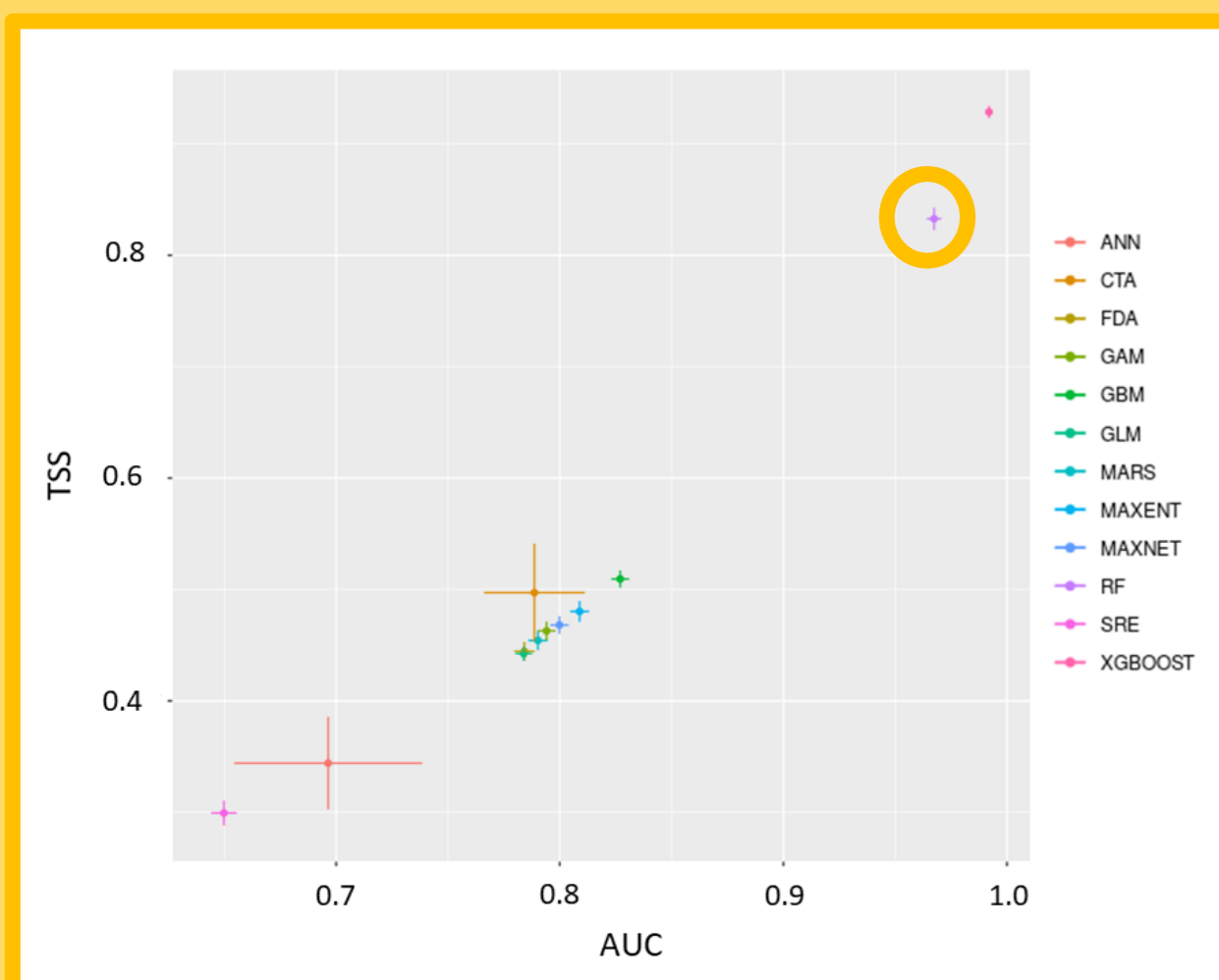
### Species Distribution Model (SDM) using biomod2 (R library)

- Cross-validation: 2 runs with random allocation of 80% training / 20% testing
- 10 sets of 4359 pseudo-absences (3 x number of observations) from a pool of 43590 random PA

