

Cetacean habitat under pressure : the case of the bottlenose dolphin in the Gulf of Lion

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INTRODUCTION

The Gulf of Lion is an area rich in marine biodiversity and is also largely under pressures from various human activities like fishing, tourism, marine traffic, substrate exploitation and development of wind farms. The bottlenose dolphin (*Tursiops truncatus*) is present all year round on this large continental shelf that is the Gulf of Lion. Hence, the aim was to **characterize the anthropogenic environment and the potential overlap between dolphins and human activities** through:

- (i) Mapping the distribution and relative abundance of the species
- (ii) Mapping human pressures at sea (categories: fishing, leisure boating, large commercial vessels).
- (iii) Defining areas of co-occurrence between habitat surface of the bottlenose dolphin and each human activity studied (overlap with whale-watching activity was also investigated).

Another aim of this study is to give legal frameworks (EU MSFD and HD N2000, French Mediterranean Strategy and development of wind farms) insights about the state of knowledge and a framework for analysis.

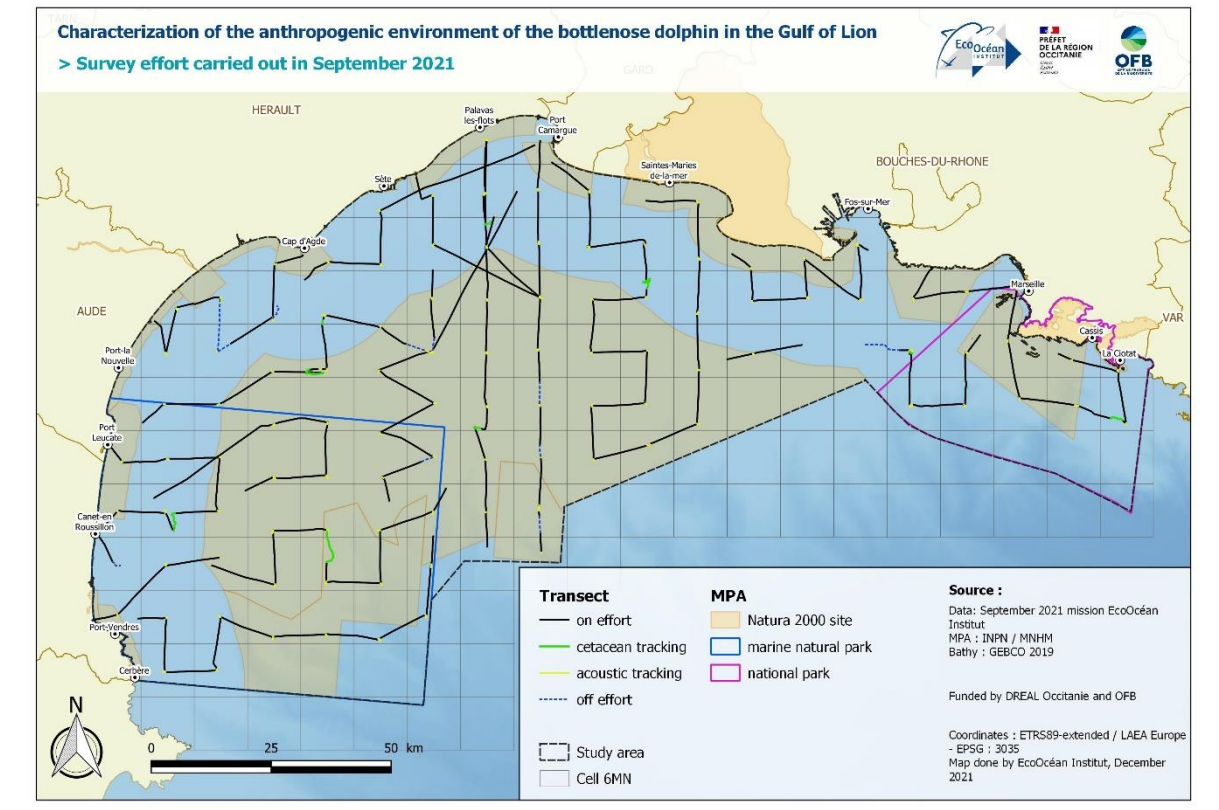


Fig. 1: Study area and survey design

MATERIAL & METHODS

The study area focused in the Gulf of Lion, located in the French part of the North-Western Mediterranean Sea (Fig. 1) in which 18 Marine and Coastal Protected Areas (MCPAs) existed. **Surveys were conducted during the whole month of September 2021** from a sailing vessel platform, according to the « linear transect/ Distance sampling » method, with a constant speed at around 6 knots and 3 permanent qualified observers. Simultaneously, 121 regularly spaced acoustic recordings have been realized in the entire survey area by our partner Chorus (<https://chorusacoustics.com/>). All results in Roul et al., 2022.

