USING DISTANCE SAMPLING TO ESTIMATE CUVIER'S BEAKED WHALES ABUNDANCE IN THE NORTHERN TYRRHENIAN SEA

Adrien C. GANNIER (1)(2), Alexandre J. GANNIER (2)

(1) École Nationale Vétérinaire de Lyon - 1, Avenue Bourgelat, 69280 Marcy L'Étoile, France

(2) Groupe de Recherche sur les Cétacés - BP 715, 06633 Antibes cedex, France

Introduction

Even if Ziphiids, also known as Beaked Whales, remain poorly known, their sensitivity to human activities has been highlighted on several occasions. In order to lessen those threats, studies should focus on characterizing beaked whales' presence, abundance and habitat preferences.

The Tyrrhenian Sea is known to be substantially inhabited by Cuvier's beaked whales (*Ziphius cavirostris*) [1]; however, there is no abundance estimate concerning this important CBW sub-population.

Materials and methods

Distance sampling is one of the standard ways to estimate cetaceans' local densities and abundances [2]. This methodology is based on line transect data and visual sighting variables for the focus species [3]. Six terms are involved when estimating abundance: mean cluster size, effective strip width, availability correction factor, line transect effort, number of observations and area size.

Effective strip width (μ) and **Mean cluster size** ($E(s)$):
They were calculated with a dedicated software, *DISTANCE 6*. CBW sightings were selected in GREC's survey database, following two criterions:
- Detection from a 12m sailboat with 3 trained observers watching the entire front sector; sailing speed was 2.5m/s
- Weather conditions were optimal (excellent atmospheric visibility, wind force < Beaufort 2 without swell)

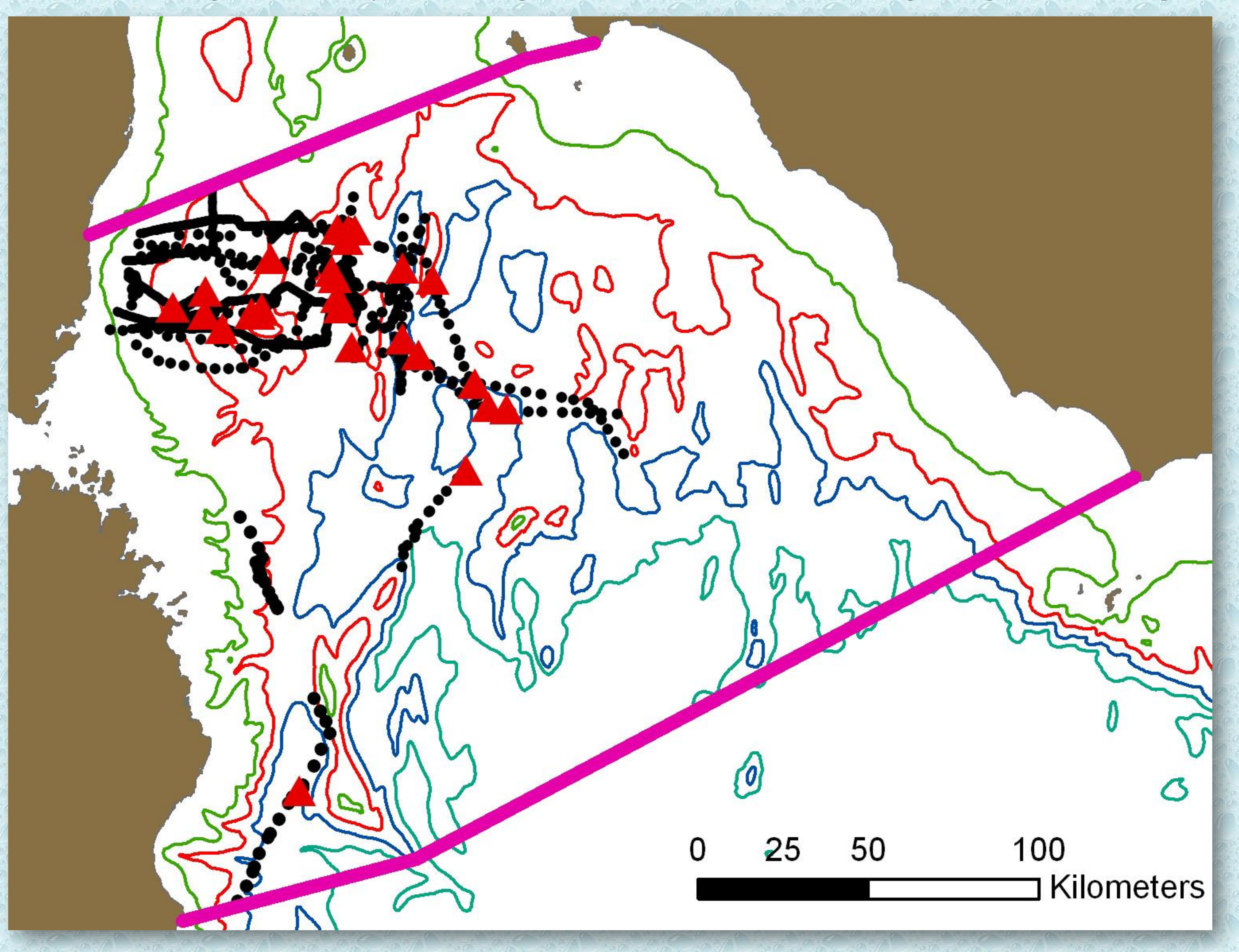
41 CBW sightings (107 animals) were eligible.