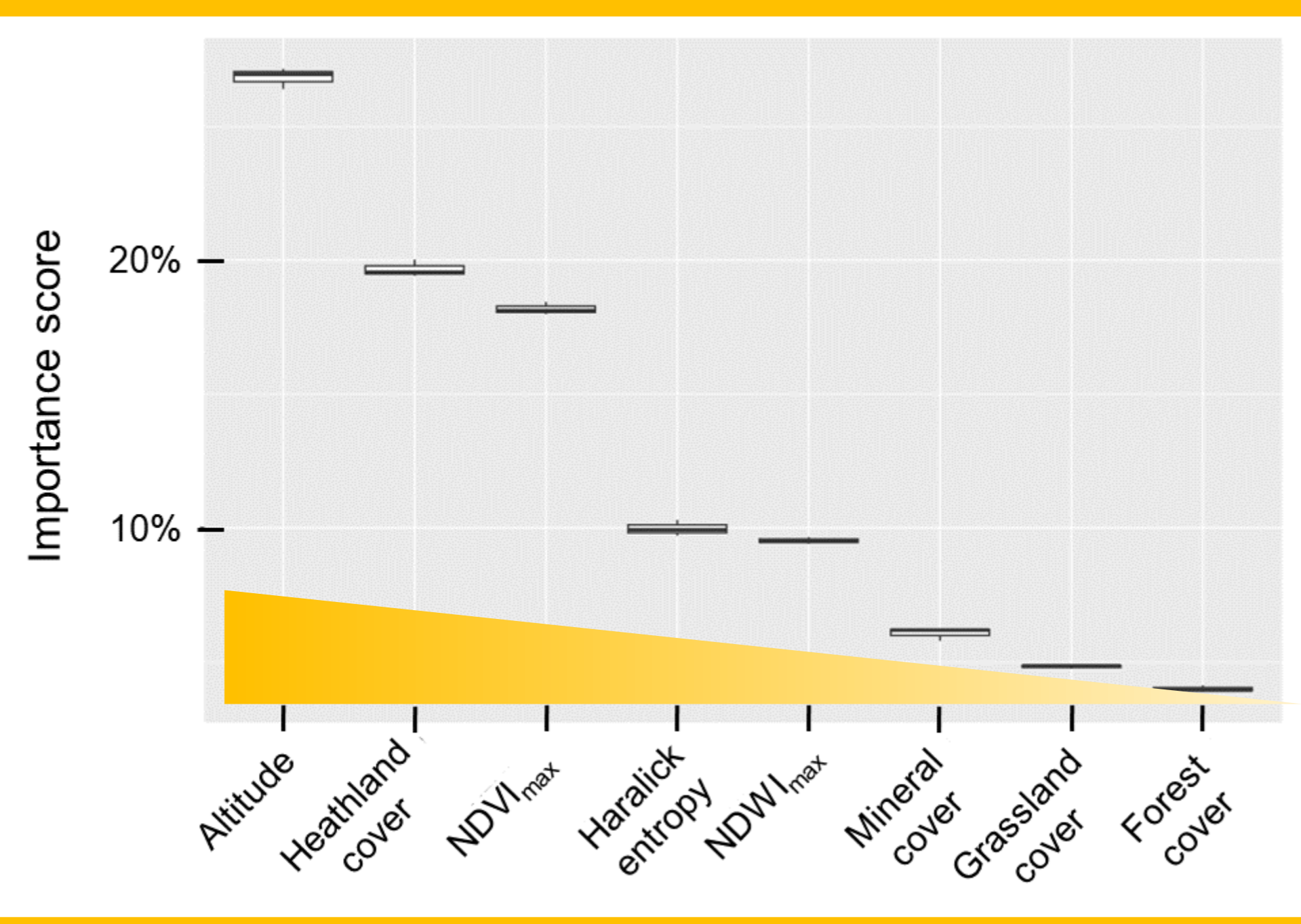
Landscape dimension	Landscape variable	Description	Processing	Type of source images	Source
Composition	Mineral_Rate	Mineral surface rate per 100m <sup>2</sup>	DL classification	Very High Spatial Resolution	SPOT 6&7
	Grassland_Rate	Grassland surface rate per 100m <sup>2</sup>	DL classification	Very High Spatial Resolution	SPOT 6&7
	Heath_Rate	Ericaceous heath surface rate per 100m <sup>2</sup>	DL classification	Very High Spatial Resolution	SPOT 6&7
	Forest_Rate	Forest surface rate per 100m <sup>2</sup>	DL classification	Very High Spatial Resolution	SPOT 6&7
Structure	Entropy	Haralick Entropy	Texture analysis	Very High Spatial Resolution	SPOT 6&7
	Altitude	Altitude (m)	DEM	Airborne LIDAR / Aerial photography	IGN database
Functioning	NDVI <sub>max</sub>	Maximum annual NDVI (DHI)	Time series analysis	Multispectral	Temporal series Sentinel 2
	NDWI <sub>max</sub>	Maximum annual NDWI (DHI)	Time series analysis	Multispectral	Temporal series Sentinel 2