RESULTS

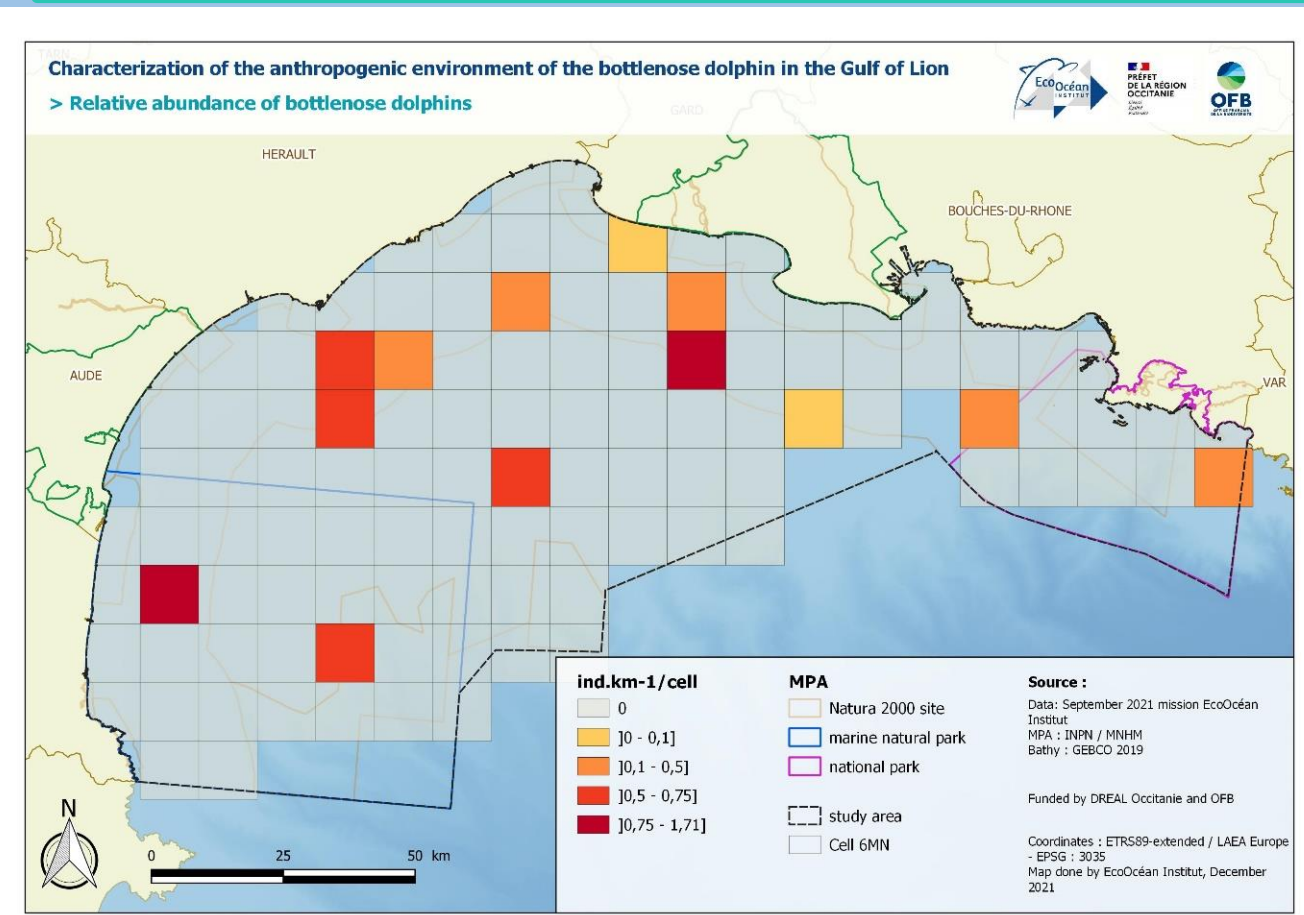
