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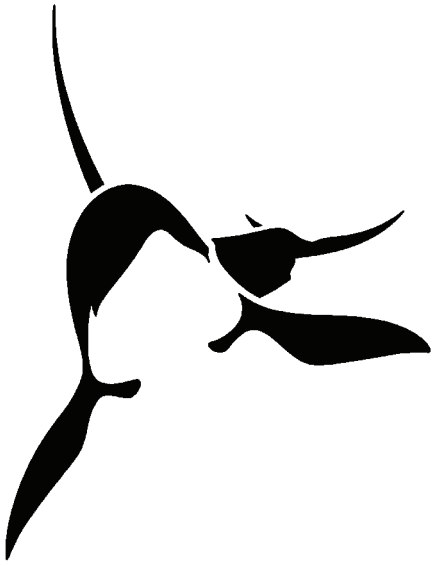

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LARGE SCALE CETACEAN MONITORING FROM PASSENGER FERRIES IN ITALY. NETWORKING SUMMER 2008 SURVEYS

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INTRODUCTION Monitoring cetacean presence, relative abundance, distribution and migration timing is an effective indicator to detect environmental changes and habitat degradation and can provide information to improve conservation and adaptive management of marine ecosystems. In particular, large scale monitoring programs are required to better understand relationship between cetacean and oceanographic and wide-ranging parameters. Types of observation platforms and cost of research have been the main problems in the development of monitoring programs capable to survey cetacean population over time. Due to low costs, standard route, speed and height of the observation point, ferries are an efficient and cost-effective platform of opportunity for long-term monitoring programmes of cetaceans (Wall *et al*., 2006). Ferries provide the opportunity to undertake repetitive surveys along a fixed line transect which can be conducted regularly throughout different years, providing, consequently, information on long-term populations pattern (MacLeod *et al*., 2007) and spatio-temporal relations with oceanographic features (Cottè *et al*., 2009).
In 2008 a network of research bodies joint together to monitor cetacean presence along the Central and Northern Tyrrhenian Sea and the Ligurian Sea. In this paper we present the results of weekly observations undertaken during summer 2008 along three ferry's routes.

MATERIALS AND METHODS From June to September 2008, weekly observations of cetacean were undertaken in "passing mode", using ferries as platform of opportunity for dedicated surveys as in Marini *et al*., (1997), along three "fixed line transect" (Fig. 1; Table 1):
A from Civitavecchia (Latium) to Golfo Aranci (Sardinia);
B from Livorno (Tuscany) to Bastia (Corsica);
C from Savona (Liguria) to Bastia.
The routes cover the Central and the Northern Tyrrhenian Sea and the Ligurian Sea. Two (B and C) out of the three routes are within the Pèlagos Sanctuary. Observations were undertaken in fine weather condition (Beaufort ≤ 3). Two or three trained observers were located on the two sides of the command deck of the ferry. Each observer focused primarily on a 90° arc ahead of the ship and continuously scanned the area by naked eye with occasional scan with binoculars. Binoculars and eventually photos were used to confirm sightings and assess species and group size. Data on radial distance and angle between the detected group and the track line were recorded, in order to apply distance sampling technique.
Each run was considered as an independent statistical unit. Correlation and autocorrelation (using Pearson coefficient) between outbound and return runs and between runs in the same direction were undertaken to assess independency of the data set.
Due to variation in visibility clearness during the survey (for changes in wind strength, rain or fog) and to rest intervals of the observers, the "on effort" was not continuous and differed according to the run. For this reason and due to the fact that, along the transect, sighting could be considered an event more than a state, relative abundance was measured as encounter rate (ER= number of sightings per hour spent in observation) (Evans and Hammond, 2004; Wall *et al*., 2006). Distance travelled was obtain by multiplying time spend "on effort" for the average cruise speed. We used identification at genera level for *Balaenoptera* spp. as, from the ferry, it was not always possible to

distinguish between the two Baleen whales species present in the Mediterranean region. We primarily analysed presence, ER, mean group size, distribution and relative abundance.
Distance Sampling parameters, using Distance 5.0 software, were also evaluated separately for each different types of ferries, due to differences in height and speed of the vessels. The aim of the analysis was to determine whether distance sampling techniques are applicable to this kind of platform of opportunity. Only species with minimum number of 5 sightings per route were analysed with Distance: *Stenella coeruleoalba* (*Sc*) for routes A, B and C and *Balaenoptera* spp. for route A. Density of *Stenella coeruleoalba* in the Pèlagos Sanctuary (B & C) and of *Sc* and *Balaenoptera* spp. in Tyrrhenian sea (A) were also estimated using Distance.
In addition, in order to verify potential relationship between naval traffic and cetacean presence, a preliminary study was undertaken along the three ferries routes. Regular scan samplings of the horizon, in absence and in presence of cetacean, were undertaken in order to quantify the number of ships (sailing boats, fishing boat, ferries, cargo etc) detectable from the observation platform. In absence of cetacean, scans were undertaken randomly at a minimum of 45 minutes or 10 NM. All records were grouped together and values of naval traffic gained from scans in absence (N=228) and in presence (N=64) of cetacean were compared with non-parametric statistical tests, assessing the probability (P) of the two median and of the two distribution frequency to be equal. Moreover, possible episodes of "ferry-whale" collisions were recorded.