## Results

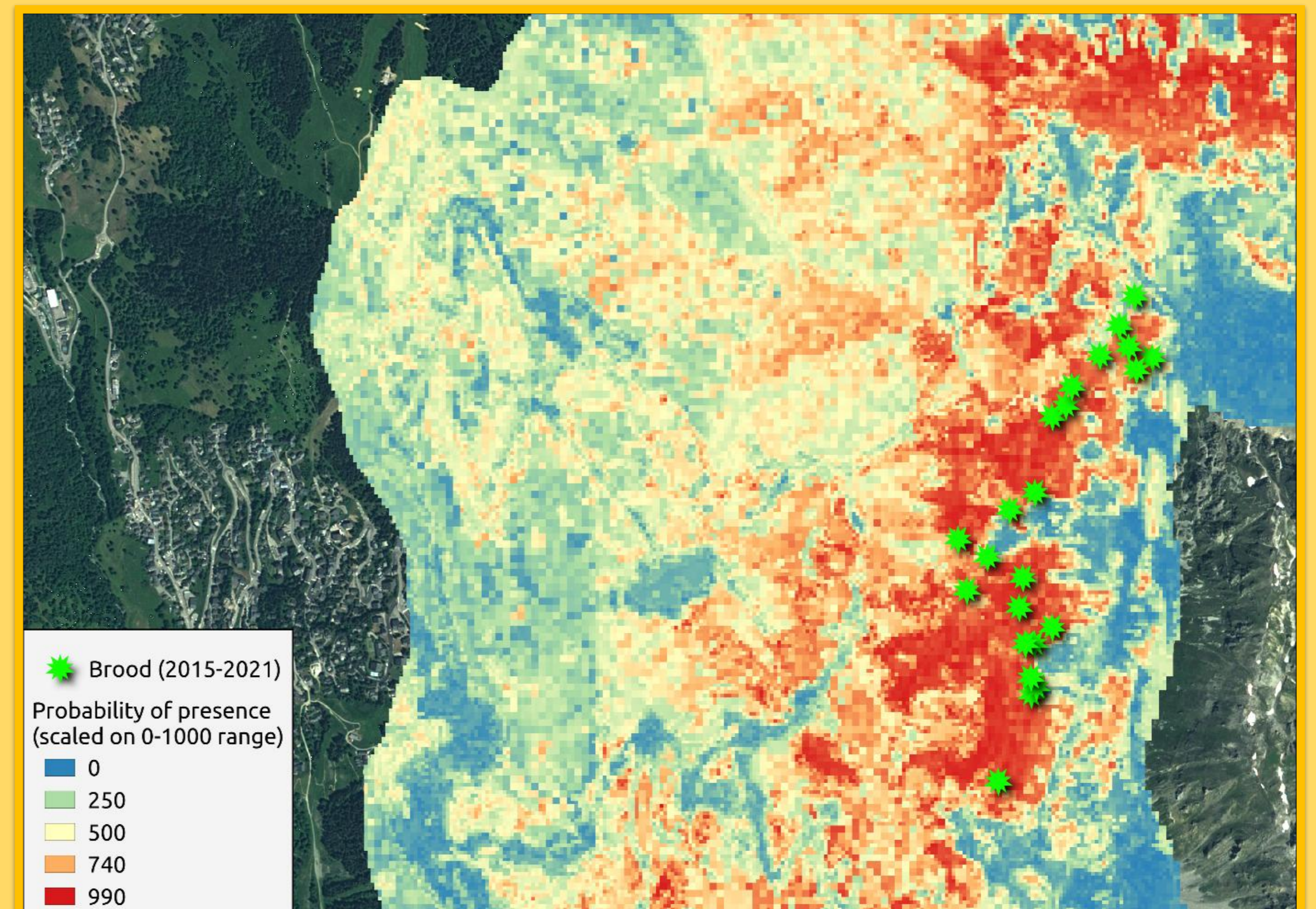
### Models performances scores



Random Forest was selected: high performance, low susceptibility to overfitting



Relative importance of the landscape variables after RF over an ensemble model (New run with updated number of PA: 3 sets of 1453 random PA (number of PA = number of observations))



Distribution map is coherent with known hot spots of black grouse broods

## Conclusion

- Three landscape dimensions (composition, structure, functioning) are essential to characterising species habitat
- RS data combined with modelling is well suited to mapping the potential presence of black grouse broods
- Ericaceous heath rate is one of the main variables explaining the distribution of broods in the French Alps, confirming the importance of these vegetation layers in describing the breeding habitat of black grouse
- NDVI<sub>max</sub> and NDWI<sub>max</sub> could be spatially (and temporally) related to a peak in food abundance or quality, which is known to be one of the main determinants of female selection of brood-rearing habitat, with suitable vegetation cover
- Altitude is an important factor: likely influence of the presence of the upper tree line and transition zones between forest and grassland

## Perspective

- Extend to other Bioclimatic Regions: Northern pre-Alps, Southern Alps
- Test other variables derived of DEM (e.g. total insolation)
- Refine vegetation layers: e.g. include "medium" heaths / alders?

## Acknowledgment

The authors would like to express their gratitude to the Observatoire des Galliformes de Montagnes (OGM) which collect and manage grouse monitoring data in the Alps, and to the Hunting associations and Office Français de la Biodiversité (OFB) services of the Haute-Savoie, Savoie, Isère and Hautes-Alpes departments for their invaluable contribution to the collection of the in situ black grouse brood dataset. We would also like to thank the OFB for their guidance on the reliability of our modelling results, and for their financial support of the "Tétras-Lyre" project (cooperation agreement OFB-21-1166) which led to the publication of this work. Finally, we would like to extend our gratitude to the Écrins National Park in the French Alps for their enthusiasm and feedback regarding the potential post-validation prospects for the BHS map.

## Coming soon !

Defossez *et al.*, Assessing habitat suitability for black grouse broods at the bioregional scale. *Wildlife Biology*. In revision