

SEMMACAPE: aerial survey of the marine megafauna in offshore windfarms by automatic characterization

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Objectives

Offshore wind farms project developers must produce environmental impact studies, particularly on marine megafauna. These studies requires observations of marine megafauna classically based on aerial overflights by specialized naturalist observers, to better characterize the frequentation of species in the proposed areas. This includes monitoring during the construction, operation and decommissioning phases, a total of about 30 years.

The **SEMMACAPE** project aims at demonstrating the relevance of software for processing and analyzing aerial photographs to ensure the automated inventory of marine megafauna.

- Acquisition of marine megafauna observations from aerial campaign (standard visual method and very high resolution digital photography system to build a database of reference images), integrating the seasonal variability of species and environmental conditions.
- Development and qualification of 2 types of automatic aerial photography processing algorithms:
 - detection and identification by deep neural (end-to-end) network, moving directly from the global image to bounding boxes
 - detection of anomalies by unsupervised deep learning (Berg *et al.* 2022)
- Assessment of the performance of each detection method tested based on indicators classed by species or group of species, as well as according to environmental conditions.

Materials and methods

Study area:

- Situated in the Bay of Biscay, covers 15,000 km².
- Includes the Gironde Estuary and Pertuis Sea Marine Natural Park and the "Pertuis Charentais-Rochelonne" SPA.

Flights and images collection:

- 3 overflight sessions at 600 feet and 90 knots, during spring, summer and autumn 2020.
- Acquisition of 92,463 high resolution (~2 cm per pixel at the sea surface) digital images of 144 megapixels, taken every 2.4 sec and covering 200x450m.



Image analysis:

- Images are pre-analyzed using bespoke software (Harmony by Wipsea) to localize potential targets ;
- Targets are manually validated or unvalidated ;
- Marine megafauna is identified to species or group species level, with indication of age-class when possible

This project benefits from an ADEME grant under the « Energies durables » call (2018-2019).



Results

Printemps	3 cibles (2 ind.) 59 cibles (40 ind.) 16 cibles (11 ind.) 44 cibles (27 ind.)	100 %, 98 % 42 %, 29 % 38 %, 73 % 61 %, 13 %	67 %, > 99 % 14 %, > 99 % 6 %, > 99 % 34 %, > 99 %
Eté	765 cibles (488 ind.) 226 cibles (135 ind.) 103 cibles (88 ind.) 35 cibles (22 ind.)	64 %, 46 % 67 %, 20 % 23 %, 59 % 37 %, 57 %	
Automne	625 cibles (387 ind.) 0 cible (0 ind.) 119 cibles (79 ind.) 7 cibles (4 ind.)	69 %, 19 % —, 100 % 5 %, 0 % 29 %, 0 %	

Figure 1: supervised (middle column) and unsupervised (left) detection performances of some taxas targets annotated by an expert on digital images (right) in spring, summer and autumn. Recall in green, false positive rate in orange