Availability correction factor (g_0):
It was estimated using a *MATLAB*-written script. Several parameters were processed, among which:
- CBW dive cycles, as measured during GREC's surveys
- Sailing speed (2.5m/s in standardized conditions)
- Observer's maximal visual efficiency (truncation to 1500m for CBW, in standardized conditions)

Area size (A):
Area of interest was delimited in the northern Tyrrhenian Sea so that it matched the habitat supposedly favorable to CBW presence. It was measured using a GIS software, for a total surface of 22,600km².

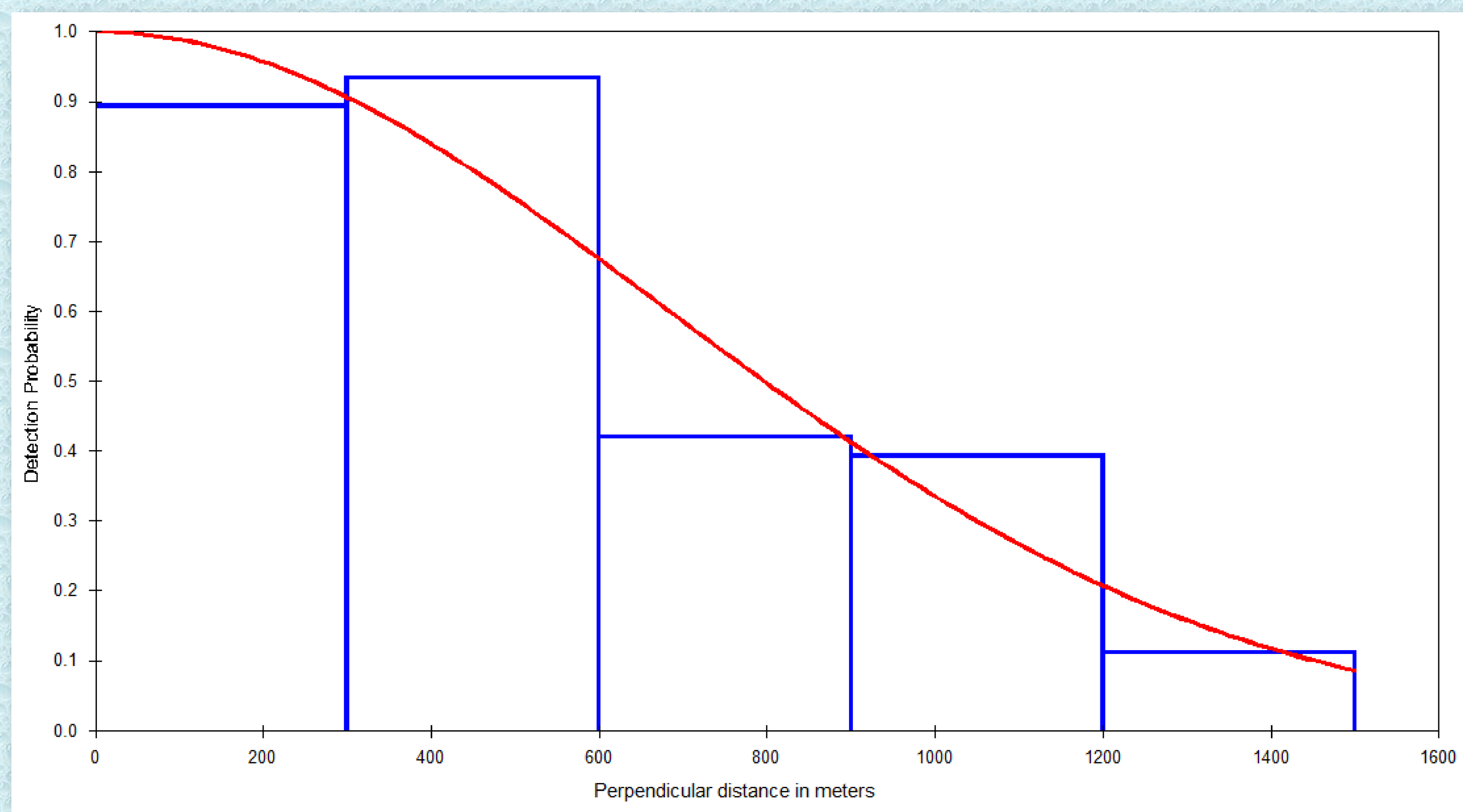
Line transect effort (L) and **Number of observations** (n_{obs}):
Line transect segments were selected in GREC's summer survey database for the period 2007-2012, following two criterions:
- Visual prospection, in the area of interest, from a 12m sailboat with 3 trained observers watching the entire front sector; sailing speed was 2.5m/s
- Weather conditions were optimal (excellent atmospheric visibility, wind force < Beaufort 2 without swell)