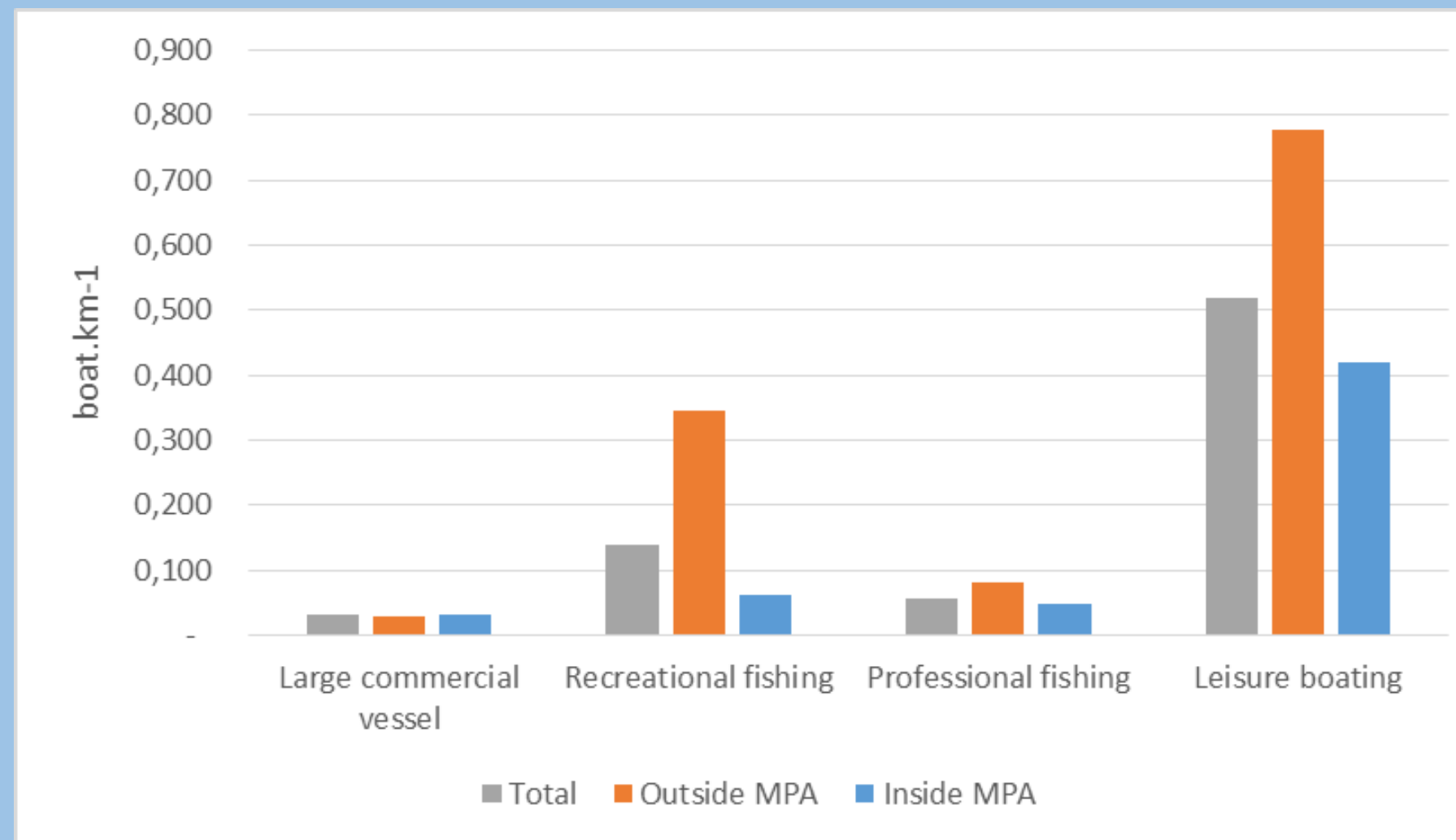


