PRELIMINARY RESULTS ON SEASONAL VARIATION OF CETACEAN POPULATION IN THE MEDITERRANEAN SANCTUARY

S. Laran, A. Gannier and S. Bourreau [1] [2]

[1] CRC, Marineland, 306 avenue Mozart, 06600 Antibes, France.
[2] GREC, Chemin des Moyennes Bréguières, BP 751, 06633 Antibes cedex, France.

INTRODUCTION The region between Corsica island and mainland France includes the International Marine Mammal Sanctuary of Mediterranean Sea. In this region the cyclonic Ligurian current generates a frontal system, conspicuous on satellite imagery. A high primary productivity period occurs once a year, in March-April and slighter production peak occurs in October. This area is known as an important summer feeding ground for fin whales (Relini *et al*., 1992) and several odontocete species. Few attempts have been made to describe the situation during the winter, however, four species are known to be present between September and June: the striped, Risso's, bottlenose dolphins and the fin whale (Gannier, 1998). Monitoring surveys have been conducted during one year on a monthly basis to assess the seasonal variation of cetacean population (distribution and relative abundance) in this area.

MATERIAL AND METHODS Since February 2001, monthly transect have been carried out between Cap d'Antibes and Calvi, which are 90 nautical milles (167km) apart. The surveys were always conducted along the same track, on two parallel transect lines, covered during a two-day round trip in good meteorological conditions (*i.e.* wind less or equal to 3 Beaufort). We used a 12 meter Grand Banks motorboat with a 4 m high observing deck. Three experienced observers in duty were searching a 60 degree sector each with naked eyes, with observers rotating every hour (one off-duty position being available). Two reticuled binoculars were used for measuring sighting bearing and radial distance. During the first day, the 160km long transect A is conducted between Cap d'Antibes and Calvi (Corsica) at an average speed of 10 knots. The boat is stopped on ten stations (every 18.5km) to perform a 2 minutes hydrophone listening and sampling of superficial water for salinity analyses. The second day, the anti-parallel transect B (11km apart from A) is cruised at 7 knots, with only the 74km central part carried on with the standard sighting protocol. To access monthly variation we determined a relative abundance index, *R* (individuals by km) obtained from the line transect estimator of Buckland *et al*. (1993):

$$R = \left(\frac{n}{L}\right) \cdot E(s)$$

with n: the number of primary sightings, L: the line transect length and E(s): the mean school size. This index was estimated for the two main species (striped dolphin and fin whale) from visual data obtained from transect A (first day) with good sighting condition (Beaufort ≤ 3). Results were computed with *Distance 3.6*, with samples of 10 nautical milles for striped dolphin and 20 n. milles for fin whale. T-test was used to assess seasonal variation.
Acoustic data were analysed as binary outcome: presence or absence of dolphins were reported for each listening station, by listening to the recordings performed during the survey. The rate of positive listening stations was defined as the ratio between the number of stations where dolphin presence could be detected and the total number of listening stations (ten). Chi-square test was used to analyse temporal variation of positive/negative listening number.

RESULTS Eleven surveys were conducted (February 2001 to Feb. 2002), representing 2595km of on-effort sampling. A total of 130 sightings and 1500 individuals were recorded,

and four species observed (table 1): the striped dolphin (*Stenella coeruleolaba*), fin whale (*Balaenoptera physalus*), Risso's dolphin (*Grampus griseus*) and sperm whale (*Physeter macrocephalus*). All four species were observed throughout the year, summer excepted. The striped dolphin was the most abundant species encountered, followed by the fin whale.

Striped dolphin - This species represented 43% and 100% of the individuals sighted on-effort in August and January respectively. Larger pods occurred in February and June with a mean size of 27.3 and 22.6 animals respectively while smaller groups were observed in October and January (13.5 and 7.6 individual on average).

The annual mean relative abundance index on the transect A is 0.37 individual/km (max: 0.73 - min: 0.02 ind./km). The index (figure 1) for June and July was 0.73 ind./km (SE=0.05, n=2), while the rest of the year 0.29 ind./km were observed on average (SE=5.6, n=9). A t-test showed a significant difference between both periods ($T= 7.88$, $p<0.001$).

The mean distance from the shore was 43km (SE=1.16) with 63% of striped dolphin sightings observed between 15 and 35 n. milles off-shore (28 to 65km, figure 2).

Overall, acoustic survey for dolphins (table 2) provided a mean positive listening rate of 50%. However three surveys presented a maximum of positive results of 70%: February and April (beginning and end) and October. In summer, positive listening were not obtained in large number, contrary to what we would expect from the relative abundance results.