24 transect segments (representing 1288 km and 26 CBW sightings) were eligible.



Results

Effective strip width and **Mean cluster size**:
Detection function was selected using the *Akaike Information Criterion*, which pointed the half-normal cosinusal-adjusted model as the most suited to our data.



Subsequent estimations were μ=825m [95%CI = 628 – 1085] and $E(s)$=2.18 individuals per cluster [95%CI = 1.79 – 2.65].

Availability correction factor:
Using our *MATLAB*-written script, the correcting factor g_0 was estimated, in our specific case, to 0.48.

Local density and **Total abundance in the area of interest**:
Using the standard equations $\widehat{D} = \frac{n_{obs}E(s)}{2\mu L g_0}$ and $\widehat{N} = A \times \widehat{D}$, we obtained the following results:

Value	Estimation	95% Confidence Interval
D - Local density (ind./km²)	0.0505	[0.0289 – 0.0883]
N - Total abundance (individuals)	1141	[653 – 1996]

Discussion and Conclusion

Figures obtained for $E(s)$ and μ were consistent with values found in other publications for CBW [4; 5]; $E(s)$ (2.18 individuals per cluster) was significantly lower than the arithmetical mean (2.61 individuals per cluster), which was not surprising since bigger clusters are easier to detect.

The correcting factor g_0 accounting for the availability bias was consistent with values found in the literature for CBW watched from slow small boats [5; 6]. When parameterized with values used in reference studies, the *MATLAB*-written script, despite being simple, also delivered coherent figures [7].

Our spatial sampling was clearly heterogeneous, favoring an area where CBW were commonly sighted within one day range from Corsica. However, since publications concerning CBW showed a homogeneous distribution in the whole area [8], the distance sampling methodology remained usable [2]. Until the eastern part of the area is correctly sampled, a post-stratification procedure accounting for our heterogeneous sampling will significantly improve those preliminary results.

Although potentially positively biased, our results would at least confirm the presence of an important CBW population in the northern Tyrrhenian Sea. Even without extrapolating results to the whole area, the local density that we obtained is among the highest in the literature [6; 9], thus confirming the northern Tyrrhenian Sea as a hotspot for the CBW in the Mediterranean Sea. Protection measures should be implemented in accordance.

References

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