Fig. 2: Relative abundance of *Tursiops truncatus* ($nb.ind.km^{-1}.cell^{-1}$) in the Gulf of Lion in September 2021

- 1,302 km in effort
- 971 sightings of boats
- 13 sightings of bottlenose dolphins (95 individuals).

The results show that the species was observed in the entire area of study (Fig.2). Relative abundance obtained was $0,07 ind.km^{-1}$ and the mean of the encounter rate was $0,011 obs.km^{-1}$.



Recreational activities represent 87.9% of all boats (of which 69.4% are leisure boats and 18.5% recreational fishermen) and professional fishing represents 7.6% (Fig. 3). Large commercial vessels are rare (< 5%). Main activities occur outside MPAs.

Fig. 3: Mean of relative abundance of human activities ($nb.boat.km^{-1}$) counted in the Gulf of Lion in September 2021 within MPAs and outside MPAs

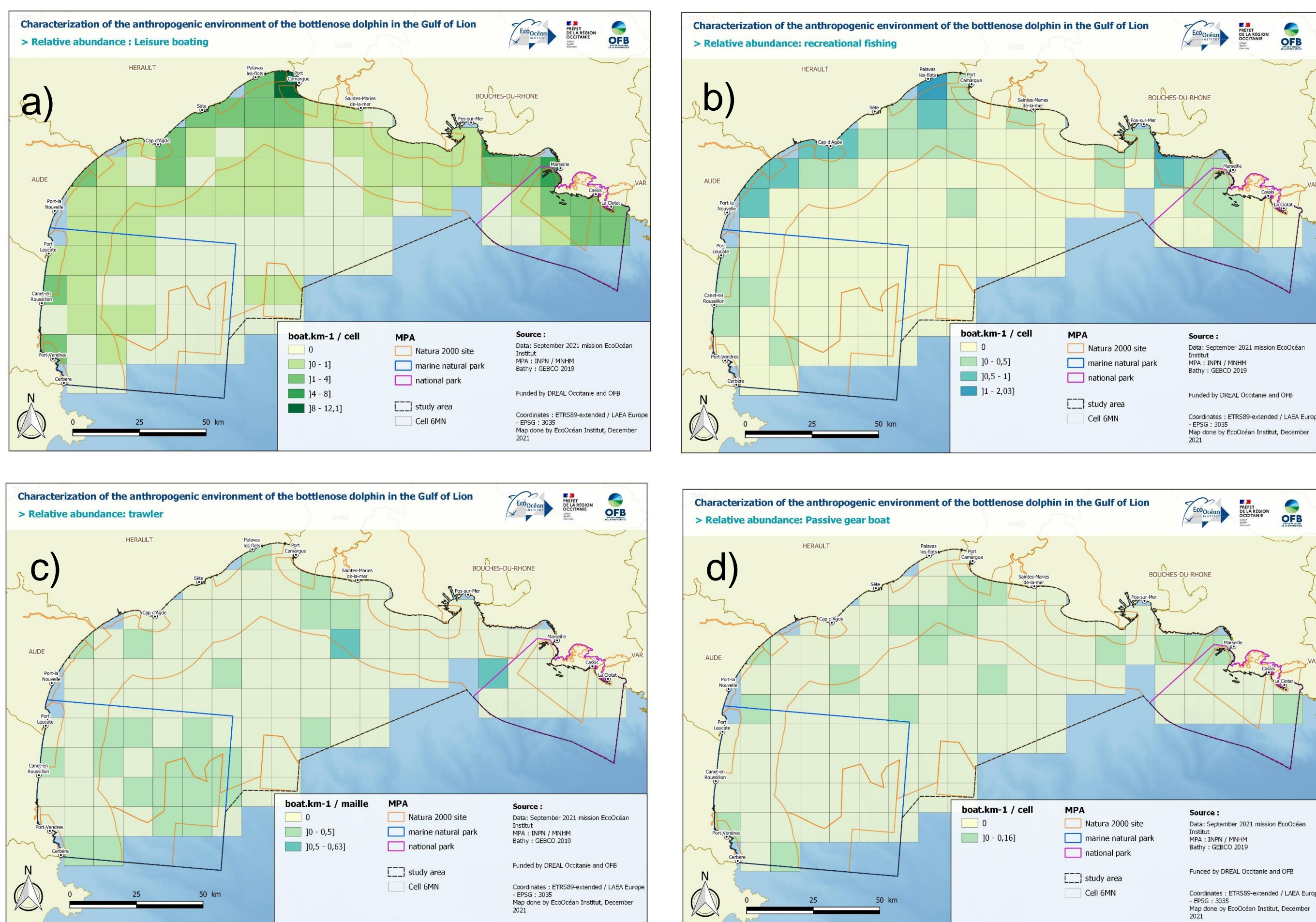


Fig. 4: Relative abundance of boats per cell ($nb.boat.km^{-1}.cell^{-1}$) for a) leisure boating b) recreational fishing c) trawlers and d) passive gear boats

On a grid of 6x6NM cells, leisure boating is characterized by a coastal distribution, close to large marinas with a Maximum Relative Abundance (MRA in number of item.km⁻¹ per cell) of 12 boats (Fig. 4a). Recreational fishing is essentially located around the coastal edge of the Gulf, with a MRA of 2 boats (Fig. 4b). For professional fisheries, trawlers are present rather extensively with a gradient from the coast to the open sea and from East to West (MRA=0.6 boats, Fig. 4c), whereas passive gear (long-line, gillnet, pot) boats, are widely distributed throughout the Gulf (MRA=0.2 boats, Fig. 4d). Finally, large commercial vessels are near large commercial harbours, Marseille, Fos-sur-mer & Sète (mean of RA=0.031, Fig. 5c).