Table 1 Routes length, cruising speed, number of runs, "on effort" and Encounter Rate.

Route	Period	Route lenght NM	Average speed KN	Average cruising time	# of runs	# hours "on effort"	# of NM "on effort"	# of sightings	Encounter rate	
									sightings per hour	sightings per NM
Civitavecchia – G. Aranci (A)	15/06 – 28/09	122,3	23,5	4,5	26	102,83	2.416,51	88	0,855	0,036
Livorno – Bastia (B)	04/06 – 02/10	65	17	3,3	30	93,4	1.587,80	22	0,235	0,013
Savona – Bastia (C)	07/06 – 26/09	109	17,6	4	26	104,16	1.833,2	54	0,518	0,029

RESULTS Along the three routes, in 82 runs (301 hours of survey effort), 164 sightings (763 individuals) of eight cetacean species were recorded. Mean ER was 0,51 sightings/hour (Table 1; Fig. 2). Eight species were sighted, of which only 4 were sighted more than twice: *Stenella coeruleoalba*, *Balaenoptera* spp., *Tursiops truncatus* (*Tt*) and *Ziphius cavirostris* (Table 2). The output of correlation between sightings of outbound and return runs was not different from the autocorrelation of runs in the same direction assessing the independency and consequent use of all the runs as statistical unit.

Table 2 Species sighted during the study: R = regular found according to IUCN Red List; 0 = no sightings; + = 1-2 sightings; X = more than 2 sightings.

		Summer 2008			Summer 1989-1991
		Savona–Bastia (C)	Livorno–Bastia (B)	Civitavecchia-G. Aranci (A)	Civitavecchia-G. Aranci (A)
R	*Balaenoptera spp*	+	X	X	X
R	*Globicephala melas*	+	0	0	0
R	*Grampus griseus*	+	0	0	+
R	*Physeter macrocephalus*	0	0	+	+
R	*Stenella coeruleoalba*	X	X	X	X
R	*Tursiops truncatus*	+	X	X	X
R	*Ziphius cavirostris*	X	0	+	X
R	*Delphinus delphis*	0	0	+	0

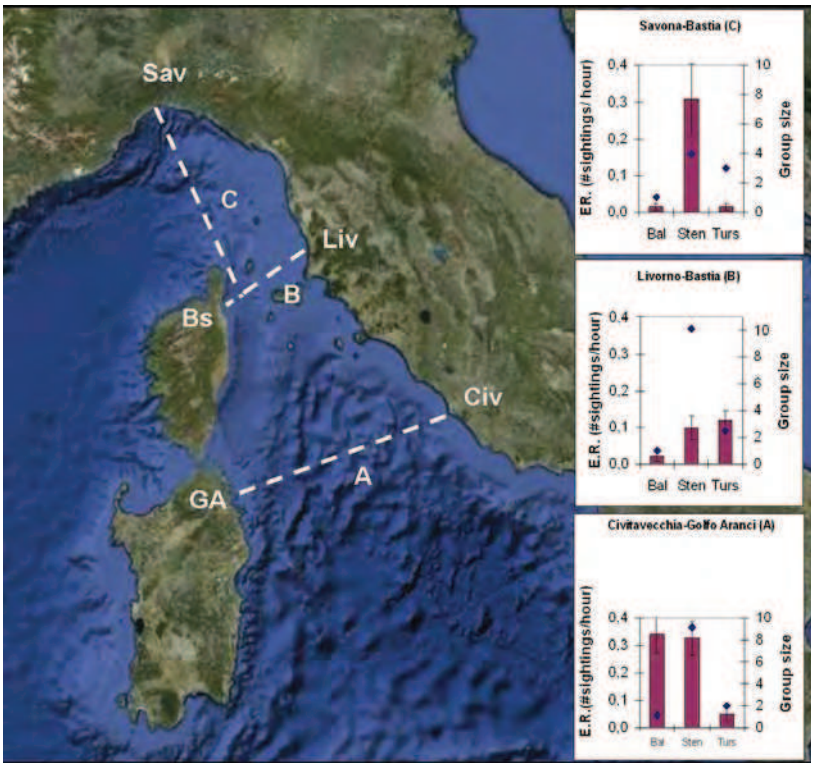

Fig. 1 Routes and summer mean Encounter Rate (bars) and Group size (dots) of the three species *Balaenoptera* spp., *Stenella coeruleoalba* and *Tursiops truncatus.* Sav=Savona; Liv= Livorno; Civ= Civitavecchia, Bs=Bastia; GA= Golfo Aranci.

