SIGHTING FREQUENCIES OF FIN WHALES (*BALAENOPTERA PHYSALUS*) ON A PREVIOUS SIGHTINGS POSITION: IMPLICATIONS FOR WHALE WHATCHING DATA

Aurélie Moulins [1] *, Barbara Nani [2], Massimiliano Rosso [3] and Maurizio Würtz [3]

[1] Interuniversity Research Center for Environmental Monitoring - CIMA, Via Cadorna, 7, 17100 Savona, Italy - aurelie@cima.unige.it
[2] Whale Watch bluWest, Via Scarincio, 12, Imperia, Italy
[3] Biology Department, University of Genoa, Viale Benedetto XV 5, 16132 Genoa, Italy

Abstract
Whale-watching activity performed in the Ligurian Sea (off Imperia-Savona) from 2004 to 2006 is analysed to access to the sighting probabilities of fin whale on previous sighting positions, during 7 days time-window. On 62 km^2 area, 15 % of the fin whale sightings occurred near a previous sighting position.
Keywords : Cetacea, Ligurian Sea.

Introduction
Since nearly 20 years, the whale watching activity has grown considerably in the Ligurian Sea especially to watch fin whales. Indeed, in the early spring and during the summer, fin whale are aggregated in function of the food availability [1]. The implantation of this tourism activity provides also opportunistic research platforms to conduct study on cetaceans habitat [2]. However, it is not clear how results obtained by whale-watching surveys may be biased by the re-sightings of one single individual on a particular position. This work analyse the quantity of fin whale sightings occurring on near one sighting position during the 7 following days.

Materials and Methods
3 years of the main whale-watching operator in the Ligurian Sea are analyzed. During 362 days of whale-watching aboard the two vessels (the *Corsara* and the *Stenella*), 186 fin whale sightings occurred. To establish the frequency of 2nd-sightings on 1st-sighting positions, we first fix the time-window to 7 days. This window can considered to be representative of the relative oceanographic stability in the Mediterranean Sea. Moreover, it is not expected that a whale remains on a static position during more than 8 days because of obvious changes of oceanographic configuration. In contrast, it is expected that a whale remains quasi-static when its prey is abundant. Therefore the 7 days window should fit for this study. Then, for each 1st-sighting position represented on a grid with a resolution of 1/60°, we calculate the sightings (called later 2nd-sightings) that occurred on surrounding grid-cells during the time-window. 4 different resolution scales were tested: 3, 5, 7 and 9 pixels.

Results and discussion
In general, the whale-watching boat realized 4 days of "survey" after one fin whale sighting (Table 1). This result indicates indirectly the favourable meteorological condition for surveys, considering that operators in this area exploit all possible occasion when the weather is good enough.

Tab. 1. Sightings results on different extension of areas (I, II, III, IV).

Type	I	II	III	IV
Width (km)	5	8	11	14
Area (km^2)	22	62	122	201
Sighting frequency	0.04	0.15	0.32	0.53
Sighting success frequency by return	0.05	0.11	0.19	0.28
Effort (NM) by return	298	1011	1956	3049
Encounter rate at the 2nd-sightings position	0.027	0.028	0.031	0.032
Effort (NM) on the 1st-sightings position	395	774	1081	1587
Encounter rate at the 1st-sightings position	0.471	0.240	0.172	0.117

Because daily horizontal pattern of movement of fin whale is not yet known, we have tested different space scale. On the more restricted area, representing about 22 km^2, (see Table 1, I), fin whale are not often sighted; the 2nd-sighting frequency is 0.04. However the boat did return a lot of times (153). The success of 2nd-sighting is of 0.05 by return. This results is quite unexpected considering that generally it was supposed to re-find more easily fin whales on previous positions. The relative encounter rate, expressed as the number of sightings divided by the number of the nautical miles done in the area, is quite low 0.027 comparing to the one obtained with casual encounters (0.48) on the even area. This demonstrates that even if the boat is looking for whales in the restricted area, 2nd-sightings are not numerous. Extending the area, on 62 km^2, the frequency of 2nd-sightings grows to 0.15 (with 28 2nd-sightings on the 1st-sightings position) with the success frequency by return of 0.11. In this situation,

the encounter rate is 0.028. Extending then to 122 km^2, the frequency of 2nd-sightings becomes 0.32 with a relative success frequency 0.19 by return; here, the encounter rate on the delimited area is 0.031. On the most extended area tested (201 km^2), the frequency of 2nd-sightings reaches 0.53. But the area is extended on the usual features where fin whale is abundant. In the Ligurian Sea, fin whale habitat is characterized by deep water (average 2136 meters), by gentle bottom slope (average of 26m/km) and daily sea surface temperature of 21.8°C [3].

This work gives access to results on whale watching data. The analysis on a restricted area (over 22 km^2) indicates a low quantity of sightings on a previous position. But on 62 km^2 area, 15 % of the fin whale sightings occurred near a previous sighting position. Extending the area, the quantity of sightings grows indicating that fin whales may move around their primary position during the 7 following days and so may be re-sighted. This study would be greatly improve by photo-identification results, in order to determine the proportion of re-sightings of the same whale.

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