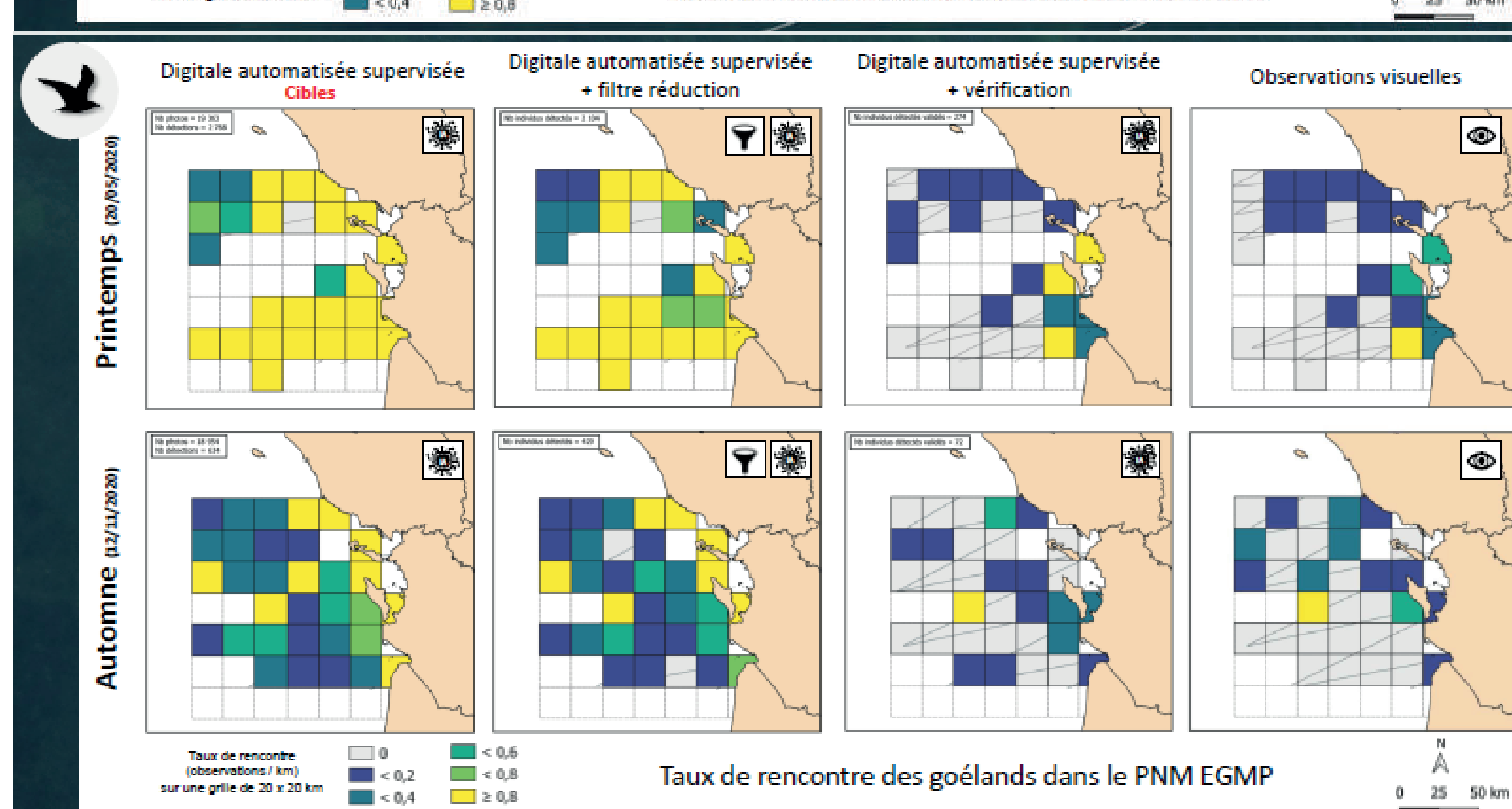
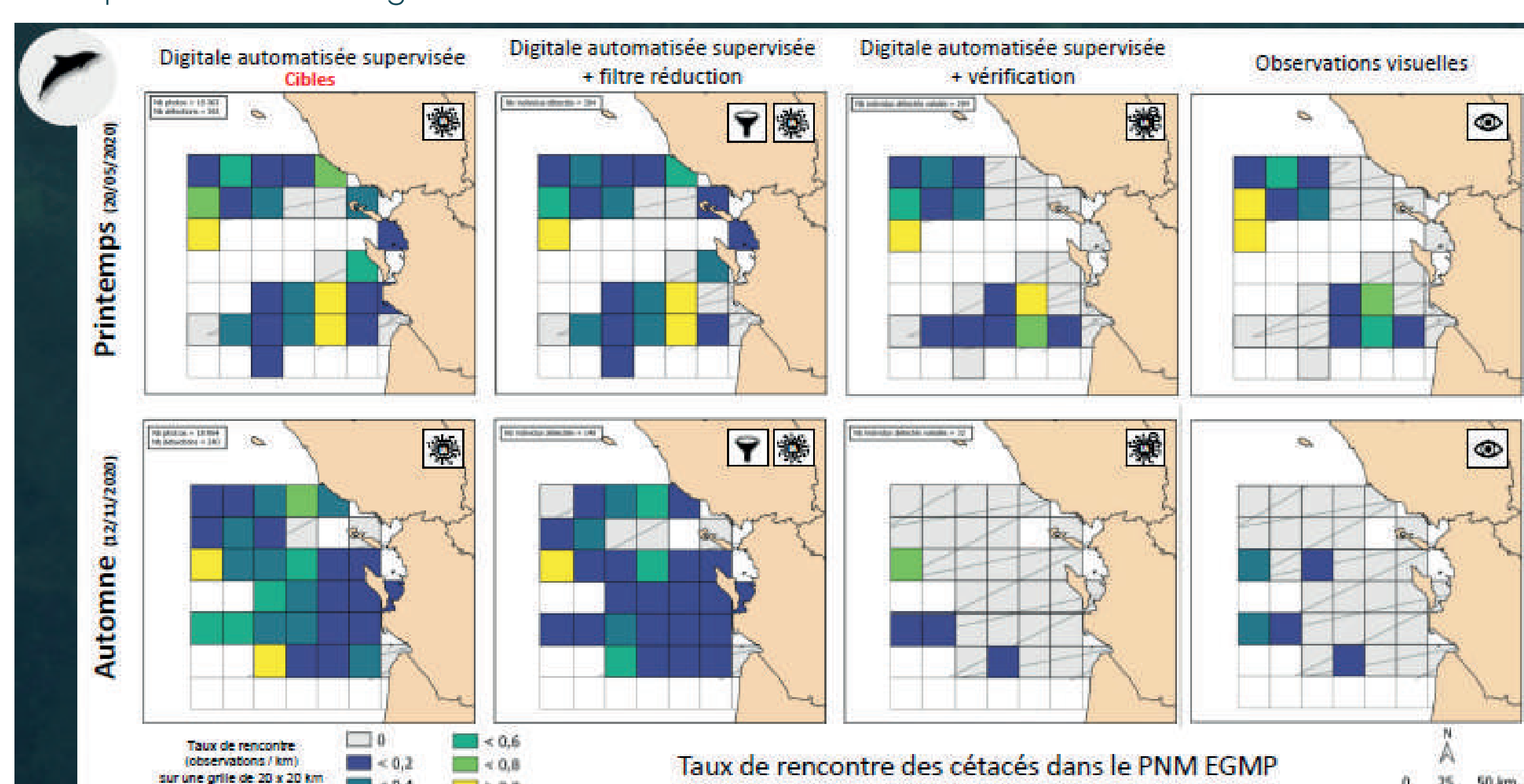


Figure 2 and 3: encounter rates obtained for cetaceans (upper part) and seagulls (lower part) from at most left: direct supervised algorithm output, at middle left after duplicate (produced by images overlapping) suppression, at middle right after a verification by an expert, compared to, at most right, encounter rates obtained directly from visual observations from the plane .

Final objective

- Objective: propose a complete technical solution adapted to the monitoring of the marine megafauna, particularly in the areas of future French and European offshore wind farms ;
- ❖ Allow observations at an altitude imposed by safety constraints after the installation of wind turbines (> 300 m) ;
- ❖ Avoid the massive recourse to naturalist experts for their interpretation.

Reference: Berg, P.; Santana Maia, D.; Pham, M.-T.; Lefèvre, S. Weakly Supervised Detection of Marine Animals in High Resolution Aerial Images. *Remote Sens.* **2022**, *14*, 339. <https://doi.org/10.3390/rs14020339>