Encounter rate As shown in Fig. 2, ER of *Balaenoptera* spp. was much higher along the central Tyrrhenian sea (0,34±0,07) compared to the Northern areas, with maximum in August (0,49±0,09) and June (0,43±0,20). *Sc* had a maximum in June in the Savona-Bastia route (0,63±0,26). Along the Livorno-Bastia route *Sc* had a general low ER while *Tursiops truncatus* was sighted more frequently than in the other areas (0,12±0,03) (Figs 1 & 2; Table 3).

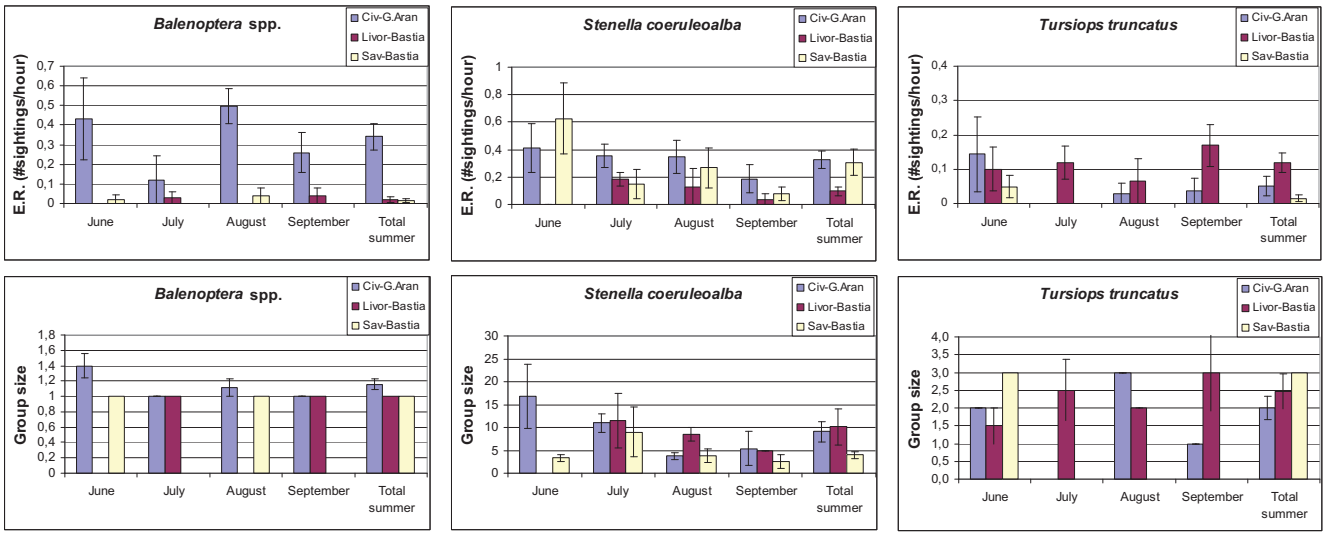

Fig. 2 Monthly encounter rate and group size of the three species *Balaenoptera* spp., *Stenella coeruleoalba* and *Tursiops truncatus* along the three routes.

Species presence and distribution As shown in Fig. 3 and Tables 2 & 3, sightings of *Balaenoptera* spp. were distributed mostly along the Central Tyrrhenian sea (route A) where most of the sightings were in a "corridor" located approx. between 30 and 70 NM from the Sardinian coastline, on bathymetry of 1.000-1.500 m. Few *Balaenoptera* spp. were sighted along the

continental shelf of Tuscany, between Livorno and Capraia Island (route B). As expected, *Stenella coeruleoalba* is distributed mostly in deep sea water along the all routes, even if some animals were sighted along the continental shelf of Latium and Tuscany (routes A and B). Group size of *Sc* sighted along the C route is smaller, except in the month of July, compared to the other two routes. *Tursiops truncatus* was distributed along the continental shelf, at the beginning and the end of the three routes and near Capraia Island. In spring, however, *Tt* was sighted along the all length of route B (Muzi, 2008).

Fig. 3 Distribution of *Balaenoptera* spp., *Stenella coeruleoalba* and *Tursiops truncatus*

Abundance ESW (Effective Stripe Width) is the most important parameter as it indicates the effectiveness of the platform for observing the species. Distance Sampling parameters calculated for *Sc* show great differences among different vessels. Savona low value of ESW could be explained by the lower average cluster size.
Distance Sampling parameters calculated for *Balaenoptera* spp. demonstrate that data coming from the two different vessel operating in the same area (A) can be pooled, as there are no significant differences in ESW. Highest values of density of *Stenella coeruleoalba* have been recorded in the Savona – Bastia transect, while density of *Balaenoptera* spp. is higher outside Pèlagos boundaries.