Fin whale - This species was observed from February to October, with a mean group size of 1.8 (SE=0.2). The annual mean index of relative abundance on the transect A is 0.03 individual/km and maximum index was recorded in August (0.19 ind. / km). Then, fin whales were relatively rare during the cold months (figure 1): December, January, February and April, with a mean relative abundance of $0.34 .10^{-2}$ ind. / km (SE=0.23, n=6 surveys).

The mean distance from the coast was 62km (SE=1.31) and 91 % of fin whales were observed further than 25 n. milles off-shore (46km, figure 2).

Sperm whale - Sightings occurred twice: in May and in October (2 animals), both of them being observed at less than 13km off-shore, in 1000 to 1500 m deep waters. This species was also detected acoustically on three other occasions (table 2) in June (one animal), in April and February (two animals).

Risso's dolphin - This species was observed four times: in April, in December (two pods) and in February. The mean distance from the shore was 47km (SE=11.1).

DISCUSSION Our results suggest an increasing number of striped dolphins in the area during summer (June, July and August) and fin whales maximal occurrence one month later, in July until October. A decrease in whale abundance in autumn has already been reported in the Ligurian Sea (Gannier, 1998; Panigada *et al*., 2001). This absence could correspond to the breeding season, assuming that it occurs in autumnm (September to November), based on the North Atlantic observation (Gambell, 1985). In the Tyrrhenian Sea however, Marini *et al*. (1992) have reported an almost constant occurrence of striped dolphins and considered *Balaenoptera sp.* as a year round resident with a peak from April to May. Sperm whale presence in the Ligurian Sea is known for summer months (Gannier, 1998; Gannier & Drouot, 1999; Gordon *et al*., 2000) but its occurrence throughout the year in this area is a new result.

In some cases we have observed heterogeneous distribution with strong variation between transect A and B. More dolphin sightings (and larger pods) were made on transect B. For instance, in April the relative abundance index (R) of striped dolphin on the return transet (B) was more than three times higher than on transect A. For fin whale, the highest difference occurred at the beginning of April. However, a paired t-test did not reveal any significant difference between transect A (sampling speed of 12 knots) and transect B (7 knots) in the monthly relative abundance indices computed for striped dolphin ($T=-1.86$, $p=0.11$, $df=6$) and

fin whale (T=-0.03, p=0.98, df=5). These differences are probably due to our straight line sampling strategy: spatial heterogeneity ("one whale is missed because a few kilometers off the sampling line") converts into temporal heterogeneity (one month with few sightings or not at all). This term of sampling variance should be dampered as number of samples increase. The same reason explain inconsistencies between transect A and B. One of the assumptions made for the sampling scheme was that no significant density gradient existed between transect A and B.

CONCLUSION As this study will be carried on during the year 2002, additional data will allow us to estimate cetacean density and seasonal trends. In addition, comparison of cetaceans distribution with primary biomass data obtained from satellite imagery could allow us to further investigate the seasonal variation observed.

ACKNOWLEDGEMENTS We thank Marineland (Antibes) for his financial support and the GREC for the logistic help, thanks to L. Prieur (Station Océanologique Villefranche/mer) for providing salinity analysis and observers for their help.

REFERENCES

Buckland S.T., Anderson D.R., Burnham K.P. & Laake J.L. 1993. *Distance sampling Estimating abundance of biological populations*. (Eds. Chapman and Hall). London. 446 pp.

Gambell R. 1985. Fin whale. *in*: Hand book of Marine Mammals, vol.3. Ridgway and Harrison Ed., London: 361 pp.

Gannier, A. 1998. Variation saisonnière de l'affinité bathymétrique des cétacés dans le basin Liguro-Provençal (Méditerranée occidentale). *Vie et Milieu*, 48(1): 25-34.

Gannier A. & Drouot V. 1999. Distribution and relative abundance of the sperm whale in the central and western Mediterranean. Pp. 227-231. In *European Research on Cetaceans -13*. Proc. 13th Ann. Conf. ECS, Valencia, 5-8 April, 1999 (Eds. P.G.H. Evans, J. Cruz and J.A. Raga). European Cetacean Society, Cambridge, England. 484pp.

Gordon J.C.D., Matthews J.N., Panigada S., Gannier A., Borsani J.F. & Notarbartolo Di Sciara G., 2000. Distribution and relative abundance of striped dolphins, and distribution of sperm whales in the Ligurian Sea Cetacean Sanctuary: results from a collaboration using acoustic monitoring techniques. *J. Cetacean Res. Manage.* 2(1): 27-36.