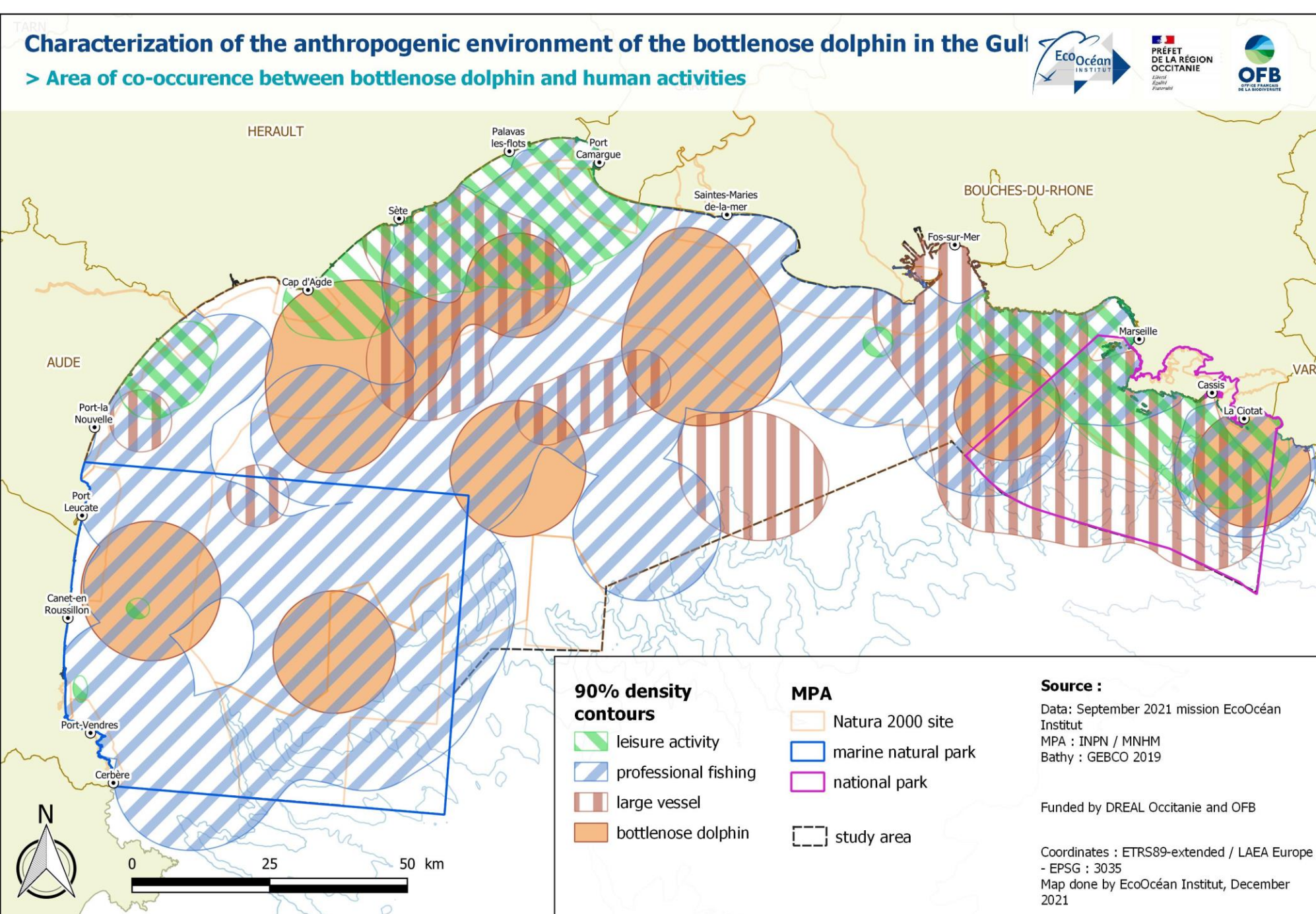


Fig. 6: Cumulation of co-occurrence areas (90% KDE) between the bottlenose dolphin and all Human activities