Table 3 *Stenella coeruleoalba* and *Balaenoptera* spp.; # = number of sightings, MW = maximum perpendicular distance of sighting, ESW = effective strip width, density.

		Stenella coeruleoalba				*Balaenoptera* spp			
	Ferry	#	M W	ESW	Density	#	M W	ESW	Density
Central Tyrrhenian (A)	Mega	14	2484,7	1026,60	0,2210 cv (0,0653-0,7444)	20	4254,5	1536, 7	0,010 cv (0.0063 0.0161)
Civitavecchia – G. Aranci	Smeralda	19	894,0	242,13	0,2412 cv (0,0993–0,5857)	18	2978,2	1707,80	
Pèlagos Livorno – Bastia (B)	Shuttle	9	1609,0	542,99	0,0696 cv (0,0171-0,2827)				0,000693 cv (0,00024-0,00198)
Pèlagos Savona – Bastia (C)	Cruise	37	2127,3	487,43	0,2682 cv (0,1305-0,5511)				

Nautical traffic During regular scan sampling of the horizon, the output showed a mean of 4.62 ships and a median of 2; in presence of cetacean there was a mean of 1.55 ships and a median of 1. Both statistical test, reject the null hypothesis that the two groups have respectively the same median ($P<0.0001$) and the same distribution frequency ($P<0.01$). No Ferry-whale collisions, or near collision, were recorded in a total of 7963 NM travelled.

DISCUSSION Encounter rate and density results are consistent. Density values, as well as encounter rate for *Stenella coeruleoalba* agree with what expected considering the topography of the track line of the routes. Along the Livorno–Bastia transect (B), for example, most of the sightings occurred on the continental shelf, thus explaining lower density values respect the other two routes. The distribution of *Tt* along the all transect B only during spring, could reflect a seasonal distribution of prey or could be explained by the high male travelling activity during breeding season.
Results of *Balaenoptera* spp. showed differences, along the routes, between the Pèlagos area and the Central Tyrrhenian sea; the species was sighted much more outside the Pèlagos boundaries during the investigated period. This could be explained by the fact that the two 'Pelagos transects'

(Savona-Bastia and Livorno-Bastia) mostly occur within the 1000 m depth contour, while *Balaenoptera* spp habitat in the Liguro-Provencal basin is known to be characterized by depths of more than 2000 m (Aissi *et al*., 2008). However, *Balaenoptera* spp. along the Livorno–Bastia route was sighted only along the continental shelf. According to Agnesi *et al*. (2007) data on nautical traffic indicate a maximum presence of vessel along the route of Savona-Bastia and in the area between Capraia Island and Corsica. This can be one of the reasons that may explain the low presence of *Balaenoptera* spp. along the Savona-Bastia transect and the preference of the species for the area on the continental shelf along the Livorno-Bastia transect, where nautical traffic is less intense. It needs to be taken into account, however, the fact that encounter rate of *Balaenoptera* spp. along the B route was higher in spring compared to summer 2008 (Muzi, 2009). In addition, the area with highest *Balaenoptera* spp. ER, located east of the Sardinian coastline, is distinguished by a local high primary production zone (MODIS) in accordance with the theory that food availability is one of the mail factor driving cetacean distribution.

Scan sampling of the horizon during cetacean sightings detected a lower average of boats compared to regular scan sampling in absence of animals. Number of boats was influenced by the high number of medium size boats detected along the Livorno-Bastia route. Given the small number of sampling, however, we should be very cautious in interpreting these results. High density values of *Balaenoptera* spp. recorded in a district (A) lacking of protection for marine mammals and along common ship routes, points out the need for further investigations in order to mitigate the risk of collisions with a "voluntary code of conduct" that should be adopted by the shipping industry to reduce cruise speed, especially under poor visibility, in areas and periods with high encounter rate (Arcangeli *et al*. 2008), as well as re-locating ferry routes to areas of lower cetacean density. These actions appear to be very urgent since it is predicted that in the next few years marine mobility will greatly increase due to short sea shipping and the development of the motorways of the sea (Lucchesi 2004; COM (2009) 8).

These results highlight the need of standardize large scale and long term monitoring programmes in order to detect variation on presence, abundance and distribution of cetacean populations and understand the effect of environmental and anthropogenic factors. If used with a standardize protocol and trained observers, ferries would be an efficient and cost effective platform of opportunity for long term and large scale monitoring programmes of cetaceans.

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