Marini L., Consiglio C., Angradi A.M., Sanna A. & Valentini T. 1992. Cetacean sightings program in the central Tyrrhenian Sea: results of the second year of activity. Pp: 66-68. In *European Research on Cetaceans -6*. Proc. 6th Ann. Conf. ECS, 20-22 February 1992, San Remo (Eds. P.G.H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Morel A. & André J.-M. 1991. Pigment Distribution and Primary production in the Western Mediterranean as Derived and Modeled From Coastal Zone Color Scanner Observations. *Journal of Geophysical Research* 96(C7): 12685-12698.

Panigada S., Notarbartolo di Sciara G., Zanardelli Panigada M., Airoldi S., Borsani F., Jahoda M., Pesante G. and Revelli E. 2001. Distribution and occurrence of fin whales in the Ligurian Sea between 1990-1999. In *European Research on Cetaceans -15*. Proc. 15th Ann. Conf. ECS, Roma (*in print*).

Relini G., L. Orsi Relini, C. Cima, C. Fasciana, F. Fiorentino, G. Palandri, M. Relini, M. P Tartaglia, G. Torchia & A. Zamboni 1992. Macroplankton, *Meganyctiphanes norvegica*, and Fin Whales, Balenoptera physalus, along some transects in the Ligurian Sea. Pp: 134-137. In *European Research on Cetaceans -6*. Proc. 6th Ann. Conf. ECS, 20-22 February 1992, San Remo (Eds. P.G.H. Evans). European Cetacean Society, Cambridge, England. 254pp.

Table 1. Number and size of cetacean schools detected during the 11 surveys.

	Schools detected		School size (total)		
Species composition	Total	On-effort	Range	Mean	S.E.
Striped dolphin	90	84	1-90	16.9	1.63
Fin whale	39	39	1-5	1.8	0.2
Risso's dolphin	4	4	2-20	7	4.36
Sperm whale	2	2	2	2	0

Table 2. Acoustic results on 10 stations between Antibes and Calvi.

Antibes ---------- Calvi

Stations

Date	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Feb-01		1	1	1	1	1	1	1	1	1
Apr-01			1		1				X	X
Apr-01			1	1	1	1	1	1	1	1
May-01	X	X	1					1		
Jun-01	1			X						
Jul-01	0									1
Oct-01		X	1	1	1		1	1	1	1
Dec-01			1	1	1			1		1
Jan-02					1	1	1	1		1
Feb-02			X		1	1		1	1	1

Legend :

1 Delphinid whistles

X Sperm whale

No signal

0 No listening

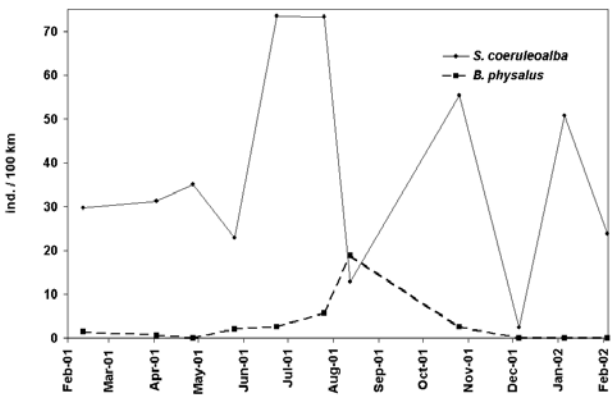

Fig. 1. Relative abundance index (individuals per km) of striped dolphin (—●—) and fin whale (-.-■-.-) obtained on transect A (continuous line) and with monthly total effort (dotted line).

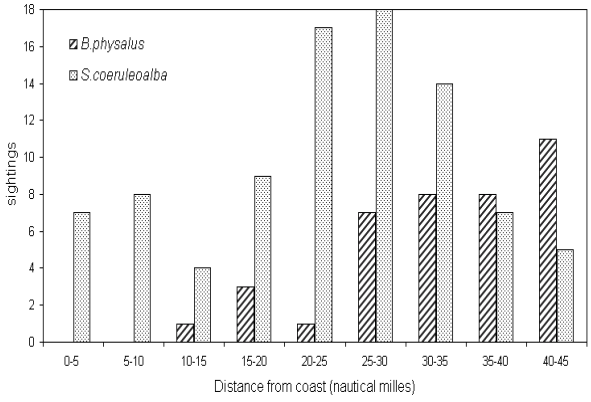

Fig. 2. Distribution of striped dolphin and fin whale on-effort sightings, function of distance from the coast.