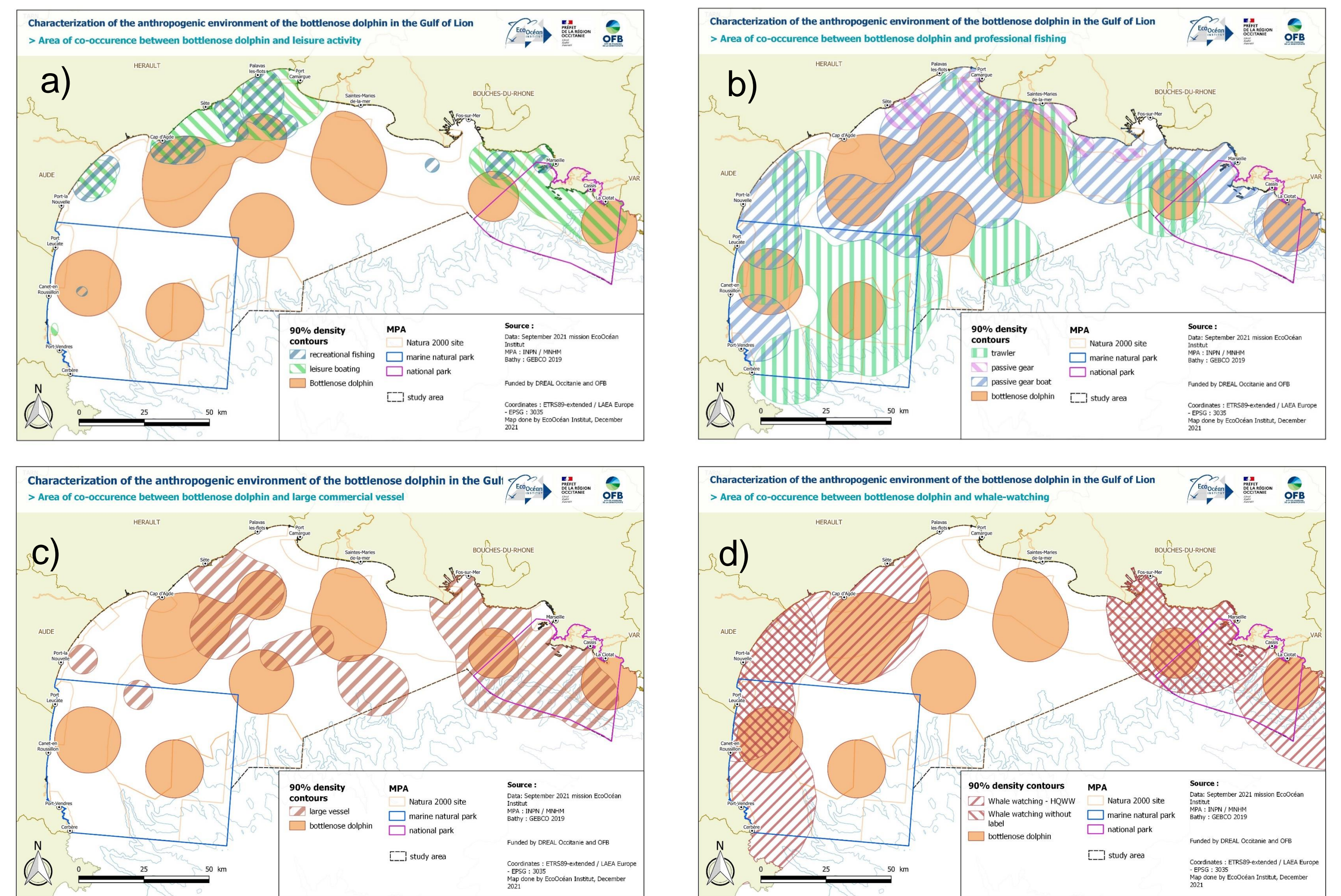


Fig. 5: Area of co-occurrence (90% of KDE) between the bottlenose dolphin and a) leisure activity b) professional fishing c) large commercial vessels and d) whale-watching

DISCUSSION AND CONCLUSION

This study helps greatly for **Marine Spatial Planning**, mapping intense activities not automatically monitored through AIS and often not taken into account in **noise modeling studies**. Moreover, collecting data on species and human activities in parallel allows **Risk Exposure mapping** for bottlenose dolphins. Adding probabilities of negative measured/known impacts for this protected species as a following step will lead to spatial or sectoral management measures through MCPA or legal frameworks.

The co-occurrences between dolphins and the different type of activities were analysed through Kernel Density Estimation (KDE) through GIS with boats relocated based on bearing and distance measurements (Distance sampling) at sea. Hence, leisure activities overlap 16% of the area frequented by the bottlenose dolphin (Fig. 5a), professional fishing activities 86% (Fig. 5b), large commercial vessels 29% (Fig. 5c) and whale-watching <50%(Fig.5d). **Overall, 92% of the surface frequented by the bottlenose dolphin in the Gulf of Lion is under various human pressures, with more cumulation in a wide coastal belt in its northern and eastern part.**

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