**HOW SEASONS INFLUENCE STRIPED DOLPHIN AND FIN WHALE DISTRIBUTION IN THE NORTH WESTERN MEDITERRANEAN SEA MARINE MAMMAL SANCTUARY?**

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**INTRODUCTION** The Ligurian Sea, located in the north western Mediterranean Sea, is well known to be an attractive area in summer for a large number of cetaceans, particularly the fin whale. Hydrodynamic features and seasonal variations have been studied for a long time, field studies and satellite imagery underline a frontal area between 10 and 50 km from the mainland coast (Sournia *et al*., 1990) and along the coast of Corsica (Goffart *et al*., 1994). Eight species of cetacean are considered to be common in this area (Gannier, 1998) and several studies have contributed to describe distribution and abundance of cetacean in summer. Nevertheless, winter season still requires more investigations to understand residency patterns year-round. A monthly survey was conducted since February 2001 to estimate abundance and distribution of the cetacean populations during the four seasons in the Marine Mammal Sanctuary of the Mediterranean Sea.

**MATERIAL AND METHODS** Monthly surveys were invariably conducted along two parallel transect lines with a 12 meter motorboat. Transects were covered during a two-day round trip in good meteorological conditions (*i.e*. wind less or equal to 3 Beaufort). Three experienced observers were searching three frontal sectors, each with naked eyes (4 m above the water's surface). Observers were rotated every hour (one off-duty position being available). Two 7x50 reticulated binoculars were used for measuring sighting bearing and radial distance. During the first day, transect A (160km) was conducted between Cap d'Antibes and Calvi (Corsica) at a constant average speed of 10 knots. The second day, a 74 km anti-parallel transect called "B" (located 11 km apart from the central part of transect A) was cruised at 7 knots.

For all on effort sightings, distance from shore was measured with Oedipe software and nine classes of 10 n. miles were used between "Cap d'Antibes" and "Cap de la Revellata". Only data with sighting index 4 to 6 on transect A were used to calculated relative abundance indices. Results were computed with *Distance 4* software using samples of 10 n. m for striped dolphin (*Stenella coeruleoalba*) and 20 n. m for fin whale (*Balaenoptera physalus*). Two year data set was divided into 6 two-month periods. The large number of striped dolphin sightings allowed us to stratify the data into two sighting condition strata corresponding to sighting index 4 and index 5-6. Detection histograms were constructed for both strata and *esw* values (effective strip half-width) compared. For each period, a corrected encounter rate was produced to account for lower effective strip obtained with sighting index of 4 $(n/L)_4$. Relative abundance indices (individuals / km) were then calculated for the 6 periods using the mean cluster size obtained with sighting index 5-6.

$$Relative \cdot abundance_{cor} = \left(\frac{n}{L}\right)_{cor} \cdot E(s)_{5-6} = \frac{\left(\frac{n}{L}\right)_4 \cdot \frac{esw_{5-6}}{esw_4} \cdot L_4 + \left(\frac{n}{L}\right)_{5-6} \cdot L_{5-6}}{L_4 + L_{5-6}} \cdot E(s)_{5-6}$$

The sighting index correction was not applied to fin whale data due to an insufficient number of sightings. To compare high (10 knots) and low speed (7 knots), encounter rates were also calculated for the 74 km central portion of transect A, to match transect B (data truncation was the same as before). Results were only compared when both transects (A central and B) were available for a given survey.

**RESULTS** In 20 surveys a total effort of 3882 km was achieved in good to excellent conditions (sighting index of 4 to 6) including 25% of effort obtained at low speed. A total of 179 striped dolphin sightings and 88 fin whale sightings were obtained "on effort".

The seasonal variation of striped dolphin distribution did not show any clear pattern (figure 1). However, we noticed a preference for central area in winter due to some large pods, and for both frontal areas in spring. The average distance off sightings to shore was 43 km (Sd= 21.5), with a maximum seasonal variation of 5 km which was not significant. Significant different effective half-width (*esw*) values were obtained according to the sighting index (T= 5.24 ; p= 0.000): 294 m (Sd= 94.1) with index 4 (n=25) and 378 m (Sd= 71.3) with index 5-6 (n=84). Then, samples observed with sighting index of 4 were corrected by a factor 1.28. For striped dolphin relative abundance, a minimum value of 0.247 ind/km (Sd= 0.15) was obtained in March-April (figure 2) just before the peak of May-June (0.792 ind/km). Mean relative abundance index of 0.646 ind./km (Sd= 0.14) from

May to October was significantly superior to November to April period with a mean index of 0.367 ind./km (T= 2.51; p= 0.043).

Fin whale distribution showed clear patterns (figure 3). In autumn, animals were in the central area with 78% of individuals between 55 and 93 km from the continental coast. In winter, fin whales were located at more than 40 km off-shore. The spring period is characterised by a bi-modal distribution in frontal area. In summer, which represents 68% of the sightings, animals were spread in the north of the central area (37 to 111 km from continental coast). Data were truncated at 1400 m (*esw*= 961m; Sd= 259). Fin whale relative abundance index increased from 0.55 $x10^{-2}$ ind./km (Sd=0.4 $x10^{-2}$) in January-February to a maximum of 6.0 $x10^{-2}$ ind./km (Sd= 4.6 $x10^{-2}$) in July-August and decreased quickly to a null value in November-December (figure 4).

For striped dolphin, encounter rates were generally superior at lower speed than at 10 knots and difference was statistically significant (T= -4.29; p= 0.0001). The mean increase between high and low speed (as percentage of transect A result) was 39%. Results obtained for fin whales were not so clear. Encounter rates obtained at 7 knots were not significantly higher than those obtained at 10 knots (T= 0.74; p= 0.24).

**DISCUSSION** **Striped dolphin** relative abundance index show an irregular pattern. The significant decrease between November and April indicates a migratory trend, and the minimum value of 0.367 ind./km represents the fraction of the population that does not leave the area during the cold season. The May-June value of 0.79 ind/km (Sd= 0.22) is equal to the value obtained by Gannier (1998) in summer period in the Ligurian Sea. Nevertheless we obtained larger values in winter and spring than Gannier (1998), probably due to this author heterogeneity of sampling at these periods.

**Fin whale** relative abundance index seems close to zero between November and February, but in December one fin whale was observed on transect B. Average index for October to April is 1.1 $x10^{-2}$ ind/ km, in agreement with 1.4 $x10^{-2}$ ind/ km obtained between end of October and April by Gannier & Gannier (1993). Both species show a preference for frontal area during spring, which correspond to the bloom period in this area.

**Speed effect** is clear on striped dolphin sightings rate and not on fin whales, due to an easier fin whale detection (size and surfacing occurrence) than for dolphins. The possibility of a density gradient in the whale distribution might also be considered.

**CONCLUSION** Results obtained after two years show some general migratory trend for the two main species. In winter a few proportion of striped dolphin population remain in the North Western Mediterranean Sanctuary when most of fin whale population leaves the area. An additional year of survey will increase the number of data available and allow more analyses and a best understanding. This knowledge is necessary for an appropriate management of the Sanctuary area.

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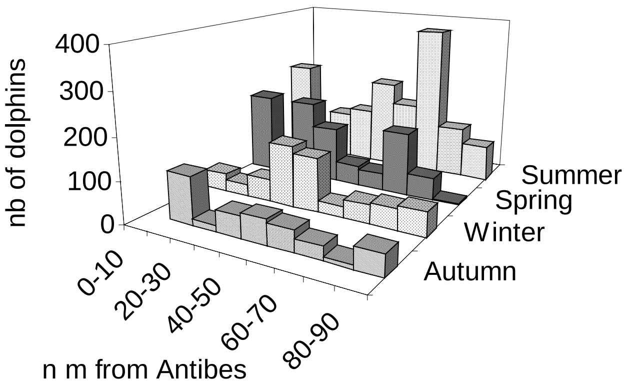

**Fig. 1** Distribution of striped dolphins between Continent and Corsica.

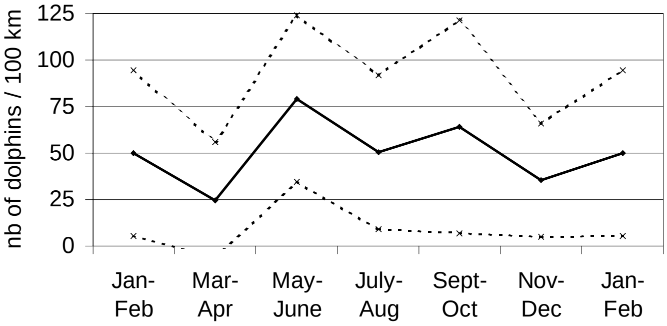

**Fig. 2** Variation of striped dolphin relative abundance (individuals / 100km) and [+/- (2 x Standard deviation)].

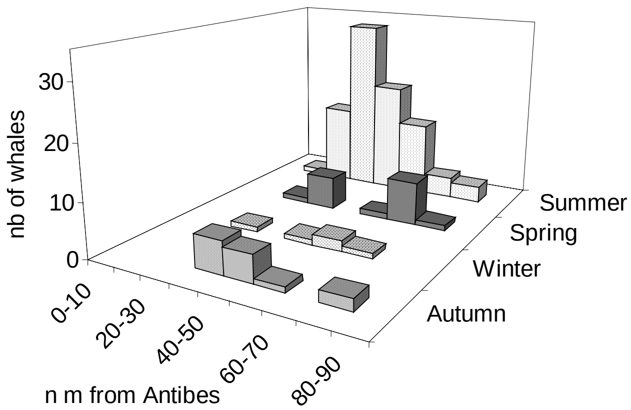

**Fig. 3** Distribution of fin whales between Continent and Corsica.

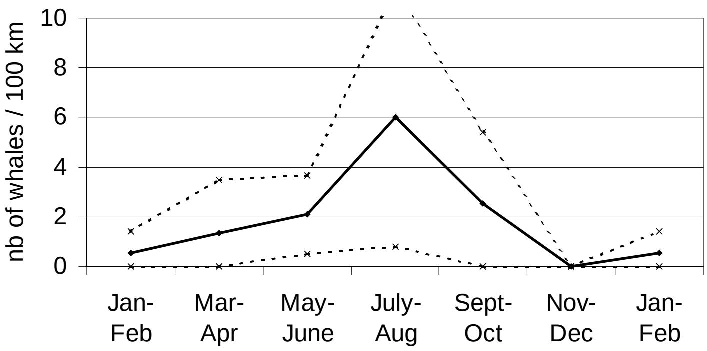

**Fig. 4** Variation of fin whale relative abundance (individuals / 100km) and [+/- (2 x Standard deviation)].